WorleyParsons
resources & energy

EcoNomics

HAWKESBURY CITY COUNCIL

# Pitt Town Development

## Updated Stormwater Management Strategy

REV 0 – FINAL REPORT

9th November 2015

301015-03518-RPT-001 [0] Pitt Town.doc

**Water & Environment**
Level 12, 141 Walker Street
North Sydney 2060 Australia
Tel: +61 2 8923 6866
Fax: +61 2 8923 6877
www.worleyparsons.com
WorleyParsons Services Pty Ltd
ABN 61 001 279 812

WorleyParsons
resources & energy

EcoNomics

**HAWKESBURY CITY COUNCIL**

PITT TOWN DEVELOPMENT
UPDATED STORMWATER MANAGEMENT STRATEGY

## Disclaimer

*This report has been prepared on behalf of and for the exclusive use of Hawkesbury City Council, and is subject to and issued in accordance with the agreement between Hawkesbury City Council and WorleyParsons Services Pty Ltd. WorleyParsons Services Pty Ltd accepts no liability or responsibility whatsoever for any use of or reliance upon this report by any third party.*



**PROJECT 301015-03518 - PITT TOWN DEVELOPMENT**

| REV | DESCRIPTION | ORIGINAL | REVIEW | WORLEY-PARSONS APPROVAL | DATE |
|---|---|---|---|---|---|
| A | Issued for Internal Review | AD<br>A Dunphy | CRT<br>C Thomas | | 11/06/2014 |
| B | Issued for Client Review | AD<br>A Dunphy | CRT<br>C Thomas | | 3/07/2014 |
| C | Final Draft | AD<br>A Dunphy | WJH<br>W Honour | | 20/11/2014 |
| 0 | Final Report | AC<br>A Crouch | AD<br>A Dunphy | WJH<br>W Honour | 9/11/2015 |

# CONTENTS

## APPENDICES

# 1 INTRODUCTION

The *Pitt Town Development Water Management Plan* (PTDWP) was prepared by Connell Wagner in November 2005 for Hawkesbury City Council. This plan outlines measures for water, wastewater and stormwater management infrastructure for the rezoning of land at Pitt Town (known as Amendment 145) for residential and rural residential purposes. The land that was to be rezoned is located immediately north of the existing built-up areas of Pitt Town and covered a total area of 212 hectares. The water management infrastructure was developed with a view to it servicing a yield of 690 lots. A series of wetlands and associated drainage works were proposed to capture and treat stormwater from the development area. The wetlands were conceptually sized using guidelines detailed in *The Constructed Wetlands Manual – Volume 2* (1998). The indicative size and location of the wetlands is shown in **Figure 1-1**.

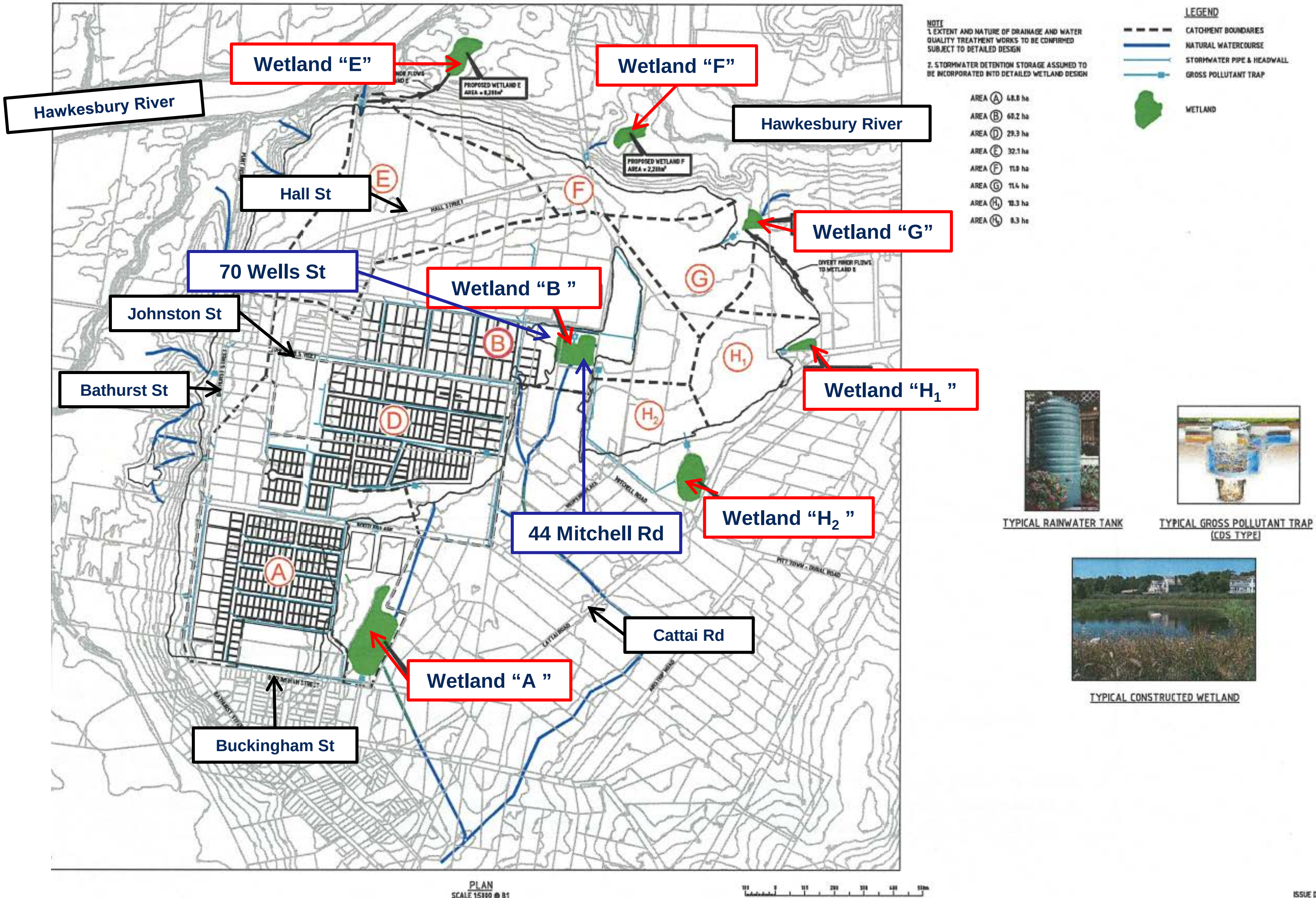
Amendment 145 was gazetted on 18th August 2006 and resulted in amendments to the *Hawkesbury Local Environmental Plan 1989* and the *Hawkesbury Development Control Plan (DCP) 2002*. Relevant provisions from the PTDWP (Connell Wagner, 2005) were incorporated into Part E of Chapter 4 of the DCP.

On 18th July 2008, land known as the Pitt Town Residential Precinct (PTRP), which incorporated land subject to Amendment 145, was further rezoned for residential and rural residential purposes. This was done via the Part 3A provisions of the *Environmental Planning and Assessment Act 1979* and *State Environmental Planning Policy (Major Projects) 2008*. The resulting lot yield increased to 943.

The PTRP has been divided into a number of development precincts with various minimum lot size and building coverage provisions. The precincts are shown in **Figure 1-2** and are:

- Blighton;
- Cleary;
- Thornton;
- Thornton East;
- Central;
- Cattai;
- Bona Vista; and,
- Fernandell.

Council has issued development consents for the subdivision of the Bona Vista, Fernandell and Cleary development precincts.

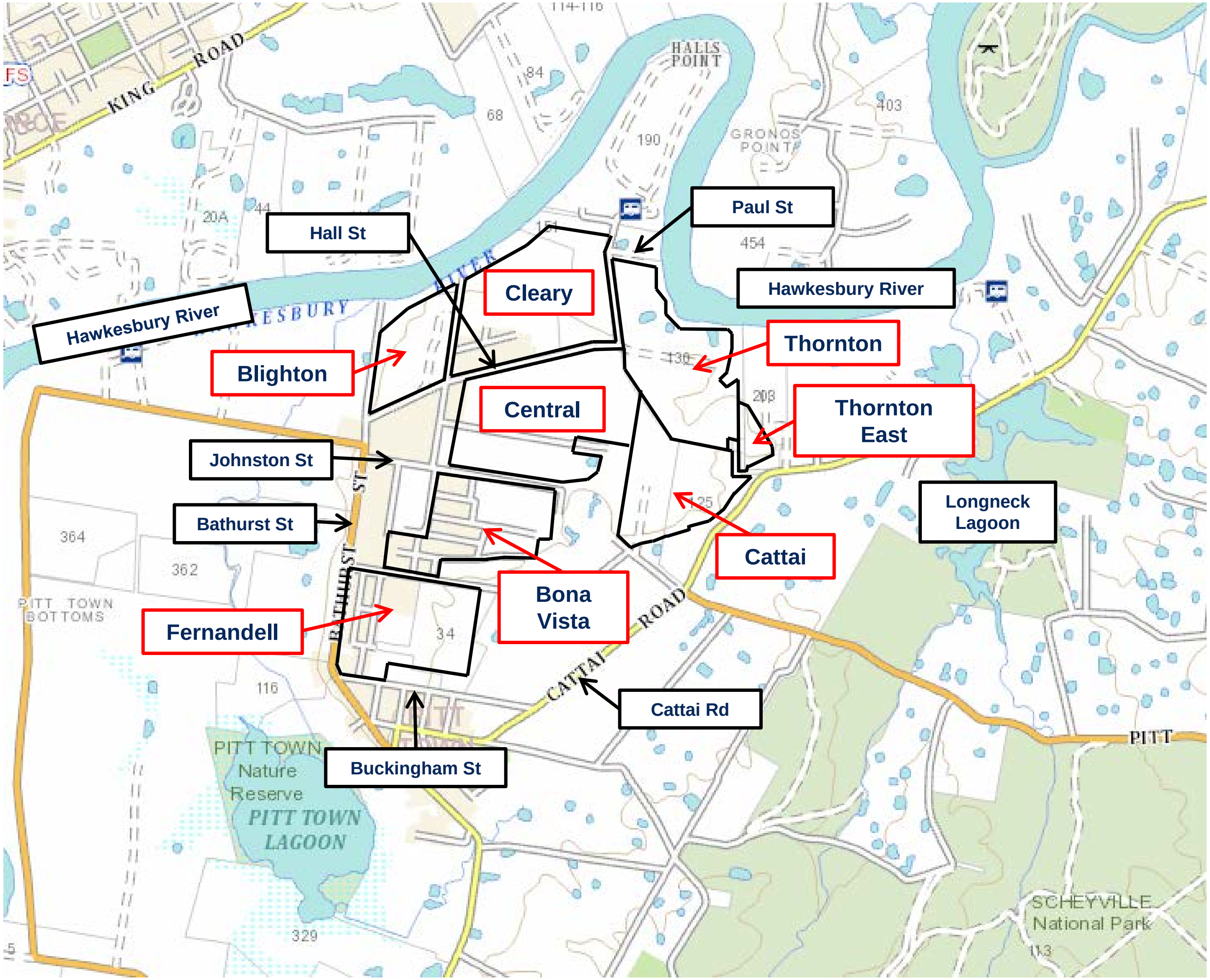



Background Image Source: PDWP (Connell Wagner, 2005)

WorleyParsons
resources & energy

301015-03518
Pitt Town Development
Updated Stormwater Management Strategy

**2005 Pitt Town Development Draft Stormwater Management Plan**
**FIGURE 1-1**




Background Image Source: https://maps.six.nsw.gov.au/

WorleyParsons
resources & energy

**301015-03518**
**Pitt Town Development**
**Updated Stormwater Management Strategy**

**Site Map with PTRP Boundary**
**FIGURE 1-2**

In April 2014, Hawkesbury City Council engaged WorleyParsons to undertake a review of the Stormwater Management Plan contained within the PTDWP. The primary objectives of this review are as follows:

1) Prepare a revised stormwater management plan for the following precincts:
   - Thornton;
   - Thornton East;
   - Central; and,
   - Cattai.
2) Determine indicative construction cost estimates for the preferred stormwater infrastructure to enable construction costs to be incorporated into the existing contributions plan.

This Report documents the findings of investigations undertaken to address this scope and includes:

- a summary of the background to the engagement (refer **Section 2**) including:
  - details of existing site conditions;
  - salient components of the existing stormwater management report;
  - design criteria; and,
  - an overview of the current status of civil designs that have been developed for each precinct.
- stormwater management options development (refer **Section 3**)
- stormwater management preferred options (refer **Section 4**)
- cost estimates (refer **Section 5**)

It is noted that the stormwater management measures proposed in the PTDWP only included constructed wetlands and these were only notionally sized using empirical methods. As part of the current review, consideration has been given to alternate treatment measures. The sizing of these alternate treatment measures has been undertaken using the Model for Urban Stormwater Improvement Conceptualisation, or MUSIC as it is commonly known. MUSIC is regarded as the current best practice tool for the sizing of water sensitive urban design infrastructure.

# 2 BACKGROUND

## 2.1 Existing Site Conditions

The land known as the PTRP is positioned within the Hawkesbury local government area on the northern fringe of the existing village of Pitt Town. Pitt Town is located in north-western Sydney and is approximately six kilometres to the north-east of Windsor. A map of the area is shown in **Figure 1-2** and highlights the close proximity of Pitt Town and the PTRP to the Hawkesbury River. The PTRP is generally bound to the:

- north by the Hawkesbury River;
- east by Cattai Road;
- west by Bathurst Street; and,
- south by Buckingham Street.

Rural, low density development is located to the west, north and east of the PTRP. Pitt Town township is located to the south. The PTRP land was used in the past for agriculture and orchards. There are houses and farm buildings scattered on the land and other features that are typical of land that has been farmed.

As shown in **Figure 2-1**, the PTRP extends across five sub-catchments (refer coloured areas). Surface runoff from these sub-catchments typically drains in an easterly direction and ultimately discharges to the nearby Hawkesbury River. An overview of each sub-catchment is provided in the following:

- Catchment A

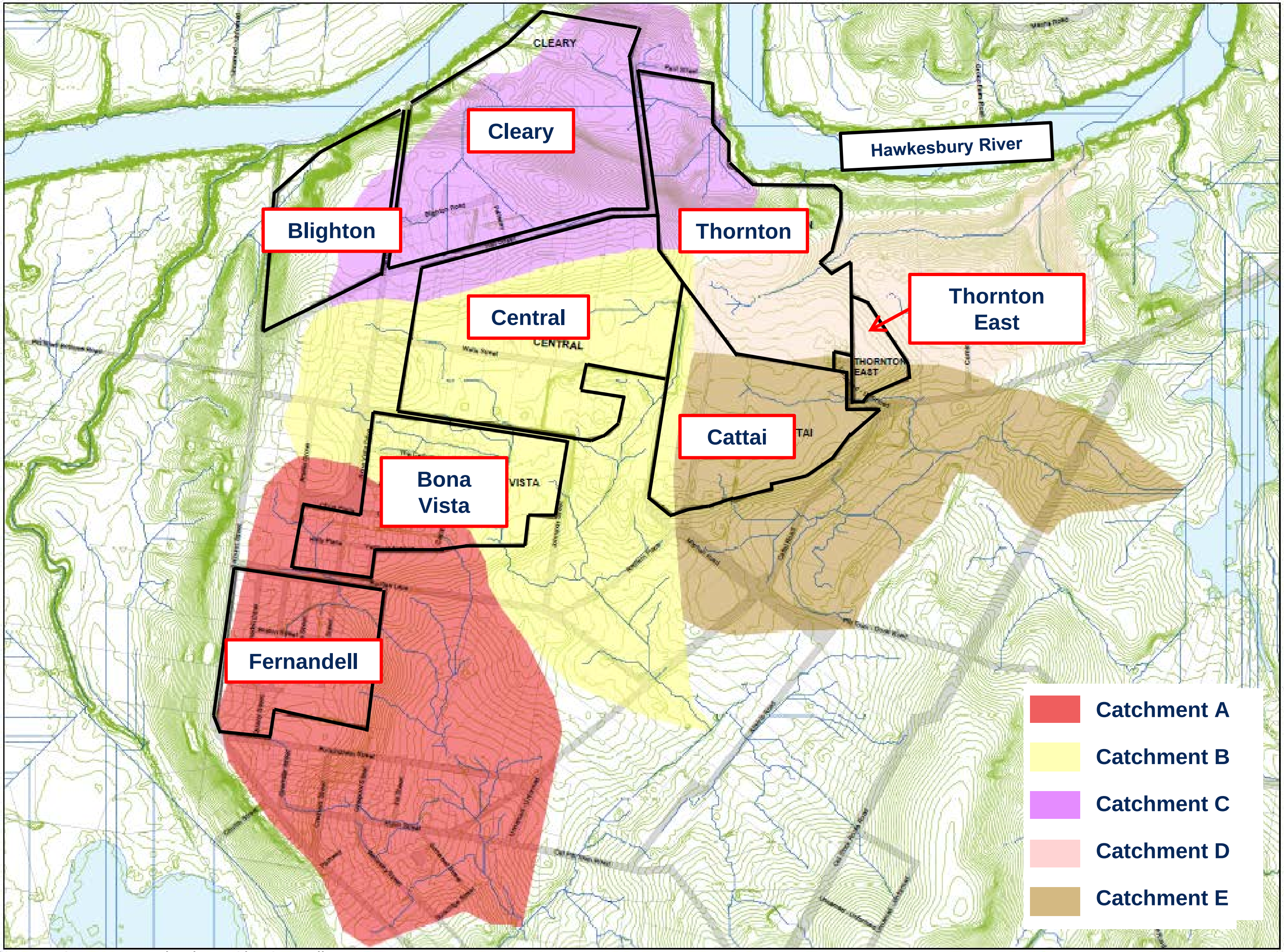
  Catchment A is located on the southern side of the PTRP and extends across the majority of the Fernandell Precinct and approximately one third of the Bona Vista Precinct. It covers an area of approximately 130 hectares and drains in a south-easterly direction toward Buckingham Street and Old Pitt Town Road.

- Catchment B

  Catchment B is located on the western side of the PTRP and includes approximately two thirds of the Bona Vista Precinct, approximately 80% of the Central Precinct and the western strip of the Cattai Precinct (approximately 10% of the Cattai Precinct). It also drains in a south-easterly direction, joining north-easterly flowing creeks at Airstrip Road. It covers an area of approximately 110 hectares.

- Catchment C

  Catchment C is located on the northern side of the PTRP and adjoins the southern bank of the Hawkesbury River. The majority of the Cleary Precinct, approximately one quarter of the Blighton




Background Image Source: Hawkesbury City Council

WorleyParsons
resources & energy

301015-03518
Pitt Town Development
Updated Stormwater Management Strategy

**Location and Extent of Sub-Catchments Draining Within PTRP Land**
**FIGURE 2-1**

Precinct, the northern strip of the Central Precinct (approximately 20% of the Central precinct) and the northern third of the Thornton Precinct fall within this catchment. It covers an area of approximately 80 hectares and discharges directly to the Hawkesbury River near Paul Street.

- Catchment D

  Catchment D is located on the north-east side of the PTRP and also adjoins the southern banks of the Hawkesbury River. The southern portion of the Thornton Precinct and the northern portion of the Thornton East Precinct fall within this catchment. It covers an area of approximately 60 hectares and discharges directly to the Hawkesbury River.

- Catchment E

  Catchment E is located on the south-east side of the PTRP and is bisected by Cattai Road. The majority of the Cattai Precinct (approximately 90%) and the southern portion of the Thornton East Precinct fall within this catchment. It drains an area of approximately 90 hectares and discharges to the Longneck Lagoon.

## 2.2 Existing Stormwater Management Plan

The PTDWP outlines water, wastewater and stormwater management measures that would be required for a yield of 690 lots. It was prepared to support the rezoning that was ultimately approved in July 2008.

A series of wetlands and associated drainage works are proposed for the purpose of capturing and treating stormwater from the development area. The wetlands were conceptually sized using procedures outlined in *The Constructed Wetlands Manual – Volume 2* by DLWC (1998). The indicative size and location of the wetlands is shown in **Figure 1-1**.

Connell Wagner (2005) indicate that alternative options such as on-site detention, on-site water quality treatment and bioretention swales, were not favoured by Council. As a consequence, the PTDWP appears to focus on a precinct based approach that relies on wetlands, as opposed to an individual lot based approach for stormwater management.

Connell Wagner (2005) recommended that computer simulated water quality modelling be undertaken to evaluate the performance of the proposed wetland systems.

## 2.3 Design Criteria for the Stormwater Quality Management Strategy

The objectives of the updated stormwater quality management strategy that is documented in this report are:

- to preserve the state of existing watercourses; and,
- to ensure that post-development pollutant loads are consistent with Council's stormwater pollutant load reduction targets.

Specific design criteria that were adopted are presented in the sections that follow.

### 2.3.1 Water Quality Targets

Council's DCP (HCC, 2002) contains specific water quality targets which are based on a percentage reduction in the average annual pollutant load. These are:

- Total Suspended Solids (TSS) 80% reduction in the average annual load.
- Total Phosphorus (TP) 45% reduction in the average annual load.
- Total Nitrogen (TN) 45% reduction in the average annual load.

