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PROJECT DELIVERY

URBAN DEVELOPMENT

YEATS CONSULTING ENGINEERS

Stormwater Quality Concept Plan

COBAKI LAKES DEVELOPMENT

PROJECT APPLICATION

CENTRAL OPEN SPACE

LEDA MANORSTEAD PTY LTD

SEPTEMBER 2010

REVISION 02

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Document history and status

Revision	Date issued	Reviewed by	Approved by	Date approved	Revision type
01	30/06/2010	CS	BY	30/06/2010	Draft Issue
02	10/09/2010	CS	BY	10/09/2010	Response to Info Request

Distribution of copies

Revision	Copy no	Quantity	Issued to
01	1	1.pdf	LEDA – Steve Twohill
02	1	1.pdf	LEDA – Steve Twohill

Printed:	13 September 2010
Last saved:	10/09/2010 16:22
File name:	G:\YC0229 Cobaki Tweed\07 Reports\01 SBSMP\YC0229-1M5 Central Open Space\Stormwater Quality Management Plan Rev02.doc
Author:	Tom Watt
Project manager:	Craig Siganto
Name of organisation:	Yeats Consulting Pty Ltd
Name of project:	Cobaki Lakes – Preferred Project Report – Central Open Space Application
Name of document:	Stormwater Quality Management Plan Rev02.doc
Document version:	REV 02
Project number:	YC0229

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1 Introduction

1.1 Background and Philosophy

Yeats Consulting Pty Ltd (Yeats) has been engaged by Leda Manorstead Pty Ltd (Leda) to undertake a Stormwater Quality Management Plan for the entire Cobaki Lakes Development. As demonstrated in this report the majority of the Cobaki Lakes Development will be treated within the Central Open Space; as such, this report is being submitted fir the Central Open Space Application of the Preferred Project Report at the Cobaki Lakes Development. The local government authority for this master planned development is Tweed Shire Council (TSC).

This report follows previous Stormwater Assessments and Management Plans prepared by Gilbert & Sutherland (G&S) for the Cobaki Lakes Development and supersedes the Stormwater Quality aspects contained within these G&S reports.

A significant change entails the removal of the lake. We note that the proposed lake would have created significant challenges in regard to water quality control and maintenance and therefore changed the methodology for managing stormwater quality. Another significant change to the Central Open Space corridor is that the major open drainage channel has been lifted to ensure the base of the drainage channel is kept above the groundwater level and to reduce environmental impacts associated excavation in acid sulphate soils.

It is anticipated that the stormwater treatment train will be delivered in stages generally in conjunction with the delivery of individual precincts.

1.2 Site Description

1.2.1 Location

The subject site is located at Piggabeen Road, Tweed Heads and is adjacent to the Tugun Bypass and Gold Coast Airport.

The site is bounded by the Queensland and New South Wales border to the north and west and Piggabeen Road to the south. The site also adjoins Cobaki Creek and Cobaki Broadwater to the east. It is approximately 6km west of Tweed Heads / Coolangatta Town Centre, 1.5km west of the Gold Coast Airport and the Gold Coast Highway, and 500m west of the Pacific Motorway (Tugun Bypass). Current access to the site is from Piggabeen Road, opposite the existing Woodlands Golf Course. Future access is proposed to be taken from an extension of Boyd Street from the north and linking to Piggabeen Road to the south via a future bridge crossing of Cobaki Creek. The site location is shown in Figure 1.1 below.

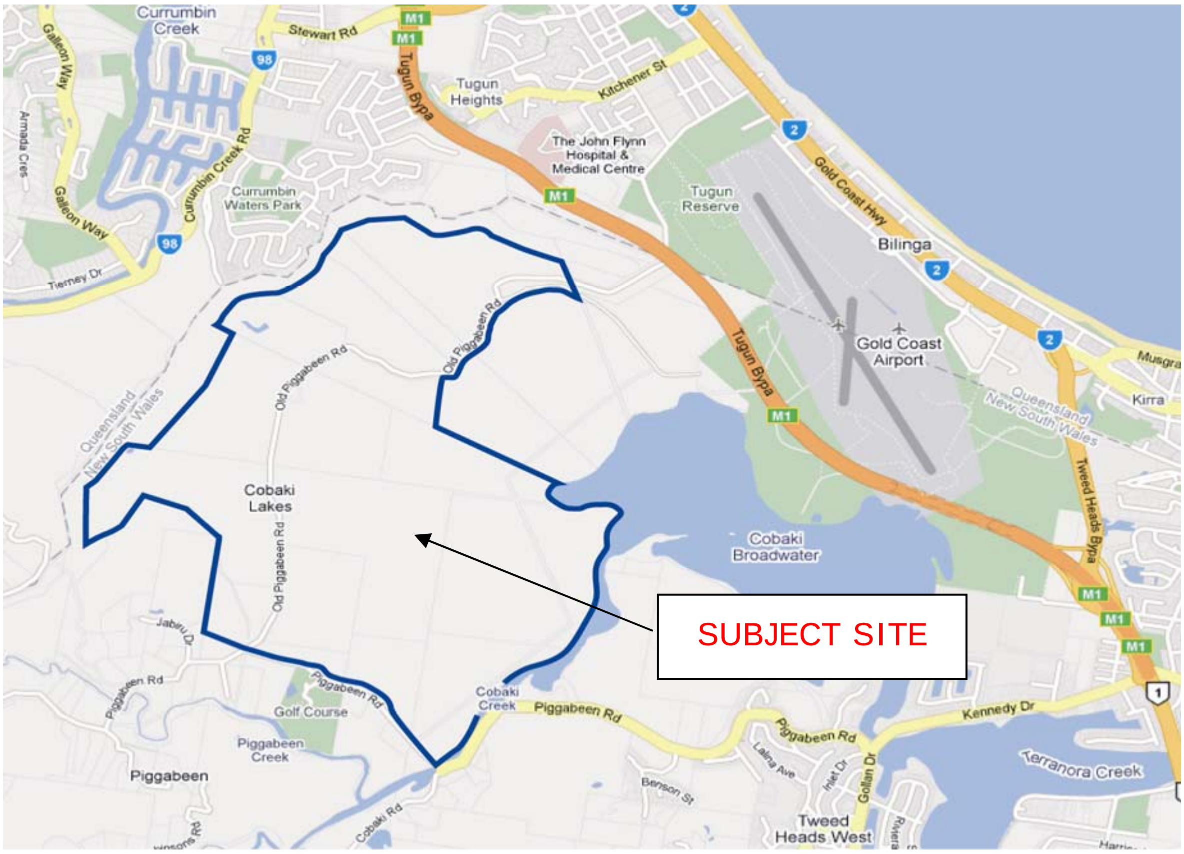


Figure 1.1 Site Location – Street Plan

(Source: Google Maps)

