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APPENDIX H

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STOCKLANDS

Sector 9 - Warriewood Valley

Stormwater Management Report, Rezoning Stage

7555 – Sector 9 – Warriewood Valley, Stormwater Management Report, Rezoning Stage

27 October 2008

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STOCKLANDS
SECTOR 9 - WARRIEWOOD VALLEY
STORMWATER MANAGEMENT REPORT, REZONING STAGE

Disclaimer

PROJECT 7555 - SECTOR 9 - WARRIEWOOD VALLEY

REV	DESCRIPTION	ORIG	REVIEW	WORLEY-PARSONS APPROVAL	DATE	CLIENT APPROVAL	DATE
A	Draft issued for internal review	JNH	MS	MS	17/10/2008	N/A	
B	Final	JNH	MS	MS	27/10/2008		

CONTENTS

1. EXECUTIVE SUMMARY

The proposed development is located on the corner of Orchard and Garden Street, Warriewood. The site consist of multiple land owners incorporating lots 206, 204 Garden Street, lots 2, 12, 14 Orchard Street, lots 1, 2, 4, 5, 9, 10 Fern Creek Road and portions of Lots 11, 12, 13 Warriewood Road. The site is proposed to be rezoned and developed for low to medium density residential use.

It is understood that the site is currently zoned as Non-Urban (B). Council recognises the site as Sector 9 and is included within the Warriewood Valley Urban Release Area. Sector 9 has a total area of approximately 17.1 ha, of which approximately 16.6 ha could be developed. The sector has a frontage along Garden Street to the east, Orchard Street to the south, adjoining protected and recreational land to the west and Fern Creek to the North. Fern Creek Road forms part of the development.

A layout of the proposed development is illustrated in **Appendix A**. The works will involve subdivision of the proposed sites into lots of low and medium density housing with open spaces to the north and west of the site, and wide vegetated buffer and core riparian zone along Fern Creek.

This document has been produced to comply with Pittwater Council's guideline titled "*Warriewood Valley Urban Land Release – Water Management Specifications (WMS)*".

The proposed water management strategy for the development will see the implementation of rainwater tanks collecting roof runoff and reused for non-potable uses. Each lot within the development will have a minimum 3kL rainwater tank collecting roof runoff for reuse with overflow from the rainwater tanks being piped into the stormwater drainage network within the roads.

A majority of the surface runoff from the front yards from each of the lots and the roads will be diverted into bio-retention swales located within the road reserve of all the roads (excluding laneways and steep sections of Fern Creek Road). These swales will act as source control pollutant treatment for surface runoff. All runoff collected in the swales will be allowed to infiltrate into the ground, with the remaining runoff piped into the stormwater drainage network.

The majority of the sites stormwater runoff will be piped and diverted to the detention basins located at the downslope ends of each of the drainage systems within the site via a gross pollutant trap (GPT) and treated in these two devices before being discharged into Fern Creek.

In total, three detention basins have been proposed for the development. A large detention/infiltration basin, Basin 1, would be located towards the north of the site, while two smaller detention/bio-retention basins, Basin 2 and 3, would be located along Garden Street. The three proposed basins have a total detention capacity of approximately 5,700 m^3.

The three basins would perform a dual function of both stormwater treatment and detention. A 1 m deep subsoil infiltration medium would sit below the detention component of the basins, and would provide additional stormwater treatment to the proposed stormwater treatment train.

The three basins will be sized and constructed with the same design principles proposed and constructed in the adjoining Sector 8.

To assist with the overall detention strategy for the site (particularly for those lots that cannot drain to the 3 major detention basins), selected lots within the south east half of the site will have On-Site Detention (OSD). Approximately 70 lots will have an underground detention tank approximately 20 ~ 25 m^3. The onsite detention tanks would collect runoff from these lots and overflows from rainwater tanks before being discharged into the piped drainage system.

The total stormwater detention volume proposed is 7,200 m^3. Hence a stormwater detention storage is proposed at the rate of 420m^3/ha, to mitigate localised increases in peak flow rates exiting the site. The proposed storage rate exceeds the detention rate of 368 m^3/ha required by Council's WMS.

Four GPT's will be located across the development. Three of the GPT's will be located along the edges of Fern Creek with the final GPT located at the intersection of Orchard and Garden Street. All are located near the main stormwater outlets from the site.

The proposed stormwater treatment train has been modelled to predict the impacts of the proposed development on water quality to the surrounding areas. The assessment found that the impacts of the proposed development with the proposed stormwater treatment train would not have a net increase in pollutants compared to pre developed conditions. The assessment has found that the proposed treatment train would improve on pre developed conditions.

Hydraulic and hydrologic investigations have been conducted to predict the impacts of the proposed development on the water quantity upon surrounding areas.

The assessment has found that the proposed stormwater management plan would not have a detrimental affect on peak discharge flows up to the 100 year ARI storm event, nor will the development have any negative implications on the flooding of Fern Creek as the proposed development sits yell beyond the PMF flood extent.

Pre construction water quality monitoring has been undertaken during this rezoning process of the site. To date, two dry weather samples have been collected and recorded as part of the rezoning process. The result from the two dry events have shown that all detectable pollutants are generally within Councils long term trigger values for all site locations.

Water quality monitoring will continue within the next 6 month and reported to Council as an addendum to this report. Further monitoring will be initiated at Development and Constructiong application stage.

The stormwater management system proposed meets all the requirements of Councils WMS and ensures no impact to the site and surrounding areas.

2. INTRODUCTION

WorleyParsons have been engaged by Stocklands to prepare a stormwater management report to support the submission of the rezoning application of the proposed development of Sector 9, Warriewood. The report provides details on how the site stormwater is proposed to be managed in accordance with Pittwater Council's guidelines titled "*Warriewood Valley Urban Land Release – Water Management Specifications (WMS)*", (February, 2001).

This current report is for the Rezoning Application stage.

The proposed site is located on Fern Creek Road, Warriewood. The site consists of multiple lots owned between Stocklands, Australand and private land owners (incorporating lots 206, 204 Garden Street, lots 2, 12, 14 Orchard Street, lots 1, 2, 4, 5, 9, 10 Fern Creek Road and Lots 11, 12, 13 of Sector 8, Warriewood Road). It is understood that the site is currently zoned as Non-Urban (B). Sector 9 has a total site area of approximately 17.1 ha, with the total area of the proposed site to be developed approximately 16.6 ha.

Council recognises the site as Sector 9 which is included within the Warriewood Valley Urban Release Area. The sector has a frontage to Garden Street to the east, Orchard Street to the south, adjoining protected and recreational land to the west and Fern Creek to the North.

A completed copy of the "*Rezoning Application Stage Documentation Checklist*", confirming that all tasks required by Council's WMS have been undertaken, is found in **Appendix B**.

2.1 Certification

The contents of this report are certified by Michael Shaw, who is a registered NPER engineer with the Institution of Engineers, to comply with the requirements of Pittwater Council's WMS (February 2001).

3. EXISTING SITE CONDITIONS

The existing site is largely undeveloped, with the exception 10 single dwelling houses, driveways, carparks etc. within privately owned parcels of land. The remainder of the site is currently used for non-residential uses, and it is understood that in the past the site was previously used for both grazing and horticultural purposes. The majority of the site is covered with low lying grass, shrubs to the north and dense vegetation to the west.

A plan illustrating the location of the site and the site boundary is shown in **Figure 1**.

Figure 1 – Plan of Site

3.1 Existing Topography

The topography of the sector is dominated by the feature known as "Hack Hill" located towards the south west of the sector, which although relatively flat on top, has steep to moderate side slopes before transitioning to the more gentle slopes to the north and east. The levels of the existing topography of the site range from RL 60 m AHD at the south west end of the site and RL 12m AHD to the north west at Fern Creek. The vectored average slope for the site as a whole was calculated to be approximately 9%, with maximum slope reaching approximately 25% towards the hill in the south west corner of the site.

3.2 Existing Geotechnical Conditions

A detailed assessment of the existing geological conditions of the site has not yet been conducted at this stage of the rezoning process.

GeoEnviro previously conducted a geological assessment of the neighbouring Sector 8. The findings from the assessment are expected to be similar and are summarised below.

- That "*the site is generally underlain by sandy profile with variable relative density at the upper 2.0m ranging from very loose to medium dense. The sub-surface profile was found to be more clayey at lower depths. The investigation infers medium dense sand or very stiff clay at lower depth*" GeoEnviro July 2000;
- The "*natural soil beneath the fill and topsoil was found to consist predominantly of sand and silty clayey sand*" GeoEnviro July 2002;
- "*Some ground water seepage was encountered … at depths ranging from 1.4m to 3.3m*" GeoEnviro July 2002;
- The calculated permeability rates for the natural soil encountered on site ranged from 90mm/h for the sands to 2.9mm/h for the silty clay sand/sandy clays, with an average infiltration rate of 34.7mm/h (*83.4cm/d*) and median value of 25.6mm/h(*61.3cm/d*) (*GeoEnviro July 2002*).; and
- "*Based on the laboratory test results, potential acid sulphate soil or acid sulphate soil was not encountered. As the results of the analysis were below the ASSMAC action criteria, an acid sulphate management plan is not required*" GeoEnviro July 2002.

It is understood that the site specific geotechnical information would be collected for Sector 9 once it is rezoned.

3.3 Existing Sub Catchments

The existing sub-catchment boundaries were defined based on review of orthophoto maps and preliminary survey data. This information shows an external sub-catchment with an approximate area of 10.2 ha draining directly into the proposed site. The external sub-catchment makes up a portion of the environmentally protected land from the west, and would deliver flows but would contribute little to no pollutants to the proposed development.

Currently the existing site drains into 3 sub-catchments; Sub-catchment A, which drains to the north towards Fern Creek; Sub-catchment B, which also drains towards Fern Creek to the north east, and Sub-catchment C, which drains to the south towards Orchard Street.

The existing sub-catchments of the proposed site is illustrated in **Figure 2**.

Figure 2 – Existing Site Sub Catchments

3.4 Proposed Sub Catchments

All sub-catchments outside of the site were assumed to remain as they do under existing conditions.

The physical properties of the sub-catchments will alter both in its grading/levels and impervious fraction. Council's DCP allows a maximum impervious fraction of 50% across the sector. As part of this investigation, a conservative approach will be adopted using the maximum impervious fraction applied on all developed areas allowed by Council.

3.5 Riparian Corridor

The layout of the proposed development has been designed to comply with Councils' WMS (2001) requirements for a minimum average core riparian zone width of 25 m from the centreline of Fern Creek and a public vegetated buffer zone of an additional 25 m. It should be noted that in some areas fronting the development, the vegetated buffer zone would be extended to the full 50 m.

The primary objective of the vegetated buffer zone is to enhance the natural creek line and to form a natural riparian channel within a vegetated floodplain. It is understood that the vegetated buffer zone can also act as an open space corridor and allows for vehicle access for maintenance and monitoring.

We confirm that an average 25 m width is achieved across the site frontage, free of development and water management devices.

4. PROPOSED DEVELOPMENT

The proposed masterplan of the development is shown in **Appendix A**.

The overall site will allow for a total of 203 new dwellings comprising of low and medium density residential lots. 3kL rainwater tanks will be implemented on each of these lots. Water will be reused from the rainwater tanks for internal and external non-potable uses.

Open park spaces have been proposed within the western section of the site as well as towards the north, while a generous core riparian and buffer zone have been provided along Fern Creek, easily providing an average buffer width of over 25 m.

Approximately 2.6 km of roads and lane ways have been proposed for the development, with minor modifications to the existing Fern Creek Road.

The current masterplan layout shows that no developments works are proposed within the flood affected areas of Fern Creek (refer **Section 9**).

During the construction of the development, a number of water management devices (swales, GPTs and detention basins) and associated services would be installed, while the vegetated buffer would be revegetated with native plants in accordance with the requirements of Councils WMS as part of the development to naturally enhance the aesthetics and the health of the riparian corridor.

4.1 Site Regrading

It is anticipated that some minor fill and site regrading works would be undertaken as development occurs. At the rezoning stage of this report, a detailed regrading plan has not yet been provided.

Currently, the majority of the overland flows fall to the north east of the site and drain towards Fern Creek with an average vectored slope of 9%. Following the development, it is proposed that flows from upstream would continue north into Fern Creek with the majority of the catchment diverted into the proposed detention basin before discharging into Fern Creek.

Overland flows from the smaller catchment, falls to the south east of the site towards Orchard and Garden Street with an average vectored slope of 11%. Following the development, it is proposed that flows from upstream would continue toward the south east with majority of the catchment diverted into the detention basin located on the corner of Orchard and Garden Street before being piped and discharged into Council's existing stormwater network.

Any regrading should continue to promote surface and piped flows towards the proposed GPTs and detention basins. The regrading aims to safely convey overland flows through the development and to encourage longer detention times for improved water quality treatment and runoff quantity.

It is unlikely that the proposed layout will require any retaining structures.

All bulk earthworks will ensure no net loss of flood storage within the 25~50 m riparian buffer zone.

The existing sub-catchment division of 13.2 ha to Fern Creek and 3.4 ha to Orchard Street will generally remain the same.

5. STORMWATER QUANTITY MANAGEMENT

The integrated strategy proposed for management of stormwater quantity at the proposed site comprises of the following:

- 3kL rainwater tanks to be installed on each of the proposed lots (639 m^3 in total, of which 50% is counted as effective OSD storage – 320 m^3) to reduce runoff volume, maximise non-potable supply/re-use and minimise peak flows for frequent storm events;
- Underground detention tanks would be installed on approximately 70 lots located within the southern and eastern catchments of the development. Average tank size is 20 to 25 m^3 (total storage of approximately 1,500 m^3). The OSD tanks will directly reduce peak runoff rates for all storm events; and
- Three detention basins are proposed across the site (1 detention/infiltration basin and 2 detention/bio-retention basins). The basin offers a total above and below ground detention storage volume of 5,700 m^3. The basins will directly reduce peak runoff rates for all storm events.

The total stormwater detention volume proposed is 7,200 m^3. Hence, a stormwater detention storage is proposed at the rate of 420m^3/ha, to mitigate localised increases in peak flow rates exiting the site. The proposed storage rate exceeds the detention rate of 368 m^3/ha required by Council's WMS.

5.1 On-Site Detention Vs Centralised Detention System

The stormwater quantity management plan consists of 70 lots that would have OSD tanks ranging between 20~25 m^3 and three detention/infiltration basins will have a total detention capacity of approximately 5,700 m^3.

If the management plan relied solely on OSD tanks, each of the 70 lots would require much larger tanks approximately 40 m^3 in storage each.

The management plan cannot rely solely on a centralised detention system as detention volumes are limited by the availability of open space within the catchments.

The proposed stormwater quantity management plan has incorporated a combination of OSD tanks and a centralised detention/infiltration basin to optimise the available open space and yield of the development.

5.2 Hydrology

5.2.1 RAFTS

XP-RAFTS was used to model the hydrology of the site and its sub-catchments. For the purposes of this study the 5yr, 20yr, 100 yr ARI design storm events and the Probable Maximum Flood (PMF) were investigated.

The XP-RAFTS software package was used to simulate the rainfall/runoff process and estimate hydographs at defined points in the catchment for the different rainfall events.

The catchment for this study was made up of several sub-catchments. Data required for each sub-catchment includes the catchment area, slope, percentage of impervious surfaces, rainfall loss rates and a surface roughness factor. The hydrographs generated for the catchment outlet is then routed through the channel network to the catchment outlet. The XP-RAFTS model has been used extensively by authorities throughout Australia on both rural and urban catchments.

The XP-RAFTS model is capable of separately routing the impervious and pervious sections of each sub-catchment, which is appropriate when modelling runoff from urban areas. The model is also capable of routing flows through a storage (eg retarding basins, dams) to assess the flood mitigation benefits downstream of the storage.

5.2.2 Pre-Development Conditions RAFTS Modelling

The sub-catchment characteristics adopted in the RAFTS model under pre-development conditions were based on site inspections, site survey, review of background information and Councils WMS.

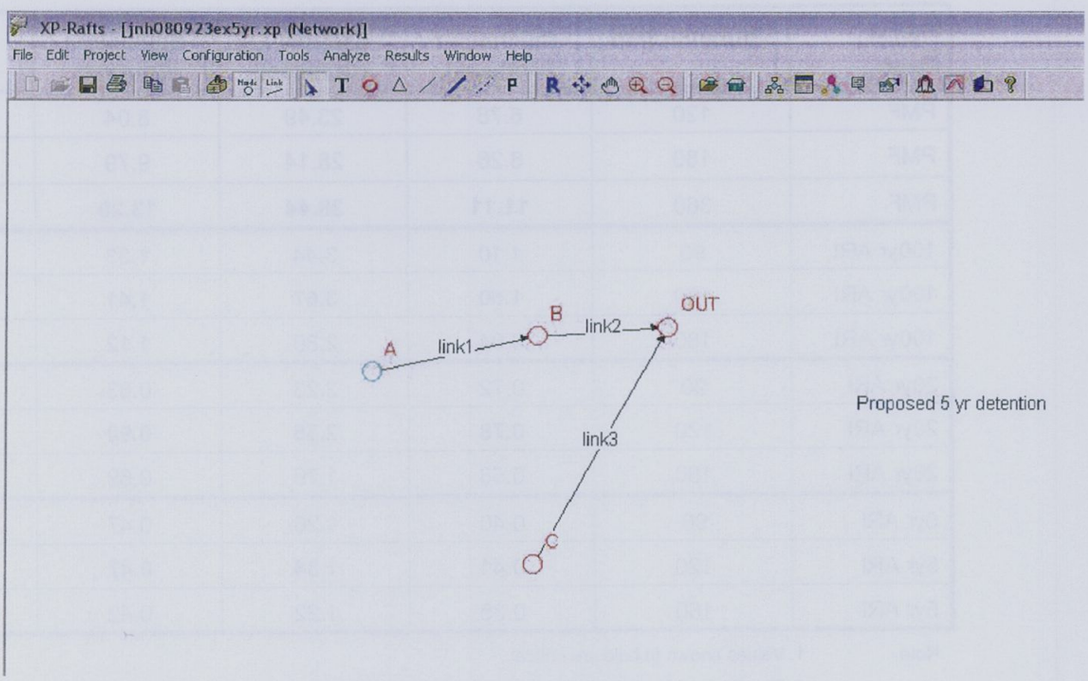
A summary of the adopted catchment characteristics is included in **Table 5-1**.

Table 5-1 – Pre-development Sub Catchment Characteristics

Parameters	Sub Catchment A	Sub Catchment B	Sub Catchment C
Catchment Area	3.565	9.701	3.421
Vectored Average Slope (%)	9	9	11
Impervious Fraction (%)	5	5	10
Pervious Mannings "n"	0.07	0.07	0.07
Impervious Mannings "n"	0.015	0.015	0.015

A RAFTS network was constructed to represent the site and upstream catchments under existing conditions as illustrated in **Figure 3**.

Figure 3 – Pre-development Conditions RAFTS Network



The rainfall losses adopted in all RAFTS modelling are shown in **Table 5-2**.

Table 5-2 – Adopted Rainfall Losses

Surface	Initial Loss	Continuing Loss
Pervious (Pre dev)	30 mm	2 mm
Pervious (Post dev)	10 mm	1.5 mm
Impervious (Pre and post dev)	5 mm	0 mm

The results of the pre-development conditions RAFTS model are summarised in **Table 5-3**.

Table 5-3 – Pre-development Condition RAFTS Results

Storm Event	Duration (min)	Catchment A (Cumecs)	Catchment B (Cumecs)	Catchment C (Cumecs)	Outlet (Cumecs)
PMF	120	6.78	23.49	8.04	31.46
PMF	180	8.26	28.14	9.79	37.82
PMF	360	**11.11**	**38.44**	**13.20**	**54.41**
100yr ARI	90	1.10	3.44	1.33	4.62
100yr ARI	120	**1.50**	**3.67**	**1.41**	**4.92**
100yr ARI	180	0.94	2.80	1.12	3.92
20yr ARI	90	0.72	2.23	0.83	2.98
20yr ARI	120	**0.78**	**2.35**	**0.90**	**3.13**
20yr ARI	180	0.58	1.79	0.69	2.45
5yr ARI	90	0.40	1.26	0.47	1.69
5yr ARI	120	**0.41**	**1.34**	**0.47**	**1.80**
5yr ARI	180	0.35	1.22	0.42	1.65

Note 1. Values shown in bold are critical

2. Two decimal reporting is for comparison purposes only

The RAFTS results show that under pre-development conditions the critical storm duration is generally around 120 min and the total flow discharged from the site under a 100yr ARI storm event is 4.9 m^3/s.

5.2.3 Proposed Conditions RAFTS Modelling without Detention

To assess the impact of modifying the exiting landuse of the site, a proposed condition RAFTS model without detention was constructed.

The site catchment was assumed to be 50% impervious, and changes to the loss parameters were made in accordance with Councils WMS. Sub-catchment areas were modified and further broken down to reflect the direction of flow under proposed conditions.

The results of the proposed conditions without detention RAFTS models is summarised in **Table 5-4**.

Table 5-4 – Proposed Condition without Detention RAFTS Results

Storm Event	Duration (mm)	Catchment A (Cumecs)	Catchment B (Cumecs)	Catchment C (Cumecs)	Outlet (Cumecs)
PMF	120	19.37	30.45	5.74	35.91
PMF	180	23.86	37.81	6.51	44.32
PMF	360	**30.32**	**47.65**	**8.11**	**55.77**
100yr ARI	60	5.00	7.90	1.63	9.47
100yr ARI	90	**5.36**	**8.57**	**1.72**	**10.06**
100yr ARI	120	4.88	7.68	1.64	9.20
20yr ARI	90	3.88	6.14	1.32	7.39
20yr ARI	120	**4.23**	**6.72**	**1.40**	**8.04**
20yr ARI	180	3.88	6.10	1.33	7.31
5yr ARI	90	2.79	4.40	0.98	5.33
5yr ARI	120	**3.13**	**4.97**	**1.05**	**5.96**
5yr ARI	180	2.83	4.51	1.00	5.41

Note 1. Values shown in bold are critical

2. Two decimal reporting is for comparison purposes only

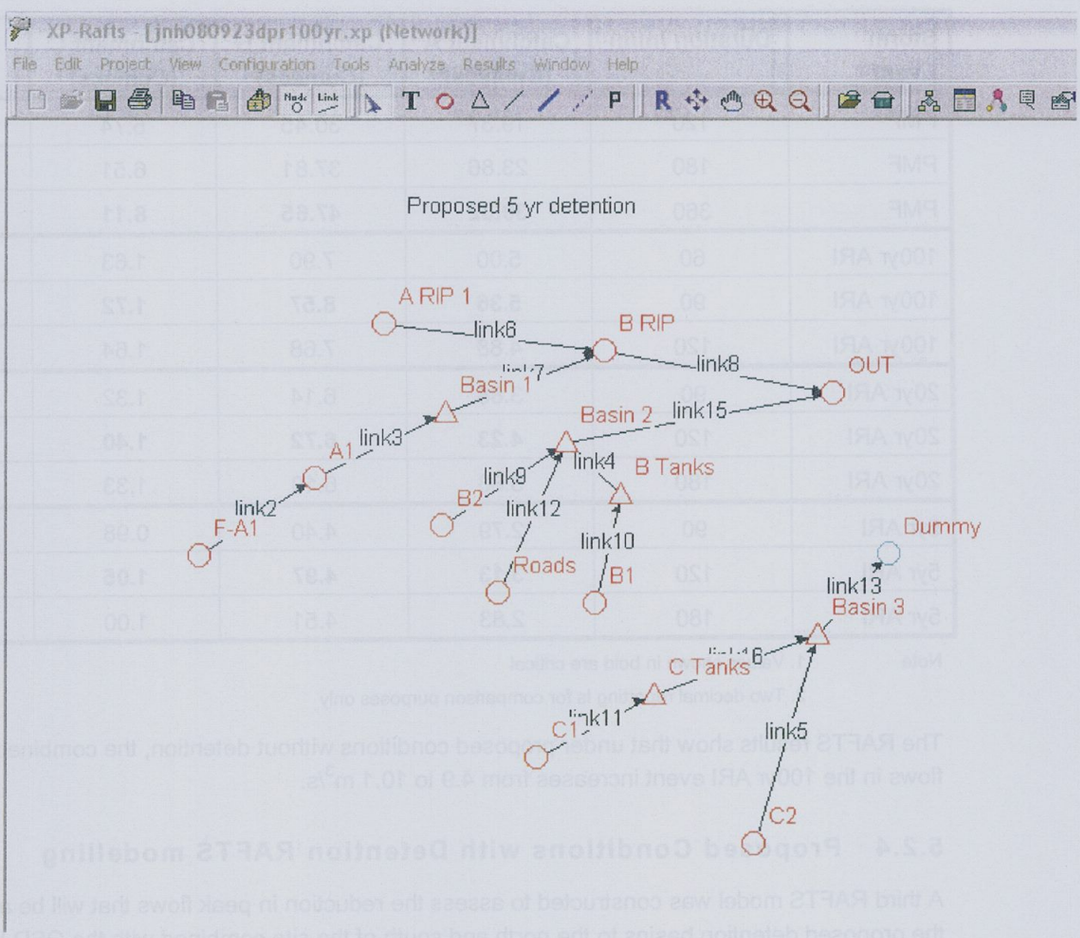
The RAFTS results show that under proposed conditions without detention, the combined total peak flows in the 100yr ARI event increases from 4.9 to 10.1 m^3/s.

5.2.4 Proposed Conditions with Detention RAFTS modelling

A third RAFTS model was constructed to assess the reduction in peak flows that will be achieved with the proposed detention basins to the north and south of the site combined with the OSD tanks located on the south east half of the site. Note at this stage for conservatism the impact of proposed rainwater tanks and other stormwater management measures that contain a detention component have not been modelled.