It is noted that more stringent water quality targets are often applied to residential development (typically 85% TSS removal; 65% TP removal; and 45% TN removal) and are being adopted for other similar developments elsewhere within NSW. Council has requested however that the DCP (HCC, 2002) objectives be adopted for the PTRP.

The updated strategy has been developed such that the quality objectives are achieved within each development precinct, independently of the other precincts. This is to account for the potential for the separate precincts to be developed at different times.

### 2.3.2 Sizing

The constructed wetlands proposed in the 2005 PTDWP (by Connell Wagner) were sized using simplistic methods. As part of the current review, the sizing will be undertaken using the computer modelling program MUSIC. This program is regarded as a current best practice method for the sizing of water sensitive urban design infrastructure.

### 2.3.3 Type

Constructed wetlands were the only stormwater management measure proposed in the 2005 PTDWP (by Connell Wagner). Council has indicated that the updated stormwater management strategy need not be limited to the use of wetlands. Alternative online and/or end of line treatment trains are to be considered.

### 2.3.4 Location

Council has indicated the following in relation to the location of stormwater management measures:

i. Avoid positioning any measures on properties not affected by the PTRP; and,

ii. Incorporate a wetland on 44 Mitchell Road in its current form or in an amended form, ensuring that any amended form does not result in it encroaching onto 70 Wells Street.

### 2.3.5 Flooding

The boundaries of the precincts have been set with consideration of flood levels and are above the 1 in 100 year flood level. The stormwater treatment measures are to be positioned in locations where they will not be frequently inundated with flood waters.

## 2.4 Current Status of Design Development

The current status of the design development for the precincts is summarised as follows.

- Brown Smart Consulting (2014a and 2014b) has developed a lot and road layout (including drainage design) for the Cleary Precinct and for the northern part of the Central Precinct. Council approved the Construction Certificate for this work in May 2014. The Cleary Precinct is not within the scope of this updated stormwater management plan however stormwater runoff from the majority of this precinct is to be transferred to a wetland located in the adjacent Thornton Precinct. This wetland formed part of the Construction Certificate that was approved.

- The Pitt Town Masterplan (Brown, 2014c) shows the lot and road layout for the Thornton Precinct. At a meeting between Council, Brown Smart Consulting and WorleyParsons on 20th May 2014, representatives from Brown Smart Consulting advised that the western portion of the Thornton Precinct would also drain to the wetland.

- A development application (number DA0255/14) was submitted to Council in May 2014 for the western portion of the Cattai Precinct. This is for a 43 lot residential development on the western side of Cattai Road and to the north of Mitchell Road. As part of the development it is proposed that a wetland with an inlet zone volume of approximately 960m$^3$ and surface area of approximately 2,200m$^2$ be installed (Stefani Group, 2014). This development application does not apply to the entire Cattai Precinct.

  A full review of the application has not been undertaken. However, a preliminary review of the stormwater management plan that was submitted with the development application by Stefani Group (2014) indicates that a 40% reduction in both TP and TN was adopted in the MUSIC model to account for projected benefits afforded by a gross pollutant trap (GPT) that are proposed as part of the treatment train. In addition, a 20% reduction in SS was adopted in the model for the GPTs. Documentation accompanying the DA suggests the application of these percentages will deliver a conservative outcome. However, data contained in the *Draft NSW MUSIC Modelling Guidelines* (BMT WBM, 2010) indicates that the TN and TP percentages are too large and the SS percentage too small.

- A masterplan has not been developed for the Thornton East Precinct or for the southern portion of the Central Precinct.

# 3 STORMWATER MANAGEMENT OPTIONS DEVELOPMENT

## 3.1 Water Quality Model Setup

The MUSIC software package is a conceptual water quality assessment model developed by the Cooperative Research Centre for Catchment Hydrology (CRCCH, now eWater). MUSIC can be used to estimate the long-term annual average stormwater volume generated by a catchment as well as the expected pollutant loads generated by that catchment. MUSIC is able to conceptually simulate the performance of a series of stormwater treatment measures (*often referred to as the "treatment train"*) to assess whether a proposed water quality strategy is able to meet specified water quality objectives.

MUSIC stormwater quality models were developed for the precincts under investigation. Stormwater quality improvement devices of varying types and sizes were modelled and those that resulted in the achievement of the stormwater pollutant reduction targets were identified. A minimum of two options per precinct have been developed.

The key model parameters adopted in the MUSIC model are summarised in the following sections.

### 3.1.1 Rainfall and Evaporation Data

The closest Bureau of Meteorology (BoM) rainfall gauge to the proposed development is located at the Richmond RAAF Base (Gauge No. 067105). Daily rainfall data from 1993 to present are available from the gauge record. It is recommended that data at six-minute intervals are used in the MUSIC model. The closest gauge to Pitt Town with data at six-minute intervals is the Penrith Lakes AWS gauge (BoM Gauge No. 67113).

A comparison was made between the average monthly rainfall derived from data gathered at Penrith Lakes AWS (data from 1995 to present) and data gathered at the Richmond RAAF Base gauge (data from 1993 to present). The purpose of the comparison was to assess the suitability of using the Penrith Lakes AWS data as being representative of rainfall conditions at Pitt Town. This comparison is presented in **Figure 3-1**.

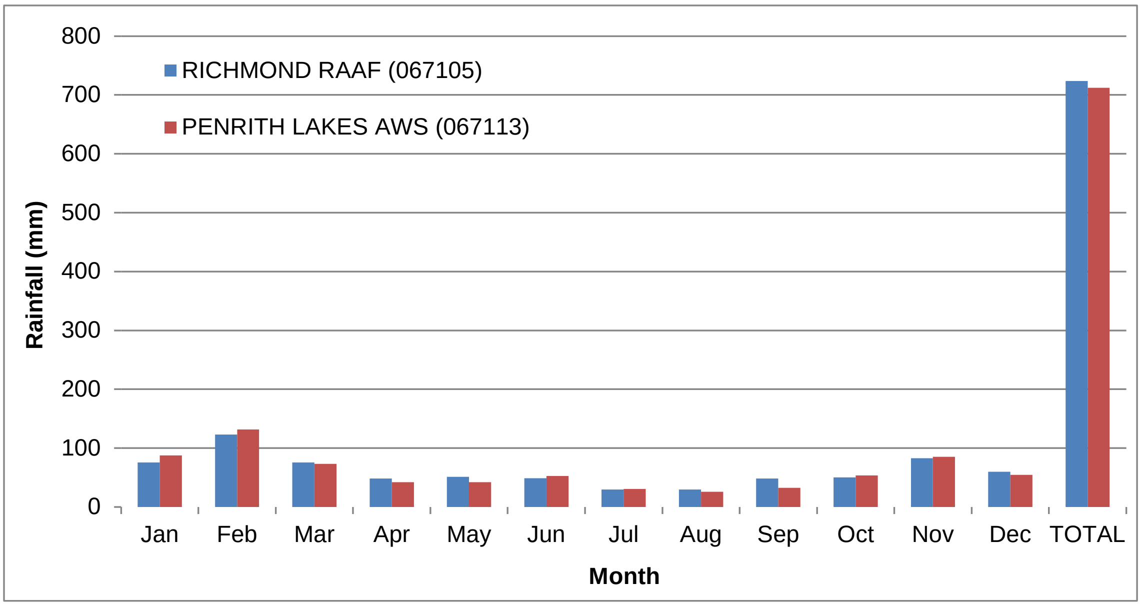



**Figure 3-1 Mean Rainfall: Richmond RAAF versus Penrith Lakes AWS**

**Figure 3-1** shows that the mean monthly rainfall is comparable for the two stations. Therefore six-minute interval data from the Penrith Lakes AWS gauge were extracted from the gauge record for a ten-year period from January 1999 to December 2008 and were used in the MUSIC model. The average annual rainfall of this data is 706mm and this is consistent with the long-term average of both the Richmond RAAF Gauge and the Penrith Lakes AWS Gauge.

Monthly areal potential evapotranspiration (PET) values were obtained from the Bureau of Meteorology website and are listed in **Table 3-1.**

**Table 3-1 Monthly Areal Potential Evapotranspiration**

| Month | Areal Potential Evapotranspiration (mm) |
|---|---|
| January | 159 |
| February | 122 |
| March | 115 |
| April | 77 |
| May | 50 |
| June | 39 |
| July | 41 |
| August | 57 |
| September | 81 |
| October | 122 |
| November | 142 |
| December | 152 |

### 3.1.2 Soil Parameters and Groundwater Properties

The soil profile parameters adopted in the MUSIC model affect the amount of stormwater runoff generated from pervious areas.

A geotechnical investigation was undertaken in 2005 by Golder Associates for the Bona Vista and Fernandell Precincts. Logged boreholes / test pits established that the soils generally comprise sand and clay mixtures. In the western half and across the northern quarter, the borelogs show the underlying strata to predominantly be sand with progressively increasing clay content with increasing depth. In the eastern part (excluding the northern quarter) the profile is predominantly clay with a variable surficial layer of silt and sand.

The geotechnical report did not consider the soil profile for the precincts being investigated as part of this revised stormwater management strategy. Hence, the characteristics of any potential fill material that may be used in the precincts cannot be specified with any certainty.

Notwithstanding, at a meeting between representatives from Council, Brown Smart Consulting and WorleyParsons on 20$^{th}$ May 2014, Council indicated that the soil type is typically sandy. Hence, Silty Clay soil has been adopted in the MUSIC model and a sensitivity analysis has been undertaken to determine the impact of any variability in soil type on treatment train performance.

The pervious area soil storage and field capacities have been adopted based on the values for Silty Clay presented in Table 3-7 of the *Draft NSW MUSIC Modelling Guidelines* (BMT WBM, 2010).

The groundwater properties that were adopted in the MUSIC model are the values presented in Table 3-8 of the *Draft NSW MUSIC Modelling Guidelines* (BMT WBM, 2010) for Silty Clay soils.

A summary of the pervious area soil parameters and groundwater properties adopted in the MUSIC modelling is presented in **Table 3-2**.

**Table 3-2 Adopted MUSIC Model Soil Parameters**

| Parameter | Value |
|---|---|
| *Pervious Area* | |
| Soil Storage Capacity | 54mm |
| Initial Storage | 30% |
| Field Capacity | 51mm |
| Coefficient – a | 180 |
| Coefficient – b | 3 |
| *Groundwater Properties* | |
| Initial Depth | 10mm |
| Recharge Rate | 25% |
| Baseflow Rate | 25% |
| Deep Seepage Rate | 0% |

The soil types investigated in the sensitivity analysis were sand, silty clay and clay. The outcome of this investigation indicates that the soil type selected has minimal impact on the overall modelling outcomes. This finding is consistent with the *Draft NSW MUSIC Modelling Guidelines* (BMT WBM, 2010) which note that once the effective impervious area is greater than 10%, the adjustment of soil parameters has little significance in improving runoff prediction.

### 3.1.3 Land Uses

Three land use types were modelled. These are:

- Rural housing (residential)

  Within the Hawkesbury DCP (HCC, 2002) rural housing is classified further into a number of precincts according to minimum lot size (i.e. B to H). Precincts C, D, E and F are relevant to the current investigations.

- Roads (sealed)
- Open Space

The percentage impervious for each of the adopted land uses is listed in **Table 3-3.** Table E4.5 of the Hawkesbury DCP (HCC, 2002) lists the maximum building coverage that is to be adopted for housing for each precinct of the PTRP. An additional 5% has been added to the percentages shown to cater for driveways, paved areas and sheds. The percentages in **Table 3-3** include the additional 5%.

**Table 3-3 Impervious Percentages for Each Land Use**

| Land Use | Percentage Impervious |
|---|---|
| Rural Residential – Precinct C | 35% |
| Rural Residential – Precinct D | 45% |
| Rural Residential – Precinct E | 30% |
| Rural Residential – Precinct F | 35% |
| Roads | 100% |
| Open Space | 0% |

### 3.1.4 Pollutant Event Mean Concentrations

Pollutant Event Mean Concentrations (EMCs) for base flow and storm flow scenarios are applied to the source nodes within the MUSIC model. The concentrations used were adopted from Table 3-9 and Table 3-10 of the Draft NSW MUSIC Modelling Guidelines (BMT WBM, 2010). A summary of the adopted EMC values for each of the nominated land uses is presented in **Table 3-4.**

**Table 3-4 Adopted EMC Values**

| Land Use | Mean Pollutant Concentration (mg/L) | | | | | |
|---|---|---|---|---|---|---|
| | TSS | | TP | | TN | |
| | Base Flow | Storm Flow | Base Flow | Storm Flow | Base Flow | Storm Flow |
| Rural Residential | 14.13 | 89.13 | 0.06 | 0.22 | 0.89 | 2.00 |
| Road (sealed) | 15.85 | 269.15 | 0.14 | 0.50 | 1.29 | 2.19 |
| Open Space | 14.13 | 89.13 | 0.06 | 0.22 | 0.89 | 2.00 |

### 3.1.5 Catchment Delineation

A separate MUSIC model was developed for each precinct. The catchments within each MUSIC model were defined on the basis of the sub-catchment area (refer **Section 2.1)** that the precinct is located within.

In the absence of detailed earthworks designs for the Thornton East, Central and Cattai Precincts, it has been assumed that the catchment delineation for the existing conditions and post-development conditions will not differ significantly.

The adopted catchment areas are summarised in the sections that follow.

#### 3.1.5.1 THORNTON PRECINCT

There are three separate catchments associated with this precinct. These are shown in **Figure 3-2** and are described below:

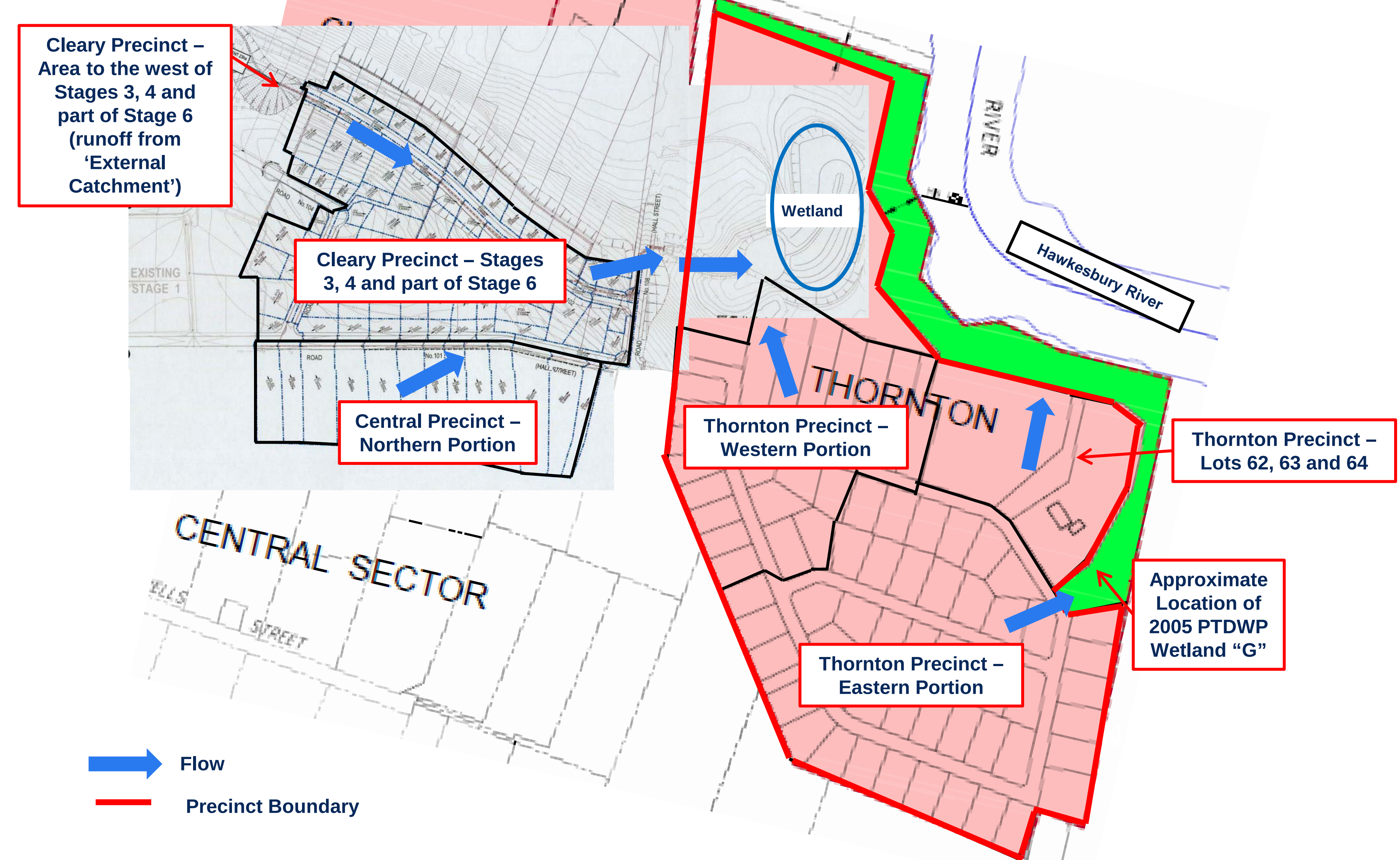
1) Catchment Draining to Wetland in Thornton Precinct

   A Construction Certificate was approved by Council in May 2014 for a wetland to be located in the northern part of the Thornton Precinct. This wetland receives flow from the following locations:

   - Cleary Precinct - Stages 3, 4 and part of Stage 6. (Refer Brown Smart Consulting Drawing no. 500 Rev 03 (project no. L03017.203)).
   - Cleary Precinct - Area to the west of Stages 3, 4 and part of Stage 6. (This is referred to as 'External Catchment' on the Brown Smart Consulting Drawing no. 500 Rev 03 (project no. L03017.203)).
   - Central Precinct - Northern portion. A ridge extending from the west to the east within the northern portion of the Central Precinct splits the precinct into two (northern and southern portions approximately).
   - Thornton Precinct - Western portion. A ridge amongst the lots in the Thornton Precinct splits the precinct into two (western and eastern portions approximately). This land is located within the DCP defined development precincts E and F.
   - Thornton Precinct - Open space surrounding wetland.

2) Catchment Draining to a Treatment Train that is to be Determined

   - Thornton Precinct - Eastern portion. A ridge amongst the lots in the Thornton Precinct splits the precinct into two (western and eastern portions approximately). This land is located within the DCP defined development precincts E and F.




Background Image Source: Brown Smart Consulting Drawing no. 500 Rev 03 (project no. L03017.203)
Brown Smart Consulting, 2014c, Pitt Town Masterplan, Rev 7

WorleyParsons
resources & energy

301015-03518
Pitt Town Development
Updated Stormwater Management Strategy

**Thornton Precinct - Catchments**
**FIGURE 3-2**

3) Catchment Draining Directly to the Hawkesbury River (No Treatment Train) or to a Treatment Train that is to be Determined

- Thornton Precinct – Lots 62, 63 and 64
- For the no treatment option, greater treatment will be provided in the other catchments to counterbalance the lack of treatment in this catchment.

The key characteristics of the catchment areas associated with the Thornton Precinct are listed in **Table 3-5**. The areas have been estimated using the Pitt Town Masterplan (Brown Smart Consulting, 2014c).

**Table 3-5 Thornton Precinct: Catchment Areas**

| Catchment | Total Area (ha) | Road Area (ha) | Open Space Area (ha) | Lot Area (ha) |
|---|---|---|---|---|
| 1. To Wetland in Thornton Precinct | | | | |
| Cleary (Stages 3, 4 and Part Stage 6) | 7.3 | 0.8 | 0 | 6.5 |
| Cleary (Other) | 23.0 | 2.3 | 1.2 | 19.6 |
| Central (Northern Portion) | 4.3 | 0 | 0 | 4.3 |
| Thornton (Western Portion of Lots – Development Precinct E) | 6.1 | 0.9 | 0 | 5.2 |
| Thornton (Western Portion of Lots – Development Precinct F) | 1.4 | 0 | 0 | 1.4 |
| Thornton (Open Space Surrounding Wetland) | 0.00015 | 0 | 0.00015 | 0 |
| 2. To Other | | | | |
| Thornton (Eastern Portion of Lots – Development Precinct E) | 11.5 | 0.9 | 0 | 10.6 |
| Thornton (Eastern Portion of Lots – Development Precinct F) | 1.3 | 0 | 0 | 1.3 |
| 3. Direct to Hawkesbury River or to Other | | | | |
| Thornton (Lots 62, 63 and 64) | 4.5 | 0 | 0 | 4.5 |
| Total | 59.4 | 5.0 | 1.2 | 53.3 |

#### 3.1.5.2 THORNTON EAST PRECINCT

There are two separate catchments associated with this precinct. These are shown in **Figure 3-3** and are listed below:

1) Northern Catchment

2) Southern Catchment

The treatment trains required for both of these are to be determined.

The key characteristics of the catchment areas associated with the Thornton East Precinct are listed in **Table 3-6.** The areas have been estimated using the measurement tool within SIX Maps (NSW Government – Land and Property Information, 2014).

**Table 3-6 Thornton East: Catchment Areas**

| Catchment | Total Area (ha) | Road Area (ha) | Open Space Area (ha) | Lot Area (ha) |
|---|---|---|---|---|
| Northern | 1.8 | 0.2 | 0.1 | 1.5 |
| Southern | 1.8 | 0.2 | 0.1 | 1.5 |
| Total | 3.6 | 0.4 | 0.2 | 3.1 |

#### 3.1.5.3 CATTAI PRECINCT

There are three separate catchments associated with this precinct. These are shown in **Figure 3-4** and these are listed below.