1.2.2 Site Description & Topography

The site is situated within the foothills of the eastern end of the McPherson Range. It forms a natural amphitheatre located within the catchment of Cobaki Broadwater comprising a low lying and level central plain surrounded by steep rising hillsides on the northern, western and southern sides of the site. The development site falls gently on the south-eastern boundary towards Cobaki Creek and Cobaki Broadwater.

The central and eastern areas of the site are very flat with low lying areas that are underlain with highly compressible marine clays. The stormwater drainage systems need to be constructed at minimum grade in these low lying areas, to minimise pipe trenches breaching the groundwater table and acid sulphate soils (ASS). The groundwater level in these areas is quite high and is approximately at RL 0.3m (AHD). The existing ground material is subject to ASS in some areas. The flood level to be adopted for the development site is RL 2.9m (AHD) as advised by Tweed Shire Council.

2 Proposed Development

Cobaki Lakes Estate is a proposed mixed use residential development with approximately 598 hectares of land in the Tweed Shire region. The proposed development is broken up into 17 precincts and will consist of a mix of residential, retail and commercial, educational and community facilities and an associated infrastructure passage.

There will be a large amount of open space area provided within the development site including sporting and recreational facilities, linear open space and neighbourhood parks. The site also includes environmental protected areas, froglet habitat areas, fauna corridors and salt marsh habitats.

The Cobaki Lakes Concept Plan prepared by The Design Forum Pty Ltd dated 31st August 2010 is shown in Appendix A.

3 Stormwater Quality Management Plan

3.1 Introduction

In order to ensure that the proposed development does not adversely impact the surrounding environment, and to meet the aims outlined in Tweed Shire Councils (TSC) Development Design Specification D7 – Stormwater Quality, a stormwater quality management strategy has been developed. This strategy incorporates rainwater tanks, a large constructed open drainage channel and bio-filtration devices to treat pollutant laden stormwater before it is discharged from the subject site.

3.2 Relevant Water Quality Objectives

It is understood that the Tweed Shire Council are currently in the process of reviewing their stormwater quality approach and water quality objectives (WQOs). Accordingly, MUSIC modelling has been undertaken to provide an assessment of the treatment effectiveness of the proposed treatment train.

TSC has advised that the Water by Design "Design Objectives for Water Management" be adopted and achieved for the basis of the water quality design for the proposed development. These design objectives and adopted targets for stormwater quality management are as follows:

Table 3.1 Load Reduction Objectives (LRO's)

Pollutant Types	Site Water Quality Objective
Total Suspended Solids (TSS)	80% Reduction
Total Phosphorous (TP)	60% Reduction
Total Nitrogen (TN)	45% Reduction
Gross Pollutants > 5mm	90% Reduction

It shall be noted that all South East Queensland Council's including neighbouring Gold Coast City Council refer to the Water by Design "Design Objectives for Water Management" and the above water quality objectives/targets.

3.3 Proposed Treatment Measures

The adopted treatment measures for the proposed development are detailed below:

3.3.1 Rainwater Tanks

It is proposed to utilise rainwater tanks across the Cobaki Lakes development as the primary source of treatment to all roof areas, providing pollution reduction through both sedimentation and reuse.

Rainwater tanks act as a settling tank, allowing the settlement of course sediments and solids which would otherwise have entered that natural water course. The collected roof water will also be used for re-use for grey water applications, reducing demand on the town water supply.

All overflows from the proposed roof water tanks shall be connected to the reticulated stormwater system.

The following table outlines the rainwater and roof catchment properties adopted for the various types of development within each precinct.

Table 3.2 Rainwater Tank Parameters

Development/Lot Type	Council Requirements		Adopted Parameters	
	Connected Roof Area	Min. Rainwater Tank Size	Connected Roof Area	Min. Rainwater Tank Size
Detached Dwelling	$160m^2$ min.	5,000L	$160m^2$	5,000L
Zero-lot Dwelling	Min 85% of roof up to $160m^2$	3,000L	$160m^2$	3,000L
Terrace Dwelling	Min 85% of roof up to $160m^2$	2,000L (3,000L if space permits)	$160m^2$	2,000L
Plexes (Each Dwelling)	Min 85% of roof up to $160m^2$	2,000L/dwelling Site min. 5,000L (can be common)	$160m^2$	2,000L
Mews (Each Dwelling)	Min 85% of roof up to $160m^2$	2,000L/dwelling No common tank without a Body Corp or single owner	$160m^2$	2,000L
SOHO Dwelling	Min 85% of roof up to $160m^2$	3,000L	$160m^2$	3,000L
Multiple Unit Developments, Commercial, Industrial	80-90% of roof area	Common tank sized to building size		20,000L
Apartments	80-90% of roof area		$300m^2$/Apartment Building	20,000L

With regard to water reuse, based on the TSC water demand management strategy provides and liaison with TSC, a daily demand of 220 L/ET/day demand has been adopted for each tank, catering for outdoor use, toilets and cold water washing machines.

