REDLAND CITY COUNCIL

Weinam Creek Stormwater Quality Infrastructure Plan






May 2013

M8000_018

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	DESCRIPTION	AUTHOR	REVIEWER	APPROVED BY	DATE
Rev 0	Client Issue	David Sexton	Mark Page	Mark Page	3 May 2013
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1. INTRODUCTION

Redland City Council (RCC) has engaged Engeny to develop an updated stormwater quality infrastructure plan for the Weinam Creek Catchment to supersede the stormwater quality component of the original Weinam Creek Catchment Concept Stormwater Management Plan (GHD, 2006).

In response to a review undertaken by Engeny of the original Concept Stormwater Management Plan (GHD, 2006), it was identified that the stormwater quality component of the report required updating to conform to current best practice. A copy of the letter summarising the findings from the review is provided in Appendix A.

Redland City Council (RCC) has therefore engaged Engeny to develop an updated stormwater quality infrastructure plan for the Weinam Creek catchment.

The purpose of this study was to determine the stormwater quality infrastructure requirements and associated costs for the catchment area. The stormwater infrastructure plan will assist Council in applying appropriate planning and acquisition principles for servicing forecasted demands. Figure 1.1 which illustrates the extent of the Weinam Creek catchment (study area).

The South East Queensland Regional Plan 2009-2031 included the Weinam Creek study area within the Urban Footprint regional land use category. In accordance with the South East Queensland Regional Plan 2009-2031 (SEQ Regional Plan), land use and infrastructure planning is required to be prepared and adopted prior to any future development taking place within the Weinam Creek area.

A previously undertaken study for the catchment has been used by Engeny to provide background information to this study. The previous study includes:

- Report for Redland PIP – Pilot Investigation Study 'Weinam Creek Catchment Conceptual Stormwater Management Plan (GHD, 2006).

This investigation has adopted a design approach consistent with the Queensland Government's Guide to Planning Stormwater Trunk Infrastructure (March, 2010), Statutory Guideline 01/09, Queensland Urban Design Manual (DERM 2007) and relevant Council policies for stormwater management.



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Weinam Creek Stormwater Quality Infrastructure Plan

Figure 1.1

Locality Plan

Job Number: M8000_018
Revision: A
Drawn: JNA
Date: 3 Apr 2013

2. SCOPE OF WORKS

The scope of works for this study has included stormwater quality analysis including determination of infrastructure requirements and associated construction costs and reporting. Specifically, the technical scope of works included the following:

- Development of a MUSIC Version 5.0 model for the catchment to represent the ultimate development unmitigated scenario. This model allows for a quantitative assessment of stormwater runoff quality for the proposed development plan (proposed ultimate land use);
- Amend the ultimate development unmitigated MUSIC model to include the appropriate treatment measures required to achieve the prescribed water quality objectives from the catchment. This model represents the ultimate mitigated scenario for the proposed development area and enables the appropriate water quality treatment infrastructure to be determined;
- Concept design of the proposed stormwater quality mitigation measures including estimation of construction costs for the proposed stormwater quality infrastructure requirements for the proposed development.

3. CATCHMENT DESCRIPTION

The Weinam Creek catchment outlets to Moreton Bay approximately two (2) kilometres south of Victoria Point. The Weinam Creek catchment covers the area of waterway between Cleveland Redland Bay Rd and the outlet. The majority of the catchment is fully developed resulting in little changes in the ultimate land use for the catchment. The area is currently known as the Weinam Creek Wetlands and has been marked as a significant landscape within Redland City's biodiversity.

The Weinam Creek catchment covers a total area of three (3) square kilometres which is bound by Redland Bay Marina to the north, Collins St to the east, Cleveland Redland Bay Rd to the south and Moogurrapum Creek to the west.

The majority of the proposed ultimate land use within the catchment will remain similar to its current residential use. The topography of the site is relatively flat with the majority of catchments discharging directly to existing ponds or water bodies. The land use classification within the catchment is residential with varying fractions of imperviousness due to differences in housing density.

4. STORMWATER QUALITY ANALYSIS

4.1 MUSIC Modelling

A quantitative assessment of stormwater runoff quality has been undertaken for the ultimate land use scenario for the Weinam Creek Wetlands area. This assessment was undertaken in order to develop a required footprint for water quality treatment devices within the Weinam Creek Wetlands Area.

State Planning Policy (SPP) 4/10 and Urban Stormwater Quality Planning Guidelines 2010 (DERM, 2010) provide the development criteria intended to ensure development is carried out in a way that will achieve the relevant water quality objectives of the EP Water Policy 2009. This policy outlines best practice stormwater quality management to protect the environmental values of receiving waters.

The SPP 4/10 guidelines references the Urban Stormwater Quality Planning Guidelines 2010 (DERM, 2010) to provide details of the required management of the site. These guidelines identify pollutant load reductions for urban stormwater. Load based objectives compare loads produced by an unmitigated developed catchment to the loads coming from the developed catchment where Water Sensitive Urban Design has been implemented. It is recommended that these objectives for urbanised areas within the Weinam Creek catchment are adopted to ensure “Best Practice” Stormwater Management Standards are achieved. The percentage removal efficiency or the “treatment train effectiveness” required to be achieved are outlined in Table 1.1.

