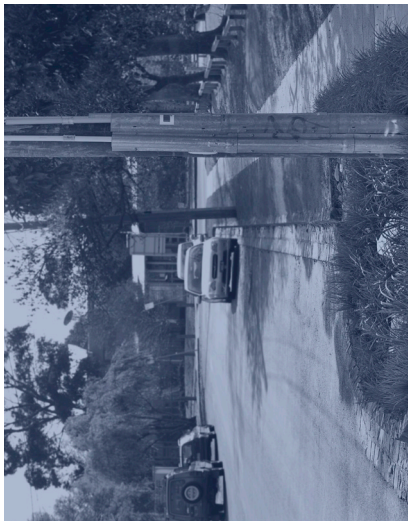
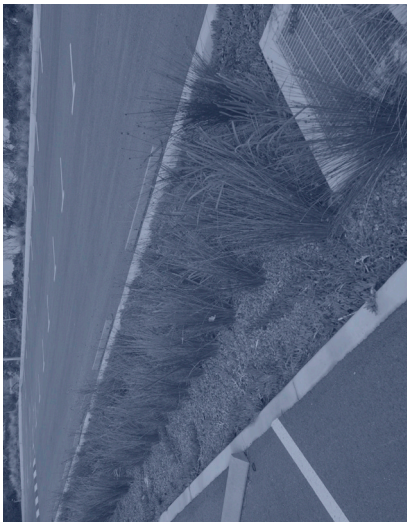
STREETSCAPE WSUD RAINGARDEN & TREE PIT DESIGN PACKAGE

Moreland City Council





CONTENTS

1 INTRODUCTION 5

2 DESIGN PROCEDURE 9

3 ILLUSTRATED CATALOGUE 17

4 AUTOCAD LIBRARY 41

5 SUPPLEMENTARY INFORMATION 57

6 CONSTRUCTION SPECIFICATION TEMPLATE 63

7 DESIGN BASIS MEMORANDUM TEMPLATE 87

8 MAINTENANCE CHECKLIST TEMPLATE 99

9 REFERENCES 107

Photography credits

Main image page 3 – *City of Stonnington, image supplied courtesy of Melbourne Water*
Main image page 7 – *City of Stonnington, image supplied courtesy of Melbourne Water*
Main image page 15 – *City of Banyule, image supplied courtesy of Spiire Australia*
Main image page 39 – *City of Bayside, image supplied courtesy of Melbourne Water*
Main image page 45 – *City of Boroondara, image supplied courtesy of Melbourne Water*
Main image page 87 – *City of Port Phillip, image supplied courtesy of Melbourne Water*

Document Status

Rev No.	Description	Organisation	Author	Reviewer		Approved for Issue		
				Name	Signature	Name	Signature	Date
0	Final	GHD Pty Ltd	Kate Wilson Ralph Nowoisky	Matt van der Peet		Scott Graham		3/7/2013

Disclaimer

This toolkit (consisting of this document "Streetscape WSUD Raingarden and Tree Pit Design Package" and the accompanying AutoCAD library and template documents) has been prepared by GHD to provide general advice regarding the implementation of raingardens and tree pits. When using this toolkit it is necessary for a suitably skilled professional to review the applicability of the advice provided herein to specific site circumstances. Designs prepared using this toolkit should be reviewed from a public safety and construction safety perspective prior to being issued for construction. Designs prepared using this toolkit should also be reviewed for compliance with WSUD Engineering Procedures: Stormwater (Melbourne Water, 2005) or whatever design guidelines supersede this publication.

GHD prepared the original version of this toolkit, which is labelled revision 0 on the document control page table above and in the title block of the drawings. Revisions beyond revision 0, unless noted otherwise, have not been prepared by GHD or reviewed by GHD. GHD disclaims responsibility to any person arising in connection with this toolkit. GHD also excludes implied warranties and conditions, to the extent legally permissible.

1 INTRODUCTION

Urban settlements are complex, evolving social-ecological systems that are dependent on the health of their associated natural systems for ongoing sustainability. Urban designers, landscape architects and engineers are increasingly looking for ways to improve sustainable water use in our expanding urban environments. Through the careful integration of site planning and design, the management, protection and conservation of the water cycle can be achieved.

Water Sensitive Urban Design (WSUD) is a key component of sustainable water management and improvement of water quality. Successful WSUD requires a holistic approach that combines these objectives with improvements to habitat, public open space and recreational and visual amenity for the community.

1.1 Document Outline

Moreland City Council's WSUD Raingarden Standard Design Scenario Package provides a suite of design elements, applications and standard drawings to assist in the efficient design and successful implementation of raingardens and tree pit projects. The Package supplements Council's Integrated Water Management Plan and provides a tool for assisting Moreland City Council in meeting stormwater pollutant load reduction targets via the efficient delivery of streetscape raingardens.

The WSUD Raingarden Standard Design Scenario Package consists of the following elements:

- Introduction providing contextual information;
- Design procedure summary;
- Illustrated catalogue of raingarden elements;
- Supplementary information;
  - Construction cost estimate
  - Maintenance cost estimate
  - Safety codes and guidlines
- Library of AutoCAD details;
- Construction specification template;
- Design basis memorandum template;
- Maintenance checklist template.

1.2 WSUD in the context of Moreland's objectives

The Moreland Integrated Water Management Plan (IWMP) was adopted by Council in October 2009. The IWMP sets the strategic direction for Council relating to the sustainable management of water resources within Moreland and specifically for Council assets and projects, including how Council manages water consumption of our assets, efficiency of irrigation for sportfields, community water use and the amount of waste and stormwater generated from the municipality.

In line with the recommendations of the IWMP, Council adopted Stormwater Quality Targets for the City of Moreland in June 2012. The Targets aim for reduced pollutant loads entering the receiving environment against a 2004 baseline of:

- 80% reduction in Total Suspended Solids (TSS) (786 tonnes/year)
- 60% reduction in Total Phosphorus (TP) (1.2 tonnes/year)
- 45% reduction in Total Nitrogen (TN) (6.4 tonnes/year)

Alongside regional stormwater treatment projects such as stormwater harvesting, distributed streetscape raingardens and tree pits form a key aspect of Council's actions to achieve the Stormwater Quality Targets. Streetscape raingardens and tree pits provide a means of undertaking local treatment of stormwater before it enters the stormwater system. Targeted implementation across a catchment can then result in the catchment meeting stormwater quality targets. Streetscape raingardens and tree pits can be implemented in a number of different street types and not only bring about stormwater quality benefits, but provide amenity and social benefits to the community as well.

1.3 Raingarden System Functions

Raingardens (also known as bioretention systems) provide treatment of stormwater through fine filtration, extended detention and biological uptake. It is recommended that raingardens contain a submerged zone (permanent saturated zone) which enhances nitrogen removal by promoting denitrification. Water is treated within the raingarden/tree pit and then released to a receiving water body (e.g. waterway, drain, groundwater). During high flows, runoff bypasses the raingarden treatment function and the bypassed flows remain untreated. Raingardens can be designed in all shapes and sizes, and can be desinged as infiltration systems to directly reduce stormwater volumes. Where bioretention systems are not feasible due to site specific factors, passive irrigation can be considered for plant health benefits and to reduce stormwater loads. Examples of passive irrigation systems include three pits and porous paving.

Figure 1 illustrates the intended flow pathways for stormwater through a typical raingarden.

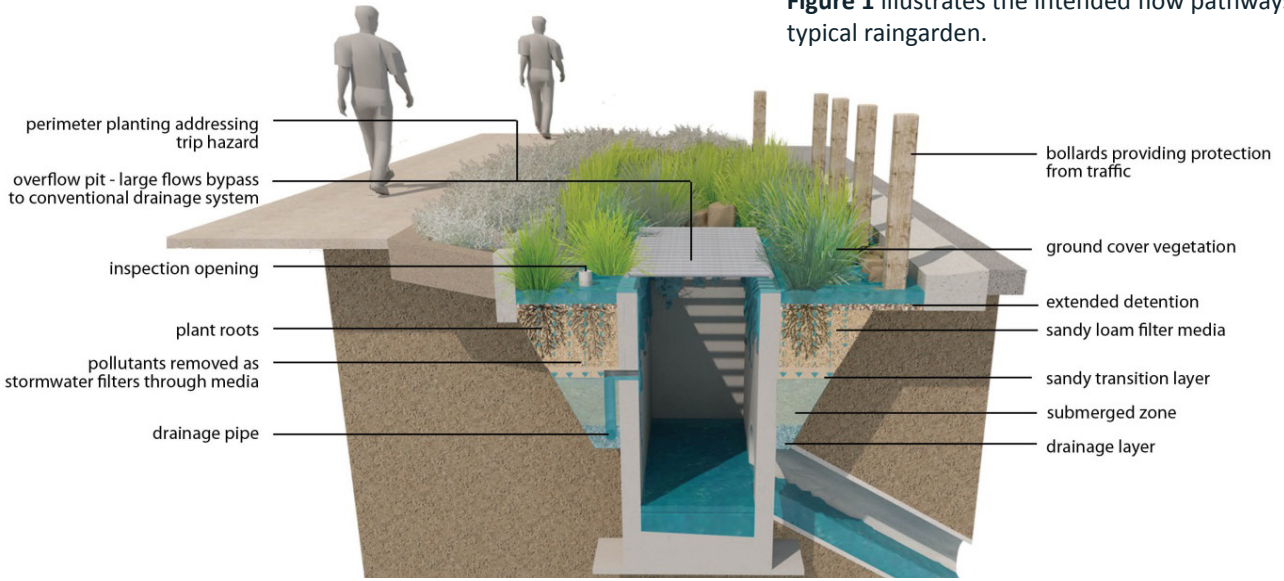


Figure 1: *Flow Pathways through a Typical Raingarden*

2 DESIGN PROCEDURE

2.1 Step-by-step Guide to Developing Detailed Design Drawings

A design procedure has been prepared to assist Moreland Council staff with the detailed design of WSUD initiatives. The procedure is presented as a flow chart, which describes the general steps involved in the design process. A detailed explanation of some of the key steps is provided below the flow chart where required.

STEP 1
COMPLETE PREREQUISITE ITEMS

STEP 1A ❑
Preliminary layout

STEP 1B ❑
Hydrology and hydraulic checks

STEP 1C ❑
MUSIC modelling

STEP 1D ❑
Dial Before You Dig and service proving

STEP 2
DETERMINE CONFIGURATION

STEP 2A ❑
Refer to the illustrated catalogue (3.1) to determine the most appropriate configuration for the project, considering the pros and cons of each configuration and the specific site conditions.

Passive irrigation should be considered if bioretention systems are not feasible.

STEP 3
RECONFIGURE STANDARD LAYOUT

STEP 3A ❑
Develop a detailed layout based upon the selected standard configuration.

STEP 3B ❑
Use the preliminary layout, service constraints, inlet and outfall arrangements and preliminary MUSIC modelling to inform the detailed layout.

STEP 3C ❑
Create a project specific base drawing.

Use a standard configuration layout (SK001-SK005) and combine with available survey and services drawings to create a project specific base drawing.

STEP 4
SELECT CIVIL WORKS DESIGN FEATURES

STEP 4A ❑
Select the appropriate edge treatment.

Refer to the Illustrated Catalogue (3.2, 3.3, 3.5) to select appropriate edge treatment(s) and fencing. Consider pros and cons of each arrangement and suggested suitable applications. Carefully consider the safety measures associated with each edge treatment/ fence option and how they would be applied to the project.

STEP 4B ❑
Select the inlet and outlet arrangement.

Refer to the Illustrated Catalogue (3.6, 3.7) to select appropriate inlet and outlet arrangement. Consider pros and cons of each arrangement and suggested suitable applications. The selection of these items will be largely based on project specific site conditions.

STEP 4C ❑
Review the safety measures.

Refer to the Illustrated Catalogue to select appropriate safety measures.

STEP 5
CREATE DETAILED DRAWING SHEETS

STEP 5A ❑
Prepare detailed drawings including using details from the AutoCAD library

STEP 5B ❑
Reference the relevant sheets and details on the standard layout

STEP 6
SELECT PLANTING OPTIONS

STEP 6A ❑
Select appropriate plant species for the project

Refer to the Illustrated Catalogue (3.8, 3.9) for plant species suggestions and densities. Consideration should be made of local character and conditions and micro-climates specific to each individual project.

STEP 6B ❑
Select mulch

Refer to the Illustrated Catalogue (3.4) for mulch descriptions and applications.

STEP 7
UNDERTAKE DETAILED DESIGN CHECKS

STEP 7A ❑
Update MUSIC modelling

STEP 7B ❑
Determine design flow (e.g. 1 in 3 month ARI)

STEP 7C ❑
Undertake hydraulic checks

STEP 8
PREPARE DOCUMENTATION

STEP 8A ❑
Prepare Construction Specification (Refer Section 6)

STEP 8B ❑
Prepare Design Basis Memo (Refer Section 7)

STEP 8C ❑
Prepare Maintenance Checklist (Refer Section 8)

STEP 9
PREPARE COST ESTIMATES

STEP 9A ❑
Prepare Construction Cost Estimate (Refer Section 5.2)

STEP 9B ❑
Prepare Maintenance Cost Estimate (Refer Section 5.3)

2.2 Additional Information for Items within the Flow Chart

Step 1: Complete Prerequisite items

The following items are prerequisites for the detailed design phase. The methodology for each is not specifically described in this procedure.

Step 1A - Preliminary Layout

A preliminary layout should have been developed, which includes the approximate location and dimensions of the WSUD treatment initiative proposed on the site (for example the figure on this page).

Step 1B - Hydrology and Hydraulic Checks

Inlet Achievable – Confirmation that flow can enter the raingarden under gravity via overland an opening in the kerb) or by surcharging (e.g. surcharging flows from an underground pipe).

Outfall Achievable – Confirmation that flow can discharge from raingarden under gravity. For the raingarden to function a minimum of 450 mm depth is required from the inlet level. Alternatively a decision may have been made that treated flows would discharge from the raingarden via exfiltration only.

Step 1C - MUSIC Modelling

A MUSIC model should have been developed that estimates the treatment efficiency of the bioretention system based on the following objectives and with the following attributes;

- Meet Moreland City Council's water quality targets for WSUD treatment as discussed in Section 1.2;
- Submerged zone has been included or excluded from the model depending on the outfall arrangement selected;
- Follows the Facility for Advanced Water Biofiltration (FAWB) guidelines for filter media specification; and
- Based on Melbourne Water MUSIC modelling guidelines[1] .

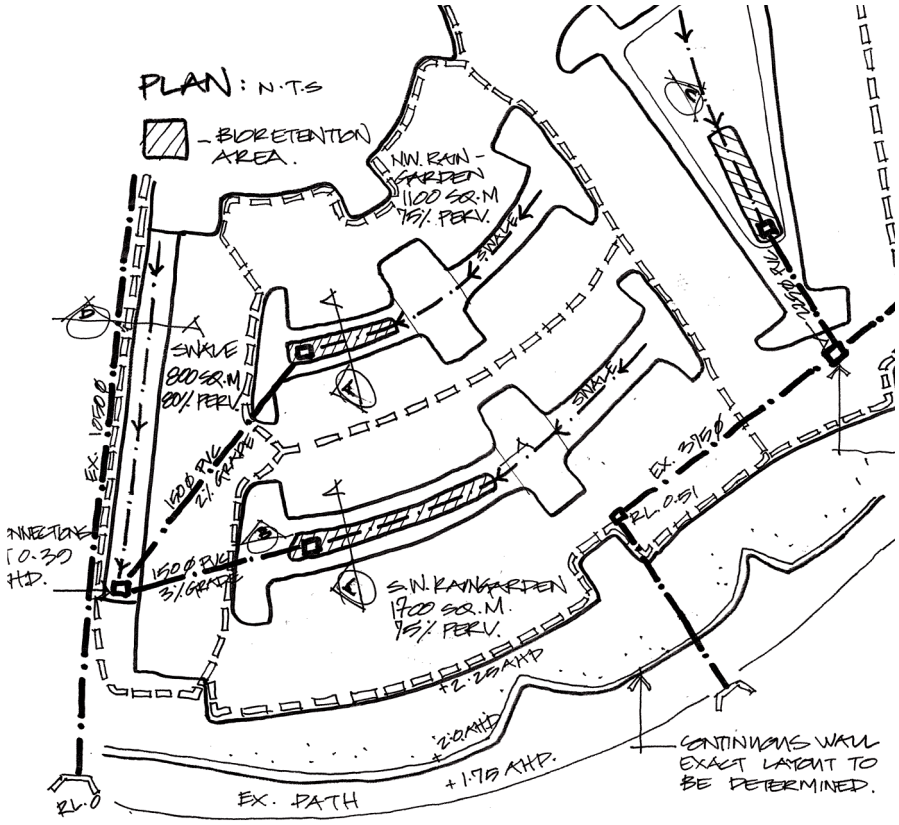
[1] http://www.melbournewater.com.au/content/library/wsud/guidelines_for_the_use_of_music.pdf

Step 1D - Dial Before You Dig and Service Proving if Required

Dial Before You Dig (DBYD) enquiry has been undertaken and services in the vicinity of the raingarden works have been mapped on the preliminary layout plan.

Where services may impact on raingarden design, a service proving company has been engaged to establish the exact location and depth of the services.

This collated service location information has been checked to make sure the preliminary layout is viable.



Step 4: Select civil works options

Step 4A- Select Appropriate Edge Treatment

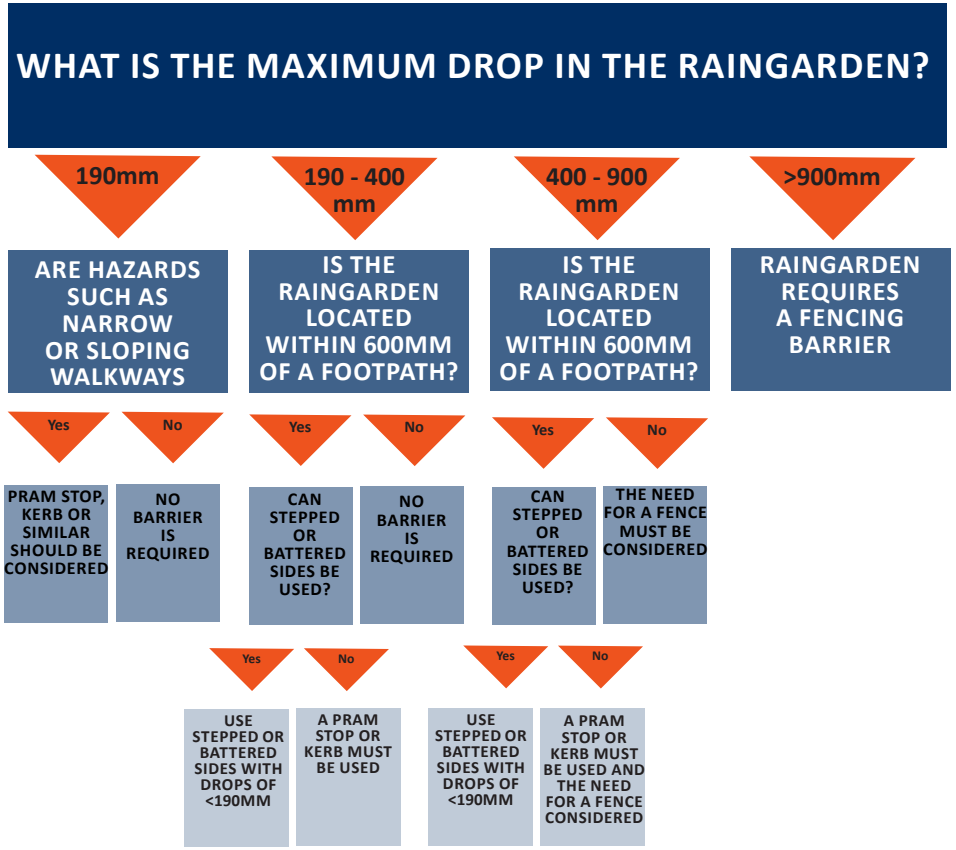
Safety considerations should be considered foremost when selecting raingarden edge treatments. The following flow chart can be used to provide guidance regarding appropriate edge treatments and safety measures.

For raingardens immediately adjacent to roads, a pedestrian refuge must be incorporated into the design under the following circumstances:

- The raingarden is adjacent to any road other than a local traffic street or collector road (brown and orange roads in the Melways);
- The raingarden is located at the back of kerb where vehicles will often be parked hard against the kerb with no option to park elsewhere (for example shopping strips or kerb outstands abutting nose to kerb parking); or
- Where fencing is required between a road and raingarden (to avoid pedestrians being trapped between the road and fence).

Other circumstances may exist where safety measures, fencing and/or pedestrian refuges are required. The project team should separately consider the safety requirements of each raingarden and where required implement safety measures in addition to those recommended here.

Having selected appropriate edge treatments and safety measures from a safety perspective, consult the catalogue to make any necessary decisions regarding aesthetic / material choices.



Step 5 – Create Drawings Sheets

Step 5B - Guideline on use of AutoCAD library

Checklist for drawing documentation

Drawings to include the following details:

All drawings to have:

- ❑ *Title block with site/project name, locality, date, revision, drawing purpose (i.e. design, tender, construction etc.)*
- ❑ *Dimensions and curve radii (where relevant)*
- ❑ *Levels (in plan and sections)*
- ❑ *Titles with scale and scale bar*
- ❑ *North point*
- ❑ *Relevant instructions and warnings (e.g. DBYD service location)*

Cover Page:

- ❑ *Locality plan*
- ❑ *Drawing list including standard drawing references*
- ❑ *General construction notes*
- ❑ *Permanent and temporary benchmarks (minimum 3)*

General Arrangement Plan:

- ❑ *Relevant existing conditions information from survey*
- ❑ *Services*
- ❑ *Template plan view to be reshaped to fit specific site conditions*
- ❑ *Connection to existing drainage*
- ❑ *Location of inlet(s) and outlet(s)*
- ❑ *Sub-soil drainage including maintenance access flush-out point*
- ❑ *Location of key landscape features*
- ❑ *Cross-references to standard details of key features including inlets, outlets, edge treatments, safety measures, landscape features, drainage*
- ❑ *Set out points (unless on separate plan)*

Set Out Plan (unless shown on general plan) and Tables:

- ❑ *Set out points in plan of key design points including raingarden edge, inlets, outlets and drainage*
- ❑ *Set out table of key points*

Cross Sections:

- ❑ *Inlet and outlet arrangements*
- ❑ *Connection to existing and new drainage including sub-soil drainage to outlet pit*
- ❑ *Services depths (if known) and dimensions to proposed works*
- ❑ *Filter media profile with relevant layer thickness and level of submerged zone (if required)*

Landscape Plan and Planting Schedule:

- ❑ *Planting zones*
- ❑ *Planting schedule with plant densities*
- ❑ *Location and extent of other key landscape features*

Typical Details Plan and Sections:

- ❑ *Select relevant typical details from AutoCAD Library including edge treatment, inlets, outlets, landscape features, fencing, pedestrian refuge, etc.*
- ❑ *Cross reference relevant plans and sections*

Step 7 - Undertake Detailed Design Checks

The following items are to be undertaken outside of this procedure.

Step 7A - Update MUSIC modelling

MUSIC modelling should now be updated to reflect the detailed layout and sections.

Step 7B - Determine design flow (e.g.1 in 3 month ARI)

The raingarden needs to be designed to convey the targeted design flow (e.g. typically 1 in 3-month peak flow). The peak flow should be calculated using the Urban Rational Method which is detailed in *Australian Rainfall and Runoff* Book 8, Section 1.5.5[2].

Step 7C- Undertake hydraulic check

For the hydraulic design procedure refer to sections 6.3.1 to 6.3.5 of *WSUD Engineering Procedures: Stormwater*[3].

Step 8 – Prepare Documentation

Step 8A - Prepare Construction Specification (Refer Section 6)

The construction specification template contains the necessary clauses to construct all possible elements contained within the illustrated catalogue and AutoCAD library. It contains guidance for the use of non-standard clauses so that the package user knows under what circumstances to include or exclude specific clauses.

How to use template –

- Specification items that are common to all configurations are in black text.
- Items be included/excluded depending on the options chosen are in red text. Delete items not relevant to project.
- Additional guidance is provided throughout the template through use of comments in yellow and should be deleted once the document is complete.

Step 8B - Prepare Design Basis Memo (Refer Section 7)

The purpose of the Design Basis Memo is to provide Council with some confidence that raingardens have been designed to the correct water quality, drainage and safety standards. This short memo allows toolkit users to document their design inputs, assumptions and results for review and record by Council.

How to use template –

- Fill out the design basis memo for the specific project. All project specific information to be replaced is in red text.
- Most of the elements to be documented within the toolkit have been designed outside of this procedure however assumptions should be documented.

Step 8C - Prepare Maintenance Checklist (Refer Section 8)

The maintenance checklist has been developed to assist Council staff in understanding the components of the system that require maintenance. This checklist has been compiled according to the system components and the specific assets to be maintained. This includes a description of the maintenance task and the expected frequency of undertaking the task.

How to use template –

- Maintenance items that are common to all configurations are in black text.
- Items be included/excluded depending on the options chosen are in red text. Delete items not relevant to project and update example text with project specific information.
- Additional guidance is provided throughout the template through use of comments. All guidance/comments are highlighted in yellow and should be deleted once document is completed.

2. Pilgrim, DH (ed), 1998. *Australian Rainfall and Runoff - A Guide to Flood Estimation,* Institute of Engineers, Australia, Barton, ACT.