3.3.2 Bio-retention Basins

Bio-retention basins will be provided for each precinct to treat the pollutant laden stormwater from the development parcels. These basins will be constructed adjacent to the central open drain system to ensure water quality objectives are met before entering the major drainage channel. The invert of the filter media within the bio-retention basins will be kept above the existing groundwater level to ensure the stormwater runoff is treated before entering the groundwater sources.

The bio-retention basins will accept flow from the underground piped drainage system, retain this runoff within an extended detention depth of 0.3m and percolate this water through the filter media (sandy loam topsoil). Filtered stormwater is then recovered at the base of the filter media via a drainage layer containing perforated pipes. The surface of the bio-retention device is to be densely planted out with locally occurring native ground cover species and shrubs. The vegetation should be selected in consultation with a landscape architect and the approved landscaping plans for the site. A typical section of a bio-retention basin is presented in Figure 3.1. Further details of the bio-retention basins proposed within the development site will be included in future Construction Certificate applications.

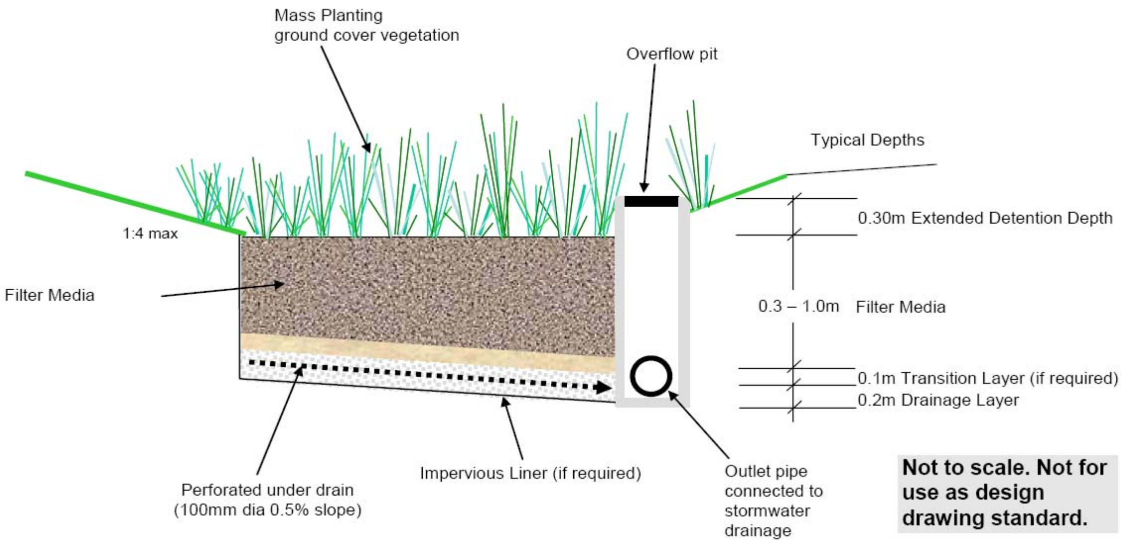


Figure 3.1 Bio-retention Basin – Typical Section

(Source: Healthy Waterways WSUD Technical Design Guidelines)

It is also proposed that GPT's, in the form of rock lined basins/forebays immediately downstream of all outlet headwalls, be installed to assist in capturing and retaining the coarse pollutants that enter the piped drainage systems. The outlet end of the basin shall be constructed to ensure flows are spread evenly over a wide area to ensure that risk of erosion is minimised.

3.3.3 Treatment within Open Drains

An additional element of the proposed treatment train that has been excluded from the MUSIC modelling software will be the constructed major central open drain and some associated minor open drain tributaries. These open drains will provide a final polishing function to the stormwater quality treatment train prior to entering salt marsh areas south of Sandy Road and eventually into Cobaki Creek.

The proposed open drains form an integral part of the proposed stormwater management strategy for the Cobaki Parkway Development with the proposed central open space corridor to be utilised for stormwater detention and conveyance (Quantity) and concluding stormwater quality treatment.

The follow hierarchy of drains are proposed across the site, with corresponding typical dimensions:

1. CENTRAL OPEN DRAIN – 30m base width, 1V:6H side slopes, 0.5% base slope to low flow/bioretention zone along one side, longitudinal grade of approx 0.085% (1V:1200H).
2. MINOR OPEN DRAINS – 5-20m base widths, 1V:2H side slopes, longitudinal slope varies.

All of the proposed open drains shall be vegetated across their full width in accordance with the Central Open Space Landscape Plan. As runoff passes through the vegetation, contaminants are removed by the combined effects of filtration, infiltration, adsorption, and biological uptake. Vegetation also decreases the velocity of flow and allows for particulates to settle.

The proposed open drain network comprises a total vegetated base area of approximately 11.8Ha. With a total developed catchment area of 311 Ha, this equates to a 3.8% of the developed catchment.

Efficiency of contaminant removal within the open drains depends directly on the residence time of water through drain and the depth of water relative to the height of vegetation. Residence time is maximised within the proposed open drains by the following key attributes:

- Significantly flat longitudinal grades (0.085% for major central open drain).
- Wide, flat channel cross sections spreading flow to a minimal depth over a wide area

The above ensures low flow velocities, distribution of flows and good contact with vegetation and soil which is required to promote the operation of the various mechanisms that capture and transform contaminants.

The passage of stormwater through the vegetation within the open drains utilises a number of physical, chemical, and biological factors to reduce stormwater contaminants.

Physical factors include:

- Reduction of flow speed by the vegetation to improve settlement
- Filtration by the dense vegetation
- The rough nature of the soil/vegetation interface which improves retention of settled material and reduces re-suspension
- Infiltration, which in suitable soils can be a major contaminant removal and volume reduction mechanism

Biological factors include:

- Microorganisms which degrade organic contaminants uptake of nutrients and contaminants by vegetation
- The provision of large surface areas of vegetation to which contaminants become absorbed

A 1.0m wide, 0.5m deep trench is proposed along the length of the central open drain invert to facilitate keeping the channel bed dry for future maintenance. The trench will consist of a bottom 300mm gravel material layer for drainage and top 200mm sandy loam topsoil layer for vegetation. This trench will also function as minor bio-retention device.