A RAFTS network was constructed to represent the site and upstream catchments under proposed conditions incorporating the onsite detention basin as shown in **Figure 4**.

Figure 4 – Proposed Conditions with Detention RAFTS network



Pittwater Council's WMS recommends the following detention parameters for Sector 9.

- Minimum detention volume, 368 m^3/ha = 6,300 m^3 for a 17.1 ha site; and
- 100yr ARI permitted site discharge (120min – critical), 202 L/s/ha = 3.45 m^3/s for a 17.1 ha site.

This combination of PSD and storage volume was applied in RAFTS as a single storage node downstream of subcatchment A, B and C. The results of this detention stage model are contained in **Table 5-5** and detailed at **Appendix C**.

Table 5-5 – Proposed Condition (With Detention) RAFTS Results

Storm Event	Duration (mm)	Catchment A (Cumecs)	Catchment B (Cumecs)	Catchment C (Cumecs)	Outlet (Cumecs)
PMF ARI	120	20.24	25.52	3.85	28.79
PMF ARI	180	24.85	30.04	4.99	34.29
PMF ARI	360	**32.12**	**40.64**	**6.95**	**45.84**
100yr ARI	90	2.40	3.09	0.41	3.43
100yr ARI	120	**2.49**	**3.23**	**0.48**	**3.59**
100yr ARI	180	2.08	2.64	0.44	2.94
20yr ARI	90	1.63	2.16	0.35	2.43
20yr ARI	120	**1.72**	**2.26**	**0.36**	**2.43**
20yr ARI	180	1.43	1.88	0.33	2.13
5yr ARI	90	1.17	1.55	0.25	1.74
5yr ARI	120	**1.23**	**1.61**	**0.26**	**1.79**
5yr ARI	180	1.02	1.34	0.25	1.58

Note 1. Values shown in bold are critical

2. Two decimal reporting is for comparison purposes only

The RAFTS results illustrated in **Table 5-5** show that with detention, the combined total peak flow in the 100yr ARI event under proposed conditions is brought back from 10.1 m^3/s down to 3.6 m^3/s which is less than the pre development conditions flow of 4.9 m^3/s. A similar result is achieved for all storms with all post development flows (*ie incorporating* detention) being less than those under existing conditions.

5.3 Stormwater Detention System Description

The proposed rainwater tanks on site are the first component of the proposed detention system and will assist in reduction of peak flow rates for the more frequent events. Studies (*Coombes et al*) indicate that approximately 50% of the total volume of large rainwater tanks is available as effective detention storage. The total storage proposed is 639 m^3, comprising of 3kL tanks per lot. Hence, the effective detention storage is estimated to be around 320 m^3.

A detention volume is also available for the less frequent events in the roadways due to their proposed conveyance characteristics. Conservatively this volume has not been accounted for at this preliminary stage.

The main detention features for Sector 9 will be three large above ground basins. The three basins would perform a dual function of both stormwater treatment and detention. Basins 1, 2 and 3 would treat Sub-catchment A, B and C respectively and would comprise of both above and below ground

water storage. Stormwater treatment in the basins would be provided by infiltration through a filter media layer beneath the storage volume, with additional treatment in Basins 2 and 3 which will have macrophytes planted within the basins (ie bio-retention basin).

A volume of storage beneath the basin in the filter medium has been calculated with the adoption of a single large grade aggregate. A void ratio of approximately 0.3 was adopted.

Basin 1, the detention/infiltration basin, is located towards the north end of Fern Creek Road and will have both above ground and below ground water storage zones. The basin will have a surface area of approximately 3,200m^2, and will be sized to detain minor flood events below ground in "Atlantis Cells" and moderate to large flood events above ground. Stored water would then be slowly released via an infiltration media before being piped into Fern Creek.

Basin 1 would be designed to look like an open park with flood levels rising within the park during moderate to large storm events. The basin would dip approximately 1.3 m below the road reserve and would have a minimum 1(V):6(H) grassed batter slopes to match with the vegetated buffer zone of Fern Creek.

Basin 2, a detention/bio-retention basin, is located towards the north east corner of the site, within the vegetated buffer zone of Fern Creek, fronting Garden Street. Basin 2 will cover a surface area of approximately 600 m^2, and will only have a total above and below ground detention capacity of approximately 710 m^3. The basin would dip approximately 0.5 m below the road reserve and would have a minimum 1(V):3(H) grassed batter slopes and would be planted out with macrophytes.

Basin 3, the final detention/bio-retention basin, is located towards the south east corner of the site, on the corner of Orchard Street and Garden Street. With a surface area of approximate 300 m^2, Basin 3 will also have a total above and below ground detention capacity of approximately 590 m^3. The basin would dip approximately 1 m below the road reserve and would have a minimum 1(V):3(H) grassed batter slopes and planted out with macrophytes.

Layout and cross sections of the proposed basin is shown in **Appendix D**.

A summary of the detention storage within the three basins are shown in **Table 6**.

Table 6 – Summary of Detention Storage within the Three Basins

	Basin 1	Basin 2	Basin 3	TOTAL	Pond depth
Above Ground Storage	1,840 m^3	300 m^3	300 m^3	**2,440 m^3**	1 m
Below Ground Storage	1,600 m^3	230 m^3	200 m^3	**2,030 m^3**	0.5 m
Filter Medium Storage	960 m^3	180 m^3	90 m^3	**1,230 m^3**	1 m
TOTAL	**4,400 m^3**	**710 m^3**	**590 m^3**	**5,700 m^3**	-

Overflows from the rainwater tanks, landscaped areas to the north and the remaining carpark/driveways of the proposed buildings will drain to corresponding basins. Discharge control will be achieved via outlet pits with orifice plates before being discharged into Fern Creek.

The major contributor to detention storage for the site is from the proposed above and below the ground water storage within the three basins. In total the basin will hold 5,700 m^3 of runoff which will retain and control peak discharge for the 100 year ARI storm event.

To assist with detention within Sub-catchments B and C, 70 lots will implement OSD tanks. These tanks would be approximately 20~25 m^3 and would sit below ground. These tanks are required to supplement Basins 2 and 3 where detention volume is limited by site constraints and unavailable opens space for a single centralised detention system.

Overall, the development will supply a total of 7,200 m^3 of detention which is provided by the bio retention basin and the rainwater tanks. This equates to a total of 420 m^3/ha, which exceeds councils minimum requirements of 368 m^3/ha. RAFTS modelling shows that implementation of the above detention measures reduces all flows below pre developed conditions.

Whilst the volume within the proposed piped drainage systems is not considered effective detention volume for events up to the 100yr ARI event, this volume does become effective when the piped drainage system capacity is exceeded (*ie larger events such as the 100yr ARI*). Conservatively this volume has not been accounted for at this preliminary stage.

5.4 Flood Flow Gauging

No flood flow gauging has been undertaken to date. Note that it is proposed that limited flood depth and flow velocity readings will be undertaken if possible as part of the water quality monitoring programme (*ie during large wet weather events*).

6. WATER QUALITY MONITORING

6.1 Monitoring plan objectives

Prior to development of the site, a monitoring plan has been developed in accordance with Councils Water Management Specification (February 2001) and AS/NZ 5667.6: 1998 *"Water Quality Sampling – Guidance on Sampling of Rivers and Streams"*.

The objectives of the monitoring plan are to:-

- development an understanding of the existing conditions present in the waterways of Sector 9;
- continually assess the quality of these waterways during the construction phase of Sector 9; and
- assess the impact of constructed water quality measures following construction (ie compared with existing baseline data) to ensure the development is not causing a water quality impact.

Monitoring undertaken prior to the development of the site will be used to establish the present quality of the waterways within the site (termed "baseline data"). This data will be compared with future results to determine whether pollution controls are operating adequately and if the water quality is satisfactory.

During the development stage of the site, implementation of the monitoring plan will also allow early detection of any adverse impacts likely to risk the health of the public or the quality of receiving waters.

This Rezoning stage report includes preliminary sampling results will be supplemented with more results over the next 6 months submitted as addenda to this report.

6.2 Scope of monitoring plan

The majority of the site currently drains to Fern Creek, with a minor catchment draining towards Orchard and Garden Street. Under proposed conditions this situation is proposed to be maintained.

An external catchment with an approximate area of 10.2 ha drains directly into the proposed site and into Fern Creek. The external catchment makes up a portion of the environmentally protected land from the west, and would contribute little to no pollutants through the proposed development.

6.2.1 Monitoring Locations

Three monitoring locations have been selected, with two at both the upstream (*U/S*) and downstream (*D/S*) ends of the site's frontage along Fern Creek. The third selected monitoring site is an internal site and is located at the upstream location of Mirvac's Sector 8 site (*refer to **Appendix A** for details*).

These three sites have been selected so that any major outside sources of stormwater pollution can be isolated from those loads being generated by the site alone.

Dry weather sampling at the monitoring locations is predicted to be problematic due to the lack of baseflows, resulting from the relatively small upstream catchment. In reality, dry weather sampling will only be possible during smaller wet weather events (ie those producing less than 20 mm rainfall in the preceding 24 hours).

Both sites will continue to be monitored during and following development.

For this Rezoning stage report, wet weather results were not yet available, however two dry weather water was sampled. The additional required baseline monitoring results (both dry and wet) will be collected over the next 6 months (ie to be submitted progressively as addenda to this report).

6.2.2 Types of Monitoring

The monitoring plan for the site consists of three main categories:-

- physio-chemical water quality monitoring;
- ecosystem/rapid biological assessment monitoring; and
- bed sediment toxicant monitoring.

6.2.3 Water Quality Monitoring (*Discrete Sampling*)

The water quality monitoring component of the plan consists of:-

- dry weather sampling undertaken quarterly; and
- wet weather sampling undertaken for at least 3 events (recording a rainfall depth greater than 20mm over the catchment in a 24 hour period) spread evenly over the year and sampling throughout the rainfall event (rising and falling limbs of storm hydrograph).

Samples will be tested for the constituents listed in Council's WMS and reported to conform with Council's specification.

Following construction of the proposed stormwater treatment devices, sampling will be undertaken at the major inflow points to the detention basin and at the single outlet point to monitor water quality during wet weather. A wet weather event will be monitored for these treatment devices at least once every 4 months (*dependant on rainfall*) and reported to conform to Council's specification.

6.2.4 Rapid Biological Assessment Monitoring

For this Rezoning stage report habitat monitoring has not yet been undertaken, primarily due to seasonal requirements but also due to a distinct lack of permanent ponded water in recent months

The first round of habitat monitoring will be undertaken within the next 6 month and reported to Council as an addendum to this report. Further monitoring will be initiated at Development and Construction certificate stage.

All habitat monitoring uses the Biotic Index Signal to measure biological activitiy.

All reporting shall conform to Council's specifications.

6.2.5 Sediment Toxicant Monitoring

Sampling and testing of bed sediment within Fern Creek, is programmed to be undertaken on an annual basis. The first sediment sample is due to be collected at all three sampling site locations over the next 6 months. Further sampling will be undertaken immediately prior to commencement of construction, during construction and following completion of construction.

All sediment samples will be tested for metals, pesticides and oils/greases.

All reporting shall conform to Council's specifications.

6.2.6 SQUID Monitoring

Following completion of the subdivision construction, all stormwater quality improvement devices (SQUID's) will be monitored for a period of 2 years. This will include:

- Measurement of volume/mass of material removed from GPT's and an assessment of its relative composition;
- Discrete sampling at the major inlets/outlets of the proposed bio-retention basins; and
- Qualitative assessment of effectiveness of other proposed water quality control measures (ie rainwater tanks)

All reporting shall conform to Council's specifications.

6.2.7 Flow Gauging for Monitoring

To assess the magnitude of wet weather events and determine the position of a particular sample within a storm event, both the rainfall depth and flood depth will be recorded. Rainfall depth data will be obtained from the Bureau of Meteorology (BoM), whilst flood depths will be recorded at the upstream and downstream sampling sites.

The total depth of rainfall experienced during the event will allow WorleyParsons to determine if the event sampled will comply with Council's minimum 20mm depth over 24 hours criteria and a sustained length of record of the water levels at the downstream and upstream sites will allow WorleyParsons to determine if the sample has been taken on either the rising or falling limb of the regional storm hydrograph.

6.2.8 Quality Assurance/Measurement Accuracy

All samples collected as part of this monitoring plan will be tested by a NATA certified laboratory. Copies of all original data testing certificates will be provided along with information detailing the collection and preservation status upon delivery at the laboratory. The laboratory testing detection limits will also be included on all test certificates.

6.3 Monitoring Results

6.3.1 Rainfall

Rainfall records since commencement of the rezoning application stage monitoring programme (ie 1st April 2008) have been collected by WorleyParsons. Data was obtained from the Bureau of Meteorology for the station at Terry Hills (Station 066059).

An illustration of the daily rainfall records for the period of April to September 2008 is included in

6.3.2 Water Quality and Monitoring Results

To date water samples have been collected as follows:

Date	Location
Rezoning Stage Monitoring	
18/06/08	1st Dry weather event, upstream site
18/06/08	1st Dry weather event, intermediate site
18/06/08	1st Dry weather event, downstream site
11/09/08	2nd Dry weather event, upstream site
11/09/08	2nd Dry weather event, intermediate site
11/09/08	2nd Dry weather event, downstream site

The resultant quality of these samples is detailed in **Appendix E** and summarised in **Table 7**.

DRY WEATHER DISCUSSION

Two dry weather events have been sampled to date.

All detected pollutants in the first dry event were all generally within Councils long term trigger values with the exception of TN at the intermediate site, which only met Councils medium term trigger values. High levels of FC were found at the upstream and downstream location (400, 1600), and an elevated pH level was detected at the upstream location of the site

All detected pollutants in the second dry event were generally within Councils long term trigger values with the exception of TN at the downstream site, which only met Councils medium term trigger values. Elevated TP and turbidity levels were also found at the downstream site. The elevated levels at the downstream location may be due to the creek works conducted on the site during the installation of a new concrete culvert under Garden Street.

The result from the two dry events have shown that all detectable pollutants are generally within Councils long term trigger values for all site locations.

WET WEATHER DISCUSSION

No wet weather event has been samples to date

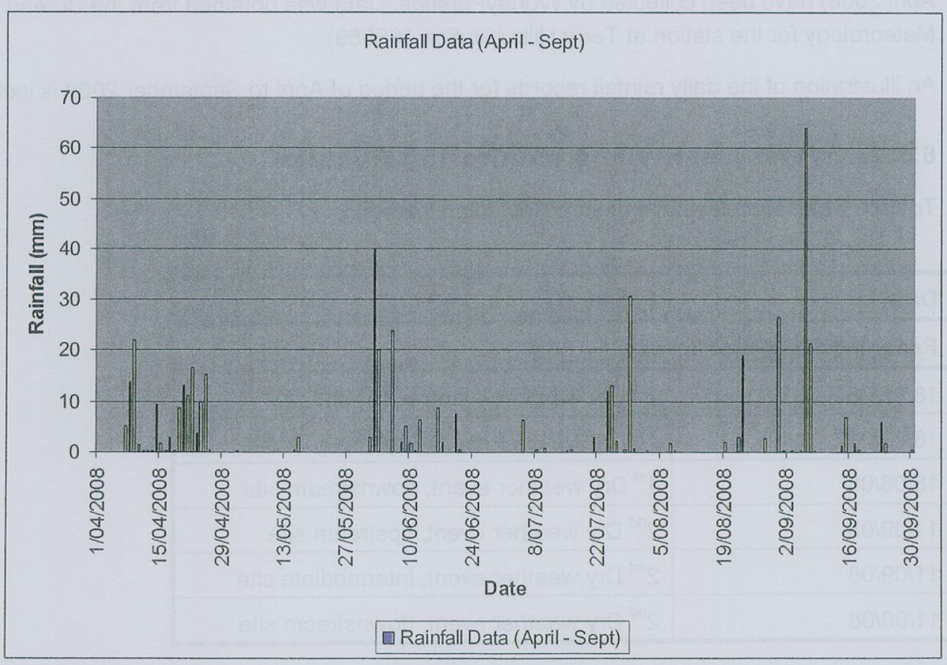


Diagram 1 – Rainfall Records at Terry Hills (April – September 2008) – Station: 066059

Table 7 – Summary of Water Sampling Results

Parameters	Units	Short-Term Goal	Medium-Term Goal	Long-Term Goal	1st Dry Weather Event (18/06/08)			2nd Dry Weather Event (11/09/08)		
					WS811US/1111DS	WS811IS	WS811DS	WS812DS	WS812IS	WS812US
					Downstream	Intermediate	Upstream	Downstream	Intermediate	Upstream
Total rain (5 days preceeding)	mm				10.6	10.6	10.6	21.6	21.6	21.6
Ammonia – N	mg/L	NS	<0.3	<0.3	0.03	0.01	0.02	<0.01	<0.01	<0.01
Total Nitrogen	mg/L	SQ	<1.6	1.0	0.8	1.1	0.9	1.3	0.6	0.3
Nitrate	mg/L	NS	NS	NS	0.26	0.45	0.03	0.21	0.31	0.07
Nitrite	mg/L	NS	NS	NS	0.02	0.02	0.02	0.02	0.02	0.02
Filterable Phosphorous	mg/L	NS	NS	NS	<0.1	<0.1	<0.1	<0.01	<0.01	<0.01
Non-Filterable Phosphorous	mg/L	NS	NS	NS	<0.1	<0.1	<0.1	<0.01	<0.01	<0.01
Total Phosphorous	mg/L	SQ	<0.1	0.04	0.02	0.02	0.01	0.17	0.02	0.02
Total Suspended Solids	mg/L	SQ	<20	<6	1	1	1	50	<5	<5
Turbidity	NTU	SQ	<50	<20	2	2.1	0.7	80.5	3.9	2.8
Faecal Coliforms	cfu/100ml	<1000	<150	<150	1600	28	400	79	16	100
TKN	mg/L	NS	NS	NS	0.5	0.6	0.8	1.1	0.3	0.2
pH	pH	6.6 - 8	6.6 - 8	6.6 – 8	7.4	7.9	8.3	7.3	7.2	6.1
Dissolved Oxygen	% Sat	NS	NS	NS	6.7	7.6	8	6.1	6.7	6.2
Conductivity	ms/cm	NS	NS	NS	0.4	0.4	0.4	0.41	0.41	0.37
Temperature	^{o}C	SQ	SQ	SQ	15	16	16	13	12	14
Salinity	PPT	NS	NS	NS	0.00	0.00	0.00	0.00	0.00	0.00
Arsenic	ug/L	SQ	50%SQ	50	NA	NA	NA	NA	NA	NA
Chromium	ug/L	SQ	50%SQ	10	NA	NA	NA	NA	NA	NA
Copper	ug/L	SQ	50%SQ	2	NA	NA	NA	NA	NA	NA
Lead	ug/L	SQ	50%SQ	1	NA	NA	NA	NA	NA	NA
Mercury	ug/L	SQ	50%SQ	0.1	NA	NA	NA	NA	NA	NA
Zinc	ug/L	SQ	50%SQ	50	NA	NA	NA	NA	NA	NA
OC Pesticides	ug/L	SQ	50%SQ	NS	NA	NA	NA	NA	NA	NA
OP Pesticides	ug/L	SQ	50%SQ	NS	NA	NA	NA	NA	NA	NA
Phenols	ug/L	SQ	50%SQ	NS	NA	NA	NA	NA	NA	NA
Hardness	mg/L	NS	NS	NS	NA	NA	NA	NA	NA	NA
Chlorophyll A	ug/L	15	15	10	NA	NA	NA	NA	NA	NA
Oil & Grease	mg/L	NS	NS	NS	NA	NA	NA	NA	NA	NA
Priority PAH	ug/L	NS	NS	NS	NA	NA	NA	NA	NA	NA
Total Algal Count	Cells/ml	NS	NS	NS	NA	NA	NA	NA	NA	NA

1. Long-Term water quality goals are derived from ANZECC, 1992 guidelines and Councils WMS Feb 2001
2. Figures in **BOLD** satisfy long-term water quality goals
3. Figures BLUE do not achieve long term goals
4. Figures in ORANGE do not achieve the medium & long term goals
5. Figures in RED do not achieve the short, medium & long term goals
6. Rainfall data obtained from the Bureau of Meteorology for the Terry Hills Station (66183)
7. NS – Not Specified by Council, SQ – Status Quo, NR – Not Required by Council, NA – Not Available
8. Refer to lab printouts for constituents results. Note that the figure included in this summary table is the highest recorded constituent value not the total value.

7. STORMWATER QUALITY MANAGEMENT

7.1 Construction phase

During construction of internal roads, associated infrastructure or any site regrading works for the proposed development, sediment and erosion control facilities will be designed and constructed/installed in accordance with Council's specification and with the requirements of the publications "Managing Urban Stormwater – Soils and Construction".

A sediment and erosion control plan will be prepared prior to construction, outline the strategies proposed to prevent excessive pollutant loads being exported from the site in runoff during immediately following constructions.

7.2 Post Development Phase

The proposed water quality management system for the ultimate conditions consists of the following elements (refer to **Figure 3** for details):

- Rainwater storage tanks for reuse in toilet flushing and irrigation;
- A single large detention/infiltration basin;
- Two detention/bio-retention basins;
- Bio-retention swales within the road reserves (1,800 m in total); and
- Four underground Gross Pollutant Traps (GPTs).

The software package developed by th CRC for Catchment Hydrology termed "MUSIC" (Model for Urban Stormwater Improvement Conceptualisation" was used to assess the effectiveness of the proposed "treatment train" compared with two other land use scenarios.

- Existing conditions;
- Post development conditions with no treatment measures; and
- Post development conditions with treatment measures.

Details of the MUSIC modelling exercise (including results) are included at **Appendix F** and summarised in the following sections.

7.3 MUSIC

"MUSIC simulates the performance of a group of stormwater management measures, configured in series or in parallel to form a treatment train." In this case, MUSIC has been run on a continuous basis, allowing rigorous analysis of the merit of proposed strategies over the long-term.

"the adoption of a continuous simulation approach is recommended in water quality modelling. This stem from the fact that impacts of poor stormwater quality on aquatic ecosystem health are associated with cumulative pollutant loads and frequency of aquatic ecosystem "exposure" to poor water quality. Pollutant loads delivered to receiving waters from many of the small storm events (e.g. of magnitude less than the 3 month ARI peak discharge) can make up in excess of 90% of the annual loads discharged from the catchment.

The evaluation of the adequacy's of the stormwater management systems is based on a risk-based approach associated with examination of the long-term mean annual pollutant load delivered to the receiving waters.

MUSIC is designated to simulate stormwater systems in urban catchments and have the capability to operate at a range of temporal and spatial scales, suitable for catchment areas from 0.01km^2 to 100km^2. Modelling time step can range from 6 minutes to 24 hours to match the range of spatial scale.

The model's algorithms are based on the known performance characteristics of common stormwater quality improvement measures. These data, derived from research undertaken by CRCCH and other organisations, represent the most reliable information currently available in our industry" MUSIC Manual, CRC for Catchment Hydrology.

7.3.1 Site Sub-Catchment Areas

The entire area of Sector 9 was modelled in MUSIC. Under existing conditions three nodes with a total area of 16.6 ha were modelled. Under proposed conditions the site was delineated into individual sub-catchments, also totalling 16.6 ha.

The post development site sub catchment areas are illustrated in **Appendix G** and summarised below in **Table 7-1**.

Table 7-1 – Sub catchment Areas of Proposed Development

Catchment	Area (ha)	Impervious Fraction
A1 Roof	0.720	100%
A1 Lots	1.058	24%
A1 Roads	0.817	85%
A2 Roof	1.215	100%
A2 Lots	2.249	26%
A2 Roads	1.518	85%
Basin 1	0.559	0%
B1 Roof	0.400	100%
B1 Lots	0.891	31%

Catchment	Area (ha)	Impervious Fraction
B1 Roads	0.491	85%
B2 Roof	0.800	100%
B2 Lots	0.701	19%
B2 Roads	0.158	85%
Basin 2	0.088	0%
Riparian Zone	2.469	0%
C1 Roof	0.520	100%
C1 Lots	0.760	27%
C1 Roads	0.412	85%
C2 Roof	0.200	100%
C2 Lots	0.370	33%
C2 Roads	0.104	85%
Basin 3	0.055	0%
Total	16.665	~50%

Note that subcatchment "Riparian Zone" represents the undeveloped stage of the development that is unable to drain to the proposed basin of the site.

Impervious Fraction with each catchment varies depending on density of housing and size of lots.

7.3.2 Rainfall and Evaporation

Rainfall and evaporation data was sourced from the Manly Hydraulic Lab (MHL) and the Bureau of Meteorology (BoM).

Thirty minute rainfall data was utilised in the MUSIC models for the range of rainfall years representing a mix of average, wet and dry years for the region (1996 – 1999). The closest rainfall station to the site with pluvio data was middle Creek (uses a 15 min logger). A thirty minute time step was used in MUSIC as it accepts 6, 12 and 30 minute and greater time step intervals and as the Middle Creek logger was for 15 minutes the smallest increment that would be accepted using this data was 30 minutes.

The average annual rainfall depth for the area between 1996 to 1999 was 1,402 mm. The long term average for the region is approximately 1,230 mm/yr. Hence, the historical period assessed was marginally wetter than average.

Evaporation data was extrapolated for the site using the BoM publication titled *"Climate Atlas of Australia – Evapotranspiration"* (BoM 2001).

7.3.3 Soil Properties

The parameter values adopted were based on adopted values for similar sites and the resultant volumetric runoff coefficients were comparable with published values. A summary of the adopted soil properties entered into the runoff module are shown in **Table 7-2**.

