ZAM-WSUD

Zero Additional Maintenance Water Sensitive Urban Design

Handbook

Water Sensitive Urban Design without ongoing maintenance requirements for asset owners.

MANNINGHAM

Melbourne Water

CRC for Water Sensitive Cities

The ZAM-WSUD project is a collaboration between Manningham City Council, Melbourne Water, the Co-operative Research Centre for Water Sensitive Cities and Monash Water for Liveability Centre. The project is supported by the City of Glen Eira.

The project was initiated by Manningham City Council and received funding support through the Melbourne Water Living Rivers Program. The project also received a financial contribution from the Co-operative Research Centre for Water Sensitive Cities.

Laboratory testing conducted at the Monash Water for Liveability Centre.

Stage 1 construction works were completed by Roadside Services & Solutions and prototypes were constructed by Versini.

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For the most up to date version, visit: www.clearwater.asn.au/resource-library/publications-and-reports/zero-additional-maintenance-water-sensitive-urban-design-zam-wsud-handbook.php

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What is ZAM-WSUD ?

Zero Additional Maintenance Water Sensitive Urban Design (ZAM-WSUD) is a water sensitive urban design system that has been designed so that the ongoing maintenance implications for the asset owner are negligible. The design objective is that a ZAM-WSUD system should not have increased overall maintenance requirements at the installation location compared to the maintenance requirements for the site prior to the construction of a ZAM-WSUD asset.

Why ZAM-WSUD is Important ?

Becoming a water sensitive city involves physical changes to stormwater infrastructure systems such that stormwater is treated prior to discharge into waterways. Water Sensitive Urban Design is one approach to stormwater treatment that typically utilises biofiltration to treat stormwater at the local scale. Biofiltration systems allow stormwater to pass through vegetated sand filter media which removes nutrients and other pollutants prior to discharge to waterways via the drainage network.

If stormwater is to be treated by biofiltration at a local scale prior to discharge to waterways by local biofiltration, a very large number of the local biofiltration systems will be required. Each of these assets has typically required ongoing maintenance to continue to function effectively.

Asset owners are now identifying that the long term ongoing maintenance requirements of many types of biofiltration systems can be significant. Consequently there is significant long term value for asset owners (and communities) in developing and implementing Water Sensitive Urban Design systems with zero or very low maintenance implications for asset owners.

This handbook provides examples of practical design and construction details for urban street scale water sensitive urban design systems with zero or very low maintenance implications based on ZAM-WSUD installations that have been constructed by Manningham City Council as part of the ZAM-WSUD trial project.

The ZAM-WSUD design philosophy can also be extended more broadly to other WSUD installations. As a design objective ‘ZAM-WSUD’ sets maintainability objectives of ‘best ensuring that new WSUD assets have minimal ongoing maintenance requirements for asset owners’. ZAM-WSUD systems have been demonstrated to be feasible for street scale installations and may also be practical for medium and larger scale biofiltration systems. Setting ‘ZAM-WSUD’ as an objective for designers encourages innovation and improved maintainability for new stormwater biotreatment systems.

