Site Based Stormwater Management Plan for DETE Kindergarten at Blackwater North State School

Revision A
July 2013

Prepared by
Bradlees
34 Thomas Drive
CHEVRON ISLAND, QLD 4215
Ph: (07) 5528 6411
Fax: (07) 5528 6422

Bradlees
Part of the Meinhardt Group

EXECUTIVE SUMMARY

Bradlees has been commissioned to prepare a Site Based Stormwater Management Plan for the proposed kindergarten at Blackwater North State School. This document presents hydrologic and hydraulic analysis of stormwater runoff including detailed stormwater treatment design and analysis for the proposed development to satisfy the requirements of relevant regulatory departments.

- **Stormwater Quantity** – no worsening of stormwater peak discharges will occur after construction is complete due to the implementation of on-site detention. Twin 12kL rainwater tanks located near the rear wall of the proposed kindergarten will attenuate the increased post-development flows sufficient for the entire site to be mitigated by retaining water until the storm event has passed.

- **Stormwater Quality** – pollutant reduction targets required to achieve the necessary Environmental Values and Water Quality Objectives would be met with a treatment train consisting of a bioretention swale running between the proposed carpark and the entry to the proposed informal parking area grading into a soakage pit.

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CONTENTS

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1. INTRODUCTION

Bradlees has been commissioned to prepare a Site Based Stormwater Management Plan Blackwater Kindergarten, Blackwater.

This document presents detailed stormwater treatment design and analysis for the proposed development and hydrologic and hydraulic analysis of stormwater runoff. The proposed stormwater quality and mitigation measures have been reviewed and analysed in accordance with (but not limited to) Design Objectives as set forth by Central Highland Regional Council, regulatory departments and Queensland Government.

2. PURPOSE/ SCOPE OF REPORT

2.1 Purpose

The purpose of this report is to present a detailed plan outlining stormwater quantity and quality controls for the construction and operational phases of the proposed residential development, including strategies to prevent or minimise environmental harm to receiving environments, and flood immunity to existing and proposed allotments and roads

The following aspects have been addressed in this report:

- Stormwater Quantity (detention method)
- Stormwater Quality (proposed treatment devices)
- Maintenance of stormwater quality treatment devices

2.2 Constraints

Key statutory requirements that provide constraints for the proposed development include:

- The proposed development is not to produce adverse hydraulic impacts on adjacent properties during the construction, maintenance and operational phases of the development
- Stormwater discharging from the site is to be at acceptable discharge standards for containment and control of pollutants on-site
- All reasonable and practical measures must be taken to minimise or prevent environmental harm

PHYSICAL CONSTRAINTS

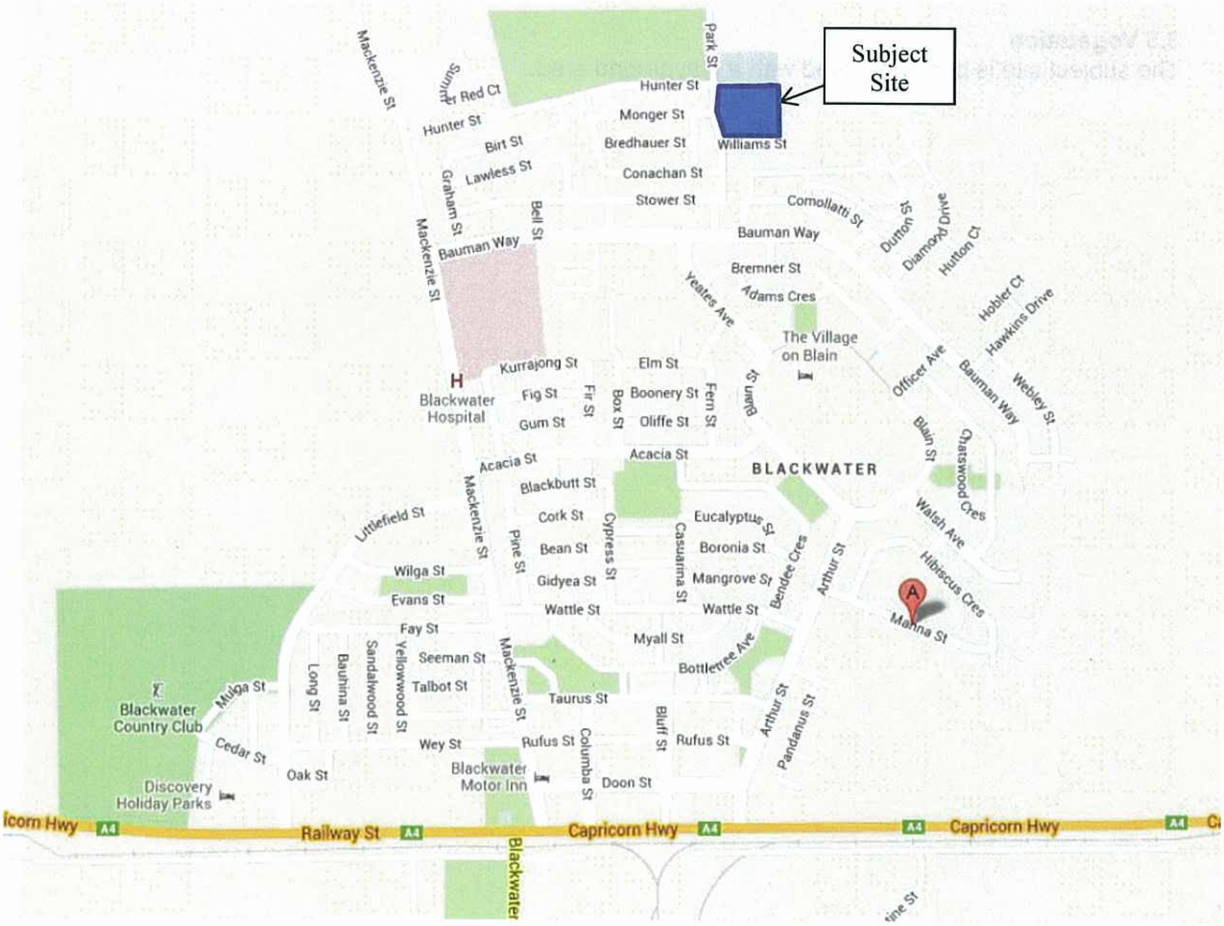
The subject site is an existing state school with a proposed new kindergarten building and carpark to be constructed with pathways all located at the downstream portion of the site. The location of stormwater detention/treatment devices will be limited to the remaining downstream undeveloped area.

3. SITE CHARACTERISTICS

3.1 Location & Density

The proposed development comprises the construction of a new kindergarten building within the grounds of Blackwater North State School.

FIGURE 1
SITE LOCATION



3.2 Topography and Site Drainage

The subject site grades towards the existing Williams Street with grades ranging from approximately 1% to 2% and elevations ranging from RL167.0 to RL166.0, over a total affected site area of 0.22Ha. The development proposes to construct a new building requiring a small amount of earthworks.

The stormwater discharge point is existing Williams Street. Refer Appendix A for general layout.

3.3 Data
The hydrologic and water quality assessments detailed in this report have been based on detailed survey provided by the Principal's surveyor, rainfall data for Dingo Post Office (Station 35025) and monthly evapotranspiration data supplied by the Bureau of Meteorology.

3.4 Acid Sulfate Soils
The presence of Acid Sulfate Soils is typically in Holocene sediments below RL5m AHD. The subject site is above RL166m and therefore acid sulfate soils have not been considered.

3.5 Vegetation
The subject site is poorly grassed with a playground area..

4. HYDROLOGIC ASSESSMENT

4.1 Methodology

The following sections analyse pre and post-development scenarios for determination of peak discharge flows. The analysis has been undertaken using XPRafts software. XPRafts is a link-node model capable of performing hydrology and runoff routing analysis and has been used in accordance with Central Highlands Regional Council Guidelines, Queensland Urban Drainage Manual and Australian Rainfall and Runoff.

The legal point of discharge from the subject site's proposed stormwater drainage system will be the existing Williams Street which terminates at the south-eastern boundary of the. Refer Appendix A for general layouts.

The model has been set up to include the subject site catchments flowing towards Williams Street. The model layout and sub-catchment boundaries for existing and post-development conditions are shown in Appendix B.

The model was used to assess the impacts of the proposed development on the peak flows discharging from the site for ARIs of 2, 5, 10, 20, 50 and 100 years.

The following scenarios were modeled with XPRafts:

- **Existing Case:** The proposed site is in its existing state with no detention of flows. There is one catchment adopted in this scenario – Catchment A (refer to Appendix B). Catchment A includes the upstream open space and existing playground.
- **Developed Case:** The proposed site has been developed as shown in Appendix A. Catchment A will have its percent impervious values increased for the developed case.
- **Mitigated Case:** This scenario is based on the developed case with a rainwater tank(s) sized to attenuate the increase in flows resulting from the development's increased impervious areas. The tank will be located adjacent to the rear wall of the proposed new building.

The proposed site developed catchments were determined from architectural plans of the proposed new building roof and hardstand layout (refer to Appendix A and B).

4.2 Model Assumptions

The portion of open space catchment upstream of the new kindergarten building and carpark will be picked up in the bio-retention swale. The roof and hardstand areas will discharge into a soakage pit which will also pick up the bio-swale flows and discharge from the eastern 'informal parking area'. Initial loss used was 5mm for pervious and impervious areas and pervious continuing loss was 2.5mm/hr.