3. Melbourne Water, 2005. *WSUD Engineering Procedures: Stormwater*, CSIRO Publishing, Collingwood VIC.

3 ILLUSTRATED CATALOGUE

3.1 Raingarden Configurations

Sheet 1 of 3 – *Standard Drawing SK001 and SK003*		DESCRIPTION	PROS	CONS	APPLICATIONS
CAR PARKS		As car parks consist of large areas of impervious surface they can contribute significantly to catchment flow and pollutant loads. Landscape features are now common place in car parks, often used to separate car spaces or delineate boundaries between the car park and adjacent streets.	• Easily retrofitted • Can be installed as a part of a car park renewal or original construction • Readily integrated with landscape features • High public awareness	• Loss of pedestrian refuge from cars • May obstruct line of sight if not maintained • High litter loads associated with car parks may require higher levels of litter maintenance	• Existing or new car parks • Commercial or industrial areas
NATURE STRIP		In residential areas nature strips provide opportune sites for locating raingardens. This configuration can also be applied to wide footpaths that do not have grassed areas.	• Easy to retrofit into existing nature strip • Makes use of existing road, kerb and drainage infrastructure • No obstruction to road users	• Loss of space for bins if outside a residence • Can limit access between the road and footpath • Potential clashes with existing trees • Potential clashes with existing services	• Residential streets • Industrial streets

Sheet 2 of 3 – *Standard Drawing SK002 and SK004*

		DESCRIPTION	PROS	CONS	APPLICATIONS
KERB OUTSTAND		A kerb outstand is a protrusion from the kerb. Kerb outstands offer excellent opportunities for raingarden installations, either as retrofits or as part of the original road infrastructure.	• Easily retrofitted • Enhanced traffic control • Improved pedestrian safety • Development of streetscape features • Easy to connect to existing stormwater drain	• Potential loss of car parking space • Risk of service clashes • Potential to clash with tree roots • Potential safety risks during maintenance	• Areas with on-street parking • Wide streets • High traffic areas
CORNER		Corner raingardens are similar to kerb outstands, occupying a combination of roadway and nature strip / pedestrian space.	• Potential to capture more road runoff from intersection • Can be combined as enhanced traffic control devices • Improved pedestrian safety • Development of streetscape features • Easy to connect to existing stormwater drain	• May obstruct line of sight if not maintained • Inlet and outlet arrangements can be more challenging • Potential safety risks during maintenance	• Corners of streets anywhere with available space

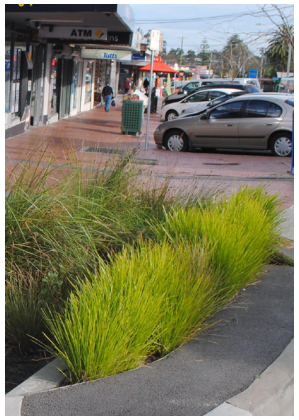
Sheet 3 of 3 – *Standard Drawing SK005 and SK014*

		DESCRIPTION	PROS	CONS	APPLICATIONS
SLOPING		Raingarden can be 'tiered' to suit sloping sites. This minimises the drop heights into the raingarden , which increases safety and minimises the required excavation.	• Can be constructed where other WSUD options may not be suitable • Raingarden tiers can form interesting landscaping feature	• May be more difficult and costly to construct • May be more difficult to design hydraulically • Requires additional design intervention to protect from erosion • May require more maintenance	• Steep sites where other raingarden configurations would result in unsafe fall heights
TREE PIT		Tree pits are bioretention systems that can be constructed as an alternative to traditional street tree planting techniques. This provides stormwater treatment as well as directing water to the tree roots.	• Can be incorporated in streetscape, malls or within larger raingardens • Can be installed with very limited space • Makes use of existing road and kerb infrastructure	• Pedestrian safety when installed on footpaths • Can be hard to maintain • Smaller treatment potential than raingardens	• Shopping Strips • Back of kerb tree pits

3.2 Edge Treatment Configurations

Adjacent to Pedestrian Access

Sheet 1 of 2 – *Standard Drawing SK013 and SK008*

		DESCRIPTION	PROS	CONS	APPLICATIONS	SAFETY PARAMETERS*
PLANTED BUFFER		Planted buffers offer a physical barrier and visual cue to warn pedestrians of step-downs into raingardens. Planted buffers are typically 600mm wide.	• Soft barrier alternative • Offers an opportunity to incorporate accent planting	• Requires relatively large footprint to implement • Failed planting can look unsightly and become weed infested	• Areas with high pedestrian traffic • Typically adjacent to raingardens in corners and at kerb outstand where there is usually a larger available footprint	• Drop heights into raingardens adjacent to planted buffers may be up to 400mm without the need for further barrier requirements • Drops of up to 900mm may be considered with no fencing depending on the individual characteristics of the site
PRAM STOP / KERBS		Pram stops are designed to stop wheelchairs, visually impaired people, prams, etc. from inadvertently finding their way into the raingarden. Pram stops can either be separate features or vertical extensions of edge treatment forming a barrier.	• Easily Retrofitted • Can be landscape features when material ties in with surrounds	• Could be a tripping hazard • Drainage of adjacent paths need to be considered	• Raingardens immediately adjacent to footpaths with high pedestrian traffic • Raingardens adjacent to narrow paths • Raingardens adjacent to paths with steep cross fall	• Drop heights greater than 190mm require the use of a pram stop or kerb barrier • For drop heights less than 190mm pram stops or kerb barriers are not required as this may be reasonably expected in a pedestrian area, however,may be applied at the discretion of the project team

** In all cases the project team should apply a common sense approach to safety and assess and apply appropriate safety measures that take into consideration all factors of the individual site.*

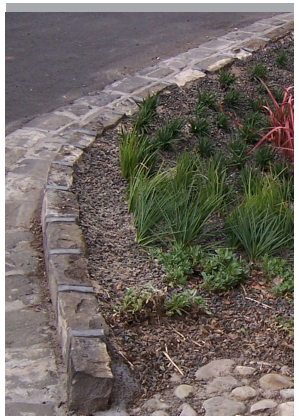
Sheet 2 of 2 – *Standard Drawing SK008*

		DESCRIPTION	PROS	CONS	APPLICATIONS	SAFETY PARAMETERS*
STEPPED SIDES		One type of edge treatment or a variety can be combined to create stepped sides to the raingarden. The resulting terraces can be landscaped in a complimentary manner or paved.	• Potential to achieve more extended detention depth hence better water quality outcomes • Integration of step material with surrounding landscape	• Increased risk associated with higher ponding depths • Relatively high cost depending on construction methods	• Can apply to many configurations	• Steps are to be kept at a maximum of 190mm

** In all cases the project team should apply a common sense approach to safety and assess and apply appropriate safety measures that take into consideration all factors of the individual site.*

Adjacent to Roads

Sheet 1 of 1 – *Standard Drawing SK008 and SK006*

		DESCRIPTION	PROS	CONS	APPLICATIONS	SAFETY PARAMETERS*
PEDESTRIAN REFUGE		Pedestrian refuges are often placed between streets and raingardens, providing a place for pedestrians to stand away from traffic without having to step into the raingarden. Pedestrian refuges are generally 500 mm wide, but can be created to any width required.	• Easy access for maintenance personnel tending to the raingarden • Can be paved to complement surrounding pavements	• Loss of raingarden area, which results in a loss of treatment capacity • High relative capital cost	• Existing or new carparks • Outstands with adjacent parking • Areas with high pedestrian traffic	• Drop heights into raingardens adjacent to roadside pedestrian refuges can be a maximum of 190mm. • Drop heights beyond 190mm will require some other form of barrier, either pram stop, planted buffer or a stepped arrangement
BATTERED EDGES		Battered edge from top of back of kerb. The batter may start below a 190mm drop.	• Low capital cost • Easy to implement	• Vegetated batters should be no greater than 1 in 4 to prevent slumping or scouring • Requires larger footprint or reduced effective treatment area footprint to accommodate buffer	• Can apply to many configurations	• Batter gradients should be considered with reference to the available space for the raingarden and safety for inadvertent pedestrian access and maintenance activities

** In all cases the project team should apply a common sense approach to safety and assess and apply appropriate safety measures that take into consideration all factors of the individual site.*

3.3 Raingarden Edge Detailing Options

Sheet 1 of 2 – *Standard Drawing SK006 and SK009*		DESCRIPTION	PROS	CONS	PRECINCT	
TIMBER RETAINING WALL		Timber retaining wall generally constructed from hardwood timber or treated pine sleepers.	• Low capital cost • Ease of construction	• Deteriorates over time • Only able to acheive straight edges	☑ ☑ ☑ ☒	Brunswick (Refer to the Public Domain Manual Coburg (Refer to the Coburg Streetscape Master Plan Glenroy Shopping Strips
BLUESTONE PITCHERS		Bluestone Pitchers laid on a concrete footing. Typical dimension 200x200x300mm.	• Able to use recycled materials • Can compliment existing character	• Labour intensive to implement	☑ ☑ ☒ ☑	Brunswick (Refer to the Public Domain Manual Coburg (Refer to the Coburg Streetscape Master Plan Glenroy Shopping Strips

Sheet 2 of 2 – *Standard Drawing SK006 and SK008*

		DESCRIPTION	PROS	CONS	PRECINCT	
CONCRETE EDGING		Cast in situ concrete wall. Typically 150mm thick.	• Able to be flexible enough to achieve various forms • Durable	• High capital cost • Difficult to construct	☒ ☒ ☑ ☑	Brunswick (Refer to the Public Domain Manual Coburg (Refer to the Coburg Streetscape Master Plan Glenroy Shopping Strips
STEEL EDGING		Galvanised steel edge. Typically used to form an facing edge to asphalt or segmental paving.	• Able to be flexible enough to achieve various forms • Low profile	• May corrode if protective coating is compromised • High capital cost	☒ ☒ ☑ ☑	Brunswick (Refer to the Public Domain Manual Coburg (Refer to the Coburg Streetscape Master Plan Glenroy Shopping Strips

3.4 Raingarden Mulch Options

		DESCRIPTION	PRECINCT	
TUSCAN PEBBLE		20mm	☑	Brunswick (Refer to the Public Domain Manual
			☑	Coburg (Refer to the Coburg Streetscape Master Plan
			☑	Glenroy
			☒	Shopping Strips
BLUE METAL STONE		20mm	☑	Brunswick (Refer to the Public Domain Manual
			☑	Coburg (Refer to the Coburg Streetscape Master Plan
			☒	Glenroy
			☑	Shopping Strips
RIVER PEBBLE		A range of colours and types. Size: 20-25mm	☒	Brunswick (Refer to the Public Domain Manual
			☒	Coburg (Refer to the Coburg Streetscape Master Plan
			☑	Glenroy
			☑	Shopping Strips
BRICK		Crushed recycled brick. Size: 15-30mm	☒	Brunswick (Refer to the Public Domain Manual
			☒	Coburg (Refer to the Coburg Streetscape Master Plan
			☑	Glenroy
			☑	Shopping Strips

3.5 Fencing

Where safety standards cannot be achieved using one or more other safety measures it may be necessary to install a barrier, bollards or fencing between the raingarden and adjacent footpaths and/or roadways.

Fencing is a non-preferred option and alternative safety measures should be investigated as a priority. A variety of options exist depending on the level of protection required and the desired visual outcome.

Sheet 1 of 1 – *Standard Drawing SK007*

		DESCRIPTION	PROS	CONS	APPLICATIONS
RAIL FENCE		Timber posts with galvanised pipe rail. Only used when drop is less than 900mm where additional safety is deemed necessary by the project team. Height can vary 600-1000mm.	• Low cost • Easy installation • Durable	• Difficult to repair once damaged	• Car parks • Streets
BOLLARDS		Timber or recycled plastic bollards. Primarily used as a vehicle warning and deterent device.	• Low cost • Easy installation	• Difficult to repair once damaged	• Car parks • Streets
TIMBER POST FENCE		Timber posts and rail full barrier fence. Only used when drop is greater than 900mm with no openings greater than 125mm in line with BCA clause 3.9.2.3. Height min. 1000mm.	• Flexible design options	• High cost	• Car parks • Streets • Parks
SEAT		Custom or proprietary seating can be used as a barrier. Only used when drop is less than 900mm where additional safety is deemed necessary by the project team.	• More aesthetic option to fencing • Provides public amenity and compliments street character	• High cost	• Streets • Malls/Plazas

3.6 Inlet Options

Sheet 1 of 2 – *Standard Drawing SK010 and SK009*		DESCRIPTION	PROS	CONS	APPLICATIONS
KERB OPENING/BREAK		Kerb openings are the most common type of raingarden inlet adopted for streetscape raingardens. Existing kerbs can easily be modified to include a kerb inlet, which will be sized according to hydraulic requirements. The portion of raingarden adjacent to the inlet will be protected from scouring using a small area of rock protection.	• Simplest and most common type of raingarden inlet • Existing kerbs can easily be modified to include a kerb inlet • These can be configured as multiple breaks in a single length of kerb to provide multiple flow inlet points • Low cost retrofit option	• Sometimes a break in the kerb is not acceptable • Prone to build up of leaf litter or sediment at inlet • Cannot be fitted to raingardens where the raingarden does not abut the back of kerb	• Existing Kerbs • Road flow catchments • Car parks • Streets
GRATED CHANNEL		Where the raingarden is separated from the catchment by a footpath a grated channel may allow for connection.	• Use of a grated channel rather than a covered culvert increases ease of maintenance • Allows for raingarden configurations that may not be achievable with other inlet types.	• Grates can present a hazard for pedestrians. Heelguard grating is normally specified to reduce risk • More costly to construct than other inlet types	• Existing Kerbs • Car parks • Street Raingardens • Corner Raingardens

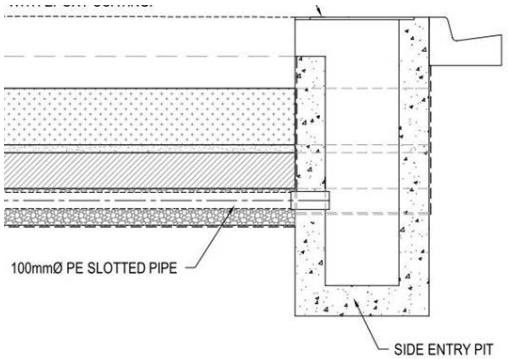
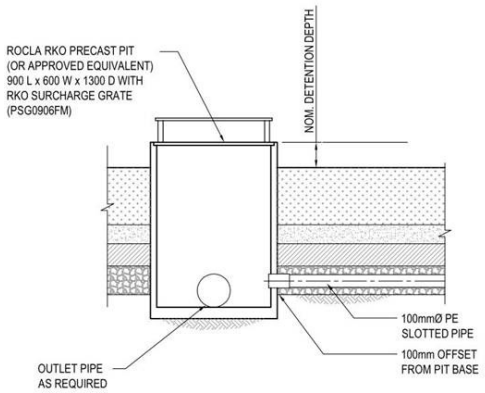
Sheet 2 of 2 – *Standard Drawing SK009*

KERB AND CHANNEL

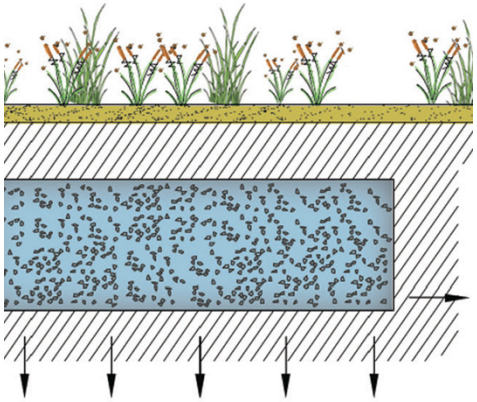
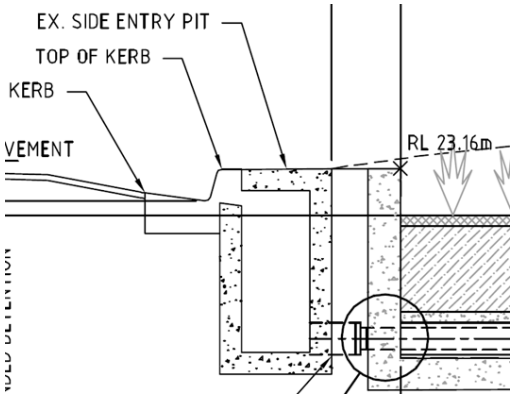
DESCRIPTION	PROS	CONS	APPLICATIONS
Modifications to kerb and channel to allow low flows to enter into raingarden. Can be used implemented in both bluestone pitcher and concrete channels.	• Integration with surrounding landscape	• Pitchers can subside over time	• Existing Kerbs • Road flow catchments • Car parks • Streets

3.7 Outlet Options

Sheet 1 of 2 – *Standard Drawing SK011*

		DESCRIPTION	PROS	CONS	APPLICATIONS
SIDE ENTRY PIT		In high flows water ponded above the raingarden bed extended detention depth (typically 300 mm) spills into the side-entry pit. Treated water outlets to the downstream drainage system via a slotted agi- drain that taps into the side-entry pit wall. The level of the agi-drain connection defines the depth or existence of a submerged zone (note the example left is shown without a submerged zone).	• Side entry pits often coincide with location of retrofit raingardens and can be modified to provide an outlet • Existing junction pits can be similarly modified • Low cost solution if existing pit	• Smaller opening can be prone to blockage from floating debris or litter	• Adapt existing pits • Construct new pits and connect with existing or new drainage
GRATED PIT		In high flow events water ponded above the raingarden bed extended detention depth (typically 300 mm) spills into the grated pit. Treated water outlets to the downstream drainage system via a slotted agi- drain that taps into the grated pit wall. The level of the agi-drain connection defines the depth or existence of a submerged zone (note the example left is shown without a submerged zone).	• Larger inlet capacity than side entry pit • Easier maintenance for clearing debris on grate • Can be located anywhere within the raingarden	• Depending on design, can be prone to blockage	• Construct new pits and connect with existing or new drainage • Adapt existing junction or grated pits if raingarden constructed around pit

Sheet 2 of 2 – *Standard Drawing SK011*

		DESCRIPTION	PROS	CONS	APPLICATIONS
EXFILTRATION		The raingarden is unlined so that treated water exfiltrates into surrounding soil after it has passed through the raingarden filter media.	• Provides a more natural flow regime as enables recharge of stormwater to groundwater • Reduces load to stormwater system	• Requires particular soil conditions to operate effectively • Potential undermining of nearby structures and pavements	• Sandy soil environments • Verge raingardens (not directly adjacent to road pavement) or those located in public open space areas
SIDE ENTRY PIT OUTSIDE RAINGARDEN		Where a raingarden is installed within the verge area behind the kerb, an existing side entry pit can be used as the outlet. In a high flow scenario water ponds from the raingarden back onto the street and enters the side entry pit via the kerb and channel.	• Lower cost option as minimal modification to existing drainage required	• Only suitable where raingarden can coincide with side entry pit and raingarden inlet is upstream of side entry pit	• Verge raingarden, where side entry pit located nearby

3.8 Planting Options

Planting in Bioretention Filter Media

Planting of a raingarden system has two important benefits; water quality and visual amenity. Planting within the bioretention filter media should comprise primarily of plants that have been demonstrated to be effective for removal of nutrients as recommended in Stormwater Biofiltration Systems Adoption Guidelines[1]. Additional secondary accent feature planting can be included to improve the aesthetic of the raingarden. Secondary species can be selected for foliage, flowering or colour to give the designer the opportunity to express a pattern offering the flexibility to express complimentary texture or colour. Species selection should also consider micro-climates and conditions specific to each individual project. Examples of typical planting arrangements using primary and secondary species are suggested in the Figure below. These examples are not intended to be prescriptive and the design should be developed on an individual project basis.

Information on the suggested species list for bioretention filter media is provided in the Planting Palette section.

Install size of plants will be dependent on the project budget and the importance of initial impact. Typically install size is either tubestock or 150mm pots for groundcovers and shrubs and a minimum of 45 litre pot for trees.

Where indigenous species are used plants should be of local provenance.

Note this list provides a basis for species selection and is not intended to be exhaustive or exclusive. Particular projects may have other considerations that influence species selection including local character. Plants within the filter media should however be able to adapt to the conditions of the biofiltration system and have the same attributes as the suggested species.

Plants should be tolerant of the following conditions:

- Free draining coarse textured soils
- Periodic flooding
- Extended dry periods

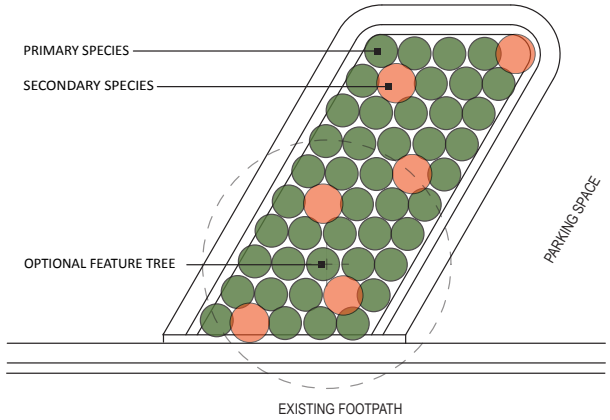
Desirable plant attributes include:

- High growth rate
- High root density
- High total root, leaf and shoot biomass
- High root:shoot ratio
- High leaf area ratio
- High length of longest root

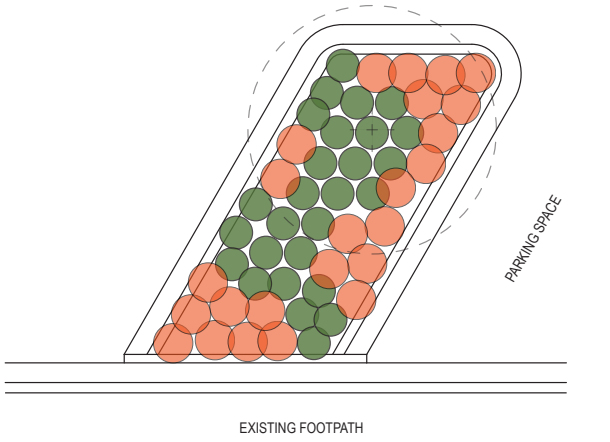
PRIMARY SPECIES	SECONDARY FEATURE SPECIES	TREE SPECIES
To comprise at least 75% of total plant numbers: • *Carex appressa* • *Juncus amabilis* • *Juncus flavidus* • *Ficinia nodosa*	To comprise no more than 25% of total plant numbers: • *Anigozanthus species* • *Brachyscome multifida* • *Carpobrotus modestus* • *Dianella longifolia* • *Dianella revoluta* • *Leucophyta brownii* • *Lomandra longifolia* • *Myoporum parvifolium*	• *Banksia species* • *Callistemon viminalis* • *Callistemon salignus* • *Callistemon sieberi* • *Lagerstroemia cultivars* • *Lophostemon confertus* • *Pyrus calleryana* • *Casuarina cunninghamiana* • *Maclura pomifera* 'Witchita' • *Brachychiton acerifolius*

[1] FAWB, 2009. *Adoption Guidelines for Stormwater Biofiltration Systems,* Facility for Advanced Water Biofiltration, Monash University, Melbourne.

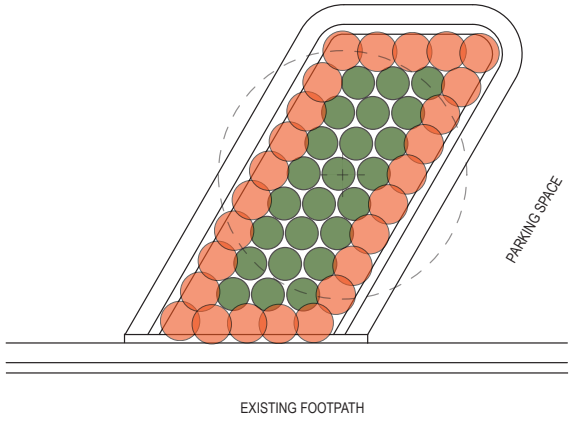
Typical Planting Arrangements



RANDOM



SWATHE



BORDER

Edge Planting

		DESCRIPTION	SUGGESTED SPECIES
EDGE PLANTING		Complementary edge planting can be included in stepped edges or any landscaped areas immediately abutting the raingarden. A thin strip of edge planting can form a useful barrier and visual cue to stop pedestrians from straying into the raingarden. Larger install size should be considered for edge planting to form an immediate barrier and visual cue for pedestrians.	• *Anigozanthus species* • *Brachyscome multifida* • *Callistemon species* • *Carpobrotus modestus* • *Chrysocephalum apiculatum* • *Chrysocephalum semipapposum* • *Dianella longifolia* • *Dianella revoluta* • *Dianella species* • *Hardenbergia violacea* • *Iris germanica* • *Leucophyta brownii* • *Lomandra longifolia* • *Lomandra species* • *Myoporum parvifolium* • *Patersonia occidentalis*
FEATURE TREES		Small trees can be included in the adjacent planting, within biofiltration tree pits or in some circumstances within raingardens themselves to add an extra dimension of vegetation or help tie the raingarden into the surrounding landscape character.	• *Callistemon viminalis,* • *Callistemon salignus* • *Callistemon sieberi* • *Lagerstroemia cultivars* • *Lophostemon confertus* • *Pyrus calleryana* • *Casuarina cunninghamiana* • *Maclura pomifera* 'Witchita' • *Platanus orientalis* • *Platanus x acerifolia* • *Brachychiton acerifolius*

3.9 Planting Palette

The following planting palette is a suggested list of plants suitable for use in bioretention filter media with planting composition done in accordace with Section 3.8.

This list provides a basis for species selection and is not intended to be exhaustive or exclusive.

PRIMARY SPECIES	CAREX APPRESSA	FICINIA NODOSA	JUNCUS AMABILIS	JUNCUS FLAVIDUS
IMAGE				
DETAILS	**Common Name:** Tall Sedge **Size at maturity (HXW):** 1.5-1.2 x 0.5-1m **Recommended density:** 8/m²	**Common Name:** Knobby Club Rush **Size at maturity (HXW) :** 0.5 -1 x 0.5 -1m **Recommended density:** 8/m²	**Common Name:** Hollow Rush **Size at maturity (HXW) :** 0.2 - 1.2 x 0.2 - 0.5m **Recommended density:** 8/m²	**Common Name:** Juncas **Size at maturity (HXW):** 0.04-0.12 x 0.04-0.1m **Recommended density:** 8/m²
COMMENTS	Grows well in wet soils along margins of water areas in full sun/ semi shade. Will tolerate some drying out and frost.	Grows in a range of conditions and soil types, in full sun to part-shade. Fast growing.	Grows in a range of conditions and soil types, in full sun to part-shade.	Tolerant of most soil conditions, including wet areas and swampy soil. Tolerant of frost.