Table 7-2 – Adopted MUSIC Soil Parameters

Parameters	Default	Adopted
Impervious Area rainfall threshold (mm/d)	1	1.5
Perv area soil storage capacity	150	150
Initial storage (%cap)	25	25
Field Capacity (mm)	50	150
Infiltration capacity co-efficient "a"	50	50
Infiltration capacity co-efficient "b"	2	2
Groundwater initial depth (mm)	50	50
Groundwater daily recharge rate	0.65	0.65
Groundwater daily baseflow rate	0.85	0.85
Daily deep seepage rate (%)	0	0

7.3.4 Pollutant loads

Each sub-catchment was divided into pervious, residential, road and roof area to allow runoff from each area to be directed to specified treatment measures. The expected pollutant load from the catchment was determined by applying the pollutant concentrations or Event Mean Concentrations (EMC's).

The adopted EMC's for total suspended solids (TSS), total phosphorus (TP) and total nitrogen (TN) are given in **Table 7-3** and are sourced from Councils WMS.

The Urban EMC's were adopted for the remaining lots and the roads, while the Roof EMC's were adopted for the Roof catchment. The riparian corridors were modelled as Native vegetation.

Since the site in its existing conditions was assumed to be 50% horticulture and 50% pasture/grazing, EMC values of horticultural and pastures were selected.

Table 7-3 – Runoff Pollutant Event Mean Concentrations (EMC)

Land Use	TSS	TP	TN
	Mg/L	Mg/L	Mg/L
Lots/Roads	100	0.3	1.5
Roof	20	0.13	1.5
Native Vegetation (Riparian zone/Forest)	10	0.03	0.32
Existing Conditions (Horticulture/Pasture)	35	0.15	1.3

These values were adopted for the MUSIC model.

7.3.5 MUSIC Network Layout

The adopted MUSIC models networks for the pre-development, developed (without treatment) and developed (with treatment) scenarios are shown in **Figure 5**, **Figure 6,** and **Figure 7** respectively.

Figure 5 – Schematic of Pre-developed Conditions MUSIC model

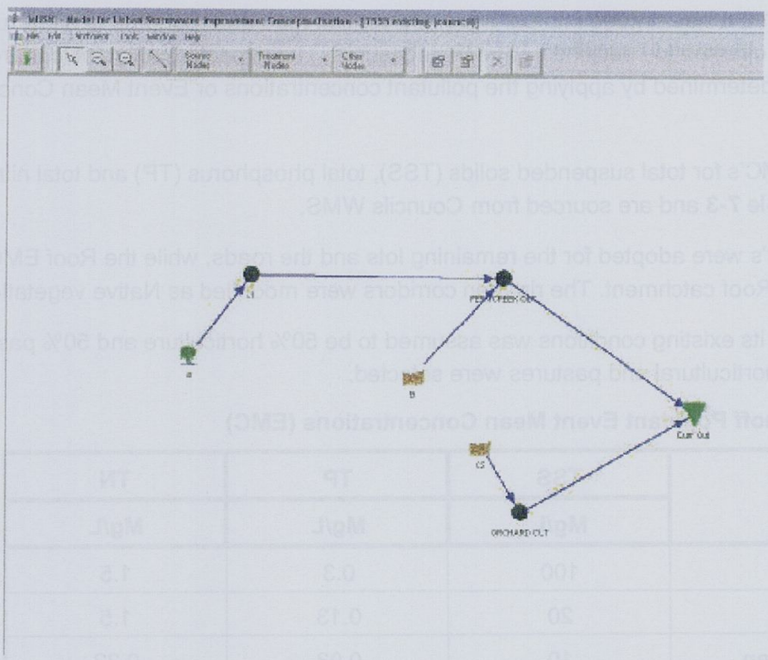


Figure 6 – Schematic of Proposed Conditions (without Treatment Measures) MUSIC model

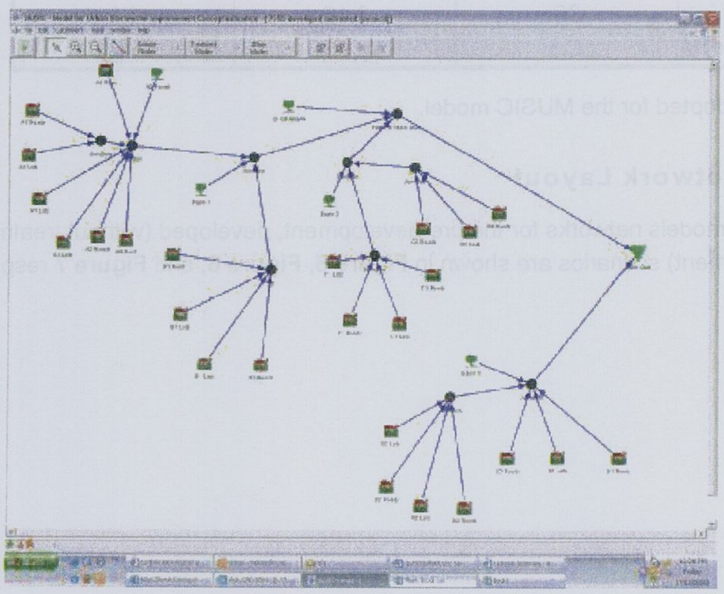
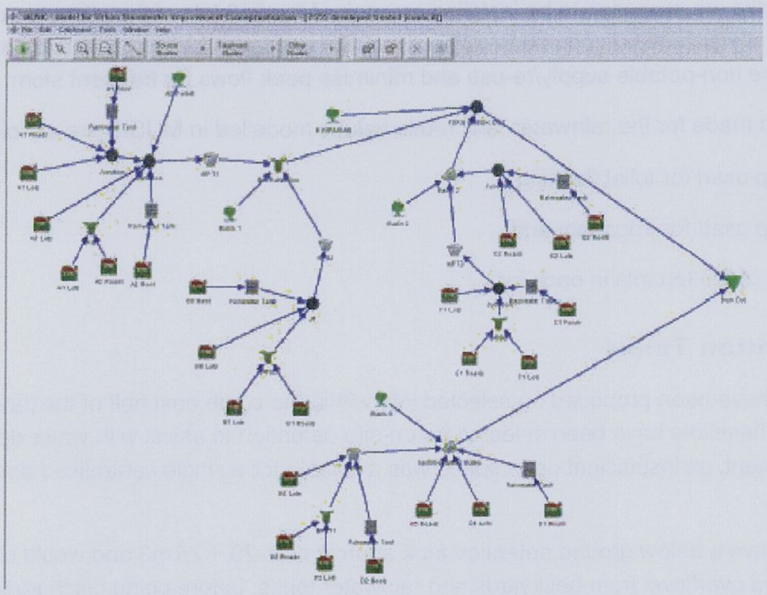


Figure 7 – Schematic of Proposed Conditions (with Treatment Measures) MUSIC model



7.3.6 Treatment objectives

A common and practical guideline that is used throughout NSW (*and is recognised by the NSW DECC – Formerly the NSW DEC)* is the setting of treatment objectives that a are achievable using best practice. These best practice treatment objective are summarised in **Table 7-4**.

Table 7-4 – Adopted Treatment Objectives

Pollutants	Reduction Targets
Gross Pollutants (GP)	90%
Total Suspended Solids (TSS)	80%
Total Phosphorous (TP)	60%
Total Nitrogen (TN)	45%

However, Pittwater Councils WMS requires that all post development pollutant loads are reduced to levels equal to or less than pre development conditions. The latter has been adopted as the key treatment objectives for this site, but the former is also used as a reference.

7.3.7 Rainwater Tanks

3kL rainwater tanks are proposed to be installed on each of the 213 lots of the ultimate sub-division (639 m^3 in total, of which 50% is counted as effective OSD storage – 320 m^3) to reduce runoff volume, maximise non-potable supply/re-use and minimise peak flows for frequent storm events.

The assumptions made for the rainwater tank reuse values modelled in MUSIC are as follows:

- 30 L/d/pp used for toilet flushing;
- 20 L/d/pp used for irrigation; and
- Average of 2.6 tenants in each lot.

7.3.8 Detention Tanks

Detention tanks have been proposed on selected lots within the south east half of the development (**Appendix H**). These lots have been selected for on-site detention to assist with water detention within the catchment, as insufficient open space was available for a single centralised detention system.

Each lot would have a below ground detention tank approximate 20 ~ 25 m3 and would collect surface runoff and overflows from backyards and rainwater tanks, before being discharged into the stormwater drainage system.

Without OSD tanks within the selected catchments, additional large open space areas would be required for a single centralised detention system.

7.3.9 Bio Retention Swales

Bio retention swales will be implemented within the stormwater management strategy and would be located along the wider road reserves (**Appendix H**) to collect and treat surface runoff generated off the front yards of front lots and the road reserve.

A total length of 1.8 km of swale have been proposed and modelled as part of the stormwater treatment train. The swales would have a filter medium 0.6 m wide and 1 m deep and consist of a detention depth of 0.3 m with grassed batter slopes of 1(V):3(H). The total width of the swale would be approximately 2.6 m wide.

7.3.10 Detention/Infiltration/Bio-Retention Basin

Three detention basins were proposed as part of the stormwater management plan and would perform a dual function of both stormwater treatment and detention. Each basin would have both above and below ground water storage.

Basin 1 would be designed as a detention/infiltration basin, similar to that designed and constructed in Sector 8, while Basins 2 and 3 would be designed as a detention/bio-retention basin.

The basins will directly reduce peak runoff rates for all storm events and also treat runoff via infiltration though below ground media similar to a bio-retention system.

7.3.11 GPT

The proposed GPTs will be used to capture litter and coarse sediment from a majority of the site in accordance with the following assumed capture rates:

- TSS 80%
- TN 10%
- TP 30%
- Litter 95%

7.3.12 Music Modelling Results

The results from the MUSIC model for the four development scenarios are shown in **Table 7-5**.

The results in **Table 7-5** show a significant reduction in pollutants under developed conditions in comparison to pre development conditions and that the overall objectives of less then existing achieved as well as 80% (SS), 60% (TP) and 45% (TN).

Table 7-5 – MUSIC Results

Pollutants	Pre developed Conditions	Proposed Conditions (Untreated)	Proposed Conditions (Treated)	% reduction from Pre developed conditions
Cv	0.44	0.63	0.47	25
Total Suspended Solids (kg/yr)	2,650	9,240	1,420	85
Total Phosphorus (kg/yr)	13	31	9.92	68
Total Nitrogen (kg/yr)	118	198	102	49

7.4 Maintenance Programme

The proposed maintenance program for the sites water quality control measures will consist of the following;

- Periodic (6 monthly) inspection and removal of any gross pollutants & coarse sediment that is deposited in the bio-retention swales and basins and replacement of vegetation as necessary;
- Periodic (3 monthly) and episodic (post storm greater than 1 yr ARI) inspection and removal of trapped pollutants from all GPT's; and
- Periodic (annually) inspection (and flushing if required) of the bio-retention basins.

7.5 Preliminary Mosquito risk Assessment

The waterways of Warriewood Valley are known to produce moderate populations of pest mosquitoes. The development lies nearby both Fern Creek, and the wetlands downstream of the site. Fern Creek normally provides intermittent baseflow, as such the risk will be low for this water body becoming a major mosquito breeding area. However the wetland areas further downstream will have a greater potential for mosquito breeding. The works are unlikely to impact the existing mosquito breeding regimes of both these sources.

The site itself shall be regraded to a moderate slope, accordingly it is expected that there will be no low lying areas where ephemeral waterbodies are likely to form following rain.

In addition no permanent waterbodies have been proposed for this development.

With regards to the treatment train, the detention/infiltration basins and bio retention swales are not expected to contain storage for extended lengths of time. If this measure is properly designed and maintained there is a low risk that these will act as mosquito breeding areas.

The GPTs may have a small volume of standing water, and thus may form a potential mosquito habitat. However, if maintained appropriately, this should not create any significant risks.

The proposed rainwater tanks also pose a minimal risk for becoming mosquito breeding areas however again if they are adequately maintained with emphasis on the inlet screening to prevent pests from entering the device.

At this stage it is expected that the risk of providing habitat for pest mosquitos shall remain the same before and after the proposed works. During CC stage, a further mosquito risk assessment is proposed to be undertaken by a specialist to confirm this hypothesis.

7.6 Sizing of the GPT

The proposed GPT for the site will be designed to treat all the peak flows up to and including 1 in 3 month ARI event (approximately 90% of the annual flow volume).

8. WATER BALANCE

The MUSIC model that was used to simulate the performance of stormwater treatment devices described in **Section 7** was also used to assess the sites water balance.

As a large portion of the site is proposed to be sealed (ie approximately 50% of the site will contain impervious surfaces following development) it would be very difficult to achieve a reduction in runoff volume that comes close to matching existing conditions.

Reuse of roof runoff for toilet flushing and garden irrigation is proposed as well as promotion of subsurface infiltration within the proposed detention basins in the north and south of the site, which has a significant reduction in runoff volumes (ie by 25 %) from a Runoff Coeffiecent (Cv) value of 0.63 down to 0.47 (ie compared with an estimated Cv of 0.44 under existing conditions).

This significant reduction has been achieved with the large open spaces provided for detention and infiltration, and is considered an excellent outcome for the Sector.

For details of the MUSIC water balance assumptions and results refer to **Section 7** and **Appendix F**.

9. FLOODING

Currently, there are no major overland flow paths or creeks traversing the site. Any flows generated from the site flow uniformly towards Fern Creek.

Under proposed conditions, the roads will act as controlled overland flow paths. The proposed drainage system (ie pipes plus roads) for the development will be designed to safely cater for the 100 year ARI storm event. All surface flows generated across the site will be piped and diverted along the road reserve towards the proposed detention basins, which will safely detain flows before discharging into Fern Creek.

Fern Creek traverse the northern boundary of the development, flowing west to east. A flood study of Narrabeen Creek has previously been conducted by Cardno Lawson Treloar (CLT) (*Warriewood Valley Flood Study, 2005*). The study looked at flooding behaviour of all creeks within Warriewood Valley.

Results from the study showed that during a 20 year ARI flood event, the maximum water level at the upstream and downstream of Fern Creek passing the site would be 20.25 and RL 12.12 m AHD respectively. During the 100 year ARI the maximum upstream and downstream levels would be 20.33 and RL 12.33 m AHD respectively and PMF flood event would reach a maximum water level of 21.56 and RL 13.8 m AHD at the upstream and downstream of Fern Creek respectively.

The extent of flooding from the CLT flood study is shown in **Appendix I**. **Appendix I** illustrates that the development does not extend far enough into the riparian and vegetated buffer zone of Fern Creek to have a hydraulic impact upon flows or flooding within the creek.

Since the proposed roads and lots do not sit below existing surface levels, the development will not be impacted or be inundated by Fern Creek flooding.

It has been noted that works have been proposed at the downstream end of the creek by a neighbouring site. It is understood that the proposed works, in its conceptual stage, would not have a negative impact upon flood levels within the Creek.

9.1 Flood Emergency Response Plan

A flood emergency response plan is proposed to be implemented for all major flood events up to and including the Probable Maximum Flood (PMF).

It has been estimated that the PMF level according to the Warriewood Valley Flood Study on the proposed site would reach a maximum level of approximately RL 21.56 AHD at the upstream end and RL 13.8 m AHD at the downstream end.

As the majority of the site is well above this level, the PMF flooding does not have impact on the development. As a result, the entire site sits above the PMF level with safe egress from the site still possible via the proposed roads.

9.2 Flood Planning Levels

Pittwater council's policy with regards to flood planning levels for adjacent properties to the creek is 100yr ARI level plus 500mm. It is clear that the majority of the developable portion of the site will sit well above both the 100 year and PMF level.

9.3 Flood Category Notations

The developable portion of the site will not undergo inundation under both 100yr ARI and Probable Maxiumum Precipitation (PMP) events, hence no FC1's or 2's. Notations will be applied to the proposed Sector 9 subdivision lots

9.4 Filling within the Creek Line

No filling within the creek line would be proposed for the Sector 9, as the proposed extent of the development is well beyond the PMF flood extents of Fern Creek, as shown in **Appendix I**.

As a result, the proposed development will not have any negative flooding impacts within the creek and no creek works would be required.

A flood study of Fern Creek was undertaken by WorleyParsons incorporating Patterson and Britton during the development of the neighbouring Sector 8 site. This was followed up with creek works along the total length of Fern Creek with a section of the creek works omitted. As part of this rezoning stage, it is proposed that omitted creek works be completed as per the original creek design to complement the original flood study.

10. STORMWATER DRAINAGE CONCEPT PLAN

The elements of the proposed stormwater drainage concept plan for the site are presented in **Appendix A** and summarised below.

For the development, flows from the roof areas of each building will be directed to rainwater storage tanks so that it can be reused for toilet flushing and garden irrigation. Overflows from these tanks as well as runoff from each lots carpark/driveways and landscaped areas would be captured via inter-allotment drainage or drain directly to the street drainage system and be conveyed to one of the three detention/infiltration/bio-retention basins. Before discharging into each basin, flows will be treated by a GPT located directly upstream of each basin.

Piped flows generated from the site will be directed to a gross pollutant trap that will treat the equivalent three month flows before being discharged into the basin.

A majority of the surface runoff from the front yards from each of the lots and the roads will be diverted into bio-retention swales located within the road reserve of all the roads (excluding laneways and steep sections of Fern Creek Road). These swales will act as source control pollutant treatment for surface runoff. All runoff collected in the swales will be allowed to infiltrate into the ground, with the remaining runoff piped into the stormwater drainage network.

In Sub-catchments B and C, overland flows from the rainwater tanks and runoff from each lot would be captured within on-site detention tanks located within selected lots before being discharged to the basin as designed above.

Once in the basins, low flows would be detained within the below ground storage area allowed to infiltrate, be treated and collected via the filtration medium and eventually discharge flows into Fern Creek. Higher flows will pond within the basin itself, above ground, to ensure post development flows achieve pre development levels (ie for all storm events up to and including the 100 year ARI). Flows in excess of the 100yr ARI capacity will overflow into Fern Creek.

All flows that by pass the stormwater treatment train would be collected by the stormwater drainage system. The stormwater drainage system would be designed to convey a capacity up to the 20 year ARI storm event, while overland flows up to 100 year ARI storm event will be conveyed in the road reserves.

Fern Creek would be retained in its current rehabilitated form, with additional planting incorporated in the 2nd 25 m offset in keeping with Councils recent works. No fill is proposed within the riparian corridor.

Basin 1 would be similar to those recently constructed in the adjacent Sector 8, while Basin 2 and 3 would be fully planted out (ie bio-retention system).

11. CONCLUSION & RECOMMENDATION

This Stormwater Management Report has been prepared in support of the Rezoning Application for Sector 9, Warriewood and complies with Council's Stormwater Management Specification (2001).

Detailed hydraulic, hydrologic and water quality modelling has been undertaken to assist in developing a stormwater management plan that will ensure that the proposed development will not have any detrimental impacts downstream and to adjoining areas.

The proposed development will implement a water management system incorporating rainwater tanks on each lot, On Site Detention tanks on selected lots, bio retention swales within the road reserves and three detention/infiltration basins located downstream of the development to control and treat stormwater quality and quantity to ensure no net increase in peak discharge flows and pollutant loads from the site.

The proposed stormwater management plan for the site has been designed for all storm events up to the 100 year ARI storm event. Basin 1 has been designed with the same design principles proposed and constructed in the adjoining Sector 8.

A water quality monitoring plan has been proposed to monitor pollutants both during and post construction. The monitoring will ensure efficient operation of the proposed water management plan and immediately identify any problems that may arise during the development of the proposed site.

Pre construction water quality monitoring has been undertaken during this rezoning process of the site. To date, two dry weather samples have been collected and recorded as part of the rezoning process. The result from the two dry events have shown that all detectable pollutants are generally within Councils long term trigger values for all site locations.

Water quality monitoring will continue within the next 6 month and reported to Council as an addendum to this report. Further monitoring will be initiated at Development and Constructiong application stage.

Since the proposed extent of the development is kept well beyond the PMF flood affected zone, it has been concluded that the proposed development will not have a negative flood impact on Fern Creek, nor will flooding within the creek have any adverse affect on the proposed lots and roads.

Appendix A -

PROPOSED LAYOUT

APPENDIX A

WorleyParsons
resources & energy

LAYOUT OF SECTOR 9
AND PROPOSED DEVELOPMENT

Appendix B -

COUNCIL CHECKLIST

DOCUMENTATION CHECKLIST - REZONING

(Detach and include with submissions)

Section	Item	Requirement	Check (√)
4.1	Water Cycle Assessment - Water Balance Modelling Pre & Post Development		✓
4.1.1	Stream Gauging, infiltration testing and use of local rainfall data for modelling	♦♦♦♦♦♦♦♦	✓
4.2.1	Water Quality Monitoring Plan	♦♦♦♦♦♦♦♦	✓
4.2.1	Water Quality Monitoring Sites Shown on Plan (at least three)	♦♦♦♦♦♦♦♦	✓
4.2.1, 2, C	Water Quality Monitoring Data	♦♦♦♦♦♦♦♦	✓
4.2.1, 2, C	Assessment and interpretation of water quality monitoring data	♦♦♦♦♦♦♦♦	✓
4.2.1, 2, C	Assessment and interpretation of water quality monitoring data from SQID's		
4.3	Water Quality Management Assessment - Load Modelling Pre and Post Development		✓
4.3.1, 3	Justification of assumptions for Event Mean Concentrations	♦♦♦♦♦♦♦♦	✓
4.3.2	Identification of and details for Stormwater quality facilities		✓
4.3.2, 4.4.5	Mosquito Risk Assessment for both Watercourse and Water Quality/Quantity features		✓
4.3.6, 4.6.5	Inspection and Cleaning Reports for SQID's and OSD		
4.3.5	Environmental Management Plan (Soil and Water Aspects)		
4.3.4	Erosion and Sediment Control Plan		
4.3.6	Management Plan for Stormwater Quality Improvement Devices		
4.4.3, 4, 5	Existing and Proposed Creek Corridor in plan with cross/long sections with flood levels	□□□□□□□□□□	NA
4.4.4	Proposed Creek Corridor Planting Schedule		NA
4.4.5	Creek Corridor Vegetation Monitoring and Management Plan		
4.4.5	Vegetation and Creek Maintenance and Monitoring Reports		
4.5	Flood Analysis – existing and design conditions		✓
4.5.2	Compliance of structures and creek corridor with flood planning levels		✓
4.5.4	Details of Interim Flood Protection Works		✓
4.6.3	Design Storm Hydrological Modelling of Site - Pre and Post Development		✓
4.6.3	On-Site Detention Facilities		✓
4.6.4	Stormwater Retention Facilities		✓
4.7	Stormwater Concept Drainage Plan	□□□□□□□□□□	✓

KEY:

	Preliminary Calculations/Assessment Required		*Work as Executed Plans*
□□□□□□□	*Concept Design Required*	♦♦♦♦♦♦	*Required/Reviewed/Updated*
+++++++	*Detailed Assessment/Calculations/Design*		*Not required*

Note 1 Even if the works are not to be constructed by the Applicant on the land to be transferred to Council under the Material Public Benefit Option in the Section 94 Plan, preliminary investigation for Rezoning and concept design at DA stage is required

Completed by Principal Certifier:

Name: Michael Shaw
Title: Manager, CI
Organisation: Worley Parsons Services

Signature:
Date: 27/10/08

Appendix C -

RAFTS DATA

PRE DEVELOPMENT RAFTS RESULTS

5 YR

	Subcatchment Number	Storm Number	Peak outflow [m^3/s]	Total Area [ha]	Catchment Mannings 'n' [n value]	Percentage Impervious [%]	Catchment Slope [%]
A	1	1	0.0782	3.3871	0.07	0.001	9
	1	2	0.3149				
	1	3	0.3763				
	1	4	0.3996				
	1	5	0.412				
	1	6	0.3534				
	2	1		0.1783	0.015	99.999	9
OUT	1	1	0.6236	0.001	0.025	0	0.001
	1	2	1.287				
	1	3	1.57				
	1	4	1.678				
	1	5	1.793				
	1	6	1.646				
B	1	1	0.4741	8.7313	0.07	0.001	9
	1	2	1.013				
	1	3	1.224				
	1	4	1.328				
	1	5	1.419				
	1	6	1.306				
	2	1		0.9701	0.015	99.99	9
C	1	1	0.1498	3.0793	0.07	0.001	9
	1	2	0.31				
	1	3	0.3622				
	1	4	0.3857				
	1	5	0.393				
	1	6	0.3402				
	2	1		0.3421	0.015	99.99	9

20 YR

	Subcatchment Number	Storm Number	Peak outflow [m^3/s]	Total Area [ha]	Catchment Mannings 'n' [n value]	Percentage Impervious [%]	Catchment Slope [%]
A	1	1	0.1454	3.3871	0.07	0.001	9
	1	2	0.4303				
	1	3	0.5753				
	1	4	0.6798				
	1	5	0.7159				
	1	6	0.7833				
	1	7	0.5823				
	1	8	0.7188				
	2	1		0.1783	0.015	99.999	9
OUT	1	1	0.5685	0.001	0.025	0	0.001
	1	2	1.679				
	1	3	2.441				
	1	4	2.862				
	1	5	2.981				
	1	6	3.13				
	1	7	2.446				
	1	8	3.24				
B	1	1	0.3771	8.4413	0.07	0.001	9
	1	2	1.236				
	1	3	1.82				
	1	4	2.124				
	1	5	2.229				
	1	6	2.35				
	1	7	1.788				
	1	8	2.405				
	2	1		0.4443	0.015	99.99	9
C	1	1	0.2557	3.8135	0.07	0.001	9
	1	2	0.5032				
	1	3	0.6667				
	1	4	0.79				
	1	5	0.8247				
	1	6	0.8968				
	1	7	0.6898				
	1	8	0.8466				
	2	1		0.4237	0.015	99.99	9