Table 4.1 details the area and fraction impervious for the catchment. The areas were determined from an existing surface digital terrain model based on ground survey supplied by the Principal's surveyor. Fraction impervious values were determined by measurement of developed areas compared with overall areas:

TABLE 4.1
XPRAFTS CATCHMENT AREA AND FRACTION IMPERVIOUS

Sub-Catchment	Fraction Impervious (%)		Catchment Area (ha)	
	Existing Case	Developed and Mitigated Cases	Existing Case	Developed and Mitigated Cases
A	9.0	37.0	0.170	0.170

Due to the relatively small catchment sizes a Rational Method comparison was made to confirm the model results. Table 4.2 presents the parameters applied to the Rational Method:

TABLE 4.2
RATIONAL METHOD CATCHMENT AREA AND RUNOFF COEFFICIENT

ARI	Runoff Coefficient		Total Flow (m^3/s)	
	Existing Case	Developed Case	Existing Case	Developed Case
2	0.55	0.61	0.025	0.030
5	0.62	0.68	0.036	0.043
10	0.65	0.72	0.043	0.052
20	0.68	0.76	0.053	0.064
50	0.75	0.83	0.069	0.084
100	0.78	0.86	0.081	0.099

Refer to Appendix C for example Rational Method calculations.

Storm Durations of 10, 15, 20, 25, 30, 45, 60, 90, 120 and 180 minutes were run in XPRafts for the 2, 5, 10, 20, 50 and 100yr ARIs to determine the worst case peak discharge condition for each return period.

4.3 Rainwater Tank

As mentioned above roof flows from Catchment A will be attenuated in the rainwater tank(s). The tank(s) will be built with an overflow outlet to allow storage of rainwater for usage with sufficient volume above the overflow to hold the increased volume from the post-developed event until it has passed. The overflow outlet will ensure that the retention storage area is free before a subsequent storm requiring retention occurs.

Each storm was run in XPRafts to determine pre-development and post-development flows, as well as the volume of runoff from each storm. The percentage increase in discharge was determined and this value multiplied by the post-developed volume. This volume is the minimum required storage volume above the rainwater tank's overflow outlet.

4.4 Bio-retention swale

The ground flow portion of the post-developed discharge will be picked up in the bio-retention swale running adjacent to the proposed carpark and will retain the excess runoff until the storm passes.

4.5 Results

The results for Catchment A are presented in Table 4.3 below:

TABLE 4.3
PREDICTED PEAK FLOWS AT DISCHARGE POINT – CATCHMENT A

ARI	Existing Case			Developed Case			Reduction Ratio	Storage Volume m^3
	Flow m^3/s	Critical Time min	Time to Peak min	Flow m^3/s	Critical Duration min	Time to Peak min		
2	0.032	60	31	0.041	60	25	0.2	14
5	0.043	60	25	0.055	25	15	0.2	11
10	0.051	60	25	0.063	25	15	0.2	11
20	0.056	25	15	0.075	25	15	0.3	18
50	0.073	60	25	0.084	25	15	0.1	11
100	0.086	60	25	0.096	25	15	0.1	10

Table 4.3 includes the critical duration for the storm which gives the greatest predicted peak discharge for each ARI. The time to reach peak discharge within each of these events is also shown. The results show that twin 12kL tanks will have enough storage to ensure no increase in peak flows.

5. STORMWATER QUALITY

5.1 Water Quality Objectives

Definable targets for Environmental Values (EV's) and Water Quality Objectives (WQO's) for this project have been reviewed and analysed in the following sections. In the absence of specific water quality guidelines for Rockhampton Regional Council, the guidelines from Brisbane City Council, regulatory departments and Queensland Government have been adopted.

Primary focus is placed on pollutant generation and treatment control during the construction and operational phases of the proposed development.

CONSTRUCTION PHASE

Pollutants typically generated during the construction phase as listed in Table C4.1 of BCC's Water Sensitive Urban Design Guidelines are reproduced below:

TABLE 5.1
TYPICAL POLLUTANTS GENERATED DURING THE CONSTRUCTION PHASE

Pollutant	Sources	Priority
Litter	Paper, construction packaging, food packaging, cement bags, off-cuts	High
Sediment	Unprotected exposed soils and stockpiles during earthworks and building works	High
Hydrocarbons	Fuel and oil spills, leaks from construction equipment and temporary carpark areas	High
Toxic materials	Cement slurry, asphalt prime, solvents, cleaning agents, washwaters (e.g. from tile works)	Medium
Acid or Alkaline substances or producing substances	Acid sulfate soils, cement slurry and washwaters	High

The above pollutants shall be monitored and controlled during the construction phase by a combination of appropriate Erosion and Sediment Control (ESC) devices, visual inspections throughout the construction phase by the Superintendent, and contractor responsibility and liability under the construction contract. Correctly installed devices such as sediment fences, grass filter strips, diversion drains, check dams and inlet sediment barriers will reduce the amount of detached sediment discharging off site. Such devices will also assist in mitigating peak discharge volumes.

OPERATIONAL PHASE
The key pollutants as listed in Table C4.2 of BCC's Water Sensitive Urban Design Guidelines to be targeted for trapping during the operational phase for subdivisions category are:

- Litter
- Sediment
- Nutrients (N & P)
- Hydrocarbons (including oil & grease)
- Surfactants (e.g. detergents from car washing)

While there are definable targets for sediment and nutrients (discussed in detail below), there are currently no definable targets for heavy metals. However, as heavy metals are generally attached to sediment, effective control and reduction of sediment loads should consequently assist in the mitigation of heavy metal loads.

Definable Water Quality Objectives (WQO's) as listed in BCC Table C4.2 are also listed by the Department of Environment and Resource Management's "Queensland Water Quality Guidelines – Version 3" as follows:

TABLE 5.2
WATER QUALITY OBJECTIVES FOR REDUCTION OF KEY POLLUTANTS

Pollutant Type	Reduction Target
Total Suspended Solids (TSS)	85%
Total Phosphorous (TP)	70%
Total Nitrogen (TN)	45%
Gross Pollutants	90%

Therefore the load-based approach as per DERM should be adopted as the primary design objectives (as a minimum) for managing the quality of urban stormwater.

5.2 Pollutant Export Modeling - MUSIC

A pollutant treatment train has been incorporated into the development design to reduce target pollutants leaving the site. The key components are a soakage pit discharging into a bio-retention swale immediately downstream of the proposed kindergarten building and a bio-retention swale running between the proposed carpark and the 'informal parking area' which also discharges into the soakage pit. Further details on each device are listed in the following sections.

MUSIC Version 5.11 has been used to quantify and model the pollutant generation characteristics of the proposed development site. Data has been entered into the model in accordance with the "Music Modeling Guidelines version 1.0" 2010 by Water by Design (unless noted otherwise), herein referred to as *the Guidelines*.

Meteorological data was adopted using Dingo Post Office 1970-2000 6-minute time step recorded rainfall data from Station ID 35025.

General post-development catchments and model layout can be found in Appendix D.

DATA ENTRY

Each sub-catchment was modeled as an 'Urban' node and calibrated using tables 3.7 and 3.8 of the Guidelines. Parameters used for modeling are reproduced below:

TABLE 5.4
RUNOFF GENERATION PARAMETERS FOR URBAN RESIDENTIAL NODE

Parameters	Urban Residential
Field Capacity (mm)	200
Infiltration Capacity Coefficient a	211
Infiltration Capacity Coefficient b	5
Rainfall Threshold (mm)	1
Soil Capacity (mm)	500
Initial Storage (%)	10
Daily Recharge Rate (%)	28
Daily Drainage rate (%)	27
Initial Depth (mm)	50

*Source: Water by Design "Music Modelling Guidelines" (2010)

TABLE 5.5
BASE AND STORM FLOW CONCENTRATION PARAMETERS FOR CATCHMENTS

Land-use Type	Parameters	TSS Log_{10} mg/L		TP Log_{10} mg/L		TN Log_{10} mg/L	
		Base Flow	Storm Flow	Base Flow	Storm Flow	Base Flow	Storm Flow
Urban Residential	Mean	1.0	2.18	-0.97	-0.47	0.20	0.26
	STD Dev.	0.34	0.39	0.31	0.31	0.20	0.23
Roof	Mean	0.0	1.30	0.0	-0.89	0.0	0.26
	STD Dev.	0.0	0.39	0.0	0.31	0.0	0.23
Carpark	Mean	1.0	2.43	-0.97	-0.3	0.2	0.26
	STD Dev.	0.34	0.39	0.31	0.31	0.2	0.23

*Source: Water by Design "Music Modelling Guidelines" (2010)

Rooftop and carpark nodes were entered as 100% impervious. Urban Residential was entered as 30% impervious to account for any additional pathways, etc.