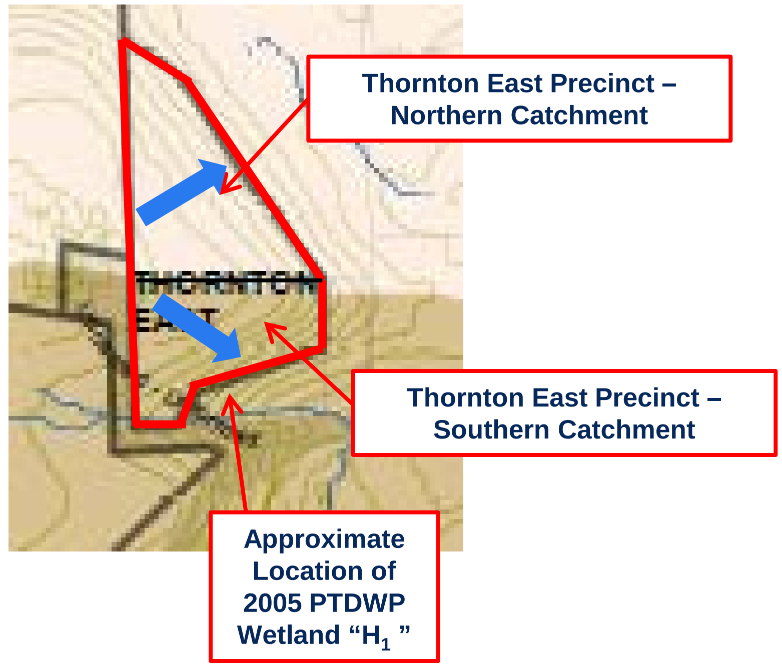
1) Western Catchment

2) North-Western Catchment

3) Remainder

The key characteristics of the catchment areas associated with the Cattai Precinct are listed in **Table 3-7**. The areas have been estimated using the measurement tool within SIX Maps (NSW Government – Land and Property Information, 2014).

Treatment trains have not been investigated for the western (part of catchment B - refer **Section 2.1**) and north-western (part of catchment D - refer **Section 2.1**) catchments due to the relatively small size of these. Instead greater treatment will be provided in the other catchment ("Remainder") to counterbalance the lack of treatment in these catchments.




Flow

Precinct Boundary

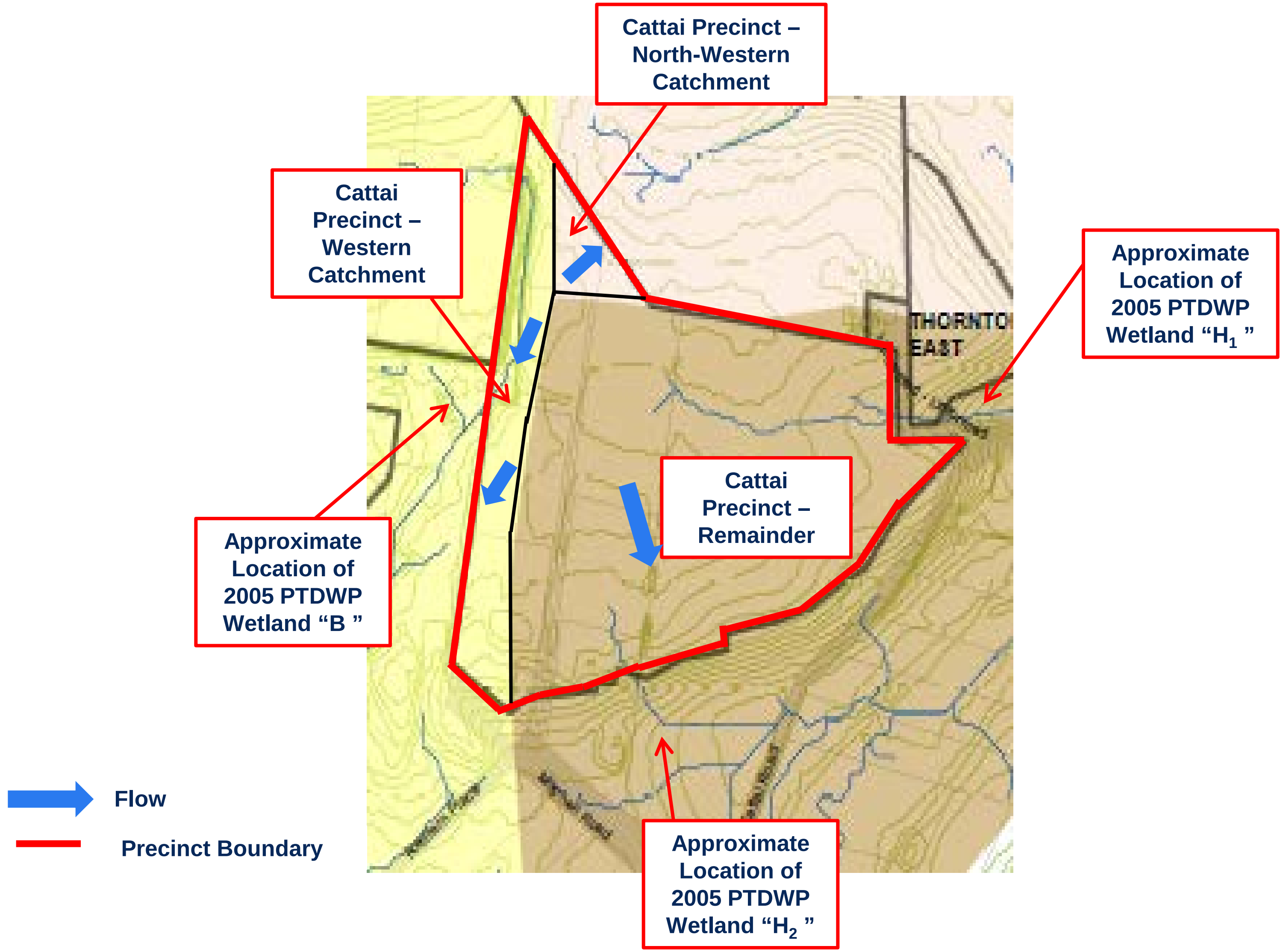
Background Image Source: Hawkesbury City Council

WorleyParsons

resources & energy

301015-03518
Pitt Town Development
Updated Stormwater Management Strategy

**Thornton East Precinct - Catchments**
**FIGURE 3-3**




WorleyParsons
resources & energy

301015-03518
Pitt Town Development
Updated Stormwater Management Strategy

**Cattai Precinct - Catchments**
**FIGURE 3-4**

**Table 3-7 Cattai Precinct: Catchment Areas**

| Catchment | Total Area (ha) | Road Area (ha) | Open Space Area (ha) | Lot Area (ha) |
|---|---|---|---|---|
| Western | 4.3 | 0.43 | 0.22 | 3.66 |
| North-Western | 0.9 | 0.09 | 0.05 | 0.77 |
| Remainder | 22.8 | 2.3 | 1.14 | 19.38 |
| Total | 28.0 | 2.8 | 1.4 | 23.8 |

#### 3.1.5.4 CENTRAL PRECINCT

There are five sub-catchments associated with the Central Precinct (denoted as C1 to C5) based on the existing ground surface contours. These are shown in **Figure 3-5**. These sub-catchments are to drain to three locations as follows:

1) Catchment 1 Draining to a Treatment Train that is to be Determined

   This treatment train receives flow from the following locations:

   - C1 - Northern side of Wells Street. Current catchment outlet on eastern boundary of Central Precinct (discharges into the Cattai Precinct). It is assumed that the outlet will need to be re-directed to avoid entering the Cattai Precinct.
   - C2 - Southern side of Wells Street and adjacent to the eastern boundary of the precinct. Outlet on the eastern boundary of the precinct.

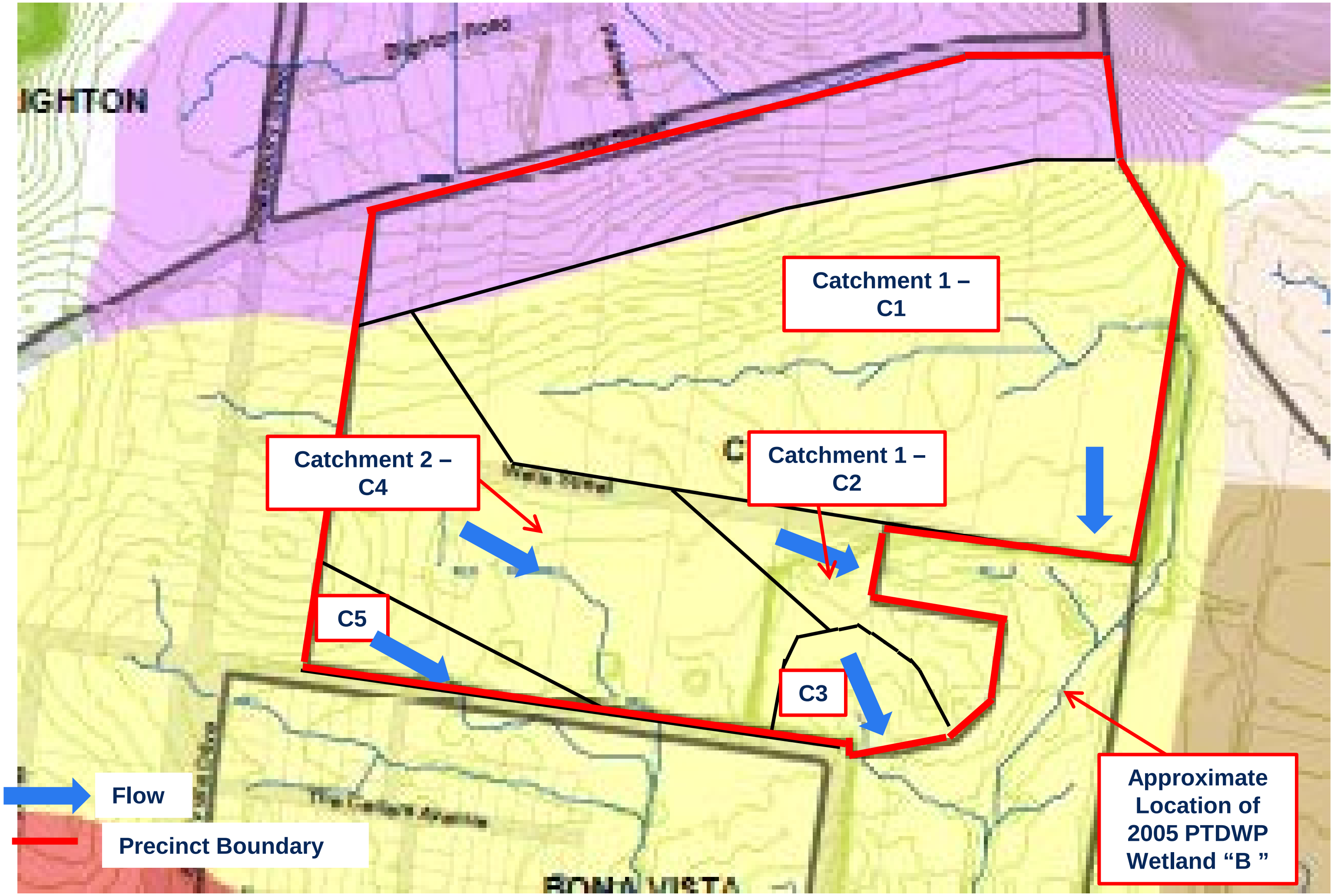
2) Catchment 2 Draining to a Treatment Train that is to be Determined

This treatment train receives flow from the following location:

- C4 - Northern side of Wells Street adjacent to the western boundary and southern side of Wells Street adjacent to the western boundary.

3) No Treatment

- C3 - South-eastern corner of precinct.
- C5 - South-western corner of precinct.
- Greater treatment will be provided in the other catchments to counterbalance the lack of treatment associated with these sub-catchments.




Background Image Source: Hawkesbury City Council

WorleyParsons
resources & energy

301015-03518
Pitt Town Development
Updated Stormwater Management Strategy

**Central Precinct - Catchments**
**FIGURE 3-5**

The key characteristics of the catchment areas associated with the Central Precinct are listed in **Table 3-8**. The areas have been estimated using the measurement tool within SIX Maps (NSW Government – Land and Property Information, 2014).

External to the Central Precinct and adjacent to its western boundary is existing development. The lots associated with this existing development are not of sufficient size to allow for further subdivision. Contour information indicates that this existing development flows in the direction of the Central Precinct. It is assumed that the existing stormwater drainage is appropriate and capable of handling the volume of stormwater runoff associated with the existing development. The existing infrastructure may or may not achieve the water quality targets. The current investigations have not considered the treatment of the existing development flows, as the achievement of the water quality targets is based on new development related flows only.

**Table 3-8 Central Precinct: Catchment Areas**

| Catchment | Total Area (ha) | Road Area (ha) | Open Space Area (ha) | Lot Area (ha) |
|---|---|---|---|---|
| 1. Catchment 1 | | | | |
| Central 1 (C1) | 19.6 | 2.0 | 1.0 | 16.7 |
| Central 2 (C2) | 2.3 | 0.2 | 0.1 | 2.0 |
| 2. Catchment 2 | | | | |
| Central 4 (C4) | 9.6 | 1.0 | 0.5 | 8.1 |
| 3. No Treatment | | | | |
| Central 3 (C3) | 1.7 | 0.2 | 0.1 | 1.5 |
| Central 5 (C5) | 0.9 | 0.1 | 0.04 | 0.7 |
| Total | 34.1 | 3.4 | 1.7 | 29.0 |

## 3.2 Proposed Water Quality Control Measures

It is proposed that a series of water quality control measures be implemented to achieve the specified quality targets. A general description of the proposed stormwater treatment train components is presented in the following sections.

### 3.2.1 Gross Pollutant Traps

GPTs are a means of primary stormwater treatment. GPTs are designed to capture litter, debris, coarse sediment, as well as some oils and greases. A range of proprietary GPTs are available on the market. The most appropriate GPT would be selected at the subdivision Development Application stage.

Pollutant capture efficiency differs between various proprietary GPTs. The *Draft NSW MUSIC Modelling Guidelines* (BMT WBM, 2010) provides some guidance on typical pollutant removal rates that can be adopted for the GPT treatment node in MUSIC. The guidelines are reproduced in **Table 3-9**. These parameters have been adopted for the proposed GPTs in the MUSIC modelling.

**Table 3-9 GPT Treatment Node Inputs in MUSIC**

| Pollutant | Input | Output | % Reduction |
|---|---|---|---|
| TSS | 0 mg/L | 0 mg/L | 0 |
| | 75 mg/L | 75 mg/L | 0 |
| | 1000 mg/L | 350 mg/L | 85 |
| TP | 0 mg/L | 0 mg/L | 0 |
| | 0.50 mg/L | 0.50 mg/L | 0 |
| | 1.00 mg/L | 0.85 mg/L | 15 |
| TN | 0 mg/L | 0 mg/L | 0 |
| | 0.5 mg/L | 0.5 mg/L | 0 |
| | 5.0 mg/L | 4.3 mg/L | 14 |
| Gross Pollutants | 0 kg/ML | 0 kg/ML | 0 |
| | 15 kg/ML | 1.5 kg/ML | 90 |

Source: *Draft NSW MUSIC Modelling Guidelines* (BMT WBM, 2010)

### 3.2.2 Bioretention Systems

The objective of bioretention systems is to provide a filtering effect when stormwater runoff flows through a vegetation layer and sand and/or gravel filter media in order to remove pollutants from the runoff. Bioretention systems generally consist of an open space containing landscaping of native grasses, shrubs and trees with an underlying filter media. An example of a typical bioretention system is presented in **Figure 3-5**.

**Figure 3-5 Example of a Bioretention System**

The following general parameters have been adopted for the proposed bioretention systems in the MUSIC modelling. Refer to **Appendix 1** for commentary on the parameters, including a schematic of the system.

- Extended Detention Depth: 300 mm
- Unlined Filter Media Perimeter: 0.01 m
- Saturated Hydraulic Conductivity: 100 mm/hour
- Filter Depth: 500 mm
- TN Content of Filter Media: 800 mg/kg
- Orthophosphate Content: 55 mg/kg
- Exfiltration Rate: 0 mm/hour
- Assumed to be vegetated with effective nutrient removing plants (exact species to be determined at subsequent stages of the development).
- Assumed to have a lined base with an underdrain present.
- Assumed that there is no submerged zone with carbon present.

### 3.2.3 Swales

Vegetated swales are typically trapezoidal shaped open channels that are provided to convey stormwater runoff through grass or low lying vegetation and thereby assist in the removal of coarse sediment and suspended solids. The water quality polishing performance of a swale is largely dependent on the density and height of the vegetation within the swale and the gradient and length of the swale.

The following general parameters have been adopted for the proposed swales in the MUSIC modelling. Refer to **Appendix 2** for commentary on the parameters, including a schematic of the system.

- Bed Slope: 3 %
- Depth: 0.5 m
- Vegetation Height: 0.25 m
- Exfiltration Rate: 0 mm/hour

### 3.2.4 Wetlands

A constructed wetland is a tertiary treatment measure that is adopted for the removal of suspended solids and nutrients. Constructed wetland systems allow sedimentation, filtration and biological nutrient uptake processes to occur to remove pollutants from stormwater runoff.

The MUSIC model treatment node that simulates the performance of a constructed wetland includes parameters for an inlet pond and the main macrophyte cell (wetland). Constructed wetlands are typically designed such that stormwater can by-pass the system when it falls below or exceeds certain pre-defined flow rates. The macrophyte cell has a permanent volume of water with a low flow outlet level notionally set at the standing water level (SWL) of this permanent pool volume. An overflow weir is typically located at a level that provides a specified extended detention depth above the standing water level of the permanent pool volume.

Constructed wetlands are most effective when placed at the lower end of a catchment where a large proportion of runoff can be collected and treated. The edges of the permanent pool would be planted with a macrophyte berm or gentle slope to enable the establishment of permanent reed beds of varying widths.

Examples of typical constructed wetlands systems are shown in **Figure 3-6**.

**Figure 3-6 Examples of Constructed Wetlands**

The following general parameters have been adopted for the constructed wetlands in the MUSIC modelling. Refer to **Appendix 3** for commentary on the parameters, including a schematic of the system.

- Exfiltration Rate: 0 mm/hour
- Evaporative Loss as % of PET: 125
- Notional Detention Time: between 48 and 72 hours

### 3.2.5 Sedimentation Basins

Sedimentation basins are used to retain and capture coarse and medium sized sediment from stormwater. They achieve this by reducing water velocities and encourage sediments to settle out of the water.

The following general parameters have been adopted for the sedimentation basins in the MUSIC modelling. Refer to **Appendix 3** for commentary on the parameters, including a schematic of the system.

- Extended Detention Depth: 500 mm
- Exfiltration Rate: 0 mm/hr
- Evaporative Loss as % of PET: 75

### 3.2.6 High Flow Bypass

The Draft NSW MUSIC Modelling Guidelines (BMT WBM, 2010) recommend adopting 50% of the 1-year average recurrence interval (ARI) peak flow as the high flow bypass value for a GPT, sedimentation basin, constructed wetland and bioretention system.

Within the 2005 PTDWP (by Connell Wagner) the 1-year ARI value is presented for each of the modelled catchments. These are listed in **Table 3-10**. The boundary of each of the modelled catchments defined in the 2005 PTDWP do not align with the boundary of each of the precincts that form the basis of the current investigations. Therefore the relationship between 1-year ARI and catchment area was investigated using the 2005 PTDWP data to determine if a 1-year ARI value could be derived for each of the precincts. Listed in **Table 3-10** is the value representing the 1-year ARI per hectare for each catchment. It was found that for every hectare the 1-year ARI was approximately $0.05m^3/s$. This relationship has been adopted for the current investigations.

**Table 3-10 2005 PTDWP 1-Year ARI Values (Connell Wagner, 2005)**

| Catchment | Area (ha) | 1-Year ARI ($m^3/s$) | 1-Year ARI ($m^3/s$) / ha |
|---|---|---|---|
| AD | 78.10 | 5.06 | 0.065 |
| B | 60.20 | 2.73 | 0.045 |
| E | 32.10 | 1.70 | 0.053 |
| F | 11.00 | 0.75 | 0.068 |
| G | 15.02 | 0.70 | 0.047 |
| H1 | 10.26 | 0.48 | 0.047 |
| H2 | 8.28 | 0.39 | 0.047 |

## 3.3 Water Quality Modelling Results

A minimum of two treatment train options have been investigated for each precinct. The options investigated and the estimated mean annual pollutant loads associated with these are summarised in the sections that follow. The attributes of the treatment trains have been determined such that they will satisfy the pollutant reduction targets outlined in **Section 2.3.1**.

Where there are multiple flow paths and even treatment trains upstream of the ultimate receiving point, the percentage reductions have not been assessed on an individual flow path or treatment train basis but have been assessed on a precinct scale. This means that a single treatment train alone may not meet the pollutant reduction targets, but the treatment trains operating in parallel within each precinct result in the reduction targets being met.