Table 1.1 RCC Water Quality Objectives

Pollutant Type	Objective	Urban Stormwater Quality Planning Guidelines 2010
Total Suspended Solid	Reduction in average annual load of pollutants leaving the developed unmitigated scenario compared to the developed mitigated scenario	80%
Total Phosphorous	Reduction in average annual load of pollutants leaving the developed unmitigated scenario compared to the developed mitigated scenario	60%
Total Nitrogen	Reduction in average annual load of pollutants leaving the developed unmitigated scenario compared to the developed mitigated scenario	45%
Gross Pollutant	Reduction in average annual load of pollutants leaving the developed unmitigated scenario compared to the developed mitigated scenario	90%

The MUSIC model was established for the ultimate catchment scenario. Climate data for the catchment was sourced from the Bureau of Meteorology (BOM). Rainfall data is from

the Redlands BOM station (40265), and uses the 1996-2006 rainfall data with a 6 minute rainfall intervals.

The pollutant export loads from the catchment were assessed using the Cooperative Research Centre for Catchment Hydrology's (CRCCH) Model for Urban Stormwater Improvement Conceptualisation (MUSIC). MUSIC is a decision support tool, used to plan and design appropriate urban stormwater management systems at the conceptual level. MUSIC Version 5.0, released in August 2011, was used in this assessment.

In accordance with State Planning Policy 4/10 MUSIC modelling has been undertaken in accordance with the Water by Design (2009) "DRAFT MUSIC modelling Guidelines for South East Queensland", in conjunction with the Healthy Waterways "Water Sensitive Urban Design Technical Design Guidelines for South East Queensland".

The stormwater quality treatment devices incorporated into the catchment model have been setup based on the design parameters recommended by the Water by Design (2009) "DRAFT MUSIC modelling Guidelines for South East Queensland".

The MUSIC model was established for the ultimate unmitigated and ultimate mitigated scenarios. This involved the following steps:

1. Climate data for the catchment was sourced from the Bureau of Meteorology (BOM). Rainfall data was used from the Redlands BOM station (40265) for the 1996-2006 rainfall events with six (6) minute rainfall intervals.

2. Land uses for the ultimate catchment were derived from GIS information supplied by Redland City Council. Residential was the adopted land use for the MUSIC model with an impervious percentage ranging between 30% and 80%.

3. A treatment train was developed based on available space, existing drainage infrastructure and target pollutant reductions.

It should be noted that:

- In accordance with the Water by Design MUSIC modelling guidelines, the natural assimilative capacity of any waterway was not represented within the MUSIC model; and

- Rainwater tanks have not been included within the MUSIC model. The requirements for rainwater tanks are managed under the Queensland Development Code which is currently undergoing legislative changes.

4.1.1 Typical Treatment Train

Best management practices in Water Sensitive Urban Design (Healthy Waterways, 2006) techniques are proposed to be implemented throughout the Weinam Creek Wetlands Area. Stormwater runoff will be treated by a range of treatment devices prior to discharge

to the receiving waterways. Certain techniques of WSUD target varying aspects with regard to pollutant reduction and water re-use. Examples of typical WSUD treatment measures include:

Gross Pollutant Traps (GPT's)

GPT's trap coarse sediment, trash and debris carried in stormwater flows. Most GPT's act by passing a design storm flow collected from the pipe networks through a screen. This screen captures gross pollutants down to a certain diameter. The GPT's are generally designed so that flows above the design event by-pass the trash screens so that re-suspension of captured material does not occur.

Bioretention Basins

Bioretention systems act to treat stormwater by accepting stormwater flows into a shallow planted depression where water ponds above a sandy-loam filter media. This maximises the volume of runoff that passes through the filtration media. Water then percolates through the filter media at an infiltration rate of approximately 200 mm an hour and out through an underdrainage system where it exits into the receiving drainage system or waterway.

The treatment system operates by firstly filtering surface flows through surface vegetation and then percolating runoff through the prescribed filtration media that provides treatment through fine filtration, extended detention and some biological uptake. They also provide flow retardation for smaller events and are particularly efficient in removing nutrients. An example of a street scale system is provided in Plate 5.1.



Plate 5.1 Example of Street Scale Bioretention

Wetlands

Constructed Wetlands are designed to primarily remove stormwater pollutants, associated with fine to colloidal particles and dissolved contaminants. Because of these properties wetlands are effective in reducing loads associated with TN and TP as well as TSS. The wetland is setup with an inlet zone, which acts as a sedimentation basin to protect the macrophyte zone. The macrophyte zone is largely vegetated using wetland species and is the main process for nutrient removal. Fluctuating water levels within the wetland to mimic wetting and drying cycle is a key in their long-term health. A riser outlet is ideally designed to facilitate this characteristic. A typical layout and cross section for a constructed wetland is included in Plate 5.2.