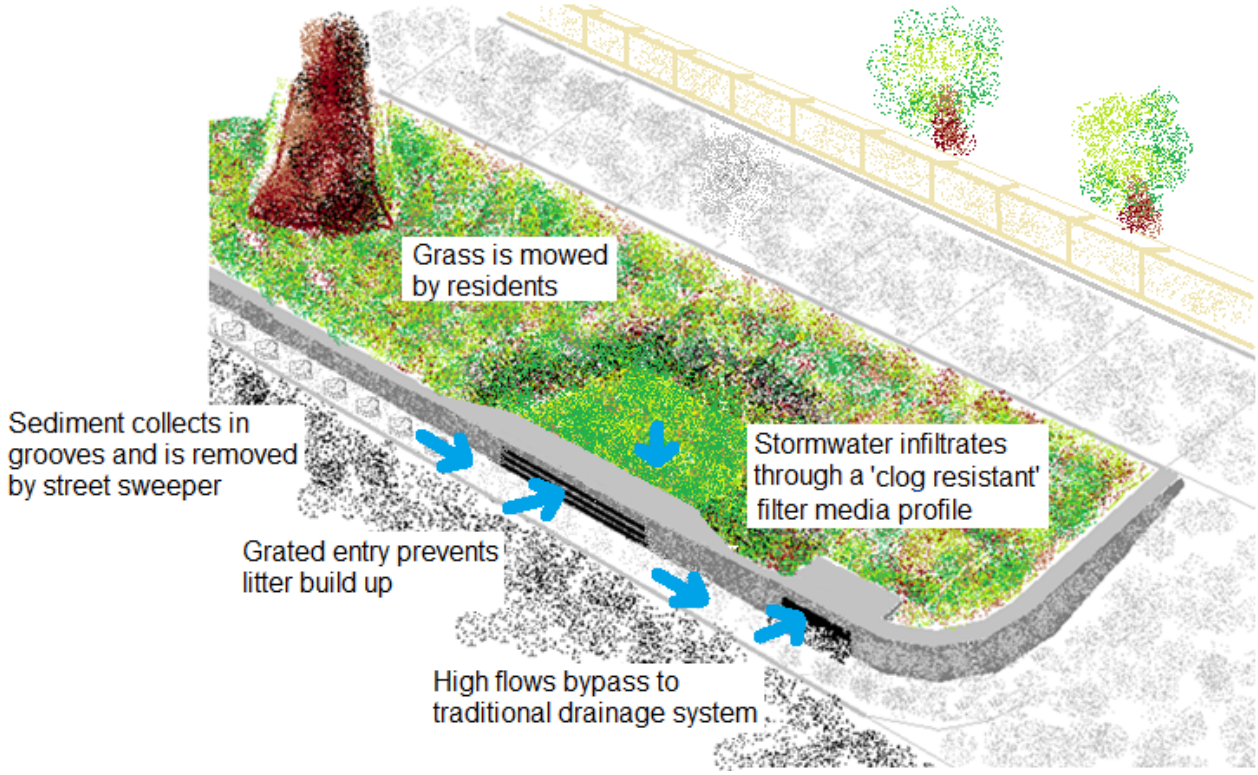
ZAM WSUD Initiatives

The ZAM-WSUD research project investigated typical maintenance requirements for street scale water sensitive urban design systems, and adopted various alternative design solutions that removed ongoing maintenance requirements for asset owners.

Design solutions implemented in the ZAM-WSUD trials were:

- Sediment grooves
- Grass turf for biofiltration
- 'Clog resistant' filter media profile
- Litter guard inlets

ZAM-WSUD designs were developed primarily for the retrofit of typical suburban residential streetscapes with grassed nature strips, but are also suitable for new urban developments, car parking areas and industrial sites.



Schematic of a grassed ZAM-WSUD installation

Sediment grooves

Biofiltration systems can be susceptible to filter media clogging if large amounts of fine sediment (typically silts) enter the biofiltration system and form a thin impervious surface layer, preventing water entry to subsurface layers.

Sediment collection prior to a biofiltration system reduces sediment quantities entering the biofilter, reducing the risk of clogging and helping to ensure that systems can function effectively in the long term without requiring sediment removal and/or filter media replacement.

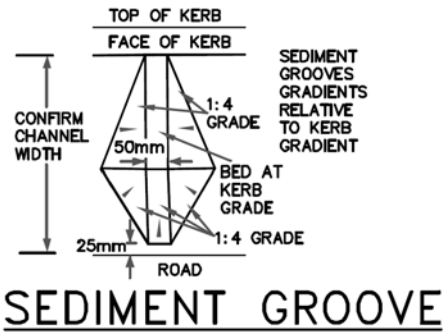
Appropriately dimensioned sediment grooves constructed in the concrete channel prior to a biofilter inlet have been shown to be effective at trapping sediment.

Deposition in a sediment grove prototype

Constructed sediment grooves

Sediment grooves have been designed so that collected sediment will be effectively removed by street sweepers during routine street-sweeping, (typically every 5 to 6 weeks). Field testing (using a MacDonald Johnston VT605 Sweeper) confirmed that 1V:4H side and rear gradients were optimal to allow sediment grooves to be clean out by a street sweeper. The sediment groove bed gradient is designed as flat and level with the kerb invert to prevent water ponding. Bed width was selected as 50mm to ensure adequate collection capacity and also moderating risks to pedestrians and cyclists.

Field trials to design sediment grooves



Sediment grooves during construction

Grassed WSUD Systems

WSUD systems have typically utilised low level riparian vegetation to remove nutrient and other pollutants during infiltration. Research trials previously undertaken at Monash University (Payne et Alia, 2014) identified that soft leaf buffalo grass also effectively removes nitrogen and phosphorous from stormwater passing through a sand filtration system. As such grasses were confirmed as potentially suitable for WSUD applications.

The ZAM-WSUD research project identified that grassed biofilter systems could meet the 'zero additional maintenance' objective when installed in a typical suburban nature strip. Normal grass mowing arrangements (by residents, Council or others) will provide regular removal of vegetation growth, effectively removing nutrients from the biofiltration system and ensuring that the system continues to effectively treat stormwater system in the long term.

The Palmetto SS100 soft leafed buffalo cultivar was initially identified as potentially suitable due to characteristics such as: drought tolerance, shade tolerance, frost tolerance, slow growth rate, wear tolerance and low growth height. Preliminary field trials undertaken in Manningham in 2014-16 confirmed that the Palmetto SS100 cultivar could be suitable for in-field grassed ZAM-WSUD installations, but that there could be some establishment difficulties for "full sun" sites with dry soils.

Comparative grass trails (2016) indicated that Kenda Kikuyu and Empire Zoysia have improved initial survival characteristics in sandy soils compared to soft leafed buffalo cultivars. Nara Native Zoysia may also be suitable for areas with high environmental values, low to medium pedestrian traffic and part shade (up to 40%). Grass condition 4 months after planting is shown in the pictures below.