SECONDARY SPECIES

	ANIGOZANTHOS SPECIES	CARPOBROTUS MODESTUS	DIANELLA LONGIFOLIA	DIANELLA REVOLUTA
IMAGE				
DETAILS	**Common Name:** Kangaroo Paw **Size at maturity (HXW):** 0.5-1.2 x 0.5-0.8m **Recommended density:** 6/m²	**Common Name:** Pig Face **Size at maturity (HXW) :** 0.2 x 0.1m **Recommended density:** 2/m²	**Common Name:** Smooth Flax Lily **Size at maturity (HXW):** 0.5-1 x 1m **Recommended density:** 8/m²	**Common Name:** Blue Flax Lily **Size at maturity (HXW):** 0.1 x 0.25m **Recommended density:** 8/m²
COMMENTS	Grows best in well-drained soils in a sunny position. Kangaroo paws are relatively short-lived plants. Some species do not tolerate frost.	Grows in a range of conditions and soil types, in full sun to part-shade. Fast growing.	Grows in most soil conditions in full sun or part shade. Fast growing, hardy and drought tolerant.	Grows in most free draining soils, in full sun to part-shade. Tolerates drought and frost.

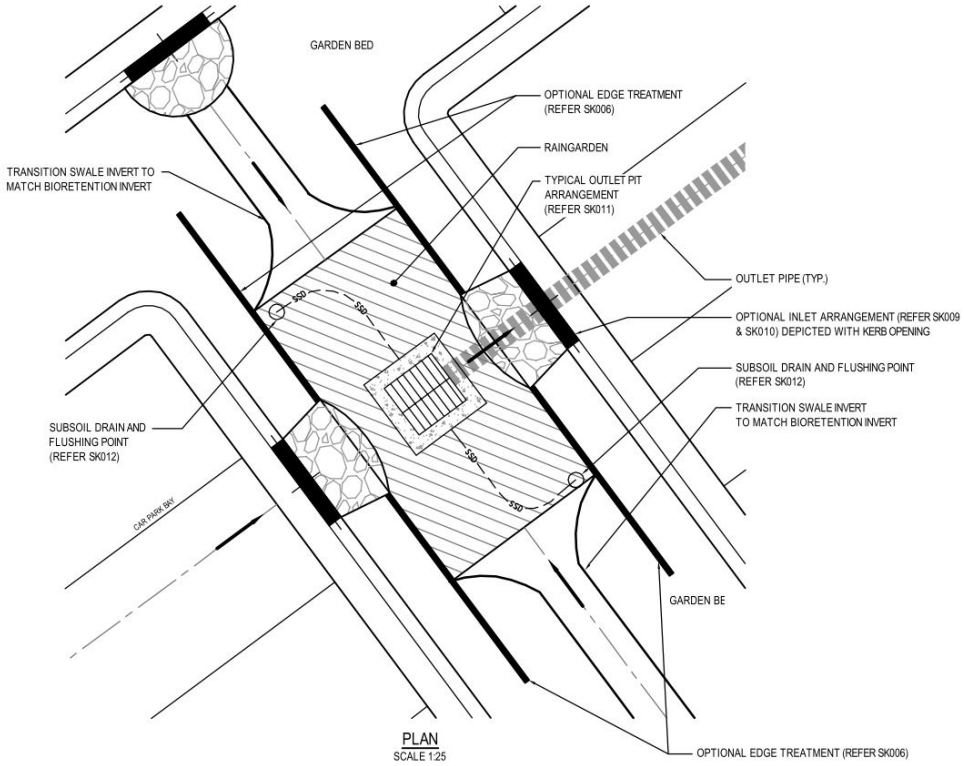
	LEUCOPHYTA BROWNII	LOMANDRA LONGIFOLIA	MYOPORUM PARVIFOLIUM
IMAGE			
DETAILS	**Common Name:** Cushion Bush **Size at maturity (HXW):** 1 x 1m **Recommended density:** 4/m²	**Common Name:** Spiny Head Mat Rush **Size at maturity (HXW) :** 1-2 x 1-2m **Recommended density:** 2/m²	**Common Name:** Creeping Boobialla **Size at maturity (HXW):** 0.2 x 1.5-5m **Recommended density:** 2/m²
COMMENTS	Prefers well-drained soil and full sun. Grows in coastal conditions and can tolerate frost and drought.	Grows in full sun and part-shade. Grows well in both coastal and inland conditions.	Grows in a variety of soil types in full sun to part shade. It will tolerate coastal conditions, and moderate drought and frost.

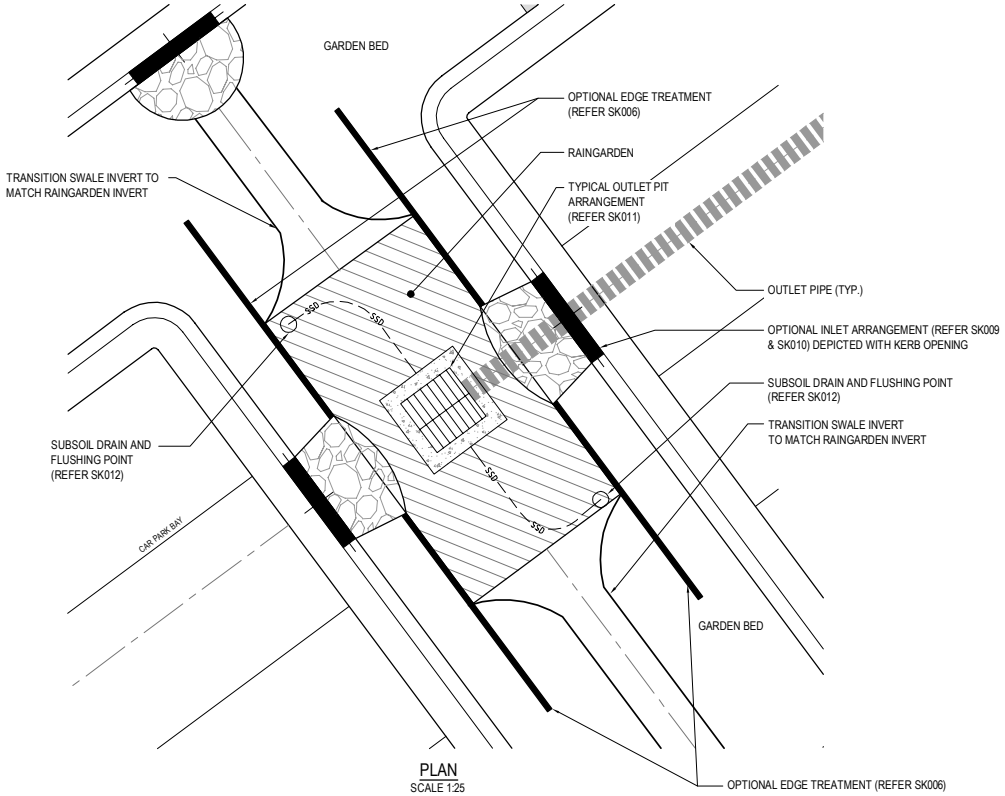
TREES

	BANKSIA SPECIES	CALLISTEMON VIMINALIS	CALLISTEMON SALIGNUS	EUCALYPTUS LEUCOXYLON	LAGERSTROEMIA CULTIVARS
IMAGE					
DETAILS	**Common Name:** Banksia **Size at maturity (HXW):** 2-25 x 2-10m	**Common Name:** Red Bottlebrush **Size at maturity (HXW):** 6-8 x 4-6m	**Common Name:** Willow Bottle Brush **Size at maturity (HXW) :** 6-8 x 4-5m	**Common Name:** Yellow gum **Size at maturity (HXW):** 8-12 x 5-7m	**Size at maturity (HXW):** 4-6 x 3-5m
COMMENTS	Woody, evergreen plants ranging from round shrubs to tall trees. Grow best in well drained soils and in a sunny position. Only low phosphorus fertilisers should be used.	Optimal conditions are in moist well-drained soils in full - partial sun. It will grow in heavy waterlogged soils but is susceptible to frost damage.	Grows well in most soil types, in full sun or part-shade. Moderate drought tolerance and high tolerance of water logging and therefore tolerates periods of inundation.	Can grow with some coastal and saline conditions and irregular waterlogging.	Grows well in moist, slightly acidic soils in full sun.

	LOPHOSTEMON CONFERTUS	PYRUS CALLERYANA	ALLOCASUARINA CUNNINGHAMIANA	MACLURA POMIFERA 'WITCHITA'	BRACHYCHITON ACERIFOLIUS
IMAGE					
DETAILS	**Common Name:** Brush Box **Size at maturity (HXW) :** 15 x 8m	**Common Name:** Callery Pear **Size at maturity (HXW):** 8-12 x 5-7m	**Common Name:** The River She-Oak **Size at maturity (HXW) :** 15 -35 x 8-15m	**Common Name:** Wichita Osage Orange **Size at maturity (HXW):** 12 -20 x 10-15m	**Common Name:** Illawarra Flame Tree **Size at maturity (HXW):** 15-20 x 10-15m
COMMENTS	Prefers sandy soils and full sun- part shade. Drought and frost tolerant.	Not drought tolerant. Can be used in narrow sites.	Prefers sandy soils and full sun- part shade. Drought and frost tolerant.	Adapts to most soils, prefers full sun and has tolerance to a range of difficult site conditions after irrigation during establishment.	Will grow in most soils and prefers sunny position. Tolerant of dry conditions but can be sensitive to frost.

4 AUTOCAD LIBRARY





PLAN
SCALE 1:25

REF: CITY OF BAYSIDE 'IMAGE SUPPLIED COURTESY OF MELBOURNE WATER'

NOTE: INLET CONFIGURATION SHOWN IN IMAGE DIFFERS FROM THAT SHOWN ON PLAN

IMAGE
NTS

0 0.25 0.5 0.75 1.0 1.25m
SCALE 1:25 AT ORIGINAL SIZE

CAR PARK CONFIGURATION

NOTES

1. THE STANDARD DETAILS SHOWN ON THIS DRAWING ARE TYPICAL ONLY. THESE DETAILS MAY NEED TO BE RECONFIGURED TO SUIT SITE SPECIFIC CONDITIONS.

FOR ISSUE

rev	description	app'd	date
0	FOR ISSUE	SG	4/7/13

MORELAND CITY COUNCIL
WSUD MELBOURNE STANDARDS
RAINGARDEN
CAR PARK CONFIGURATION

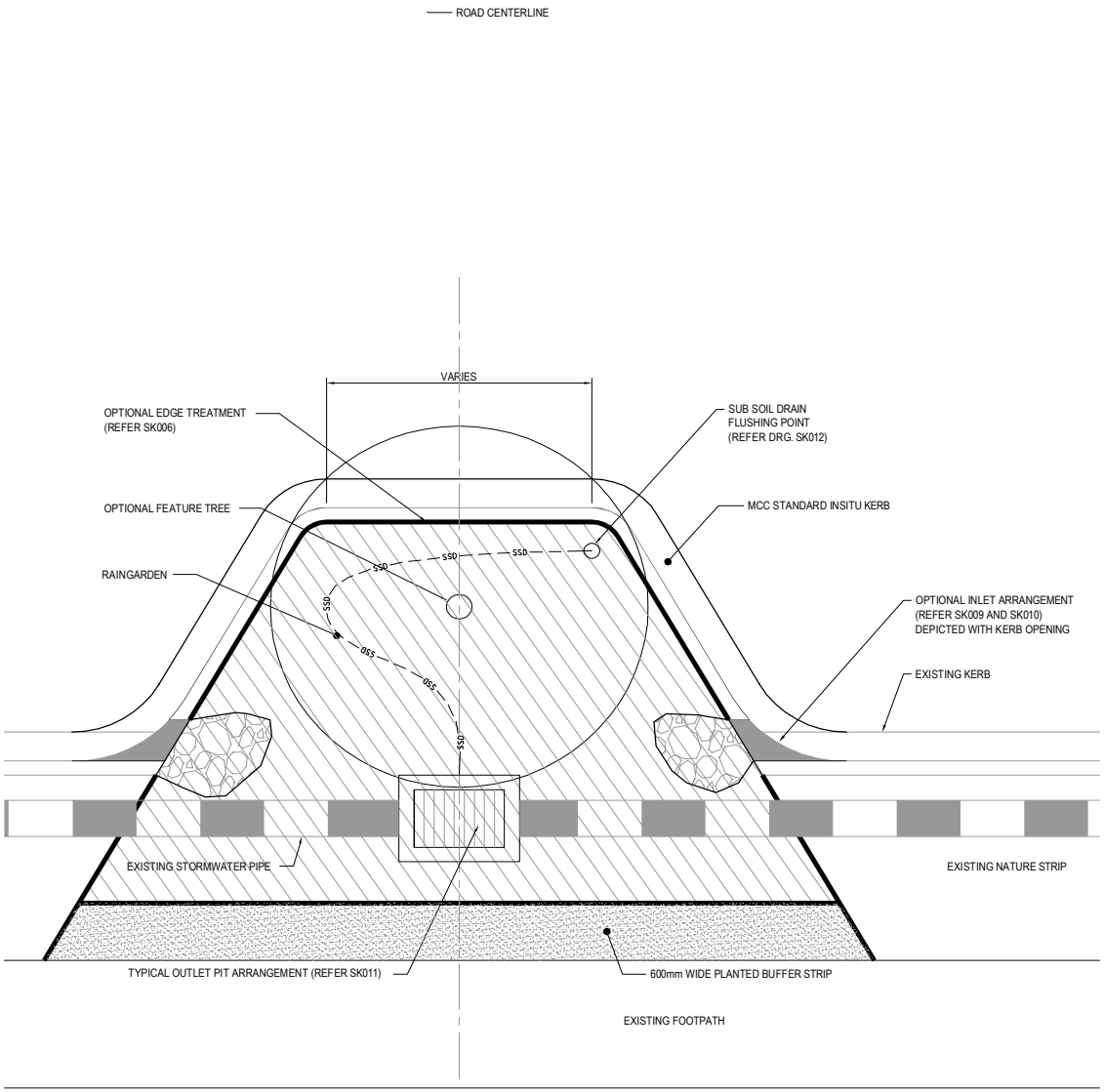
Moreland City Council

DEVELOPED BY GHD

Conditions of Use: This document may only be used by GHD's client (and any other person who GHD has agreed can use this document) for the purpose for which it was prepared and must not be used by any other person or for any other purpose.

scale 1:25 for A4 job no. 31-30117
date JULY 2013 rev no. 0

approved (PD) S. GRAHAM SK001



PLAN
SCALE 1:25

KERB OUTSTAND CONFIGURATION

REF: CITY OF STONNINGTON 'IMAGE SUPPLIED COURTESY OF MELBOURNE WATER'

IMAGE
NTS

NOTES

1. THE STANDARD DETAILS SHOWN ON THIS DRAWING ARE TYPICAL ONLY. THESE DETAILS MAY NEED TO BE RECONFIGURED TO SUIT SITE SPECIFIC CONDITIONS.

0 0.25 0.5 0.75 1.0 1.25m
SCALE 1:25 AT ORIGINAL SIZE

FOR ISSUE

rev	description	app'd	date
0	FOR ISSUE	SG	4/7/13

MORELAND CITY COUNCIL
WSUD MELBOURNE STANDARDS
RAINGARDEN
KERB OUTSTAND CONFIGURATION

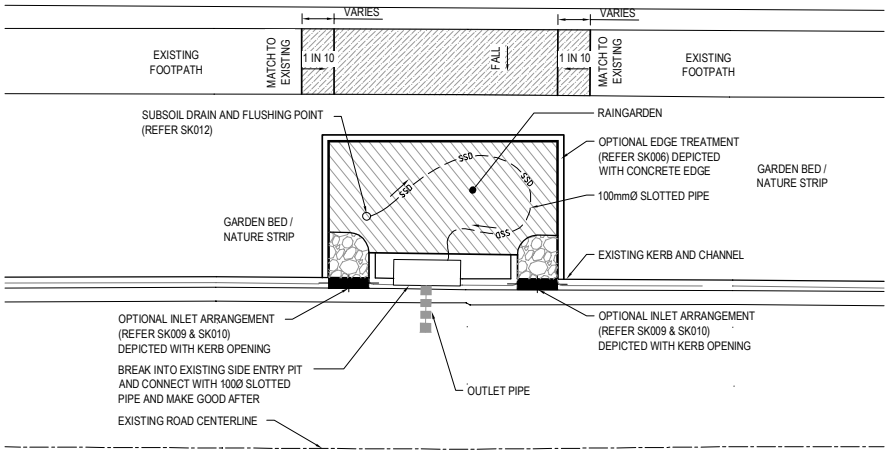
Moreland City Council

DEVELOPED BY GHD

Conditions of Use: This document may only be used by GHD's client (and any other person who GHD has agreed can use this document) for the purpose for which it was prepared and must not be used by any other person or for any other purpose.

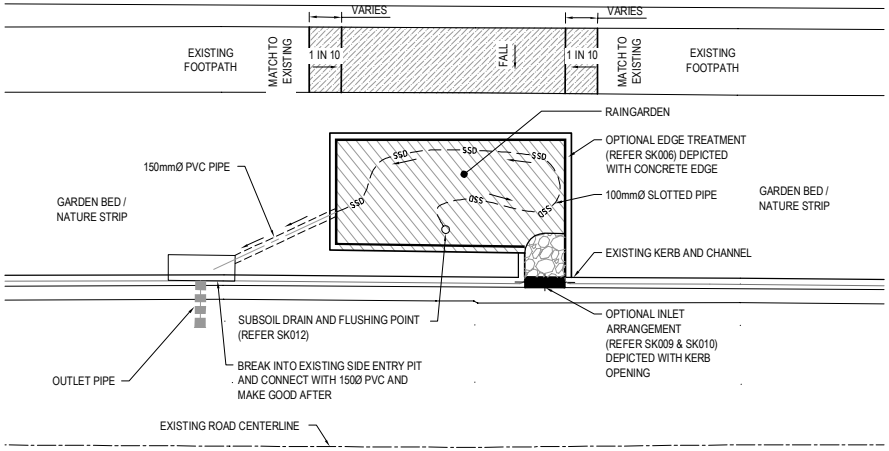
scale 1:25 for A4 job no. 31-30117
date JULY 2013 rev no. 0

approved (PD) S. GRAHAM SK002



PLAN - SIDE ENTRY PIT WITHIN RAINGARDEN

SCALE 1:50



PLAN - SIDE ENTRY PIT OUTSIDE RAINGARDEN

SCALE 1:50

IMAGE

NTS

NOTES

1. THE STANDARD DETAILS SHOWN ON THIS DRAWING ARE TYPICAL ONLY. THESE DETAILS MAY NEED TO BE RECONFIGURED TO SUIT SITE SPECIFIC CONDITIONS.

0 0.5 1.0 1.5 2.0 2.5m

SCALE 1:50 AT ORIGINAL SIZE

FOR ISSUE

rev	description	app'd	date
0	FOR ISSUE	SG	4/7/13

MORELAND CITY COUNCIL
WSUD MELBOURNE STANDARDS

RAINGARDEN

NATURE STRIP CONFIGURATION

Moreland City Council

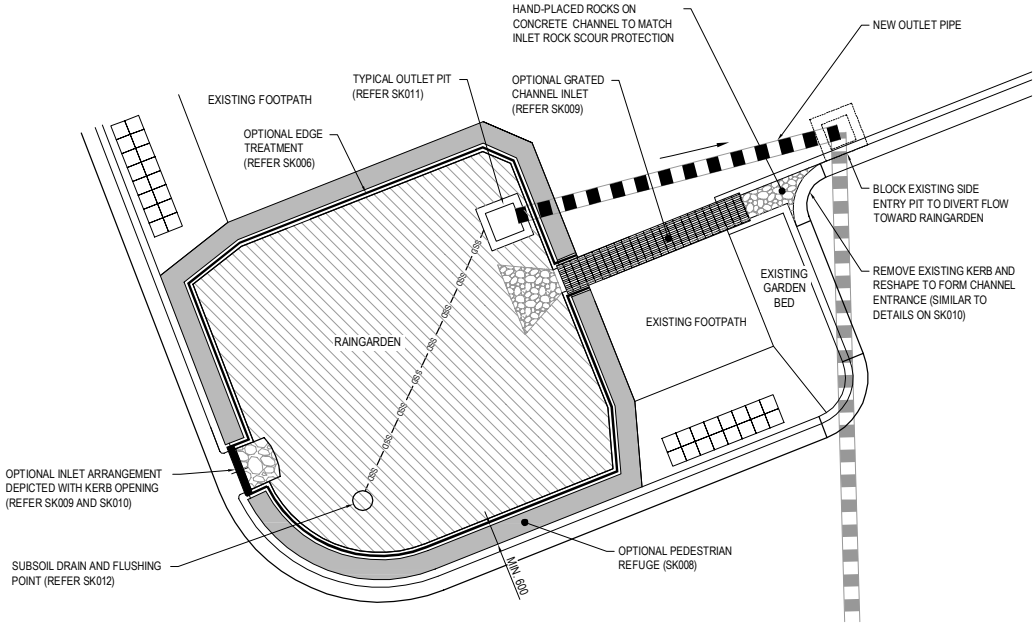
DEVELOPED BY GHD

Conditions of Use: This document may only be used by GHD's client (and any other person who GHD has agreed can use this document) for the purpose for which it was prepared and must not be used by any other person or for any other purpose.

scale 1:50 for A4 job no. 31-30117

date JULY 2013 rev no. 0

approved (PD) S. GRAHAM SK003



PLAN
SCALE 1: 50

REF: CITY OF PORT PHILLIP 'IMAGE SUPPLIED COURTESY OF MELBOURNE WATER'

IMAGE
NOT TO SCALE

0 0.5 1.0 1.5 2.0 2.5m
SCALE 1:50 AT ORIGINAL SIZE

FOR ISSUE

rev	description	app'd	date
0	FOR ISSUE	SG	4/7/13

MORELAND CITY COUNCIL
WSUD MELBOURNE STANDARDS
RAINGARDEN
CORNER CONFIGURATION

Moreland City Council

DEVELOPED BY GHD

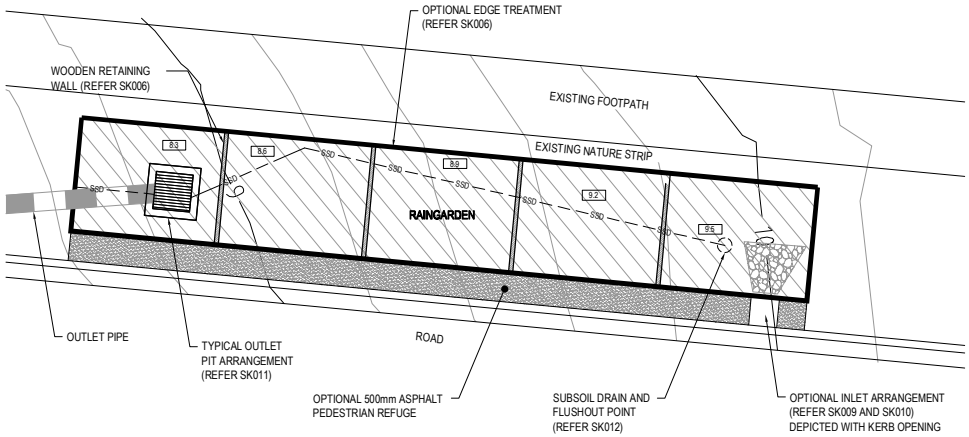
Conditions of Use: This document may only be used by GHD's client (and any other person who GHD has agreed can use this document) for the purpose for which it was prepared and must not be used by any other person or for any other purpose.

scale 1:50 for A4 job no. 31-30117
date JULY 2013 rev no. 0

approved (PD) S. GRAHAM SK004

NOTES:

1. THE STANDARD DETAILS SHOWN ON THIS DRAWING ARE TYPICAL ONLY. THESE DETAILS MAY NEED TO BE RECONFIGURED TO SUIT SITE SPECIFIC CONDITIONS.



PLAN
SCALE 1:50

NOTES

1. THE STANDARD DETAILS SHOWN ON THIS DRAWING ARE TYPICAL ONLY. THESE DETAILS MAY NEED TO BE RECONFIGURED TO SUIT SITE SPECIFIC CONDITIONS.