100YR

	Subcatchment Number	Storm Number	Peak outflow [m^3/s]	Total Area [ha]	Catchment Mannings 'n' [n value]	Percentage Impervious [%]	Catchment Slope [%]
A	1	1	0.3528	3.3871	0.07	0.001	9
	1	2	0.7786				
	1	3	0.9121				
	1	4	1.099				
	1	5	1.099				
	1	6	1.195				
	1	7	0.9383				
	1	8	0.9363				
	2	1		0.1783	0.015	99.999	9
OUT	1	1	1.266	0.001	0.025	0	0.001
	1	2	3.201				
	1	3	3.939				
	1	4	4.532				
	1	5	4.615				
	1	6	4.918				
	1	7	3.918				
	1	8	4.21				
B	1	1	0.9445	8.4413	0.07	0.001	9
	1	2	2.393				
	1	3	2.933				
	1	4	3.399				
	1	5	3.439				
	1	6	3.665				
	1	7	2.803				
	1	8	3.121				
	2	1		0.4443	0.015	99.99	9
C	1	1	0.4497	3.8135	0.07	0.001	9
	1	2	0.9				
	1	3	1.074				
	1	4	1.275				
	1	5	1.328				
	1	6	1.4				
	1	7	1.115				
	1	8	1.098				
	2	1		0.4237	0.015	99.99	9

PMF EVENT

	Subcatchment Number	Storm Number	Peak outflow [m^3/s]	Total Area [ha]	Catchment Mannings 'n' [n value]	Percentage Impervious [%]	Catchment Slope [%]
A	1	1	0.3039	3.3871	0.07	0.001	9
	1	2	2.347				
	1	3	3.746				
	1	4	4.869				
	1	5	5.954				
	1	6	6.779				
	1	7	8.262				
	1	8	11.109				
	2	1		0.1783	0.015	99.999	9
OUT	1	1	1.161	0.001	0.025	0	0.001
	1	2	9.592				
	1	3	16.52				
	1	4	21.743				
	1	5	27.616				
	1	6	31.457				
	1	7	37.816				
	1	8	51.41				
B	1	1	0.8628	8.4413	0.07	0.001	9
	1	2	7.186				
	1	3	12.349				
	1	4	16.273				
	1	5	20.649				
	1	6	23.49				
	1	7	28.14				
	1	8	38.438				
	2	1		0.4443	0.015	99.99	9
C	1	1	0.3752	3.8135	0.07	0.001	9
	1	2	2.71				
	1	3	4.429				
	1	4	5.783				
	1	5	7.074				
	1	6	8.036				
	1	7	9.789				
	1	8	13.199				
	2	1		0.4237	0.015	99.99	9

POST DEVELOPMENT(NO DETENTION) RAFTS RESULTS

5YEAR

	Subcatchment Number	Storm Number	Peak outflow [m^3/s]	Total Area [ha]	Catchment Mannings 'n' [n value]	Percentage Impervious [%]	Catchment Slope [%]	Peak Basin Stage [m]	Peak basin storage [m^3]	Peak inflow to head of link [m^3/s]
A RIP 1	1	1	0.2263	1.5745	0.04	0.01	2	0.1217	41.379	0.2263
	1	2	0.2585					0.1107	37.624	0.2585
	1	3	0.2654					0.1335	45.379	0.2654
	1	4	0.284					0.1536	52.221	0.284
	1	5	0.225					0.1374	46.719	0.225
	2	1		0.0101	0.04	99.99	2			
F-A1	1	1	1.267	4.5893	0.07	0.01	20			1.267
	1	2	1.544							1.544
	1	3	1.739							1.739
	1	4	1.732							1.732
	1	5	1.301							1.301
	2	1		0.0464	0.05	99.99	15			
A1	1	1	1.919	2.9648	0.025	0.01	5			1.919
	1	2	2.549							2.549
	1	3	2.808							2.808
	1	4	2.579							2.579
	1	5	1.654							1.654
	2	1		4.4471	0.015	99.99	5			
B RIP	1	1	2.007	0.8853	0.04	0.01	2	1.5587	3117.4	2.007
	1	2	2.79					2.4869	4973.8	2.79
	1	3	3.129					2.7604	5520.8	3.129
	1	4	2.834					2.9607	5921.3	2.834
	1	5	1.985					3.0492	6098.3	1.985
	2	1		0.0089	0.04	99.99	2			
OUT	1	1	3.362	0.001	0.025	0	0.001			3.362
	1	2	4.403							4.403
	1	3	4.965							4.965
	1	4	4.514							4.514
	1	5	3.182							3.182
B2	1	1	0.7081	1.344	0.025	0.01	6			0.7081
	1	2	0.9579							0.9579
	1	3	1.036							1.036
	1	4	0.9414							0.9414
	1	5	0.6036							0.6036
	2	1		1.344	0.015	99.99	6			
B1	1	1	0.6563	1.1859	0.025	0.01	5			0.6563
	1	2	0.8951							0.8951
	1	3	0.9712							0.9712
	1	4	0.8879							0.8879
	1	5	0.5708							0.5708
	2	1		1.3588	0.015	99.99	5			
C1	1	1	0.7448	1.0042	0.025	0.01	9			0.7448
	1	2	0.9577							0.9577
	1	3	1.024							1.024
	1	4	0.9566							0.9566
	1	5	0.5664							0.5664
	2	1		1.5062	0.015	99.99	9			
C2	1	1	0.0426	0.0502	0.025	0.01	5			0.0426
	1	2	0.0496							0.0496
	1	3	0.0531							0.0531
	1	4	0.0504							0.0504
	1	5	0.0283							0.0283
	2	1		0.0752	0.015	99.99	5			
Dummy	1	1	0.7815	0.001	0.025	0	0.001			0.7815
	1	2	0.9873							0.9873
	1	3	1.049							1.049
	1	4	0.9965							0.9965
	1	5	0.5945							0.5945
Roads	1	1	0.1589	0.42	0.015	99.99	5			0.1589
	1	2	0.1704							0.1704
	1	3	0.1822							0.1822
	1	4	0.1752							0.1752
	1	5	0.0955							0.0955
node1	1	1	1.267	0.001	0.025	0	0.001			1.267
	1	2	1.544							1.544
	1	3	1.739							1.739
	1	4	1.732							1.732
	1	5	1.301							1.301
node2	1	1	4.036	0.001	0.025	0	0.001			4.036
	1	2	5.331							5.331
	1	3	5.955							5.955
	1	4	5.412							5.412
	1	5	3.776							3.776

20 YR

	Subcatchment Number	Storm Number	Peak outflow [m^3/s]	Total Area [ha]	Catchment Mannings 'n' [n value]	Percentage Impervious [%]	Catchment Slope [%]	Peak Basin Stage [m]	Peak basin storage [m^3]	Peak Inflow to head of link [m^3/s]
A RIP 1	1	1	0.3328	1.5745	0.04	0.01	2	0.1217	41.379	0.3328
	1	2	0.3899					0.1107	37.624	0.3899
	1	3	0.3905					0.1335	45.379	0.3905
	1	4	0.4219					0.1536	52.221	0.4219
	1	5	0.3401					0.1374	46.719	0.3401
	1	6	0.4555					0.1135	38.603	0.4555
	1	7	0.3421							0.3421
	1	8	0.2849							0.2849
	1	9	0.9703							0.9703
	1	10	1.531							1.531
	2	1		0.0101	0.04	99.99	2			
F-A1	1	1	1.267	4.5893	0.07	0.01	20			1.267
	1	2	1.544							1.544
	1	3	1.739							1.739
	1	4	1.732							1.732
	1	5	1.301							1.301
	1	6	2.219							2.219
	1	7	1.62							1.62
	1	8	1.38							1.38
	2	1		0.0464	0.05	99.99	15			
A1	1	1	2.69	2.9648	0.025	0.01	5			2.69
	1	2	3.493							3.493
	1	3	3.737							3.737
	1	4	3.472							3.472
	1	5	2.173							2.173
	1	6	5.667							5.667
	1	7	4.286							4.286
	1	8	3.732							3.732
	2	1		4.4471	0.015	99.99	5			
B RIP	1	1	2.875	0.8853	0.04	0.01	2	1.5587	3117.4	2.875
	1	2	3.879					2.4869	4973.8	3.879
	1	3	4.234					2.7604	5520.8	4.234
	1	4	3.875					2.9607	5921.3	3.875
	1	5	2.672					3.0492	6098.3	2.672
	1	6	6.444					2.9767	5953.5	6.444
	1	7	4.932							4.932
	1	8	4.27							4.27
	2	1		0.0089	0.04	99.99	2			
OUT	1	1	4.835	0.001	0.025	0	0.001			4.835
	1	2	6.142							6.142
	1	3	6.718							6.718
	1	4	6.099							6.099
	1	5	4.252							4.252
	1	6	8.99							8.99
	1	7	6.969							6.969
	1	8	6.075							6.075
B2	1	1	0.9922	1.344	0.025	0.01	6			0.9922
	1	2	1.3							1.3
	1	3	1.378							1.378
	1	4	1.273							1.273
	1	5	0.7902							0.7902
	1	6	1.574							1.574
	1	7	0.9685							0.9685
	1	8	0.8581							0.8581
	2	1		1.344	0.015	99.99	6			
B1	1	1	0.9259	1.1859	0.025	0.01	5			0.9259
	1	2	1.229							1.229
	1	3	1.303							1.303
	1	4	1.2							1.2
	1	5	0.7477							0.7477
	1	6	1.49							1.49
	1	7	0.9166							0.9166
	1	8	0.8112							0.8112
	2	1		1.3568	0.015	99.99	5			
C1	1	1	1.067	1.0042	0.025	0.01	9			1.067
	1	2	1.279							1.279
	1	3	1.363							1.363
	1	4	1.278							1.278
	1	5	0.74							0.74
	1	6	1.575							1.575
	1	7	0.9059							0.9059
	1	8	0.8042							0.8042
	2	1		1.5082	0.015	99.99	9			
C2	1	1	0.059	0.0502	0.025	0.01	5			0.059
	1	2	0.0653							0.0653
	1	3	0.0697							0.0697
	1	4	0.0662							0.0662
	1	5	0.037							0.037
	1	6	0.0812							0.0812
	1	7	0.0453							0.0453
	1	8	0.0402							0.0402
	2	1		0.0752	0.015	99.99	5			
Dummy	1	1	1.116	0.001	0.025	0	0.001			1.116
	1	2	1.318							1.318
	1	3	1.396							1.396
	1	4	1.33							1.33
	1	5	0.7789							0.7789
	1	6	1.663							1.663
	1	7	0.9705							0.9705
	1	8	0.8614							0.8614
Roads	1	1	0.207	0.42	0.015	99.99	5			0.207
	1	2	0.2231							0.2231
	1	3	0.2383							0.2383
	1	4	0.2289							0.2289
	1	5	0.1245							0.1245
	1	6	0.2791							0.2791
	1	7	0.1523							0.1523
	1	8	0.1353							0.1353
node1	1	1		0.001	0.025		0.001			
node2	1	1	5.795	0.001	0.025	0	0.001			5.795
	1	2	7.392							7.392
	1	3	8.038							8.038
	1	4	7.313							7.313
	1	5	5.028							5.028

100 YR

	Subcatchment Number	Storm Number	Peak outflow [m^3/s]	Total Area [ha]	Catchment Mannings 'n' [n value]	Percentage Impervious [%]	Catchment Slope [%]	Peak Basin Stage [m]	Peak basin storage [m^3]	Peak inflow to head of link [m^3/s]
A RIP 1	1	1	0.2746	1.5745	0.04	0.01	2	0.1217	41.379	0.2746
	1	2	0.4416					0.1107	37.624	0.4416
	1	3	0.4919					0.1335	45.379	0.4919
	1	4	0.5467					0.1536	52.221	0.5467
	1	5	0.5691					0.1374	46.719	0.5691
	1	6	0.5934					0.1135	38.603	0.5934
	1	7	0.4795							0.4795
	1	8	0.4087							0.4087
	2	1		0.0101	0.04	99.99	2			
F-A1	1	1	1.514	4.5893	0.07	0.01	20			1.514
	1	2	1.771							1.771
	1	3	1.809							1.809
	1	4	2.148							2.148
	1	5	2.263							2.263
	1	6	2.219							2.219
	1	7	1.62							1.62
	1	8	1.38							1.38
	2	1		0.0464	0.05	99.99	15			
A1	1	1	3.929	2.9648	0.025	0.01	5			3.929
	1	2	4.185							4.185
	1	3	3.536							3.536
	1	4	4.41							4.41
	1	5	4.628							4.628
	1	6	4.287							4.287
	1	7	2.666							2.666
	1	8	2.352							2.352
	2	1		4.4471	0.015	99.99	5			
B RIP	1	1	4.157	0.8853	0.04	0.01	2	1.5587	3117.4	4.157
	1	2	4.582					2.4869	4973.8	4.582
	1	3	3.861					2.7604	5520.8	3.861
	1	4	4.995					2.9607	5921.3	4.995
	1	5	5.358					3.0492	6098.3	5.358
	1	6	4.878					2.9767	5953.5	4.878
	1	7	3.428							3.428
	1	8	2.984							2.984
	2	1		0.0089	0.04	99.99	2			
OUT	1	1	6.614	0.001	0.025	0	0.001			6.614
	1	2	7.229							7.229
	1	3	6.429							6.429
	1	4	7.9							7.9
	1	5	8.427							8.427
	1	6	7.683							7.683
	1	7	5.465							5.465
	1	8	4.789							4.789
B2	1	1	1.502	1.344	0.025	0.01	6			1.502
	1	2	1.606							1.606
	1	3	1.357							1.357
	1	4	1.626							1.626
	1	5	1.706							1.706
	1	6	1.574							1.574
	1	7	0.9685							0.9685
	1	8	0.8581							0.8581
	2	1		1.344	0.015	99.99	6			
B1	1	1	1.402	1.1859	0.025	0.01	5			1.402
	1	2	1.506							1.506
	1	3	1.254							1.254
	1	4	1.537							1.537
	1	5	1.61							1.61
	1	6	1.49							1.49
	1	7	0.9166							0.9166
	1	8	0.8112							0.8112
	2	1		1.3588	0.015	99.99	5			
C1	1	1	1.598	1.0042	0.025	0.01	9			1.598
	1	2	1.571							1.571
	1	3	1.436							1.436
	1	4	1.584							1.584
	1	5	1.675							1.675
	1	6	1.575							1.575
	1	7	0.9059							0.9059
	1	8	0.8042							0.8042
	2	1		1.5062	0.015	99.99	9			
C2	1	1	0.0836	0.0502	0.025	0.01	5			0.0836
	1	2	0.0793							0.0793
	1	3	0.0748							0.0748
	1	4	0.0807							0.0807
	1	5	0.0854							0.0854
	1	6	0.0812							0.0812
	1	7	0.0453							0.0453
	1	8	0.0402							0.0402
	2	1		0.0752	0.015	99.99	5			
Dummy	1	1	1.647	0.001	0.025	0	0.001			1.647
	1	2	1.617							1.617
	1	3	1.499							1.499
	1	4	1.634							1.634
	1	5	1.716							1.716
	1	6	1.641							1.641
	1	7	0.9512							0.9512
	1	8	0.8444							0.8444
Roads	1	1	0.2859	0.42	0.015	99.99	5			0.2859
	1	2	0.2679							0.2679
	1	3	0.256							0.256
	1	4	0.2747							0.2747
	1	5	0.2908							0.2908
	1	6	0.2791							0.2791
	1	7	0.1523							0.1523
	1	8	0.1353							0.1353
node1	1	1		0.001	0.025		0.001			
node2	1	1	8.008	0.001	0.025	0	0.001			8.008
	1	2	8.8							8.8
	1	3	7.75							7.75
	1	4	9.466							9.466
	1	5	10.064							10.064
	1	6	9.199							9.199
	1	7	6.416							6.416
	1	8	5.633							5.633

PMF

	Subcatchment Number	Storm Number	Peak outflow [m^3/s]	Total Area [ha]	Catchment Mannings 'n' [n value]	Percentage Impervious [%]	Catchment Slope [%]	Peak Basin Stage [m]	Peak basin storage [m^3]	Peak inflow to head of link [m^3/s]
A RIP 1	1	1	0.2641	1.5745	0.04	0.01	2	0.1217	41.379	0.2641
	1	2	1.151					0.1107	37.624	1.151
	1	3	1.741					0.1335	45.379	1.741
	1	4	2.22					0.1536	52.221	2.22
	1	5	2.712					0.1374	46.719	2.712
	1	6	3.068					0.1135	38.603	3.068
	1	7	3.604							3.604
	1	8	4.858							4.858
	2	1		0.0101	0.04	99.99	2			
F-A1	1	1	1.442	4.5893	0.07	0.01	20			1.442
	1	2	3.991							3.991
	1	3	5.619							5.619
	1	4	6.795							6.795
	1	5	8.09							8.09
	1	6	9.388							9.388
	1	7	11.207							11.207
	1	8	14.254							14.254
	2	1		0.0464	0.05	99.99	15			
A1	1	1	3.464	2.9648	0.025	0.01	5			3.464
	1	2	7.207							7.207
	1	3	9.318							9.318
	1	4	10.895							10.895
	1	5	13.753							13.753
	1	6	15.904							15.904
	1	7	18.25							18.25
	1	8	22.81							22.81
	2	1		4.4471	0.015	99.99	5			
B RIP	1	1	3.594	0.8853	0.04	0.01	2	1.5587	3117.4	3.594
	1	2	8.273					2.4869	4973.8	8.273
	1	3	11.651					2.7604	5520.8	11.651
	1	4	14.041					2.9607	5921.3	14.041
	1	5	16.917					3.0492	6098.3	16.917
	1	6	19.368					2.9767	5953.5	19.368
	1	7	23.855							23.855
	1	8	30.322							30.322
	2	1		0.0089	0.04	99.99	2			
OUT	1	1	6.191	0.001	0.025	0	0.001			6.191
	1	2	13.162							13.162
	1	3	18.158							18.158
	1	4	21.912							21.912
	1	5	26.579							26.579
	1	6	30.45							30.45
	1	7	37.81							37.81
	1	8	47.654							47.654
B2	1	1	1.256	1.344	0.025	0.01	6			1.256
	1	2	2.673							2.673
	1	3	3.398							3.398
	1	4	3.983							3.983
	1	5	5.101							5.101
	1	6	5.826							5.826
	1	7	6.637							6.637
	1	8	8.271							8.271
	2	1		1.344	0.015	99.99	6			
B1	1	1	1.173	1.1859	0.025	0.01	5			1.173
	1	2	2.527							2.527
	1	3	3.216							3.216
	1	4	3.76							3.76
	1	5	4.815							4.815
	1	6	5.509							5.509
	1	7	6.279							6.279
	1	8	7.63							7.63
	2	1		1.3588	0.015	99.99	5			
C1	1	1	1.342	1.0042	0.025	0.01	9			1.342
	1	2	2.544							2.544
	1	3	3.185							3.185
	1	4	4.012							4.012
	1	5	4.871							4.871
	1	6	5.491							5.491
	1	7	6.203							6.203
	1	8	7.726							7.726
	2	1		1.5062	0.015	99.99	9			
C2	1	1	0.0751	0.0502	0.025	0.01	5			0.0751
	1	2	0.1278							0.1278
	1	3	0.1664							0.1664
	1	4	0.2074							0.2074
	1	5	0.2454							0.2454
	1	6	0.2747							0.2747
	1	7	0.3099							0.3099
	1	8	0.3859							0.3859
	2	1		0.0752	0.015	99.99	5			
Dummy	1	1	1.414	0.001	0.025	0	0.001			1.414
	1	2	2.658							2.658
	1	3	3.343							3.343
	1	4	4.2							4.2
	1	5	5.09							5.09
	1	6	5.736							5.736
	1	7	6.513							6.513
	1	8	8.112							8.112
Roads	1	1	0.332	0.42	0.015	99.99	5			0.332
	1	2	0.491							0.491
	1	3	0.6078							0.6078
	1	4	0.7069							0.7069
	1	5	0.8247							0.8247
	1	6	0.9232							0.9232
	1	7	1.041							1.041
	1	8	1.296							1.296
node1	1	1		0.001	0.025		0.001			
node2	1	1	7.383	0.001	0.025	0	0.001			7.383
	1	2	15.668							15.668
	1	3	21.251							21.251
	1	4	25.683							25.683
	1	5	31.094							31.094
	1	6	35.907							35.907
	1	7	44.323							44.323
	1	8	55.765							55.765

POST DEVELOPMENT(DETENTION) RAFTS RESULTS

5YR

	Subcatchment Number	Storm Number	Peak outflow [m^3/s]	Total Area [ha]	Catchment Mannings 'n' [n value]	Percentage Impervious [%]	Catchment Slope [%]	Peak Basin Stage [m]	Peak basin storage [m^3]	Peak inflow to head of link [m^3/s]
A RIP 1	1	1	0.1076	1.5846	0.04	0.01	2	0.1217	41.379	0.1076
	1	2	0.2264					0.1107	37.624	0.2264
	1	3	0.2689					0.1335	45.379	0.2689
	1	4	0.2557					0.1556	52.221	0.2557
	1	5	0.2844					0.1374	46.719	0.2844
	1	6	0.2253					0.1135	38.603	0.2253
	1	7	0.2434							0.2434
F-A1	1	1	0.5789	4.5893	0.07	0.01	20			0.5789
	1	2	0.8721							0.8721
	1	3	1.068							1.068
	1	4	1.2							1.2
	1	5	1.243							1.243
	1	6	0.9632							0.9632
	1	7	0.8211							0.8211
	2	1		0.0464	0.05	99.99	15			
A1	1	1	2.226	2.9648	0.025	0.01	5			2.226
	2	1	1.919							1.919
	1	3	2.549							2.549
	1	4	2.808							2.808
	1	5	2.579							2.579
	1	6	1.654							1.654
	1	7	1.459							1.459
	2	1		4.4471	0.015	99.99	5			
Basin 1	1	1	0.3863	0.5434	0.025	0.01	2	1.4491	1700.6	2.295
	1	2	0.6642					1.8072	2606.3	2.001
	1	3	0.7602					1.884	2679	2.695
	1	4	0.7758					1.9021	2719.7	2.956
	1	5	0.7955					1.9249	2771.1	2.743
	1	6	0.7258					1.844	2589	1.754
	1	7	0.7049					1.8243	2769.8	1.572
	2	1		0.055	0.02	99.99	1			
B RIP	1	1	0.5515	0.8942	0.04	0.01	2	1.5587	3117.4	0.5515
	1	2	1.025					2.4869	4973.8	1.025
	1	3	1.144					2.7604	5520.8	1.144
	1	4	1.173					2.9607	5921.3	1.173
	1	5	1.232					3.0492	6098.3	1.232
	1	6	1.017					2.9787	5953.5	1.017
	1	7	1.171							1.171
OUT	1	1	0.6842	0.001	0.025	0	0.001			0.6842
	1	2	1.358							1.358
	1	3	1.51							1.51
	1	4	1.548							1.548
	1	5	1.614							1.614
	1	6	1.343							1.343
	1	7	1.572							1.572
B2	1	1	0.1557	0.2383	0.025	0.01	6			0.1557
	1	2	0.1353							0.1353
	1	3	0.1834							0.1834
	1	4	0.1972							0.1972
	1	5	0.182							0.182
	1	6	0.1073							0.1073
	1	7	0.0955							0.0955
	2	1		0.2383	0.015	99.99	6			
B1	1	1	0.6462	1.4824	0.025	0.01	5			0.6462
	1	2	0.627							0.627
	1	3	0.8529							0.8529
	1	4	0.9397							0.9397
	1	5	0.8353							0.8353
	1	6	0.5683							0.5683
	1	7	0.4995							0.4995
	2	1		1.0624	0.015	99.99	5			
C1	1	1	0.8676	1.0042	0.025	0.01	9			0.8676
	1	2	0.7448							0.7448
	1	3	0.9577							0.9577
	1	4	1.024							1.024
	1	5	0.9566							0.9566
	1	6	0.5664							0.5664
	1	7	0.5041							0.5041
	2	1		1.5062	0.015	99.99	9			
	2	20								
C2	1	1	0.0492	0.0502	0.025	0.01	5			0.0492
	1	2	0.0426							0.0426
	1	3	0.0496							0.0496
	1	4	0.0531							0.0531
	1	5	0.0504							0.0504
	1	6	0.0283							0.0283
	1	7	0.0252							0.0252
	2	1		0.0752	0.015	99.99	5			
Basin 3	1	1	0.09	0.0545	0.025	0.01	1	1.1667	233.34	0.1783
	1	2	0.2103					1.3894	344.72	0.2764
	1	3	0.2388					1.4423	371.13	0.3074
	1	4	0.2524					1.4673	383.66	0.313
	1	5	0.2637					1.4884	394.19	0.3265
	1	6	0.2485					1.4691	380.05	0.2763
	1	7	0.2617					1.4847	392.34	0.3151
	2	1		0.001	0.015	99.99	1			
Basin 2	1	1	0.1462	0.0881	0.025	0.01	1	1.206	271.22	0.4575
	1	2	0.3388					1.4799	417.5	0.4444
	1	3	0.3753					1.5287	445.47	0.5867
	1	4	0.3834					1.54	451.58	0.6718
	1	5	0.3982					1.5608	462.86	0.5921
	1	6	0.3618					1.5094	435.05	0.4886
	1	7	0.4023					1.5656	465.94	0.4584
	2	1		0.001	0.015	99.99	1			
C Tanks	1	1	0.1687	0.001	0.025	0	0.001	0.4961	349.26	0.8676
	1	2	0.2604					0.7658	539.14	0.7448
	1	3	0.2879					0.8468	596.16	0.9577
	1	4	0.2941					0.8651	609.03	1.024
	1	5	0.3097					0.911	641.33	0.9566
	1	6	0.2696					0.7635	537.48	0.5664
	1	7	0.2897					0.852	599.84	0.5041
B Tanks	1	1	0.1714	0.001	0.025	0	0.001	0.2857	271.46	0.6462
	1	2	0.2684					0.4807	456.64	0.627
	1	3	0.3214					0.5356	508.87	0.8529
	1	4	0.3292					0.5487	521.28	0.9397
	1	5	0.3437					0.5728	544.13	0.8353
	1	6	0.2866					0.4777	453.86	0.5683
	1	7	0.3174					0.529	502.67	0.4996
Dummy	1	1	0.09	0.001	0.025	0	0.001			0.09
	1	2	0.2103							0.2103
	1	3	0.2388							0.2388
	1	4	0.2524							0.2524
	1	5	0.2637							0.2637
	1	6	0.2485							0.2485
	1	7	0.2617							0.2617
Roads	1	1	0.1635	0.42	0.015	99.99	5			0.1635
	1	2	0.1569							0.1569
	1	3	0.1704							0.1704
	1	4	0.1822							0.1822
	1	5	0.1762							0.1762
	1	6	0.0955							0.0955
	1	7	0.0851							0.0851
node1	1	1		0.001	0.025		0.001			
node2	1	1	0.7078	0.001	0.025	0	0.001			0.7078
	1	2	1.528							1.528
	1	3	1.695							1.695
	1	4	1.736							1.736
	1	5	1.795							1.795
	1	6	1.576							1.576
	1	7	1.812							1.812