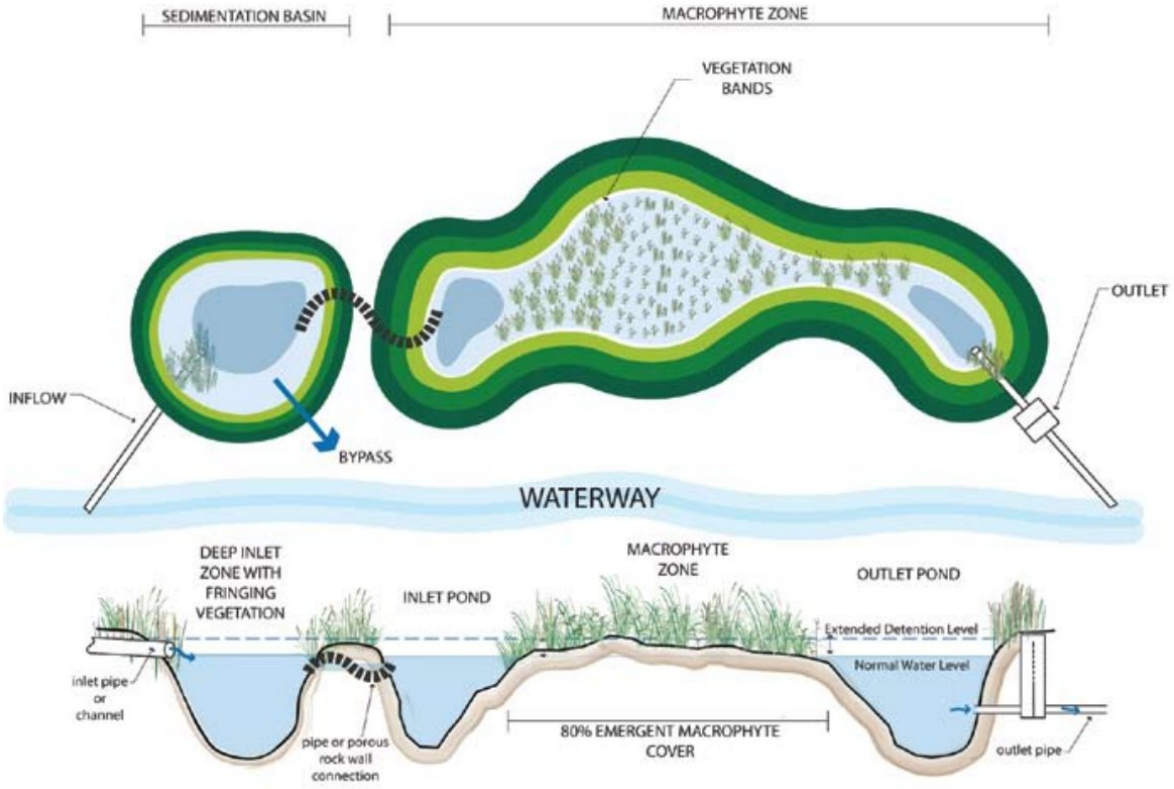


Plate 5.2 Example of a Constructed Wetland

Sediment Basins

Sediment basins as the name suggests are primarily aimed at the removal of sediment medium to course sediments. Sediment basins can to some degree help to reduce loads associated with TP which can be bound to particulates that settle out in the sediment basin and TN which is removed via the nitrogen cycle. Sediment basins are set up with an inlet zone, sediment collection zone, settling zone and outlet structure. Water enters the system where it is detained over a suitable period to allow target sediments to drop out into the sediment collection zone before clean water is discharged via the outlet structure. Sediment basins require desilting to maintain an effective depth for collection of sediments and to avoid suspension during large events.

4.1.2 Stormwater Quality Management Strategy

The stormwater quality management strategy considered the site specific constraints to integrate a range of water sensitive urban design features that will work in conjunction with the conventional drainage network to improve stormwater quality discharged to receiving waters. The majority of the catchment has recently been developed and therefore incorporates existing stormwater quality improvement measures into a large area of the catchment. This combined with the constraints of limited open space, storm

surge, creek flood levels and low trunk infrastructure invert levels in relation to receiving waters, limited the potential for incorporation of stormwater quality infrastructure in a high proportion of the catchment.

The catchment area currently incorporates a number of ponds, buffers, swales and sedimentation basins assisting in stormwater quality management. It is proposed to feed the runoff from a number of the proposed development areas into these pre-treatment devices to polish stormwater prior to secondary treatment through the bio-retention basins and constructed wetlands.

Where possible, catchments were treated to the water quality objectives outlined in the SPP 4/10. Available land, flood levels and invert level restrictions were the main limitations when considering possible stormwater quality infrastructure. The best case scenario was modelled as determined by the site constraints.