0 0.5 1.0 1.5 2.0 2.5m
SCALE 1:50 AT ORIGINAL SIZE

FOR ISSUE

0	FOR ISSUE	SG	4/7/13
rev	description	app'd	date

MORELAND CITY COUNCIL
WSUD MELBOURNE STANDARDS

RAINGARDEN SLOPING CONFIGURATION

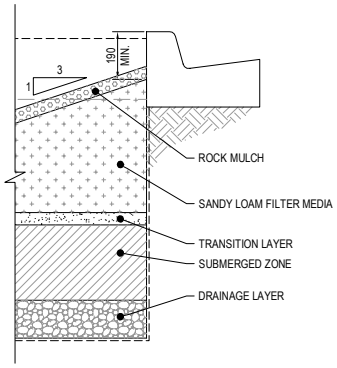
Moreland City Council

DEVELOPED BY GHD

Conditions of Use: This document may only be used by GHD's client (and any other person who GHD has agreed can use this document) for the purpose for which it was prepared and must not be used by any other person or for any other purpose.

scale 1:50 for A4 job no. 31-30117
date JULY 2013 rev no. 0

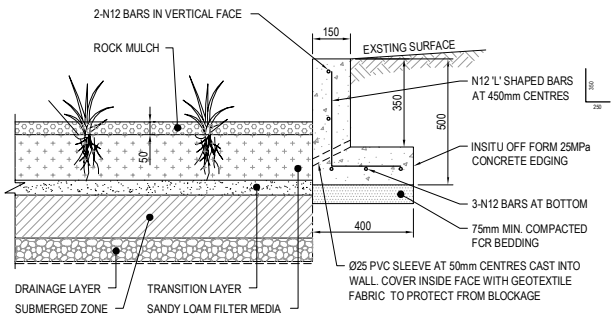
approved (PD) S. GRAHAM SK005



DETAIL
SCALE 1:10

IMAGE
NTS

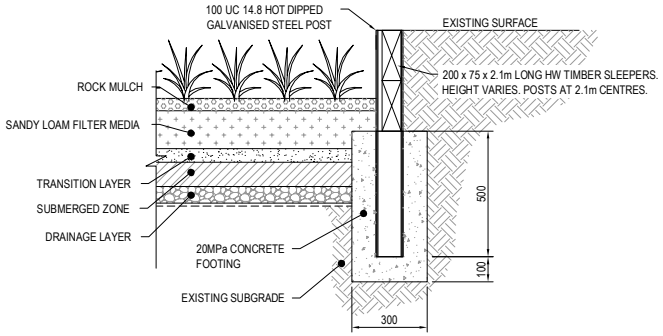
BATTERED EDGE TREATMENT



DETAIL
SCALE 1:10

IMAGE
NTS

CONCRETE EDGE TREATMENT



DETAIL
SCALE 1:10

IMAGE
NTS

TIMBER RETAINING WALL TREATMENT

NOTES

1. THE STANDARD DETAILS SHOWN ON THIS DRAWING ARE TYPICAL ONLY. THESE DETAILS MAY NEED TO BE RECONFIGURED TO SUIT SITE SPECIFIC CONDITIONS.

0 100 200 300 400 500mm
SCALE 1:10 AT ORIGINAL SIZE

FOR ISSUE

rev	description	app'd	date
0	FOR ISSUE	SG	4/7/13

MORELAND CITY COUNCIL
WSUD MELBOURNE STANDARDS
RAINGARDEN
EDGE TREATMENT - MATERIALS

Moreland City Council

DEVELOPED BY GHD

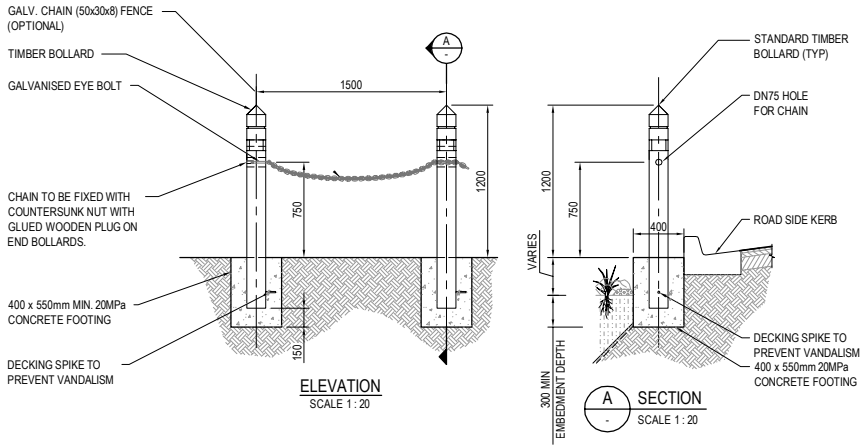
Conditions of Use: This document may only be used by GHD's client (and any other person who GHD has agreed can use this document) for the purpose for which it was prepared and must not be used by any other person or for any other purpose.

scale 1:10 for A4 job no. 31-30117
date JULY 2013 rev no. 0

approved (PD) S. GRAHAM SK006

IMAGE
NTS

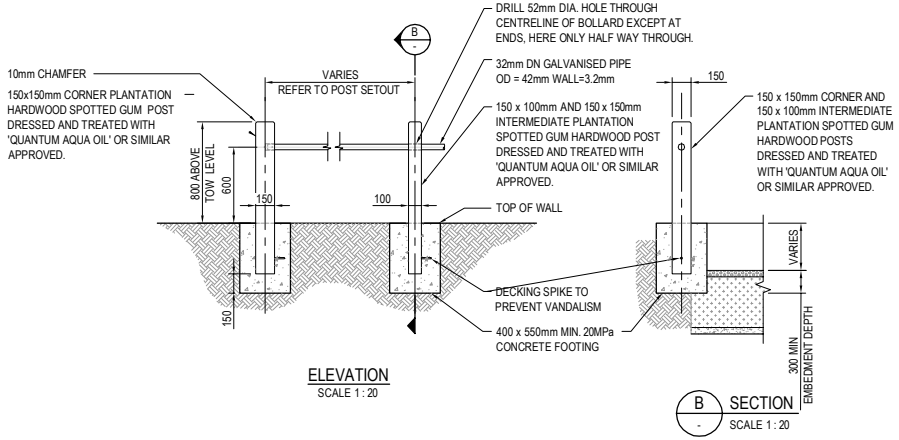
IMAGE
NTS



ELEVATION
SCALE 1 : 20

A SECTION
SCALE 1 : 20

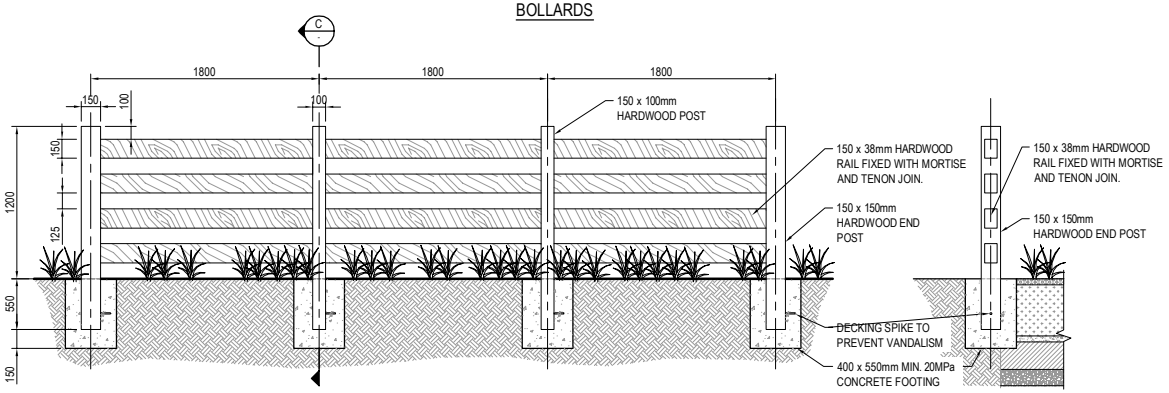
BOLLARDS



ELEVATION
SCALE 1 : 20

B SECTION
SCALE 1 : 20

GALVANISED RAIL FENCE



ELEVATION
SCALE 1 : 20

C SECTION
SCALE 1 : 20

1.2m HIGH TIMBER FENCE

IMAGE
NTS

0 0.2 0.4 0.6 0.8 1.0m
SCALE 1:20 AT ORIGINAL SIZE

FOR ISSUE

rev	description	app'd	date
0	FOR ISSUE	SG	4/7/13

MORELAND CITY COUNCIL
WSUD MELBOURNE STANDARDS
RAINGARDEN
FENCING

Moreland City Council

DEVELOPED BY GHD

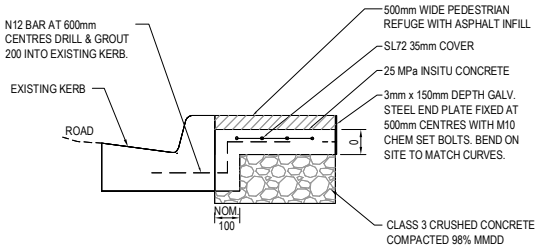
Conditions of Use: This document may only be used by GHD's client (and any other person who GHD has agreed can use this document) for the purpose for which it was prepared and must not be used by any other person or for any other purpose.

scale 1:20 for A4 job no. 31-30117
date JULY 2013 rev no. 0

approved (PD) S. GRAHAM SK007

NOTES

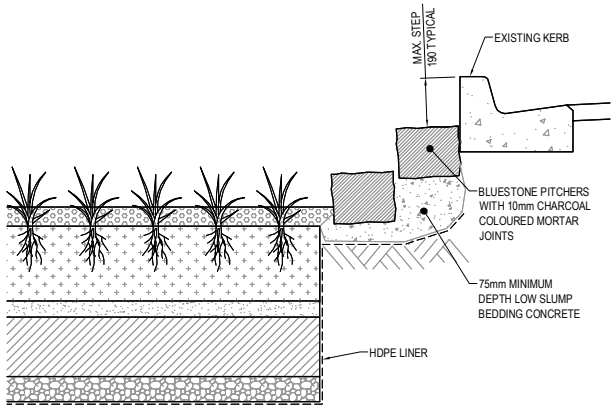
1. THE STANDARD DETAILS SHOWN ON THIS DRAWING ARE TYPICAL ONLY. THESE DETAILS MAY NEED TO BE RECONFIGURED TO SUIT SITE SPECIFIC CONDITIONS.



DETAIL
SCALE 1:10

IMAGE
NTS

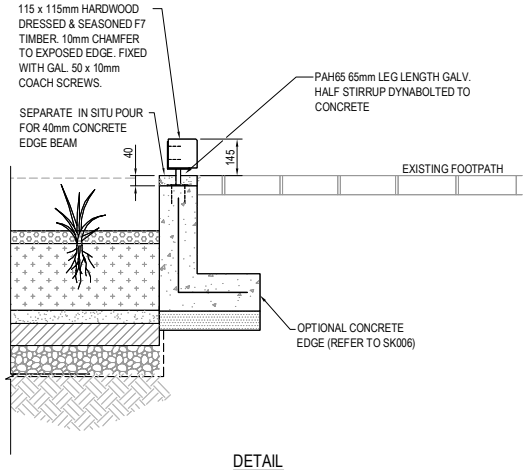
PEDESTRIAN REFUGES AND STEEL EDGING



DETAIL
SCALE 1:10

IMAGE
NTS

STEPPED SIDES



DETAIL
SCALE 1:10

IMAGE
NTS

PRAM STOPS

0 0.1 0.2 0.3 0.4 0.5m
SCALE 1:10 AT ORIGINAL SIZE

FOR ISSUE

rev	description	app'd	date
0	FOR ISSUE	SG	4/7/13

MORELAND CITY COUNCIL
WSUD MELBOURNE STANDARDS
RAINGARDEN
SAFETY MEASURES

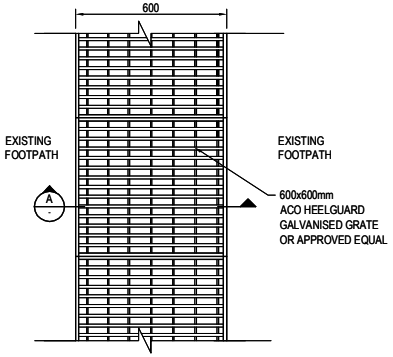
Moreland City Council

DEVELOPED BY GHD

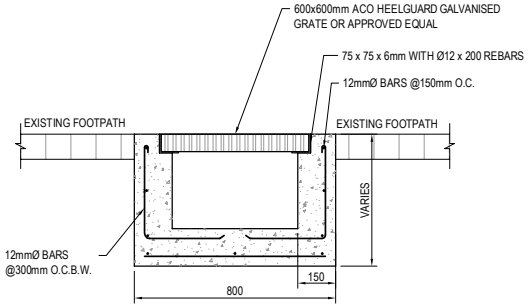
Conditions of Use: This document may only be used by GHD's client (and any other person who GHD has agreed can use this document) for the purpose for which it was prepared and must not be used by any other person or for any other purpose.

scale AS SHOWN for A4 job no. 31-30117
date JULY 2013 rev no. 0

approved (PD) S. GRAHAM SK008



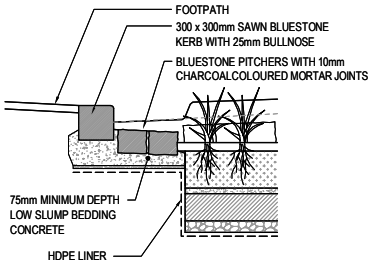
PLAN
SCALE 1:10



GRATED CONCRETE CHANNEL

A SECTION
SCALE 1 : 10

IMAGE
NTS



BLUESTONE PITCHERS WITH CROSS-FALL INLET
SCALE 1:20

IMAGE
NTS

NOTES

1. THE STANDARD DETAILS SHOWN ON THIS DRAWING ARE TYPICAL ONLY. THESE DETAILS MAY NEED TO BE RECONFIGURED TO SUIT SITE SPECIFIC CONDITIONS.

0 100 200 300 400 500mm
SCALE 1:10 AT ORIGINAL SIZE

0 200 400 600 800 1000mm
SCALE 1:20 AT ORIGINAL SIZE

FOR ISSUE

0	FOR ISSUE	SG	4/7/13
rev	description	app'd	date

MORELAND CITY COUNCIL
WSUD MELBOURNE STANDARDS
RAINGARDEN
INLET OPTIONS SHEET 1 OF 2

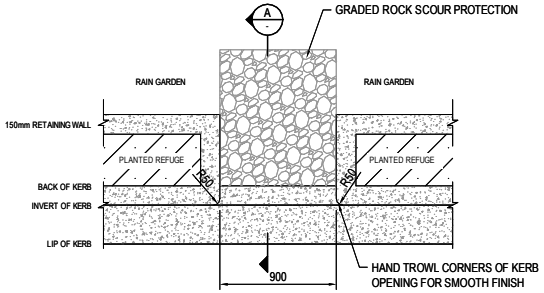
Moreland City Council

DEVELOPED BY GHD

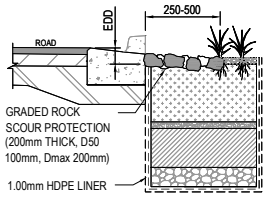
Conditions of Use: This document may only be used by GHD's client (and any other person who GHD has agreed can use this document) for the purpose for which it was prepared and must not be used by any other person or for any other purpose.

scale AS SHOWN for A4 job no. 31-30117
date JULY 2013 rev no. 0

approved (PD) S. GRAHAM SK009



PLAN
SCALE 1:20



A
-
SECTION
SCALE 1 : 20

IMAGE
NTS

KERB OPENING & ENERGY DISSIPATION

0 200 400 600 800 1000mm
SCALE 1:20 AT ORIGINAL SIZE

FOR ISSUE

rev	description	app'd	date
0	FOR ISSUE	SG	4/7/13

MORELAND CITY COUNCIL
WSUD MELBOURNE STANDARDS
RAINGARDEN
INLET OPTIONS SHEET 2 OF 2

Moreland City Council

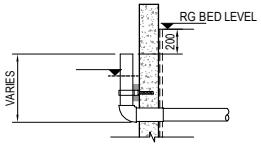
DEVELOPED BY GHD

Conditions of Use: This document may only be used by GHD's client (and any other person who GHD has agreed can use this document) for the purpose for which it was prepared and must not be used by any other person or for any other purpose.

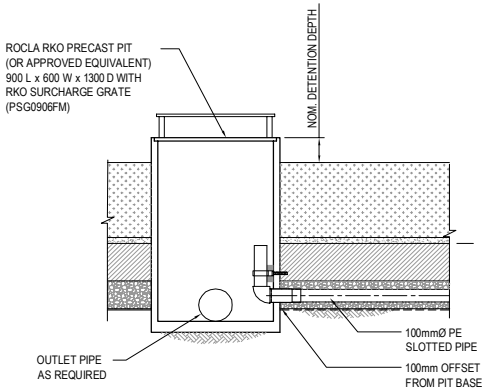
scale	1:20 for A4	job no.	31-30117
date	JULY 2013	rev no.	0

NOTES

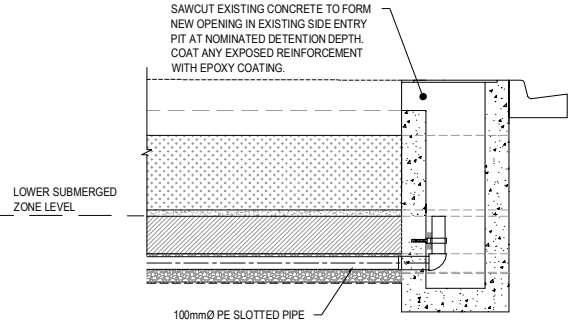
1. THE STANDARD DETAILS SHOWN ON THIS DRAWING ARE TYPICAL ONLY. THESE DETAILS MAY NEED TO BE RECONFIGURED TO SUIT SITE SPECIFIC CONDITIONS.



SUBMERGED ZONE RISER ARRANGEMENT
SCALE 1:20



TYPICAL OUTLET PIT ARRANGEMENT
SCALE 1:20



SIDE ENTRY PIT OUTLET ARRANGEMENT
SCALE 1:20

0 0.2 0.4 0.6 0.8 1.0m
SCALE 1:20 AT ORIGINAL SIZE

FOR ISSUE

rev	description	app'd	date
0	FOR ISSUE	SG	4/7/13

MORELAND CITY COUNCIL
WSUD MELBOURNE STANDARDS
RAINGARDEN
OUTLET OPTIONS

Moreland City Council

DEVELOPED BY GHD

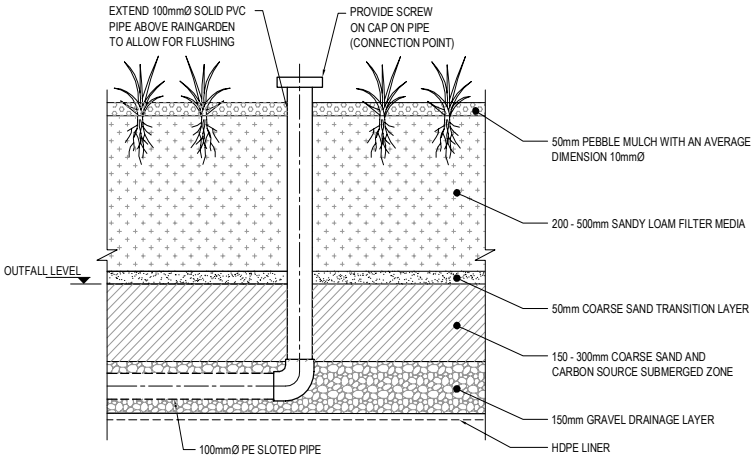
Conditions of Use: This document may only be used by GHD's client (and any other person who GHD has agreed can use this document) for the purpose for which it was prepared and must not be used by any other person or for any other purpose.

scale AS SHOWN for A4 job no. 31-30117
date JULY 2013 rev no. 0

approved (PD) S. GRAHAM SK011

NOTES

1. THE STANDARD DETAILS SHOWN ON THIS DRAWING ARE TYPICAL ONLY. THESE DETAILS MAY NEED TO BE RECONFIGURED TO SUIT SITE SPECIFIC CONDITIONS.



FLUSHING POINT DETAIL
SCALE 1:10

IMAGE
NTS

FILTER MEDIA COMPONENT NOTES:

F1. ALL FILTER MEDIA USED FOR THE WORKS IS TO BE APPROPRIATELY TESTED IN ACCORDANCE WITH THE FOLLOWING NOTES AND A COPY OF RESULTS SENT TO THE PROJECT SUPERINTENDENT PRIOR TO THE MATERIAL BEING PLACED ON SITE.

F2. FILTER MEDIA SHALL HAVE A SATURATED HYDRAULIC CONDUCTIVITY IN THE RANGE OF 250-350 mm/h UNLESS OTHERWISE APPROVED BY THE SUPERINTENDENT. SATURATED HYDRAULIC CONDUCTIVITY OF POTENTIAL FILTER MEDIA SHOULD BE MEASURED USING THE ASTM F1815-06 METHOD.

F3 FILTER EDIA, WHICH COMPLY WITH THE PARTICLE SIZE GRADING OUTLINED BELOW, WILL GENERALLY MEET SATURATED HYDRAULIC CONDUCTIVITY SPECIFICATIONS.

DESCRIPTION	PROPORTION	GRADING
CLAY & SILT	< 3 %	< 0.05 mm
VERY FINE SAND	5 - 10 %	0.05 - 0.15 mm
FINE SAND	10 - 25 %	0.15 - 0.25 mm
MEDIUM TO COARSE SAND	60 - 70 %	0.25 - 1.0 mm
COARSE SAND	7 - 10 %	1.0 - 2.0 mm
FINE GRAVEL	< 3 %	2.0 - 3.4 mm

F4 THE FILTER MEDIA SHOULD BE WELL-GRADED i.e., IT SHOULD HAVE ALL PARTICLE SIZE RANGES PRESENT FROM THE 0.075 mm TO THE 4.75 mm SIEVE (AS DEFINED BY AS1289.3.6.1 - 1995). THERE SHOULD BE NO GAP IN THE PARTICLE SIZE GRADING, AND THE COMPOSITION SHOULD NOT BE DOMINATED BY A SMALL PARTICLE SIZE RANGE.

F5. FILTER MEDIA THAT DO NOT MEET THE FOLLOWING ADAPTED AS4419 - 2003 - SOILS FOR LANDSCAPING AND GARDEN USE SPECIFICATION SHOULD BE REJECTED:

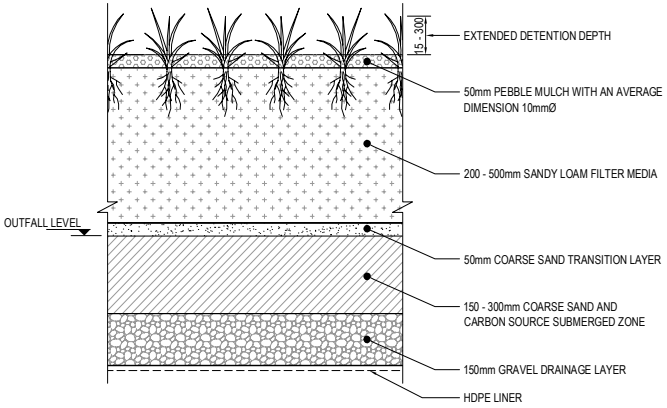
a. ORGANIC MATTER CONTENT - LESS THAN 5% (w/w). AN ORGANIC CONTENT HIGHER THAN 5% IS LIKELY TO RESULT IN LEACHING OF NUTRIENTS.
b. pH- AS SPECIFIED FOR "NATURAL SOILS AND BLENDS" 5.5 -7.5 (pH 1:5 IN WATER).
c. ELECTRICAL CONDUCTIVITY (EC) - AS SPECIFIED FOR NATURAL SOILS AND SOIL BLENDS < 1.2 dS/m.
d. PHOSPHORUS - < 100 mg/kg. SOILS WITH PHOSPHORUS CONCENTRATIONS > 100 mg/kg SHOULD BE TESTED FOR POTENTIAL LEACHING.

F6. POTENTIAL FILTER MEDIA SHOULD GENERALLY BE ASSESSED BY A HORTICULTURALIST TO ENSURE THAT THEY ARE CAPABLE OF SUPPORTING A HEALTHY VEGETATION COMMUNITY. THIS ASSESSMENT SHOULD TAKE INTO CONSIDERATION DELIVERY OF NUTRIENTS TO THE SYSTEM BY STORMWATER.

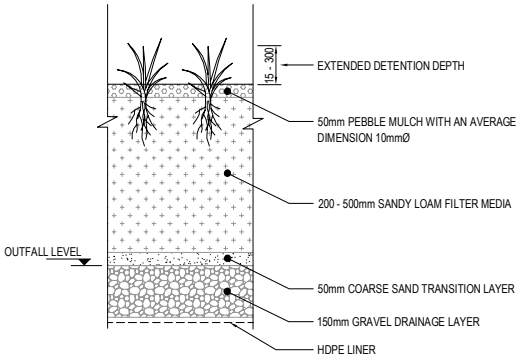
F10. THE TRANSITION LAYER SHALL CONSIST OF WASHED SAND WITH 90% PARTICLES RETAINED ABOVE 0.25mm THE HYDRAULIC CONDUCTIVITY OF THE TRANSITION LAYER IS TO BE NO LESS THAN 450mm/hr.

F12. THE DRAINAGE LAYER SHALL BE COMPOSED OF CLEAN STONE WITH ALL PARTICLES BETWEEN 4.0mm AND 7.0mm IN SIZE.

F13. SCORIA OR QUARTZ ARE NOT SUITABLE MATERIAL FOR USE AS A DRAINAGE LAYER.



STANDARD CROSS SECTION
(SUBMERGED)
SCALE 1:10



STANDARD CROSS SECTION
(NON-SUBMERGED)
SCALE 1:10

NOTES

1. THE STANDARD DETAILS SHOWN ON THIS DRAWING ARE TYPICAL ONLY. THESE DETAILS MAY NEED TO BE RECONFIGURED TO SUIT SITE SPECIFIC CONDITIONS.