20 YR

	Subcatchment Number	Storm Number	Peak outflow [m^3/s]	Total Area [ha]	Catchment Manning's 'n' [n value]	Percentage Impervious [%]	Catchment Slope [%]	Peak Basin Stage [m]	Peak basin storage [m^3]	Peak inflow to head of link [m^3/s]
A RIP 1	1	1	0.3328	1.6745	0.04	0.01	2	0.1217	41.379	0.3328
	1	2	0.3899					0.1107	37.624	0.3899
	1	3	0.3905					0.1335	45.379	0.3905
	1	4	0.4219					0.1538	52.291	0.4219
	1	5	0.3401					0.1374	46.719	0.3401
	1	6	0.3251					0.1135	38.603	0.3251
	1	7	0.3421							0.3421
	2	1		0.0101	0.04	99.99	2			
F-A1	1	1	1.267	4.5893	0.07	0.01	28			1.267
	1	2	1.544							1.544
	1	3	1.739							1.739
	1	4	1.732							1.732
	1	5	1.301							1.301
	1	6	1.107							1.107
	1	7	1.62							1.62
	2	1		0.0454	0.05	99.99	15			
A1	1	1	2.69	2.9648	0.025	0.01	5			2.69
	1	2	3.493							3.493
	1	3	3.737							3.737
	1	4	3.472							3.472
	1	5	2.173							2.173
	1	6	1.914							1.914
	1	7	4.286							4.286
	2	1		4.4471	0.015	99.99	5			
Basin 1	1	1	0.9488	0.5434	0.025	0.01	2	2.1033	3172.4	2.845
	1	2	1.041					2.2109	3414.6	3.698
	1	3	1.058					2.2313	3460.3	3.634
	1	4	1.087					2.2645	3535.2	3.698
	1	5	0.972					2.1302	3232.9	2.319
	1	6	1.065					2.2388	3477.3	2.062
	1	7	1.927					2.2762	4728.6	4.497
	2	1		0.055	0.02	99.99	1			
B RIP	1	1	1.43	0.8853	0.04	0.01	2	1.5587	3117.4	1.43
	1	2	1.612					2.4869	4973.8	1.612
	1	3	1.631					2.7604	5520.8	1.631
	1	4	1.718					2.9607	5921.3	1.718
	1	5	1.425					3.0492	6098.3	1.425
	1	6	1.563					2.9767	5953.5	1.563
	1	7	2.339							2.339
	2	1		0.0089	0.04	99.99	2			
OUT	1	1	1.901	0.001	0.025	0	0.001			1.901
	1	2	2.124							2.124
	1	3	2.158							2.158
	1	4	2.26							2.26
	1	5	1.884							1.884
	1	6	2.102							2.102
	1	7	2.868							2.868
B2	1	1	0.2097	0.2383	0.025	0.01	6			0.2097
	1	2	0.244							0.244
	1	3	0.2603							0.2603
	1	4	0.2447							0.2447
	1	5	0.1403							0.1403
	1	6	0.1247							0.1247
	1	7	0.1718							0.1718
	2	1		0.2383	0.015	99.99	6			
B1	1	1	0.9147	1.4824	0.025	0.01	5			0.9147
	1	2	1.181							1.181
	1	3	1.252							1.252
	1	4	1.143							1.143
	1	5	0.7458							0.7458
	1	6	0.6578							0.6578
	1	7	0.9148							0.9148
	2	1		1.0624	0.015	99.99	5			
C1	1	1	1.067	1.0042	0.025	0.01	9			1.067
	1	2	1.279							1.279
	1	3	1.363							1.363
	1	4	1.278							1.278
	1	5	0.74							0.74
	1	6	0.6578							0.6578
	1	7	0.9059							0.9059
	2	1		1.5062	0.015	99.99	9			
C2	1	1	0.059	0.0502	0.025	0.01	5			0.059
	1	2	0.0653							0.0653
	1	3	0.0697							0.0697
	1	4	0.0662							0.0662
	1	5	0.037							0.037
	1	6	0.0329							0.0329
	1	7	0.0453							0.0453
	2	1		0.0752	0.015	99.99	5			
Basin 3	1	1	0.295	0.0545	0.025	0.01	1	1.5464	423.18	0.3769
	1	2	0.3324					1.6156	457.81	0.4173
	1	3	0.3467					1.6421	471.06	0.4249
	1	4	0.3602					1.667	483.51	0.4388
	1	5	0.3354					1.6212	460.58	0.3733
	1	6	0.3522					1.6523	476.13	0.4169
	1	7	0.4142					1.5341	417.04	0.5066
	2	1		0.001	0.015	99.99	1			
Basin 2	1	1	0.4745	0.0881	0.025	0.01	1	1.6683	520.87	0.6179
	1	2	0.5262					1.7397	559.42	0.812
	1	3	0.5346					1.7529	566.58	0.9164
	1	4	0.5465					1.7698	575.68	0.8145
	1	5	0.4867					1.6855	530.2	0.6637
	1	6	0.5403					1.761	570.93	0.6095
	1	7	0.5687					1.6866	530.77	0.8451
	2	1		0.001	0.015	99.99	1			
C Tanks	1	1	0.3537	0.001	0.025	0	0.001	1.0404	732.44	1.067
	1	2	0.392					1.1529	811.63	1.279
	1	3	0.3991					1.1739	826.45	1.363
	1	4	0.4181					1.2296	865.67	1.278
	1	5	0.3522					1.0358	729.2	0.74
	1	6	0.3837					1.1285	794.47	0.6578
	1	7	0.45					1.3238	931.76	0.9059
B Tanks	1	1	0.3956	0.001	0.025	0	0.001	0.6593	626.34	0.9147
	1	2	0.4418					0.7364	699.58	1.181
	1	3	0.4511					0.7519	714.31	1.252
	1	4	0.4708					0.7846	745.39	1.143
	1	5	0.3927					0.6545	621.73	0.7458
	1	6	0.4215					0.7026	667.43	0.6578
	1	7	0.506					0.8434	801.2	0.9148
Dummy	1	1	0.295	0.001	0.025	0	0.001			0.295
	1	2	0.3324							0.3324
	1	3	0.3467							0.3467
	1	4	0.3602							0.3602
	1	5	0.3354							0.3354
	1	6	0.3522							0.3522
	1	7	0.4142							0.4142
Roads	1	1	0.207	0.42	0.015	99.99	5			0.207
	1	2	0.2231							0.2231
	1	3	0.2383							0.2383
	1	4	0.2289							0.2289
	1	5	0.1245							0.1245
	1	6	0.1108							0.1108
	1	7	0.1523							0.1523
node1	1	1	1.267	0.001	0.025	0	0.001			1.267
	1	2	1.544							1.544
	1	3	1.739							1.739
	1	4	1.732							1.732
	1	5	1.301							1.301
	1	6	1.107							1.107
node2	1	1	2.146	0.001	0.025	0	0.001			2.146
	1	2	2.386							2.386
	1	3	2.433							2.433
	1	4	2.526							2.526
	1	5	2.125							2.125
	1	6	2.432							2.432

100 YR

	Subcatchment Number	Storm Number	Peak outflow [m^3/s]	Total Area [ha]	Catchment Mannings 'n' [n value]	Percentage Impervious [%]	Catchment Slope [%]	Peak Basin Stage [m]	Peak basin storage [m^3]	Peak inflow to head of link [m^3/s]
A RIP 1	1	1	0.2746	1.5745	0.04	0.01	2	0.1217	41.379	0.2746
	1	2	0.4416					0.1107	37.624	0.4416
	1	3	0.4919					0.1335	45.379	0.4919
	1	4	0.5467					0.1536	52.221	0.5467
	1	5	0.5691					0.1374	46.719	0.5691
	1	6	0.5934					0.1135	38.583	0.5934
	1	7	0.4795							0.4795
	1	8	0.4057							0.4057
	2	1		0.0101	0.04	99.99	2			
F-A1	1	1	1.442	4.5893	0.07	0.01	20			1.442
	1	2	3.991							3.991
	1	3	5.619							5.619
	1	4	6.795							6.795
	1	5	8.09							8.09
	1	6	9.388							9.388
	1	7	11.207							11.207
	1	8	14.254							14.254
	2	1		0.0464	0.05	99.99	15			
A1	1	1	3.929	2.9648	0.025	0.01	5			3.929
	1	2	4.185							4.185
	1	3	3.556							3.556
	1	4	4.41							4.41
	1	5	4.628							4.628
	1	6	4.287							4.287
	1	7	2.666							2.666
	1	8	2.352							2.352
	2	1		4.4471	0.015	99.99	5			
Basin 1	1	1	0.9286	0.5434	0.025	0.01	2	1.8098	2903.5	4.13
	1	2	1.315					2.1469	3712.5	4.418
	1	3	1.463					2.2761	4022.7	3.761
	1	4	1.594					2.3906	4297.4	4.674
	1	5	1.594					2.3908	4297.8	4.675
	1	6	1.638					2.4293	4390.3	4.574
	1	7	1.371					2.1958	3830.2	2.677
	1	8	1.503					2.3115	4107.6	2.535
	2	1		0.055	0.015	99.99	1			
B RIP	1	1	1.372	0.8853	0.04	0.01	2	1.5587	3117.4	1.372
	1	2	1.964					2.4569	4973.8	1.964
	1	3	2.148					2.7604	5520.8	2.148
	1	4	2.391					2.9607	5921.3	2.391
	1	5	2.398					3.0492	6098.3	2.398
	1	6	2.489					2.9767	5953.5	2.489
	1	7	2.08							2.08
	1	8	2.122							2.122
	2	1		0.0089	0.04	99.99	2			
OUT	1	1	1.707	0.001	0.025	0	0.001			1.707
	1	2	2.517							2.517
	1	3	2.783							2.783
	1	4	3.086							3.086
	1	5	3.087							3.087
	1	6	3.23							3.23
	1	7	2.643							2.643
	1	8	2.805							2.805
B2	1	1	0.3077	0.2383	0.025	0.01	6			0.3077
	1	2	0.2991							0.2991
	1	3	0.2763							0.2763
	1	4	0.3021							0.3021
	1	5	0.3195							0.3195
	1	6	0.3009							0.3009
	1	7	0.1718							0.1718
	1	8	0.1525							0.1525
	2	1		0.2383	0.015	99.99	6			
B1	1	1	1.286	1.4824	0.025	0.01	5			1.286
	1	2	1.45							1.45
	1	3	1.2							1.2
	1	4	1.493							1.493
	1	5	1.559							1.559
	1	6	1.423							1.423
	1	7	0.9148							0.9148
	1	8	0.8094							0.8094
	2	1		1.0624	0.015	99.99	5			
C1	1	1	1.598	1.0042	0.025	0.01	9			1.598
	1	2	1.571							1.571
	1	3	1.436							1.436
	1	4	1.684							1.684
	1	5	1.675							1.675
	1	6	1.575							1.575
	1	7	0.9059							0.9059
	1	8	0.8042							0.8042
	2	1		1.5062	0.015	99.99	9			
C2	1	1	0.0836	0.0502	0.025	0.01	5			0.0836
	1	2	0.0793							0.0793
	1	3	0.0748							0.0748
	1	4	0.0807							0.0807
	1	5	0.0854							0.0854
	1	6	0.0812							0.0812
	1	7	0.0453							0.0453
	1	8	0.0402							0.0402
	2	1		0.0752	0.015	99.99	5			
Basin 3	1	1	0.2047	0.0545	0.025	0.01	1	1.3791	339.55	0.3378
	1	2	0.3309					1.6127	456.34	0.456
	1	3	0.4065					1.7627	526.36	0.5052
	1	4	0.4528					1.8365	569.25	0.5515
	1	5	0.4631					1.8575	578.77	0.5532
	1	6	0.475					1.8796	589.78	0.5657
	1	7	0.436					1.8073	553.66	0.5066
	1	8	0.4486					1.8308	565.41	0.5233
	2	1		0.001	0.015	99.99	1			
Basin 2	1	1	0.3417	0.0881	0.025	0.01	1	1.4812	419.85	0.8409
	1	2	0.5579					1.7858	584.92	0.9301
	1	3	0.6522					1.9186	656.01	0.8221
	1	4	0.7173					2.002	701.06	1.053
	1	5	0.7104					2.0002	700.12	1.166
	1	6	0.7465					2.0061	703.28	1.042
	1	7	0.6277					1.8841	637.41	0.8451
	1	8	0.6845					1.9641	680.59	0.7671
	2	1		0.001	0.015	99.99	1			
C Tanks	1	1	0.3266	0.001	0.025	0	0.001	0.9607	676.36	1.598
	1	2	0.43					1.2648	890.45	1.571
	1	3	0.4737					1.3932	980.84	1.436
	1	4	0.517					1.5207	1070.6	1.684
	1	5	0.518					1.5236	1072.6	1.675
	1	6	0.5771					1.5816	1113.4	1.575
	1	7	0.45					1.3236	931.78	0.9059
	1	8	0.4819					1.4175	997.9	0.8042
B Tanks	1	1	0.3542	0.001	0.025	0	0.001	0.5903	560.8	1.286
	1	2	0.4859					0.8098	769.35	1.45
	1	3	0.533					0.8883	843.93	1.2
	1	4	0.5876					0.9794	930.44	1.493
	1	5	0.5907					0.9846	935.35	1.559
	1	6	0.6131					1.0218	970.75	1.423
	1	7	0.506					0.8434	801.2	0.9148
	1	8	0.5295					0.8825	838.36	0.8094
Dummy	1	1	0.2047	0.001	0.025	0	0.001			0.2047
	1	2	0.3309							0.3309
	1	3	0.4065							0.4065
	1	4	0.4528							0.4528
	1	5	0.4631							0.4631
	1	6	0.475							0.475
	1	7	0.436							0.436
	1	8	0.4486							0.4486
Roads	1	1	0.2859	0.42	0.015	99.99	5			0.2859
	1	2	0.2679							0.2679
	1	3	0.256							0.256
	1	4	0.2747							0.2747
	1	5	0.2908							0.2908
	1	6	0.2791							0.2791
	1	7	0.1523							0.1523
	1	8	0.1353							0.1353
node1	1	1		0.001	0.025		0.001			
node2	1	1	1.819	0.001	0.025	0	0.001			1.819
	1	2	2.771							2.771
	1	3	3.125							3.125
	1	4	3.431							3.431
	1	5	3.431							3.431
	1	6	3.592							3.592
	1	7	2.942							2.942
	1	8	3.229							3.229

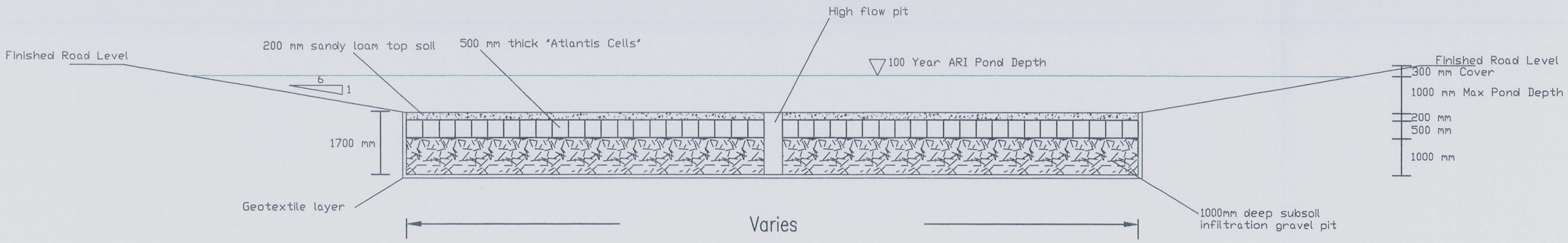
PMF

	Subcatchment Number	Storm Number	Peak outflow [m^3/s]	Total Area [ha]	Catchment Mannings 'n' (n value)	Percentage Impervious [%]	Catchment Slope [%]	Peak Basin Stage [m]	Peak basin storage [m^3]	Peak inflow to head of link [m^3/s]
A RIP 1	1	1	0.2641	1.5745	0.04	0.01	2	0.1217	41.379	0.2641
	1	2	1.151					0.1107	37.624	1.151
	1	3	1.741					0.1335	45.379	1.741
	1	4	2.22					0.1536	52.221	2.22
	1	5	2.712					0.1374	46.719	2.712
	1	6	3.068					0.1135	38.603	3.068
	1	7	3.604							3.604
	1	8	4.858							4.858
	2	1		0.0101	0.04	99.99	2			
F-A1	1	1	1.442	4.5893	0.07	0.01	20			1.442
	1	2	3.991							3.991
	1	3	5.619							5.619
	1	4	6.795							6.795
	1	5	8.09							8.09
	1	6	9.368							9.368
	1	7	11.207							11.207
	1	8	14.254							14.254
	2	1		0.0464	0.05	99.99	15			
A1	1	1	3.464	2.9648	0.025	0.01	5			3.464
	1	2	7.207							7.207
	1	3	9.318							9.318
	1	4	10.895							10.895
	1	5	13.753							13.753
	1	6	15.904							15.904
	1	7	18.25							18.25
	1	8	22.81							22.81
	2	1		4.4471	0.015	99.99	5			
Basin 1	1	1	0.7464	0.5434	0.025	0.01	2	1.8679	2686.2	3.642
	1	2	4.4					3.4207	6257.5	7.727
	1	3	8.382					3.7912	7109.7	10.042
	1	4	11.13					4.0039	7699	11.773
	1	5	13.69					4.1839	8013.1	14.81
	1	6	15.5					4.3041	8289.5	17.111
	1	7	19.23					4.5563	8823.4	19.71
	1	8	24.61					4.8453	9534.2	24.649
	2	1		0.055	0.015	99.99	1			
B RIP	1	1	1.17	0.8853	0.04	0.01	2	1.5587	3117.4	1.17
	1	2	6.095					2.4869	4973.8	6.095
	1	3	11.033					2.7604	5520.8	11.033
	1	4	14.501					2.9607	5921.3	14.501
	1	5	17.892					3.0492	6098.3	17.892
	1	6	20.237					2.9767	5953.5	20.237
	1	7	24.853							24.853
	1	8	32.119							32.119
	2	1		0.0089	0.04	99.99	2			
OUT	1	1	1.497	0.001	0.025	0	0.001			1.497
	1	2	7.508							7.508
	1	3	13.583							13.583
	1	4	17.841							17.841
	1	5	22.207							22.207
	1	6	25.516							25.516
	1	7	30.036							30.036
	1	8	40.635							40.635
	1	4	17.841							17.841
	1	5	22.207							22.207
	1	6	25.516							25.516
	1	7	30.036							30.036
	1	8	40.635							40.635
B2	1	1	0.2607	0.2383	0.025	0.01	6			0.2607
	1	2	0.4836							0.4836
	1	3	0.6067							0.6067
	1	4	0.7634							0.7634
	1	5	0.9269							0.9269
	1	6	1.043							1.043
	1	7	1.177							1.177
	1	8	1.467							1.467
	2	1		0.2383	0.015	99.99	6			
B1	1	1	1.11	1.4824	0.025	0.01	5			1.11
	1	2	2.497							2.497
	1	3	3.213							3.213
	1	4	3.757							3.757
	1	5	4.725							4.725
	1	6	5.463							5.463
	1	7	6.273							6.273
	1	8	7.829							7.829
	2	1		1.0624	0.015	99.99	5			
C1	1	1	1.342	1.0042	0.025	0.01	9			1.342
	1	2	2.544							2.544
	1	3	3.185							3.185
	1	4	4.012							4.012
	1	5	4.871							4.871
	1	6	5.491							5.491
	1	7	6.203							6.203
	1	8	7.726							7.726
	2	1		1.5062	0.015	99.99	9			
C2	1	1	0.0751	0.0502	0.025	0.01	5			0.0751
	1	2	0.1278							0.1278
	1	3	0.1664							0.1664
	1	4	0.2074							0.2074
	1	5	0.2454							0.2454
	1	6	0.2747							0.2747
	1	7	0.3099							0.3099
	1	8	0.3859							0.3859
	2	1		0.0752	0.015	99.99	5			
Basin 3	1	1	0.199	0.0545	0.025	0.01	1	1.3685	334.24	0.3293
	1	2	0.9459					2.0296	664.81	0.9737
	1	3	1.62					2.0573	678.65	1.622
	1	4	2.215					2.077	688.49	2.215
	1	5	3.119					2.1029	701.43	3.12
	1	6	3.846					2.1215	710.76	3.846
	1	7	4.998					2.1485	724.25	5.002
	1	8	6.947					2.1894	744.7	6.948
	2	1		0.001	0.015	99.99	1			
	2	20								
Basin 2	1	1	0.3321	0.0861	0.025	0.01	1	1.4677	412.55	0.7236
	1	2	1.694					2.0576	731.19	1.704
	1	3	2.597					2.0896	748.38	2.602
	1	4	3.411					2.1141	761.61	3.418
	1	5	4.694					2.1482	780.03	4.705
	1	6	5.761					2.1738	793.86	5.767
	1	7	7.075					2.203	809.64	7.079
	1	8	9.397					2.2502	835.11	9.398
	2	1		0.001	0.015	99.99	1			
C Tanks	1	1	0.3189	0.001	0.025	0	0.001	0.9379	660.3	1.342
	1	2	0.9252					2.7212	1915.7	2.544
	1	3	1.523					4.4816	3155.1	3.185
	1	4	2.094					6.1602	4336.8	4.012
	1	5	2.922					8.5955	6051.2	4.871
	1	6	3.697					10.582	7449.7	5.491
	1	7	4.617					13.582	9561.6	6.203
	1	8	6.502					19.125	13464	7.726
B Tanks	1	1	0.3455	0.001	0.025	0	0.001	0.8759	547.06	1.11
	1	2	1.072					1.7873	1697.9	2.497
	1	3	1.751					2.9188	2772.9	3.213
	1	4	2.363					3.9385	3741.6	3.757
	1	5	3.203					5.3398	5072.8	4.725
	1	6	3.919					6.533	6206.4	5.463
	1	7	4.954					8.2578	7844.9	6.273
	1	8	6.796					11.26	10697	7.83
Dummy	1	1	0.199	0.001	0.025	0	0.001			0.199
	1	2	0.9459							0.9459
	1	3	1.62							1.62
	1	4	2.215							2.215
	1	5	3.12							3.12
	1	6	3.846							3.846
	1	7	4.998							4.998
	1	8	6.948							6.948
Roads	1	1	0.332	0.42	0.015	99.99	5			0.332
	1	2	0.491							0.491
	1	3	0.6078							0.6078
	1	4	0.7069							0.7069
	1	5	0.8247							0.8247
	1	6	0.9232							0.9232
	1	7	1.041							1.041
	1	8	1.296							1.296
node1	1	1		0.001	0.025		0.001			
node2	1	1	1.613	0.001	0.025	0	0.001			1.613
	1	2	8.287							8.287
	1	3	15.11							15.11
	1	4	19.816							19.816
	1	5	24.752							24.752
	1	6	28.793							28.793
	1	7	34.265							34.265
	1	8	45.639							45.639

Appendix D -

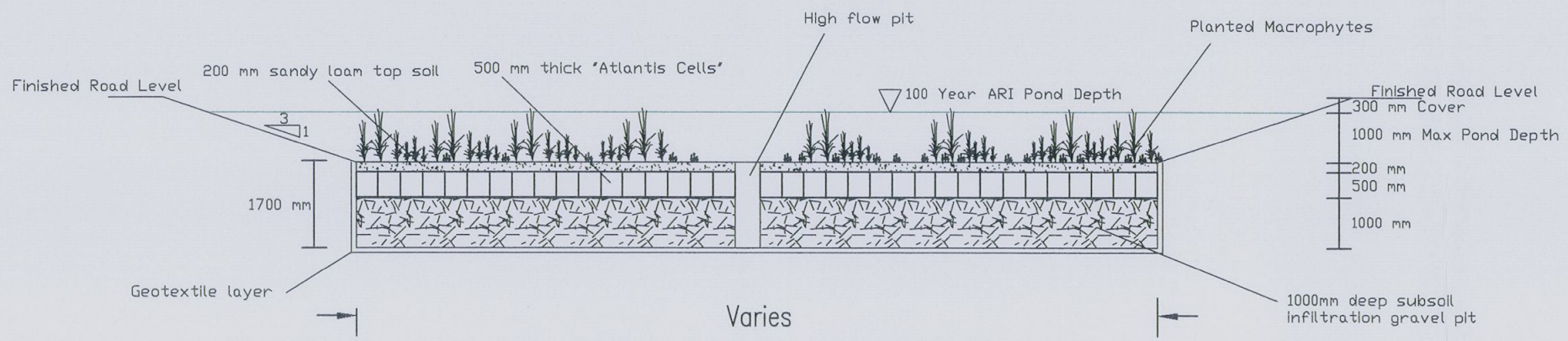
DETENTION BASIN CROSS SECTIONS

APPENDIX D



TYPICAL SECTION OF BASIN 1

NOTE: DRAWING NOT TO SCALE



TYPICAL SECTION OF BASIN 2 AND 3

NOTE: DRAWING NOT TO SCALE

TYPICAL CROSS SECTIONS OF PROPOSED DETENTION/INFILTRATION/BIO RETENTION BASINS

WorleyParsons
resources & energy

Appendix E -

WATER QUALITY RESULTS

LabMark
ENVIRONMENTAL LABORATORIES

ilac-MRA NATA Accreditation No. 13542

AQIS
AUSTRALIAN QUARANTINE AND INSPECTION SERVICE
SYDNEY License No. N0356.