Nara Native Zoysia

Soft leaf Buffalo Palmetto

Kenda Kikuyu

Empire Zoysia

Soft leaf Buffalo Sapphire

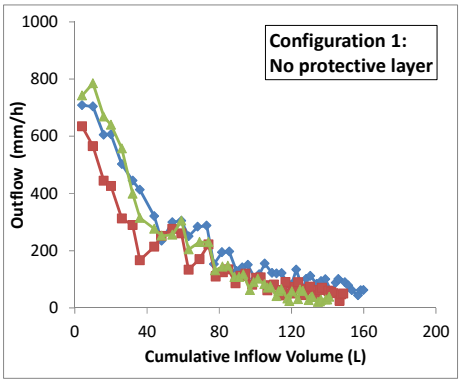
Sterile male Kikuyu species such as Kenya Kikuyu and Village Green Kikuyu offer good wear tolerance and are expected to be most suitable for sites with minimal shade (<20%). Empire Zoysia is expected to be most suitable for low to medium pedestrian traffic sites with part shade (up to 40%). Santa Ana couch may also be suitable for sunny sites, but has not yet been trialled. Laboratory testing has not yet been completed to confirm nutrient removal ability of grasses other than soft leafed buffalo.

Grass is best established in mid autumn or early spring. Grass requires regular watering (or rainfall) for at least the first six weeks after planting. Watering every second day is needed unless regular rainfall is regular. Successful establishment also requires top dressing, typically with a 15mm depth of 20/30 sand. Amelioration of the sand layer directly below the turf with organic matter, fertiliser and trace elements is recommended to assist with grass establishment.

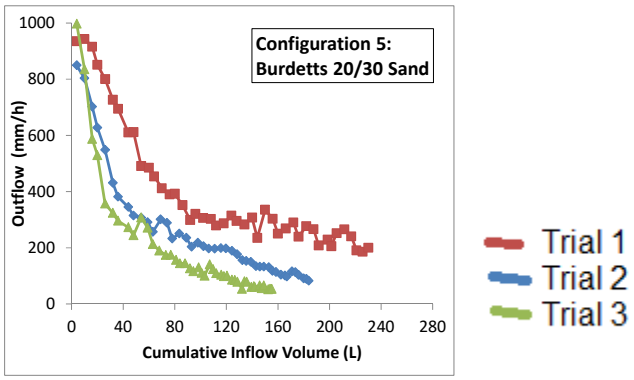
'Clog resistant' filter media profile

Biofilter media clogging has been a problem for some WSUD installations where high sediment loads occur before plants are well established. Filter media clogging is typically caused by the formation of a thin impervious layer of sediment at the top of the FAWB specification filter media sand.

A preliminary literature review by Monash University researchers indicated the potential to reduce the incidence of surface layer blocking by the addition of a coarse sand layer above the FAWB specification layer. Laboratory trials undertaken at Monash University as part of the ZAM-WSUD project (Hatt et alia, 2014) confirmed the suitability of this strategy.



FAWB specification control (300mm)



20/30 Sand (100mm) above FAWB Spec (200mm)

The graphs above show the improved clog resistance for a filter media profile with the inclusion of a coarse sand layer at the surface for an 18 month stormwater nutrient load over applied over a 15 day period. In-field clog resistance is significantly better than the above results for both filter media types due to in-field effects that increase porosity including: wetting & drying cycles, plant root growth and soil biota growth. As such the inclusion of a protective layer is expected to provide a filter media with significant long term resilience against clogging.

Suitable sands for the protection layer have a high percentage of particles between 0.5mm and 2mm in diameter, and very little fine sand, silt and clays (preferably 3% or less fines).

Particle Size (mm)		
Fine Gravel	(2.0mm)	2
Very Coarse Sand	(1.0mm)	13
Coarse Sand	(0.5mm)	61
Medium Sand	(0.25mm)	21
Fine Sand	(0.15mm)	1
Very Fine Sand	(0.05)	2
Silt and Clay	(<0.05mm)	trace
Hydraulic Conductivity (mm/hr)		1316
Drainage		
Texture		Off white sand

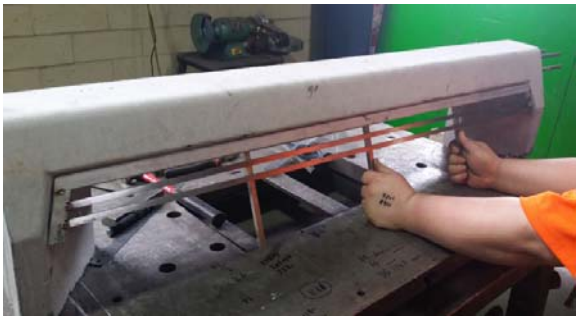
20/30 sand particle size distribution

Litter guard inlets

Typical biofilter systems are designed to allow litter to enter the filtration area where it will be retained on the surface. This has benefits in terms preventing litter entry to waterways, but also has maintenance implications as community expectations are that litter is regularly removed from WSUD assets. Community expectations for litter removal can create significant ongoing maintenance requirements for asset owners.

ZAM-WSUD systems installed in trials included inlet grates with 18mm to 20mm gaps between bars such that larger litter will continue along the kerb and bypass the biofiltration system. Square bars were used to reduce the potential for litter to jam between bars. Litter smaller than 20mm in size is able pass through the inlet grates. This sized litter would generally be expected to be collected during grass mowing. Inlet grates have also been designed so that the inlet grill is flush with the existing kerb so that the face can be effectively cleaned by street sweepers as part of normal street sweeping. Bypass flow will also assist in removing leaf matter and other debris from the face of the inlet grate. In-field observations confirm that the design is effective at ensuring that there is no long term collection of debris on the inlet grate.