4.1.3 Proposed and Existing Developments

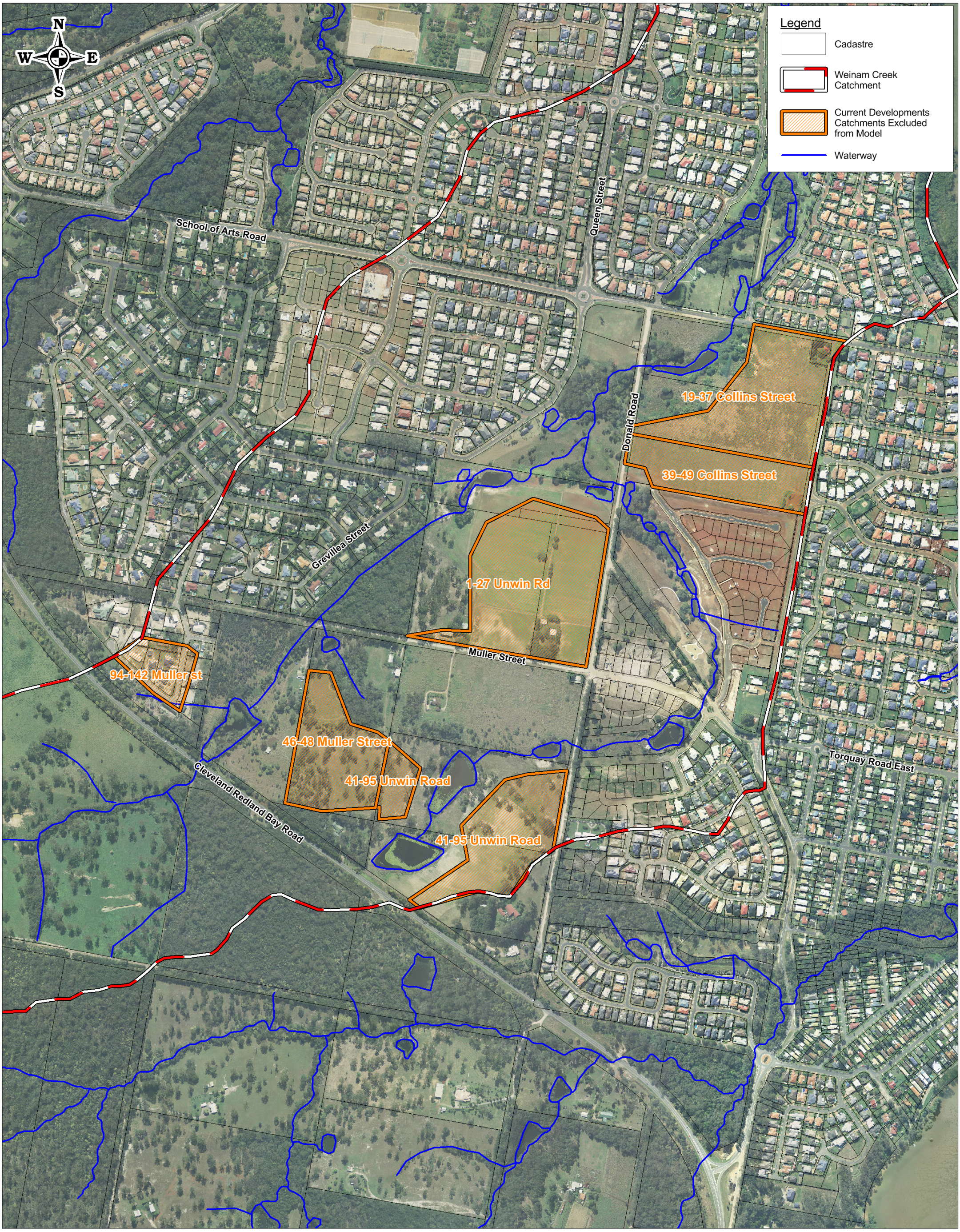
A number of developed areas within the Weinam Creek catchment currently incorporate stormwater quality infrastructure. These areas have been excluded from the model as they have been assumed to be meeting to water quality objectives. Existing infrastructure such as ponds, swales and sedimentation basins (areas requiring further treatment) were included in the MUSIC model.

There are six (6) developments that are either existing or undergoing development approval which act favourably on Weinam Creek regarding stormwater treatment and revegetation. These areas have been excluded from the model as they have been designed to meet water current water quality objectives. These developments including their property description and application numbers are displayed in Table 4.1.

Table 4.1 Developments Incorporating Water Treatment Devices within Weinam Creek catchment

Development I.D.	Real Property Description	Application Number
19-37 Collins Street	RP 222468 & RP 84961	SB005458
39-49 Collins Street	RP 48961	SB005302
46-48 Muller Street	RP 123672	OPW001252
1-27 Unwin Road	RP 105230	SB005050/MC009164
41-95 Unwin Road	R 1291 & RP 212390	SB005136
94 – 142 Muller Street	RP 205164	SB004784/ MC007710

The proposed developments and natural watercourse areas were both excluded from the MUSIC model and are displayed in Figure 4.1.



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Weinam Creek Stormwater Quality Infrastructure Plan

Figure 4.1

Current Developments Catchments Excluded from Model

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Revision: A
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4.1.4 MUSIC Model Layout

The MUSIC model was setup to include any areas that are currently developed or are included in the ultimate land use as a development area. All areas were assumed to be residential with a fraction impervious ranging from 30% to 80%. The pollutant loading for residential land use was adopted from the MUSIC modelling guidelines for lumped catchment modelling. The MUSIC model layout is shown in Figure 4.2.

Legend

Cadastre

Weinam Creek Catchment

Water Quality Catchment

Waterway

Landuse Zoning

- Urban Residential
- Medium Density Residential
- Low Density Residential
- Major Centre
- District Centre
- Neighbourhood Centre
- Local Centre
- Park Residential
- Environmental Protection
- Conservation
- Community Purposes
- Open Space
- Rural Non Urban

N

W E

S

Salisbury Street

Gordon Road

School of Arts Road

Queen Street

Donald Road

Grevillea Street

Muller Street

Cleveland Redland Bay Road

Torquay Road East

Catch A

Catch B

Catch C

Catch D

Catch E

Catch F

Catch G

Catch H

Catch I

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Figure 4.2

Water Quality Catchment Plan

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Revision: A
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As previously stated, treatment devices were only an option when limited available space was not an issue. Table 4.2 lists the sub-catchments with their corresponding existing treatment devices and proposed treatment devices.

Table 4.2 Sub-catchments with Corresponding Land Use and Percent Impervious Values

Sub-catchment	Land Use	Percent Impervious (%)	Catchment Area (hectare)	Existing Structure	Proposed Treatment
A	Residential	55	1.923	-	Bioretention System (A)
B	Residential	30	20.150	-	Infiltration Bioretention System (A)
C	Residential	55	8.218	Inlet Pond	-
D (South)	Residential	55	1.37	Inlet Pond	Bioretention System (B)
D (North)	Residential	55	13.25	-	Bioretention System (B)
E	Residential	55	8.967	Inlet Pond, Vegetated Swale	-
F (South)	Residential	55	37.000	Sedimentation Basin	Wetland (A)
F (North)	Residential	55	21.800	-	-
G	Residential	55	18.250	Buffer	Infiltration Bio-retention System (B)
H	Residential	55	2.891	-	-
I	Residential	80	8.974	-	Bioretention System (C)

Infiltration basins were required for Catchment G and B due to invert level constraints at the catchment outlet. This required a lower filter and extended storage depth to obtain a realistic outlet invert level. Standard bioretention systems were suitable for catchments A, D and I and were sized to the approximated available land or until water quality objectives were achieved for the catchment. The southern area of Catchment F was suitable for incorporation of a constructed wetland due to available land. The area currently has a sedimentation basin which was modelled as the inlet pond for the wetland, therefore only requiring the design of the macrophyte zone.