Accredited for compliance with ISO/IEC 17025. The results of tests, calibrations and/or measurements included in this document are traceable to Australian national standards. NATA is a signatory to the APLAC mutual recognition arrangement for the mutual recognition of the equivalence of testing, calibration and inspection reports.

Quarantine Approved Premises criteria 5.1 for quarantine containment level 1 (QCI) facilities. Class five criteria cover premises utilised for research, analysis and testing of biological material, soil, animal, plant and human products.

CUSTOMER CENTRIC - ANALYTICAL CHEMISTS

FINAL CERTIFICATE OF ANALYSIS - ENVIRONMENTAL DIVISION

Laboratory Report No:	E038259	Cover Page 1 of 4
Client Name:	Patterson Britton & Partners Pty Ltd	plus Sample Results
Client Reference:	6646	
Contact Name:	James Hoang	
Chain of Custody No:	na	Date Received: 20/06/2008
Sample Matrix:	WATER	Date Reported: 01/07/2008

This Final Certificate of Analysis consists of sample results, DQI's, method descriptions, laboratory definitions, and internationally recognised NATA accreditation and endorsement. The DQO compliance relates specifically to QA/QC results as performed as part of the sample analysis, and may provide an indication of sample result quality. Transfer of report ownership from Labmark to the client shall only occur once full & final payment has been settled and verified. All report copies may be retracted where full payment has not occured within the agreed settlement period.

QUALITY ASSURANCE CRITERIA

Accuracy:	matrix spike:	1 in first 5-20, then 1 every 20 samples
	lcs, crm, method:	1 per analytical batch
	surrogate spike:	addition per target organic method
Precision:	laboratory duplicate:	1 in first 5-10, then 1 every 10 samples
	laboratory triplicate:	re-extracted & reported when duplicate RPD values exceed acceptance criteria
Holding Times:	soils, waters:	Refer to LabMark Preservation & THT table VOC's 14 days water / soil VAC's 7 days water or 14 days acidified VAC's 14 days soil SVOC's 7 days water, 14 days soil Pesticides 7 days water, 14 days soil Metals 6 months general elements Mercury 28 days
Confirmation:	target organic analysis:	GC/MS, or confirmatory column
Sensitivity:	EQL:	Typically 2-5 x Method Detection Limit (MDL)

QUALITY CONTROL GLOBAL ACCEPTANCE CRITERIA (GAC)

Accuracy:	spike, lcs, crm surrogate:	general analytes 70% - 130% recovery phenol analytes 50% - 130% recovery organophosphorous pesticide analytes 60% - 130% recovery phenoxy acid herbicides, organotin 50% - 130% recovery
	anion/cation bal:	+/- 10% (0-3 meq/l), +/- 5% (>3 meq/l)
Precision:	method blank:	not detected >95% of the reported EQL
	duplicate lab RPD (metals):	0-30% (>10xEQL), 0-75% (5-10xEQL) 0-100% (<5xEQL)
	duplicate lab RPD:	0-50% (>10xEQL), 0-75% (5-10xEQL) 0-100% (<5xEQL)

QUALITY CONTROL ANALYTE SPECIFIC ACCEPTANCE CRITERIA (ASAC)

Accuracy:	spike, lcs, crm surrogate:	analyte specific recovery data <3xsd of historical mean
Uncertainty:	spike, lcs:	measurement calculated from historical analyte specific control charts

RESULT ANNOTATION

Data Quality Objective	s:	matrix spike recovery	p:	pending	bcs:	batch specific lcs
Data Quality Indicator	d:	laboratory duplicate	lcs:	laboratory control sample	bmb:	batch specific mb
Estimated Quantitation Limit	t:	laboratory triplicate	crm:	certified reference material		
not applicable	r:	RPD relative % difference	mb:	method blank		

David Burns
Quality Control (Report signatory)
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Geoff Weir
Authorising Chemist (NATA signatory)
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Simon Mills
Authorising Chemist (NATA signatory)
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NEPC GUIDELINE COMPLIANCE - DQO

1. GENERAL

A. Results relate specifically to samples as received. Sample results are not corrected for matrix spike, lcs, or surrogate recovery data.

B. EQL's are matrix dependant and may be increased due to sample dilution or matrix interference.

C. Laboratory QA/QC samples are specific to this project.

D. Inter-laboratory proficiency results are available upon request. NATA accreditation details available at www.nata.asn.au.

E. VOC spikes & surrogates added to samples during extraction, SVOC spikes & surrogates added prior to extraction.

F. Recovery data outside GAC limits shall be investigated and compared to ASAC (historical mean +/- 3sd). If recovery data <20%, then the relevant results for that compound are considered not reliable.

G. Recovery data (ms, surrogate, crm, lcs) outside ASAC limits shall initiate an investigative action. Anomolous QC data is examined in conjunction with other QC samples and a final decision whether to accept or reject results is provided by the professional judgement of the senior analyst. The USEPA-CLP National Functional Guidelines are referred to for specific recommendations.

H. Extraction (preparation) date refers to the date that sample preparation was initiated. Note that certain methods not requiring sample preparation (eg. VOCs in water, etc) may report a common extraction and analysis date.

I. LabMark shall maintain an official copy of this Certificate of Analysis for all tracable reference purposes.

2. CHAIN OF CUSTODY (COC) & SAMPLE RECEIPT NOTICE (SRN) REQUIREMENTS

A. SRN issued to client upon sample receipt & login verification.

B. Preservation & sampling date details specified on COC and SRN, unless noted.

C. Sample Integrity & Validated Time of Sample Receipt (VTSR) Holding Times verified (preservation may extend holding time, refer to preservation chart).

3. NATA ACCREDITED METHODS

A. NATA accreditation held for each in-house method and sample matrix type reported, unless noted below (Refer to subcontracted test reports for NATA accreditation status).

B. NATA accredited in-house laboratory methods are referenced from NEPC, ASTM, modified USEPA / APHA documents. Corporate Accreditation No. 13542.

C. Subcontracted analyses: Refer to Sample Receipt Notice and additional DQO comments.

Reported by EML, NATA accreditation No.2047.

Reported by Sydney Analytical Laboratories, NATA accreditation No.1884.

4. QA/QC FREQUENCY COMPLIANCE TABLE SPECIFIC TO THIS REPORT

Matrix: **WATER**

Page:	Method:	Totals:	#d	%d-ratio	#t	#s	%s-ratio
1	Nitrate as N	4	0	0%	0	0	0%
1	Nitrite as N	4	0	0%	0	0	0%
2	TKN (as N)	4	0	0%	0	0	0%
3	Ammonia as N	4	0	0%	0	0	0%
4	Total Nitrogen (as N)	4	0	0%	0	0	0%
5	Ortho phosphate (as P)	4	0	0%	0	0	0%
6	Total Phosphorus (as P)	4	0	0%	0	0	0%
7	Filtered metals	4	0	0%	0	0	0%
8	Unfiltered metals	4	0	0%	0	0	0%
9	Turbidity	4	1	25%	0	0	0%
10	Suspended Solids (TSS)	4	1	25%	0	0	0%

GLOSSARY:

#d	number of discrete duplicate extractions/analyses performed.
%d-ratio	NEPC guideline for laboratory duplicates is 1 in 10 samples (min 10%).
#t	number of triplicate extractions/analyses performed.
#s	number of spiked samples analysed.
%s-ratio	USEPA guideline for laboratory matrix spikes is 1 in 20 samples (min 5%).

LabMark
ENVIRONMENTAL LABORATORIES

CUSTOMER CENTRIC - ANALYTICAL CHEMISTS

Environmental Laboratory Industry Group
Foundation Member

Laboratory Report: E038259

5. ADDITIONAL COMMENTS SPECIFIC TO THIS REPORT

A. All tests were conducted by LabMark Environmental Sydney, NATA accreditation No. 13542, Corporate Site No. 13535, unless indicated below.
B. The following test was conducted by EML, NATA accreditation No.2047. :- Faecal Coliforms.See attached report.
C. The following tests were conducted by Sydney Analytical Laboratories, NATA accreditation No.1884. :- TSS and Turbidity.SAL reference SAL20853 report issued on 25/6/2008.

Laboratory QA/QC data shall relate specifically to this report, and may provide an indication of site specific sample result quality. LabMark DOES NOT report NON-RELEVANT BATCH QA/QC data. Acceptance of this self assessment certificate does not preclude any requirement for a QA/QC review by a accredited contaminated site EPA auditor, when and wherever necessary. Laboratory QA/QC self assessment references available upon request.

LabMark PTY LTD ABN 27 079 798 397
* SYDNEY: Unit 1, 8 Leighton Place Asquith NSW 2077 * Telephone: (02) 9476 6533 * Fax: (02) 9476 8219
* MELBOURNE: 116 Moray Street, South Melbourne VIC 3205 * Telephone: (03) 9686 8344 * Fax: (03) 9686 7344

LabMark
ENVIRONMENTAL LABORATORIES

Laboratory Report No: E038259
Client Name: Patterson Britton & Partners Pty Ltd
Contact Name: James Hoang
Client Reference: 6646

Page: 1 of 10
plus cover page
Date: 01/07/08
This report supercedes reports issued on: 30/06/08

Final
Certificate
of Analysis

Laboratory Identification		162674	162675	162676	162677	lcs	mb				
Sample Identification		WS811DS	WS811IS	WS811IS2	WS1111US/ 811DS	QC	QC				
Depth (m)		--	--	--	--	--	--				
Sampling Date recorded on COC		18/6/08	18/6/08	18/6/08	18/6/08	--	--				
Laboratory Extraction (Preparation) Date		20/6/08	20/6/08	20/6/08	20/6/08	20/6/08	20/6/08				
Laboratory Analysis Date		20/6/08	20/6/08	20/6/08	20/6/08	20/6/08	20/6/08				
Method : E037.1/E051.1											
Nitrite as N	**EQL**										
NO2-N	0.01	0.02	0.02	0.02	0.02	102%	<0.01				
Method : E037.1/E051.1											
Nitrate as N	**EQL**										
NO3-N	0.01	0.03	0.45	0.29	0.26	97%	<0.01				

Results expressed in mg/l unless otherwise specified

Comments: -

E037.1/E051.1: Nitrate determined by colour. Sample filtered through 0.45um prior to analysis.
E037.1/E051.1: Nitrite determined by colour. Sample filtered through 0.45um prior to analysis.

LabMark
ENVIRONMENTAL LABORATORIES

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Certificate of Analysis

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Sample Identification		WS811DS	WS811IS	WS811IS2	WS1111US/ 811DS	QC	QC				
Depth (m)		--	--	--	--	--	--				
Sampling Date recorded on COC		18/6/08	18/6/08	18/6/08	18/6/08	--	--				
Laboratory Extraction (Preparation) Date		20/6/08	20/6/08	20/6/08	20/6/08	20/6/08	20/6/08				
Laboratory Analysis Date		25/6/08	25/6/08	25/6/08	25/6/08	25/6/08	25/6/08				
Method : E039.1											
TKN (as N)	**EQL**										
Total Kjeldahl Nitrogen	0.1	0.8	0.6	1.0	0.5	85%	<0.1				

Results expressed in mg/l unless otherwise specified

Comments:

E039.1: Sample filtered through 0.45um filter prior to analysis. Acidic digestion followed by determination by colour.

LabMark
ENVIRONMENTAL LABORATORIES

Laboratory Report No: E038259
Client Name: Patterson Britton & Partners Pty Ltd
Contact Name: James Hoang
Client Reference: 6646

Page: 3 of 10
plus cover page
Date: 01/07/08
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Certificate
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Laboratory Identification		162674	162675	162676	162677	lcs	mb				
Sample Identification		WS811DS	WS811IS	WS811IS2	WS1111US/ 811DS	QC	QC				
Depth (m)		--	--	--	--	--	--				
Sampling Date recorded on COC		18/6/08	18/6/08	18/6/08	18/6/08	--	--				
Laboratory Extraction (Preparation) Date		20/6/08	20/6/08	20/6/08	20/6/08	20/6/08	20/6/08				
Laboratory Analysis Date		20/6/08	20/6/08	20/6/08	20/6/08	20/6/08	20/6/08				
Method : E036.1/E050.1											
Ammonia as N	**EQL**										
Ammonia	0.01	0.02	0.01	0.01	0.03	102%	<0.01				

Results expressed in mg/l unless otherwise specified

Comments:

E036.1/E050.1: Determined by colour. Sample filtered through 0.45um prior to analysis.

LabMark
ENVIRONMENTAL LABORATORIES

Laboratory Report No: E038259
Client Name: Patterson Britton & Partners Pty Ltd
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Date: 01/07/08

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Laboratory Identification		162674	162675	162676	162677	lcs	mb				
Sample Identification		WS811DS	WS811IS	WS811IS2	WS1111US/ 811DS	QC	QC				
Depth (m)		--	--	--	--	--	--				
Sampling Date recorded on COC		18/6/08	18/6/08	18/6/08	18/6/08	--	--				
Laboratory Extraction (Preparation) Date		20/6/08	20/6/08	20/6/08	20/6/08	20/6/08	20/6/08				
Laboratory Analysis Date		25/6/08	25/6/08	25/6/08	25/6/08	25/6/08	25/6/08				
Method : E038.1											
Total Nitrogen (as N)	**EQL**										
Total Nitrogen (as N)	0.1	0.9	1.1	1.3	0.8	92%	<0.1				

Results expressed in mg/l unless otherwise specified

Comments:

E038.1: Total Nitrogen by calculation.

Laboratory Identification		162674	162675	162676	162677	lcs	mb				
Sample Identification		WS811DS	WS811IS	WS811IS2	WS1111US/ 811DS	QC	QC				
Depth (m)		--	--	--	--	--	--				
Sampling Date recorded on COC		18/6/08	18/6/08	18/6/08	18/6/08	--	--				
Laboratory Extraction (Preparation) Date		20/6/08	20/6/08	20/6/08	20/6/08	20/6/08	20/6/08				
Laboratory Analysis Date		20/6/08	20/6/08	20/6/08	20/6/08	20/6/08	20/6/08				
Method : E038.1/E052.1											
Ortho phosphate (as P)	**EQL**										
Ortho Phosphate (as P)	0.005	<0.005	0.006	0.008	0.008	106%	<0.005				

Results expressed in mg/l unless otherwise specified

Comments:

E038.1/E052.1: Determined by colour. Sample filtered through a 0.45um filter prior to analysis.

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ENVIRONMENTAL LABORATORIES

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Sample Identification		WS811DS	WS811IS	WS811IS2	WS1111US/ 811DS	QC	QC				
Depth (m)		--	--	--	--	--	--				
Sampling Date recorded on COC		18/6/08	18/6/08	18/6/08	18/6/08	--	--				
Laboratory Extraction (Preparation) Date		20/6/08	20/6/08	20/6/08	20/6/08	20/6/08	20/6/08				
Laboratory Analysis Date		24/6/08	24/6/08	24/6/08	24/6/08	24/6/08	24/6/08				
Method : E038.1											
Total Phosphorus (as P)	**EQL**										
Total Phosphorus (as P)	0.01	0.01	0.02	0.02	0.02	101%	<0.01				

Results expressed in mg/l unless otherwise specified

Comments:

E038.1: Alkaline persulphate digestion followed by colour determination.

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Sample Identification		WS811DS	WS811IS	WS811IS2	WS1111US/ 811DS	QC	QC				
Depth (m)		--	--	--	--	--	--				
Sampling Date recorded on COC		18/6/08	18/6/08	18/6/08	18/6/08	--	--				
Laboratory Extraction (Preparation) Date		23/6/08	23/6/08	23/6/08	23/6/08	23/6/08	23/6/08				
Laboratory Analysis Date		27/6/08	27/6/08	27/6/08	27/6/08	24/6/08	24/6/08				
Method : E020.1/E030.1											
Filtered metals	**EQL**										
Phosphorus	0.1	<0.1	<0.1	<0.1	<0.1	102%	<0.1				

Results expressed in mg/l unless otherwise specified

Comments:

E020.1/E030.1: Filtered sample directly analysed by AAS and/or by ICP-OES.

LabMark
ENVIRONMENTAL LABORATORIES

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Laboratory Identification		162674	162675	162676	162677	lcs	mb				
Sample Identification		WS811DS	WS811IS	WS811IS2	WS1111US/ 811DS	QC	QC				
Depth (m)		--	--	--	--	--	--				
Sampling Date recorded on COC		18/6/08	18/6/08	18/6/08	18/6/08	--	--				
Laboratory Extraction (Preparation) Date		23/6/08	23/6/08	23/6/08	23/6/08	23/6/08	23/6/08				
Laboratory Analysis Date		24/6/08	24/6/08	24/6/08	24/6/08	24/6/08	24/6/08				
Method : E020.1/E030.1											
Unfiltered metals	**EQL**										
Phosphorus	0.1	<0.1	<0.1	<0.1	<0.1	107%	<0.1				

Results expressed in mg/l unless otherwise specified

Comments:

E020.1/E030.1: 25ml digested in nitric/hydrochloric acid. Analysis by AAS and/or ICP-OES. (Silicon&Titanium determination are not covered by NATA accreditation).

Laboratory Identification		162674	162675	162676	162677	162674d	162674r	mb			
Sample Identification		WS811DS	WS811IS	WS811IS2	WS1111US/ 811DS	QC	QC	QC			
Depth (m)		--	--	--	--	--	--	--			
Sampling Date recorded on COC		18/6/08	18/6/08	18/6/08	18/6/08	--	--	--			
Laboratory Extraction (Preparation) Date		20/6/08	20/6/08	20/6/08	20/6/08	20/6/08	--	20/6/08			
Laboratory Analysis Date		20/6/08	20/6/08	20/6/08	20/6/08	20/6/08	--	20/6/08			
Method : 2130B											
Turbidity	**EQL**										
Turbidity	0.1	0.7	2.1	3.1	2.0	0.6	15%	<0.1			

Results expressed in NTU unless otherwise specified

Comments:

2130B: Determination by nephelometer. Results expressed in NTU.

LabMark
ENVIRONMENTAL LABORATORIES

Laboratory Report No: E038259
Client Name: Patterson Britton & Partners Pty Ltd
Contact Name: James Hoang
Client Reference: 6646

Date: 01/07/08

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Certificate
of Analysis

This report supercedes reports issued on: 30/06/08

Laboratory Identification		162674	162675	162676	162677	162674d	162674r	mb			
Sample Identification		WS811DS	WS811IS	WS811IS2	WS1111US/ 811DS	QC	QC	QC			
Depth (m)		--	--	--	--	--	--	--			
Sampling Date recorded on COC		18/6/08	18/6/08	18/6/08	18/6/08	--	--	--			
Laboratory Extraction (Preparation) Date		20/6/08	20/6/08	20/6/08	20/6/08	20/6/08	--	20/6/08			
Laboratory Analysis Date		23/6/08	23/6/08	23/6/08	23/6/08	23/6/08	--	20/6/08			
Method : 2540D											
Suspended Solids (TSS)	**EQL**										
Total suspended solids	1	1	1	2	1	1	0%	<1			

Results expressed in mg/l unless otherwise specified

Comments:

2540D: Gravimetric test.

EML CONSULTING SERVICES PTY LTD
A.B.N 71006 308 774
P.O. Box 543, RYDALMERE BC NSW 1701
Unit 2, 9-11 South Street, RYDALMERE NSW 2116
Telephone (02) 9684 3000 • Facsimile (02) 9898 9740

EML Ref No: 229642

Report date: 23 June 2008

Labmark (Environmental)
PO Box 641
Hornsby NSW 2077

Attention Jyothi Lal

Certificate of Analysis

Overall Description: Water Samples DS:18/06/08

Samples received: 20 June 2008 at 16:34 hrs. Testing commenced: 20 June 2008 at 18:00 hrs.

EML S/No 229642	Sample Marking: Samples tested as received into the laboratory	Faecal Coliforms /100mL
1	162674 WS811DS	~400
2	162675 WS811IS	28
3	162676 WS811IS2	~600
4	162677 WS1111US/811DS	~1600
Method:		3.3.3.4

< = Less than > = Greater than ~ = Estimated Pres = Presumptive spp = Species Y = Yeasts M = Moulds SPC = Standard plate count N/D = Not detected N/R = Not required

Yours faithfully
EML CONSULTING SERVICES PTY LTD

Joe Tierney

Joe Tierney PhD, B.Sc, MASM, MAIFST
Microbiologist

LabMark
ENVIRONMENTAL LABORATORIES

ilac-MRA NATA Accreditation No. 13542

Accredited for compliance with ISO/IEC 17025. The results of tests, calibrations and/or measurements included in this document are traceable to Australian/national standards. NATA is a signatory to the APLAC mutual recognition arrangement for the mutual recognition of the equivalence of testing, calibration and inspection reports.

AQIS
AUSTRALIAN QUARANTINE AND INSPECTION SERVICE
SYDNEY License No. N0356.

Quarantine Approved Premises criteria 5.1 for quarantine containment level 1 (QC1) facilities. Class five criteria cover premises utilised for research, analysis and testing of biological material, soil, animal, plant and human products.

CUSTOMER CENTRIC - ANALYTICAL CHEMISTS

FINAL CERTIFICATE OF ANALYSIS - ENVIRONMENTAL DIVISION

Laboratory Report No:	E039639	Cover Page 1 of 4
Client Name:	Patterson Britton & Partners Pty Ltd	plus Sample Results
Client Reference:	Water Analysis	
Contact Name:	James Hoang	
Chain of Custody No:	na	Date Received: 11/09/2008
Sample Matrix:	WATER	Date Reported: 19/09/2008

This Final Certificate of Analysis consists of sample results, DQI's, method descriptions, laboratory definitions, and internationally recognised NATA accreditation and endorsement. The DQO compliance relates specifically to QA/QC results as performed as part of the sample analysis, and may provide an indication of sample result quality. Transfer of report ownership from Labmark to the client shall only occur once full & final payment has been settled and verified. All report copies may be retracted where full payment has not occured within the agreed settlement period.

QUALITY ASSURANCE CRITERIA

Accuracy:	matrix spike:	1 in first 5-20, then 1 every 20 samples
	lcs, crm, method:	1 per analytical batch
	surrogate spike:	addition per target organic method
Precision:	laboratory duplicate:	1 in first 5-10, then 1 every 10 samples
	laboratory triplicate:	re-extracted & reported when duplicate RPD values exceed acceptance criteria
Holding Times:	soils, waters:	Refer to LabMark Preservation & THT table VOC's 14 days water / soil VAC's 7 days water or 14 days acidified VAC's 14 days soil SVOC's 7 days water, 14 days soil Pesticides 7 days water, 14 days soil Metals 6 months general elements Mercury 28 days
Confirmation:	target organic analysis:	GC/MS, or confirmatory column
Sensitivity:	EQL:	Typically 2-5 x Method Detection Limit (MDL)

QUALITY CONTROL GLOBAL ACCEPTANCE CRITERIA (GAC)

Accuracy:	spike, lcs, crm surrogate:	general analytes 70% - 130% recovery phenol analytes 50% - 130% recovery organophosphorous pesticide analytes 60% - 130% recovery phenoxy acid herbicides, organotin 50% - 130% recovery
	anion/cation bal:	+/- 10% (0-3 meq/l), +/- 5% (>3 meq/l)
Precision:	method blank:	not detected >95% of the reported EQL
	duplicate lab RPD (metals):	0-30% (>10xEQL), 0-75% (5-10xEQL) 0-100% (<5xEQL)
	duplicate lab RPD:	0-50% (>10xEQL), 0-75% (5-10xEQL) 0-100% (<5xEQL)

QUALITY CONTROL ANALYTE SPECIFIC ACCEPTANCE CRITERIA (ASAC)

Accuracy:	spike, lcs, crm surrogate:	analyte specific recovery data <3xsd of historical mean
Uncertainty:	spike, lcs:	measurement calculated from historical analyte specific control charts

RESULT ANNOTATION

Data Quality Objective	s:	matrix spike recovery	p:	pending	bcs:	batch specific lcs
Data Quality Indicator	d:	laboratory duplicate	lcs:	laboratory control sample	bmb:	batch specific mb
Estimated Quantitation Limit	t:	laboratory triplicate	crm:	certified reference material		
not applicable	r:	RPD relative % difference	mb:	method blank		

David Burns
Quality Control (Report signatory)
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Geoff Weir
Authorising Chemist (NATA signatory)
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Simon Mills
Authorising Chemist (NATA signatory)
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NEPC GUIDELINE COMPLIANCE - DQO

1. GENERAL

A. Results relate specifically to samples as received. Sample results are not corrected for matrix spike, lcs, or surrogate recovery data.

B. EQL's are matrix dependant and may be increased due to sample dilution or matrix interference.

C. Laboratory QA/QC samples are specific to this project.

D. Inter-laboratory proficiency results are available upon request. NATA accreditation details available at www.nata.asn.au.

E. VOC spikes & surrogates added to samples during extraction, SVOC spikes & surrogates added prior to extraction.

F. Recovery data outside GAC limits shall be investigated and compared to ASAC (historical mean +/- 3sd). If recovery data <20%, then the relevant results for that compound are considered not reliable.