Some of the minor open drain tributaries have been modelled as vegetated swales within MUSIC and are incorporated into the treatment train prior to entering the bio-retention basins.

3.3.4 Grass Buffers

Grass buffer strips are commonly used as a source control measure, and are intended to provide a discontinuity between impervious surfaces and the drainage system. In the context of this report buffer strips have been used to treat the flow from the remaining impervious allotment surfaces (other than roof), and is assumed to be made up of front and rear lawns, road verges etc, over which runoff flows prior to entering the drainage system.

3.4 MUSIC Modelling

The adopted treatment strategy is shown in Appendix B with details of the modelling procedure described in the following sections.

3.4.1 Meteorological Data

The meteorological data utilised by MUSIC to simulate catchment hydrology processes includes rainfall data (at intervals relevant to the time step being modelled) and average areal potential evapo-transpiration (measured in millimetres per day).

Meteorological data used for the model was the Tweed standard rainfall data – Murwillumbah 58158 (6 minute time step 3/01/1978-31/12/1978) within the Music Model software program.

3.4.2 Source Nodes

Source node properties were obtained from TSC Development Design Specification D7, section 7.13.3, Table 1 and are tabulated below in Table 3.3:

Table 3.3 Mean EMC Values for Source Nodes

		Mean EMC (mg/L)					
Land Use		TSS		TP		TN	
		Storm Flow	Base Flow	Storm Flow	Base Flow	Storm Flow	Base Flow
Urban	Mean	2.000	0.800	-0.680	-1.00	0.193	-0.100
	Std Deviation	0.145	0.200	0.280	0.340	0.050	0.050
Rural	Mean	1.627	0.600	-0.950	-1.400	-0.250	-0.150
	Std Deviation	0.200	0.200	0.100	0.400	0.197	0.400
Forest	Mean	1.200	0.800	-1.470	-1.000	-0.900	-0.100
	Std Deviation	0.145	0.200	0.300	0.340	0.100	0.050

The Urban source node has been adopted for all catchments and the permeability adjusted according to the density of development. Refer to Appendix A for sub catchment areas and the Stormwater Management Strategy.

The relevant runoff parameters were sourced from the TSC Development Design Specification D7, the parameters can be seen listed below in table 3.4.

Table 3.4 Runoff Parameters

Parameter	Urban Land Use	Rural Land Use	Forest Land Use
Field Capacity (mm)	50	50	50
Infiltration Coefficient	50	50	50
Infiltration exponent	2	2	2
Rainfall threshold (mm)	1	1	1
Soil Capacity (mm)	150	150	150
Initial Storage (%)	25	25	25
Daily Recharge Rate (%)	0.65	0.65	0.65
Daily Drainage Rate (%)	0.85	0.85	0.85

3.5 Performance Assessment

The site has been modelled as a number of Urban Residential source nodes. Each Precinct is divided into a roof area and a road/concrete area. The roof (Urban nodes) discharges into rainwater treatment devices, and then to bio-retention basin before entering the central open drain network. The road and concrete areas are discharged directly into bio-retention basins prior to the open drain network. MUSIC model parameters were adopted according to the Guidelines for Tweed Shire Council. The parameters adopted for the MUSIC model are outlined in Table's 3.5 and 3.6.

Table 3.5 Adopted MUSIC Model Source Node Parameters

Parameter	Value
Source Data	
Rainfall data setup	Murwillumbah
Model time step	6 Minute
Directly connected impervious area	Road
Soil properties (Runoff generation parameter)	Urban Residential

Table 3.6 Precinct Development Summary

Precinct	Detached Dwelling	Zero-Lot Dwelling	Terrace Dwelling	Mews/Plex	SOHO Dwelling	Apartments	Apartment Dwelling	Total Area (ha)
1	99	36	0	60	0	7	1	15.2
2	154	66	0	61	0	170	10	25.5
3	60	30	80	40	0	0	0	11.76
4	0	0	0	64	0	0	0	2.1
5	0	0	0	0	0	40	3	14.2
6	21	21	100	85	20	40	2	11.7
7	213	137	70	140	30	0	0	43.6
8	250	125	75	80	30	0	0	40.2
9	61	32	171	65	0	0	0	21.3
10	220	110	50	33	0	0	0	23.2
11	35	10	69	60	0	0	0	13.7
12	120	60	76	75	10	38	3	21.72
13	240	120	0	80	0	0	0	28.57
14	25	10	76	45	0	0	0	7.9
15	90	45	55	50	0	52	4	11.5
16	65	45	30	65	0	0	0	11.3
17	0	0	65	90	0	53	4	7.22
Total	**1653**	**847**	**917**	**1093**	**90**	**400**	**27**	**311**

As Precincts 3, 4, 13, and part of 16 do not enter directly into the Central Open Space area, these precincts have been removed from the MUSIC Model. These precincts will contain their own stormwater treatment devices and will be modelled in future and separate applications.

Table 3.7 Adopted MUSIC Model Treatment Node Parameters

Parameter	Value
Treatment Devices	
TYPICAL SWALE DETAILS Major Central Open Drain	Base Width = 30.0m Top Width = 40.0m Depth = 0.50m Vegetation Height = 0.40m Seepage Loss = 0.00mm/h
TYPICAL BIO-RETENTION DETAILS	Extended Detention Depth = 0.3m Filter Depth = 0.5m Filter Median Particle Diameter = 0.45mm Saturated Hydraulic Conductivity = 180mm/hr
Swale 6	Length = 700m Bed Slope = 0.1% Base Width = 5m Top Width = 15m
Swale 15	Length = 200m Bed Slope = 3.0% Base Width = 5m Top Width = 15m
Bio-Retention 1	Surface Area = 2800m^2 Filter Area = 2500m^2
Bio-Retention 2	Surface Area = 3500m^2 Filter Area = 3300m^2
Bio-Retention 5	Surface Area = 3500m^2 Filter Area = 3300m^2
Bio-Retention 6	Surface Area = 1500m^2 Filter Area = 1300m^2
Bio-Retention 7	Surface Area = 6500m^2 Filter Area = 6000m^2
Bio-Retention 8	Surface Area = 6500m^2 Filter Area = 6000m^2
Bio-Retention 9	Surface Area = 3500m^2 Filter Area = 3200m^2