0 100 200 300 400 500mm
SCALE 1:10 AT ORIGINAL SIZE

FOR ISSUE

rev	description	app'd	date
0	FOR ISSUE	SG	4/7/13

MORELAND CITY COUNCIL
WSUD MELBOURNE STANDARDS
RAINGARDEN
STANDARD CROSS-SECTION & FLUSHING POINT

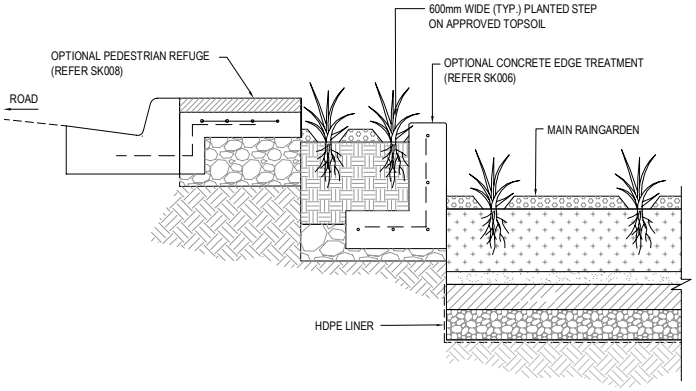
Moreland City Council

DEVELOPED BY GHD

Conditions of Use: This document may only be used by GHD's client (and any other person who GHD has agreed can use this document) for the purpose for which it was prepared and must not be used by any other person or for any other purpose.

scale 1:10 for A4 job no. 31-30117
date JULY 2013 rev no. 0

approved (PD) S. GRAHAM SK012



EDGE PLANTING
SCALE 1:10

IMAGE
NTS

0 100 200 300 400 500mm
SCALE 1:10 AT ORIGINAL SIZE

FOR ISSUE

rev	description	app'd	date
0	FOR ISSUE	SG	4/7/13

MORELAND CITY COUNCIL
WSUD MELBOURNE STANDARDS
RAINGARDEN
LANDSCAPE OPTION

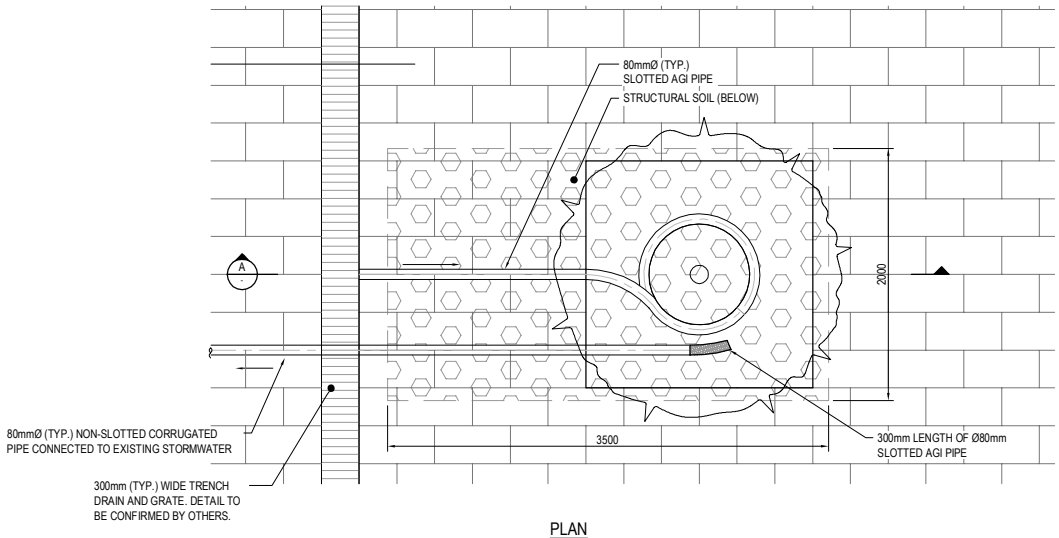
Moreland City Council

DEVELOPED BY GHD

Conditions of Use: This document may only be used by GHD's client (and any other person who GHD has agreed can use this document) for the purpose for which it was prepared and must not be used by any other person or for any other purpose.

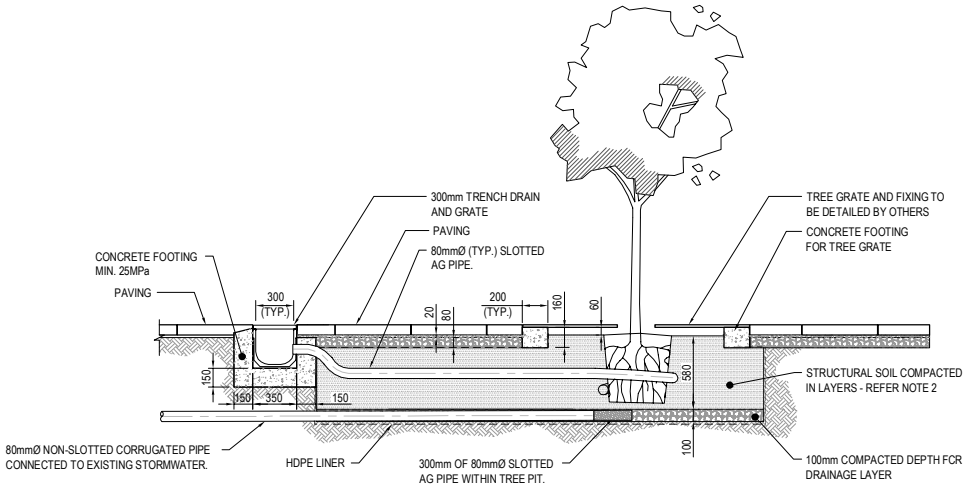
scale | 1:10 for A4 job no. | 31-30117
date | JULY 2013 rev no. | 0

approved (PD) S. GRAHAM SK013



PLAN
SCALE 1:20

IMAGE
NTS



A / - SECTION
SCALE 1 : 20

NOTES

1. THE STANDARD DETAILS SHOWN ON THIS DRAWING ARE TYPICAL ONLY. THESE DETAILS MAY NEED TO BE RECONFIGURED TO SUIT SITE SPECIFIC CONDITIONS.
2. STRUCTURAL SOIL LAYERS:
   - 2.1. 50-100mm OF "NO FINES" CONCRETE AS BEDDING FOR PAVERS;
   - 2.2. 600-900mm OF STRUCTURAL SOIL (A MATRIX OF 40mm DIAMETER STONES MIXED WITH APPROXIMATELY 20% BY VOLUME CLAY LOAM FILLER SOIL).

TREE PLANTER

0 200 400 600 800 1000mm
SCALE 1:20 AT ORIGINAL SIZE

FOR ISSUE

rev	description	app'd	date
0	FOR ISSUE	SG	4/7/13

MORELAND CITY COUNCIL
WSUD MELBOURNE STANDARDS
RAINGARDEN
TREE PIT

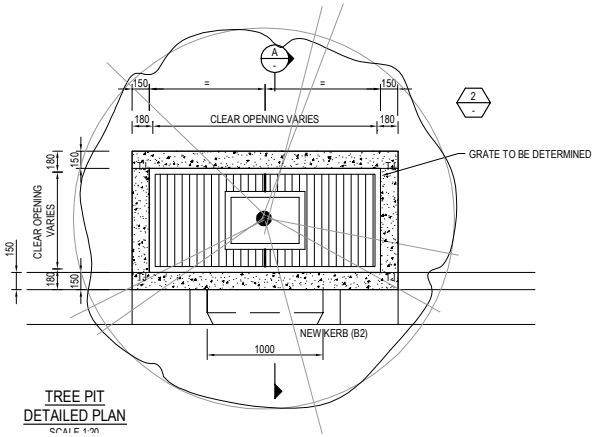
Moreland City Council

DEVELOPED BY GHD

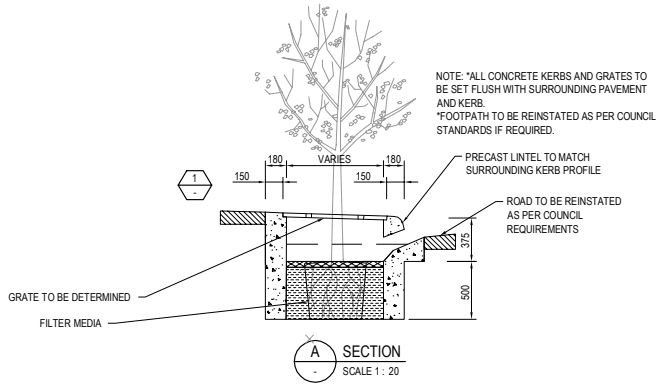
Conditions of Use: This document may only be used by GHD's client (and any other person who GHD has agreed can use this document) for the purpose for which it was prepared and must not be used by any other person or for any other purpose.

scale 1:20 for A4 job no. 31-30117
date JULY 2013 rev no. 0

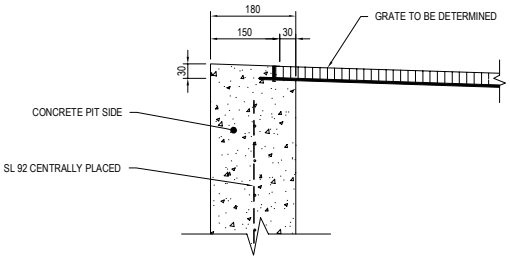
approved (PD) S. GRAHAM SK014



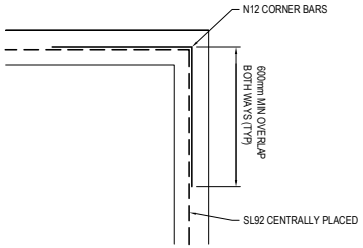
TREE PIT
DETAILED PLAN
SCALE 1:20



A
-
SECTION
SCALE 1 : 20

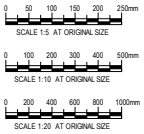


1
-
DETAIL
SCALE 1 : 5



CORNER REINFORCEMENT DETAIL

2
-
DETAIL
SCALE 1 : 10



FOR ISSUE

rev	description	app'd	date
0	FOR ISSUE	SG	4/7/13

MORELAND CITY COUNCIL
WSUD MELBOURNE STANDARDS

RAINGARDEN
BACK OF KERB TREE PIT

Moreland City Council

DEVELOPED BY GHD

Conditions of Use: This document may only be used by GHD's client (and any other person who GHD has agreed can use this document) for the purpose for which it was prepared and must not be used by any other person or for any other purpose.

scale **AS SHOWN** for A4 job no. 31-30117
date JULY 2013 rev no. 0

approved (PD) S. GRAHAM SK015

NOTES

1. THE STANDARD DETAILS SHOWN ON THIS DRAWING ARE TYPICAL ONLY. THESE DETAILS MAY NEED TO BE RECONFIGURED TO SUIT SITE SPECIFIC CONDITIONS.

5 SUPPLEMENTARY INFORMATION

5.1 Construction cost estimate procedure

Cost curves have been developed for the purpose of preparing simple cost estimates for streetscape raingardens. To view the cost curves refer to the cost estimation spreadsheet that has been provided as part of the toolkit.

Basis of curves

Cost estimate curves have been developed using data from a series of preliminary construction cost estimates for street scale raingarden projects. The estimates use rates derived from a range of sources including tenderer advice from previous projects, costs presented in Rawlinsons Construction Cost Estimate Handbook and advice from suppliers over a number of years. As these estimates reflect only preliminary estimates on the best available information they cannot be relied on to reflect actual costs for each of the projects. They are used however to provide a reasonable comparative estimate and relative order of magnitude.

The data presented shows a range of costs per unit area or raingarden size and this reflects the influence of site specific and project specific factors other than raingarden size including, ground conditions, chosen edge treatments, pedestrian access requirements, landscaping features and location of the raingarden relative to services.

Cost curves have been developed using MS Excel's trend line function developing a best-fit curve to the cost estimate data. The resulting relationships provide two estimates for construction cost for a given raingarden area, the final construction cost estimate is based on the average of these two relationships.

Updating curves

As the cost curves are based on a limited data set Council should use the estimates with caution. The data used is for small street scale raingardens and thus the cost relationships are only applicable for similar scale systems. To improve the estimates we recommend that Council update the tool with council specific data as it is collected. Over time the dataset will develop adjusted curves that better reflect Moreland Shire Council specific design criteria and landscape pallet.

The addition of this data will require updating of the tool and consumer price index (CPI) data as per the instructions in the spreadsheet.

5.2 Maintenance cost estimate procedure

As with construction costs, maintenance costs will vary between sites depending on the location, size of the system and catchment. However there are also routine maintenance activities common to every system. These activities are outlined in the Maintenance Checklist.

An annual maintenance cost has been estimated to be $2,500 based on estimates of the time required to complete these common maintenance tasks (shown in table below), the frequency outlined in the checklist and the following assumptions:

- Labour cost, 2 staff at $50/h
- Replanting required at 5% per year (assuming a 12 month establishment period) with tube stock at $4/tube
- Planting density of 10 plants/m², i.e. 5% 0.5 plants/m²
- Infiltration test required every 3 years at rate of $1,500

The main maintenance cost which relates to the size of the raingarden is the replacement of plants. The estimated annual unit cost for this task, assuming a quarterly assessment of condition is $108/m² (including labour).

ROUTINE MAINTENANCE TASK - NOT DEPENDENT ON SURFACE AREA	FREQ (/yr)	TIME REQ'D (h/person)	LABOUR COST/FEE ($/y)
Litter removal	4	0.5	$200
Sediment removal/Ameliorate surface	4	1	$400
Raking to reinstate surface at erosion points	4	0.5	$200
Top up filter media and regrade surface	1	2	$200
Infiltration test	0.33		$500
Weeding	4	1	$400
Inspect and flush-out drainage	2	1	$200
Remove debris from inlets	4	0.5	$200
Remove debris from outlets	4	0.5	$200
TOTAL			**$2,500**

ROUTINE MAINTENANCE TASK - NOT DEPENDENT ON SURFACE AREA	FREQ (/yr)	COST ($/m²)	ANNUAL UNIT COST $/m²/y)
Replace plants where dead	4	$2	$8
Time required	0.5 h/m2	$25	$100
TOTAL			**$108**

5.3 Safety codes and guidelines

The safety advice provided in the design procedure (p.13) and catalogue section of this document can be summarised as follows:

For raingardens located adjacent to walkways or within 600mm of the walkway edge:

- For drops less than 190mm, no pram stop or kerb barrier is required. A step height of 190mm is what may reasonably be expected in a pedestrian area.
- For drops greater than 190mm, a pram stop, kerb or similar pedestrian barrier is required.
- Under appropriate circumstances (for example narrow or sloping walkways), pram stops, kerb or similar pedestrian barriers may be applied at the discretion of the project team.

For raingardens located greater than 600mm from a walkway:

- Drops greater than 900mm require a fencing barrier.
- Drops up to 900mm do not require any barrier.
- However, for drops 400mm or greater, the project team is recommended to assess whether kerb stops or similar pedestrian barriers may be suitable.

In all cases, the project team should apply a common sense attitude to safety and apply the measures appropriate to the individual site.

This safety advice is based on Moreland City Council's review of the requirements outlined in Australian Standards, Building Code of Australia and Austroad guidelines. They apply to typical scenarios, however each individual project will need to be assessed and designed to address any particular safety issues using the accepted benchmarks identified within these scenarios.

The references used are as follows:

- AS 1428.1-2009 Cl10.2 (a)

The floor or ground surface abutting the sides of a walkway shall provide a firm and level surface of a different material of that of the walkway at the same level of the walkway, follow the grade of the walkway and extend horizontally for a minimum of 600mm unless one of the following is provided:

i) Kerb in accordance with Figure 18.

- Austroads Guide to Road Design – Part 6A: Pedestrian and Cyclist Paths p36 Table 6.2 Considerations Relating to Changes in Level
  - Adjacent ground for all footpaths should be within 25mm of the level of the footpath
  - If the adjacent ground has a steep slope, a kerb between 65mm and 75mm high should be provided to protect prams and wheelchairs and to guide those people with impaired vision. Handrails may also be provided.
- BCA Volume 2 – NCC 2013 3.9.1.4 Riser and going dimensions
  - The riser and going dimensions for each flight, except for the going of winders in lieu of a quarter or half landing, must comply with the following:
  - The going (G), riser (R) and slope relationship quantity (2R+G) must be in accordance with Figure 3.9.1.2.

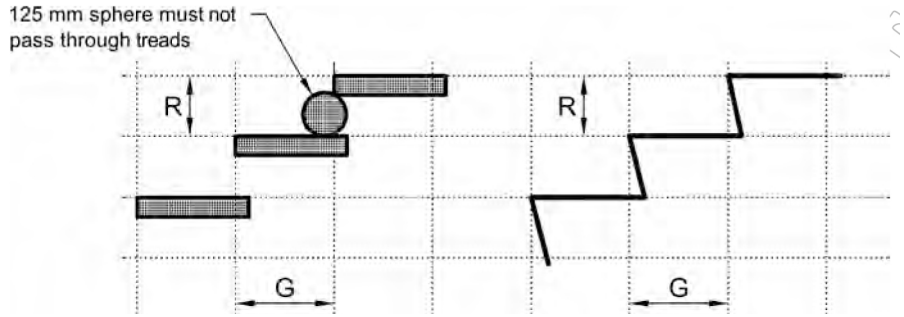
- BCA Volume 2 – NCC 2013 3.9.2.2 When balustrades or other barriers are required
  - A continuous balustrade or other barrier, except for a barrier provided to an openable window covered by 3.9.2.5, must be provided along the side of any roof to which public access is provided, any stairway or ramp, any floor, corridor, hallway, balcony, deck, verandah, mezzanine, access bridge or the like and along the side of any delineated path of access to a building, if—
    - (i) it is not bounded by a wall; and
    - (ii) its level above the surface beneath, is more than 1 m.

The requirements listed above have informed the need to incorporate the following treatments:

- a 600mm vegetated buffer adjacent to footpaths prior to a larger (>190mm) drop;
- use of a kerb if there is a need to have a drop directly adjacent to a walkway;
- maintain a maximum drop directly adjacent to a walkway of 190mm.

Figure 3.9.1.2

STAIR RISER AND GOING DIMENSIONS (MM)						
STAIR TYPE	RISER (R)		GOING (G)		SLOPE RELATIONSHIP	
	(see Figure below)		(see Figure below)		(2R+G)	
	Max.	Min.	Max.	Min.	Max.	Min.
Stairs (other than spiral)	190	115	355	240	700	550



5.4 Tree Protection

Significant existing trees adjacent to new raingarden construction works shall be protected in accordance with AS 4970.

Significant trees should undergo a preliminary assessment by the project arborist to determine quantitate and qualitative information on the tree.

The tree protection zone (TPZ) is the principle means of protecting trees on a construction site. The TPZ is a combination of the root area and crown area requiring protection.

The TPZ is calculated using Cl 32.2 (AS 4970)

The radius of the TPZ is calculated for each tree by multiplying its DBH × 12.

$$TPZ = DBH \times 12$$

where DBH = trunk diameter measured at 1.4 m above ground

Generally A TPZ should not be less than 2 m nor greater than 15 m.

Encroachment into or variations to the TPZ is possible as per Cl 3.3 (AS 4970).

6 CONSTRUCTION SPECIFICATION TEMPLATE

Instructions for Using this Document

- Specification items that are common to all configurations are in black text.
- Items be included/excluded depending on the options chosen are in red text. Delete items not relevant to project.
- Additional guidance is provided throughout the template through use of comments in yellow.
- This should be read and updated in conjunction with other relevant Moreland City Council standard specifications including sections for OVERVIEW OF CONTRACT WORKS, UNDERGROUND STORMWATER DRAINS AND CONDUITS, CONCRETE KERBS, CHANNELS, FOOTPATHS AND CROSSINGS, CONCRETE CONSTRUCTION and MATERIAL AND DESIGN REQUIREMENTS FOR STORMWATER PROTECTION MEASURES.

CONTENTS

1. Excavation

1.1 Drainage during Construction

1.2 Excavation

1.3 Backfilling of Excavations

2. Raingarden Works

2.1 HDPE Lining

2.2 Drainage Layer and Agricultural Pipe

2.3 Filter Layers

2.4 Final Surface Levels and Grades

2.5 Raingarden Soil Media

2.6 Landscape Material

2.7 Testing

2.8 Inspection and Hold Points for Raingardens Works

3. Concrete Works

3.1 General Requirements

3.2 Concrete Tolerances

3.3 Surface Finish of Walls

3.4 Stepirons and Ladders

3.5 Drainage Pits

3.6 Concrete Placing

3.7 Curing

3.8 Construction Joints

3.9 Reinforcement

4. Pavement Construction

4.1 General

4.2 Asphalt

4.3 Surface Markings

5. Landscaping Works

5.1 General landscaping requirements

5.2 Rock Scour Protection

5.3 Timber Construction

5.4 Metalwork

5.5 Bluestone Pitchers Edging & Steps

5.6 Fencing & Bollards

5.7 Garden Bed Preparation

5.8 Shrub & Groundcover Planting

5.9 Semi Advanced Tree Planting

5.10 Raingarden Mulch

5.11 Landscape Establishment / Maintenance

5.12 Sample Schedule

6. Clean up and Site Restoration

6.1 Surface Restoration

6.2 Surface Works

6.3 Cleaning Up

1. EXCAVATION

1.1 Drainage during Construction

GENERAL: Make all necessary allowances and construct temporary works to ensure that adequate drainage is maintained across the site during construction. Include allowances for provision, operation and maintenance of all equipment, which may be required including pumps, pipework and the like.

DRAINAGE OF FILL: Ensure that all placed fill surfaces are free draining during construction.

DRAINAGE OF SITE: Provide adequate drainage around the Works area, including site offices and stockpiles, to ensure that any disruption to the Works due to adverse weather conditions is minimised.

REQUIREMENT: The base of any excavation which has been disturbed by the action of water or any construction activity such that it does not meet the requirements of this Specification shall be rectified by the Contractor.

1.2 Excavation

1.2.1 General Requirements

- Refer to Moreland City Council standard specification UNDERGROUND STORMWATER DRAINS AND CONDUITS.

1.2.2 Methods of Excavation

For the purpose of this Specification, the methods of excavation are defined as follows:

- Excavation is the removal of ground from the surface to a depth necessary to execute the Works.
- Excavations required for pits and other structures.

1.2.3 Excavation

- Width:
  The width of an excavation must not exceed the minimum width by more than 100 mm unless approved by the Superintendent. The minimum width of the excavation up to the finished surface must be for pipe nominal sizes less than DN 1500, the external diameter of the pipe plus 600 mm unless approved by the superintendent or required for safety.
- Depth:
  Refer to Moreland City Council standard specification UNDERGROUND STORMWATER DRAINS AND CONDUITS.

1.2.4 Securing the Excavation

Refer to Moreland City Council standard specification UNDERGROUND STORMWATER DRAINS AND CONDUITS.

1.2.5 Nature of Ground

- If ground conditions endanger adjoining property, adjacent structures, trees, major services or require a change in construction method, the Superintended shall be notified.
- Any slippage that may occur during the course of the Works must be removed. The excessive excavation and refill resulting from slippage must be dealt with in accordance with Clause titled “Excessive Excavation” in this Specification.

1.2.6 Excessive Excavation

- Where the excavation depth and width exceed those specified above the superintendent shall be notified and will assess the structural requirements of this portion of works to determine appropriate remedial action.

1.2.7 Excavation of Unsuitable Material

- Unsuitable materials may be classified as wet soils, softened soils, loose soils, highly permeable soils and soils not meeting the requirements of Table 2 of EPA Information Bulletin 448 and EPA Information Bulletin 655.
- If the unsuitable material cannot be reworked or treated it must be disposed of in accordance with Clause titled “Disposal of Surplus Excavated Material” of this specification.

1.2.8 Disposal of Surplus Excavated Material

- Excavated materials that are unsuitable or not required for permanent construction must be progressively disposed of.
- Excavated material shall be tested for compliance with EPA requirements prior to removal from site.
- Excavated material which does not comply with Table 2 of Industrial Waste Resource Guideline - IWRG 621 SOIL HAZARD CATEGORISATION AND MANAGEMENT shall be handled according to EPA approved methods.
- The disposal area must be free draining and trimmed to reasonably regular lines and stable slopes.
- All surface rock and rubble is to be disposed of off site

1.3 Backfilling of Excavations

Only applies where there are new pipes or pits.

Refer to Moreland City Council standard specification UNDERGROUND STORMWATER DRAINS AND CONDUITS.

2. RAINGARDEN WORKS

2.1 HDPE Lining

The HDPE liner is to be installed as indicated in the drawings. The excavation area nominated for the HDPE liner is to be free from protrusions (i.e. rocks & roots) that could puncture the liner.

The liner is to be installed in accordance with the manufacturer's specifications to form a water tight seal.

2.2 Drainage Layer and Agricultural Pipe

The slotted drainage pipe is to be placed on an even bed of 20 mm depth of "drainage layer" material over the base and to be surrounded and covered with a minimum 20 mm depth of drainage layer" material.

A minimum cover of 400 mm is to be maintained over the slotted pipe before it is travelled over by plant. Drainage lines are not to be crossed by any vehicles.

2.3 Filter Layers

Installation of the coarse sand transition layer and soil filter media is to be undertaken carefully to avoid displacement of the layers and in lifts of no more than 200 mm.

On the placement of each layer a light compaction (e.g. with a light tapper) is to be undertaken to minimise subsidence and prevent uneven drainage. Any excessive compaction is not desirable and any ruts that occur on the surface need to be de-compacted prior to mulching.

2.4 Final Surface Levels and Grades

It is intended that the final surface of the filter will be planar except where indicated in the drawings. The surface is to be graded to within +/- 50 mm of the grade and level indicated on the plans. The final grading of the filter surface is to be confirmed by level survey or string lines.

2.5 Raingarden Soil Media

The soil filter media is to be in accordance with the specifications below based on the *Guideline Specifications for Soil Media in Bioretention Systems (FAWB, 2009)*[1]

2.5.1 Filter Layer Material

Material as indicated on the drawings as Filter Material shall consist of the following.

- The material can be of siliceous or calcareous origin and should be a sandy loam to loamy sand. The soils should contain some organic matter but be low in nutrients. The depth of filter media will vary in accordance with the drawings.
- Filter materials shall have a saturated hydraulic conductivity in the range of 180 – 400 mm/h unless otherwise approved by the superintendent. Filter materials, which comply with the particle size grading outlined in Table 1, will generally meet saturated hydraulic conductivity specifications.