New treatment structures were unable to be added into Catchments C, E, F (North) and H due to the outlet of each catchment having many design constraints. The MUSIC model layout is illustrated in Figure 4.3.

Due to the large proportion of the catchment where incorporation of treatment devices was unpractical, the proposed treatment devices were not overdesigned to compensate untreated catchments, as it was unrealistic to meet water quality objectives. The parameters modelled for the proposed treatment devices is show in Table 4.3 and Table 4.4.

Table 4.3 Proposed Bioretention Systems

Bio Retention Location	Extended Detention Depth (m)	Surface Area (m2)	Filter Area (m2)	Base Lined	Saturated Hydraulic Conductivity (mm/hr)	Filter Depth	TN Content (mg/kg)	Orthophosphate Content (mg/kg)	Vegetated?
Catchment A	0.4	1000	1200	Yes	180	0.6	800	80	Yes
Catchment D	0.4	4000	5000	Yes	180	0.6	800	80	Yes
Catchment I	0.4	150	200	Yes	180	0.6	800	80	Yes
Catchment B	0.2	3000	4000	Yes	180	0.4	800	80	Yes
Catchment G	0.2	1500	1900	Yes	180	0.4	800	80	Yes

Table 4.4 Proposed Wetland

Wetland Location	Inlet Pond Volume (m^3)	Extended Detention Depth (m)	Surface Area (m^2)	Permanent Pool Volume (m^3)	Exfiltration Rate (mm/hr)	Evaporative Loss as % of PET	Equivalent Pipe Diameter (m)	Overflow Weir (m)
Catchment F (south)	No inlet Pond	0.5	8000	8000	0	125	0.2	3

In recommending appropriate treatment devices for this catchment, an assessment was undertaken considering the individual site constraints for each sub-catchment. Wetlands require a larger area per hectare of developable land and are therefore generally placed where the topography is flatter and there are limitations in grade for bioretention systems. In this particular case the existing topography tended towards incorporation of Bio retention systems. This was the most cost effective method that provided increased stormwater treatment per available space. The Stormwater Quality Infrastructure Conceptual Plan is provided in Figure 4.4.

Legend

- Cadastre
- Weinam Creek Catchment
- Water Quality Catchment
- MUSIC model Link
- Catchment Node
- Junction
- Receiving Node
- Bioretention Node
- Buffer Node
- Pond Node
- Sediment Basin Node
- Wetland Node
- Swale Node

N W E S

Salisbury Street
Gordon Road
School of Arts Road
Queen Street
Donald Road
Grevillea Street
Muller Street
Cleveland Redland Bay Road
Torquay Road East

Receiving Node
Bioretention C
Catchment I
Catchment H
Infiltration Bioretention B
Buffer Existing
Catchment G
Catchment F North
Catchment F South
Wetland A
Sediment Basin Existing
Pond Existing
Swale Existing
Catchment D North
Catchment E
Bioretention B
Catchment B
Infiltration Bioretention A
Catchment D South
Bioretention A
Pond Ex Existing
Pond Existing
Catchment A
Catchment C

NOTE:
The total treatment area for each catchment can be split into multiple treatment devices.

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Figure 4.3

MUSIC Model Layout

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Revision: B
Drawn: JNA
Date: 14 May 2013

Legend

- Cadastre
- Weinam Creek Catchment
- Water Quality Catchment
- Waterway

Existing Treatment Devices

- Pond
- Sedimentation Basin

Proposed Treatment Devices

- Bioretention Basin
- Infiltration Bioretention
- Wetland
- Buffer

N W E S

Salisbury Street
Gordon Road
School of Arts Road
Queen Street
Donald Road
Muller Street
Grevillea Street
Cleveland Redland Bay Road
Torquay Road East

Catch A
Catch B
Catch C
Catch D
Catch E
Catch F
Catch G
Catch H
Catch I

Bioretention A
Bioretention B
Bioretention C
Infiltration Bioretention A
Infiltration Bioretention B
Wetland A
Buffer
Buffer

NOTE:
The total treatment area for each catchment can be split into multiple treatment devices.

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Figure 4.4

Stormwater Quality Infrastructure Conceptual Plan for Ultimate Land Use

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Revision: A
Drawn: JNA
Date: 3 May 2013

4.2 Stormwater Quality Results

The results obtained for the MUSIC model have been prepared to show the before and after effects of the proposed treatment devices on pollutant loads including the percentage reductions and whether or not it reaches the water quality objectives.