Bio-Retention 10	Surface Area = 3500m^2 Filter Area = 3000m^2
Bio-Retention 11	Surface Area = 2500m^2 Filter Area = 2000m^2
Bio-Retention 12	Surface Area = 3500m^2 Filter Area = 3000m^2
Bio-Retention 14	Surface Area = 1500m^2 Filter Area = 1200m^2
Bio-Retention 15	Surface Area = 2000m^2 Filter Area = 1800m^2
Bio-Retention 16	Surface Area = 2050m^2 Filter Area = 1800m^2
Bio-Retention 17	Surface Area = 1100m^2 Filter Area = 1000m^2

Refer to Appendix C for MUSIC Modelling inputs for the rainwater tanks.

3.6 Water Quality Objectives Performance

Table 3.8 summarises the load reduction by MUSIC using the WSUD strategy outlined above.

Table 3.8 Mitigated Pollution Export Concentrations

Parameter	Sources	Residual Load	Reduction (%)
Total Suspended Solids (kg/yr)	333,000	44,400	86.6
Total Phosphorous (kg/yr)	830	247	70.3
Total Nitrogen (kg/yr)	5,060	2,780	45.0
Gross Pollutants (kg/yr)	72,500	0	100.0

As Tables 3.8 illustrates, the water quality load based reduction objectives of 80% for Total Suspended Solids, 60% for Total Phosphorous, 45% for Total Nitrogen and 90% for Gross Pollutants have been achieved for the stormwater discharging from the Central Open Space.

It shall be noted that the final treatment device being the central open drain and some associated minor open drain tributaries has been excluded from the MUSIC modelling, but will provide additional polishing of the stormwater runoff before discharging from the development site. We believe the proposed method of water quality treatment demonstrates 'best practice', providing a solution requiring minimal ongoing maintenance by Council and a high level of stormwater treatment.

We note also that subsequent development applications of individual precincts will include site based stormwater management plans providing further detail and will generally be in accordance with this report.

4 Monitoring and Maintenance

4.1 **Monitoring**

As only proven Stormwater Quality Best Management Practices (SQBMPs) are proposed for this development, it is not considered necessary that ongoing water quality monitoring be undertaken.

4.2 **Maintenance**

Proper maintenance of the vegetated swales and bio-filtration swales is critical in ensuring that filtering capacity of the system will not be reduced. This will be primarily achieved by maintaining complete vegetation covering of the soil throughout the length or area of the system, and prevent activities that could compact the soil and limit the infiltration rate of water through it. Other maintenance works will include:

- Watering, replanting and weeding to maintain vegetation cover especially during establishment;
- Mowing of the grassed surface;
- Removal of litter and debris from the bioretention basin surface and swale drains; and
- Checking for channelling or erosion.

Maintenance works, including but not limited to the collection of litter, mowing and maintenance of the buffer strips, will be the responsibility of the property owners and will be undertaken on a regular basis. Major stormwater systems including the Central and Minor Open Drainage Corridors and piped stormwater network shall be owned and maintained by Council.

5 References

Healthy Waterways, Water Sensitive Urban Design, Technical Design Guidelines for South East Queensland, Version 1 June 2006.

Tweed Shire Council, 2000, Tweed Urban Stormwater Quality Management Plan.

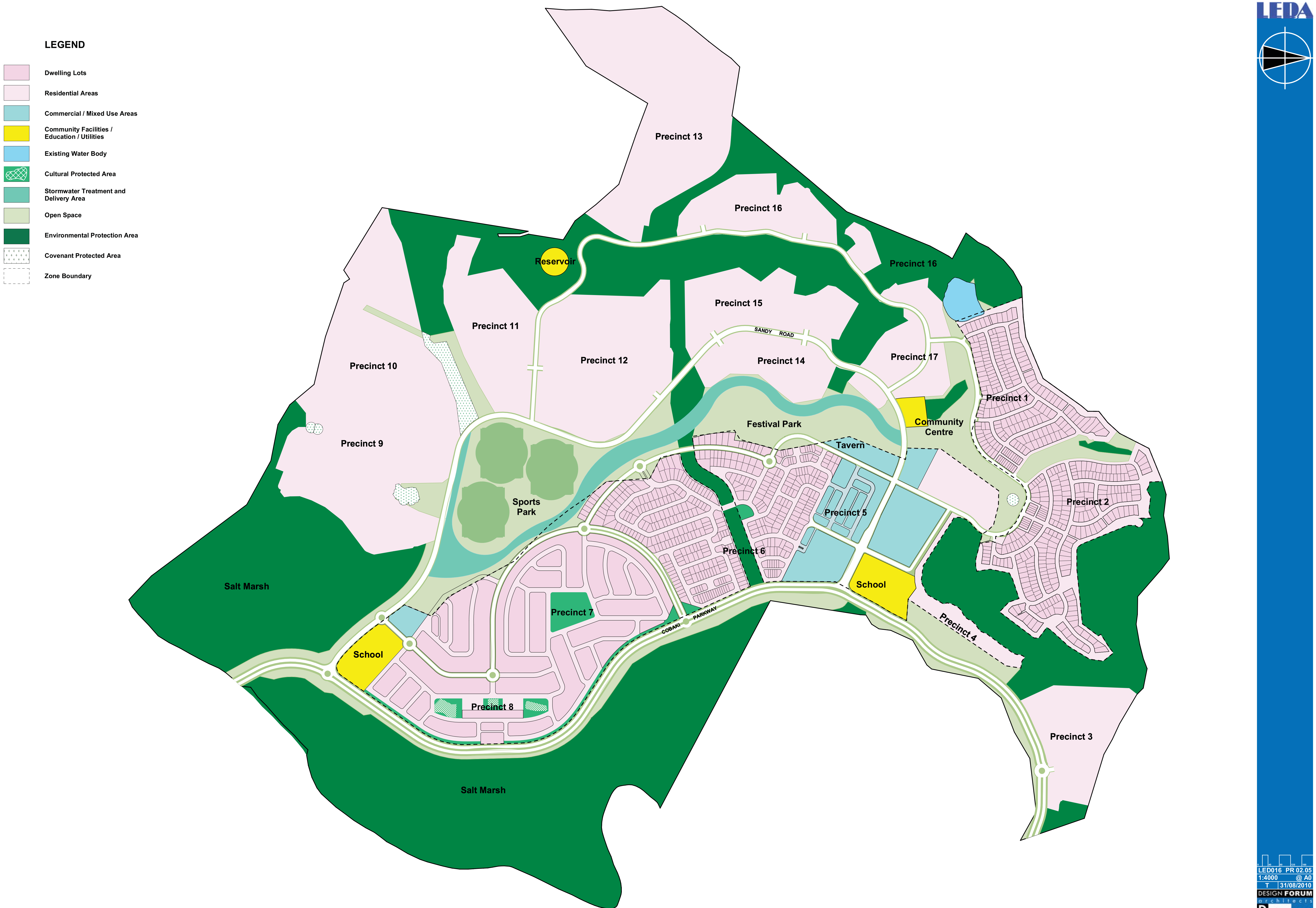
Tweed Shire Council, 2005, Development Design Specification D7 – Stormwater Quality, Version 1.3