Table 1: *Raingarden Filer Media Grading Requirements*

DESCRIPTION	PROPORTION	GRADING
Clay & Silt	<3%	<0.05 mm
Very Fine Sand	5 - 30%	0.05 - 0.15 mm
Fine Sand	10 - 30%	0.15 - 0.25 mm
Medium to Coarse Sand	40 - 60%	0.25 - 1.0 mm
Coarse Sand	7 - 10%	1.0 - 2.0 mm
Fine Gravel	<3%	2.0 - 3.4 mm

[1] FAWB, 2009 - Facility for Advancing Water Biofiltration Guidelines available http://www.monash.edu.au/fawb/products/fawb-filter-media-guidelines-v3-june-2009.pdf

- The filter media should be well-graded and should have all particle size ranges present from the 0.075 mm to the 4.75 mm sieve (as defined by AS1289.3.6.1 - 2009). There should be no gap in the particle size grading, and the composition should not be dominated by a small particle size range. This is important for preventing structural collapse due to particle migration.
- Filter Media must meet the testing criteria as detailed in Section 2.7.1.

2.5.2 Organic Matter for Ameliorating top 100 mm of Filter Layer

The top 100 mm of the filter medium should be ameliorated with appropriate organic matter, fertiliser and trace elements with the constituents and quantities detailed in Table 2.

Table 2: *Organic Matter for top 100 mm of Filter material*

CONSTITUENT	QUANTITY (kg/100 m2 FILTER AREA)
Granulated poultry manure fines	50
Superphosphate	2
Magnesium sulphate	3
Potassium sulphate	2
Trace Element Mix	1
Fertilizer NPK (16.4.14)	4
Lime	20

2.5.3 Transition Layer

Material as indicated on the drawings as Transition Layer shall consist of the following.

- Transition layer material shall be a clean, well-graded sand material containing <2% fines.
- To avoid migration of the filter media into the transition layer, the particle size distribution of the sand should be assessed to ensure it meets 'bridging criteria', that is, the smallest 15% of the sand particles bridge with the largest 15% of the filter media particles:
  - D15 (transition layer) ≤ 5 x D85 (filter media) where: D15 (transition layer) is the 15th percentile particle size in the transition layer material (i.e., 15% of the sand is smaller than D15 mm); and
  - D85 (filter media) is the 85th percentile particle size in the filter media.

2.5.4 Submerged Zone

Material as indicated on the drawings as Submerged Zone shall consist of Transition layer material as detailed in Section 2.5.3 and mixed as follows (per 100 L):

- 98 Litres of Transition Layer Material.
- 500 g biodegradable sugar cane mulch.
- 1.5 kg recycled, untreated hardwood chips or plantation hardwood chips.

2.5.5 Drainage Layer

Material as indicated on the drawings as Drainage Material shall consist of the following:

- The drainage layer collects treated water at the bottom of the system and conveys it to the underdrain pipes. Drainage layer material is to be clean, fine gravel, such as a 2 – 5 mm washed screenings as follows.

PARTICLE SIZE (MM)	% RETAINED
Greater than 5.0	0
2.0 - 5.0	100
Less than 2.0	0

Note: Scoria or quartz are not considered suitable materials for this application.

- Bridging criteria should be applied to avoid migration of the transition layer into the drainage layer as follows:
  - D15 (drainage layer) ≤ 5 x D85 (transition layer) where: D15 (drainage layer) is the 15th percentile particle size in the drainage layer material (i.e., 15% of the gravel is smaller than D15 mm); and
  - D85 (transition layer) is the 85th percentile particle size in the transition layer material.

2.6 Landscape Material

For all landscaping materials (including timber, rock, mulch, topsoil, turfing and plants) refer to the relevant clauses of Section 5 of the specification.

2.7 Testing

2.7.1 Filter Media - Testing Requirements

Testing is to be independently conducted by a NATA approved laboratory, and a copy of the test results to be sent to the project superintendent for approval, prior to the filter soil installation. To determine whether a soil is suitable the following tests should be undertaken from samples taken from the on site stockpile of all filter soil material to be used for the Works:

1. Particle size distribution (PSD)
   Variation in large particle sizes is flexible and an approved material does not have to be screened. However, the particle size distribution of the smaller particles (clay and silt) is a crucial element of the filter media specification and as such testing in accordance with AS1289.3.6.1 – 2009 would be required.
2. Filter Media
   Filter media must be tested for the following:
   i. Total Nitrogen (TN) Content – 600 - 800 mg/kg;
   ii. Orthophosphate (PO43-) Content – <55 mg/kg. Soils with total phosphorus concentrations >100 mg/kg should be tested for potential leaching. Where plants with moderate phosphorus sensitivity are to be used, total phosphorus concentrations should be <20 mg/kg;
   iii. Organic Matter Content – Between 3 and 5% (w/w).. In order to comply with both this and the TN and PO43- content requirements, a low nutrient organic matter will be required;
   iv. pH – as specified for 'natural soils and soil blends' 5.5 – 7.5 (pH 1:5 in water);
   v. Electrical Conductivity (EC) – as specified for 'natural soils and soil blends' <1.2 dS/m;
   vi. Phosphorus – <100 mg/kg. Soils with phosphorus concentrations >100 mg/kg should be tested for potential leaching. Where plants with moderate phosphorus sensitivity are to be used, phosphorus concentrations should be <20 mg/kg; and
   vii. Saturated Hydraulic Conductivity – of potential filter media should be measured using the ASTM F1815-06 method. This test method uses a compaction method that best represents field conditions and so provides a more realistic assessment of hydraulic conductivity than other test methods.

Media that do not meet these specifications should be rejected or amended.

Optional testing:

viii. Dispersibility – this should be carried out where it is suspected that the soil may be susceptible to structural collapse. If in doubt, then this testing should be undertaken.

Potential filter media should generally be assessed by a horticulturalist to ensure that they are capable of supporting a healthy vegetation community. This assessment should take into consideration delivery of nutrients to the system by stormwater. Any component or soil found to contain high levels of salt (as determined by EC measurements), high levels of clay or silt particles (exceeding the particle size limits set above), or any other extremes which may be considered retardant to plant growth should be rejected.

2.8 Inspection and Hold Points for Raingardens Works

The following elements of the works will constitute hold points for the raingardens:

- At the completion of drainage connection associated with the raingarden element and before backfill with soil material, which includes gravel, sand, soil and filter medium.
- Placement of any soil material within the raingarden, which includes gravel, sand and soil filter material.

- At practical completion of the raingarden elements.

It is the contractor's responsibility to provide a minimum of 24 hours weekdays notice (unless agreed to prior) to the superintendent to arrange for an inspection for the hold points.

No works shall proceed or be covered up under this section until the Superintendent's representative has inspected the works. The Superintendent will reserve the right to re -open works if the Contractor fails to give reasonable notice of inspection to the Superintendent. Failure to provide sufficient notification will not result in claims for additional time or monies.

3. CONCRETE WORKS

Refer to Moreland City Council standard specification CONCRETE CONSTRUCTION.

3.1 General Requirements

Refer to Moreland City Council standard specification CONCRETE CONSTRUCTION.

3.2 Concrete Tolerances

The Contractor shall construct concrete structures that meet the following requirements:

a. The invert levels of inlet and outlet pipes and inlet and outlet sills shall be within 10mm of specified.

b. The variation from the specified manhole shaft internal dimension shall not exceed 2%.

c. The variation of wall thickness shall not be less than that specified and no greater than 25 mm.

d. The position of the structure shall not deviate from the position indicated on the Drawings by more than 75 mm.

e. The variation from plumb shall not exceed 10 mm in any 3 metres or 15 mm in any 5 metres or more.

f. The level of the cover shall be within 5 mm of the level specified on the Drawings or as directed by the Superintendent.

3.3 Surface Finish of Walls

The surface finish of all walls shall be Class 3C or better. If the Contractor fails to achieve the required finish, the concrete shall be repaired in accordance with the requirements of AS3600 or as directed by the Superintendent. If directed by the Superintendent, the structure shall be rebuilt at the contractor's expense. Bagged mortar shall not be applied to manhole walls.

Visible edge walls and landscape features shall be Class 2 or better.

3.4 Stepirons and Ladders

a. Stepirons and ladders shall be located and fixed in the structure in accordance with Melbourne Water standard drawing 7251/4/314.

b. Access stepirons shall be cast in situ.

c. All bolts shall be placed in the formwork before pouring the concrete. Care shall be taken to ensure that stepirons remain in place and are properly aligned after pouring.

3.5 Drainage Pits

a. All Drainage Pits shall be constructed in accordance with the Drawings and any relevant standard drawings belonging to the Principal.

3.6 Access Covers

a. The Contractor shall prevent distortion of cast iron frames during fixing and replace any distorted cover or frame. Cast iron covers shall be filled with N20 Grade concrete. The identification, cover locating marks and numbering pad shall be left exposed.

b. The covers and frames shall be cleaned and greased after completion of the section of the Works

3.7 Concrete Placing

Refer to Moreland City Council standard specification CONCRETE CONSTRUCTION.

3.8 Curing

Refer to Moreland City Council standard specification CONCRETE CONSTRUCTION.

3.9 Construction Joints

Refer to Moreland City Council standard specification CONCRETE CONSTRUCTION.

3.10 Reinforcement

Refer to Moreland City Council standard specification CONCRETE CONSTRUCTION.

4. PAVEMENT CONSTRUCTION

Remove Section 4 if your project does not involve disturbing road pavement

4.1 General

- The road pavement, where disturbed by the works, shall be reinstated in accordance with the Drawings and Specification and to the approval of the relevant owner (e.g. Council or VicRoads).
- Road reinstatement is to extend 100 mm minimum beyond both edges of the trench. Reinstatement is also required where strips of bitumen between the kerb and the reinstatement would otherwise be narrower than 600 mm.
- Kerb and channels to be reinstated in accordance with the requirements of Council and VicRoads.

4.2 Asphalt

- The hot mix asphalt used for the road wearing course shall be in accordance with the requirements of Council or VicRoads.
- All reinstatement works to be chased neatly into existing surface ensuring sufficient crossfall.

4.3 Surface Markings

- Long life white paint (Degador or approved similar) shall be used.
- Linemarking paint for traffic lanes and parking bays must be compatible with road surfacing material and be in accordance with AS 4049.

5. LANDSCAPING WORKS

5.1 General landscaping requirements

This section of the Contract comprises the execution generally of the Landscape Works including the supply of all labour and materials as specified. The whole of the works shall be executed in strict accordance with this specification, the General Conditions of Contract, the accompanying drawings and with any working drawings furnished by the Superintendent as work proceeds, to the satisfaction of the Superintendent.

The specification and drawings represent as fully as possible the requirements and intentions of the Contract. Any other operations which may be reasonably inferred from these documents to form part of the true intent and meaning of this Contract, although not specifically stated as such, will be deemed to have been included and due allowance for their execution must be made.

This section covers the labour, materials, plant and services to carry out the operations necessary for proper performance of the landscape works as shown on the drawings and as specified herein. All works within this section shall be carried out by an approved landscape Contractor and shall include but not be limited to the following:

- Supply and installation of scour protection.
- Spreading of topsoil to planting areas.
- Supply and installation of inorganic mulch.
- Supply and installation of plants as specified.
- 52 week plant establishment/maintenance period.

5.1.1 Setting Out

The Contractor shall be responsible for accurately setting out of the Landscape works on the site in accordance with the drawings and survey information supplied, and for checking works in progress. The Contractor shall advise the Superintendent once set out is completed and prior to proceeding with works. Should the Contractor discover any discrepancy in the drawings or on the site, they shall immediately notify the Superintendent before proceeding with the works.

5.1.2 Construction

Figured dimensions shall take precedence over scale measurements and large scale drawings over small scale. Unless otherwise specified the drawings and specification shall include everything reasonable for the proper and entire completion of the work, notwithstanding any omission in the Specification or drawings.

Discrepancies between the Specification and drawings shall be verified with the Superintendent before proceeding with the particular work and failure to do so will not be taken as a reason to claim for extra work.

5.1.3 Workmanship and Materials

All materials shall be new unless otherwise specified and all materials and workmanship are to be the best quality throughout and subject to the approval of Superintendent. The Contractor shall cover all materials susceptible to damage by exposure to weather at a location to the approval of the Superintendent. The Contractor shall be held responsible for any loss or damage occurring in the course of loading, unloading, transit or storage, no matter what the cause.

5.1.4 Mandatory Inspection of Works

The Contractor is to notify the Superintendent at least three days in advance when each of the following phases are ready for inspection. Failure to advise and gain an inspection of the works at the nominated stage may invalidate the works and require reconstruction to the satisfaction of the Superintendent, wholly at the cost of the Contractor:

- Set out of all works.
- Delivery of all plants and trees.

The Contractor is encouraged to combine inspection of one or more phases to facilitate effective management of the Contract period. The Contractor must give a minimum of three working days notice (or as otherwise agreed) of intended inspection dates to the Superintendent.

No works shall proceed or be covered up under this section until the Superintendent has inspected the works. The Superintendent will reserve the right to re -open works if the Contractor fails to give reasonable notice of inspection to the Superintendent.

5.1.5 Samples

The Contractor is to provide the Superintendent with the samples as described in the Specification. Samples are to be approved in writing by the Superintendent before bulk orders are placed or before installation of finishes proceed.

5.1.6 Standards

Unless otherwise specified in the Contract, and where applicable, materials and workmanship shall be in accordance with the relevant standards of the Standards Association of Australia.

5.1.7 Current Edition

A standard application to the Works shall be the edition last published prior to the closing date for tenders unless otherwise specified.

Comply with the following standards unless otherwise specified:

AS1289: Methods of testing soils for engineering purposes

AS4419: Garden soils for domestic use

Site Copy: Keep on the site a copy of AS4419

5.1.8 Specified Suppliers

Obtain material from specified suppliers. Substitutions will only be considered if considered meeting or improving the technical, design, aesthetic or performance criteria of the specified product. The Principal reserves the right to reject any substitutions or alternatives offered. All conforming pricing to be based on the nominated supplier, options for alternatives must be clearly indicated along with their item and or cost saving.

5.2 Rock Scour Protection

5.2.1 Type

Rock shall be supplied to dimensions shown on the drawings or approved equivalent. Rock for scour protection shall not be single sized but shall be a well-graded mixture designed to ensure that all interstices between larger rock are filled. The range of rocks size shall be as specified on the drawings.

5.2.2 Sample

Requirement: Provide samples of rock in specified sizes and colours. Place rock as instructed by Superintendent.

When the rock have been approved, all rock shall in the opinion of the Superintendent matches the sample, or otherwise be rejected.

5.3 Timber Construction

5.3.1 Scope of Work

This section covers the labour, materials, plant and services to carry out timber construction works as shown on the drawings and schedules.

5.3.2 Materials and Workmanship

Design, workmanship and materials shall be the best of their respective kinds all in accordance with the requirements of AS1720, AS1684 and AS1604 and other relevant Australian Standards, including bracing, blocking, tie downs etc. Any materials rejected as unsuitable by the Superintendent shall be removed from site and replaced by the Contractor at his own expense.

Timber is to be free of loose veins. Pockets, unsound knots, knot holes, shakes, splits, termite galleries and other defects. Timber to be completely free of any defects within 200 mm of connections.

Exposed timber to be hardwood of durability grade I or II.

Timber visible in final works to be appearance grade. Ensure exposed surfaces of timber accessible to public in finished works are smooth, free of defects including shakes, splits etc and do not present a safety hazard.

Identify all timber by branding to show: stress grade, grading method, ‘seasoned’ or ‘s’. Ensure brand marks are hidden in final works.

Provide suppliers certification (or certification by an independent NATA registered inspection authority) that timber complies with specification, including moisture content, preservative treatment, etc.

Place heartwood on down side.

Install beams with natural camber upward.

Drill holes for bolts = bolts diameter plus 1 to 2 m in seasoned timber, and = bolt diameter plus 2 to 3 mm in unseasoned timber. Drill holes for coach screws as follows: holes for shank = shank diameter plus 1 mm. Hole for thread – root diameter.

Do no use scant shank bolts.

Coat nuts, bolts, washers, etc with bituminous paint/grease prior to installation in timber.

Pre-drill holes at 0.8 x nail diameter in hardwoods and areas subject to splitting.

Provide washers under head and nut of bolts:

M10 bolt - Ø45 x 2.5 thick washers

M12 bolt - Ø55 x 3.0 thick washers

M16 bolt - Ø65 x 4.0 thick washers

M20 bolt - Ø75 x 5.0 thick washers

M24 bolt - Ø85 x 6.0 thick washers

Retighten all bolts at completion of contract and again at completion of Defects Liability Period.

5.3.3 Timber Edgeboards

The Contractor shall supply and install treated pine edging to all interfaces between garden beds, gravel surfaces and grass, as indicated on the drawings and as detailed.

Timber edging, unless stated otherwise, shall be of 75 x 38 mm treated pine set on edge with the top flush with the adjoining grass area or gravel surface. All edging to be continuous, with all timber lengths butt jointed. Timber edging shall be kept vertical at all times. The edging shall be staked at 1 200 mm centres with 50 x 25 x 300 mm long stakes. Fix stakes to edge with 2 No. 70 mm galvanized flat head nails.

5.3.4 Delivery Storage and Handling

Deliver, store and handle products so that damage, deterioration and loss will be prevented. Control delivery schedules to minimise long term storage on site. Store timbers on site in indoor conditions or above ground with secure impervious covers.

5.3.5 Installation Particulars

Perform operations including grooving, rebating, framing, housing, beading, mitring, scribing, nailing, screwing, bolting, gluing and so on necessary to complete the works. Use timber in single lengths whenever possible and as detailed on the drawings. If joins are necessary in locations not shown on the drawings obtain approval from the landscape architect prior to proceeding with the works.

5.4 Metalwork

5.4.1 General

Supply, fabricate and erect galvanised seats as detailed on the drawings and as described in AS 1250.

Provide sufficient fastenings of a strength, type and suitable material, compatible and matching in appearance to the components fastened.

Wherever machine screw or bolt fixing into wall anchors is required such anchors shall be expanding metal anchors installed in accordance with the manufacturer's recommendations. Ensure that each anchor grips firmly. Any anchor found to be loose shall be withdrawn and then grouted into position.

5.4.2 Handling and storage

Do not damage workshop applied finishes during delivery, off-loading, stacking and erection.

5.4.3 Set Out

Verify dimensions and levels for the work on site. The Contractor will allow in his tender for all set out required to carry out the Works.

5.4.4 Materials and workmanship

Workmanship otherwise specified, fabricate as shown on the drawings and as described in AS 1250 unless otherwise specified.

Where work is exposed to view and forms part of the Landscape Architectural treatment, give special attention to the finish. Shearing, flame cutting and chipping shall be done carefully and accurately, sharp corners and rough edges shall be faired by grinding or other approved means, and where noted on the drawings, welds shall be made smooth to approval.

5.4.5 Fabrication

Unless otherwise specified, fabricate as shown on the drawings and as described in AS 1250.

Cut edges, drilled holes and flat sheets should be clean, neat, free from burrs and indentations. Remove sharp edges without excessive radiusing. Fit mitres joints accurately to a fine hairline.

Carry out and complete fabrication and all welding in the workshop. Site operations where necessary shall be placed in positions of easy access. Site welds shall be located where possible in positions for down hand welding. All welds shall be of structural grade. Electrode to be no less than 6 mm continuous fillet unless noted otherwise.

Remove all foreign matter, scale, weld splatter, etc, and grind welds smooth before applying surface treatments specified. Do not weld short lengths together to make up required member lengths without first obtaining approval.

Assemble and connect components as shown on the drawings so that they withstand twisting, warping, bending or overstressing during transport and handling. Provide temporary braces where necessary to prevent damage.

Holes shall be 2 mm larger than the nominal diameter of the bolt or rivet unless otherwise specified. Drill holes and shop fix cleats, lugs, ties and other fixings necessary before applying protective coatings.

5.4.6 Erection

Erect, fix, adjust and maintain all members in their intended vertical and lateral alignment and level. Make good damaged steelwork before erection, as directed by the Landscape Architect.

The Contractor shall allow in his tender for all necessary cranage, means of hoisting, scaffolds, temporary bracing, etc. for the erection of the various components and to carry out the works in a safe manner.

5.4.7 Bedding and grouting

Unless otherwise specified or shown on the drawings, grout supports as described in AS 1250.

Grout shall be 1:2 cement:sand mortar or approved proprietary flowable non-shrink grout. Place grout by ramming or under pressure. Grout shall have a minimum compressive strength of 30 MPa at 28 days.

5.4.8 Fastenings

Unless otherwise specified use commercial bolts and nuts complying with AS 1111 and fitted with appropriate washers. Masonry anchors shall be of the patent expansion type of approved manufacture. All holes shall be 2 mm larger than the nominal bolt diameter unless noted otherwise. All bolts shall be galvanised unless noted otherwise.

5.4.9 Welding

Welding shall comply with AS 1554 and AS 1250. Use building techniques and procedures such that residual stresses in the structure do not exceed the values given in AS 1250.

Welders shall be passed the relevant tests specified in AS 1554 and possess the appropriate certificate specified therein.

All shop and site welds that are exposed are to be ground smooth.

5.4.10 Protective Coatings

All steel components and fixings (including nuts, screws, bolts, washers etc) exposed in its final location to be hot dipped galvanised prior to being delivered to site in accordance to AS 1650.

Fabrication, surface preparation, galvanising, transport and storage shall be in accordance with requirements of AS 1650 and 'Hot Dip Galvanising'

produced by the Galvanisers Association of Australia.

5.5 Bluestone Pitchers Edging & Steps

5.5.1 Type

Recycled Bluestone Pitchers to be reused from demolition works for this project or sourced from Council depot. If none are available through these means then recycled Bluestone pitchers are to be purchased from a supplier.

All Recycled Bluestone Pitchers to be clean and have any existing asphalt, mortar or concrete removed from their surface.

5.5.2 Sample

Requirement: Provide samples of bluestone to the Superintendent for approval prior to bulk ordering.

5.5.3 Installation

Bluestone pitchers to be butted together on a minimum 75mm stiff concrete pad and treated crushed rock sub-base. Joints to be filled with a mix grout of; 16% cement, 67% blended washed sand, 16% stonedust and 1% lime, “Readymix Bluestone Grout” or equivalent.

5.6 Fencing & Bollards

5.6.1 Type

TIMBER BOLLARDS: To be seasoned 125 x 125mm class 1 or 2 hardwood, 1000mm above ground. Bollard to be secured minimum 500mm below ground in min. 25Mpa concrete sleeve. All exposed edges to be chamfered. Maximum spacing of bollards to be 1400mm.

Application of protective coating or paint to be confirmed with Superintendent.

TIMBER POST AND RAIL FENCE: To be constructed in accordance with the drawings and Section 5.3 of this Specification.

GALVANISED RAIL: Singular 90mm diam. hot dipped galvanised steel pipe rail to be secured between timber bollards (refer above). All ends of pipe to be finished inside timber with no exposure to public. All fixings to be hot dipped galvanised steel.

TENSIONED STAINLESS STEEL WIRE: To be used as a barrier where fall height exceeds 1000mm. Contractor to supply and install all materials to meet BCA regulations for steel balustrade. Maximum space between strands to be 125mm. Gauge of wire strand, tensioning system and tension level to be determined by the Contractor. Contractor to supply marine grade stainless steel in coastal applications.

5.6.2 Sample

Requirement: Provide samples of;

- One timber bollard –prior to bulk ordering,
- Stainless steel wire and swaged terminal – prior to bulk ordering.

5.6.3 Installation

Bollards and posts for rails to be secured minimum 500mm below ground in 25Mpa concrete sleeve. Post depths for posts supporting tensioned wire balustrade will need to be designed with reference to the soil type/ geotechnical advice and the amount of tension required for the wires. It is the Contractors responsibility to ensure sufficient depth and type of footing to meet BCA regulations.

5.7 Garden Bed Preparation

Remove this section if project contains no edge planting or garden beds

5.7.1 General

These works include the preparation of garden bed areas by cultivation, application of gypsum, and supply and installation of approved topsoil and mulch as detailed on the drawings.

5.7.2 Sub-soil Preparation

- Remove all weeds, roots, builder's rubbish and other debris.
- Contractor is to accurately locate, prior to commencement of cultivation, all in-ground services and ensure that these are not disturbed during cultivation.
- Cultivate to the required depths outside of the tree protection zone. Do not disturb services or tree roots; if necessary cultivate these areas by hand. If large roots are encountered all work should cease and the superintendent should be notified immediately. It may be deemed necessary to have an arborist inspect the work. During cultivation, thoroughly mix in any materials required to be incorporated into the subsoil. Cultivate manually within 300 mm of paths or structures. Remove stones exceeding 25 mm, clods of earth exceeding 50 mm, and any weeds, rubbish or other deleterious material brought to the surface during cultivation. Trim the surface to the required design levels after cultivation.

5.7.3 Cultivation Depths

- Cultivate the subsoil to the following typical depths
- Grassed areas (seeded, turf, strip turf, stolonized): 75 mm
- Planting areas: 200 mm.

5.7.4 Topsoil Definitions

Site topsoil: Is defined as soil excavated from the site which:

- Contains organic matter;
- Supports plant life;
- Is free from unwanted matter such as:
  - stones over 25 mm diameter;
  - clay lumps;
  - weeds and tree roots;
  - sticks and rubbish;
  - material toxic to plants;
  - is approved by the Superintendent for reuse on site as topsoil;
- Topsoil mixture: Topsoil and compost or other additives, thoroughly mixed before placing;
- Top dressing: Coarse or medium soil to AS 2223 clause 4, suitable for application to turf or grass areas;
- Soil textures: Use topsoils described by the following terms (or their equivalents) which comply generally with the texture classifications and typical uses of AS 2223 Table B2;
- Fine (loam, silt, clay loam);
- Medium (sandy loam); and
- Coarse (sandy soil).