G. Recovery data (ms, surrogate, crm, lcs) outside ASAC limits shall initiate an investigative action. Anomolous QC data is examined in conjunction with other QC samples and a final decision whether to accept or reject results is provided by the professional judgement of the senior analyst. The USEPA-CLP National Functional Guidelines are referred to for specific recommendations.

H. Extraction (preparation) date refers to the date that sample preparation was initiated. Note that certain methods not requiring sample preparation (eg. VOCs in water, etc) may report a common extraction and analysis date.

I. LabMark shall maintain an official copy of this Certificate of Analysis for all tracable reference purposes.

2. CHAIN OF CUSTODY (COC) & SAMPLE RECEIPT NOTICE (SRN) REQUIREMENTS

A. SRN issued to client upon sample receipt & login verification.

B. Preservation & sampling date details specified on COC and SRN, unless noted.

C. Sample Integrity & Validated Time of Sample Receipt (VTSR) Holding Times verified (preservation may extend holding time, refer to preservation chart).

3. NATA ACCREDITED METHODS

A. NATA accreditation held for each in-house method and sample matrix type reported, unless noted below (Refer to subcontracted test reports for NATA accreditation status).

B. NATA accredited in-house laboratory methods are referenced from NEPC, ASTM, modified USEPA / APHA documents. Corporate Accreditation No. 13542.

C. Subcontracted analyses: Refer to Sample Receipt Notice and additional DQO comments.

Reported by EML, NATA accreditation No.2047.

Reported by LabMark Environmental Sydney, NATA accreditation No. 13542, Corporate Site No. 13535

4. QA/QC FREQUENCY COMPLIANCE TABLE SPECIFIC TO THIS REPORT

Matrix: **WATER**

Page:	Method:	Totals:	#d	%d-ratio	#t	#s	%s-ratio
1	Nitrate as N	4	0	0%	0	0	0%
1	Nitrite as N	4	0	0%	0	0	0%
2	TKN (as N)	4	0	0%	0	0	0%
3	Ammonia as N	4	0	0%	0	0	0%
4	Total Nitrogen (as N)	4	0	0%	0	0	0%
5	Ortho phosphate (as P)	4	0	0%	0	0	0%
6	Total Phosphorus (as P)	4	0	0%	0	0	0%
7	Filtered metals	4	0	0%	0	0	0%
8	Unfiltered metals	4	0	0%	0	0	0%
9	Turbidity	4	0	0%	0	0	0%
10	Total Suspended Solids	4	0	0%	0	0	0%

GLOSSARY:

#d	number of discrete duplicate extractions/analyses performed.
%d-ratio	NEPC guideline for laboratory duplicates is 1 in 10 samples (min 10%).
#t	number of triplicate extractions/analyses performed.
#s	number of spiked samples analysed.
%s-ratio	USEPA guideline for laboratory matrix spikes is 1 in 20 samples (min 5%).

LabMark
ENVIRONMENTAL LABORATORIES

CUSTOMER CENTRIC - ANALYTICAL CHEMISTS

Environmental Laboratory Industry Group
Foundation Member

Laboratory Report: E039639

5. ADDITIONAL COMMENTS SPECIFIC TO THIS REPORT

A. All tests were conducted by LabMark Environmental Sydney, NATA accreditation No. 13542, Corporate Site No. 13535, unless indicated below.
B. The following test was conducted by EML, NATA accreditation No.2047. :- Faecal Coliforms, reference 238059. Report issued 15/9/08.

Laboratory QA/QC data shall relate specifically to this report, and may provide an indication of site specific sample result quality. LabMark DOES NOT report NON-RELEVANT BATCH QA/QC data. Acceptance of this self assessment certificate does not preclude any requirement for a QA/QC review by a accredited contaminated site EPA auditor, when and wherever necessary. Laboratory QA/QC self assessment references available upon request.

LabMark Environmental Laboratories ABN 30 008 127 802
* SYDNEY: Unit 1, 8 Leighton Place Asquith NSW 2077 * Telephone: (02) 9476 6533 * Fax: (02) 9476 8219
* MELBOURNE: 1868 Dandenong Road, Clayton VIC 3168 * Telephone: (03) 9538 2277 * Fax: (03) 9538 2278

LabMark
ENVIRONMENTAL LABORATORIES

Laboratory Report No: E039639
Client Name: Patterson Britton & Partners Pty Ltd
Contact Name: James Hoang
Client Reference: Water Analysis 6646

Date: 19/09/08
This report supercedes reports issued on: N/A

Final
Certificate
of Analysis

Laboratory Identification		175544	175545	175546	175547	lcs	mb				
Sample Identification		WS812US	WS812IS	WS812IS2	WS812DS	QC	QC				
Depth (m)		--	--	--	--	--	--				
Sampling Date recorded on COC		11/9/08	11/9/08	11/9/08	11/9/08	--	--				
Laboratory Extraction (Preparation) Date		11/9/08	11/9/08	11/9/08	11/9/08	11/9/08	11/9/08				
Laboratory Analysis Date		11/9/08	11/9/08	11/9/08	11/9/08	11/9/08	11/9/08				
Method : E037.1/E051.1 **Nitrite as N**	**EQL**										
NO2-N	0.01	0.02	0.02	0.02	0.02	87%	<0.01				
Method : E037.1/E051.1 **Nitrate as N**	**EQL**										
NO3-N	0.01	0.07	0.31	0.18	0.21	104%	<0.01				

Results expressed in mg/l unless otherwise specified

Comments:

E037.1/E051.1: Nitrate determined by colour. Sample filtered through 0.45um prior to analysis.
E037.1/E051.1: Nitrite determined by colour. Sample filtered through 0.45um prior to analysis.

LabMark
ENVIRONMENTAL LABORATORIES

Laboratory Report No: E039639
Client Name: Patterson Britton & Partners Pty Ltd
Contact Name: James Hoang
Client Reference: Water Analysis 6646

Date: 19/09/08
This report supercedes reports issued on: N/A

Final
Certificate
of Analysis

Laboratory Identification		175544	175545	175546	175547	lcs	mb				
Sample Identification		WS812US	WS812IS	WS812IS2	WS812DS	QC	QC				
Depth (m)		--	--	--	--	--	--				
Sampling Date recorded on COC		11/9/08	11/9/08	11/9/08	11/9/08	--	--				
Laboratory Extraction (Preparation) Date		11/9/08	11/9/08	11/9/08	11/9/08	11/9/08	11/9/08				
Laboratory Analysis Date		15/9/08	15/9/08	15/9/08	15/9/08	12/9/08	12/9/08				
Method : E039.1											
TKN (as N)	**EQL**										
Total Kjeldahl Nitrogen	0.1	0.2	0.3	0.2	1.1	90%	<0.1				

Results expressed in mg/l unless otherwise specified

Comments:

E039.1: Acidic digestion followed by determination by colour.

LabMark
ENVIRONMENTAL LABORATORIES

Laboratory Report No: E039639
Client Name: Patterson Britton & Partners Pty Ltd
Contact Name: James Hoang
Client Reference: Water Analysis 6646

Date: 19/09/08
This report supercedes reports issued on: N/A

Final
Certificate
of Analysis

Laboratory Identification		175544	175545	175546	175547	lcs	mb				
Sample Identification		WS812US	WS812IS	WS812IS2	WS812DS	QC	QC				
Depth (m)		--	--	--	--	--	--				
Sampling Date recorded on COC		11/9/08	11/9/08	11/9/08	11/9/08	--	--				
Laboratory Extraction (Preparation) Date		11/9/08	11/9/08	11/9/08	11/9/08	11/9/08	11/9/08				
Laboratory Analysis Date		11/9/08	11/9/08	11/9/08	11/9/08	11/9/08	11/9/08				
Method : E036.1/E050.1											
Ammonia as N	**EQL**										
Ammonia	0.01	<0.01	<0.01	<0.01	<0.01	106%	<0.01				

Results expressed in mg/l unless otherwise specified

Comments:

E036.1/E050.1: Determined by colour. Sample filtered through 0.45um prior to analysis.

LabMark
ENVIRONMENTAL LABORATORIES

Laboratory Report No: E039639
Client Name: Patterson Britton & Partners Pty Ltd
Contact Name: James Hoang
Client Reference: Water Analysis 6646

Date: 19/09/08
This report supercedes reports issued on: N/A

Final
Certificate
of Analysis

Laboratory Identification		175544	175545	175546	175547	lcs	mb				
Sample Identification		WS812US	WS812IS	WS812IS2	WS812DS	QC	QC				
Depth (m)		--	--	--	--	--	--				
Sampling Date recorded on COC		11/9/08	11/9/08	11/9/08	11/9/08	--	--				
Laboratory Extraction (Preparation) Date		11/9/08	11/9/08	11/9/08	11/9/08	11/9/08	11/9/08				
Laboratory Analysis Date		15/9/08	15/9/08	15/9/08	15/9/08	12/9/08	12/9/08				
Method : E038.1											
Total Nitrogen (as N)	**EQL**										
Total Nitrogen (as N)	0.1	0.3	0.6	0.4	1.3	94%	<0.1				

Results expressed in mg/l unless otherwise specified

Comments:

E038.1: Total Nitrogen by calculation.

Laboratory Identification		175544	175545	175546	175547	lcs	mb				
Sample Identification		WS812US	WS812IS	WS812IS2	WS812DS	QC	QC				
Depth (m)		--	--	--	--	--	--				
Sampling Date recorded on COC		11/9/08	11/9/08	11/9/08	11/9/08	--	--				
Laboratory Extraction (Preparation) Date		11/9/08	11/9/08	11/9/08	11/9/08	11/9/08	11/9/08				
Laboratory Analysis Date		11/9/08	11/9/08	11/9/08	11/9/08	11/9/08	11/9/08				
Method : E038.1/E052.1											
Ortho phosphate (as P)	**EQL**										
Ortho Phosphate (as P)	0.005	<0.005	<0.005	0.008	0.012	103%	<0.005				

Results expressed in mg/l unless otherwise specified

Comments:

E038.1/E052.1: Determined by colour. Sample filtered through a 0.45um filter prior to analysis.

LabMark
ENVIRONMENTAL LABORATORIES

Laboratory Report No: E039639
Client Name: Patterson Britton & Partners Pty Ltd
Contact Name: James Hoang
Client Reference: Water Analysis 6646

Date: 19/09/08
This report supercedes reports issued on: N/A

Final
Certificate
of Analysis

Laboratory Identification		175544	175545	175546	175547	lcs	mb				
Sample Identification		WS812US	WS812IS	WS812IS2	WS812DS	QC	QC				
Depth (m)		--	--	--	--	--	--				
Sampling Date recorded on COC		11/9/08	11/9/08	11/9/08	11/9/08	--	--				
Laboratory Extraction (Preparation) Date		11/9/08	11/9/08	11/9/08	11/9/08	11/9/08	11/9/08				
Laboratory Analysis Date		15/9/08	15/9/08	15/9/08	15/9/08	11/9/08	11/9/08				
Method : E038.1											
Total Phosphorus (as P)	**EQL**										
Total Phosphorus (as P)	0.01	0.02	0.02	0.02	0.17	105%	<0.01				

Results expressed in mg/l unless otherwise specified

Comments:

E038.1: Alkaline persulphate digestion followed by colour determination.

Laboratory Identification		175544	175545	175546	175547	lcs	mb				
Sample Identification		WS812US	WS812IS	WS812IS2	WS812DS	QC	QC				
Depth (m)		--	--	--	--	--	--				
Sampling Date recorded on COC		11/9/08	11/9/08	11/9/08	11/9/08	--	--				
Laboratory Extraction (Preparation) Date		15/9/08	15/9/08	15/9/08	15/9/08	15/9/08	15/9/08				
Laboratory Analysis Date		15/9/08	15/9/08	15/9/08	15/9/08	15/9/08	15/9/08				
Method : E020.1/E030.1											
Filtered metals	**EQL**										
Phosphorus	0.1	<0.1	<0.1	<0.1	<0.1	94%	<0.1				

Results expressed in mg/l unless otherwise specified

Comments:

E020.1/E030.1: Filtered sample directly analysed by AAS and/or by ICP-OES.

Laboratory Identification		**175544**	**175545**	**175546**	**175547**	**lcs**	**mb**				
Sample Identification		WS812US	WS812IS	WS812IS2	WS812DS	QC	QC				
Depth (m)		--	--	--	--	--	--				
Sampling Date recorded on COC		11/9/08	11/9/08	11/9/08	11/9/08	--	--				
Laboratory Extraction (Preparation) Date		15/9/08	15/9/08	15/9/08	15/9/08	15/9/08	15/9/08				
Laboratory Analysis Date		15/9/08	15/9/08	15/9/08	15/9/08	15/9/08	15/9/08				
Method : E020.1/E030.1											
Unfiltered metals	**EQL**										
Phosphorus	0.1	<0.1	<0.1	<0.1	0.2	102%	<0.1				

Results expressed in mg/l unless otherwise specified

Comments:

E020.1/E030.1: 25ml digested in nitric/hydrochloric acid. Analysis by AAS and/or ICP-OES. (Silicon&Titanium determination are not covered by NATA accreditation).

Laboratory Identification		175544	175545	175546	175547	lcs	mb				
Sample Identification		WS812US	WS812IS	WS812IS2	WS812DS	QC	QC				
Depth (m)		--	--	--	--	--	--				
Sampling Date recorded on COC		11/9/08	11/9/08	11/9/08	11/9/08	--	--				
Laboratory Extraction (Preparation) Date		11/9/08	11/9/08	11/9/08	11/9/08	11/9/08	11/9/08				
Laboratory Analysis Date		11/9/08	11/9/08	11/9/08	11/9/08	11/9/08	11/9/08				
Method : 4040											
Turbidity	**EQL**										
Turbidity	0.1	2.8	3.9	3.4	80.5	110%	<0.1				

Results expressed in NTU unless otherwise specified

Comments:

4040: Determination by nephelometer. Results expressed in NTU.

LabMark
ENVIRONMENTAL LABORATORIES

Laboratory Report No: E039639
Client Name: Patterson Britton & Partners Pty Ltd
Contact Name: James Hoang
Client Reference: Water Analysis 6646

Date: 19/09/08
This report supercedes reports issued on: N/A

Final
Certificate
of Analysis

Laboratory Identification		175544	175545	175546	175547	lcs	mb				
Sample Identification		WS812US	WS812IS	WS812IS2	WS812DS	QC	QC				
Depth (m)		--	--	--	--	--	--				
Sampling Date recorded on COC		11/9/08	11/9/08	11/9/08	11/9/08	--	--				
Laboratory Extraction (Preparation) Date		11/9/08	11/9/08	11/9/08	11/9/08	11/9/08	11/9/08				
Laboratory Analysis Date		17/9/08	17/9/08	17/9/08	17/9/08	15/9/08	15/9/08				
Method : 4100											
Total Suspended Solids	**EQL**										
Total Suspended Solids	5	<5	<5	<5	50	85%	<5				

Results expressed in mg/l unless otherwise specified

Comments:

4100: Gravimetric analysis. Results expressed in mg/L.

EML CONSULTING SERVICES PTY LTD
A.B.N 71006 308 774
P.O. Box 543, RYDALMERE BC NSW 1701
Unit 2, 9-11 South Street, RYDALMERE NSW 2116
Telephone (02) 9684 3000 • Facsimile (02) 9898 9740

EML Ref No: 238059

Client Ref No: E039639

Report date: 15 September 2008

Labmark (Environmental)
PO Box 641
Hornsby NSW 2077

Attention Jyothi Lal

Certificate of Analysis

Overall Description: Water Samples 11/09/08

Samples received: 11 September 2008 at 17:20 hrs. Testing commenced: 11 September 2008 at 19:00 hrs.

EML S/No 238059	**Sample Marking:** Samples tested as received into the laboratory	**Faecal Coliforms MPN** /100mL
1	Lab ID: 175544 WS812US	100
2	Lab ID: 175545 WS812IS	16
3	Lab ID: 175546 WS812IS2	21
4	Lab ID: 175547 WS812DS	79
Method:		3.3.3.5

< = Less than > = Greater than ~ = Estimated Pres = Presumptive spp = Species Y = Yeasts M = Moulds SPC = Standard plate count N/D = Not detected N/R = Not required

Yours faithfully
EML CONSULTING SERVICES PTY LTD

Joe Tierney

Joe Tierney PhD, B.Sc, MASM, MAIFST
Microbiologist

Appendix F -

MUSIC DATA

PRE DEVELOPED MUSIC DATA

Source nodes

Location	A	B	C2
ID	4	5	7
Node Type	ForestSourceNode	AgriculturalSourceNode	AgriculturalSourceNode
Total Area (ha)	3.564	8.886	4.237
Area Impervious (ha)	0.171634737	0.467294474	0.429275
Area Pervious (ha)	3.392365263	8.418705526	3.807725
Field Capacity (mm)	50	50	50
Pervious Area Infiltration Capacity coefficient - a	50	50	50
Pervious Area Infiltration Capacity exponent - b	2	2	2
Impervious Area Rainfall Threshold (mm/day)	1.5	1.5	1.5
Pervious Area Soil Storage Capacity (mm)	150	150	150
Pervious Area Soil Initial Storage (% of Capacity)	25	25	25
Groundwater Initial Depth (mm)	50	50	50
Groundwater Daily Recharge Rate (%)	0.65	0.65	0.65
Groundwater Daily Baseflow Rate (%)	0.85	0.85	0.85
Groundwater Daily Deep Seepage Rate (%)	0	0	0
Stormflow Total Suspended Solids Mean (log mg/L)	1.9	-1.544	1.544
Stormflow Total Suspended Solids Standard Deviation (log mg/L)	0.2	0.31	0.31
Stormflow Total Suspended Solids Estimation Method	Stochastic	Mean	Mean
Stormflow Total Suspended Solids Serial Correlation	0	0	0
Stormflow Total Phosphorus Mean (log mg/L)	-1.1	-0.824	-0.824
Stormflow Total Phosphorus Standard Deviation (log mg/L)	0.22	0.3	0.3
Stormflow Total Phosphorus Estimation Method	Stochastic	Mean	Mean
Stormflow Total Phosphorus Serial Correlation	0	0	0
Stormflow Total Nitrogen Mean (log mg/L)	-0.075	0.114	0.114
Stormflow Total Nitrogen Standard Deviation (log mg/L)	0.24	0.26	0.26
Stormflow Total Nitrogen Estimation Method	Stochastic	Mean	Mean
Stormflow Total Nitrogen Serial Correlation	0	0	0
Baseflow Total Suspended Solids Mean (log mg/L)	-10	-10	-10
Baseflow Total Suspended Solids Standard Deviation (log mg/L)	0.13	0.13	0.13
Baseflow Total Suspended Solids Estimation Method	Stochastic	Mean	Mean
Baseflow Total Suspended Solids Serial Correlation	0	0	0
Baseflow Total Phosphorus Mean (log mg/L)	-10	-10	-10
Baseflow Total Phosphorus Standard Deviation (log mg/L)	0.13	0.13	0.13
Baseflow Total Phosphorus Estimation Method	Stochastic	Mean	Mean
Baseflow Total Phosphorus Serial Correlation	0	0	0
Baseflow Total Nitrogen Mean (log mg/L)	-10	-10	-10
Baseflow Total Nitrogen Standard Deviation (log mg/L)	0.13	0.13	0.13
Baseflow Total Nitrogen Estimation Method	Stochastic	Mean	Mean
Baseflow Total Nitrogen Serial Correlation	0	0	0
OUT - Mean Annual Flow (ML/yr)	22	54.8	27.5
OUT - TSS Mean Annual Load (kg/yr)	1.75E+03	1.42	880
OUT - TP Mean Annual Load (kg/yr)	1.79	7.44	3.77
OUT - TN Mean Annual Load (kg/yr)	20.8	64.5	32.7
OUT - Gross Pollutant Mean Annual Load (kg/yr)	96.8	241	263

No Imported Data Source nodes

No USTM treatment nodes

No Generic treatment nodes

Other nodes

Location	Dum Out	J1	FERN CREEK OUT	ORCHARD OUT
ID	1	2	3	6
Node Type	ReceivingNode	JunctionNode	JunctionNode	JunctionNode
IN - Mean Annual Flow (ML/yr)	104	22	76.7	27.5
IN - TSS Mean Annual Load (kg/yr)	2.63E+03	1.75E+03	1.75E+03	880
IN - TP Mean Annual Load (kg/yr)	13	1.79	9.23	3.77
IN - TN Mean Annual Load (kg/yr)	118	20.8	85.3	32.7
IN - Gross Pollutant Mean Annual Load (kg/yr)	601	96.8	338	263
OUT - Mean Annual Flow (ML/yr)	0	22	76.7	27.5
OUT - TSS Mean Annual Load (kg/yr)	0	1.75E+03	1.75E+03	880
OUT - TP Mean Annual Load (kg/yr)	0	1.79	9.23	3.77
OUT - TN Mean Annual Load (kg/yr)	0	20.8	85.3	32.7
OUT - Gross Pollutant Mean Annual Load (kg/yr)	0	96.8	338	263

Links

Location	Drainage Link	Drainage Link	Drainage Link	Drainage Link	Drainage Link	Drainage Link
Source node ID	4	5	2	3	6	7
Target node ID	2	3	3	1	1	6
Muskingum-Cunge Routing	Not Routed	Not Routed	Not Routed	Not Routed	Not Routed	Not Routed
Muskingum K						
Muskingum theta						
IN - Mean Annual Flow (ML/yr)	22	54.8	22	76.7	27.5	27.5
IN - TSS Mean Annual Load (kg/yr)	1.75E+03	1.42	1.75E+03	1.75E+03	880	880
IN - TP Mean Annual Load (kg/yr)	1.79	7.44	1.79	9.23	3.77	3.77
IN - TN Mean Annual Load (kg/yr)	20.8	64.5	20.8	85.3	32.7	32.7
IN - Gross Pollutant Mean Annual Load (kg/yr)	96.8	241	96.8	338	263	263
OUT - Mean Annual Flow (ML/yr)	22	54.8	22	76.7	27.5	27.5
OUT - TSS Mean Annual Load (kg/yr)	1.75E+03	1.42	1.75E+03	1.75E+03	880	880
OUT - TP Mean Annual Load (kg/yr)	1.79	7.44	1.79	9.23	3.77	3.77
OUT - TN Mean Annual Load (kg/yr)	20.8	64.5	20.8	85.3	32.7	32.7
OUT - Gross Pollutant Mean Annual Load (kg/yr)	96.8	241	96.8	338	263	263

POST DEVELOPED MUSIC DATA

Source nodes

Location	A1 Lots	A3 Forest	B RIPARIAN	B1 Roads	B1 Lots	A2 Roof	A2 Roads	B1 Roof	Basin 1	C1 Roads	C1 Lots	C1 Roofs	C2 Roofs
ID	3	4	6	7	8	15	16	19	20	22	23	25	27
Node Type	UrbanSourceNode	ForestSourceNode	ForestSourceNode	UrbanSourceNode	UrbanSourceNode	UrbanSourceNode	UrbanSourceNode	UrbanSourceNode	ForestSourceNode	UrbanSourceNode	UrbanSourceNode	UrbanSourceNode	UrbanSourceNode
Total Area (ha)	1.124	4.669	2.469	0.374	0.186	1.215	1.418	0.36	0.559	0.491	0.446	0.4	0.8
Area Impervious (ha)	0.293127368	0	0	0.299659298	0.029556053	1.215	1.136141404	0.36	0	0.393123026	0.139044825	0.4	0.8
Area Pervious (ha)	0.830872632	4.669	2.469	0.074340702	0.156443947	0	0.281858596	0	0.559	0.097876974	0.307955175	0	0
Field Capacity (mm)	50	50	50	50	50	50	50	50	50	50	50	50	50
Pervious Area Infiltration Capacity coefficient - a	50	50	50	50	50	50	50	50	50	50	50	50	50
Pervious Area Infiltration Capacity exponent - b	2	2	2	2	2	2	2	2	2	2	2	2	2
Impervious Area Rainfall Threshold (mm/day)	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Pervious Area Soil Storage Capacity (mm)	150	150	150	150	150	150	150	150	150	150	150	150	150
Pervious Area Soil Initial Storage (% of Capacity)	25	25	25	25	25	25	25	25	25	25	25	25	25
Groundwater Initial Depth (mm)	50	50	50	50	50	50	50	50	50	50	50	50	50
Groundwater Daily Recharge Rate (%)	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
Groundwater Daily Baseflow Rate (%)	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85
Groundwater Daily Deep Seepage Rate (%)	0	0	0	0	0	0	0	0	0	0	0	0	0
Stormflow Total Suspended Solids Mean (log mg/L)	2	1	1	2	2	1.301	2	1.301	2	2	2	1.301	1.301
Stormflow Total Suspended Solids Standard Deviation (log mg	0.32	0.2	0.2	0.32	0.32	0.32	0.32	0.32	0.2	0.32	0.32	0.32	0.32
Stormflow Total Suspended Solids Estimation Method	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean
Stormflow Total Suspended Solids Serial Correlation	0	0	0	0	0	0	0	0	0	0	0	0	0
Stormflow Total Phosphorus Mean (log mg/L)	-0.523	-1.523	-1.523	-0.523	-0.523	-0.886	-0.523	-0.886	-0.523	-0.523	-0.523	-0.886	-0.886
Stormflow Total Phosphorus Standard Deviation (log mg/L)	0.25	0.22	0.22	0.25	0.25	0.25	0.25	0.25	0.22	0.25	0.25	0.25	0.25
Stormflow Total Phosphorus Estimation Method	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean
Stormflow Total Phosphorus Serial Correlation	0	0	0	0	0	0	0	0	0	0	0	0	0
Stormflow Total Nitrogen Mean (log mg/L)	0.176	-0.495	-0.495	0.176	0.176	0.176	0.176	0.176	0.176	0.176	0.176	0.176	0.176
Stormflow Total Nitrogen Standard Deviation (log mg/L)	0.19	0.24	0.24	0.19	0.19	0.19	0.19	0.19	0.24	0.19	0.19	0.19	0.19
Stormflow Total Nitrogen Estimation Method	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean
Stormflow Total Nitrogen Serial Correlation	0	0	0	0	0	0	0	0	0	0	0	0	0
Baseflow Total Suspended Solids Mean (log mg/L)	-10	-10	-10	-10	-10	-10	-10	-10	-10	-10	-10	-10	-10
Baseflow Total Suspended Solids Standard Deviation (log mg/L	0.17	0.13	0.13	0.17	0.17	0.17	0.17	0.17	0.13	0.17	0.17	0.17	0.17
Baseflow Total Suspended Solids Estimation Method	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean
Baseflow Total Suspended Solids Serial Correlation	0	0	0	0	0	0	0	0	0	0	0	0	0
Baseflow Total Phosphorus Mean (log mg/L)	-10	-10	-10	-10	-10	-10	-10	-10	-10	-10	-10	-10	-10
Baseflow Total Phosphorus Standard Deviation (log mg/L)	0.19	0.13	0.13	0.19	0.19	0.19	0.19	0.19	0.13	0.19	0.19	0.19	0.19
Baseflow Total Phosphorus Estimation Method	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean
Baseflow Total Phosphorus Serial Correlation	0	0	0	0	0	0	0	0	0	0	0	0	0
Baseflow Total Nitrogen Mean (log mg/L)	-10	-10	-10	-10	-10	-10	-10	-10	-10	-10	-10	-10	-10
Baseflow Total Nitrogen Standard Deviation (log mg/L)	0.12	0.13	0.13	0.12	0.12	0.12	0.12	0.12	0.13	0.12	0.12	0.12	0.12
Baseflow Total Nitrogen Estimation Method	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean
Baseflow Total Nitrogen Serial Correlation	0	0	0	0	0	0	0	0	0	0	0	0	0
OUT - Mean Annual Flow (ML/yr)	8.43	27.3	14.4	4.1	1.28	14.9	15.5	4.4	3.27	5.38	3.49	4.89	9.78
OUT - TSS Mean Annual Load (kg/yr)	793	244	129	405	118	297	1.54E+03	88	293	532	330	97.8	196
OUT - TP Mean Annual Load (kg/yr)	2.38	0.733	0.388	1.21	0.354	1.93	4.6	0.572	0.878	1.59	0.99	0.636	1.27
OUT - TN Mean Annual Load (kg/yr)	11.9	7.82	4.13	6.07	1.77	22.3	23	6.6	4.39	7.97	4.95	7.33	14.7
OUT - Gross Pollutant Mean Annual Load (kg/yr)	155	0	0	97.2	17.8	349	368	103	0	128	69	115	230