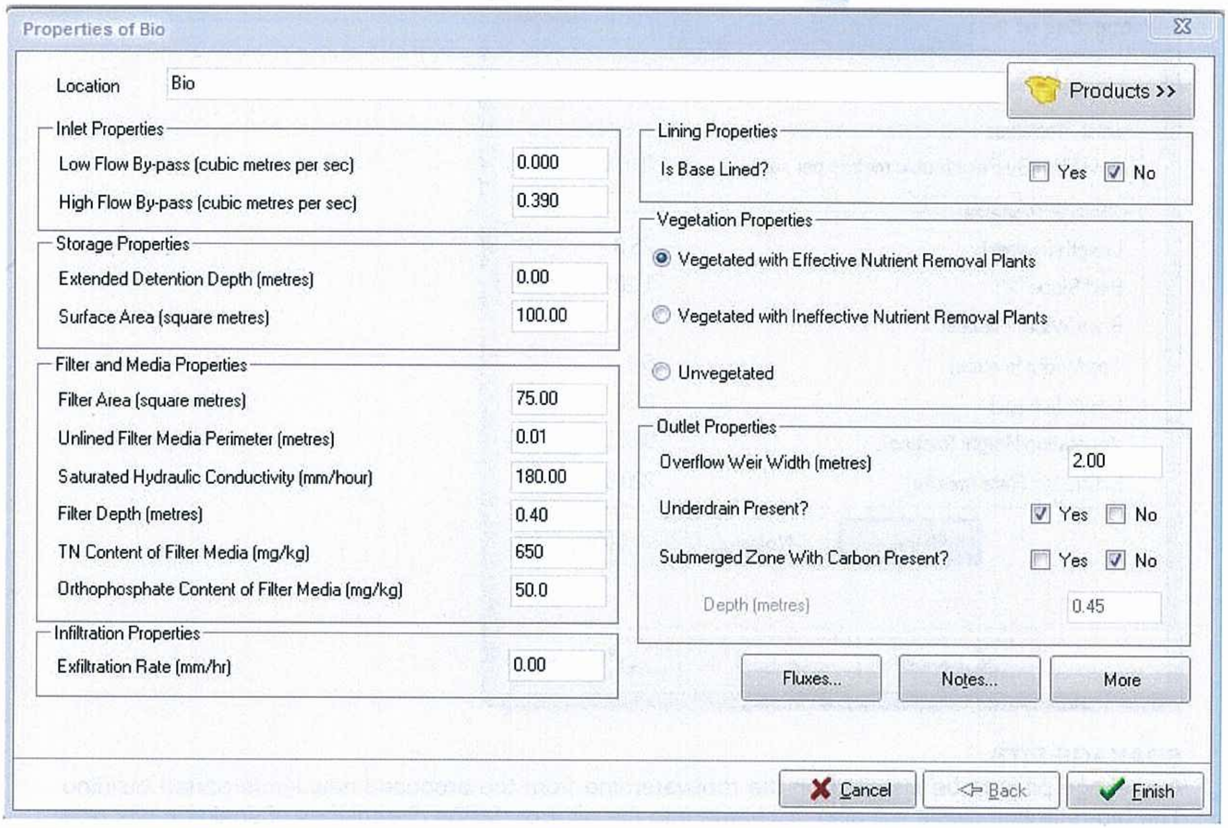
TREATMENT TRAIN

BIO-RETENTION SWALES

The primary treatment devices to be installed are bioretention swales in the open space area. These have been designed and detailed in accordance with the Guidelines. For device dimensions refer Appendix E.

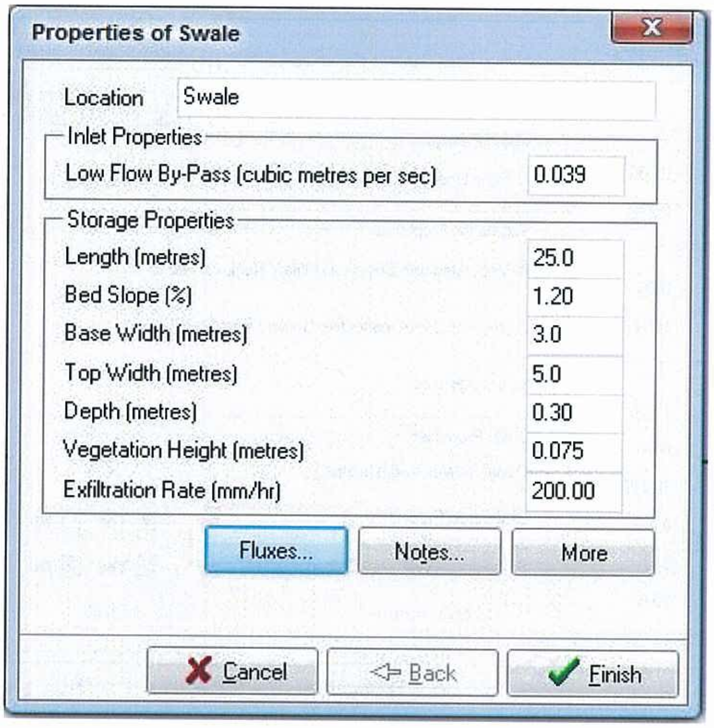
Bio-retention swales are modeled in MUSIC using a combination of a bioretention basin node and a swale node.

Bio-retention parameters entered into MUSIC are as follows:



The physical properties entered above were based on the proposed dimensions as shown in Appendix F. The Saturated Hydraulic Conductivity (180mm/hr) was adopted from the value supplied in the MUSIC user manual for Sandy Loam, whereas TN Content and Orthophosphate parameters were entered in accordance with FAWB acceptable ranges.

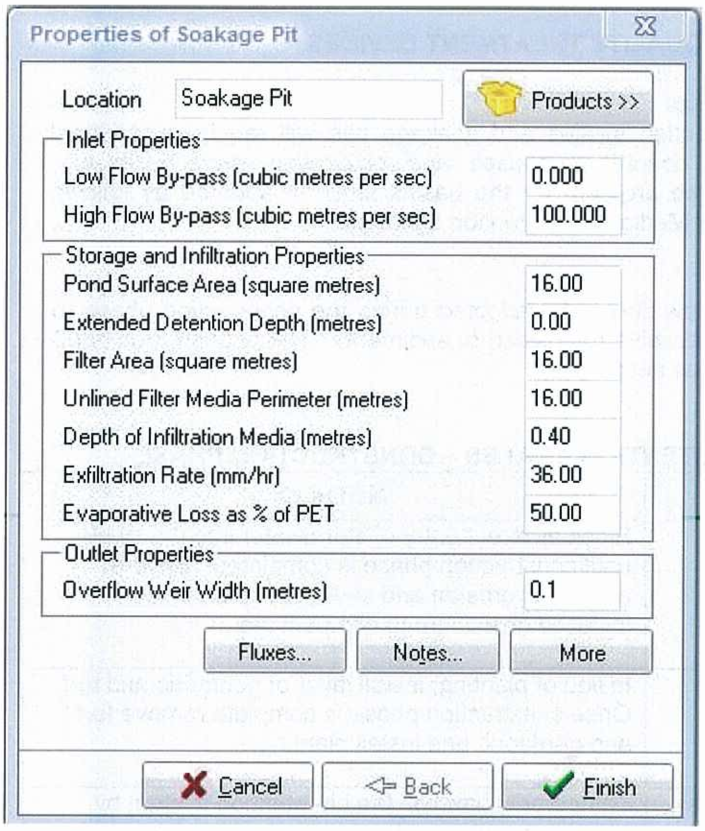
The parameters of the swale component of the bio-retention swale were entered as follows:



SOAKAGE PITS

A soakage pit is to be installed on the roofwater line from the proposed new kindergarten building. The bio-retention swale will also discharge into the pit. For design dimensions of soakage pits refer Appendix E.

Soakage pit parameters entered into MUSIC are as follows:



The soakage pit dimensions were based on MUSIC Infiltration System node. Refer to Appendix E.

RESULTS

The output results for the model are summarised in the tables below (MUSIC model "Receiving Node" statistics). For full results refer Appendix F.

TABLE 5.6
TREATMENT TRAIN EFFICIENCY – CATCHMENT A

Indicator	Post Development *Unmitigated* (kg/yr)	Post Development *Mitigated* (kg/yr)	Treatment Train Efficiency (% Reduction)	Reduction Target *(SEQ Plan)* (% Reduction)
Total Suspended Solids (TSS)	67.9	9.99	85.3	≥ 85
Total Phosphorous (TP)	0.184	0.05	72.4	≥ 70
Total Nitrogen (TN)	1.47	0.52	64.9	≥ 45
Gross Pollutants	21.4	0.00	100.0	≥ 90

As shown above, the treatment train meets all state and regional requirements for target load reductions.

6. MAINTENANCE OF STORMWATER QUALITY TREATMENT DEVICES

6.1 Bio-retention Swales and Soakage Pits

In order to perform satisfactorily bio-retention swales and soakage pits will require inspection/ maintenance during the construction and operational phases, and rectification where necessary. An inspection/ monitoring and maintenance program for the basins shall be adopted as follows based on FAWB's Guidelines for Soil Filter Media in Bioretention Systems:

CONSTRUCTION PHASE

One or a combination of the methods below should be adopted during the construction phase to protect against failure (primarily due to excessive deposition of sediment). The chosen method(s) shall be determined and instructed on site as necessary.

TABLE 6.1
MAINTENANCE PROGRAM FOR BIO-RETENTION SWALES – CONSTRUCTION PHASE

TASK	METHOD
Keep the Swales offline	Block all direct entry of stormwater into the swale until construction phase is completed. Ensure additional erosion and sediment controls are installed elsewhere to compensate.
Delay final landscaping and protect system	In lieu of planting, install layer of geofabric and turf. Once construction phase is complete remove turf and geofabric and install planting.
Create temporary partition/ sediment forebay	Temporarily partition the bioretention system by creating a sediment forebay at the inlet (see geofabric and turf method above) and planting out the balance of the system. This will allow the balance of the system to become established whilst being protected by the partition. Once construction phase is completed remove sediment forebay and establish.