Table 3: *Topsoil particle size schedule (% passing by mass)*

AS SIEVE APERTURE	SOIL TEXTURES		
	FINE	MEDIUM	COARSE
2.36	100	100	100
1.18	90 - 100	95 - 100	95 - 100
0.60	75 - 100	75 - 100	70 - 90
0.30	57 - 90	55 - 85	30 - 46
0.15	45 - 70	38 - 55	10 - 22
0.075	35 - 55	25 - 35	5 - 10
0.002		2 - 15	2 - 8

Table 4: *Topsoil Properties Schedule*

PROPERTY	TYPE	AMOUNT
Nutrient levels	Phosphorus (P) (mg/L)	0.7 - 4
	Potassium (K) (mg/L)	35 - 250
	Sulfur (S) (mg/L)	greater than 40
	Calcium (Ca) (mg/L)	50 - 350
	Nitrogen (N) (mg/L)	100 or less
	Manganese (Mn) (mg/L)	1 - 15
Additives	Gypsum (% by volume)	
	Compost	
Other properties	Organic matter (% by mass)	20
	Soil reaction	pH 6.7
	Soluble salts (% by mass)	0.1
	Moisture content (% by mass)	
	Toxicity index to AS 3743	

5.7.5 Source

Re-use existing site topsoil where the existing soil matches the specification requirements - provide additives such as compost where possible to modify existing soil to ensure compliance with the specification. Import topsoil from an approved off-site source where the site topsoil is not able to meet the specification requirements.

5.7.6 Additives

Topsoil raised to the standard of the appropriate type by the use of additives may be used subject to compliance with the relevant test criteria.

5.7.7 Topsoil Mixture

Where indicated use a topsoil mixture comprising two parts by volume of topsoil type medium, one part coarse soil type and one part of compost as specified, all thoroughly mixed.

5.7.8 Topsoil Stockpiles

Stockpile site topsoil approved for reuse, and imported topsoil where necessary, before placing. Establish stockpiles to sizes and in locations as directed. Provide adequate drainage and aeration. Do not burn off or remove plant growth which may occur during storage. Do not allow traffic on stockpiles. If a stockpile is to remain for more than four weeks, sow with temporary grass.

5.7.9 Topsoil Tests

Provide tests for site topsoil taking soil samples as recommended in AS 2223 Appendix A, and test to the methods in AS 2223 clause 3, or AS 3743, as applicable. Test imported topsoils and submit for approval at least five working days in advance of carting, test results stating sieve analysis, organic matter, salt content and pH.

5.7.10 Topsoil Locations

The following types of topsoil shall be placed as shown:

Grassed areas: Medium

Planting areas: Medium

5.7.11 Placing Topsoil

Contamination: Where diesel oil, cement or other phytotoxic material has been spilt on the subsoil or topsoil, excavate the contaminated soil, dispose of it off the site, and replace it with site soil or imported topsoil, as directed, to restore design levels.

Placing: Place the appropriate topsoil on the prepared subsoil to the depths shown on drawing. Spread and grade evenly making the necessary allowances so that the required finished levels and contours shall be achieved after light compaction; and grassed areas shall be finished flush with adjacent hard surfaces such as kerbs, paths and mowing strips, where so required.

Spreading: On steep batters the spreading may be by means of a chain drag, provided there is no danger of batter disturbance.

Compaction: Prevent areas of excess compaction from being caused by constructional plant. Compact lightly and uniformly in 150 mm layers and avoid differential subsidence. Produce a finished topsoil surface which is:

- At design levels; allowing for thickness of mulch where specified;
- Smooth and free from stones or lumps of soil;
- Graded to drain freely, without ponding, to catchment points; and
- Graded evenly into adjoining ground surfaces.

The Contractor is to supply a sample of the imported topsoil to the Superintendent for approval prior to purchasing bulk amount.

Where imported soil and site topsoil are used on the site, rough mixing of the two shall be carried out prior to final placement and grading.

Topsoil depths as referred to on the drawings and details refer to consolidated/compacted depths.

5.7.12 Compost

Description: Well rotted vegetative material or animal manure, or other approved material, free from harmful chemicals, grass and weed growth, and with a neutral pH value. Provide a certificate of proof of compost pH value.

Incorporate compost with topsoil, where so required, by mixing thoroughly at the specified proportions.

5.7.13 Mulch

GENERALLY: Use mulch that is free of deleterious and extraneous matter such as soil, weeds and sticks. Mulch may be organic timber mulch or inorganic mulch to match that used in the body of the rain garden.

APPLICATION: Place mulch to required depth, clear of plant stems, and rake to an even surface flush with the surrounding finished levels.

ORGANIC TIMBER MULCH: Nominal 12-20 mm size pinebark mulch or as shown on the drawings or selected by the Superintendent.

NATURAL STONE AGGREGATE MULCH: Nominal 10- 20 mm size with no fines. Stone type to be as shown on the drawings or selected by the Superintendent.

RECYCLED BRICK MULCH: Nominal 15- 20 mm diameter recycled brick. Brick mulch to be free of any fines prior to application.

SAMPLE: The Contractor is to provide a sample of all mulch types, as specified in the SAMPLES SCHEDULE to the Superintendent prior to delivery to site.

5.7.14 Final Grading

- Garden beds shall be finished to give a gentle crowned appearance to ensure positive drainage or to conform with levels indicated on the drawing and shall finish flush with paved surfaces and kerbs. Finished levels of mulch shall be at least 50 mm below weepholes and/or damp proof courses and grade evenly towards grated pits and other drainage structures.
- Provide gentle transition zones at toes of batters and embankments. These should be gently rolling in appearance rather than having a sharp angled profile.
- Grade lawn areas evenly or to conform with levels indicated on the drawing.

5.8 Shrub & Groundcover Planting

Remove this section if the project is for tree pits only.

5.8.1 General

The Contractor shall provide plant material from an approved nursery/ supplier, fertilisers, stakes and labour to plant out the garden beds as set out and scheduled on the drawings. The size of the plant material covered in this section includes cells, tubestock, 100 mm, 150 mm and 200 mm diam. pots.

5.8.2 Plant Material

All plant material shall be obtained from an approved nursery/supplier where plants are exposed and have been hardened off in the open. Plants are to be healthy, well-grown specimens, free of pest, injury and diseases.

The Contractor shall confirm the availability of the stated species and shall contact the Superintendent should there be any difficulty in securing all the plants for the project. Where indigenous planting is used plants of local provenance should be used. Prior to planting, the plants shall be cared for adequately to the satisfaction of the Superintendent. Superintendent is to inspect and approve trees prior to the Contractor taking delivery. Plants are to be delivered to site in such a manner as to prevent damage in transit.

5.8.3 Setting Out

The Contractor shall set out the plant material in accordance with the planting plan and obtain the on-site approval, of the Landscape Architect prior to planting.

Planting in large areas may be staged to ensure plants are not on site, in containers for longer than 24 hours.

5.8.4 Planting Conditions

Planting shall not be carried out if the soil is very wet and waterlogged, or during periods of adverse or extreme weather or windy conditions.

Where possible the Contractor shall install plants directly in place, immediately after delivery to site and store other materials in a secure location on site. If plant material cannot be installed immediately after delivery, the trees must be heeled in or covered with moist soil or hessian or as directed by the Superintendent.

It is the Contractors responsibility to adequately protect and maintain vegetative material against any adverse or damaging climatic conditions before and during the planting procedure.

5.8.5 Planting Procedure for Shrubs & Groundcovers

Thoroughly soak the plant before planting.

Over excavate each plant hole by at least twice the pot diameter.

If the soil is very dry, fill with water and allow to drain completely.

All fertilisers shall be delivered to the site in sealed bags, labelled with the type and manufacturer's name. All fertilisers shall be applied in strict accordance with manufacturer's instructions. Place the fertiliser in the bottom of the hole and cover with soil to ensure there is no contact between the roots and fertiliser.

Fertiliser shall be an approved prolonged release type such as 'Osmocote Total All Purpose' by Scotts or approved equivalent with an N:P:K ratio of 19.4 : 1.6 : 5 applied at the rate specified by the manufacturer. For native plants use 'Osmocote Native Garden' by Scotts or approved equivalent with an N:P:K ratio of 17.9 : 0.8 : 7.3.

Place the plant into the hole and backfill with approved soil free from weeds, stones, clods of sub soil and other extraneous matter.

Plants are to be set plumb and level with the adjacent soil – ensure no soil is placed against the stem of the root crown.

Gently apply pressure by hand for smaller tubestock planting to ensure contact with soil and roots is made.

Form a watering ‘bowl’ around the plant.

Thoroughly water in plants, with a minimum of 5 litres of water for each plant.

5.9 SEMI ADVANCED TREE PLANTING

5.9.1 Presentation Criteria

Contractor to ensure that all advanced tree stock must be free of pests and pathogens, free of scarring, damaged leaders, abrasions of the bark, disfigured knots or fresh cuts of limbs that have not been callused. Advanced trees to show a vigorous central leader, open branching framework and well formed open ‘V’ limb crotches.

All limbs and trunks to be well formed, sturdy and well rooted. All dead wood and branches are to be removed.

The Contractor is to ensure that the trees are true to species and size specified on the drawings and in the schedule. The Superintendent is to inspect and approve all trees prior to the Contractor placing deposits with the Nursery. The Contractor must provide the Superintendent with three (3) days notice to inspect the trees. The Superintendent has the right to reject any trees and request that alternate trees be sourced.

5.9.2 Planting Hole

The Contractor is to observe proper precautions so as not to disturb or damage sub-surface conditions. Before doing any excavation the Contractor is to ascertain location of existing underground services. In the event such are uncovered, the Contractor is to promptly notify the Superintendent to enable the relocation of plant material.

The Contractor is to confirm location of trees prior to excavation of tree holes. The tree planting holes must be prepared in fine weather only to avoid damage to the soil structure. The holes are to be free from glazing and clay sides. If glazing occurs, the Contractor is to loosen the affected soil with spade or other hand tool. Excess spoil must be disposed of from the site.

Contractor to dig the hole to sufficient size, approximately 2.5-3 times the width of the rootball with angled sides. The Contractor is to ensure that the tree hole is only as deep as the rootball, so that the top of the root ball is flush with finished surface level. Contractor must ensure that the tree hole is not over excavated as this will cause saturation at the base.

If the Contractor encounters any soil or drainage conditions which may be detrimental to the growth of the plant material, the Contractor must notify the Superintendent and discontinue any tree hole excavation works until the Superintendent has inspected the soil or drainage condition.

5.9.3 Fertiliser

Place 50 grams of approved slow release fertiliser, around base of advanced trees or mix thoroughly with broken up backfill soil.

5.9.4 Planting

No advanced trees are to be stored on site. The advanced trees are to be handled carefully to ensure that no damage to limbs, bark or rootball occurs. If damage does occur, the Contractor must replace the damaged tree at their own expense. The rootball must rest gently on the base of the hole and be supported during backfilling. The tree must be located centrally in the hole and in a vertical upright position. Plant is to be set plumb and level with adjacent soil, with no soil placed against the stem of the root crown.

5.9.5 Backfilling

Backfill hole using prepared backfill mix of equal volumes of soil from the hole, compacted organic matter and sand. Care is to be taken to mix the fill thoroughly. Contractor to ensure a pH level of 5.5 to 7.0 is maintained in the fill mix. Gently cover the roots with backfill material in layers of 150mm and slightly compacted around the perimeter of the hole to ensure there are no air pockets and that all root ends bend downwards. Ensure roots are not pressed against the bottom of the hole by backfilling too quickly or using lumpy soil. Contractor to firm the soil gently to a level approximately 30mm below the surrounding soil surface level to create a ‘watering bowl’.

5.9.6 Watering

Contractor to thoroughly water trees with a minimum of 10 litres of clean recycled or dam water immediately after planting, and at such times during the contract period as required to maintain growth, free from water stress. Any signs of water stress (leaf drop or yellowing) should be reported to the Superintendent for further investigation.

5.9.7 Mulching

After the placement and planting out of the plant material in all garden beds, the Landscape Contractor will supply and spread the specified mulch type to an average depth of 75mm. The mulch shall be free from soil clods, rocks and all other non organic matter. The Contractor is to submit a sample of the mulch to be used to the Superintendent for approval prior to delivery of mulch to site.

Mulch to finish level with surrounding pavement levels after settlement allowances of the top soil and mulch. Contractor is to keep mulch away from the trunks to avoid rotting at ground level.

In lawn areas the mulch shall be placed after formation of the 'water bowl', to an area of approximately 0.5 metre radius from the centre of the tree.

5.9.8 Staking & Tying

Hardwood stakes, as per details to be installed immediately after planting. Stakes are to be driven 600mm into the ground or deep enough to ensure that the stake will remain stable and vertical and at the same height above ground level throughout. Tie tree to stakes using "figure eight" ties of canvas or Velcro or approved equivalent. Contractor to provide a sample of the tree tie to be used prior to ordering. The ties are to be no further than one-third the height of the tree, from the base of the trunk. Stakes and ties are to be inspected by the Superintendent on completion of these works. Stakes and ties to be matt black in colour. Refer to the drawings for details.

5.10 Raingarden Mulch

5.10.1 General

Use an inorganic mulch that is free of deleterious and extraneous matter such as soil, weeds and sticks

5.10.2 Application

Place mulch to required depth, clear of plant stems, and rake to an even surface flush with the surrounding finished levels.

NATURAL STONE AGGREGATE MULCH: Nominal 10- 20 mm size with no fines. Stone type to be as shown on the drawings or selected by the Superintendent.

RECYCLED BRICK MULCH: Nominal 15- 20 mm diameter recycled brick. Brick mulch to be free of any fines prior to application.

SAMPLE: The Contractor is to provide a sample of all mulch types, as specified in the SAMPLES SCHEDULE to the Superintendent prior to delivery to site.

5.11 Landscape Establishment / Maintenance

5.11.1 General

The defects liability period shall cover all hard, soft and irrigation landscape works for a period of 52 weeks and synchronous with the plant establishment/maintenance period. The synchronous Landscape Establishment / Maintenance period will be for 52 weeks from the date of Practical Completion.

The Contractor is responsible for the satisfactory maintenance of all Landscape Works and parts thereof for the duration of the maintenance establishment period until the issuance of the Final Completion Certificate. Practical Completion of the planting works shall include but not be limited to replacement of plants which have failed or been damaged or stolen during the work under the Contract.

Maintenance shall mean the care and maintenance of the contract area by accepted horticultural practices, as well as rectifying any defects that may become apparent in the works under normal use.

The Landscape Contractor is advised to maintain all insurances during the Maintenance Period.

5.11.2 Period Commencement

The planting establishment period shall commence from the Date of Practical Completion of the Works or from the Date of Practical Completion of the planting works (hereby specified to be a separable part of the Works), whichever is the later.

5.11.3 Practical Completion

Practical completion of the soft landscape works includes, but is not limited to, the complete germination of grassed areas, establishment of turfed areas, and replacement of plants which have failed, been damaged or been stolen during the works.

Grassed areas are required to be properly established with an even dense grass sward and to have been mown at least once before they are accepted as having reached a stage of Practical Completion.

The Landscape Contractor shall request an inspection of the works by the Superintendent for granting of Practical Completion. Minimum notice of seven days is to be given before the requested date for the Practical Completion inspection. The Landscape Architect shall inspect the works and if any defects or deficiencies are found they shall be rectified within 14 days.

Before requesting the inspection of the works, the Landscape Contractor shall ensure that all works of the Contract are complete.

The date of Practical Completion shall be the date of acceptance of the works as Practically Complete by the Superintendent.

5.11.4 Program

Furnish a proposed planting maintenance program, and amend it as required by the Superintendent. Comply with the amended program.

5.11.5 Log Book

Keep a log book recording when and what maintenance work has been done and what materials, including toxic materials, have been used. Make the log book available for inspection on request.

5.11.6 Existing Planting and Grass

Where existing planting or grass is within the landscape contract area, maintain it as for the corresponding classifications of new grassland or planting.

5.11.7 Recurrent Works

Throughout the planting establishment period, continue to carry out recurrent works of a maintenance nature including, but not limited to, watering, mowing, weeding, rubbish removal, fertilising, pest and disease control, reseeding, returfing, staking and tying, replanting, cultivating, pruning, hedge clipping, aerating, renovating, top dressing, and keeping the site neat and tidy.

5.11.8 Grass Areas

Commence grass maintenance works at the completion of sowing, hydroseeding, turfing and the like, and continue to carry out grass maintenance throughout the contract and planting establishment period, maintaining healthy weed free growth and mowed as required to maintain the grass height between 50 – 100 mm.

5.11.9 Garden Beds

Continue to replace failed, damaged or stolen plants. The cost for replacement of plants which fail as a result of poor nursery stock or poor horticultural practices shall be borne by the Landscape Contractor. All garden beds to be kept free from weeds and rubbish at all times.

5.11.10 Mulched Surfaces

Maintain the surface in a clean and tidy condition, free from weeds and reinstate the mulch as necessary to maintain the specified depth.

5.11.11 Stakes and Ties

Adjust, straighten or replace as required. Remove those not required at the end of the planting establishment period.

5.11.12 Watering

Grassed and planted areas are to be watered to maintain a healthy condition and stress free growth. The Landscape Contractor shall be responsible for provision of appropriate temporary water supply if necessary to meet these requirements.

Where an irrigation system exists, the Landscape Contractor shall be responsible for the programming and management of the system and shall ensure that adequate watering is provided to the landscape whilst taking care to ensure that such areas are not over watered.

5.11.13 Final Completion

The Contractor shall ensure that all works of the Contract are complete immediately prior to the expiry date of the Contract time. The Contractor shall remove all debris from the site and any material he may have stored on or adjacent to the site and leave the area tidy to the satisfaction of the Superintendent.

Grass areas shall have a healthy and vigorous grass sward appropriate to the area and trees and shrubs shall show signs of healthy vigorous growth.

5.12 Sample Schedule

The following items are to be inspected by the Superintendent prior to site delivery. Where testing of the items are indicated within the specification, the Contractor is to supply the Superintendent with a copy of the report prior to the inspection.

- Bioretention Materials:
  - Mulch;
  - Filter Media;
  - Drainage Layer;
- Landscape Materials:
  - Mulch;
  - Rock Materials for Scour Protection;
  - Topsoil; and
  - Compost.

6. CLEAN UP AND SITE RESTORATION

6.1 Surface Restoration

The Contractor must make permanent repairs to the unpaved off-carriageway surfaces, including nature strips, make temporary repairs to the paved surfaces (or final repairs to the requirements of Council or VicRoads) and leave the surfaces in a safe condition, unless with the written permission of the property owner, council or other authority having care, management or control of any thoroughfare.

The Contractor shall after the removal of all debris, surplus material, temporary works and construction plant restore the Site and all other areas utilised by it by filling, shaping, or levelling to a stable, free draining state.

Unless a clearance is obtained from the relevant authority, the Contractor must maintain any temporary repairs to paved surfaces until a permanent repair is done.

The Contractor must pay all costs associated with maintenance and temporary and permanent restoration.

6.2 Surface Works

The Contractor must grade the final surrounding surface to suit the level of all surface structures and fittings and ensure that there are no low lying areas and that the site is free draining.

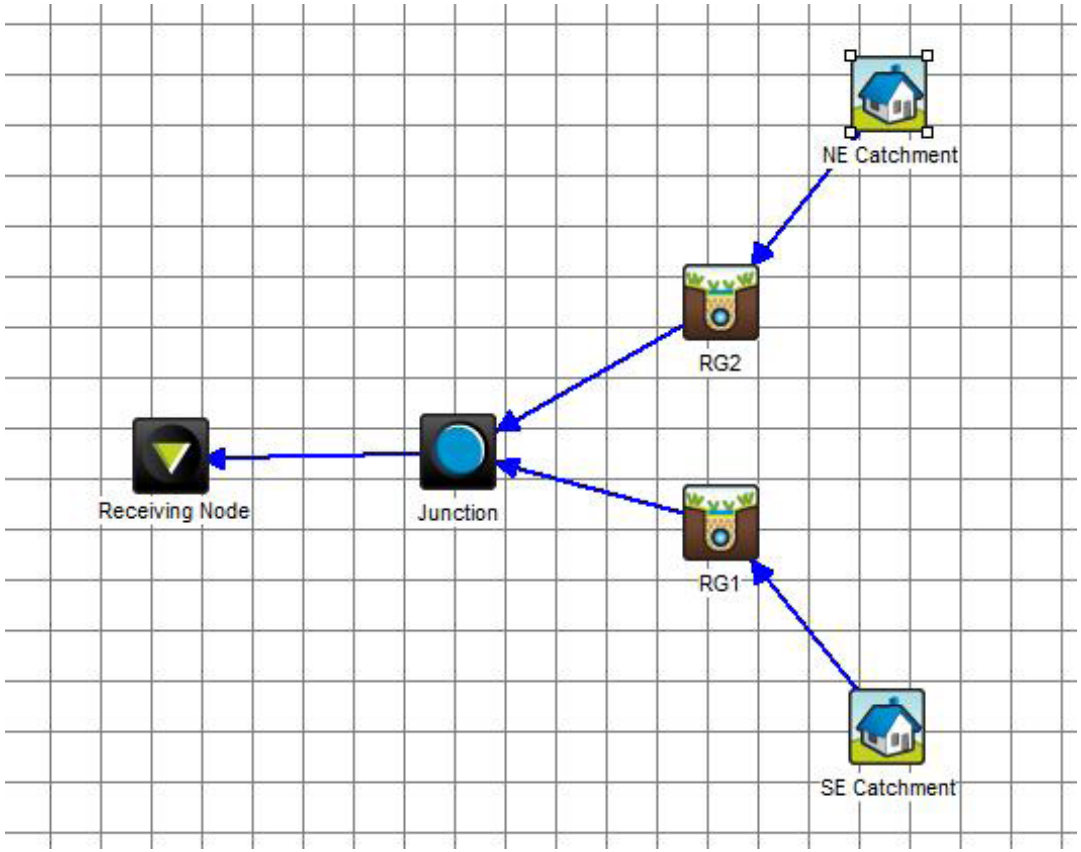
6.3 Cleaning Up

The Contractor must remove all surplus materials from the site and any other area used by the contractor for the Works.

The Contractor must leave the site and other areas clean and tidy as determined by the superintendent.

The materials and rubbish removed from the Site or other areas used by the Contractor must be disposed of lawfully

7 DESIGN BASIS MEMORANDUM



Instructions for Using this Document

- Maintenance items that are common to all configurations are in black text.
- Items be included/excluded depending on the options chosen are in red. Delete items not relevant to project and update example text with project specific information.
- Additional guidance is provided throughout the template through use of comments. All guidance/comments are highlighted in yellow and can be deleted once document is completed.

CONTENTS

1 Introduction

1.1 Project Description

1.2 Report Summary

2 Background

2.1 Project Background

2.2 Existing Conditions and Site constraints

3 MUSIC Modelling

3.1 Summary

3.2 Catchment Delineation

3.3 Meteorological Data Input

4 Design Basis

4.1 Hydrology and Hydraulics

4.2 Design Elements

5 Conclusions

1 INTRODUCTION

1.1 Project Description

Moreland City Council (Council) has recently made modifications to the intersection of First Avenue and Alpha Street in Cleanwater. Kerb outstands have been added to each corner and space made available for the construction of raingardens on two of the four corners. A review of Council's concept design has been undertaken and the general proposed layout adopted. The key features of the proposed design include:

- Two raingardens located in the existing kerb outstands;
- Treatment of stormwater runoff from adjacent local catchments to meet Best Practice Environmental Management Guidelines objectives;
- Pedestrian refuges and landscaped concrete stepped sides to comply with Council safety standards; and
- Landscaping to match the surrounding planted areas.

1.2 Report Summary

This report outlines the detailed design basis for the First Avenue and Alpha Street raingarden/tree pit works. This report includes the following sections:

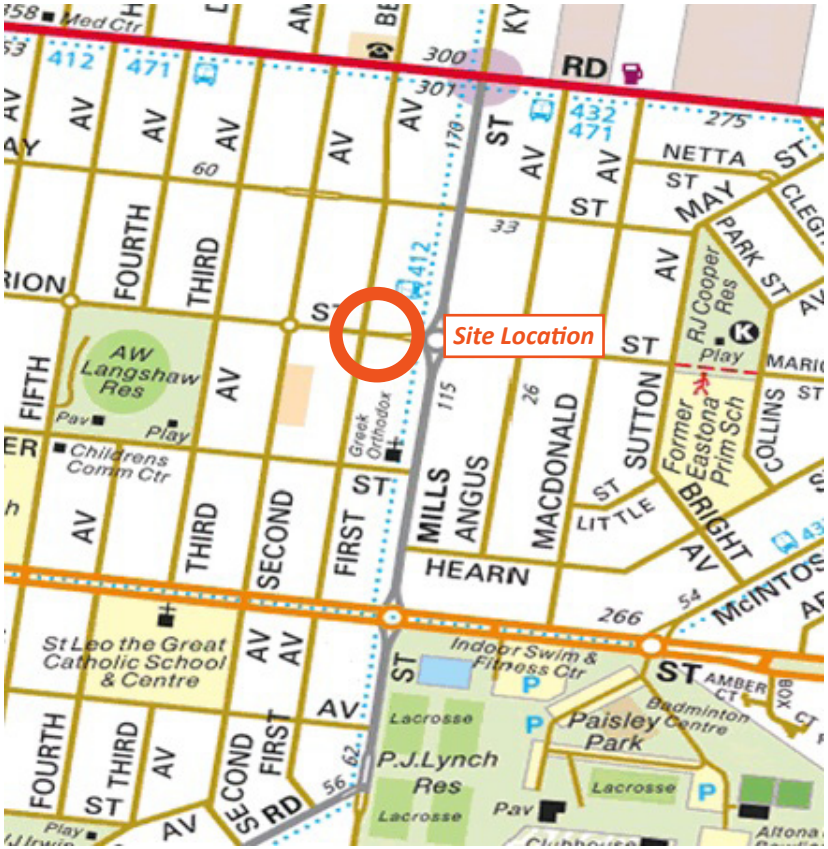
- Section 2 – Background
- Section 3 – MUSIC modelling
- Section 4 – Design Basis
- Section 5 – Cost Estimates
- Section 6 – Conclusions

2 BACKGROUND

2.1 Project Background

The site is located in a residential/commercial/industrial portion of [Insert suburb] at the intersection of First Avenue and Alpha Street. Figure 1 shows the precise location of the works.