C2 Roads	C2 Lots	D2 Lots	D2 Roofs	C5 Roads	D1 Lots	D1 Roofs	D2 Lots	A1 Lots	B1 Lots	C1 Lots	A1 Lots	A1 Roads	A1 Roof	Basin 2	Basin 3	D2 Roads
29	30	32	35	36	37	39	43	44	45	46	48	49	50	52	53	54
UrbanSourceNode	UrbanSourceNode	UrbanSourceNode	UrbanSourceNode	UrbanSourceNode	UrbanSourceNode	UrbanSourceNode	UrbanSourceNode	UrbanSourceNode	UrbanSourceNode	UrbanSourceNode	UrbanSourceNode	UrbanSourceNode	UrbanSourceNode	ForestSourceNode	ForestSourceNode	UrbanSourceNode
0.158	0.701	0.185	0.2	0.412	0.76	0.52	0.185	1.125	0.186	0.445	0.686	0.343	0.36	0.089	0.05	0.103
0.141992105	0.133128509	0.061358333	0.2	0.370257895	0.201566667	0.52	0.061358333	0.288404605	0.029556053	0.137735307	0.16674614	0.308248684	0.36	0	0	0.082526491
0.016007895	0.567871491	0.123641667	0	0.041742105	0.558433333	0	0.123641667	0.836595395	0.156443947	0.307264693	0.51925386	0.034751316	0	0.089	0.05	0.020473509
50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150
25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25
50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	2	2	1.301	2	2	1.301	2	2	2	2	2	2	1.301	1	1	2
0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.2	0.2	0.32
Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-0.523	-0.523	-0.523	-0.886	-0.523	-0.523	-0.886	-0.523	-0.523	-0.523	-0.523	-0.523	-0.523	-0.886	-1.523	-1.523	-0.523
0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.22	0.22	0.25
Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.176	0.176	0.176	0.176	0.176	0.176	0.176	0.176	0.176	0.176	0.176	0.176	0.176	0.176	-0.495	-0.495	0.176
0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.24	0.24	0.19
Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-10	-10	-10	-10	-10	-10	-10	-10	-10	-10	-10	-10	-10	-10	-10	-10	-10
0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.13	0.13	0.17
Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-10	-10	-10	-10	-10	-10	-10	-10	-10	-10	-10	-10	-10	-10	-10	-10	-10
0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.13	0.13	0.19
Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-10	-10	-10	-10	-10	-10	-10	-10	-10	-10	-10	-10	-10	-10	-10	-10	-10
0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.13	0.13	0.12
Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1.83	4.95	1.47	2.45	4.77	5.75	6.36	1.47	8.44	1.28	3.48	5.06	3.97	4.4	0.52	0.292	1.13
182	460	140	48.9	475	541	127	140	793	118	329	474	395	88	4.66	2.62	112
0.546	1.38	0.418	0.318	1.42	1.62	0.827	0.419	2.39	0.354	0.988	1.42	1.19	0.572	1.40E-02	7.85E-03	0.334
2.73	6.9	2.09	3.67	7.12	8.12	9.53	2.09	11.9	1.77	4.94	7.11	5.93	6.6	0.149	8.37E-02	1.67
43.3	76.9	29.8	57.4	113	107	149	29.8	155	17.8	68.9	89.4	94.1	103	0	0	26.8

No Imported Data Source nodes

USTM treatment nodes

Location	BRS1	BRS2	Rainwater Tank	Rainwater Tank	BRS6	Rainwater Tank	Rainwater Tank	BRS11	Rainwater Tank	Rainwater Tank	Sedimentation Basin	Basin 2	Rainwater Tank	Bio-Retention
ID	5	11	17	18	24	26	28	33	34	38	41	42	51	55
Node Type	BioRetentionNode	BioRetentionNode	RainWaterTankNode	RainWaterTankNode	BioRetentionNode	RainWaterTankNode	RainWaterTankNode	BioRetentionNode	RainWaterTankNode	RainWaterTankNode	SedimentationBasinNode	SedimentationBasinNode	RainWaterTankNode	BioRetentionNode
Lo-flow bypass rate (cum/sec)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hi-flow bypass rate (cum/sec)	10	10	100	100	10	100	100	10	100	100	100	100	100	100
Inlet pond volume			0	0		0	0		0	0	0	0	0	
Area (sqm)	2561	686	218.7	48.6	913	54	108	179	27	62.1	550	540	48.6	2500
Extended detention depth (m)	0.3	0.3	0.2	0.2	0.3	0.2	0.2	0.3	0.2	0.2	2	2	0.2	2.8
Permanent pool volume (cum)			243	54		60	120		30	92	150	160	54	
Proportion vegetated			0	0		0	0		0	0	0	0	0	
Equivalent pipe diameter (mm)			50	50		50	50		50	50	300	300	50	
Overflow weir width (m)	2.5	2.5	10	10	2.5	10	10	2.5	10	10	2	2	10	2
Notional Detention Time (hrs)			4.66	1.04		1.15	2.3		0.576	1.32	1.03	1.01	1.04	
Orifice discharge coefficient			0.6	0.6		0.6	0.6		0.6	0.6	0.6	0.6	0.6	
Weir coefficient	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7
Number of CSTR cells	3	3	2	2	3	2	2	3	2	2	1	1	2	3
Total Suspended Solids k (m/yr)	1000	1000	400	400	1000	400	400	1000	400	400	15000	15000	400	1000
Total Suspended Solids C* (mg/L)	12	12	12	12	12	12	12	12	12	12	30	30	12	12
Total Suspended Solids C** (mg/L)			12	12		12	12		12	12	30	30	12	
Total Phosphorus k (m/yr)	500	500	300	300	500	300	300	500	300	300	12000	12000	300	500
Total Phosphorus C* (mg/L)	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.18	0.18	0.13	0.13
Total Phosphorus C** (mg/L)			0.13	0.13		0.13	0.13		0.13	0.13	0.18	0.18	0.13	
Total Nitrogen k (m/yr)	50	50	40	40	50	40	40	50	40	40	1000	1000	40	50
Total Nitrogen C* (mg/L)	1.3	1.3	1.4	1.4	1.3	1.4	1.4	1.3	1.4	1.4	1.7	1.7	1.4	1.3
Total Nitrogen C** (mg/L)			1.4	1.4		1.4	1.4		1.4	1.4	1.7	1.7	1.4	
Threshold hydraulic loading for C** (m/yr)			3500	3500		3500	3500		3500	3500	3500	3500	3500	
Extraction for Re-use	Off	Off	On	On	Off	On	On	Off	On	On	Off	Off	On	Off
Annual Re-use Demand - scaled by daily PET (ML)			0	0		0	0		0	0	0		0	
Constant Daily Re-use Demand (kL)			6.318	1.404		1.56	3.12		0.78	1.794			1.404	
User-defined Annual Re-use Demand (ML)			0	0		0	0		0	0			0	
Percentage of User-defined Annual Re-use Demand Jan			8.333333333	8.333333333		8.333333333	8.333333333		8.333333333	8.333333333			8.333333333	
Percentage of User-defined Annual Re-use Demand Feb			8.333333333	8.333333333		8.333333333	8.333333333		8.333333333	8.333333333			8.333333333	
Percentage of User-defined Annual Re-use Demand Mar			8.333333333	8.333333333		8.333333333	8.333333333		8.333333333	8.333333333			8.333333333	
Percentage of User-defined Annual Re-use Demand Apr			8.333333333	8.333333333		8.333333333	8.333333333		8.333333333	8.333333333			8.333333333	
Percentage of User-defined Annual Re-use Demand May			8.333333333	8.333333333		8.333333333	8.333333333		8.333333333	8.333333333			8.333333333	
Percentage of User-defined Annual Re-use Demand Jun			8.333333333	8.333333333		8.333333333	8.333333333		8.333333333	8.333333333			8.333333333	
Percentage of User-defined Annual Re-use Demand Jul			8.333333333	8.333333333		8.333333333	8.333333333		8.333333333	8.333333333			8.333333333	
Percentage of User-defined Annual Re-use Demand Aug			8.333333333	8.333333333		8.333333333	8.333333333		8.333333333	8.333333333			8.333333333	
Percentage of User-defined Annual Re-use Demand Sep			8.333333333	8.333333333		8.333333333	8.333333333		8.333333333	8.333333333			8.333333333	
Percentage of User-defined Annual Re-use Demand Oct			8.333333333	8.333333333		8.333333333	8.333333333		8.333333333	8.333333333			8.333333333	
Percentage of User-defined Annual Re-use Demand Nov			8.333333333	8.333333333		8.333333333	8.333333333		8.333333333	8.333333333			8.333333333	
Percentage of User-defined Annual Re-use Demand Dec			8.333333333	8.333333333		8.333333333	8.333333333		8.333333333	8.333333333			8.333333333	
Filter area (sqm)	591	158			211			41						2300
Filter depth (m)	1	1			1			1						1
Filter median particle diameter (mm)	5	5			5			5						5
Saturated hydraulic conductivity (mm/hr)	100	100			100			100						100
Voids ratio	0.3	0.3			0.3			0.3						0.3
Length (m)														
Bed slope														
Base Width (m)														
Top width (m)														
Vegetation height (m)														
Proportion of upstream impervious area treated														
Seepage Rate (mm/hr)	4	4	0	0	4	0	0	4	0	0	4	4	0	4
Evap Loss as proportion of PET			0	0		0	0		0	0	0.75	0.75	0	
Depth in metres below the drain pipe	0	0			0			0						0
IN - Mean Annual Flow (ML/yr)	24	5.37	14.9	4.4	8.86	4.89	9.78	2.6	2.45	6.36	22.4	31.1	4.4	66.7
IN - TSS Mean Annual Load (kg/yr)	2.33E+03	523	297	88	862	97.8	196	251	48.9	127	1.16E+03	888	88	767
IN - TP Mean Annual Load (kg/yr)	6.98	1.57	1.93	0.572	2.58	0.636	1.27	0.753	0.318	0.827	4.45	4.62	0.572	7.96
IN - TN Mean Annual Load (kg/yr)	34.9	7.85	22.3	6.6	12.9	7.33	14.7	3.77	3.67	9.53	30.6	38.9	6.6	76.2
IN - Gross Pollutant Mean Annual Load (kg/yr)	523	115	349	103	197	115	230	56.5	57.4	149	222	124	103	19
OUT - Mean Annual Flow (ML/yr)	19.9	4.41	12.6	3.89	7.4	4.32	8.65	2.22	2.16	5.7	15.7	23.9	3.89	56.2
OUT - TSS Mean Annual Load (kg/yr)	212	42.5	204	65	82.2	72.3	144	35	36.1	94.7	466	722	65	82.3
OUT - TP Mean Annual Load (kg/yr)	1.76	0.373	1.63	0.506	0.666	0.562	1.12	0.233	0.281	0.741	2.85	4.28	0.506	2.4
OUT - TN Mean Annual Load (kg/yr)	16.1	3.46	18.6	5.77	6.03	6.41	12.8	1.98	3.2	8.45	24.5	36	5.77	37
OUT - Gross Pollutant Mean Annual Load (kg/yr)	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Generic treatment nodes

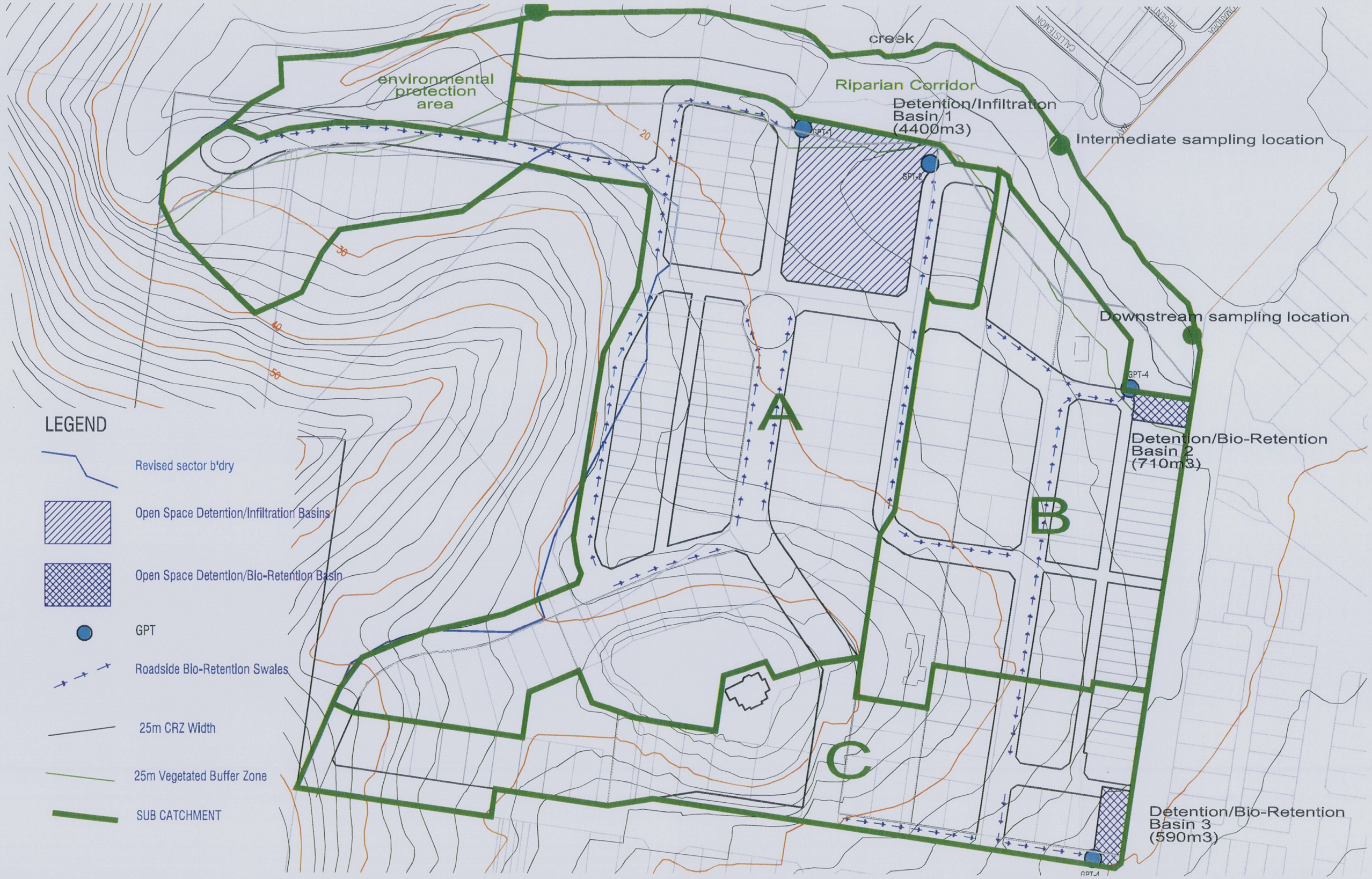
Location	GPT1	GPT4	GPT2	GPT3
ID	10	12	13	14
Node Type	GPTNode	GPTNode	GPTNode	GPTNode
Lo-flow bypass rate (cum/sec)	0	0	0	0
Hi-flow bypass rate (cum/sec)	10	10	10	10
Flow Transfer Function				
Input (cum/sec)	0	0	0	0
Output (cum/sec)	0	0	0	0
Input (cum/sec)	10	10	10	10
Output (cum/sec)	10	10	10	10
Gross Pollutant Transfer Function				
Input (kg/ML)	0	0	0	0
Output (kg/ML)	0	0	0	0
Input (kg/ML)	15	15	15	15
Output (kg/ML)	0.8	0.8	0.8	0.8
Total Nitrogen Transfer Function				
Input (mg/L)	0	0	0	0
Output (mg/L)	0	0	0	0
Input (mg/L)	50	50	50	50
Output (mg/L)	47	47	47	47
Total Phosphorus Transfer Function				
Input (mg/L)	0	0	0	0
Output (mg/L)	0	0	0	0
Input (mg/L)	5	5	5	5
Output (mg/L)	3.5	3.5	3.5	3.5
Total Suspended Solids Transfer Function				
Input (mg/L)	0	0	0	0
Output (mg/L)	0	0	0	0
Input (mg/L)	1000	1000	1000	1000
Output (mg/L)	200	200	200	200
IN - Mean Annual Flow (ML/yr)	53.8	5.85	9.57	15.2
IN - TSS Mean Annual Load (kg/yr)	2.15E+03	211	226	494
IN - TP Mean Annual Load (kg/yr)	8.89	0.932	1.23	2.22
IN - TN Mean Annual Load (kg/yr)	65.4	7.28	11	17.4
IN - Gross Pollutant Mean Annual Load (kg/yr)	338	29.8	17.8	68.9
OUT - Mean Annual Flow (ML/yr)	53.8	5.85	9.57	15.2
OUT - TSS Mean Annual Load (kg/yr)	429	42.1	45.1	96.8
OUT - TP Mean Annual Load (kg/yr)	6.22	0.653	0.863	1.55
OUT - TN Mean Annual Load (kg/yr)	61.5	6.84	10.3	16.3
OUT - Gross Pollutant Mean Annual Load (kg/yr)	18.1	1.59	0.948	3.67

Other nodes

Location	Dum Out	FERN CREEK OUT	J1	Junction	Junction	Junction	Junction
ID	1	2	9	21	31	40	47
Node Type	ReceivingNode	JunctionNode	JunctionNode	JunctionNode	JunctionNode	JunctionNode	JunctionNode
IN - Mean Annual Flow (ML/yr)	110	94.5	9.57	15.2	15.4	53.8	12.9
IN - TSS Mean Annual Load (kg/yr)	1.42E+03	933	226	494	787	2.15E+03	935
IN - TP Mean Annual Load (kg/yr)	9.92	7.07	1.23	2.22	3.05	8.89	3.11
IN - TN Mean Annual Load (kg/yr)	102	77.1	11	17.4	22.5	65.4	18.8
IN - Gross Pollutant Mean Annual Load (kg/yr)	0	0	17.8	68.9	120	338	183
OUT - Mean Annual Flow (ML/yr)	0	94.5	9.57	15.2	15.4	53.8	12.9
OUT - TSS Mean Annual Load (kg/yr)	0	933	226	494	787	2.15E+03	935
OUT - TP Mean Annual Load (kg/yr)	0	7.07	1.23	2.22	3.05	8.89	3.11
OUT - TN Mean Annual Load (kg/yr)	0	77.1	11	17.4	22.5	65.4	18.8
OUT - Gross Pollutant Mean Annual Load (kg/yr)	0	0	17.8	68.9	120	338	183

Appendix G -

PROPOSED CATCHMENT PLAN



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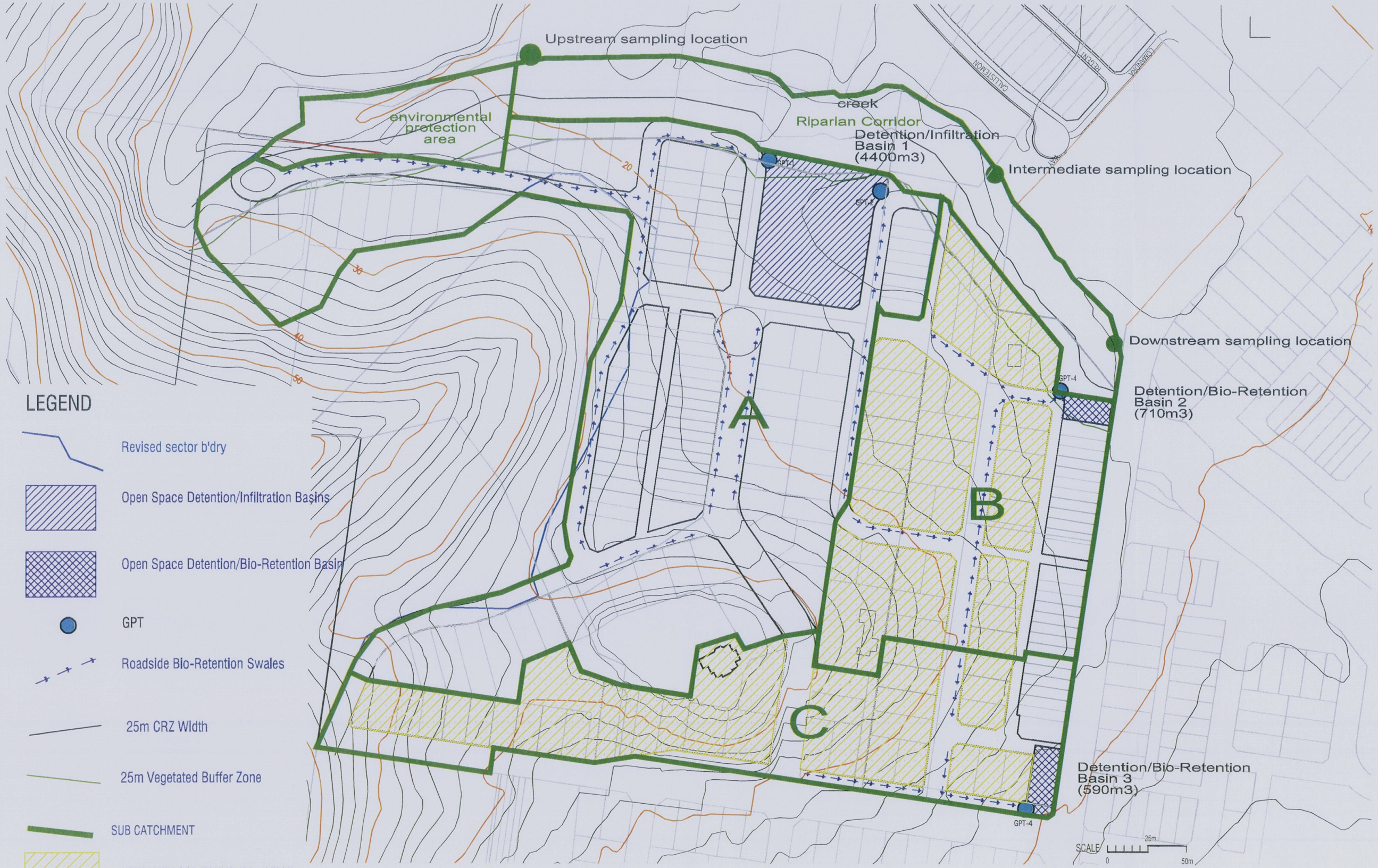
CATCHMENT PLAN OF DEVELOPMENT
UNDER PROPOSED CONDITIONS

Appendix H -

PROPOSED STORMWATER DRAINAGE PLAN

APPENDIX H



LEGEND

- Revised sector b'dry
- Open Space Detention/Infiltration Basins
- Open Space Detention/Bio-Retention Basin
- GPT
- Roadside Bio-Retention Swales
- 25m CRZ Width
- 25m Vegetated Buffer Zone
- SUB CATCHMENT
- LOTS WITH OSD TANKS (20~25M3)

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LAYOUT OF PROPOSED DRAINAGE AND STORMWATER MANAGEMENT PLAN

Appendix I -

PMF FLOOD EXTENT

APPENDIX I

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PRELIMINARY PMF FLOOD EXTENT