Table 4.5 Weinam Creek Water Quality Results

Location	Pollutants	Unmitigated	Mitigated	Reduction (%)	Target	Target Achieved
Receiving Node	TSS (kg/yr)	216000	88500	59.1	80	x
	TP (kg/yr)	387	223	42.4	60	x
	TN (kg/yr)	1990	1270	36.3	45	x
	GP (kg/yr)	25100	7210	71.2	90	x
Catchment A	TSS (kg/yr)	2730	53.3	98	80	✓
	TP (kg/yr)	5.43	2.45	54.8	60	x
	TN (kg/yr)	26	7.38	71.6	45	✓
	GP (kg/yr)	348	0	100	90	✓
Catchment B	TSS (kg/yr)	38500	3660	90.5	80	✓
	TP (kg/yr)	34.4	11.2	67.5	60	✓
	TN (kg/yr)	278	75	73.1	45	✓
	GP (kg/yr)	2580	0	100	90	✓
Catchment C	TSS (kg/yr)	11500	3910	66.1	80	x
	TP (kg/yr)	22.9	10.7	53.2	60	x
	TN (kg/yr)	114	83.4	26.6	45	x
	GP (kg/yr)	1490	0	100	90	✓
Catchment D	TSS (kg/yr)	20400	813	96	80	✓
	TP (kg/yr)	40.6	20.5	49.5	60	x
	TN (kg/yr)	20	65.1	67.5	45	✓

Location	Pollutants	Unmitigated	Mitigated	Reduction (%)	Target	Target Achieved
	GP (kg/yr)	2640	0	100	90	✓
Catchment E	TSS (kg/yr)	12500	2350	81.3	80	✓
	TP (kg/yr)	26	9.1	65	60	✓
	TN (kg/yr)	121	87.8	27.2	45	x
	GP (kg/yr)	1620	0	100	90	✓
Catchment F (South)	TSS (kg/yr)	30700	6510	78.8	80	x
	TP (kg/yr)	60.6	18.1	70.1	60	✓
	TN (kg/yr)	297	178	40	45	x
	GP (kg/yr)	3940	0	100	90	✓
Catchment F (North)	TSS (kg/yr)	53300	0	0	80	x
	TP (kg/yr)	104	0	0	60	x
	TN (kg/yr)	507	0	0	45	x
	GP (kg/yr)	6690	0	0	90	x
Catchment G	TSS (kg/yr)	25400	4810	81	80	✓
	TP (kg/yr)	50.5	13.4	73.5	60	✓
	TN (kg/yr)	250	100	59.9	45	✓
	GP (kg/yr)	3300	0	100	90	✓
Catchment H	TSS (kg/yr)	4020	0	0	80	x
	TP (kg/yr)	7.91	0	0	60	x
	TN (kg/yr)	40	0	0	45	x
	GP (kg/yr)	523	0	0	90	x
Catchment I	TSS (kg/yr)	17100	9000	47.4	80	x
	TP (kg/yr)	34.3	25.3	26.2	60	x

Location	Pollutants	Unmitigated	Mitigated	Reduction (%)	Target	Target Achieved
	TN (kg/yr)	156	123	21.2	45	x
	GP (kg/yr)	1960	0	100	90	✓

4.3 Construction Cost Estimates

Costing for the bio-retention basins and wetlands was obtained from the life cycle costing module in MUSIC. It should be noted that the connection from the outlet of each catchment to the bioretention basins has not been included in the cost estimation as this should be undertaken at the detailed design stage. It should also be noted that cost estimation is based on upper acquisition cost as calculated in MUSIC Version 5. The total acquisition cost does not include land acquisition, annual maintenance, annual renewal, annual establishment or decommissioning costs.

The summary of the stormwater quality infrastructure life cycle cost (excluding land acquisition) is outlined in Table 4.6.

Table 4.6 Stormwater Quality Infrastructure Cost Estimate

Treatment Device	$Cost_{2013}$ ($)
Bioretention A	$220,080
Bioretention B	$729,010
Bioretention C	$62,358
Infiltration Bioretention A	$558,805
Infiltration Bioretention B	$305,135
Wetland A	$1,171,569
Total Cost	$3,046,957

5. CONCLUSIONS/RECOMMENDATIONS

This study has been prepared for the purposes of identifying the water quality aspects of the development of the Weinam Creek Structure Plan Area.

The study has quantified stormwater infrastructure requirements relating to water quality measures for the catchment. These measures have been defined in order to ensure that the area can improve its stormwater quality management outcomes and to address Council's Codes and Policies relating to stormwater quality.

This study has included a comprehensive assessment of water quality to assist in determining required infrastructure to appropriately manage and address any environmental impacts on Weinam Creek due to stormwater pollutants.

The proposed stormwater quality infrastructure requirements including cost estimates are presented in this report. The construction cost estimates represent budget cost allocations based upon conceptual infrastructure sizing within the MUSIC model and should be updated as part of the future detailed design of the infrastructure works.

The total cost (present value term for 2013) for all stormwater quality infrastructure within the Weinam Creek catchment is $3.04 Million and excludes land acquisition, renewal, maintenance and decommissioning costs. A cost estimate for each treatment device is provided in Table 4.6.

It should be noted that the stormwater infrastructure requirements identified and assessed in this study are preliminary only and will require further concept and detailed design prior to construction. The concept design and finalising of treatment options should consider all possible constraints such as existing services, land ownership, site specific survey information and directly impacted residents.

It is recommended that the locations and types of stormwater quality treatment devices are reviewed when additional planning is undertaken for the catchment. The stormwater infrastructure construction cost estimates are preliminary estimates and should also be reviewed once additional planning and design has been undertaken.

6. QUALIFICATIONS

a. In preparing this document, including all relevant calculation and modelling, Engeny Management Pty Ltd (Engeny) has exercised the degree of skill, care and diligence normally exercised by members of the engineering profession and has acted in accordance with accepted practices of engineering principles.

b. Engeny has used reasonable endeavours to inform itself of the parameters and requirements of the project and has taken reasonable steps to ensure that the works and document is as accurate and comprehensive as possible given the information upon which it has been based including information that may have been provided or obtained by any third party or external sources which has not been independently verified.

c. Engeny reserves the right to review and amend any aspect of the works performed including any opinions and recommendations from the works included or referred to in the works if:

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   (ii) Engeny considers it prudent to revise any aspect of the works in light of any information which becomes known to it after the date of submission.

d. Engeny does not give any warranty nor accept any liability in relation to the completeness or accuracy of the works, which may be inherently reliant upon the completeness and accuracy of the input data and the agreed scope of works. All limitations of liability shall apply for the benefit of the employees, agents and representatives of Engeny to the same extent that they apply for the benefit of Engeny.