OPERATIONAL PHASE

Long term maintenance tasks are adopted as follows from FAWB Guidelines:

TABLE 6.2
REGULAR INSPECTION AND MAINTENANCE OF BIO-RETENTION SWALES AND SOAKAGE PITS
(SCHEDULE OF SITE VISITS)

PURPOSE OF VISIT	FREQUENCY
Inspection	Regular inspection and maintenance should be carried out to ensure the system functions as designed. It is recommended that these checks be undertaken on a <u>three monthly basis</u> during the initial period of the operating

Maintenance	system. A less frequent schedule may be determined after the system has established.

TABLE 6.3
MAINTENANCE TASKS FOR BIO-RETENTION SWALES AND SOAKAGE PITS

FILTER MEDIA TASKS	
Sediment Deposition	Remove sediment build up from forebays/ from the surface of bioretention areas **FREQUENCY – 3 MONTHLY AFTER RAIN**
Holes or Scour	Infill any holes in the filter media. Check for erosion scour and repair, provide energy dissipation (e.g. rocks and pebbles at inlet) if necessary. **FREQUENCY – 3 MONTHLY AFTER RAIN**
Filter Media Surface Porosity	Inspect for the accumulation of an impermeable layer (such as oily or clayey sediment) that may have formed on the surface of the filter media. A symptom may be that water remains ponded in the basin for more than a few hours after a rain event. Repair minor accumulations by raking away any mulch on the surface and scarifying the surface of the filter media between plants. **FREQUENCY – 3 MONTHLY AFTER RAIN**
Litter Control	Check for litter (including organic litter) in and around treatment areas. Remove both organic and anthropogenic litter to ensure flow paths and infiltration through the filter media are not hindered. **FREQUENCY – 3 MONTHLY OR AS DESIRED FOR AESTHETICS**
HORTICULTURAL TASKS	
Pests and Diseases	Assess plants for disease, pest infection, stunted growth or senescent plants. Treat or replace as necessary. Reduced plant density reduces pollutant removal and infiltration performance. **FREQUENCY – 3 MONTHLY OR AS DESIRED FOR AESTHETICS**
Maintain Original Plant Densities	Infill planting: Between 6 and 10 plants per square metre should (depending on species) be adequate to maintain a density where the plant's roots touch each other. Planting should be evenly spaced to help prevent scouring due to a concentration of flow. **FREQUENCY – 3 MONTHLY OR AS DESIRED FOR AESTHETICS**
Weeds	It is important to identify the presence of any rapidly spreading weeds as they occur. The presence of such weeds can reduce dominant species distributions and diminish aesthetics. Weed species can also compromise the systems long term performance. Inspect for and manually remove weed species. Application of herbicide should be limited to a wand or restrictive spot spraying due to the fact that basins are directly connected to the stormwater system. **FREQUENCY – 3 MONTHLY OR AS DESIRED FOR AESTHETICS**

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DRAINAGE TASKS	
Perforated Pipe	Ensure that perforated pipes are not blocked to prevent filter media and plants from becoming waterlogged. A small steady clear flow of water may be observed discharging from the perforated pipe at its connection into the downstream pit some hours after rainfall. Note that smaller rainfall events after dry weather may be completely absorbed by the filter media and not result in flow. Remote camera (e.g. CCTV) inspection of pipelines for blockage and structural integrity could be useful. **FREQUENCY – 6 MONTHLY AFTER RAIN**
High flow inlet pits, overflow pits and other stormwater junction pits	Ensure inflow areas and grates over pits are clear of litter and debris and in good and safe condition. A blocked grate would cause nuisance flooding of streets. Inspect for dislodged or damages pit covers and ensure general structural integrity. Remove sediment from pits and entry sites etc. (likely to be an irregular occurrence in mature catchment). **FREQUENCY – MONTHLY AND OCCASIONALLY AFTER RAIN**
OTHER ROUTINE TASKS	
Inspection after rainfall	Occasionally observe basins after a rainfall event to check infiltration. Identify signs of poor drainage (extended ponding on the filter media surface). If poor drainage is identified, check land use and assess whether it has altered from design capacity (e.g. usually high sediment loads may require installation of a sediment forebay) **FREQUENCY – TWICE A YEAR AFTER RAIN**

NOTE: REGULAR INSPECTION AND MAINTENANCE FORMS HAVE BEEN INCLUDED IN APPENDIX G FOR USE BY INSPECTORS.

7. CONCLUSION

This report provides the details for the proposed stormwater management for the site which meets Council's stormwater management requirements for both flood detention and stormwater quality management.

The stormwater treatments detailed in this report have been designed to protect receiving waters from detriment, and have been analysed in accordance with applicable Water Quality Targets and Objectives of Brisbane City Council (in the absence of specific Central Highlands Regional Council guidelines) and the Queensland Water Quality Guidelines. This report demonstrates reasonable and practical measures have been taken to minimize or prevent environmental harm. Successful implementation and maintenance of these treatment devices shall ensure the demonstrated performance parameters are met.

The detention systems presented in this report are predicted to reduce peak flows discharging from the overall development site to pre-development levels or less.

Author: Steve Fittock

Authorised by:

Jason Murdoch
RPEQ 6336
On behalf of and for
BRADLEES

Bradlees
Part of the Meinhardt Group

8. REFERENCES

- BCC (2003) *Guidelines for Pollutant Export Modeling in Brisbane Version 7*
- Queensland Department of Natural Resources (2007) *Queensland Urban Drainage Manual Volume 1 2007.*
- BCC (2008) *Subdivision and Development Guidelines Part C Water Quality Management Guidelines*
- FAWB: Facility for Advancing Water Biofiltration (2008) Various publications – refer http://www.monash.edu.au/fawb/index.html .
- Water by Design *MUSIC Modeling Guidelines Version 1.0 (2010)*
- Department of Environment and Resource Management (2009) *Queensland Water Quality Guidelines Version 3*

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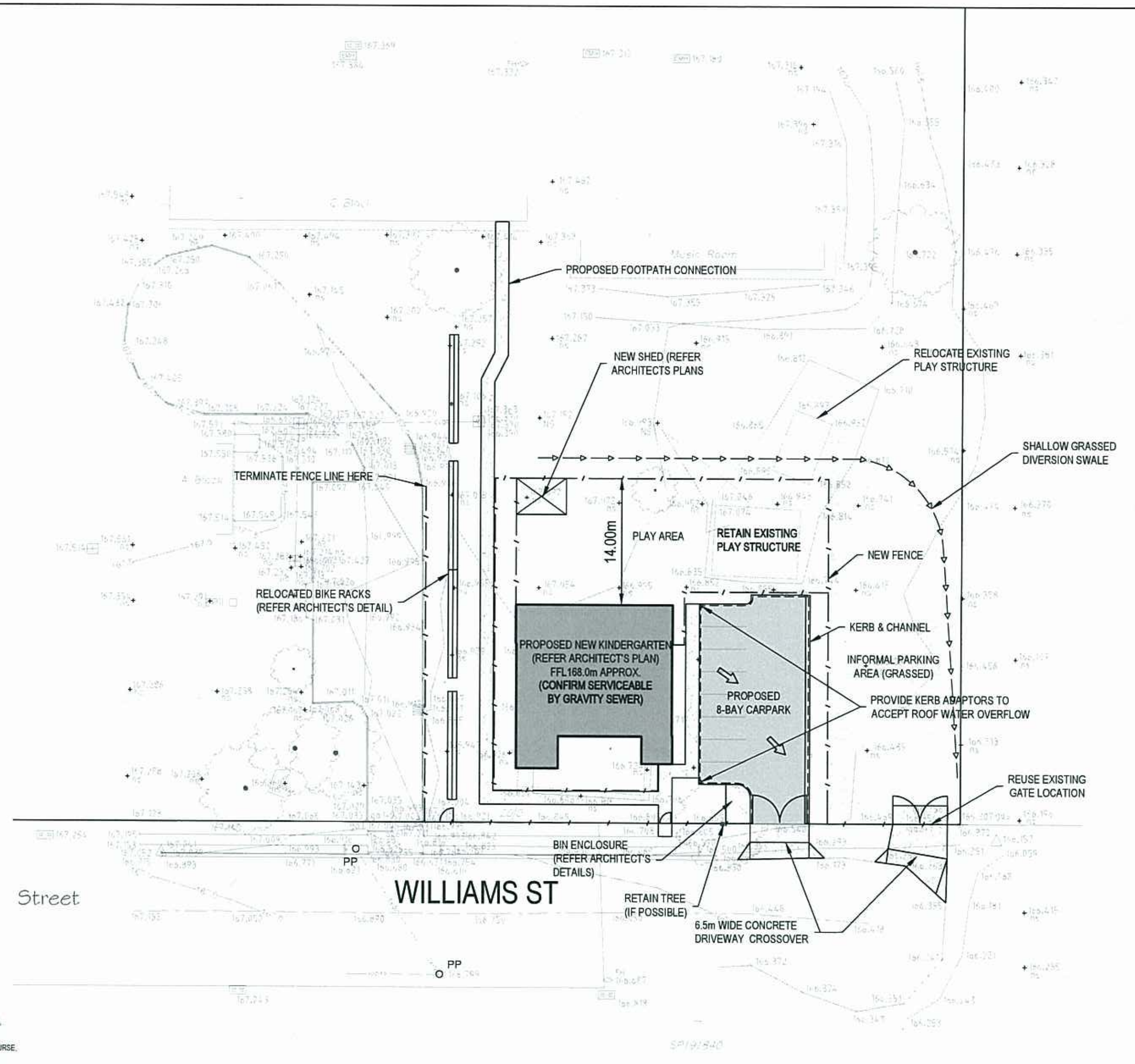
Appendix A
General Site Layout