To prevent abrasive damage from stainless steel street sweeper brushes, 304 stainless steel has been identified as the preferred construction material for grates. Hot dip galvanised steel will also be effective, but may be susceptible to long term removal of the galvanising coating on the front face. Barrier kerb inlets are now commercially available in 304 stainless steel. For the more complex grates used for roll over kerbs, galvanised steel was used due to cost considerations.



Grated inlet for a barrier kerb – 304SS

Grated inlet for rollover kerb – hot dip galv. steel

As part of overall catchment strategies, asset owners may also wish to consider the inclusion of gross pollutant traps elsewhere in the stormwater network to complement ZAM-WSUD installations.

At this stage ‘Zero Additional Maintenance Gross Pollutant Traps’ (ZAM-GPTs) have not yet been developed, but a three year research project is currently underway to develop a street scale gross pollutant trap system that can be emptied at very low cost by standard garbage trucks. The project is sponsored by the Melbourne Metropolitan Waste Management Group and Manningham City Council.

Practical ZAM-WSUD Examples

Grassed

Prototype at the Manningham Depot, Blackburn Road, Doncaster East

Park Avenue, Doncaster, single barrier kerb installation

Hummel Way, Doncaster, single barrier kerb installation

Edwin Street, Templestowe, single barrier kerb installation

Sanctuary Place, Templestowe, roll over kerb installations

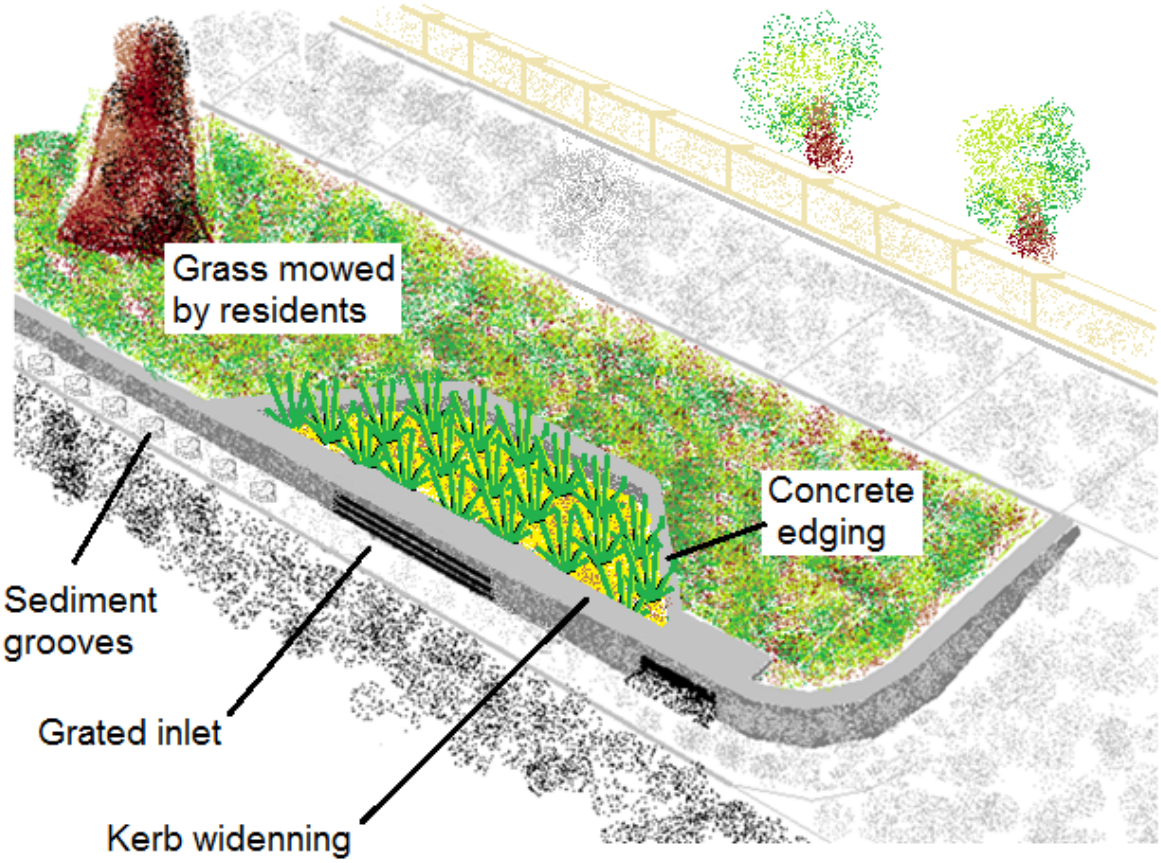
Ruffey Lake Park, Victoria Street car park, Doncaster, barrier kerb installations (5 no.)

Vegetated

Vegetated WSUD systems can also be designed to require no or minimal additional maintenance.

For areas where feature landscaping is existing or proposed for aesthetic reasons, a vegetated ZAM-WSUD system can be installed with similar maintenance requirements to a typical landscaped area such that the design criteria of 'zero additional maintenance' is achieved.

For new urban street scale installations, some occasional weed removal and vegetation trimming may still be required. Inclusion of a surface layer of 20/30 course sand has been shown to significantly reduce weed growth in ZAM-WSUD systems installed to date. The selection of plant species with low to moderate foliage growth rates will minimise trimming requirements.