Refer to **Appendix 1** (bioretention systems), **Appendix 2** (swales), **Appendix 3** (constructed wetlands) and **Appendix 4** (sedimentation basins) for commentary on the parameters, including a schematic of each of the system types.

### 3.3.1 Thornton Precinct

#### 3.3.1.1 Construction Certificate Approved Wetland

A construction certificate has been issued for a wetland to be positioned in the northern part of the Thornton Precinct. This wetland is to be positioned in the general vicinity of the wetland denoted as "F" within the 2005 PTDWP developed by Connell Wagner.

Brown Consulting present the TSS, TP and TN inflow load, outflow load and percentage reduction on design drawing no. 500 rev 03 (project no. L03017.203) that forms part of the detailed design drawing set for the wetland.

The reported inflow loads and wetland performance were investigated as part of the current investigations. The inflow loads were found to be significantly less than those reported. The difference may be due to the parameters adopted as part of the model set-up, particularly the pollutant EMC values, the percentage impervious values, the soil type values and the rainfall data applied. The performance of the wetland (in terms of percentage reduction) is skewed by the inflow numbers. If the model inputs are manipulated such that the inflow loads are achieved (i.e. by adopting an agricultural catchment and increasing the percentage imperviousness of the catchment) the percentage reduction values are comparable.

The reason for the differences has not been investigated further (and it is not within the current project scope to do this). The focus has been on investigating treatment trains that achieve the water quality objectives for runoff associated with the eastern portion and lots 62, 63 and 64 of the Thornton Precinct.

#### 3.3.1.2 OPTIONS ASSESSMENT

Four treatment train options have been investigated for the flow associated with the eastern portion of the Thornton Precinct and Lots 62, 63 and 64 within the Thornton Precinct.

Option 1 – Thornton Precinct – Eastern Portion: GPT + Swale + Wetland

No direct treatment is proposed for the runoff from Lots 62, 63 and 64 within the Thornton Precinct, however greater treatment will be provided by the treatment train in the eastern portion of the precinct to counterbalance this lack of direct treatment.

The treatment train for the flow associated with the eastern portion of the Thornton Precinct is proposed to be located in the general vicinity of the wetland denoted as "G" within the 2005 PTDWP developed by Connell Wagner. This wetland has an area of approximately 3,000 $m^2$.

The characteristics of the GPT are as presented in **Section 3.2.1**.

The key attributes of the swale are:

- Length: 50 m
- Base Width: 20 m
- Top Width: 30 m

The key attributes of the wetland are:

- Inlet Pond Volume: 1,500 $m^3$
- Storage Surface Area: 10,000 $m^2$
- Extended Detention Depth: 500 mm
- Permanent Pool Volume: 3,200 $m^3$

Option 2 – Thornton Precinct – Eastern Portion: GPT + Swale + Bioretention System

No treatment is proposed for the runoff from Lots 62, 63 and 64 within the Thornton Precinct, however greater treatment will be provided by the treatment train in the eastern portion of the precinct to counterbalance this lack of direct treatment.

The treatment train for the flow associated with the eastern portion of the Thornton Precinct is proposed to be located in the general vicinity of the wetland denoted as "G" within the 2005 PTDWP developed by Connell Wagner.

The characteristics of the GPT are as presented in **Section 3.2.1**.

The key attributes of the swale are:

- Length: 40 m
- Base Width: 20 m
- Top Width: 30 m

The key attributes of the sedimentation basin are:

- Surface Area: 80 $m^2$

The key attributes of the bioretention system are:

- Storage Surface Area: 2,640 $m^2$
- Filter Area: 2,020 $m^2$

Option 3 – Thornton Precinct – Eastern Portion: GPT + Wetland and Thornton Precinct – Lots 62, 63 and 64: Swale

The runoff from Lots 62, 63 and 64 within the Thornton Precinct is proposed to be directed to a swale located to the north of these lots and then to the wetland located in the north of the Thornton Precinct. At the location of the proposed swale the level of the existing terrain ranges from approximately RL7m to RL10m (fall of approximately 1%) and grades in a westerly direction. Potentially significant earthworks would be required to construct a swale as in some locations a couple of metres of cut would be required and in other locations a couple of metres of fill would be required.

The key attributes of the swale are:

- Length: 250 m
- Base Width: 15 m
- Top Width: 20 m

The treatment train for the flow associated with the eastern portion of the Thornton Precinct is proposed to be located in the general vicinity of the wetland denoted as “G” within the 2005 PTDWP developed by Connell Wagner.

The characteristics of the GPT are as presented in **Section 3.2.1**. The key attributes of the wetland are:

- Inlet Pond Volume: 1,500 $m^3$
- Storage Surface Area: 5,000 $m^2$
- Extended Detention Depth: 500 mm
- Permanent Pool Volume: 1,600 $m^3$

Option 4 – Thornton Precinct – Eastern Portion: GPT + Bioretention System and Thornton Precinct – Lots 62, 63 and 64: Swale

The runoff from Lots 62, 63 and 64 within the Thornton Precinct is proposed to be directed to a swale located to the north of these lots and then to the wetland located in the north of the Thornton Precinct. Refer to the comments under Option 3 for further details relating to the existing terrain in the vicinity of the proposed swale.

The key attributes of the swale are:

- Length: 250 m
- Base Width: 15 m
- Top Width: 20 m

The treatment train for the flow associated with the eastern portion of the Thornton Precinct is proposed to be located in the general vicinity of the wetland denoted as "G" within the 2005 PTDWP developed by Connell Wagner

The characteristics of the GPT are as presented in **Section 3.2.1**. The key attributes of the bioretention system are:

- Storage Surface Area: 1060 $m^2$
- Filter Area: 800 $m^2$

### 3.3.1.3 RESULTS

A summary of the stormwater quality modelling results for these options is provided in **Table 3-11**.

**Table 3-11 Thornton Precinct: Summary of Stormwater Quality Modelling Results**

| Option | Pollutant | No Treatment (kg/yr) | With Treatment (kg/yr) | % Reduction |
|---|---|---|---|---|
| 1 | TSS | 6,750 | 1,320 | 80.5 |
| | TP | 13.9 | 4.3 | 69.1 |
| | TN | 103 | 48.5 | 53.0 |
| | GP | 1,260 | 58.4 | 95.4 |
| 2 | TSS | 6,730 | 1,340 | 80.1 |
| | TP | 14.0 | 7.0 | 49.8 |
| | TN | 105 | 49.3 | 52.9 |
| | GP | 1,260 | 58.4 | 95.4 |
| 3 | TSS | 6,750 | 1,110 | 83.5 |
| | TP | 14.0 | 4.88 | 65.1 |
| | TN | 104 | 56.7 | 45.2 |
| | GP | 1,260 | 44.9 | 96.4 |
| 4 | TSS | 6,730 | 1,180 | 82.5 |
| | TP | 13.8 | 7.11 | 48.5 |
| | TN | 104 | 56.8 | 45.2 |
| | GP | 1,260 | 44.9 | 96.4 |

#### 3.3.1.4 CONCLUSION

The results of the MUSIC modelling show that the area of wetland “G” as proposed in the 2005 PTDWP is not large enough to achieve the required pollutant reduction targets if a wetland option is selected (Options 1 and 3). In order for a wetland solution to be effective at this location, it will be necessary for some of the land allocated for residential development to be dedicated for stormwater infrastructure.

There is sufficient area available for the bioretention system that forms part of Options 2 and 4 at the proposed location of the 2005 PTDWP wetland “G”.

The runoff from Lots 62, 63 and 64 within the Thornton Precinct may be directed to a swale (Options 3 and 4) located to the north of these lots and then to the wetland located in the north of the Thornton Precinct. Potentially significant earthworks would be required to construct this swale.

### 3.3.2 Thornton East Precinct

#### 3.3.2.1 OPTIONS ASSESSMENT

Two treatment train options have been investigated for the Thornton East precinct. For both of these options it has been assumed that both the northern and southern catchments will drain to the same treatment train. Alternate arrangements include keeping the catchments separate and therefore installing two separate treatment trains. A summary of the advantages and disadvantages of installing a single treatment train versus two are listed in **Table 3-12** and **Table 3-13** respectively.

**Table 3-12 Thornton East Precinct: Single Treatment train – Advantages and Disadvantages**

| Advantages | Disadvantages |
|---|---|
| Only one system needs to be maintained. | If system is out of order, no runoff is treated. |
| System can be positioned on a single block of land and therefore if land must be acquired negotiations would only be required with one land owner. | For one catchment the system will not be positioned at its outlet and therefore stormwater transfer infrastructure is required (typically either pipe or swale). |
| Overall cost of a single system is less than the cost of two systems. | |

**Table 3-13 Thornton East Precinct: Two Treatment Trains – Advantages and Disadvantages**

| Advantages | Disadvantages |
|---|---|
| Even if one system is out of order, the runoff from the other catchment will still be treated. | Two systems must be maintained |
| Minimal stormwater transfer infrastructure (i.e. pipes or swales) as systems can be positioned as close as possible to catchment outlets. | Systems would be positioned on two separate blocks of land and if land must be acquired negotiations may need to occur with two land owners. |
| | Overall cost of two systems is greater than the cost of a single system. |

Another option is to direct the flow associated with the northern catchment to the treatment train within the Thornton Precinct. This approach was adopted in the 2005 PTDWP. The 2005 PTDWP assumed that runoff from the southern part of this precinct is directed to the wetland denoted as "$H_1$". This wetland has an area of approximately 2,000 $m^2$.

Option 1 – GPT + Wetland

The characteristics of the GPT are as presented in **Section 3.2.1**. The key attributes of the wetland are:

- Inlet Pond Volume: 400 $m^3$
- Storage Surface Area: 1,200 $m^2$
- Extended Detention Depth: 500 mm
- Permanent Pool Volume: 385 $m^3$

Option 2 – GPT + Bioretention System

The characteristics of the GPT are as presented in **Section 3.2.1**. The key attributes of the bioretention system are:

- Storage Surface Area: 352 $m^2$
- Filter Area: 175 $m^2$

#### 3.3.2.2 RESULTS

A summary of the stormwater quality modelling results for these two options is provided in **Table 3-14**.

**Table 3-14 Thornton East Precinct: Summary of Stormwater Quality Modelling Results**

| Option | Pollutant | No Treatment (kg/yr) | With Treatment (kg/yr) | % Reduction |
|---|---|---|---|---|
| 1 | TSS | 1,780 | 336 | 81.2 |
| | TP | 3.56 | 1.28 | 64.0 |
| | TN | 24.5 | 13.3 | 45.6 |
| | GP | 326 | 12.0 | 96.3 |
| 2 | TSS | 1,800 | 341 | 81.0 |
| | TP | 3.57 | 1.83 | 48.7 |
| | TN | 24.5 | 13.2 | 46.1 |
| | GP | 326 | 12.0 | 96.3 |

#### 3.3.2.3 CONCLUSION

A lot layout has not been developed for this precinct at this stage. Allowance should be made for the inclusion of a suitable treatment train. It could be located in the general vicinity of the wetland denoted as "$H_1$" within the 2005 PTDWP. There is sufficient area available at this location for both of the options investigated.

### 3.3.3 Cattai Precinct

#### 3.3.3.1 OPTIONS ASSESSMENT

The development application (number DA0255/14) submitted for this precinct has directed the flow to a single wetland on the southern side of the precinct. The 2005 PTDWP assumed that runoff from this precinct would be directed to three separate wetlands referred to as Wetland "B", "$H_1$" or "$H_2$". The approximate areas of these wetlands were specified as 11,000 $m^2$, 2,000 $m^2$ and 10,000 $m^2$, respectively.

Two treatment train options have been investigated for this precinct. As part of the investigation, it has been assumed that stormwater runoff from the Cattai Precinct will be transferred to a single treatment train within the precinct.

Option 1 – GPT + Wetland

No direct treatment is proposed for the runoff from the western and north-western catchments within the Cattai Precinct, however greater treatment will be provided by the treatment train receiving runoff from the remainder of the precinct to counterbalance this lack of direct treatment.

The characteristics of the GPT are as presented in **Section 3.2.1**. The key attributes of the wetland are:

- Inlet Pond Volume: 1,000 $m^3$
- Storage Surface Area: 10,400 $m^2$
- Extended Detention Depth: 500 mm
- Permanent Pool Volume: 3,325 $m^3$

Option 2 – GPT + Bioretention System

No direct treatment is proposed for the runoff from the western and north-western catchments within the Cattai Precinct, however greater treatment will be provided by the treatment train receiving runoff from the remainder of the precinct to counterbalance this lack of direct treatment.

The characteristics of the GPT are as presented in **Section 3.2.1**. The key attributes of the bioretention system are:

- Storage Surface Area: 1,820$m^2$
- Filter Area: 1,500$m^2$

#### 3.3.3.2 RESULTS

A summary of the stormwater quality modelling results for these two options is provided in **Table 3-15.**

**Table 3-15 Cattai Precinct: Summary of Stormwater Quality Modelling Results**

| Option | Pollutant | No Treatment (kg/yr) | With Treatment (kg/yr) | % Reduction |
|---|---|---|---|---|
| 1 | TSS | 13,900 | 2,760 | 80.2 |
| | TP | 27.7 | 9.99 | 63.9 |
| | TN | 192 | 103 | 46.6 |
| | GP | 2,540 | 93.4 | 96.3 |
| 2 | TSS | 13,800 | 2,610 | 81.0 |
| | TP | 27.9 | 14.4 | 48.4 |
| | TN | 193 | 106 | 45.0 |
| | GP | 2,540 | 93.4 | 96.3 |

#### 3.3.3.3 CONCLUSION

There is sufficient area to the south of the precinct for both of the options investigated in the vicinity of wetland “$H_2$” (Connell Wagner, 2005).

### 3.3.4 Central Precinct

#### 3.3.4.1 OPTIONS ASSESSMENT

Four treatment train options were investigated for this precinct.

For all options the treatment train associated with catchment 1 (sub-catchments C1 and C2) is proposed to be located in the vicinity of the wetland denoted as “B” in the 2005 PTDWP. This wetland is approximately 11,000 $m^2$ in area. In the PTDWP it does encroach from 44 Mitchell Road onto 70 Wells Street. One of the design criteria for the current project is that the wetland should not encroach on the Wells Street property.

In Options 1, 2 and 3 the treatment train associated with catchment 2 (sub-catchment C4) is proposed to be located within the precinct.

In Option 4, the treatment train associated with catchment 1 (sub-catchments C1 and C2), also treats the runoff from catchment 2 (sub-catchment C4). From catchment 2 (sub-catchment C4), it is proposed that stormwater runoff be redirected via trunk drainage running along the northern side of Johnston Street, then along an easement through 54 Wells Street and then it is proposed to connect with the flow from catchment 1 (sub-catchments C1 and C2) at Wells Street.

Option 1 – GPT + Swale + Wetland (one treatment train per catchment)

No direct treatment is proposed for the runoff from sub-catchments C3 and C5 within the Central Precinct, however greater treatment will be provided by the treatment trains in the other catchments within the precinct to counterbalance this lack of direct treatment.

The characteristics of the GPT are as presented in **Section 3.2.1**.

The key attributes of the swale for catchment 1 (sub-catchments C1 and C2) are:

- Length: 50 m
- Base Width: 20 m
- Top Width: 30 m

The key attributes of the wetland for catchment 1 (sub-catchments C1 and C2) are:

- Inlet Pond Volume: 1,000 $m^3$
- Storage Surface Area: 9,200 $m^2$
- Extended Detention Depth: 500 mm
- Permanent Pool Volume: 2,950 $m^3$

The key attributes of the swale for catchment 2 (sub-catchment C4) are:

- Length: 50 m
- Base Width: 20 m
- Top Width: 30 m

The key attributes of the wetland for catchment 2 (sub-catchment C4) are:

- Inlet Pond Volume: 500 $m^3$
- Storage Surface Area: 3,500 $m^2$
- Extended Detention Depth: 500 mm
- Permanent Pool Volume: 1,100 $m^3$

Option 2 – GPT + Swale + Wetland (catchment 1) – GPT + Bioretention System (catchment 2)

No direct treatment is proposed for the runoff from sub-catchments C3 and C5 within the Central Precinct, however greater treatment will be provided by the treatment trains in the other catchments within the precinct to counterbalance this lack of direct treatment.

The characteristics of the GPT are as presented in **Section 3.2.1**.

The key attributes of the swale for catchment 1 (sub-catchments C1 and C2) are:

- Length: 50 m
- Base Width: 20 m
- Top Width: 30 m

The key attributes of the wetland for catchment 1 (sub-catchments C1 and C2) are:

- Inlet Pond Volume: 1,000 $m^3$
- Storage Surface Area: 9,200 $m^2$
- Extended Detention Depth: 500 mm
- Permanent Pool Volume: 2,950 $m^3$

The key attributes of the bioretention system for catchment 2 (sub-catchment C4) are:

- Storage Surface Area: 1,170 $m^2$
- Filter Area: 900 $m^2$

Option 3 – GPT + Bioretention System (one treatment train per catchment)

No direct treatment is proposed for the runoff from sub-catchments C3 and C5 within the Central Precinct, however greater treatment will be provided by the treatment trains in the other catchments within the precinct to counterbalance this lack of direct treatment.

The characteristics of the GPT are as presented in **Section 3.2.1**.

The key attributes of the swale for catchment 1 (sub-catchments C1 and C2) are:

- Length: 50 m
- Base Width: 20 m
- Top Width: 30 m

The key attributes of the bioretention system for catchment 1 (sub-catchments C1 and C2) are:

- Storage Surface Area: 2,525 $m^2$
- Filter Area: 2,000 $m^2$

The key attributes of the bioretention system for catchment 2 (sub-catchment C4) are:

- Storage Surface Area: 730 $m^2$
- Filter Area: 550 $m^2$

Option 4 – GPT + Swale + Bioretention (single treatment train)

No direct treatment is proposed for the runoff from sub-catchments C3 and C5 within the Central Precinct, however greater treatment will be provided by the treatment train provided for the other catchments to counterbalance this lack of direct treatment.

The characteristics of the GPT are as presented in **Section 3.2.1**.

The key attributes of the swale are:

- Length: 65 m
- Base Width: 20 m
- Top Width: 30 m

The key attributes of the bioretention system are:

- Storage Surface Area: 2,525 $m^2$
- Filter Area: 2,000 $m^2$

#### 3.3.4.2 RESULTS

A summary of the stormwater quality modelling results for these three options is provided in **Table 3-16**.

**Table 3-16 Central Precinct: Summary of Stormwater Quality Modelling Results**

| Option | Pollutant | No Treatment (kg/yr) | With Treatment (kg/yr) | % Reduction |
|---|---|---|---|---|
| 1 | TSS | 18,800 | 3,500 | 81.4 |
| | TP | 37.9 | 13.0 | 65.8 |
| | TN | 266 | 146 | 45.0 |
| | GP | 3,660 | 258 | 93.0 |
| 2 | TSS | 18,800 | 3,790 | 79.9 |
| | TP | 37.9 | 15.0 | 60.4 |
| | TN | 266 | 142 | 46.6 |
| | GP | 3,660 | 295 | 91.9 |
| 3 | TSS | 18,500 | 3,650 | 80.2 |
| | TP | 37.2 | 19.0 | 48.8 |
| | TN | 267 | 138 | 48.4 |
| | GP | 3,660 | 295 | 91.9 |
| 4 | TSS | 18,600 | 3,680 | 80.2 |
| | TP | 37.4 | 18.9 | 49.4 |
| | TN | 267 | 145 | 45.9 |
| | GP | 3,660 | 258 | 93.0 |

### 3.3.4.3 CONCLUSION

The area of the parcel of land at 44 Mitchell Road is approximately 14,000 $m^2$. There is therefore sufficient space at this location for the treatment train proposed for catchment 1 in all options and the combined catchment 1 and 2 treatment train proposed in Option 4. The property at 70 Wells Street will not be encroached on.

A lot layout has not been developed for this precinct at this stage. If Option 1, 2 or 3 is selected allowance should be made within the layout for the inclusion of a suitable treatment train for the flow associated with catchment 2. Therefore the larger the footprint of the treatment train, the smaller the area available for residential housing lots.

# 4 STORMWATER MANAGEMENT PREFERRED OPTIONS

A workshop was held with Council and WorleyParsons personnel on 17th July 2014 to discuss the stormwater management options identified. Council later held internal discussions in relation to the options and advised WorleyParsons of the preferred ones on 1st October 2014. In August 2015, Council requested that the option selected for the Central Precinct be revised.

The preferred options are summarised in the sections that follow and the proposed location of each option is shown in **Figure 4-1**.