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f. If any claim or demand is made by any person against Engeny on the basis of detriment sustained or alleged to have been sustained as a result of reliance upon the report or information therein, Engeny will rely upon this provision as a defence to any such claim or demand.

7. REFERENCES

This report has been prepared with reference to the following sources:

1. Brisbane City Council 2008, *Subdivision and Development Guidelines.*
2. Department of Natural Resources and Mines 2007, *Queensland Urban Drainage Manual – Volume 1 Second Edition.*
3. Healthy Waterways 2006, *WSUD Technical Design Guidelines for Southeast Queensland.*
4. Water by Design 2010, *MUSIC Modelling Guidelines for Southeast Queensland – Version 1*.
5. GHD 2006, *Weinam Creek Catchment Conceptual Stormwater Management Plan.* Redland Shire Council.

APPENDIX A

Weinam Creek CSMP Water Quality Review

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7 May 2013

Redland City Council
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ATTENTION: Giles Tyler

Dear Giles & Tim,

Weinam Creek CSMP Water Quality Review

We have undertaken a quick review of the water quality component of the Weinam Creek CSMP. Findings of the review are provided below.

The stormwater quality modelling was undertaken using the old version of MUSIC and as such the input characteristics of the model are outdated. The latest MUSIC version (5) provides a significant reduction in treatment area. The treatment train itself is also impractical in the way it is laid out with stormwater passing through multiple systems that are placed within the low flow channel of the waterway. Installing stormwater quality infrastructure in this manner is not cost effective and will likely lead to very high maintenance costs or failure of the systems.

Issues with modelling include:

- Total areas for land use post vs. existing aren't equal (Pg. 10-11);
- MUSIC version 3 has been used (In using version 5 bioretention areas can often be reduced);
- 30% reduction in TP for GPT's is likely to high (Pg. 43);
- Extended detention depth and detention depths are pushing the boundaries of what is current best practice for wetland design (Pg. 43);
- Seepage rates have been incorporated into both wetlands and bioretention systems, this is not accepted;
- Extended detention depth and hydraulic conductivity are incorrect for the bioretention systems (Pg. 44);
- Wetlands C and E have been modelled with an extended detention depth of 750 mm, this will likely cause maintenance issues or result in failure of the system.

Issues with the stormwater quality treatment train include:

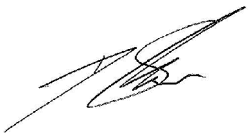
- The treatment train has been set up so treated flows pass through at least 2 secondary treatment measures. In passing stormwater through 2 treatment measure to provide what is referred to a as a compounding of treatment effectiveness the system is treating water that has already been treated, therefore reducing the efficiency of the systems. It also means that the downstream systems are required to be unnecessarily large to avoid scour and detain the required quantity of water;

- Treatment measures have been placed online within the waterway, this is especially an issue with bioretention systems. Placement of treatment measure online within the waterway will result in flows from the upstream catchment passing directly through the systems. This is likely to cause big issues with maintenance and likely failure of the system due to prolonged inundation, scour and subsequent loss of vegetation;

- GPT"s has been placed on all stormwater outlets. How has council's policy in relation to GPT's changed (Pg. 42).

In summary, based on this review it is recommended that the stormwater quality component of the Weinam Creek CSMP be revised to ensure a treatment train that conforms to current best practice and will drastically reduce long term maintenance costs and failure of the systems.

Yours faithfully



David Sexton
Senior Engineer

DS/ts

APPENDIX B

MUSIC Model Screen Shots

Bioretention A - Life Cycle Cost Results

Summary | Relative Distribution | Temporal Distribution | Sensitivity to Real Discount Rate

Costing Inputs

Life Cycle (yrs)	50	Renewal/Adaptation Cost	$100,051	Real Discount Rate (%)	5.50
Acquisition Cost	$220,080	Renewal Period (yrs)	15	Annual Inflation Rate (%)	2.00
Annual Maintenance Cost	$16,764	Decommissioning Cost	$102,655	Base Year for Costing	2013
Annual Establishment Cost	$0	Establishment Period (yrs)	0		

Costing Results



Life Cycle Cost of Bioretention A ($2013)	$584,103
Equivalent Annual Payment Cost of the Asset ($2013/annum)	$11,682
Equivalent Annual Payment per m3/s maximum flow reduction	$33,418.65
Equivalent Annual Payment/ML flow reduction/annum	$5,142.49
Equivalent Annual Payment/kg Total Suspended Solids/annum	$4.34
Equivalent Annual Payment/kg Total Phosphorus/annum	$3,947.96
Equivalent Annual Payment/kg Total Nitrogen/annum	$626.28
Equivalent Annual Payment/kg Gross Pollutant/annum	$33.59

Close

Infiltration Bioretention A - Life Cycle Cost Results

Summary | Relative Distribution | Temporal Distribution | Sensitivity to Real Discount Rate

Costing Inputs

Life Cycle (yrs)	50	Renewal/Adaptation Cost	$254,040	Real Discount Rate (%)	5.50
Acquisition Cost	$558,805	Renewal Period (yrs)	15	Annual Inflation Rate (%)	2.00
Annual Maintenance Cost	$28,169	Decommissioning Cost	$260,651	Base Year for Costing	2013
Annual Establishment Cost	$0	Establishment Period (yrs)	0		