"Queensland Urban Drainage Design Manual (QUDM)", Volume 1, Second Edition 2007

YEATS CONSULTING ENGINEERS

Appendix A

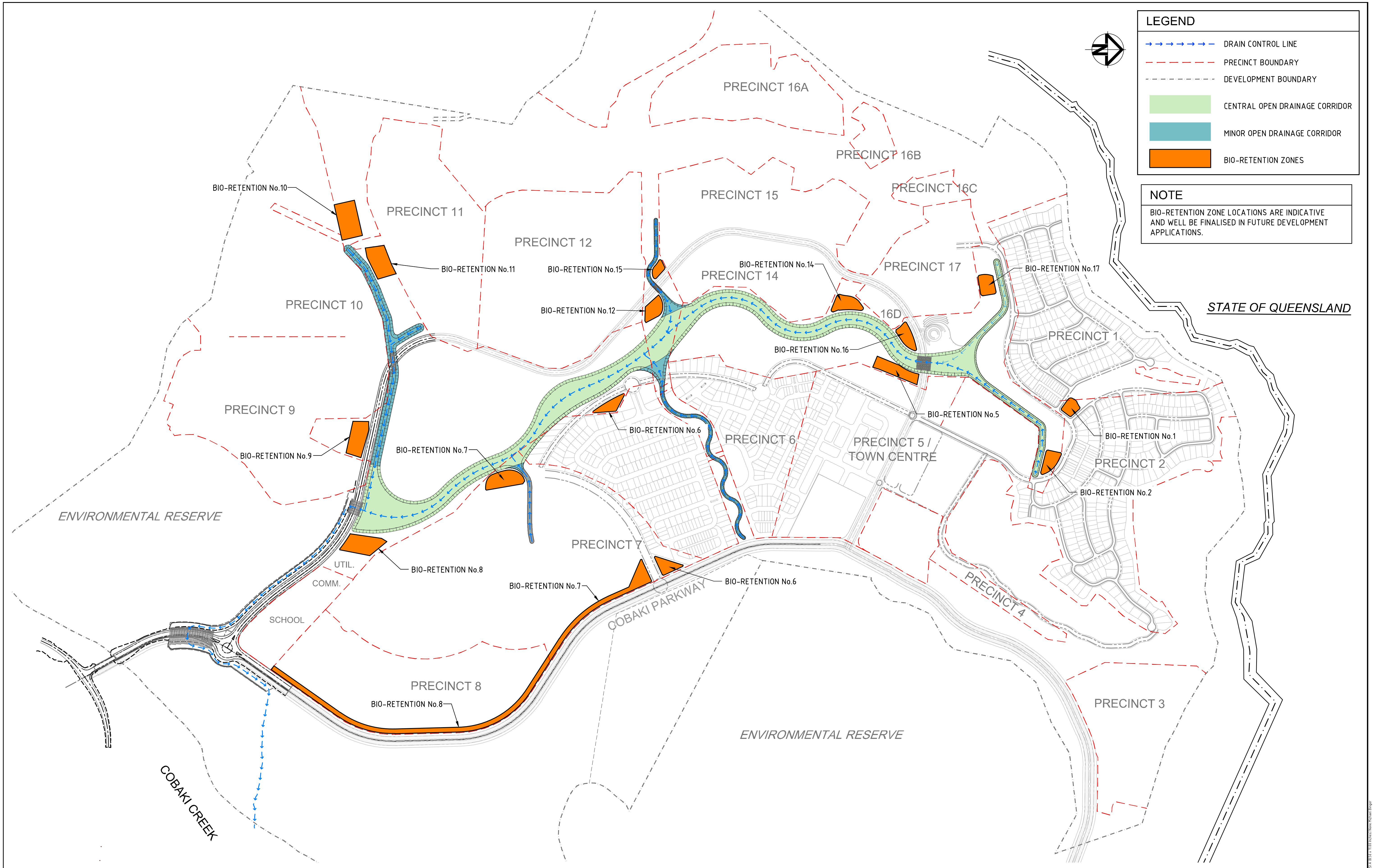
Development Concept Plan



Master Plan **Leda Manorstead Pty Ltd** **Cobaki Precincts Open Space Application**