GENERAL LEGEND

SYMBOL	DESCRIPTION
PROPOSED WORKS	
	KERB INLET PIT (KIP)
	GRATED PIT (GP)
	JUNCTION PIT (JP)
	STORMWATER PIPE
FP — SSD	FLUSHPOINT (FP) & SUBSOIL DRAINAGE
225 TG	TRENCH GRATE (TG)
SWALE	SWALE DRAIN & DIRECTION OF FLOW
+58.25 or 58.25	FINISHED SURFACE LEVELS
RW	RETAINING WALL (RW)
KO	KERB ONLY
KG	KERB AND CHANNEL
DD	DISH DRAIN
TOP OF BATTER / BATTER TICKS / BOTTOM OF BATTER	BATTERS
	HEADWALL (HW) & RIPRAP SCOUR PROTECTION
	EXISTING TREE TO BE REMOVED (SHOWN HATCHED)
	EXISTING TREE
EXISTING WORKS	
	FENCE
Ex.DR	EXISTING PIT
Ex.G	GAS MAIN
Ex.S	SEWER MAIN
Ex.W	WATER MAIN
Ex.U/G	ELECTRICITY SUPPLY
Ex.T	TELECOMMUNICATION CABLES
Ex.DR	STORMWATER PIPE
Ex.DR	STORMWATER PIPE TO BE DECOMMISSIONED
ABBREVIATIONS	
IL59.25	INVERT LEVEL
SSL	STRUCTURAL SLAB LEVEL (TOP)
FFL	FINISHED FLOOR LEVEL
VC	VEHICULAR CROSSING
PR	PRAM RAMP
DR	DRIVEWAY
FP	FOOTPATH
CH	CHAINAGE
UNO	UNLESS NOTED OTHERWISE
DP	DOWNPIPE



ASPHALT WEARING COURSE (MIN. 25mm COMPACTED THICKNESS), TYPE 2, 10mm AGGREGATE SIZE, BITUMEN CLASS 170, CLASS 320 OR CLASS 1000/320 MULTIGRADE.

PRIME COAT, AMCO (1.0 l/m2), WITHIN 24 HOURS OF PRE-SEAL INSPECTION APPROVAL OF PREPARED BASE COURSE. (WAIT 3 DAYS / 72 HRS PRIOR TO LAYING ASHPALT)

125mm COMPACTED THICKNESS TYPE 2.1 CBR 60 BASE COURSE, COMPACTED TO MINIMUM 98% MOD. MAX. DRY DENSITY (M.D.D.)

150mm COMPACTED THICKNESS TYPE 2.3 CBR 45 SUB-BASE COURSE, COMPACTED TO MINIMUM 95% MOD. MAX. DRY DENSITY (M.D.D.)

SUB-GRADE SHALL BE PREPARED TO A MINIMUM COMPACTION OF 100% STD MAX. DRY DENSITY (S.D.D.) AT BETWEEN 97% TO 103% STD. OPTIMUM MOISTURE CONTENT, & FOR A MINIMUM DEPTH OF 200mm. TEST ROLL AS SPECIFIED

AS SHOWN ON PLAN

ALL FILL, SUB-GRADE SOFT SPOTS/REPLACEMENT SHALL BE COMPACTED TO A MINIMUM OF 98% STD. MAX. DRY DENSITY AT BETWEEN 97% TO 103% MOD. OPTIMUM MOISTURE CONTENT.

ASSUMED SUBGRADE CBR OF 5%. INSPECTION AND LEVEL 2 TESTING & SAMPLING AS SPECIFIED TO CONFIRM.

TYPICAL LIGHT DUTY ASPHALT PAVEMENT
(AS PER LOCAL COUNCIL SPECIFICATIONS)
NOT TO SCALE

WARNING
PROPOSED SERVICES
THE LOCATION AND EXTENT OF PROPOSED SERVICES IS INDICATIVE ONLY AND ARE NOT TO BE USED FOR CONSTRUCTION. REFER TO AUTHORISED DOCUMENTATION BY RELEVANT AUTHORITY FOR CONSTRUCTION DETAILS

WARNING
BEWARE OF UNDERGROUND SERVICES
THE LOCATIONS OF UNDERGROUND SERVICES ARE APPROXIMATE ONLY AND THEIR EXACT POSITION SHOULD BE PROVEN ON SITE. NO GUARANTEE IS GIVEN THAT ALL EXISTING SERVICES ARE SHOWN.

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BARCODE

PRELIMINARY
NOT FOR CONSTRUCTION

AMENDMENTS

ISSUE	DATE	SUBJECT	BY
A	13.05.2013	PRELIMINARY SKETCH	MH
B	29.05.2013	REVISED SCHEMATIC DESIGN	MH

DRAWINGS INDEXING SYSTEM
FOR PROJECT SERVICES, PLANS AND RECORDS USE ONLY

- ☐ BUILDING PLATFORM
- ☐ CARPARK
- ☒ CIVIL WORKS
- ☐ COURTS
- ☐ DRAINAGE PLANS
- ☐ EARTHWORKS
- ☐ GROUND IMPROVEMENTS
- ☐ LAYOUT PLANS
- ☐ OTHER
- ☐ RETAINING WALLS
- ☐ ROADWORKS/ACCESS ROADS
- ☐ SEWERAGE PLANS
- ☐ SPORTSFIELD/OVAL
- ☐ STANDARDS
- ☐ STORMWATER PLANS
- ☐ SURVEY PLAN
- ☐ WATER RETICULATION SITE PLAN
- ☐ WATER RETICULATION

SCALE @ A1
0 2.5 5 7.5 10 12.5m
SCALE 1:250 AT ORIGINAL SIZE

PROJECT NORTH

ARCHITECT
COBiE building efficiency
www.cobie.com.au
COBiE pty ltd trading as COBiE group
ACN 153 753 863
ABN 59 153 753 863

CONSULTANT
MEINHARDT
Level 2, 135 Wickham Terrace
Spring Hill QLD 4000
Telephone: (07) 3018 5000
Fax: (07) 3018 5099
www.meinhardtgroup.com
A.C.N. 010 014 776
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CENTRAL QUEENSLAND KINDERGARTEN PROGRAM
BLACKWATER NORTH STATE SCHOOL