## 4.1 Thornton Precinct

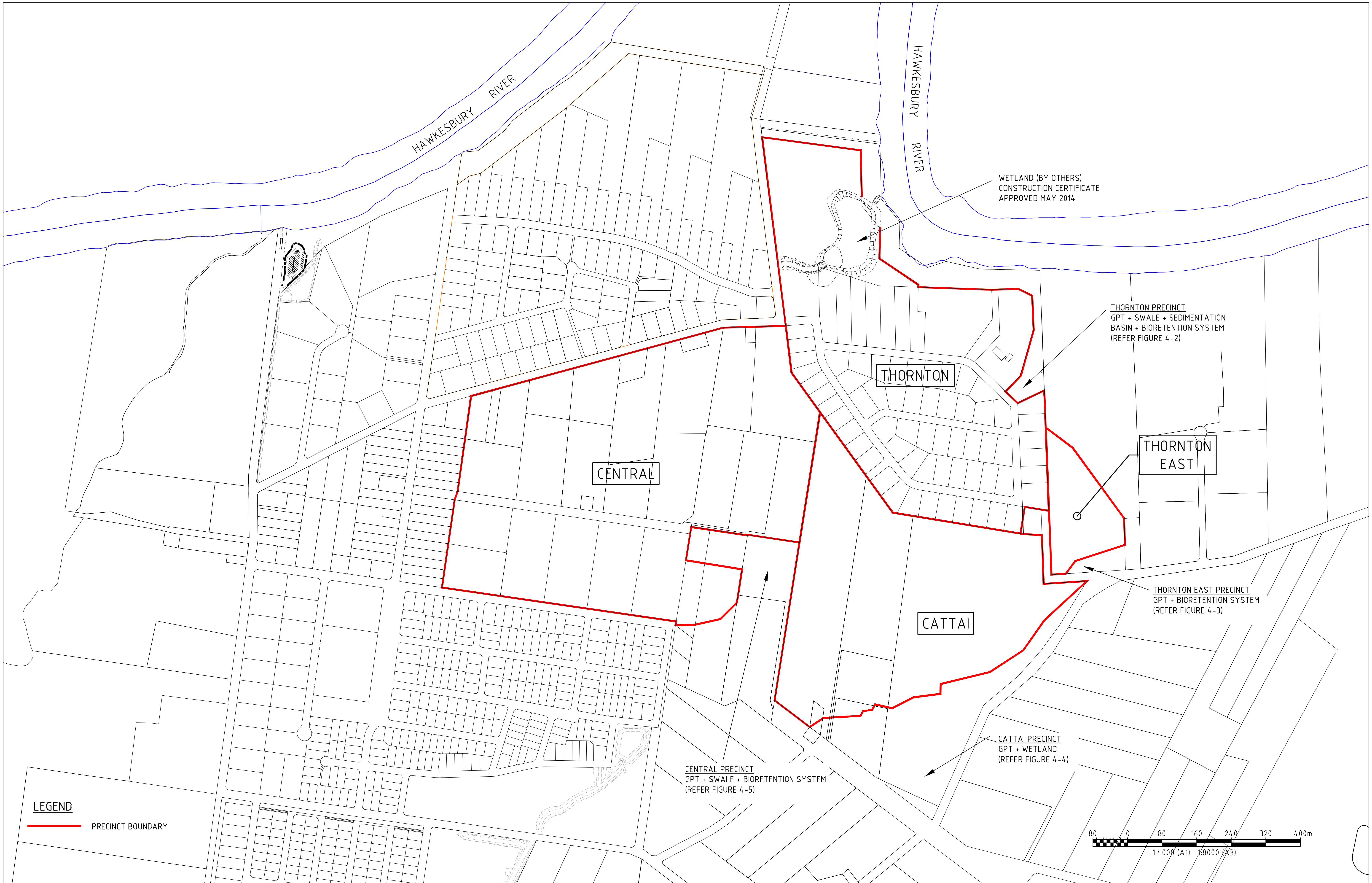
*** Preferred Option - Option 2 – GPT + Swale + Sedimentation Basin + Bioretention System ***

The proposed treatment train for the Thornton Precinct is shown in **Figure 4-2**. It is shown on the eastern side of the precinct, adjacent to and external to the eastern boundary.

The treatment train is proposed to be positioned online (i.e. it forms part of the overall stormwater drainage system). Therefore to ensure that the bioretention system is not scoured out during high flows it is important that a bypass be incorporated into the design. This should be investigated during future design phases. It is proposed that an overflow form part of the sedimentation basin on the upstream end of the bioretention system. During normal conditions the flow would move from the sedimentation basin to the bioretention system, for example via a weir. During wet weather conditions, the flow would overflow from the bioretention basin to a pipe or overland channel, such as a grass swale, and be transferred along the eastern side of the bioretention system, to the downstream creek.

It is important to ensure that runoff spreads across the full width of both the swale and bioretention system so that the systems perform optimally and their as designed life spans are not compromised. If runoff concentrates through the centre of the system the treatment capacity of the system will be used up through the central portion prior to that of the edge portions. There are a number of options that should be investigated during future design phases to assist with this. Examples include:

- A structure positioned across the width of the system, typically made of rocks, that acts as a weir and causes flow to be distributed relatively evenly across the full width of the system.
- A weir structure as noted above that includes a rock lined drop pool upstream of the weir. The drop pool will dissipate the energy associated with the runoff prior to it passing over the weir. This drop pool could double as the sedimentation basin.
- A series of channels positioned across the surface of the bioretention system that link to a central channel positioned along the length of the system. The top level of all of the channels is the same and is higher than the top surface of the bioretention system. Flow enters the central channel and is transferred through to the other channels. Eventually the level of the flow in the channels will




WorleyParsons
resources & energy

OneWay
to zero harm

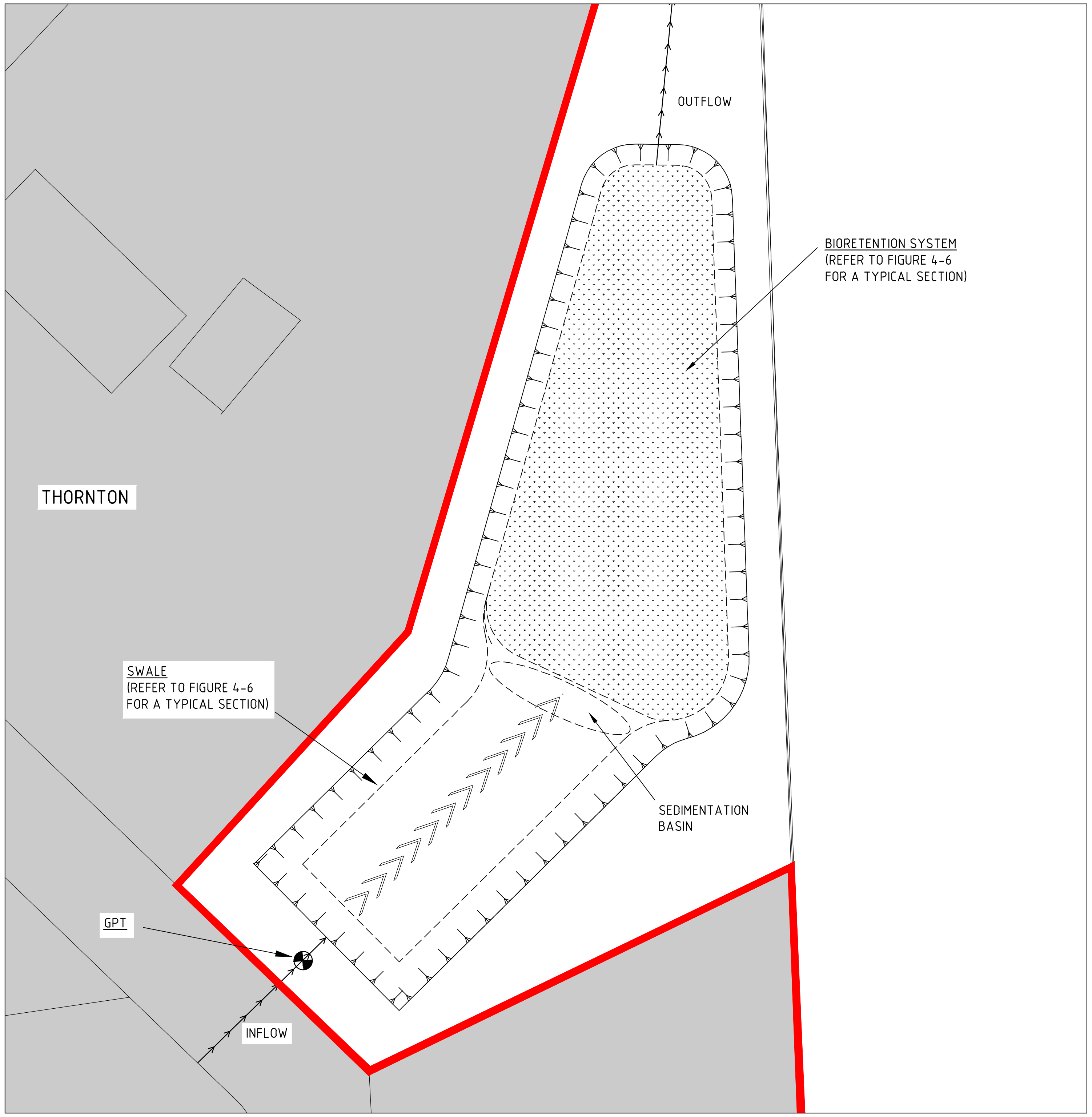
| ISSUE | DATE | ISSUE DESCRIPTION | DRAWN |
|---|---|---|---|
| B | 29.10.15 | UPDATED CENTRAL PRECINCT CATCHMENT 2 DRAINAGE | BW |
| A | 29.10.14 | FOR INFORMATION | BW |

NORTH

**PITT TOWN DEVELOPMENT**
**UPDATED STORMWATER MANAGEMENT PLAN**
**PREFERRED OPTIONS: CONCEPT OVERVIEW**

**FIGURE 4-1**

PLOT DATE & TIME: 29/10/2015 11:09:34 AM USER NAME: william.watkins LOCATION: W:_INFRASTRUCTURE\PROJECTS\301015\03518 - PITT TOWN DEVELOPMENT SMP REVIEW\12.0 DRAWINGS\SKETCHES\FIGURE 4-1.DWG
SAVE DATE & TIME: 27/10/2015 12:12:52 PM CTB FILE: Worley-Full.ctb Plotter:None




## LEGEND

- PRECINCT BOUNDARY
- STORMWATER FLOW
- PROPOSED GROSS POLLUTANT TRAP
- PROPOSED SWALE
- PROPOSED BIORETENTION SYSTEM
- PROPOSED WETLAND

8000 0 8000 16000 24000 32000 40000mm

1:400 (A1) 1:800 (A3)

WorleyParsons

resources & energy

OneWay to zero harm

| ISSUE | DATE | ISSUE DESCRIPTION | DRAWN |
|---|---|---|---|
| A | 29.10.14 | FOR INFORMATION | BW |

NORTH

**PITT TOWN DEVELOPMENT**

**UPDATED STORMWATER MANAGEMENT PLAN**

**THORNTON PRECINCT - PREFERRED OPTION - CONCEPT - PLAN**

**FIGURE 4-2**

PLOT DATE & TIME: 29/10/2014 10:55:22 AM USER NAME: william.watkins LOCATION: W:_INFRASTRUCTURE\PROJECTS\301015\03518 - PITT TOWN DEVELOPMENT SMP REVIEW\12.0 DRAWINGS\SKETCHES\FIGURE 4-1.DWG

SAVE DATE & TIME: 29/10/2014 10:17:18 AM CTB FILE: Worley-Full.ctb Plotter:None exceed the top of the channel and will overflow onto the surface of the bioretention system. This arrangement will ensure that the flow is distributed across the entire bioretention system.

The outflow from the system would discharge into the existing creek that extends from the eastern side of the Thornton Precinct to the Hawkesbury River.

The ground surface elevation at the proposed location of the treatment train is at RL 14.68m approximately. The precinct boundary is approximately at the 100-year ARI level (RL 17.14m) and although the proposed location is lower than this level it is not anticipated to be frequently inundated by flood water.

No treatment is proposed for the runoff from Lots 62, 63 and 64, however greater treatment is provided by the proposed Thornton Precinct treatment train to counterbalance this lack of direct treatment.

## 4.2 Thornton East Precinct

*** Preferred Option - Option 2 – GPT + Bioretention System ***

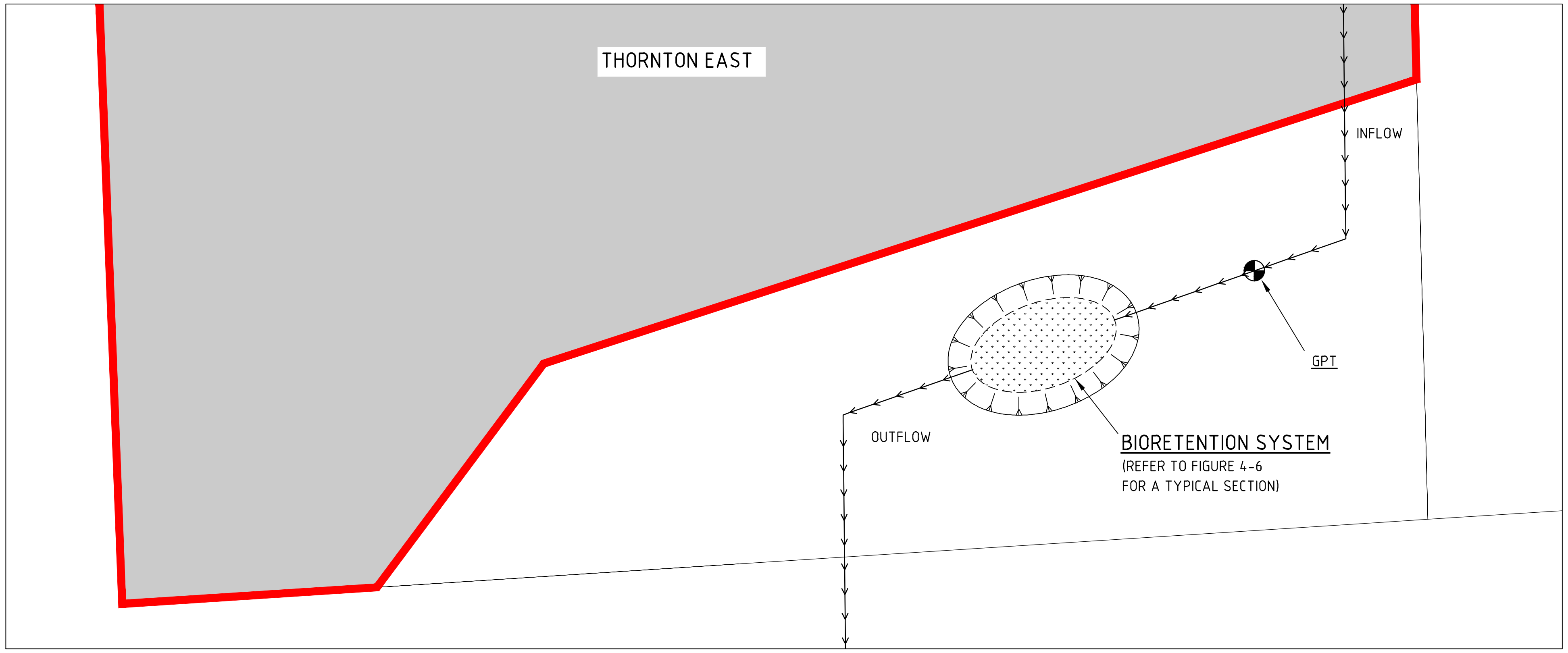
The proposed treatment train for the Thornton East Precinct is shown in **Figure 4-3**. It is proposed to be positioned on the southern side of the precinct, adjacent to and external to the southern boundary. Both the northern and southern catchments would drain to this treatment train.

Flow would need to be transferred from the outlet of the northern catchment to the system. This could be achieved by a pipe or overland, such as by a grassed swale.

The proposed treatment train is proposed to be positioned online (i.e. it forms part of the overall stormwater drainage system). As noted for the Thornton Precinct to ensure that the bioretention system is not scoured out during high flows, it is important that a bypass be incorporated into the design. As also noted for the Thornton Precinct it is important to ensure that runoff spreads across the full width of the bioretention system.

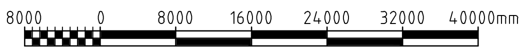
The outflow from the system would discharge into the existing creek that extends from the southern side of the Thornton East Precinct to the Longneck Lagoon.

The ground surface elevation at the proposed location of the treatment train is at RL 16.52m approximately. The precinct boundary is approximately at the 100-year ARI level (RL 17.14m) and although the proposed location is lower than this level it is not anticipated to be frequently inundated by flood water.




LEGEND

- PRECINCT BOUNDARY
- STORMWATER FLOW
- PROPOSED GROSS POLLUTANT TRAP
- PROPOSED SWALE
- PROPOSED BIORETENTION SYSTEM
- PROPOSED WETLAND




WorleyParsons
resources & energy

OneWay to zero harm

| ISSUE | DATE | ISSUE DESCRIPTION | DRAWN |
|---|---|---|---|
| A | 29.10.14 | FOR INFORMATION | BW |

**PITT TOWN DEVELOPMENT**
**UPDATED STORMWATER MANAGEMENT PLAN**
**THORNTON EAST PRECINCT - PREFERRED OPTION - CONCEPT - PLAN**

**FIGURE 4-3**

PLOT DATE & TIME: 29/10/2014 11:02:39 AM USER NAME: william.watkins LOCATION: W:_INFRASTRUCTURE\PROJECTS\301015\03518 - PITT TOWN DEVELOPMENT SMP REVIEW\12.0 DRAWINGS\SKETCHES\FIGURE 4-1.DWG
SAVE DATE & TIME: 29/10/2014 10:55:33 AM CTB FILE: Worley-Full.ctb Plotter:None

## 4.3 Cattai Precinct

*** Preferred Option - Option 1 – GPT + Wetland ***

The proposed treatment train for the Cattai Precinct is shown in **Figure 4-4**. It is proposed to be positioned on the southern side of the precinct, adjacent to and external to the southern boundary.

As noted for the Thornton Precinct to ensure that the wetland is not scoured out during high flows it is important that a bypass be incorporated into the design.

The outflow from the system would discharge into the existing creek that extends from the southern side of the Cattai Precinct to the Longneck Lagoon.

The ground surface elevation at the proposed location of the treatment train is at RL 15.48m approximately. The precinct boundary is approximately at the 100-year ARI level (RL 17.14m) and although the proposed location is lower than this level it is not anticipated to be frequently inundated by flood water.

No direct treatment is proposed for the runoff from the western and north-western catchments within the Cattai Precinct, however greater treatment is provided by the proposed Cattai Precinct treatment train to counterbalance this lack of direct treatment.

## 4.4 Central Precinct

*** Preferred Option - Option 4 – GPT + Swale + Bioretention System ***

The proposed treatment train for the Central Precinct is shown in **Figure 4-5**. The treatment train associated with catchments 1 and 2 is proposed to be positioned on the eastern side of the precinct, adjacent to and external to the eastern boundary. As noted for the Thornton Precinct to ensure that the bioretention system is not scoured out during high flows, it is important that a bypass be incorporated into the design. As also noted for the Thornton Precinct, it is important to ensure that runoff spreads across the full width of the swale and bioretention system.

The outflow from the catchment 1 and 2 treatment train would discharge into the existing creek that extends south from the eastern side of the Central Precinct.

The ground surface elevation at the location proposed for the catchment 1 and 2 treatment train is approximately RL 19.52m. The treatment train is proposed to be positioned higher than the 100-year ARI level (RL 17.14m) and therefore it is anticipated that it will be rare for the system to be inundated by flood water.

The alignment of the easement and flow path through 54 Wells Street would need to be confirmed by detailed topographical survey in order to assure that this option can be pursued.

No direct treatment is proposed for the runoff from sub-catchments C3 and C5 within the Central Precinct, however greater treatment is provided by the proposed Central Precinct treatment trains to counterbalance this lack of direct treatment.