Appendix B

Stormwater Quality Plan



STATUS: PRELIMINARY — NOT TO BE USED FOR CONSTRUCTION

REV	DESCRIPTION	DRAWN	DATE
B	LAYOUT UPDATED AND STRATEGY AMENDED	MB	13.09.10
A	ORIGINAL ISSUE	TW	02.07.10

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SCALE (AT ORIGINAL SHEET SIZE) 1:5000 — ORIGINAL SHEET SIZE A1

CLIENT: LEDA Manorstead Pty Ltd

PROJECT: CENTRAL OPEN SPACE PROJECT APPLICATION COBAKI LAKES, COBAKI PWY

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TITLE: STORMWATER QUALITY PLAN

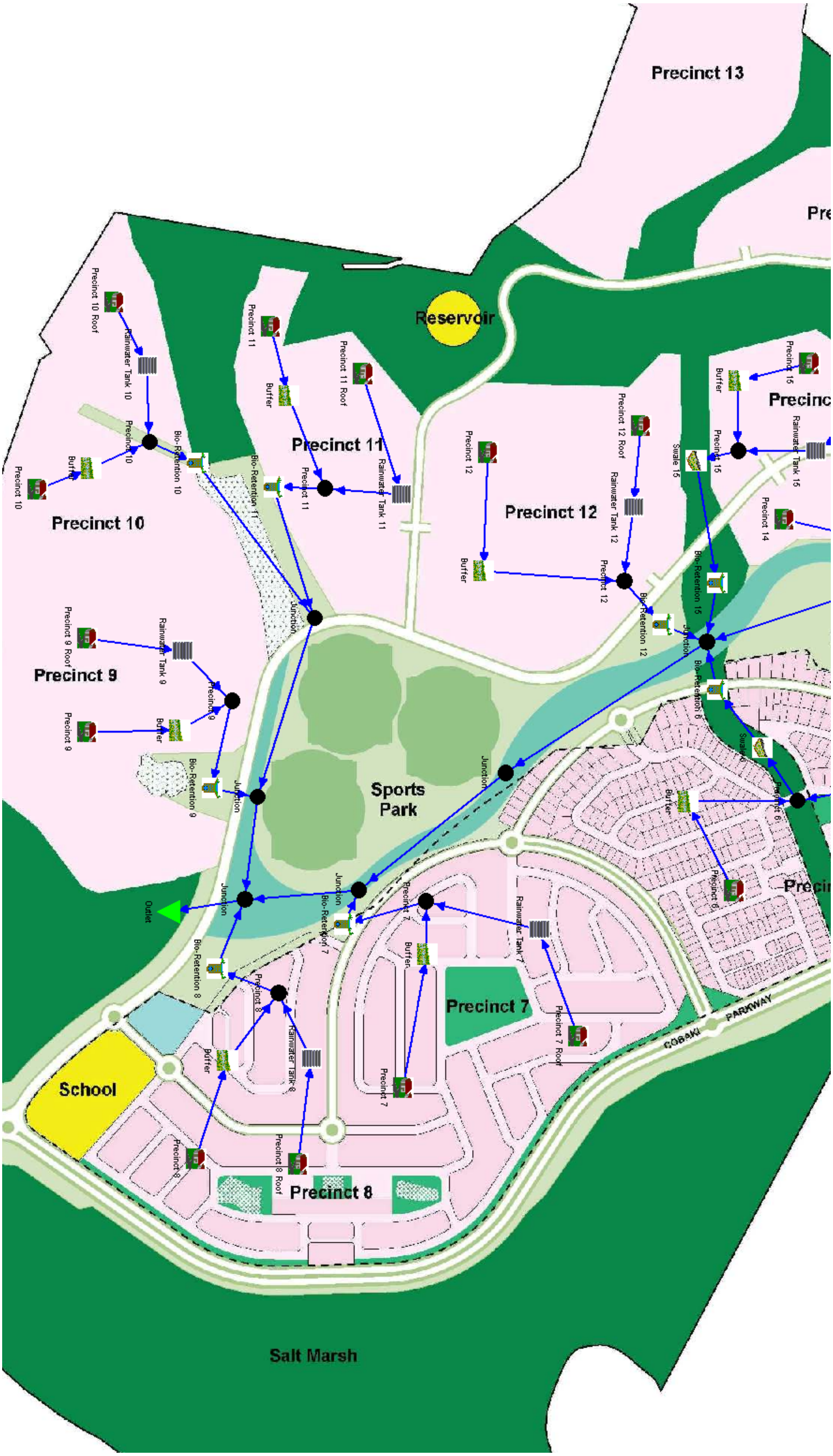
TASK	BY	INITIAL	DATE
REVIEW	CS		02.07.10
DESIGN	TW		02.07.10
DRAWN	TW		02.07.10

APPROVED — RPEQ No N/A
DRAWING NUMBER: YC0229-SW01 — REVISION: B

Appendix C

MUSIC Modelling Inputs


Precinct 16
Precinct 16
Precinct 15
Precinct 14
Precinct 17
Precinct 1
Precinct 2
Precinct 3
Precinct 4
Precinct 5
Precinct 6
Festival Park
Community Centre
Tavern
School
SANDY ROAD
Rainwater Tank 15
Rainwater Tank 14
Rainwater Tank 16
Rainwater Tank 17
Rainwater Tank 1
Rainwater Tank 2
Rainwater Tank 5
Rainwater Tank 6
Precinct 15 Roof
Precinct 14 Roof
Precinct 16 Roof
Precinct 17 Roof
Precinct 1 Roof
Precinct 2 Roof
Precinct 5 Roof
Precinct 6 Roof
Bio-Retention 14
Bio-Retention 16
Bio-Retention 17
Bio-Retention 5
Bio-Retention 1
Bio-Retention 2
Buffer
Junction
Swale