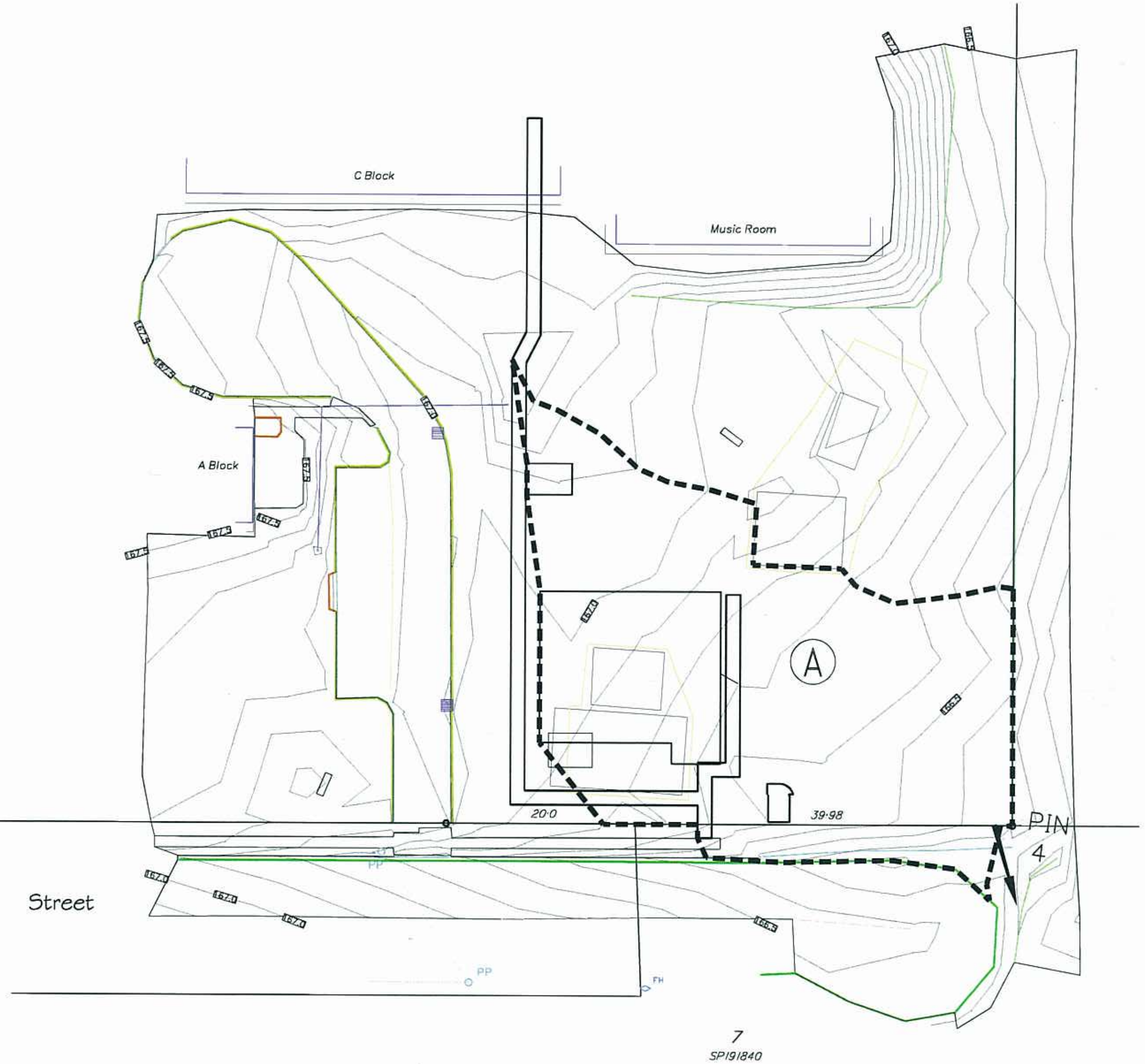
CIVIL SCHEMATIC DESIGN

MHT#: 110582 PRINTED: 29 May 2013, 6:09pm

SCALE 1:250 AT A1 SIZE
MASTER SITE NUMBER ?????
CLIENT REFERENCE NUMBER 34-141161
DRAWING NUMBER ????? /D /SK01
ISSUE B
SHEET NO 1 OF 1

Appendix B

XPRafts Catchment Layouts



CATCHMENT	AREA
A	0.170 ha

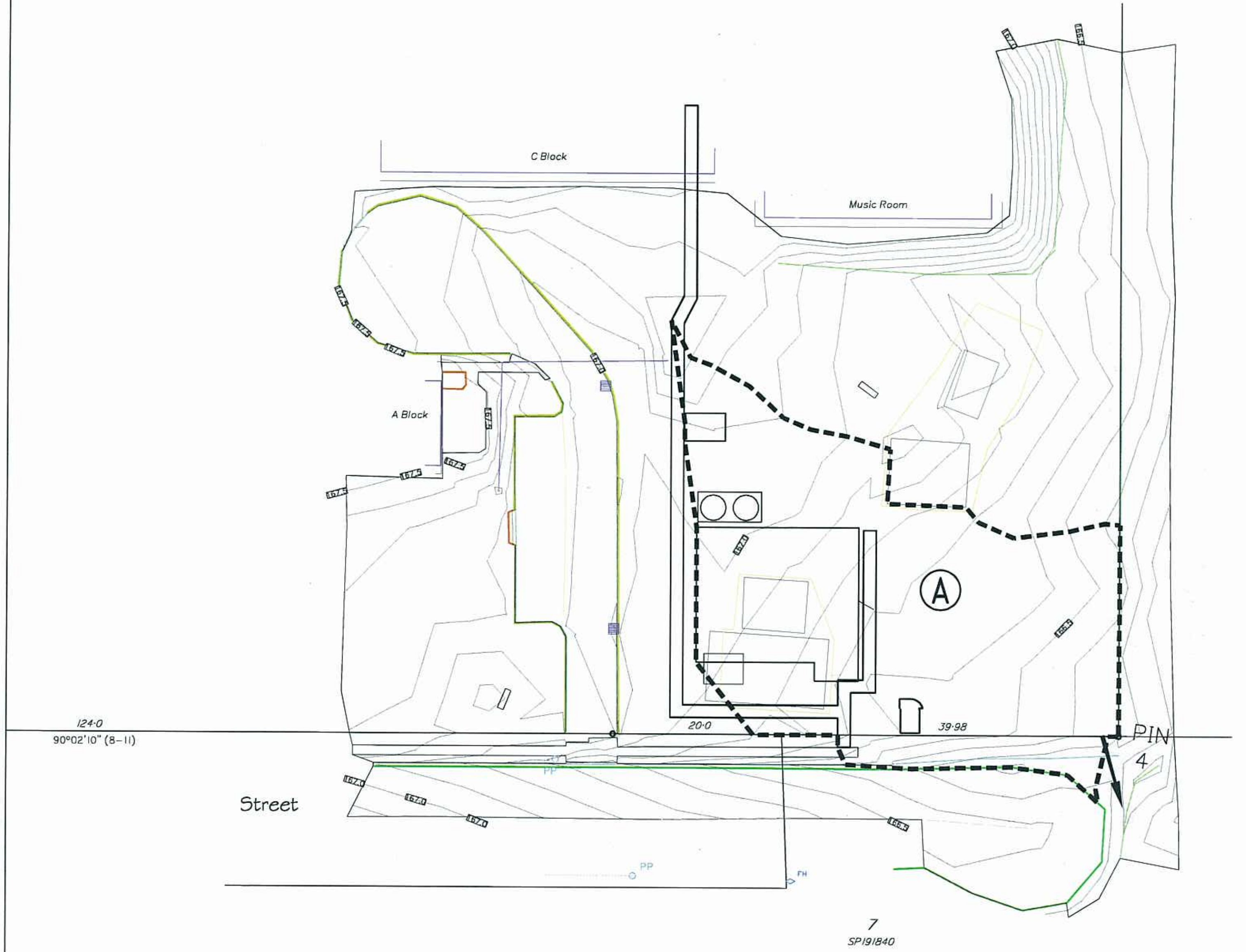
PRELIMINARY

QUEENSLAND GOVERNMENT

BLACKWATER KINDERGARTEN SBSWMP

STORMWATER CATCHMENT PLAN - EXISITING

PROJECT NO.	13-670
DRAWING NO.	SK4084
SCALE @ A3	1:500
26/06/13	ISSUE: A



CATCHMENT	AREA
A	0.170 ha

LEGEND

- CATCHMENT BOUNDARY
- POINT OF DISCHARGE
- TWIN 12kL RAINWATER TANKS

0m 5m 10m 15m 20m 25m

PRELIMINARY

QUEENSLAND GOVERNMENT

BLACKWATER KINDERGARTEN SBSWMP

STORMWATER CATCHMENT PLAN - DEVELOPED

N

PROJECT NO.	13-670
DRAWING NO.	SK4085
SCALE @ A3	1:500
26/06/13	ISSUE: A

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Appendix C

Rational Method Calculations

EXISTING CASE

Catchment A - runoff to Williams Street:

Area	0.17	ha
Fraction Impervious	0.09	
10yr 1 hour Intensity (from BCC Table 3.3.6)	64	mm/hr
10yr runoff coefficient (QUDM Table 4.05.3 (a)	0.65	
100yr runoff coefficient	0.78	

Time of Concentration:

Sheet flow from grassed area upstream:		
Sheet flow length	50	m
Sheet flow average slope	1.4	%
Hortons 'n'	0.032	
Sheet flow time = $107nL^{0.333}/S^{0.2}$	11.8	min
Channel flow to Williams Street:		
Channel Length	22	m
Channel fall	0.5	m
Channel flow time (QUDM Figure 4.09)	1.8	min
Total time of concentration	13.6	min
100yr Intensity (from BCC Table 3.3.6)	219	mm/hr
Q100 = CIA/360	0.081	m^3/s

PROPOSED CASE

Catchment A - runoff to Williams Street:

Area	0.17	ha
Fraction Impervious	0.37	
10yr 1 hour Intensity (from BCC Table 3.3.6)	64	mm/hr
10yr runoff coefficient (QUDM Table 4.05.3 (a)	0.72	
100yr runoff coefficient	0.86	

Time of Concentration:

Sheet flow from grassed area upstream:		
Sheet flow length	24.3	m
Sheet flow average slope	1.4	%
Hortons 'n'	0.032	
Sheet flow time = $107nL^{0.333}/S^{0.2}$	9.3	min
Channel flow to Williams Street:		
Channel Length	60.8	m
Channel fall	0.7	m
Channel flow time (QUDM Figure 4.09)	1.2	min
Total time of concentration	10.5	min
100yr Intensity (from BCC Table 3.3.6)	242	mm/hr
Q100 = CIA/360	0.099	m^3/s

4.03 The rational method

4.03.1 General

In its general form the Rational Formula is:

$$Q = C \, . \, I \, . \, A \tag{4.01}$$

For design, the formula becomes:

$$Q_y = (2.78 \times 10^{-3}) \; C_y \, . \, {}^{t}I_y \, . \, A \tag{4.02}$$

where Q_y = peak flow rate (m^3/s) for average recurrence interval (ARI) of 'y' years

C_y = coefficient of discharge (dimensionless) for ARI of 'y' years

A = area of catchment (ha)

${}^{t}I_y$ = average rainfall intensity (mm/h) for a design duration of '*t*' hours and an ARI of '*y*' years.

t = the nominal design storm duration as defined by the *time of concentration* (t_c) – refer to Section 4.06

The value of 2.78×10^{-3} (*or* 1/360) is a conversion factor to suit the units used.

Calculation of the flow at the various inlets and junctions along the drainage line is carried out from the top of the system progressively downstream.