Sketch of a typical vegetated ZAM-WSUD installation

In order to ensure that vegetated ZAM-WSUD systems are effective at removing nitrogen, systems should be planted with at least 50% of plants from the list of species recommended in *Adoption Guidelines for Stormwater Biofiltration Systems – Summary Report* (Payne et alia, 2015). Suggested species from this list that are suitable for general installations are: *Goodenia ovata, Juncus flavidus, Baumea rubiginosa* and *Ficinia nodosa.* The remainder of plants can be selected from a broad range of species, but species that fix nitrogen should be avoided.

Highview Drive, Doncaster, vegetated ZAM-WSUD installation, photo and design plan

Mullum Mullum Reserve, Donvale, vegetated ZAM-WSUD installation

Worrell Street, Nunawading, ZAM-WSUD inlet retrofit (in construction)

Site Selection

A wide range of factors need to be considered when assessing the suitability of a proposed site for a ZAM-WSUD system.

Strategic planning

WSUD systems offer greatest benefits to waterways in catchments where there is no other previously constructed stormwater treatment infrastructure, (such as a treatment wetland). As such installations are most beneficial when strategically coordinated in accordance with an overall stormwater management plan for the catchment.

Catchment area and size

WSUD systems aim to break the direct link between impervious areas and the stormwater network. To be most effective systems should generally be located just upstream of a side entry or grated stormwater pit to allow stormwater from the largest catchment to be collected and treated.

The ZAM-WSUD system size needs to be proportional to the impervious catchment area size that drains into the biofilter to ensure that systems provide effective stormwater treatment and are resistant to clogging.

A treatment area of 1-2% of the impervious catchment area is considered ideal for biofiltration systems. ZAM-WSUD systems are expected to be able function effectively with larger catchment areas compared to traditional WSUD systems as ZAM-WSUD systems include additional measures to provide resilience to clogging, i.e. sediment grooves and the modified filter media profile.

Small sized, single inlet ZAM-WSUD systems with a $2m^2$ treatment area are expected to be effective for impervious catchment areas between approximately $100m^2$ and $400m^2$.

Suitable road gradients

Grassed ZAM-WSUD systems have been constructed and are operating successfully on roads with gradients up to 1V:10H. There may be some soil movement during the grass establishment phase for ZAM-WSUD systems on roads with gradients close to 1V:10H.

For roads with steeper gradients than 1V:10H, it may be difficult to design mowable ZAM-WSUD systems with batters that do not exceed 1V:5H that can adequately contain water. Additional velocity control measures may also be required at the inlet to reduce velocities to prevent scouring.

Underground services

Conflicts with existing underground services can make ZAM-WSUD retrofit installations impractical and/or very costly in many instances. As road reserves typically contain many underground services,

it essential to obtain underground services information when assessing the suitability of a potential ZAM-WSUD site.

Excavation clearance distances to power poles in accordance with authority requirements also need to be considered.

ZAM-WSUD systems require a connection to the piped drainage network, preferably to an existing stormwater pit. Consequently ZAM-WSUD systems are most cost effective when constructed in close proximity to existing drainage assets, preferably an existing drainage pit.

Street Trees

ZAM-WSUD systems should be constructed away from trees and large shrubs to minimise the potential for tree root entry into ag drains.

Vehicle compaction

Vehicles parking on, or driving over, biofilter systems will compact the filter media reducing hydraulic conductivity. This can increase susceptibility to clogging. Consequently systems should be located where the incidence of vehicles parking on the nature strip is expected to be low, or can be controlled by physical barriers.

Nature strip width and gradient

Grassed ZAM-WSUD systems are generally practical where the nature strip width is at least 2m wide and the footpath level is not significantly elevated (more than 10cm) above the level of the top of kerb. This ensures pedestrian safety and mowability by ensuring that batter slopes generally do not exceed 1V:5H.

Generally vegetated ZAM-WSUD systems can be constructed where the nature strip width is at least 1.5m wide.

Resident and community acceptance of ZAM-WSUD assets

Gaining local community acceptance of ZAM-WSUD assets is essential to any successful installation. This is particularly important for installations outside residential properties where residents will be responsible for mowing of the grass. For these installations it is appropriate to engage residents as part of the site selection process. If residents are unsupportive, it may be appropriate to seek an alternative location for the ZAM-WSUD asset. An asset which has received acceptance from adjacent residents prior to construction will have a far better long term prospects than an asset that has been installed without appropriate consultation and/or acceptance.

One strategy that may be appropriate for obtaining resident acceptance is to offer a choice between a grassed and a vegetated ZAM-WSUD asset.