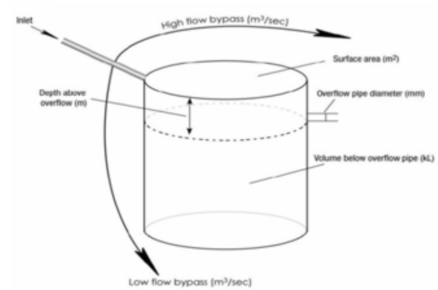


Precinct 13
Reservoir
Precinct 10 Roof
Rainwater Tank 10
Precinct 10
Buffer
Bio-Retention 10
Precinct 10
Precinct 11
Buffer
Precinct 11 Roof
Precinct 11
Rainwater Tank 11
Precinct 11
Bio-Retention 11
Precinct 12
Buffer
Precinct 12
Precinct 12 Roof
Rainwater Tank 12
Precinct 12
Bio-Retention 12
Precinct 15
Buffer
Precinct 15
Rainwater Tank 15
Swale 15
Bio-Retention 15
Precinct 14
Junction
Precinct 9 Roof
Rainwater Tank 9
Precinct 9
Precinct 9
Buffer
Precinct 9
Bio-Retention 9
Junction
Junction
Sports Park
Junction
Bio-Retention 6
Swale 6
Buffer
Precinct 6
Precinct 6
Junction
Outlet
Junction
Bio-Retention 7
Precinct 7
Rainwater Tank 7
Buffer
Precinct 7
Precinct 7 Roof
Precinct 7
Bio-Retention 8
Precinct 8
Buffer
Rainwater Tank 8
Precinct 8
Precinct 8 Roof
Precinct 8
School
COBAKI PARKWAY
Salt Marsh

MUSIC MODELLING - INPUTS

Project:	Cobaki - YC0229
Date:	5-Jul-10
Designed:	D.B.B
Comments:	Concept Planning

A conceptual diagram of the rainwater tank properties in MUSIC is presented below:



RAIWATER TANK PROPERTIES

Assumed demand 0.220 kl/day/household

In accordance with TSC Water Demand Management Strategy

Assumed dimensions of each tank (5000L)		*Assumed dimensions of each tank (3000L)*		*Assumed dimensions of each tank (2000L)*		*Assumed dimensions of each tank (20000L)*	
Height	2 m	*Height*	2 m	*Height*	2 m	*Height*	2 m
Volume	5.00 m^3	*Volume*	3.00 m^3	*Volume*	2.00 m^3	*Volume*	20.00 m^3
Surface Area	2.50 m^2	*Surface Area*	1.50 m^2	*Surface Area*	1.00 m^2	*Surface Area*	10.00 m^2
Diameter	1.78 m	*Diameter*	1.38 m	*Diameter*	1.13 m	*Diameter*	3.57 m
Depth of Anaerobic zone	0.1 m	*Depth of Anaerobic zone*	0.1 m	*Depth of Anaerobic zone*	0.1 m	*Depth of Anaerobic zone*	0.1 m
Depth of trickle top-up	0.1 m	*Depth of trickle top-up*	0.1 m	*Depth of trickle top-up*	0.1 m	*Depth of trickle top-up*	0.1 m
Permanent Depth	0.2 m	*Permanent Depth*	0.2 m	*Permanent Depth*	0.2 m	*Permanent Depth*	0.2 m
Permanent Volume	0.50 m^3	*Permanent Volume*	0.30 m^3	*Permanent Volume*	0.20 m^3	*Permanent Volume*	2.00 m^3
Volume below overflow pipe (& above permanent volume)	4.50 m^3	below overflow	2.70 m^3	below overflow	1.80 m^3	below overflow	18.00 m^3
Tank Outlet Diameter	90 mm	*Tank Outlet Diameter*	90 mm	*Tank Outlet Diameter*	90 mm	*Tank Outlet Diameter*	180 mm
Outlet Area	0.006 m^2	*Outlet Area*	0.006 m^2	*Outlet Area*	0.006 m^2	*Outlet Area*	0.025 m^2

INPUTS FOR MUSIC MODELLING

CATCHMENT	***1***	***2***	***3***	***4***	***5***	***6***	***7***	***8***	***9***	***10***	***11***	***12***	***13***	***14***	***15***	***16***	***17***	Total
TOTAL Area (Ha)	15.2	25.5	11.76	2.1	14.2	11.7	43.6	40.2	21.3	23.2	13.7	21.72	28.57	7.9	11.5	11.3	7.22	311
Number of Lots (5000L)	99	154	60	0	0	21	213	250	61	220	35	120	240	25	90	65	0	1653
Number of Lots (3000L)	36	66	30	0	0	41	167	155	32	110	10	70	120	10	45	45	0	937
Number of Lots (2000L)	60	61	120	64	0	185	210	155	236	83	129	151	80	121	105	95	155	2010
Apartments	7	170	0	0	40	40	0	0	0	0	0	38	0	0	52	0	53	400
Number of (20,000L) Tanks	1	10	0	0	3	2	0	0	0	0	0	3	0	0	4	0	4	
Total Lots	202	451	210	64	40	287	590	560	329	413	174	379	440	156	292	205	208	5000
RAINWATER TANK PROPERTIES																		
Storage Properties																		
Volume below overflow (m^3)	668.7	1161.0	567.0	115.2	54.0	574.2	1787.4	1822.5	785.7	1436.4	416.7	1054.8	1548.0	357.3	787.5	585.0	351.0	14072.4
Depth above overflow (m)	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	
Surface area (m2)	371.5	645.0	315.0	64.0	30.0	319.0	993.0	1012.5	436.5	798.0	231.5	586.0	860.0	198.5	437.5	325.0	195.0	7818.0
Outlet Properties																		
Equivalent Pipe Diameter (mm)	2313	3120	2176	720	312	2467	3781	3664	2595	3099	1839	3157	3185	1725	2740	2207	1480	40579
Daily Demand (KL/day)	44.4	99.2	46.2	14.1	8.8	63.1	129.8	123.2	72.4	90.9	38.3	83.4	96.8	34.3	64.2	45.1	45.8	1100.0

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