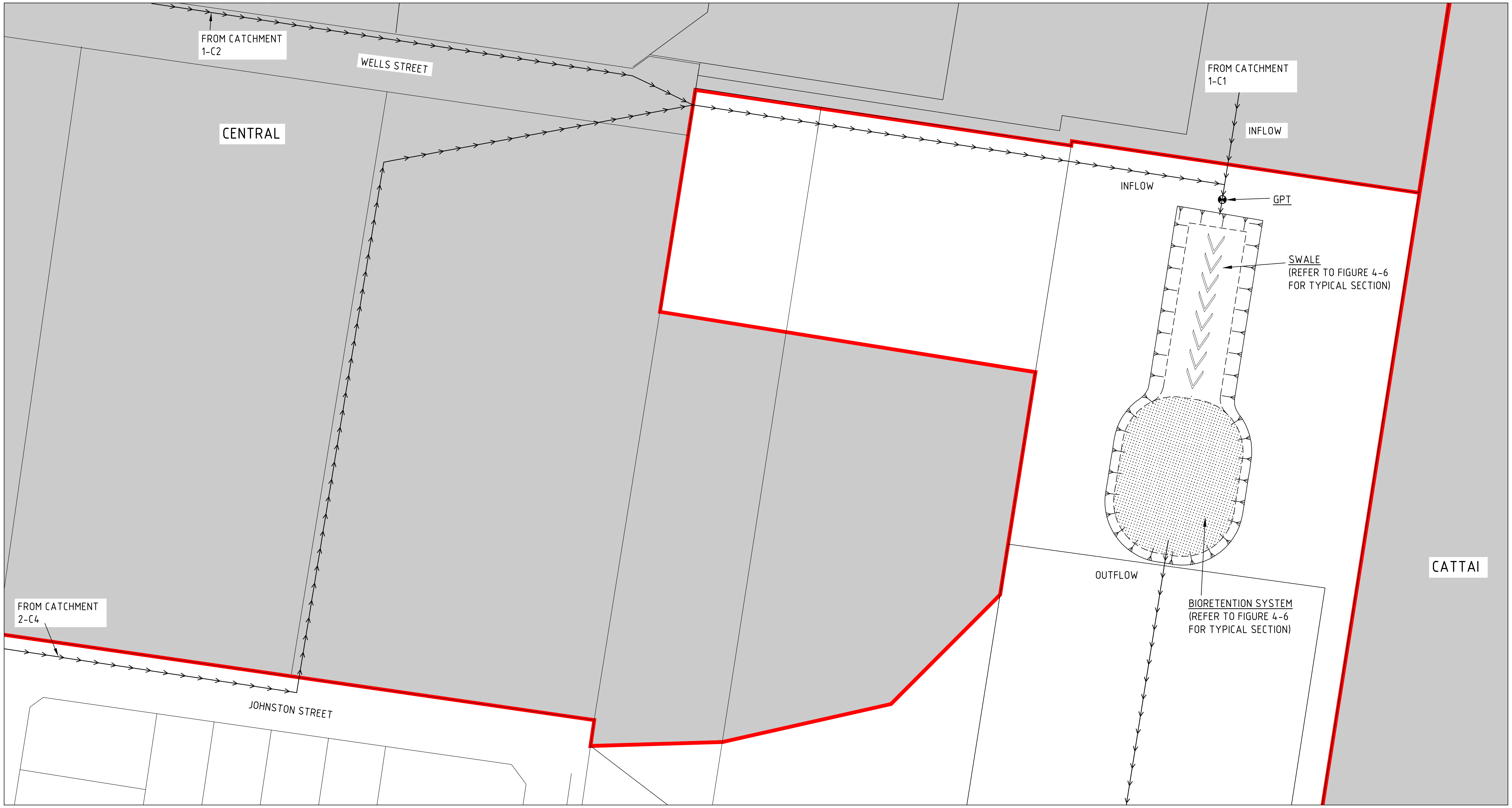

WorleyParsons
resources & energy

OneWay to zero harm

| ISSUE | DATE | ISSUE DESCRIPTION | DRAWN |
|---|---|---|---|
| A | 29.10.14 | FOR INFORMATION | BW |

**PITT TOWN DEVELOPMENT**
**UPDATED STORMWATER MANAGEMENT PLAN**
**CATTAI PRECINCT - PREFERRED OPTION - CONCEPT - PLAN**

**FIGURE 4-4**




BIORETENTION SYSTEM

LEGEND

- PRECINCT BOUNDARY
- STORMWATER FLOW
- PROPOSED GROSS POLLUTANT TRAP
- PROPOSED SWALE
- PROPOSED BIORETENTION SYSTEM
- PROPOSED WETLAND

15000 0 15000 30000 45000 60000 75000mm
1:750 (A1) 1:1500 (A3)

WorleyParsons resources & energy

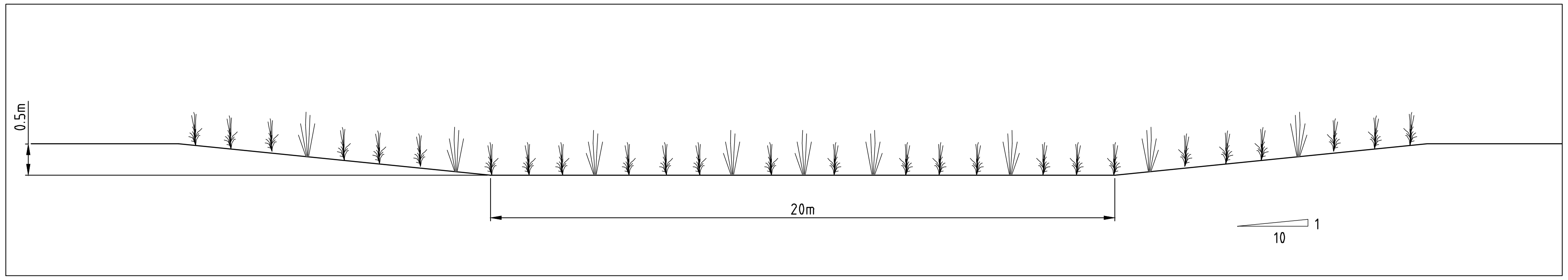
OneWay to zero harm

| ISSUE | DATE | ISSUE DESCRIPTION | DRAWN |
|---|---|---|---|
| B | 29.10.15 | UPDATED CENTRAL PRECINCT CATCHMENT 2 DRAINAGE | BW |
| A | 29.10.14 | FOR INFORMATION | BW |

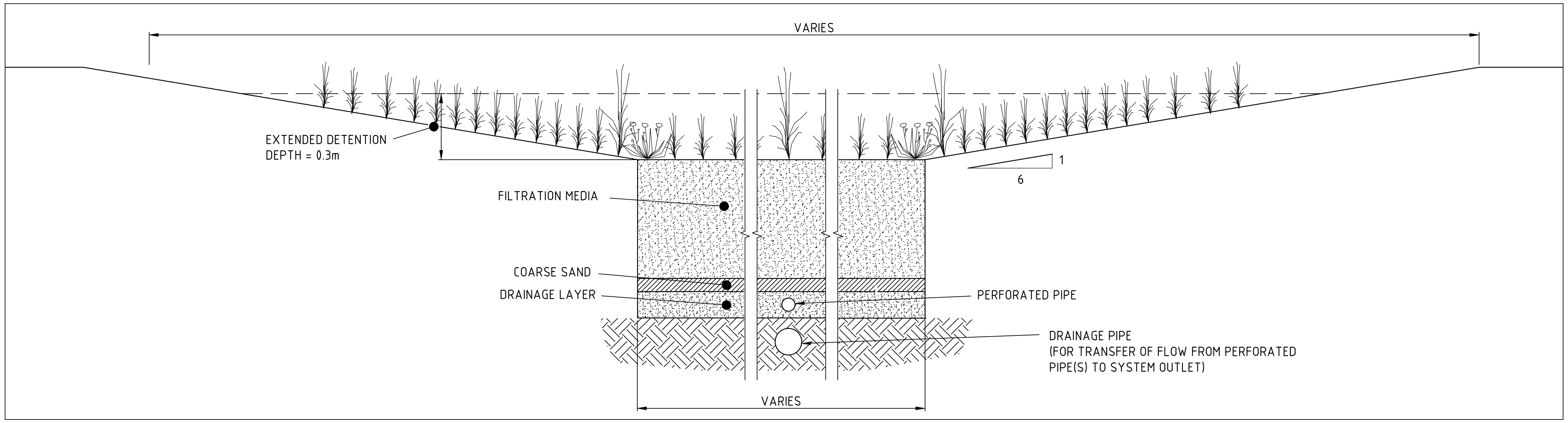
**PITT TOWN DEVELOPMENT**
**UPDATED STORMWATER MANAGEMENT PLAN**
**CENTRAL PRECINCT - PREFERRED OPTION - CONCEPT - PLAN**

**FIGURE 4-5**

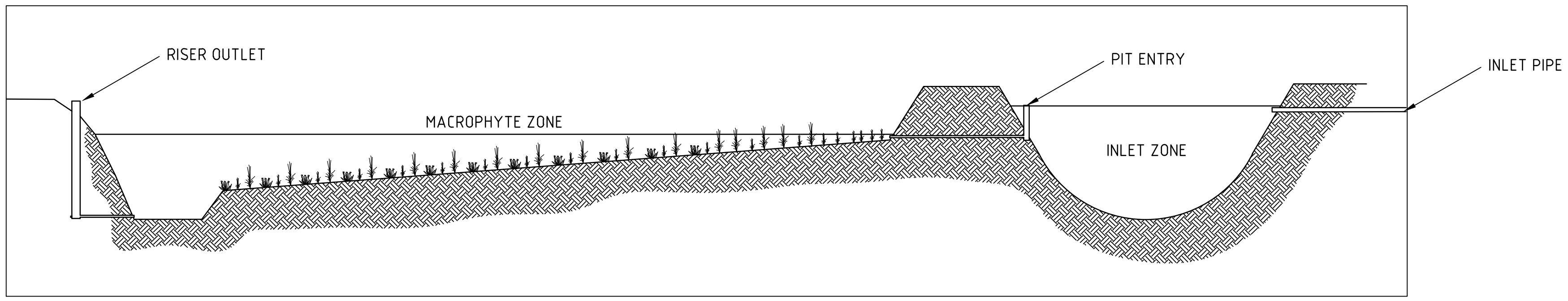
PLOT DATE & TIME: 29/10/2015 11:27:05 AM USER NAME: william.watkins LOCATION: W:_INFRASTRUCTURE\PROJECTS\301015\03518 - PITT TOWN DEVELOPMENT SMP REVIEW\12.0 DRAWINGS\SKETCHES\FIGURE 4-1.DWG
SAVE DATE & TIME: 27/10/2015 12:12:52 PM CTB FILE: Worley-Full.ctb Plotter:None




SWALE
TYPICAL SECTION




BIORETENTION SYSTEM
TYPICAL SECTION




WETLAND
TYPICAL SECTION

NOTE: NOT TO SCALE

WorleyParsons
resources & energy

OneWay
to zero harm

| ISSUE | DATE | ISSUE DESCRIPTION | DRAWN |
|---|---|---|---|
| A | 29.10.14 | FOR INFORMATION | BW |

**PITT TOWN DEVELOPMENT**
**UPDATED STORMWATER MANAGEMENT PLAN**
**PREFERRED OPTIONS : CONCEPT - TYPICAL SECTIONS & DETAILS**

**FIGURE 4-6**

# 5 COST ESTIMATES

Construction and maintenance cost estimates for the preferred options have been developed using life cycle costing data presented by Melbourne Water (2013a). This data is included in **Appendix 5**.

The data were compiled by Melbourne Water to assist councils with estimating the costs associated with stormwater treatment assets during the design, construction, establishment, maintenance and renewal phases. The purpose of the data is to inform council budgets and ensure allowances for stormwater treatment assets are based on whole of life cycle costs.

**Table 5-1** to **Table 5-4** list the estimated construction and maintenance costs for the treatment trains proposed for the Thornton, Thornton East, Cattai and Central Precincts respectively.

Specific clarifications and assumptions in relation to the costs are:

- The construction costs presented by Melbourne Water include planning and design costs.
- On top of the Melbourne Water cost, an allowance of $5,000 has been assumed for survey.
- On top of the Melbourne Water cost, an allowance of 10% of the estimated construction cost has been included for project management.
- On top of the Melbourne Water costs, an allowance of $1,500 has been assumed for the undertaking of water quality monitoring. It is assumed that stormwater will be collected from the inlet and outlet of each treatment train six times per year. The stormwater will be tested for SS, TP and TN. Advice from Eurofins, a testing laboratory, was obtained in relation to the cost of sample testing. For these three analytes it is estimated that it will cost approximately $100 per sample.
- The cost of equipment hire is not included in the estimates.
- Due to the lack of experience with renewing WSUD systems in Australia there is very limited renewal cost and frequency information available. Therefore renewal costs have not been presented.
- It is reported that wetlands are typically renewed every 20 years and bioretention systems and swales are typically renewed every 25 years (eWater, 2012). For constructed wetlands, the bulk of the renewal/adaptation costs are associated with recontouring and replanting the macrophyte zone. For bioretention systems, the bulk of the renewal/adaption costs are associated with replacing the filtration media and the vegetation.
- Based on Melbourne Water's publication *Maintenance Guidelines – A Guide for Asset Managers* (2013b) maintenance includes inspections and routine and periodic maintenance.
- Earthworks are not included in the estimates.
- The relocation of existing services is not included in the estimates.

- The purchase of easements and/or land is not included in the estimates.

**Table 5-1 Thornton Precinct: Cost Estimates**

| System | Cost ($) | | |
|---|---|---|---|
| | Construction | Maintenance | |
| | | Establishment (first two years of system's life) | Ongoing (third year of system's life onwards) |
| GPT | 150,000 | N/A | 13,200 |
| Swale | 24,000 | 18,000 | 3,600 |
| Sedimentation Basin | 20,000 | 8,000 | 1,600 |
| Bioretention System | 567,000 | 56,700 | 11,340 |
| *Sub-total* | *761,000* | *82,700* | *29,740* |
| *Survey* | *5000* | *N/A* | *N/A* |
| *Project Management* | *76,100* | *N/A* | *N/A* |
| *Water Quality Monitoring* | *N/A* | *1,500* | *1,500* |
| *Total* | *842,100* | *84,200* | *31,240* |

**Table 5-2 Thornton East Precinct: Cost Estimates**

| System | Cost | | |
|---|---|---|---|
| | Construction | Maintenance | |
| | | Establishment (first two years) | Ongoing (third year onwards) |
| GPT | 50,000 | N/A | 13,200 |
| Bioretention System | 87,800 | 8,800 | 1,760 |
| *Sub-total* | *137,800* | *8,800* | *14,960* |
| *Survey* | *5,000* | *N/A* | *N/A* |
| *Project Management* | *13,780* | *N/A* | *N/A* |
| *Water Quality Monitoring* | *N/A* | *1,500* | *1,500* |
| *Total* | *156,580* | *10,300* | *16,460* |

**Table 5-3 Cattai Precinct: Cost Estimates**

| System | Cost | | |
|---|---|---|---|
| | Construction | Maintenance | |
| | | Establishment (first two years) | Ongoing (third year onwards) |
| GPT | 150,000 | N/A | 13,200 |
| Wetland | 855,000 | 28,500 | 5,700 |
| *Sub-total* | *1,005,000* | *28,500* | *18,900* |
| *Survey* | *5,000* | *N/A* | *N/A* |
| *Project Management* | *100,500* | *N/A* | *N/A* |
| *Water Quality Monitoring* | *N/A* | *1,500* | *1,500* |
| *Total* | *1,110,500* | *30,000* | *20,400* |

**Table 5-4 Central Precinct: Cost Estimates**

| System | Cost | | |
|---|---|---|---|
| | Construction | Maintenance | |
| | | Establishment (first two years) | Ongoing (third year onwards) |
| GPT | 150,000 | N/A | 13,200 |
| Swale | 39,000 | 29,250 | 5,850 |
| Bioretention System | 532,500 | 53,250 | 10,650 |
| *Subtotal* | *721,500* | *82,500* | *29,700* |
| *Survey* | *5,000* | *N/A* | *N/A* |
| *Project Management* | *72,150* | *N/A* | *N/A* |
| *Water Quality Monitoring* | *N/A* | *3,000* | *3,000* |
| *Total* | *798,650* | *85,500* | *32,700* |

# 6 CONCLUSION

The 2005 PTDWP by Connell Wagner outlines measures for the management of water, wastewater and stormwater for the rezoning (known as Amendment 145) of land at Pitt Town for residential and rural residential purposes. The water management infrastructure was developed with a view to it servicing a yield of 690 lots. A series of wetlands and associated drainage works were proposed to capture and treat stormwater from the development area. In 2008 land known as the PTRP, which incorporated land subject to Amendment 145, was further rezoned for residential and rural residential purposes. The resulting lot yield increased to 943. The PTRP has been divided into a number of development precincts.

Hawkesbury City Council engaged WorleyParsons in 2014 to undertake a review of the Stormwater Management Plan contained within the PTDWP. The primary objectives of this review are:

1) Prepare a revised stormwater management plan for the following precincts:
   - Thornton;
   - Thornton East;
   - Central; and,
   - Cattai.
2) Determine indicative construction cost estimates for the preferred stormwater infrastructure to enable construction costs to be incorporated into the existing contributions plan.

Stormwater quality improvement devices of varying types and sizes, including GPTs, bioretention systems, swales, sedimentation basins and wetlands, have been modelled using the stormwater quality program MUSIC. For each precinct a minimum of two stormwater treatment train options have been investigated. The treatment trains that resulted in the achievement of the stormwater pollutant reduction targets outlined in Council's DCP (HCC, 2002) (i.e. 80% for TSS, 45% for TP and TN) were identified.

The stormwater management options were discussed at a workshop with Council and WorleyParsons personnel. Council later held internal discussions in relation to the options and advised WorleyParsons of the preferred ones. The preferred options are:

- Thornton Precinct

  Option 2 – GPT + Swale + Sedimentation Basin + Bioretention System

- Thornton East Precinct:

  Option 2 – GPT + Bioretention System

- Cattai Precinct:

  Option 1 – GPT + Wetland

- Central Precinct:

  Option 4 – GPT + Swale + Bioretention System

For each of these options concept plans have been developed that provide an indication of the location, arrangement and overall footprint of each of the proposed options.

Construction and maintenance costs for the preferred options were developed using life cycle costing data presented by Melbourne Water (2013a). These estimates are listed in **Table 6-1** for the various precincts.

**Table 6-1 Treatment Train Cost Estimates**

| Precinct | Cost ($) | | |
|---|---|---|---|
| | Construction | Maintenance | |
| | | Establishment (first two years of system's life) | Ongoing (third year of system's life onwards) |
| Thornton | 842,100 | 84,200 | 31,240 |
| Thornton East | 156,580 | 10,300 | 16,460 |
| Cattai | 1,110,500 | 30,000 | 20,400 |
| Central | 798,650 | 85,500 | 32,700 |

# 7 REFERENCES


- BMT WBM, 2010, *Draft NSW MUSIC Modelling Guidelines*, (for Sydney Metropolitan Catchment Management Authority), August 2010, Reference R.B17048.001.01
- Brown Smart Consulting, 2014a, *Pitt Town (Cleary) Stages 3, 4 & Part 6 Catchment Plan*, Project No. L03017.203, Drawing No. 500 Rev 3 (and associated drawings)
- Brown Smart Consulting, 2014b, *Pitt Town (Cleary) Stages 3, 4 & Part 6 Wetland Overview Plan*, Project No. L03017.203, Drawing No. 550 Rev 3 (and associated drawings)
- Brown Smart Consulting, 2014c, *Pitt Town Masterplan*, Rev 7
- Connell Wagner, 2005, *Pitt Town Development Water Management Plan (PTDWP)*, prepared for Hawkesbury City Council, Reference 1230/3.5, Revision 2
- Department of Land and Water Conservation (DLWC), 1998, *The Constructed Wetlands Manual*, Volume 2
- eWater, 2012, *MUSIC User Manual*, Version 5.1
- Golder Associates, 2005, *Report on Geotechnical Investigation: Proposed Residential Development Pitt Tow*n, NSW, 05623002/12
- Hawkesbury City Council (HCC), 1989, *Hawkesbury Local Environment Plan (LEP) 1989*
- Hawkesbury City Council (HCC), 2002, *Hawkesbury Development Control Plan (DCP) - Part E: Specific Areas - Chapter 4: Pitt Town*
- Melbourne Water, 2013a, *Water Sensitive Urban Design Life Cycle Costing Data* [Online]. Available: http://www.melbournewater.com.au/Planning-and-building/Forms-guidelines-and-standard-drawings/Documents/Life%20Cycle%20Costing%20-%20WSUD.pdf [Accessed: 16th July 2014]
- Melbourne Water, 2013b, *WSUD Maintenance Guidelines – A Guide for Asset Managers*, Melbourne Water Corporation
- NSW Government – Land and Property Information, 2014, *SIX Maps* [Online]. Available: https://maps.six.nsw.gov.au/ [Accessed: June 2014]
- Stefani Group, 2014, *Stormwater Management Plan for Lot 1 DP551960 and Lot 76 DP1009124 Cattai Road*, Pitt Town, Issue April 2014

# Appendix 1 Extract from MUSIC Modelling Guidelines – Bioretention Systems

- The weir overflow from a constructed wetland is located at the inlet. The high flow bypass value can be estimated by adopting 50% of the peak 1 yr ARI flow.
- If the high flow bypass is located at the outlet the measure should be modelled as a pond and k and C* parameters in the pond node adjusted to be equivalent to the corresponding wetland parameters.
- Calculate the surface area of input for this treatment node when the water level is approximately ½ of the extended detention depth. This assumes trapezoidal banks for the wetland. If the wetland is surrounded by vertical or near vertical walls, the surface area is likely to be almost equivalent to the surface area when the permanent storage is full.
- In situations where a GPT is not provided for pre-treatment, a constructed wetland should be modelled with an inlet pond with a volume not less than 10% of the permanent pool volume.
- A fixed default 50% coverage of vegetation applies to the constructed wetland node. If less vegetation is proposed, the constructed wetland node k and C* values should be modified to the pond node values to represent a lower level of treatment.
- Extended detention should typically not exceed 0.50m unless it can be demonstrated that a higher depth is achievable without flooding impacts.
- The permanent pool in the constructed volume should not exceed the surface area (at permanent pool level) multiplied by 1m unless more detailed information is provided of the wetland configuration.
- The seepage loss should be 0mm/hr unless it can be demonstrated that infiltrated runoff would not contribute to observed flows downstream either through surface runoff, seepage into drainage lines, interflow or groundwater.
- The evaporative loss should be the default value of 125% of PET.
- The notional detention time should typically be between 48 to 72 hours to ensure optimal treatment of nutrient species. The value can be set by adjusting the equivalent pipe diameter, as this is simply a way of controlling the nominal outlet size.

### *3.8.3.2 Bioretention Systems*

Bioretention systems include bioretention swales, raingardens and bioretention basins. Raingardens are typically small basins distributed within lots, the road reserve or open space areas to capture and treat flow at a specific location. Bioretention basins are typically large basins provided in large open space areas to manage stormwater quality at the sub-catchment scale. Bioretention swales are typically provided within medians or footpaths within the road reserve and these may also provide a minor flow conveyance function.