Costing Results



Life Cycle Cost of Infiltration Bioretention A ($2013)	$1,240,325
Equivalent Annual Payment Cost of the Asset ($2013/annum)	$24,806
Equivalent Annual Payment per m3/s maximum flow reduction	$7,270.80
Equivalent Annual Payment/ML flow reduction/annum	$443.90
Equivalent Annual Payment/kg Total Suspended Solids/annum	$0.75
Equivalent Annual Payment/kg Total Phosphorus/annum	$1,061.80
Equivalent Annual Payment/kg Total Nitrogen/annum	$124.42
Equivalent Annual Payment/kg Gross Pollutant/annum	$9.63

Close

Infiltration Bioretention B - Life Cycle Cost Results

Summary | Relative Distribution | Temporal Distribution | Sensitivity to Real Discount Rate

Costing Inputs

Life Cycle (yrs)	50	Renewal/Adaptation Cost	$138,719	Real Discount Rate (%)	5.50
Acquisition Cost	$305,135	Renewal Period (yrs)	15	Annual Inflation Rate (%)	2.00
Annual Maintenance Cost	$20,059	Decommissioning Cost	$142,329	Base Year for Costing	2013
Annual Establishment Cost	$0	Establishment Period (yrs)	0		

Costing Results



Life Cycle Cost of Infiltration Bioretention B ($2013)	$756,153
Equivalent Annual Payment Cost of the Asset ($2013/annum)	$15,123
Equivalent Annual Payment per m3/s maximum flow reduction	$7,428.67
Equivalent Annual Payment/ML flow reduction/annum	$217.43
Equivalent Annual Payment/kg Total Suspended Solids/annum	$0.81
Equivalent Annual Payment/kg Total Phosphorus/annum	$430.67
Equivalent Annual Payment/kg Total Nitrogen/annum	$105.26
Equivalent Annual Payment/kg Gross Pollutant/annum	$4.58

Close

Wetland A - Life Cycle Cost Results

Summary | Relative Distribution | Temporal Distribution | Sensitivity to Real Discount Rate

Costing Inputs

Life Cycle (yrs)	80	Renewal/Adaptation Cost	$630,060	Real Discount Rate (%)	5.50
Acquisition Cost	$1,171,569	Renewal Period (yrs)	20	Annual Inflation Rate (%)	2.00
Annual Maintenance Cost	$35,254	Decommissioning Cost	$0	Base Year for Costing	2013
Annual Establishment Cost	$0	Establishment Period (yrs)	0		

Costing Results



Life Cycle Cost of Wetland A ($2013)	$2,118,535
Equivalent Annual Payment Cost of the Asset ($2013/annum)	$26,482
Equivalent Annual Payment per m3/s maximum flow reduction	$6,242.72
Equivalent Annual Payment/ML flow reduction/annum	$1,679.69
Equivalent Annual Payment/kg Total Suspended Solids/annum	$1.79
Equivalent Annual Payment/kg Total Phosphorus/annum	$876.24
Equivalent Annual Payment/kg Total Nitrogen/annum	$256.08
Equivalent Annual Payment/kg Gross Pollutant/annum	invalid

Close

Bioretention B - Life Cycle Cost Results

Summary | Relative Distribution | Temporal Distribution | Sensitivity to Real Discount Rate

Costing Inputs

Life Cycle (yrs)	50	Renewal/Adaptation Cost	$331,417	Real Discount Rate (%)	5.50
Acquisition Cost	$729,010	Renewal Period (yrs)	15	Annual Inflation Rate (%)	2.00
Annual Maintenance Cost	$32,763	Decommissioning Cost	$340,043	Base Year for Costing	2013
Annual Establishment Cost	$0	Establishment Period (yrs)	0		

Costing Results



Life Cycle Cost of Bioretention B ($2013)	$1,550,894
Equivalent Annual Payment Cost of the Asset ($2013/annum)	$31,018
Equivalent Annual Payment per m3/s maximum flow reduction	$28,188.23
Equivalent Annual Payment/ML flow reduction/annum	$3,280.61
Equivalent Annual Payment/kg Total Suspended Solids/annum	$1.74
Equivalent Annual Payment/kg Total Phosphorus/annum	$1,723.04
Equivalent Annual Payment/kg Total Nitrogen/annum	$242.30
Equivalent Annual Payment/kg Gross Pollutant/annum	$12.95

Close

Bioretention C - Life Cycle Cost Results

Summary | Relative Distribution | Temporal Distribution | Sensitivity to Real Discount Rate

Costing Inputs

Life Cycle (yrs)	50	Renewal/Adaptation Cost	$28,349	Real Discount Rate (%)	5.50
Acquisition Cost	$62,358	Renewal Period (yrs)	15	Annual Inflation Rate (%)	2.00
Annual Maintenance Cost	$8,966	Decommissioning Cost	$29,087	Base Year for Costing	2013
Annual Establishment Cost	$0	Establishment Period (yrs)	0		

Costing Results



Life Cycle Cost of Bioretention C ($2013)	$236,587
Equivalent Annual Payment Cost of the Asset ($2013/annum)	$4,732
Equivalent Annual Payment per m3/s maximum flow reduction	invalid
Equivalent Annual Payment/ML flow reduction/annum	$12,406.77
Equivalent Annual Payment/kg Total Suspended Solids/annum	$0.58
Equivalent Annual Payment/kg Total Phosphorus/annum	$520.95
Equivalent Annual Payment/kg Total Nitrogen/annum	$140.14
Equivalent Annual Payment/kg Gross Pollutant/annum	$2.41

Close