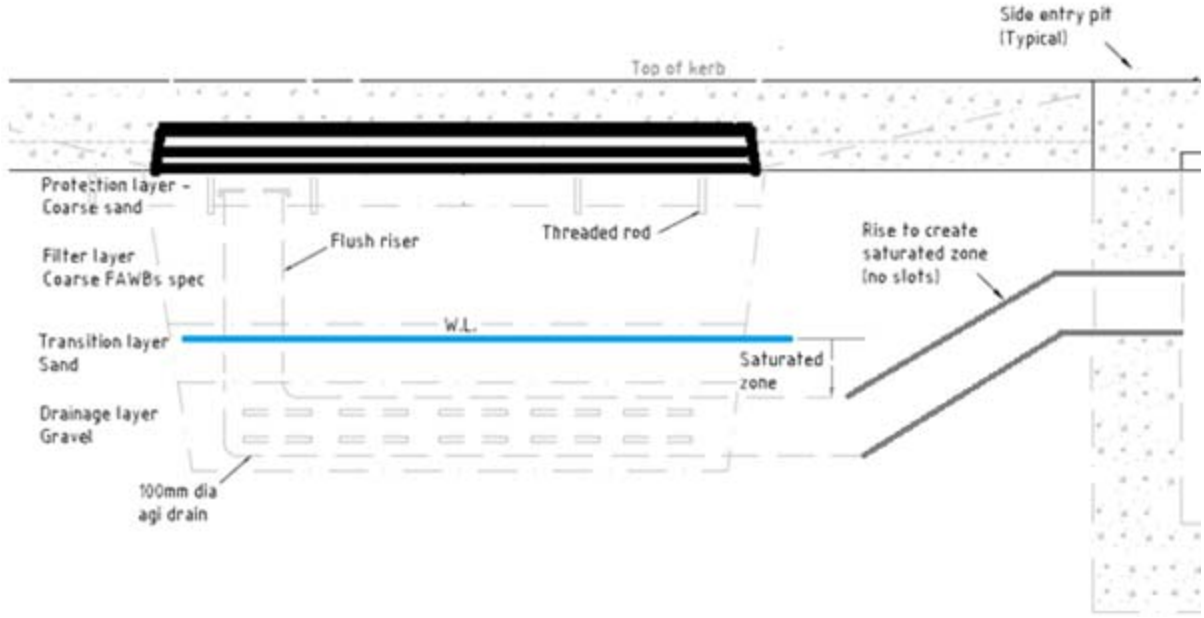
Detailed Design

Key factors to consider when designing a ZAM-WSUD system include:

Saturated zone

The saturated zone holds water and is very important for ensuring that ZAM-WSUD systems are resilient during extended dry periods. ZAM-WSUD systems need to be designed and constructed to ensure that a submerged zone is created with the saturated water level set just below the level of the FAWB specification filter media.

Submerged zones are generally created by using a geomembrane to seal the bottom of the ZAM-WSUD system. In heavy, impermeable clay soils a geomembrane may not be required to create an effective saturated zone. A slotted ag pipe is installed at the base of the treatment profile to ensure adequate drainage of the FAWB specification layer. The ag pipe needs to be connected to solid pipe with a raised elbow configuration to allow water to be stored at the base of the ZAM-WSUD system.



Saturated zone creation using unslotted pipe bends

Minimising trip hazards

ZAM-WSUD systems modify nature strip levels, and include some level changes. Detailed design should seek to minimise additional pedestrian trip hazards. Design elements that can reduce trip hazard potential include:

- Utilising a double lintel (back to back) to provide a 400mm wide step to assist persons exiting vehicles, and providing a visual point of difference compared to adjacent kerbing,
- Limiting step down height from the top of kerb to the ZAM-WSUD bed to approx. 200mm,
- Selecting sites in proximity to street lighting,
- Allowing for a 300mm strip adjacent to footpaths with a cross fall not exceeding 1V:10H.

Number of sediment grooves

For a typical urban catchment with 150m^2 of impervious surface area, 12 no. sediment grooves (as recommended on the standard drawings) are estimated to have adequate capacity to capture up to 50% of the total suspended solids for the catchment based on street sweeping at 6 week intervals. For larger catchments sizes it is appropriate to include additional sediment grooves, refer to the technical specifications.

Vandalism protection and structural integrity

Installations need to be robust such that they are not susceptible to physical damage or vandalism. Inlet grates should include legs cast into concrete so that they cannot be removed. Concrete thickening (to 150mm min) and steel bar reinforcement is appropriate at inlet locations to prevent cracking.

Excessive cyclic localised saturation and drying of road subgrade and subbase materials can accelerate structural deterioration and/or subsidence of this material. Including an impermeable geomembrane layer between the filter media and the road subgrade and subbase materials will limit localised water inflow to subgrade materials and limit any associated accelerated road pavement degradation.

Concrete Apron

A concrete apron at the back of kerbing improves mowability by allowing grass to be mowed without requiring specialised edge trimming equipment such as a brush cutter.

Concrete Apron Retrofit, Edwin Street, Templestowe

Concrete Apron, Park Avenue, Doncaster

Construction

Many construction requirements will be similar for other road construction works such as concrete quality control, underground services checks, traffic and pedestrian management plans and in some cases road opening permits.

Some requirements are specifically relevant to ZAM-WSUD installations. As many elements of the ZAM-WSUD system are relatively new, effective communication and supervision of contractors is essential to ensure that constructed assets are fit for purpose and achieve the Zero Additional Maintenance objective.

Validation of Materials

For a WSUD system to function effectively, correct sand types must be used. Sand types for biofilters are now commercially available through major suppliers.