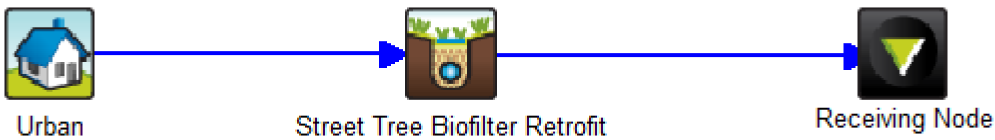


**Figure 3-43 Example of Bioretention Node Application in MUSIC**

These measures can be represented as one node in MUSIC as shown in the following diagrams.

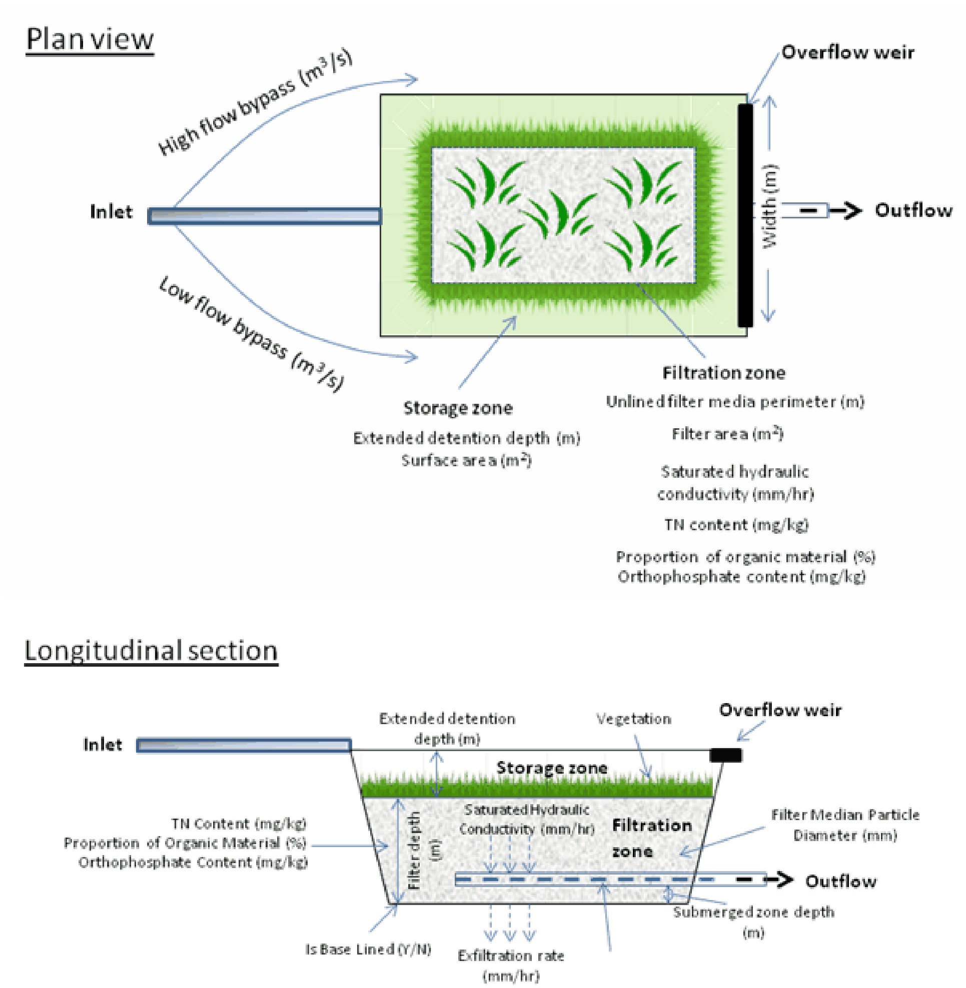



**Figure 3-44 Conceptual View of Bioretention System (as used in MUSIC v4)**

MUSIC Version 4 includes significant revisions to the bioretention node to reflect the recent studies undertaken by the Facility for Advancing Water Biofiltration (FAWB). This has also resulted in significant changes to the parameters needed to model these systems in MUSIC. The key parameters which have changed are related to the filter media properties and any exfiltration. These parameters are summarised below.

***Filter area (m2)***: The filter area is scenario-dependant and is set as the area of the bioretention filter media.

***Unlined filter media perimeter (m)***: The parameters for an unlined filter media perimeter are scenario-dependent. If an exfiltration rate of 0 mm/hr is used, set the unlined perimeter to zero. If the unlined perimeter is unknown, a useful rule-of-thumb to use is four times the square root of the surface area.

***Saturated hydraulic conductivity (mm/hr)***: It is usually best to use a loamy sand as the filter media for bioretention systems, with an effective particle diameter of around 0.45 mm and a hydraulic conductivity of 200 mm/hr. For sensitivity testing, simulate the bioretention system in MUSIC using a hydraulic conductivity of 50 mm/hr. **The final bioretention size should be based on the larger area of the two simulations**.

***Filter depth (m2)***: The recommended bioretention filter depth is 0.4–1.0 m. The depth depends on the available depth based on the inlet and outlet levels and the species of plants being used. For particularly flat sites where streetscape bioretention pods are used the filter depth can be limited to 0.3m. Any filter media depth greater than 0.8m will require the planting of deep-rooted plants. If a filter media depth greater than 0.8 m is proposed expert advice from a landscape architect or ecologist is required at the conceptual design stage with adequate justification for plant selection lodged with development applications.

Do not model the depth of the drainage layer or intermediate layer as part of the filter media depth.

***TN content in the filter media (mg/kg)***: Where this is unknown, use the default value of <800 mg/kg. The TN content is the amount of nitrogen available within the filter media consistent with the Facility for Advancing Water Biofiltration's (FAWB) current Guidelines for Soil Filter Media in Bioretention Systems (— Version 2.01 March 2008 or later).

***Proportion of organic matter in the filter media (%)***: Where this is unknown, use a value of <5%. While some organic matter in filter media is desirable, excessive amounts can cause leaching of nutrients.

***Orthophosphate content of filter media (mg/kg)***: Where this is unknown, use a value of range <55 mg/kg. This is the amount of phosphorus available within the filter media defined by testing consistent with the Guidelines for Soil Filter Media in Bioretention Systems — Version 2.01 (Facility for Advancing Water Biofiltration, 2008).

**Other properties**

***Lining properties:*** Is the base of the bioretention system lined?: When demonstrating compliance with water quality objectives, it is necessary to tick "Yes" to indicate that the base is lined and then set the exfiltration rate (mm/hr) to zero.

***Vegetation properties:*** Plant types have a significant impact on reducing nutrient loads with root morphology and associated physiochemical processes being key factors (Reed et. al. 2008). Bioretention systems perform best with deep-rooting plants and these are to be modelled using the option 'Vegetated with Effective Nutrient Removal Plants'. Where the vegetation in the bioretention system is turf for example, then the 'Vegetated with Ineffective Nutrient Removal Plants' option must be used.

***Infiltration and outlet properties***

- ***Overflow weir width (m):*** The length of the overflow weir controls the discharge rate when the water level in the bioretention system exceeds the top of extended detention. An undersized overflow weir results in water backing up, effectively adding additional extended detention. To avoid this, it is recommended that, as a starting point, the overflow weir length (m) is set as the surface area (m2) divided by 10 m.
- ***Exfiltration rate (mm/hr):*** If a bioretention system is modelled with exfiltration, the pollutant loads in the water lost to exfiltration are included in the reduction of pollutant loads achieved across the treatment node (as shown by the mean annual loads and treatment train effectiveness statistics). Objectives for reducing stormwater pollutants relate to all runoff leaving the site, including that exfiltrating to groundwater. Where an exfiltration rate is set greater than 0 mm/hr, sum all losses at any node that has exfiltration (using the node water balance statistics option at each node) as per the guidance provided in the Infiltration Node section, and add them to the total pollutant loads reported leaving the site when demonstrating compliance with stormwater pollutant load reduction objectives.

  If exfiltration is used the rate must be justified through in-situ soil testing. The applicant must suitably demonstrate that in-situ soils will not be compacted during earthworks.

  When a system is designed and modelled to exfiltrate, lining is still required to the sides of the bioretention filter media to ensure that that stormwater is properly treated through the filter before it enters the receiving environment i.e. exfiltration should only occur either at the level of the drainage layer or through the base of the bioretention.

***Underdrain present?***: Usually the ‘Yes’ option  as Bioretention systems in are generally configured with collection pipes.  If not, then the infiltration node should be used to model the system.

***Submerged zone with carbon present (depth (m))?***: To improve the potential for denitrification in bioretention systems, and to provide a moisture storage for the plants, where practicable include a zone below the underdrain.

**Key points – Bioretention measures**

- The high flow bypass value can be estimated by adopting 50% of the 1yr ARI peak flow. Extended detention for measures within lots or road reserve should be between 0.15 and 0.30m. This range of depths is typically most feasible for measures positioned within the road reserve. Bioretention with a depth closer to 0.15m should only be modelled for local streets where it can be demonstrated that the measure has sufficient flow capacity to minimize the potential for nuisance flooding to occur. Depths closer to 0.30m are preferred wherever possible.
- The extended detention depth for areas outside lots and road reserves (e.g. open space areas) may be deeper than 0.30m, although this must be clearly demonstrated as being achievable and the vegetation selected suitable for inundation at greater depths for prolonged periods.
- For a raingarden or bioretention basin, the longitudinal gradient is likely to be close to 0% across the measure, whilst a bioretention swale may have a gradient typically up to 2% and consequently the storage depth along the swale will vary. This should be accounted for when estimating the extended detention depth. Bioretention swales should be limited to locations where a longitudinal gradient <4% is achievable.
- MUSIC currently assumes that the extended detention storage has vertical sides. Therefore, if the system modelled does not have vertical sides an estimate of surface area needs to be calculated. If the system modelled has a trapezoidal shaped extended detention storage, the surface area should be calculated as the detention depth when it is at 1/2 of the maximum extended detention depth.The filter area should not be greater than 70% of the surface area unless specific calculations are provided to indicate otherwise.
- It should be demonstrated that the base of the bioretention system will be located within soil and not recessed into rock. The base of the bioretention measure should also be located 0.5m minimum above the seasonal high groundwater table to ensure that the media is not frequently saturated by groundwater.
- For systems where the filtered flow is to be collected in a sub-soil drain near the base of the bioretention filter and directed to a constructed drainage system, the modeller should confirm that the sub-soil drain is not below the base of the stormwater pit that the subsoil drain would connect into. Determine an appropriate soil media considering the Facility for Advancing Water Biofiltration (FAWB) “Stormwater Biofiltration Systems Adoption Guideline”.

### 3.8.4 Lifecycle Cost Analysis

The proponent should submit the overall life cycle costs for all elements in the treatment train and split these into Total Acquisition, Typical Annual Maintenance and Renewal/Adaptation Costs. In the majority of cases, a decommissioning cost should not be included and this should be set to the same value as the Typical Annual Maintenance cost.

Life cycle costing information in MUSIC is able to be extracted when setting up the life cycle costing properties at each node. To extract this information, the MUSIC model must have been run and

# Appendix 2 Extract from MUSIC Modelling Guidelines – Swales

### *3.8.2.3 Vegetated Swales*

Vegetated swales are typically trapezoidal shaped open channels provided to convey stormwater runoff and filter this runoff through vegetation to assist in the removal of coarse sediment and TSS. The performance of these measures in MUSIC is largely dependent on the vegetation density and height, and the gradient/length of the swale.

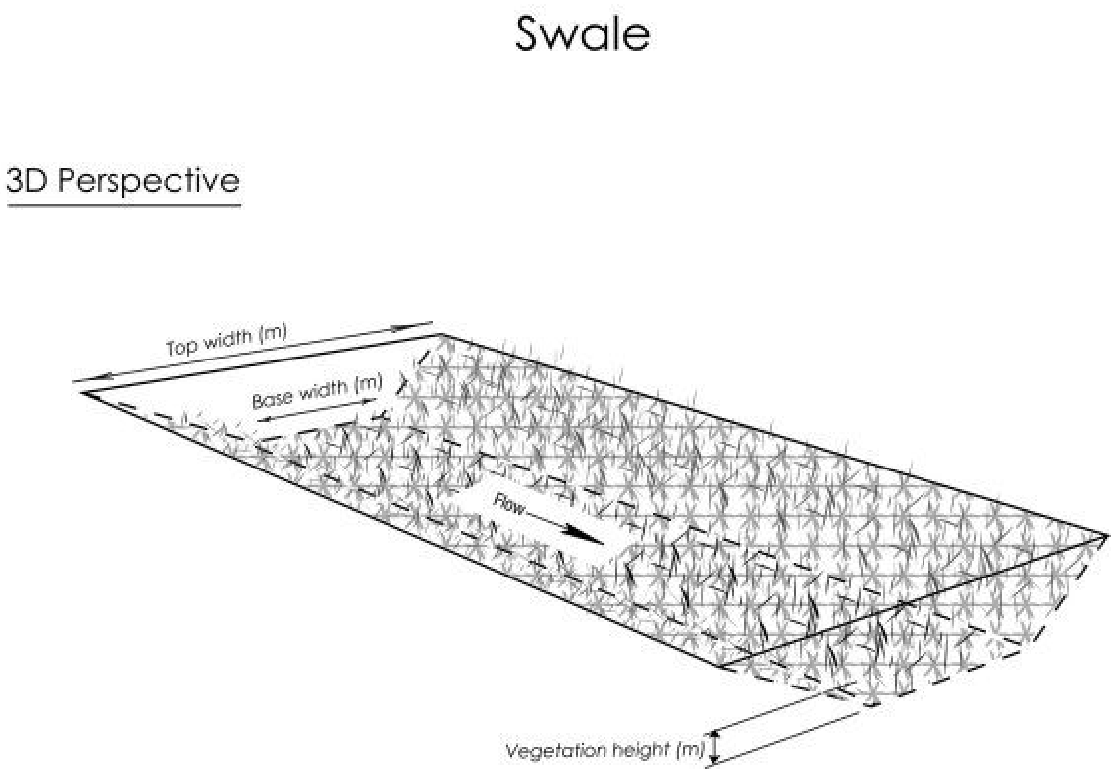



**Figure 3-31 Conceptual Diagram of Swale (as used in MUSIC v4)**

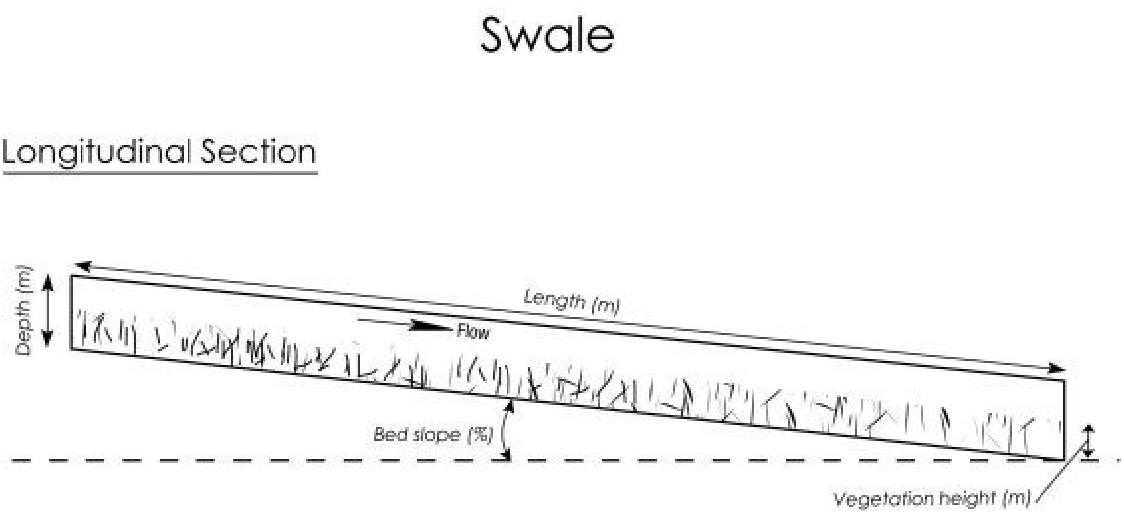



**Figure 3-32 Conceptual Cross Section of Swale (as used in MUSIC v4)**

The swale length should be selected to reflect the physical configuration of the development. It is important to consider whether the swales should be modelled in series or parallel. Where the constructed swale will be relatively long and linear with individual allotment drainage entering the swale, it can be modelled as several sections representing the individual lot flows into the swale. The configuration of this approach is shown in **Figure 3-33**.

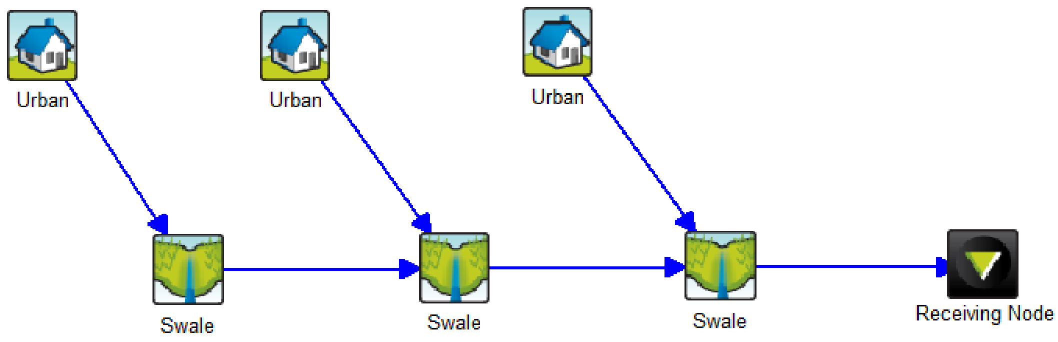



**Figure 3-33 Vegetated Swales in Series**

Where a swale has lot drainage (or similar) inlets positioned along its length, but each one of these swale lengths has an associated overflow pit, then the above approach is no longer appropriate. The source node catchment area for each swale should be estimated based on the proposed location of drainage inlets. This approach assumes that all flows will not bypass a drainage inlet and is useful to simulate where the length of a swale discharges into underground drainage. The configuration of this approach is shown in **Figure 3-34**.

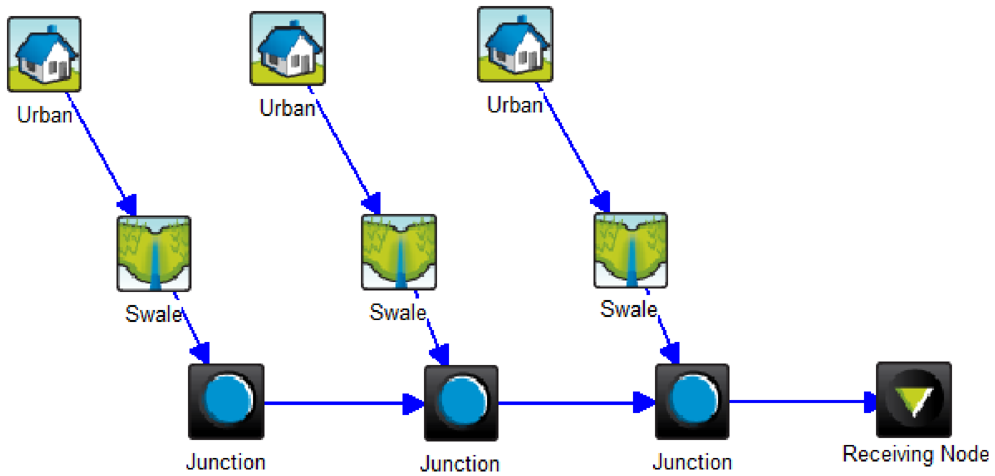



**Figure 3-34 Vegetated Swales in Parallel**

**Key points – Swales**

- Table drains with a primary drainage function should not be modelled as grassed swales.
- The local council's engineering standards should be confirmed to define appropriate swale characteristics.
- Ensure that swales are correctly positioned in the treatment train to ensure that modelled concentrations do not increase, as the background concentration (C*) for a swale is relatively high.
- Consider if the swales are best modelled as a series of segments or as parallel measures.
- In most circumstances the low flow bypass should be set to $0m^3/s$. This should only be modified where it is clear that runoff draining to the swale would bypass during low flow events, either by a below ground piped system or similar system.
- An average slope for swales with varying gradients should be estimated using the equal area method. The longitudinal bed slope should be within 1 to 4%. For gradients of 1-2%, swales with sub-soil drainage may be appropriate.
- If the swale is of a non-linear shape (e.g. curved profile), the modeller should select top and base widths that provide an appropriate simplified representation of the swale dimensions.
- Swale depths in the road reserves should typically be within the 0.15m to 0.30m range to achieve suitable side slopes. This range of depths is typically most feasible for measures positioned within the road reserve. Swales with a depth closer to 0.15m should only be modelled for local streets where it can be demonstrated that the swale has sufficient flow capacity to minimize the potential for nuisance flooding to occur. Swale depths closer to 0.30m are preferred wherever possible. Swale depths outside the road reserve (e.g. open space areas) may be deeper where appropriate, although this must be clearly demonstrated as being achievable within the proposal and appropriate safety factors considered.
- Vegetation height should be should consider appropriate available species.
- Seepage loss should be 0mm/hr unless a separate node representing direct rainfall on the measure is created in which case a seepage loss of 0.1mm/hr which is broadly representative of average PET conditions can be adopted. If a site is modelled to generate regular base flow a relatively small seepage rate (<1mm/hr) is all that is required to remove a high proportion of the base flow (and entrained pollutants) discharged into the swale.