Figure : *Site Locality Plan*



2.2 Existing Conditions and Site constraints

Define site conditions and constraints. An example is provided below:

The site is defined by the raingarden footprints allocated in the newly constructed kerb outstands. The north-east site is largely bare except for a planter box which will need to be removed prior to construction. The south-east site has some scattered planting that appears to have been undertaken by the community. This planting will need to be removed prior to construction.

Generally these sites are bounded by footpaths, the road kerb and garden beds. To protect the roots of nearby established trees no works have been proposed within their drip-lines.

A Dial Before You Dig request was submitted for the site. The responses revealed a number of potential conflicts including:

- Electricity: underground high voltage conduits run through the eastern portion of the southern raingarden site. The raingarden design has been modified to avoid this conflict;
- Telecommunications: cables run beneath the southern portion of the southern raingarden. The raingarden layout has been adjusted slightly to avoid this service; and
- Gas: only crosses the inlet channel, which will be at or near the grade of the old gutter, so should not present a conflict.

3 MUSIC MODELLING

3.1 Summary

Describe whether the whole system meets Best Practice Objectives or only part of it.

The MUSIC modelling shows that Raingardens 2 meets Best Practice objectives, however Raingarden 2, due to its larger catchment and service conflict, does not meet objectives for TSS and TN. The system as a whole meets Best Practice Objectives.

3.2 Catchment Delineation

The catchment was delineated based on contour information and stormwater asset plans provided by Council.

3.3 Meteorological Data Input

Melbourne City is an appropriate station to use in most cases for the Moreland municipality as recommended in the Melbourne Water MUSIC Guidelines (2010).

The model runs were based on Bureau of Meteorology (BOM) rainfall data for Melbourne City. For the water quality performance model the rainfall data for Melbourne City supplied within MUSIC for the year 1966 was adopted. This year was selected as a representative year, based on the consistency of the mean annual rainfall and 90th percentile rainfall with the long-term record. In addition, the monthly average areal potential evaporation data for Melbourne were also sourced from within MUSIC (Table 1).

Table 1: *Monthly Potential Evapotranspiration for Melbourne City adopted for MUSIC Modelling*

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Et (mm)	4.81	4.32	3.03	2.00	1.23	1.00	1.06	1.39	2.07	3.32	4.23	4.32

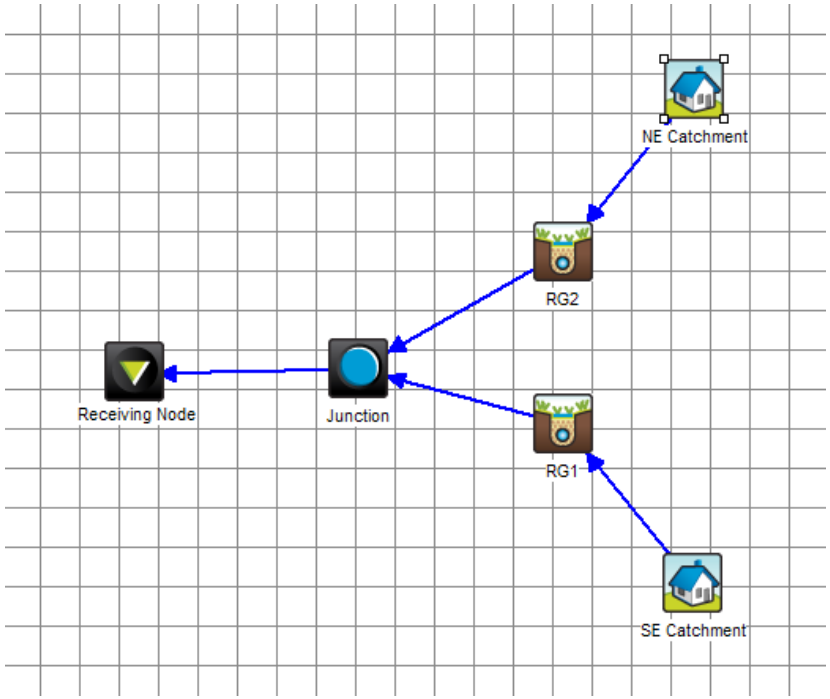
Model Development

For the purposes of the water quality modelling, the following catchment parameters were adopted:

- Catchment delineation based on local drainage network information, contours, aerial photos and site inspection;
- Impervious fraction of 0.85 based on the typical value given in the Melbourne Water MUSIC guidelines for the relevant planning zone and allotment size; and
- Urban pollutant loads stochastically generated.

As illustrated in Figure 2, the proposed works are represented in MUSIC as a treatment train with four catchments and three bioretention nodes. All raingardens have been modelled as bioretention nodes that are lined and have a submerged zone to enhance the removal of nitrogen and phosphorous.

Figure 2: *MUSIC Model Layout [Take a 'screen shot' of MUSIC model]*



3.3.1 Model Input Parameters

The bioretention model parameters for these systems are summarised in Table 2.

Table 2: *Modelled Bioretention Parameters*

PARAMETER	RAINGARDEN 1	RAINGARDEN 2
Extended detention depth (m)	0.2	0.15
Surface Area (m2)	44.0	40.5
Filter Area (m2)	33.4	40.5
Filter Depth (m)	0.25	0.4
Filter Media Saturated hydraulic conductivity (mm/hr)	180	180
Unlined filter media perimeter (m)	0	0
Exfiltration rate (mm/hr)	Not Applicable	Not Applicable
Total nitrogen content of filter media (mg/kg)	800	800
Orthophosphate content of filter media (mg/kg)	40	40
Overflow weir width (m)	2.4	2.4
Submerged Zone Depth (m)	0.35	0.45

3.3.2 MUSIC Model Results

System Treatment Performance

The MUSIC model was run to estimate the treatment performance of the raingarden systems.

Table 3 summarises the treatment train effectiveness of the proposed water quality works versus Stormwater Quality Targets for the City of Moreland. The Targets aim for reduced pollutant loads entering the receiving environment against a 2004 baseline of:

- 80% reduction in Total Suspended Solids (TSS)
- 60% reduction in Total Phosphorus (TP)
- 45% reduction in Total Nitrogen (TN)

This indicates that the system will provide significant water quality improvement benefits.

Table 3: *Modelled Bioretention Parameters*

	FLOW (ML/YR)	TSS (KG/YR)	TP (KG/YR)	TN (KG/YR)
Best Practice Target (%)	-	***80%***	***60%***	***45%***
Raingarden 1				
Sources	7.00	1470	2.98	20.0
Residual load	6.9	362	1.44	11.4
Percent reduction	1.4%	75.4%	51.6%	42.9%
Raingarden 2				
Sources	3.19	634	1.29	9.21
Residual load	3.07	53.5	0.55	3.40
Percent reduction	3.8%	91.6%	57.5%	63.1%
Total				
Sources	10.2	2100	4.27	29.2
Residual load	10.0	731	1.99	14.8
Percent reduction	1.9%	80.2%	53.4%	49.3%

4 DESIGN BASIS

4.1 Hydrology and Hydraulics

4.1.1 Design Flows

The raingarden is design to treat up to the 1 in 3 month ARI flow event. The design flow was calculated using the Urban Rational Method as detailed Australian Rainfall and Runoff[1].

Inputs to the Urban Rational Method were as follows:

- Catchment areas were obtained from [insert source of catchment data];
- Site specific rainfall intensity data was obtained from the Bureau of Meteorology's Online Intensity-Frequency-Duration Program;
- Time of concentration was assumed to be [5 minutes initially for flow to travel from allotments to the gutter plus gutter flow time calculated using Manning's equation]; and
- A Fraction impervious of 85% was used, consistent with Melbourne Water MUSIC guidelines for high density residential allotments.

Table 4 below shows the design peak flows (1 in 3 month year ARI) adopted.

Table 4: *Design Flows*

RAINGARDEN	AREA (ha)	IMPERVIOUS FRACTION (%)	T_C (MINUTES)	INTENSITY (mm/hr)	ESTIMATED FLOW (m^3/s)
1	1.461	85%	9.08	80.85	0.256
2	0.734	85%	9.10	80.78	0.129

4.1.2 High Flow Bypass

The raingardens were designed so that at least the 1 in 3 month ARI flow event would be intercepted by the kerb openings and directed into the raingarden for treatment. The raingardens would fill until the stormwater reaches the ponding depth (extended detention depth) then overflow via the high flow diversion.

The capacity of the high-flow diversions was checked using the broad-crested weir equation and orifice flow equation where applicable. A blockage factor of 50% was assumed. Heights above the extended detention depths need to be less than freeboard allowed in the raingarden to avoid flooding neighbouring footpaths and streets. High flow bypass calculations are summarised in the table below.

Table 5: *High Flow Bypass Check*

RAINGARDEN	HIGH FLOW (m^3)	WEIR LENGTH (m)	FREEBOARD (m)	WEIR FLOW DEPTH (m)	ESTIMATED FLOW (m^3/s)
1	0.240	2.4	0.22	0.15	0.256
2	0.119	2.4	0.21	0.09	0.129

4.1.3 Inlet Capacity

The capacity of the inlet channels was checked using Manning's Equation. As a conservative approach the concrete channels were assumed to have a consistent grade of 1% and a Manning's roughness coefficient (Manning's n) of 0.020, which is consistent with rough stone in mortar. The largest flow requiring conveyance through this channel profile will originate from the eastern catchment of raingarden 1. A separate rational method calculation was undertaken to determine a peak 1 in 3 month ARI flow of 0.123 m3/s. Using Manning's equation with the aforementioned inputs yields a capacity of 0.140 m3/s which is sufficient to convey the maximum inflow of 0.123 m3/s.

[1] IEAust (1997). Australian Rainfall and Runoff, A Guide to Flood Estimation. Institution of Engineers, Australia, 1997.

4.1.4 Summary of key levels

Table 6 below presents a summary of the key levels as determined based on site topography and the considerations in Section 2.2.

Table 6: *Key Raingarden Levels (RLs)*

RAINGARDEN	TOP OF FILTER	OUTLET LEVEL (TOP OF EXTENDED DETENTION)	MAXIMUM PONDED LEVEL	MINIMUM ADJOINING LEVEL (FOOTPATH/ WALL)
1	5.90	6.10	6.25	6.32
2	5.89	6.04	6.13	6.21

4.1.5 Maximum Infiltration Rate

The maximum infiltration rate for each raingarden was calculated using Darcy's equation. The saturated hydraulic conductivity of the filter media was assumed to be 180 mm/hr. This is consistent with the hydraulic conductivity assumed during MUSIC modelling. Other equation input parameters and results are summarised in Table 7 below.

Table 7: *Maximum Raingarden Infiltration Rates*

RAINGARDEN	FILTER AREA (m^2)	DEPTH OF FILTER (m)	EXTENDED DETENTION (m)	MAXIMUM INFILTRATION RATE (m^3/s)
1	0.240	2.4	0.22	0.15
2	0.119	2.4	0.21	0.09

4.1.6 Perforated Collection Pipes

The inlet capacity of the perforated collection pipe was calculated using an orifice flow equation. Pipe characteristics were assumed to be 1500 mm2/m water entrance, with 50% blockage and 1.5 mm x 7.5 mm slots. It was assumed that each slot acts as a sharp-edged orifice.

Table 8: *Perforated Collection Pipe Inlet Capacities*

RAINGARDEN	DEPTH OF TOP LAYERS (m)	EXTENDED DETENTION (m)	PIPE LENGTH (m)	PIPE INLET CAPACITY (m^3/s)
1	0.7	0.2	6.0	0.017
2	0.75	0.15	6.3	0.017

All pipe inlet capacities exceed the maximum infiltration rates for the relevant raingardens, hence pipe inlet capacity is adequate.

The capacity of the perforated pipes were checked using the Colebrook-White equation. The internal diameter of the 100 mm perforated pipes is 86 mm and the Darcy-Weisback roughness is 3.0 mm. Due to the submerged zone the pipes will be laid flat, hence the slope was assumed to be the head of water over the pipe divided by the length of pipe to the pit. The head of water over the pipe was assumed to be 0.05 m, which is the depth of the transition zone. This assumption is conservative because it allows for maximum infiltration rate to flow through the pipe even once the filter layer has mostly drained.

Table 9: *Perforated Collection Pipe Capacities*

RAINGARDEN	TOTAL PIPE LENGTH (m)	PIPE CAPACITY (m^3/s)
1	6.0	0.028
2	10.3	0.021

All pipe capacities exceed the maximum infiltration rates for the relevant raingardens, hence pipe capacity is adequate.

4.2 Design Elements

A number of non-standard design elements were incorporated into the design to meet Council requirements and specific site constraints.

4.2.1 Safety Features

Safety has been considered throughout the design process and the following features have been incorporated into the design:

- Maximum drop of 190 mm at raingarden edges.
- 600 mm wide planted pedestrian refuges between raingardens and the street to allow pedestrians to escape from traffic in an emergency without having to step down into the raingarden.
- 500 mm wide planted buffer between raingardens and footpaths to reduce the risk of pedestrians falling into the raingarden.
- Filter media footprints within raingardens located to accommodate offsets from existing services, including gas and electricity.

4.2.2 Grated Inlet Channel

Grated inlet channels divert stormwater from the kerb and channel into the raingardens. These grated inlet channels have a number of features:

- Rough stone bases at their inlets to help settle out sediment prior to it entering the raingarden;
- A stepped base (where grade allows) to help dissipate energy prior to entry into the raingarden;
- Removable heelguard grates for easy maintenance of the inlet channel; and
- Grates that extend 500 mm beyond the edge of the footpath to reduce the risk of pedestrians stepping into the channel.

4.2.3 Submerged Zone and Adjustable Inlet Riser

Each raingarden features a submerged zone formed by a high outlet level and contained by the fully lined system. This submerged zone aids plant health during prolonged dry periods and improves the treatment efficiency of the raingarden.

An adjustable inlet riser in the raingarden outlet pit allows the level of the submerged zone to raised or lowered. It is recommended that the submerged zone be set to a raised level (200 mm below the filter surface) during the plant establishment phase and lowered to the standard operating level (50 mm below the base of the filter) once plants are established.

4.2.4 Raingarden and Edge Planting

Raingarden and edge planting species were selected to match the existing Council planting palette in the Illustrated Catalogue and to comply with species recommended the FAWB Adoption Guidelines[2].

[2] FAWB (2009). Adoption Guidelines for Stormwater Biofiltration Systems, Facility for Advancing Water Biofiltration, Monash University, June 2009.

5 CONCLUSIONS

The key features of the proposed raingardens at the corner of First Avenue and Alpha Street in Cleanwater are:

- Two raingardens in the treatment train achieving Moreland Stormwater Quality Targets;
- All raingardens designed to comply with Moreland City Council safety requirements for maximum fall height and pedestrian refuges;
- Grated inlet channels to allow for ease of inlet maintenance and passage of footpaths between the raingardens and the adjacent kerb low points; and
- Adjustable depth submerged zone to increase treatment efficiency and allow for maintenance of plant health during dry periods.

8 MAINTENANCE CHECKLIST TEMPLATE

CONTENTS

1	Establishment Phase Maintenance	1
2	Long Term Maintenance	2

Instructions for Using this Document

- Maintenance items that are common to all configurations are in black text.
- Items be included/excluded depending on the options chosen are in red. Delete items not relevant to project and update example text with project specific information.
- Additional guidance is provided throughout the template through use of comments. All guidance/comments are highlighted in yellow and can be deleted once document is completed.

1 ESTABLISHMENT PHASE MAINTENANCE

The first 12 months after construction is the most intensive periods in terms of maintenance. Following a 52 week defect period Council will be responsible for the maintenance of the raingardens during the establishment phase. During this time, weed removal and replanting may be required.

During the establishment phase, a range of works are needed, including:

- Irrigation Watering – as required;
- Control of weeds – a monthly visit;
- Removal of litter and sediment – as required; and
- Replacement of plant losses – typically 10% to 15% of initial plantings.

During construction phase of the project, a high load of sediment in stormwater may be generated. These sediments can affect plant growth as well as clog the filter media.

It is recommended that the filter media is protected during the construction phase by keeping the raingarden off-line during this period, delaying the final landscaping to protect the system or covering the filtration surface with geotextile.

During construction the submerged zone (where applicable) will be set to a raised 'establishment phase' level 200 mm below the surface of the filter material. At the end of the establishment phase the inlet riser in each outlet pit needs to be cut back to the permanent submerged zone level. Details regarding riser levels can be found in the civil drawing set.

If at the end of the establishment phase the planting is showing signs of stress as a result of lack of water the raised submerged zone should be maintained until wetter weather conditions prevail.

If after lowering the submerged zone level it is deemed necessary to raise the level once more to aid plant health, it is possible to do so by connecting a short length of PVC pipe to the inlet riser and sealing it in position using PVC pipe cement.

2 LONG TERM MAINTENANCE

The raingarden/tree pit should be routinely maintained as a landscaped area as part of the local maintenance regime. Typically the main maintenance task for the raingarden will be visual inspections. These include inspection of:

- The health of the vegetation;
- The level of ponding during and after a rain event; and
- The structural elements including pits, inlet channels and surrounding paths.

Table 1 presents the inspections tasks and maintenance tasks required for each of the system components within the raingarden/tree pit. This includes a description of the maintenance task and the expected frequency of undertaking the task.

Table 1: *Raingarden/Tree Pit Inspection and Maintenance Tasks*

NO.	DESCRIPTION	RESPONSIBILITY	INSPECTION TASK	FREQUENCY	MAINTENANCE ACTION
1	Filter Media and Raingarden/Tree Pit Surface		Inspect litter accumulation	3 monthly	Litter removal as part of routine maintenance of garden beds
			Inspect sediment accumulation	3 monthly	Sediment removal from surface/ameliorate surface
			Inspect for surface erosion, holes or scour	3 monthly	Reinstate surface layer by raking
				Annually	Top up filter media and form regraded surface
			Assess hydraulic performance	3-yearly	Conduct testing of filter media infiltration rate (hydraulic conductivity testing see FAWB[1] (Appendix B for details)
			Assess hydraulic performance	As required	Replacement of filter media and drainage layers (when hydraulic conductivity <50 mm/hr)
2	Vegetation		Assess plant health (disease or pest infection)	3 monthly	Treat or replace as necessary
			Inspect plants for signs of dying off	3 monthly	Check volume of water plants are receiving and reset inlet and overflow levels
			Check plant density	3 monthly	Replace plants as required to maintain original density
			Check for presence of weeds	3 monthly	Manually remove weeds where possible. Or spot spray with herbicide appropriate for use near waterways

[1] FAWB, 2009 - *Facility for Advancing Water Biofiltration Guidelines* available http://www.monash.edu.au/fawb/products/fawb-filter-media-guidelines-v3-june-2009.pdf

NO.	DESCRIPTION	RESPONSIBILITY	INSPECTION TASK	FREQUENCY	MAINTENANCE ACTION
3	Raingarden Drainage		Inspect for blockage in underdrain	6 monthly	Underdrain to be flushed out via pipe snake or water jet through flushing point
			Check water level in submerged zone is at design level	6 monthly	Check outflow level is correct and reset as required
			Inspect integrity of underdrain	Annually	Repair or replace as required
4	Raingarden Inlet		Inspect raingarden inlets for debris and sediment build up	3 monthly	Remove as required
			Inspect raingarden kerb inlets for scour	6 monthly	Reinstate inlet scour protection as required
5	Overflow Pit (Raingarden Outlet)		Inspect outlet into overflow pit for blockage	3 monthly	Remove any debris from pit, including from inlet openings and pipe connections
6	Surroundings		Inspect perimeter planting	3 monthly	Replace as required

A sample of a maintenance checklist adopted from the WSUD Procedures[1] and FAWB Adoption Guidelines is included in Table 2.

The maintenance report should include details of the following:

- The date of maintenance;
- The name of the persons performing the maintenance;
- What types of maintenance actions were performed for each water quality device;
- The environmental state of the device including an estimate of the type and weight of litter removed and the amount of sediment captured where appropriate; and
- The state of the contributing catchment and detail potential needs for further landscaping or maintenance controls.

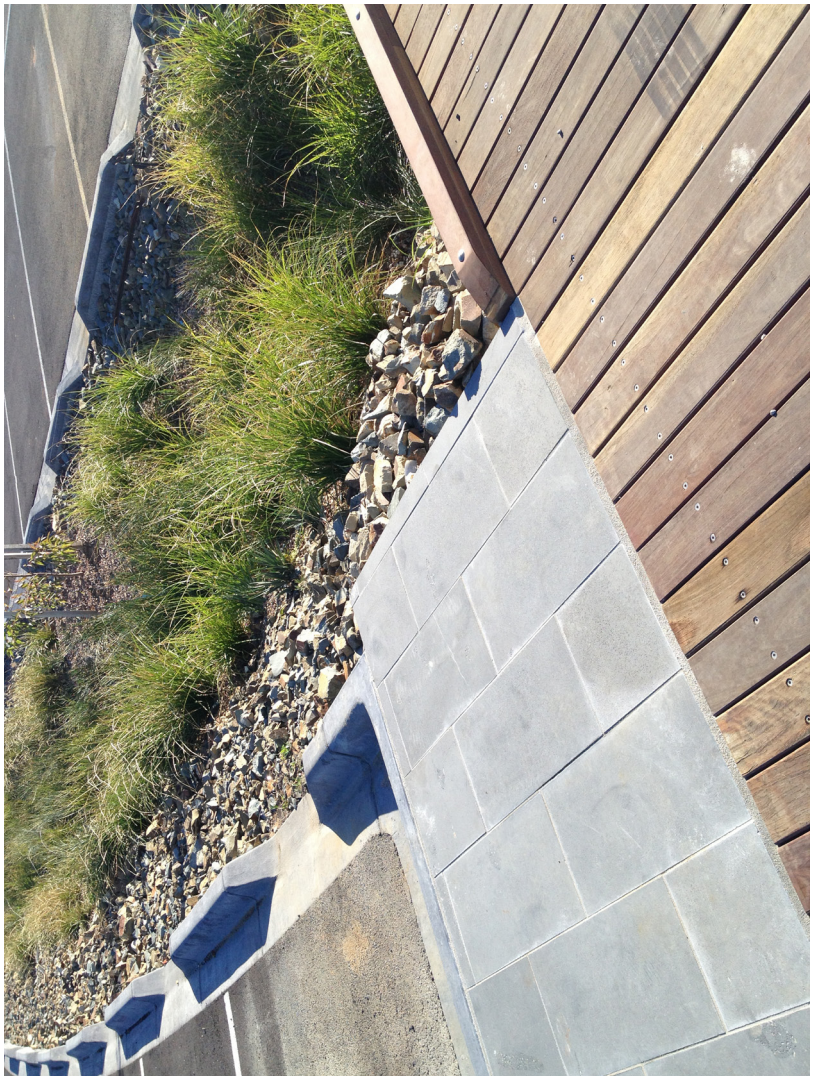
[1] CSIRO (2005) *WSUD Engineering Procedures: Stormwater ©Melbourne Water Corporation* SIRO Publishing, Collingwood VIC.

Table 2: *Raingarden Maintenance Checklist*

INSPECTION FREQUENCY: 3 MONTHLY	DATE OF VISIT		
LOCATION	First Avenue and Alpha Street Raingardens/Tree Pit		
DESCRIPTION	Raingarden with submerged zone		
SITE VISIT BY			
INSPECTION ITEMS	Y	N	ACTION REQUIRED/PERFORMED (DETAILS) OR GENERAL COMMENTS
Filter Media and Raingarden Surface			
Surface clogging visible?			
Litter within garden?			
Evidence of extended ponding?			
Sediment/silt/clay build up?			
Surface scour/holes?			
Vegetation			
Vegetation condition (disease/pests/poor growth?)			
Vegetation densities?			
Build up or organic matter?			
Additional watering required?			
Replanting required?			
Weeds present?			
Pits, pipes and inflow areas			
Sediment and litter accumulation at inflow points (Provide volume and typical nature of pollutants)			

INSPECTION FREQUENCY: 3 MONTHLY	DATE OF VISIT		
LOCATION	First Avenue and Alpha Street Raingardens/Tree Pit		
DESCRIPTION	Raingarden with submerged zone		
SITE VISIT BY			
INSPECTION ITEMS	**Y**	**N**	**ACTION REQUIRED/PERFORMED (DETAILS) OR GENERAL COMMENTS**
Erosion at inlet or other structures?			
Drainage system inspected?			
Clogging of drainage points (inc. under drains) with sediment or debris)?			
Submerged zone upturned pipe damaged/blocked?			
Submerged zone water level (at design level/drawn down?) (some drawdown during dry periods is expected)			
Comments and Other Elements not included above:			

9 REFERENCES



EPA Victoria, 2003. State Environment Protection Policy (Waters of Victoria) available *http://www.epa.vic.gov.au/~/media/Publications/905.pdf*

FAWB, 2009 - *Facility for Advancing Water Biofiltration Guidelines* available: http://www.monash.edu.au/fawb/products/fawb-filter-media-guidelines-v3-june-2009.pdf

Melbourne Water, 2010, Guidelines for the Use of MUSIC available: http://www.melbournewater.com.au/content/library/wsud/guidelines_for_the_use_of_music.pdf

Melbourne Water, 2005. *WSUD Engineering Procedures: Stormwater*, CSIRO Publishing, Collingwood VIC.

Royal Life Saving, 2004. *Guidelines for Water Safety in Urban Water Developments*. Royal Life Saving Society of Australia.

Victorian Stormwater Committee. 1999. *Urban Stormwater Best-Practice Environmental Management Guidelines.* CSIRO Publishing, Collingwood VIC

Moreland City Council

Locked bag 10
Moreland Victoria 3058
info@moreland.vic.gov.au
moreland.vic.gov.au

Moreland City Council
Switchboard and after hours emergency:
T 9240 1111
TTY 9240 2256

For information on this document contact:
Vaughn Grey
Utility Management and Water Engineer
vgrey@moreland.vic.gov.au
T 9240 2481