Visual inspections and the provision of receipts from suppliers may be adequate in many cases to confirm that the correct sand types have been used. If there is any concern about the suitability of materials being used, samples can be taken and sent to a NATA approved geotechnical laboratory for hydraulic conductivity testing and particle size analysis to confirm whether the material used is suitable.

It may be appropriate to collect and retain filter media samples at the time of construction so that if there are any later concerns or contractual disputes about system performance, uncontaminated samples are available for testing.

Filter media materials used for ZAM-WSUD installations

Preventing filter media contamination

Contamination of filter media sands with excessive construction dirt can cause clogging and failure of the filter media. An appropriate methodology needs to be developed by contractors to ensure

that this does not occur. Suitable protection measures during construction include placing and removing a sacrificial sand layer, placing a cover over the filter media and/or blocking the inlet until the construction site has been fully cleaned.

Sediment groove construction

Sediment grooves constructed to date have been constructed by hand. The method used involved roughly constructing kerbing, rough hand trowel construction, mould pressing, slurry placement, mould pressing (again) and hand trowel finishing.

Sediment groove installation, Park Avenue, Doncaster

After construction completion, concrete should be protected from vehicles for at least 3 days to minimise the risk of cracking.

Establishment

It is essential that grass is kept moist during transport, immediately after placement and for the first six weeks at least after placement. If grass dries out in the period immediately after installation, it may not fully recover. Appropriate arrangements need be made for regular watering. In dry conditions watering may be needed up to twice daily for the first 10 days.

There may be some movement of top dressing sand and subsidence during establishment. Site inspections 6 weeks after planting and after 12 months are recommended to allow any establishment issues to be addressed.

Chemical weed spraying (such edge spraying) must not be carried out during the establishment phase and should be avoided in general.

References

Belinda Hatt, Veljko Prodanovic & Ana Deletic (2014) *Zero Additional Maintenance WSUD Systems: Clogging Potential of Alternative Filter Media Arrangements.* Monash University Water for Liveability Centre

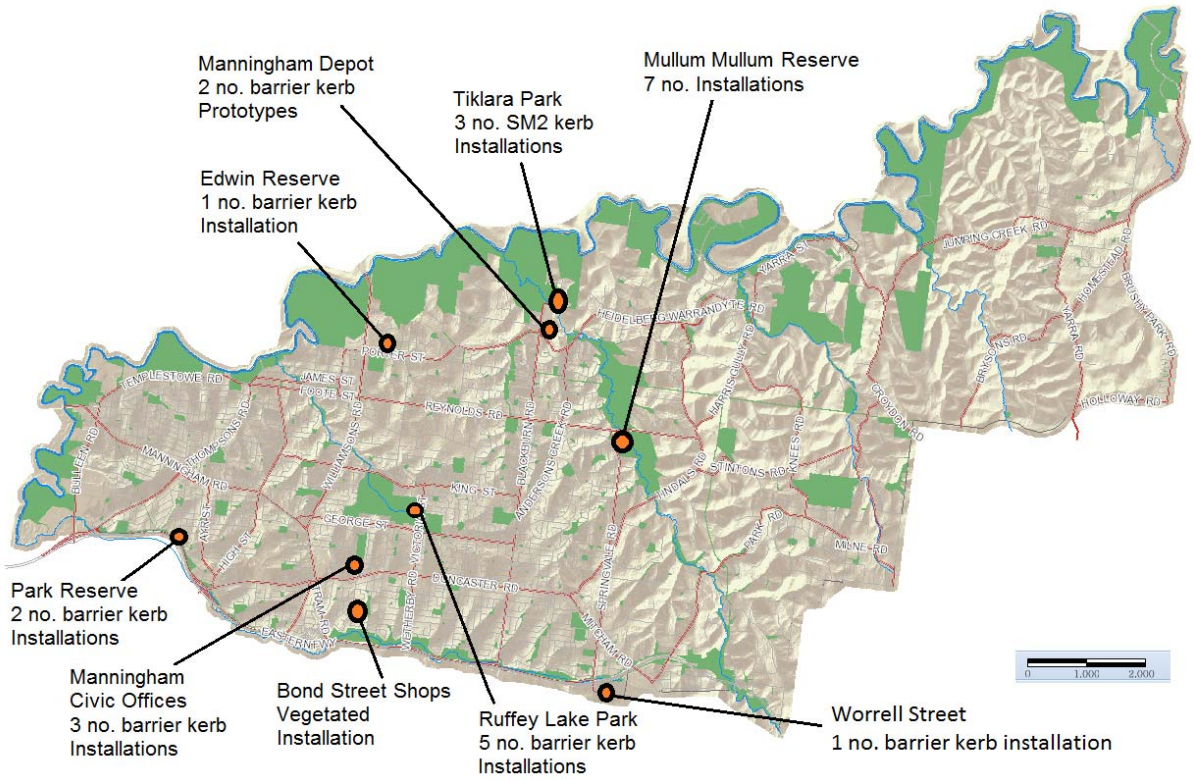
Emily G. I. Payne, Tracey Pham, Perran L. M. Cook, Tim D. Fletcher, Belinda E. Hatt & Ana Deletic (2014) *Biofilter design for effective nitrogen removal from stormwater – influence of plant species, inflow hydrology and use of a saturated zone.* Water Science and Technology 69.6.