The total peak flow at any point is **not the sum** of the calculated sub-area flows contributing at that point, but is **dependent on the *time of concentration*** at that point. The actual flow being the product of the sum of the *C.A* values of the contributing sub-catchments, multiplied by ${}^{t}I_y$ appropriate for time of concentration at that point.

$$Q_{peak} = (2.78 \times 10^{-3}).[\Sigma(C.A)].\, {}^{t}I_y \;\; (\mathrm{m^3/s}) \tag{4.03}$$

The time of concentration (t_c) is defined as the travel time for flow from the most remote part of the catchment to the outlet, or the time taken from the start of rainfall until all of the catchment is simultaneously contributing flow to the outlet.

The Rational Method should not be used to analyse historical (real) storms. For additional explanation of the Rational Method refer to Books 4 and 8 of Australian Rainfall and Runoff (1998).

Table 4.05.3 (a) Table of C_{10} Values

Intensity (mm/hr) $^{1}I_{10}$	FRACTION IMPERVIOUS *fi*						
	0.00	**0.20**	**0.40**	**0.60**	**0.80**	**0.90**	**1.00**
39-44	Refer to Table 4.05.3(b)	0.44	0.55	0.67	0.78	0.84	0.90
45-49		0.49	0.60	0.70	0.80	0.85	0.90
50-54		0.55	0.64	0.72	0.81	0.86	0.90
55-59		0.60	0.68	0.75	0.83	0.86	0.90
60-64		0.65	0.72	0.78	0.84	0.87	0.90
65-69		0.71	0.76	0.80	0.85	0.88	0.90
70-90		0.74	0.78	0.82	0.86	0.88	0.90

$^{1}I_{10}$ = One hour rainfall intensity for a 1 in 10 year ARI

C_{10} = Coefficient of discharge for a 1 in 10 year ARI

f_i = Fraction impervious

Table 4.05.3 (b) C_{10} values for Zero Fraction Impervious [1]

Land description	Dense bushland			Medium density bush, or Good grass cover, or High density pasture, or Zero tillage cropping			Light cover bushland, or Poor grass cover, or Low density pasture, or Low cover bare fallows		
Intensity (mm/hr) $^{1}I_{10}$	**Soil permeability**			**Soil permeability**			**Soil permeability**		
	High	**Med**	**Low**	**High**	**Med**	**Low**	**High**	**Med**	**Low**
39–44	0.08	0.24	0.32	0.16	0.32	0.40	0.24	0.40	0.48
45–49	0.10	0.29	0.39	0.20	0.39	0.49	0.29	0.49	0.59
50–54	0.12	0.35	0.46	0.23	0.46	0.58	0.35	0.58	0.69
55–59	0.13	0.40	0.53	0.27	0.53	0.66	0.40	0.66	0.70
60–64	0.15	0.44	0.59	0.30	0.59	0.70	0.44	0.70	0.70
65–69	0.17	0.50	0.66	0.33	0.66	0.70	0.50	0.70	0.70
70–90	0.18	0.53	0.70	0.35	0.70	0.70	0.53	0.70	0.70

Note: [1] Developed from Qld. Department of Natural Resources & Mines (2005). Coefficients are not suitable for soils compacted by construction activities.

Table 4.06.3 Recommended maximum length of overland sheet flow

Surface Condition	Assumed Maximum Flow Length (m)
Steep (say >10%) grassland (Horton's n = 0.045)	20
Steep (say >10%) bushland (Horton's n = 0.035)	50
Medium gradient (approx. 5%) bushland or grassland	100
Flat (0–1%) bushland or grassland	200

(c) Friend's Equation/Nomograph for Overland Sheet Flow Time (Preferred Method for Overland Flow Calculation)

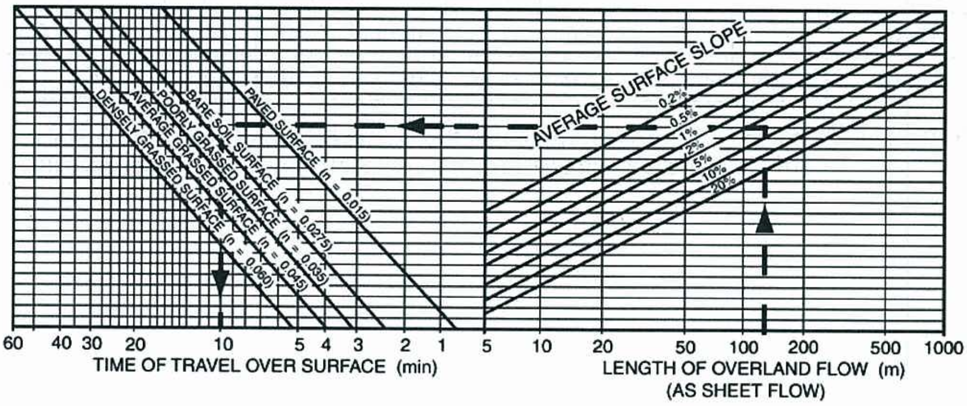
The formula shown below and attributed to Friend (1954) may be used for determination of overland sheet flow times. This was derived from previous work in the form of a nomograph for shallow sheet flow over a plane surface. (Figure 4.07). It is recommended that this procedure be adopted in preference to that given in Section 4.06.6 (d).

Friend's Equation

$$t = (107n\,L^{0.333})/S^{0.2} \qquad (4.06)$$

where
- t = overland sheet flow travel time (min)
- L = overland sheet flow path length (m)
- n = Horton's surface roughness factor
- S = slope of surface (%)

Note: Values for Horton's "n" are similar to those for Manning's "n" for similar surfaces.



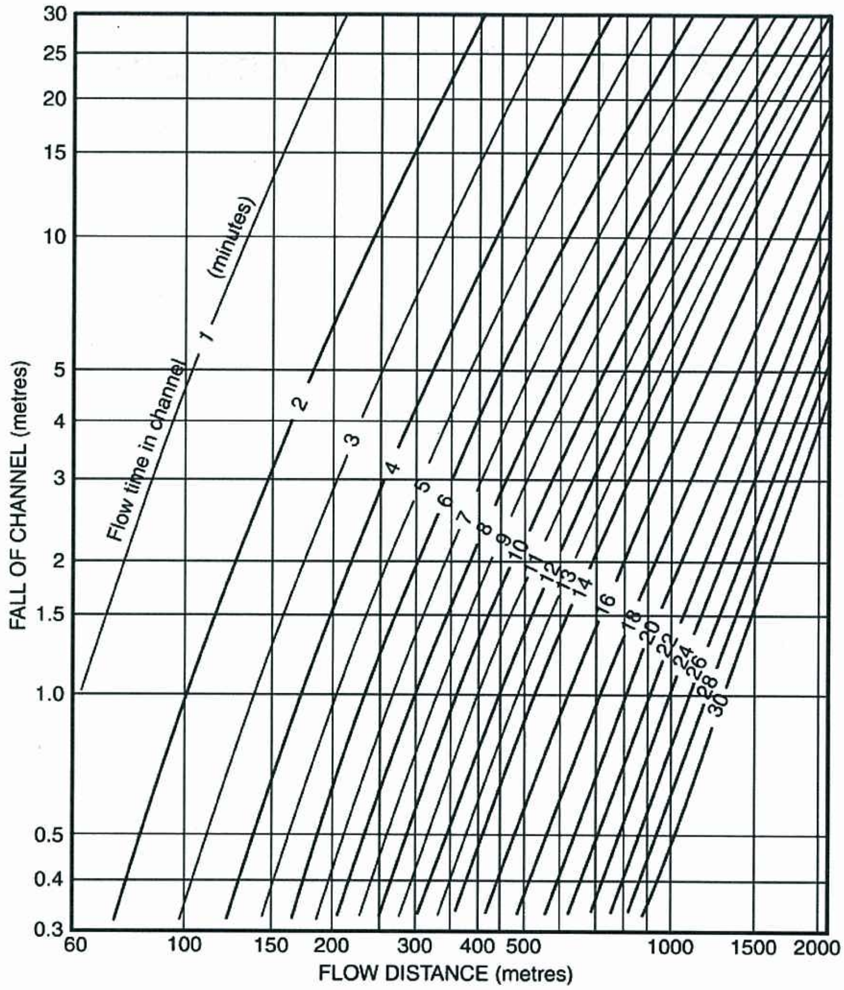
Overland Sheet Flow Times – Shallow Sheet Flow Only
(source: ARR-1977)

Figure 4.07

4.06.7 Initial estimate of kerb, pipe and channel flow time

An initial (trial) estimate of flow time can be determined from Figure 4.09. The chart may be used directly to determine approximate travel times along a range of rigid channel types and, with the application of multiplier Δ for a range of loose-boundary channel forms.

Once a trial flow rate has been determined, the travel time determined from Figure 4.09 will need to be checked using either Figures 4.10 or 4.11.