### *3.8.2.4 Sand Filters*

Sand filters operate in a similar manner to bioretention systems, with the exception that stormwater passes through a filter media (typically sand) that has no vegetation growing on the surface. Sand filters do not incorporate vegetation because the filter media does not retain sufficient moisture to support plant growth and they are often installed underground, therefore light limits plant growth.

# Appendix 3 Extract from MUSIC Modelling Guidelines – Constructed Wetlands

**Key points – Ponds**

- It is preferred that the pond treatment node is not used in MUSIC. It is considered that the potential for water quality issues to occur in ponds which have limited vegetation coverage/biological treatment exceeds the benefit of providing these measures. If ponds are modelled in MUSIC the modelled performance should be confirmed utilising a more detailed pond/lake model (e.g. DYRESM-CAEDYM) and the modeller should demonstrate that appropriate pre-treatment measures would be provided to minimise organic and nutrient loading on the pond.
- A GPT and a vegetated treatment node should be incorporated into the model to ensure that water quality entering a pond will minimise potential problems. .
- If the weir overflow or high flow bypass for a pond is to be located near the inlet, the measure should be modelled as a constructed wetland and the C* and k parameters adjusted to the default MUSIC values for a pond. This is because the weir overflow from a pond is assumed to be located at the downstream end of the pond and therefore spills from the pond are assumed to be partially treated (which is not the case for this scenario).
- MUSIC currently assumes that the extended detention storage has vertical sides. Therefore, if the system modelled does not have vertical sides an estimate of surface area needs to be calculated. If the system modelled has a trapezoidal shaped extended detention storage, the surface area should be calculated as the detention depth when it is at 1/2 of the maximum extended detention depth.

### 3.8.3 Tertiary Treatment Measures

#### *3.8.3.1 Constructed Wetlands*

Constructed wetlands are artificial systems that mimic functions of natural wetlands in reducing fine particulates and associated contaminates (including metals, nutrients and toxicants), and soluble contaminants. They are simulated in MUSIC as surface wetlands with permanent or ephemeral water bodies in the upstream inlet (sediment) pond and main wetland (macrophyte) zone. The diagram below shows how they are conceptually represented within MUSIC.

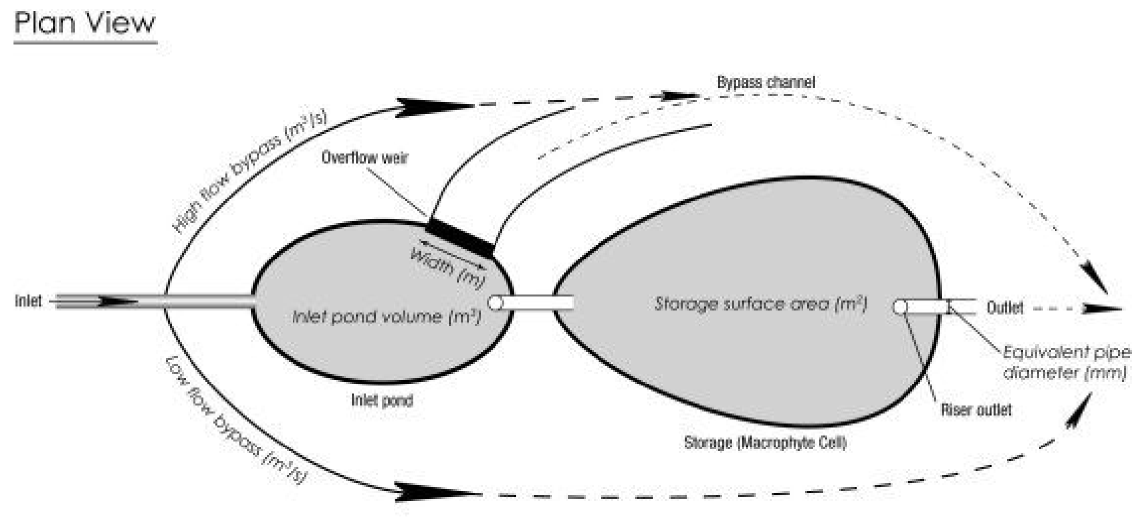



**Figure 3-40 Conceptual Plan View of Wetland (as used in MUSIC v4)**

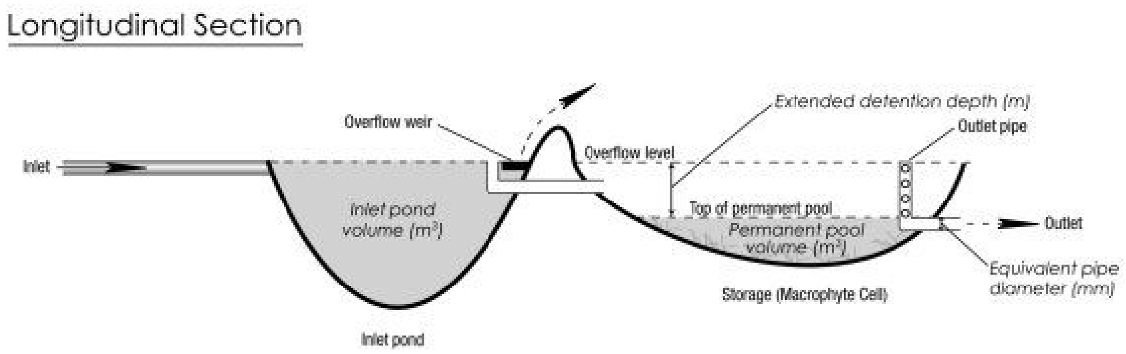



**Figure 3-41 Conceptual Cross Section of Wetland (as used in MUSIC v4)**

Constructed wetlands have a higher proportion of shallow water zones when compared to ponds, and aquatic vegetation is distributed more widely across the wetland (within ponds vegetation is primarily limited to the fringes of the pond). They also include low flow and high flow bypass channels. The low flow bypass channel offtake is located upstream of the wetland zone, while the high flow bypass offtake is located within the inlet pond and operates when the wetland (macrophyte) zone is full.

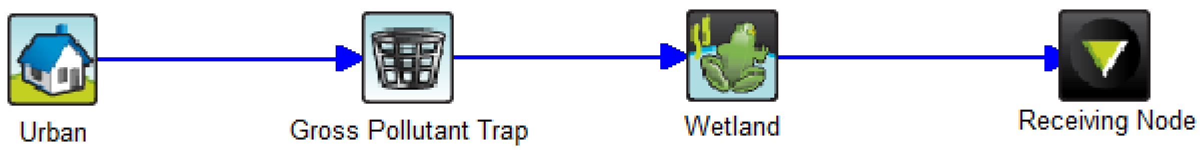


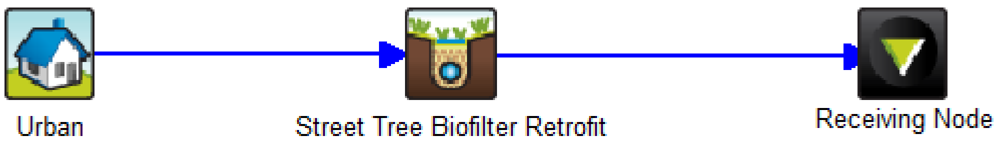

**Figure 3-42 Example of Constructed Wetland Node Application in MUSIC**

- **Key point – Constructed wetlands**

- The weir overflow from a constructed wetland is located at the inlet. The high flow bypass value can be estimated by adopting 50% of the peak 1 yr ARI flow.
- If the high flow bypass is located at the outlet the measure should be modelled as a pond and k and C* parameters in the pond node adjusted to be equivalent to the corresponding wetland parameters.
- Calculate the surface area of input for this treatment node when the water level is approximately ½ of the extended detention depth. This assumes trapezoidal banks for the wetland. If the wetland is surrounded by vertical or near vertical walls, the surface area is likely to be almost equivalent to the surface area when the permanent storage is full.
- In situations where a GPT is not provided for pre-treatment, a constructed wetland should be modelled with an inlet pond with a volume not less than 10% of the permanent pool volume.
- A fixed default 50% coverage of vegetation applies to the constructed wetland node. If less vegetation is proposed, the constructed wetland node k and C* values should be modified to the pond node values to represent a lower level of treatment.
- Extended detention should typically not exceed 0.50m unless it can be demonstrated that a higher depth is achievable without flooding impacts.
- The permanent pool in the constructed volume should not exceed the surface area (at permanent pool level) multiplied by 1m unless more detailed information is provided of the wetland configuration.
- The seepage loss should be 0mm/hr unless it can be demonstrated that infiltrated runoff would not contribute to observed flows downstream either through surface runoff, seepage into drainage lines, interflow or groundwater.
- The evaporative loss should be the default value of 125% of PET.
- The notional detention time should typically be between 48 to 72 hours to ensure optimal treatment of nutrient species. The value can be set by adjusting the equivalent pipe diameter, as this is simply a way of controlling the nominal outlet size.

### *3.8.3.2 Bioretention Systems*

Bioretention systems include bioretention swales, raingardens and bioretention basins. Raingardens are typically small basins distributed within lots, the road reserve or open space areas to capture and treat flow at a specific location. Bioretention basins are typically large basins provided in large open space areas to manage stormwater quality at the sub-catchment scale. Bioretention swales are typically provided within medians or footpaths within the road reserve and these may also provide a minor flow conveyance function.



# Appendix 4 Extract from MUSIC Modelling Guidelines – Sedimentation Basins

### 3.8.1.5 Sedimentation Basins

Sedimentation basins are primarily used to target the removal of coarse and medium sediment from stormwater. Sedimentation basins may also be designed to incorporate a gross pollutant trapping function. Sedimentation basins are measures that can be utilised during the construction and post development phases for a site. It is important to note the key differences between these two phases.

A sediment basin is represented conceptual in MUSIC as shown below

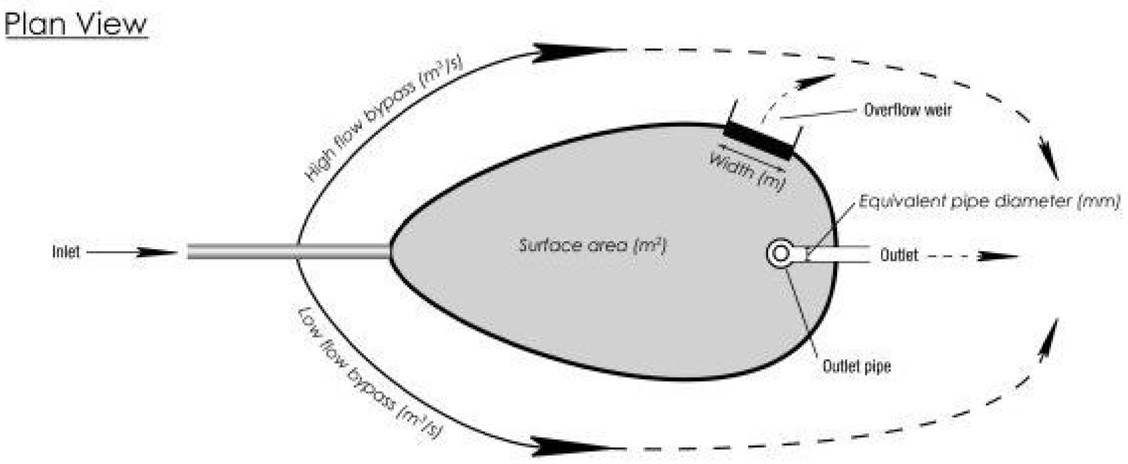



**Figure 3-25 Conceptual Plan View of Sediment Basin (as used in MUSIC v4)**

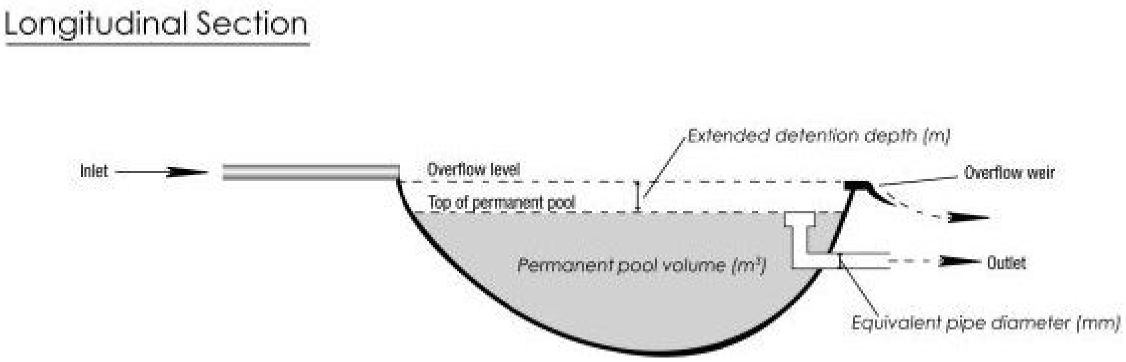



**Figure 3-26 Conceptual Cross Sectional View of Sediment Basin (as used in MUSIC v4)**

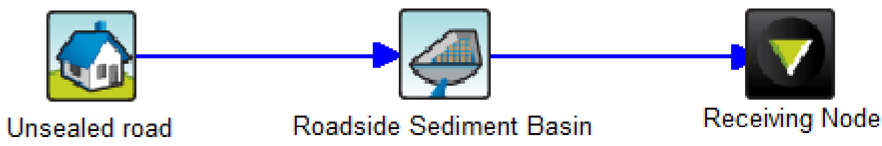



**Figure 3-27 Example of Sedimentation Basin Node Application in MUSIC**

During the **construction phase**, sedimentation basins are provided to capture and enable settling of coarse and/or fine sediment particles generated from erosion of exposed surfaces during construction. The basin sizing is typically **based on a specific design event** and should be undertaken applying the approaches outlined in the current version of Managing Urban Stormwater: Soils and Construction – Volumes 1 and 2 (the "Blue Book"). Construction phase sediment basins should not be simulated using MUSIC.

Construction phase sediment basins can be modified to function as other measures (e.g. pond, wetland) during the post development phase. During the **post development phase** this treatment node should only be used when simulating catchments where unvegetated/exposed soils form a significant part of post development conditions (e.g. unsealed roads). The basin sizing is typically **based on continuous simulation modelling of a range of events** and MUSIC can be used for appropriate sizing.

**Key points – Sediment basins**

- Construction phase sediment basins should be sized applying the methods in the "Blue Book".
- Post development phase sediment basins should be modelled to remove the coarser range of TSS particles.
- Sediment basins should only be applied within sites where unvegetated areas with exposed soils form a component of the post development site conditions (e.g. coal mine, pasture, unsealed road).
- Basins should be designed to having a length to width rations of at least 3:1 and be at least 0.6m deep to reduce the risk of scouring previously settled sediments.
- MUSIC currently assumes that the extended detention storage has vertical sides. Therefore, if the system modelled does not have vertical sides an estimate of surface area needs to be calculated. If the system modelled has a trapezoidal shaped extended detention storage, the surface area should be calculated as the detention depth when it is at 1/2 of the maximum extended detention depth.
- The storm flow TSS concentration for areas that are unvegetated in the post development state (e.g. coal mines, pastures, unsealed roads) should be set at 1000mg/L. In addition k and C* must be adjusted to 15,000 and 90mg/L respectively.
- A maximum notional detention time of 8 hours should be adopted for sizing a sediment basin (assuming an average settling zone depth of 1m) to target coarser particles. If a longer detention time is desirable, an alternative treatment measure incorporating vegetation should be modelled to ensure that any captured nutrients are capable of being removed biologically otherwise water quality issues such as excessive algal growth may occur within the basin.
- Provide an appropriate high flow bypass to minimise the potential for scouring of the basin (50% of 1yr ARI flow).

# Appendix 5 WSUD Life Cycle Costing Data (Melbourne Water, 2013)

# Water sensitive urban design
# Life cycle costing data

Melbourne Water has recently developed a life cycle costing data table to assist councils in estimating costs associated with stormwater treatment asset planning during the design, construction, establishment, maintenance and renewal phases. The data will inform council budgets and ensure allowances for stormwater treatment assets are based on whole of life cycle costs.

The life cycle cost information is grouped according to asset type, size, service level (maintenance frequency) and, where possible, contracted rates versus in-house works. Other factors including traffic management and access issues are also considered.

A summary of the life cycle costs for asset construction, maintenance (establishment and ongoing) and renewal is provided overleaf.

## BENEFITS OF WATER SENSITIVE URBAN DESIGN

Water Sensitive Urban Design aims to integrate the urban water cycle into urban design. The social and environmental benefits of stormwater treatment systems are widely recognised and include:

- improved urban waterways
- greener open spaces and enhanced urban landscapes
- reduced localised flooding
- improved amenity in our local communities
- alternative water supply option.

## HOW COUNCILS CAN USE THE DATA

The life cycle costing data can be used by councils to refine stormwater treatment asset management planning. In particular, the life cycle costs will enable councils to better plan for maintenance of stormwater treatment assets and refine budgets for life cycle costs of individual stormwater treatment assets. This includes informing and assisting councils to better forecast budgets for the management of stormwater treatment assets.

The incorporation of realistic maintenance costs into council budgets will help ensure that stormwater treatment assets are adequately maintained; and therefore help reduce the financial burden to councils associated with rectifying assets that are failing due to inadequate maintenance.

It is expected that the maintenance cost estimates provided will assist councils to get better value for money when negotiating maintenance contracts.

For more information on inspection and maintenance schedules and sample maintenance contract documentation please refer to the Melbourne Water WSUD Maintenance Guidelines on our website **melbournewater.com.au**

For access to the full Life Cycle Costing Report, please contact the Melbourne Water Stormwater Team at livingrivers@melbournewater.com.au

healthy waterways

State Government Victoria | Melbourne Water

| ASSET | ASSET PARAMETERS | CONSTRUCTION[1] | MAINTENANCE | | RENEWAL |
|---|---|---|---|---|---|
| | | | ESTABLISHMENT (FIRST TWO YEARS) | ONGOING | |
| WETLANDS[2] | < 500 $m^2$<br>500 to 10,000 $m^2$<br>> 10,000 $m^2$ | \$150/$m^2$<br>\$100/$m^2$<br>\$75/$m^2$ | | \$10/$m^2$/yr<br>\$2/$m^2$/yr<br>\$0.5/$m^2$/yr | No data |
| SEDIMENT BASINS[2] | < 250 $m^2$<br>250 to 1000 $m^2$<br>> 1000 $m^2$ | \$250/$m^2$<br>\$200/$m^2$<br>\$150/$m^2$ | | \$20/$m^2$/yr<br>\$10/$m^2$/yr<br>\$5/$m^2$/yr | Remove and dispose of:<br>Dry waste = \$250/$m^3$<br>Liquid waste = \$1,300/$m^3$ |
| ON-STREET RAINGARDENS[3] | < 50 $m^2$<br>50 to 250 $m^2$<br>> 250 $m^2$ | \$2000/$m^2$<br>\$1000/$m^2$<br>\$500/$m^2$ | | \$30/$m^2$/yr<br>\$15/$m^2$/yr<br>\$10/$m^2$/yr | Minor reset =<br>\$50 to \$100/$m^2$ |
| BIORETENTION BASINS[3] | < 100 $m^2$<br>100 to 500 $m^2$<br>> 500 $m^2$ | \$1000/$m^2$<br>\$350/$m^2$<br>\$250/$m^2$ | | \$5/$m^2$/yr | No data |
| TREE PITS[3] | < 10 $m^2$ total<br>10 to 50 $m^2$ total<br>> 50 $m^2$ total | \$8000/$m^2$<br>\$5000/$m^2$<br>\$1000/$m^2$ | Two to five times ongoing maintenance cost | No access issues = \$150/asset/yr<br>Traffic issues or specialist equipment required = \$500/asset/yr | No data |
| GRASS SWALES AND BUFFER STRIPS[4] | Seeded – no subsoil drain<br>Seeded – subsoil drain<br>Turfed – no subsoil drain<br>Turfed – subsoil drain<br>Native grasses established | \$15/$m^2$<br>\$25/$m^2$<br>\$20/$m^2$<br>\$35/$m^2$<br>\$60/$m^2$ | | \$3/$m^2$/yr | No data |
| VEGETATED SWALES AND BIORETENTION SWALES[4] | | 150/$m^2$ | | \$5/$m^2$/yr | No data |
| IN-GROUND GPTS | < 300 L/s<br>300 to 2000 L/s<br>> 2000 L/s | \$50,000/asset<br>\$150,000/asset<br>\$250,000/asset | N/A | Inspection = \$100/visit<br>Cleanout = \$1000/visit | No data |

1 Includes planning and design
2 Area at normal water level
3 Area of filter media at bottom of extended detention
4 Total vegetated area

**Disclaimer:** The cost estimates provided should be considered as a starting point only and represent the best cost estimates available based on current information (Oct 2013). The cost estimates will be reviewed and refined over time as better data becomes available. It should be noted that data are generally based on 'standard residential' developments and the cost of equipment hire is not included in the estimates.