Flow travel time in pipes and channels (Source: Argue, 1986)
Figure 4.09

NOTES (Figure 4.09):

1. Flow travel time (approximate) may be obtained directly from this chart for:
- kerb-and-gutter channels
- stormwater pipes
- allotment channels of all types (surface and underground)
- drainage easement channels (surface and underground)

2. Multiplier Δ, should be applied to values obtained from the chart as per:
- grassed swales, well maintained and without driveway crossings Δ = 4
- blade-cut earth table drains, well maintained and no driveway crossings Δ = 2
- natural channels Δ = 3

Appendix D

MUSIC Model Catchments

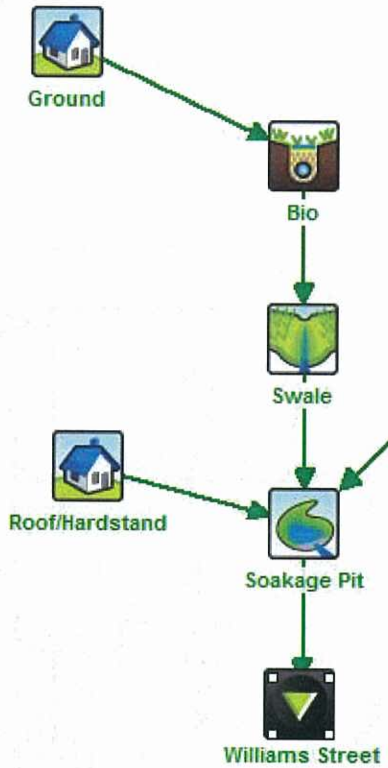
PRELIMINARY

QUEENSLAND GOVERNMENT

BLACKWATER KINDERGARTEN SBSWMP

MUSIC CATCHMENT PLAN

PROJECT NO.	13-670
DRAWING NO.	SK4086
SCALE @ A3	1:500
26/06/13	ISSUE: A



Treatment Train Effectiveness - Williams Street

	Sources	Residual Load	% Reduction
Flow (ML/yr)	0.712	0.280	60.6
Peak Flow (m3/s)	45.7E-3	94.8E-3	-107.3
Total Suspended Solids (kg/yr)	67.9	9.99	85.3
Total Phosphorus (kg/yr)	0.184	50.9E-3	72.4
Total Nitrogen (kg/yr)	1.47	0.515	64.9
Gross Pollutants (kg/yr)	21.4	0.00	100.0

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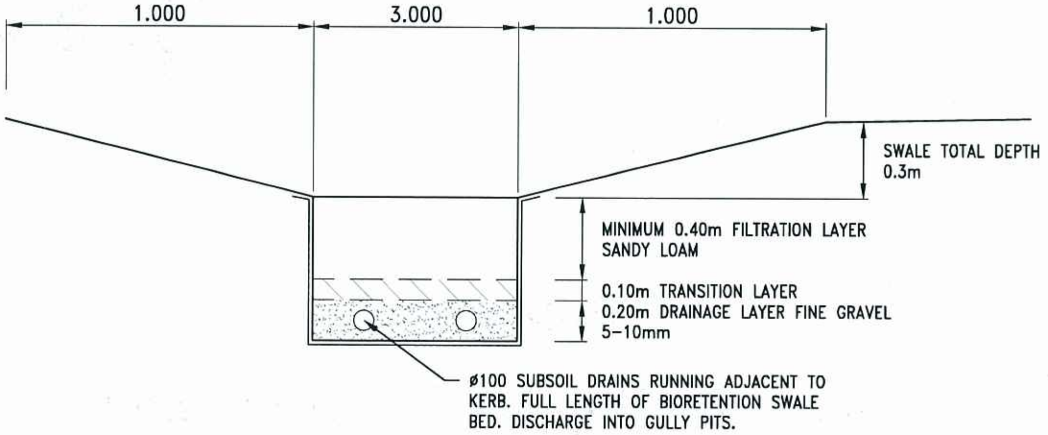
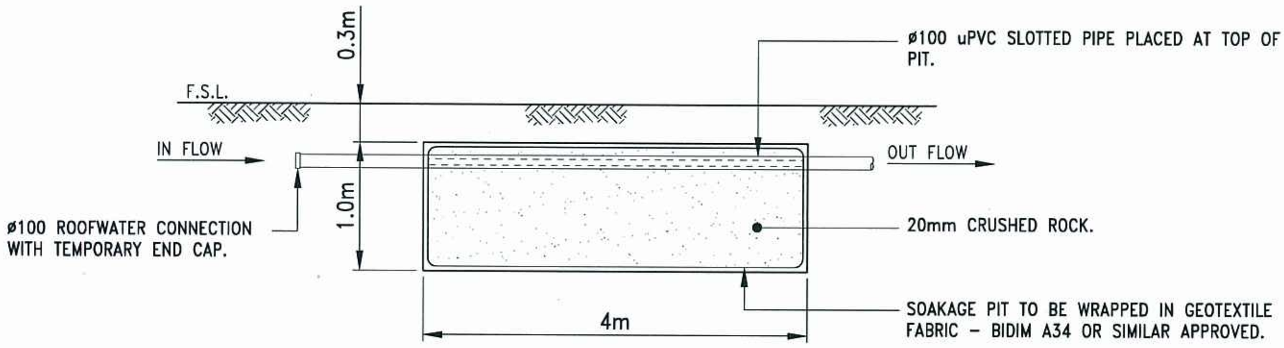
Appendix E

Water Quality Device Dimensions



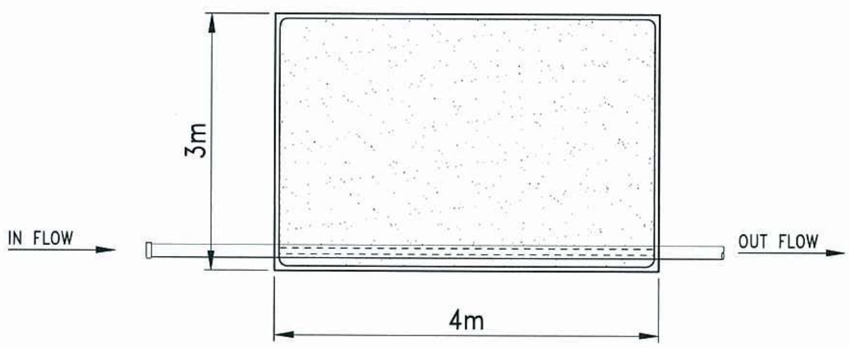
BIORETENTION SWALE – TYPICAL CROSS SECTION

NOT TO SCALE



ROOFWATER SOAKAGE PIT – TYPICAL SECTION

NOT TO SCALE



ROOFWATER SOAKAGE PIT – PLAN

NOT TO SCALE

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Appendix F

MUSIC Results

Williams Street

8/07/2013 10:44:32 AM

Treatment Train Effectiveness

	Flow (ML/yr)	Peak Flow (m3/yr)	TSS (kg/yr)	TP (kg/yr)	TN (kg/yr)	Gross Pollutants (kg/yr)
Sources	0.712	45.7E-3	67.9	0.184	1.47	21.4
Residual Load	0.280	94.8E-3	9.99	50.9E-3	0.515	0.00
% Reduction	60.6	-107.3	85.3	72.4	64.9	100.0

Appendix G

Maintenance & Inspection Forms

4.2.5 FORM (REGULAR INSPECTION & MAINTENANCE)

Location	**Raingarden/Tree Pit**		
Site Visit Date:		Site Visit By:	
Weather:			
Purpose of the Site Visit	Routine Inspection	☐	Complete section 1 (below)
	Routine Maintenance	☐	Complete sections 1 and 2 (below)

NOTE: Where maintenance is required ('yes' in Section 2), details should be recorded in the 'Additional Comments' section at the end of this document.

1. Filter media	Section 1		Section 2	
**In addition to regular inspections, it is recommended that inspection for damage and blockage is made after significant rainfall events that might occur once or twice a year.*	Maintenance Required?		Maintenance Performed	
	Yes	No	Yes	No
Filter media (*CIRCLE* – pooling water/accumulation of silt & clay layer/scour/holes/sediment build up)	☐	☐	☐	☐
Litter (*CIRCLE* - large debris/accumulated vegetation/anthropogenic)	☐	☐	☐	☐
2. Vegetation				
Vegetation health (*CIRCLE* - signs of disease/pests/poor growth)	☐	☐	☐	☐
Vegetation densities (*CIRCLE* – low densities- infill planting required)	☐	☐	☐	☐
Build up of organic matter, leaf litter (*CIRCLE* - requires removal)	☐	☐	☐	☐
Weeds (*CIRCLE* - isolated plants/infestation) (*SPECIES* - ....)	☐	☐	☐	☐

3. *Pits, pipes and inflow areas*

	Section 1		Section 2	
	Maintenance Required?		Maintenance Performed?	
	Yes	No	Yes	No
Perforated pipes (*CIRCLE* – full blockage/partial blockage/damage)	☐	☐	☐	☐
Inflow areas (*CIRCLE* – scour/excessive sediment deposition/litter blockage)	☐	☐	☐	☐
Overflow grates (*CIRCLE* – damage/scour/blockage)	☐	☐	☐	☐
Pits (*CIRCLE* – poor general integrity/sediment build-up/litter/blockage)	☐	☐	☐	☐
Other stormwater pipes and junction pits (*CIRCLE* – poor general integrity/sediment build-up/litter/blockage)	☐	☐	☐	☐

4. *Submerged zone*

	Section 1		Section 2	
	Maintenance Required?		Maintenance Performed?	
	Yes	No	Yes	No
Weir/up-turned pipe (*CIRCLE* – full blockage/partial blockage/damage)	☐	☐	☐	☐
Water level (*CIRCLE* – at design level/drawn down) **SOME DRAWDOWN DURING DRY PERIODS IS EXPECTED**	☐	☐	☐	☐

5. *Additional Comments*