FAWB (2009) *Adoption Guidelines for Stormwater Biofiltration Systems, Facility for Advancing Water Biofiltration*, Monash University

Payne et alia (2015) *Adoption Guidelines for Stormwater Biofiltration Systems – Summary Report*, Cooperative Research Centre for Water Sensitive Cities

ZAM-WSUD Trial Sites and Construction Toolkit

The location of existing and ZAM-WSUD installations within the Manningham municipality is showing on the figure and table below.



Site	Address	Suburb	Melways Reference
Manningham Depot	620-628 Blackburn Road (staff car park)	Doncaster East	34 D3
Tikilara Park	Sanctuary Place	Templestowe	34E1
Manningham Civic Offices	Hummel Way	Doncaster	33F12
Ruffey Lake Park	Victoria Street Car Park	Doncaster	33J10
Park Reserve	Park Avenue	Doncaster	32J12
Edwin Reserve	Edwin Road	Templestowe	33G3
Bond Street Shops	Corner Bond Street and Highview Drive	Doncaster	47F2
Mullum Mullum Reserve	Corner Reynolds and Springvale Roads	Donvale	34H7
Worrell Street Shops	Worrell Street	Nunawading	48G6

Standard drawings and a technical specification (refer to subsequent pages) has been developed to assist future ZAM-WSUD installations. Standards drawings are for:

Grassed

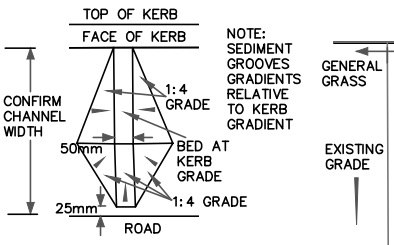
- Barrier kerb
- SM kerb
- Roll over kerb
- Mountable kerb

Vegetated

- Barrier kerb

The technical specification provides recommended details for successful installations including: filter media profile, lintels, turf, grates, impermeable membranes, plumbing and suitable gradients.

This standard drawings and technical specification documentation should be used in conjunction with site specific plans and general technical specifications for concrete, earthworks, road works, drainage, etc.

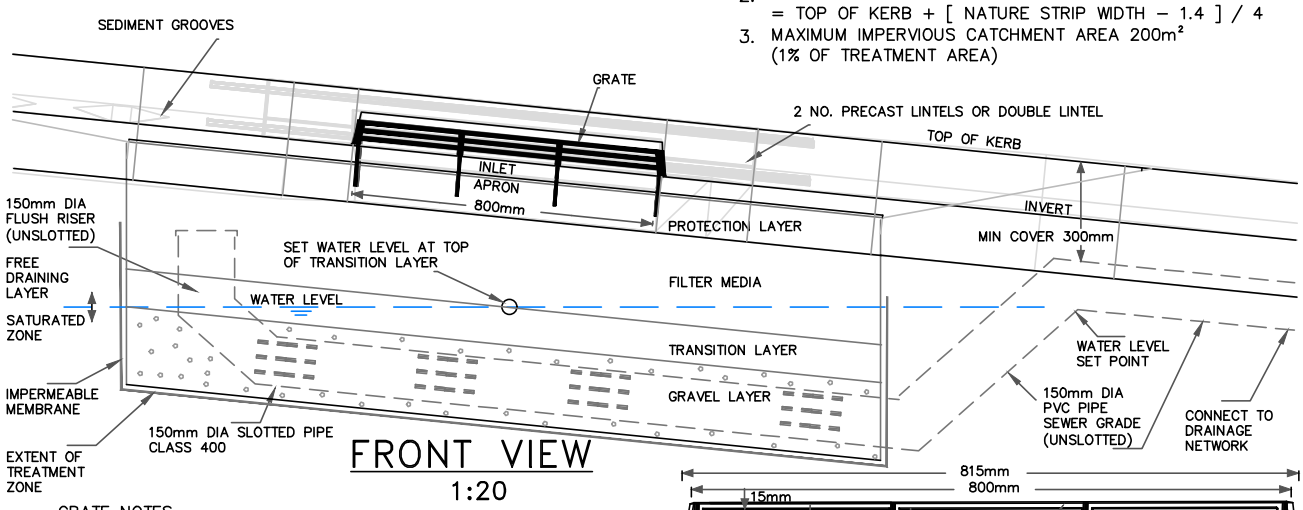


SEDIMENT GROOVE
1:20

PLAN VIEW
1:50

DESIGN NOTES

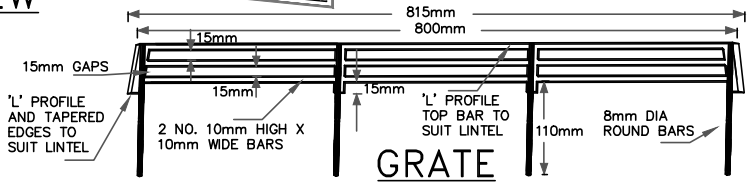
1. UNSUITABLE FOR ROAD GRADIENTS EXCEEDING 1V:10H
2. MAXIMUM ALLOWABLE HEIGHT OF FOOTPATH = TOP OF KERB + [NATURE STRIP WIDTH − 1.4] / 4
3. MAXIMUM IMPERVIOUS CATCHMENT AREA 200m² (1% OF TREATMENT AREA)



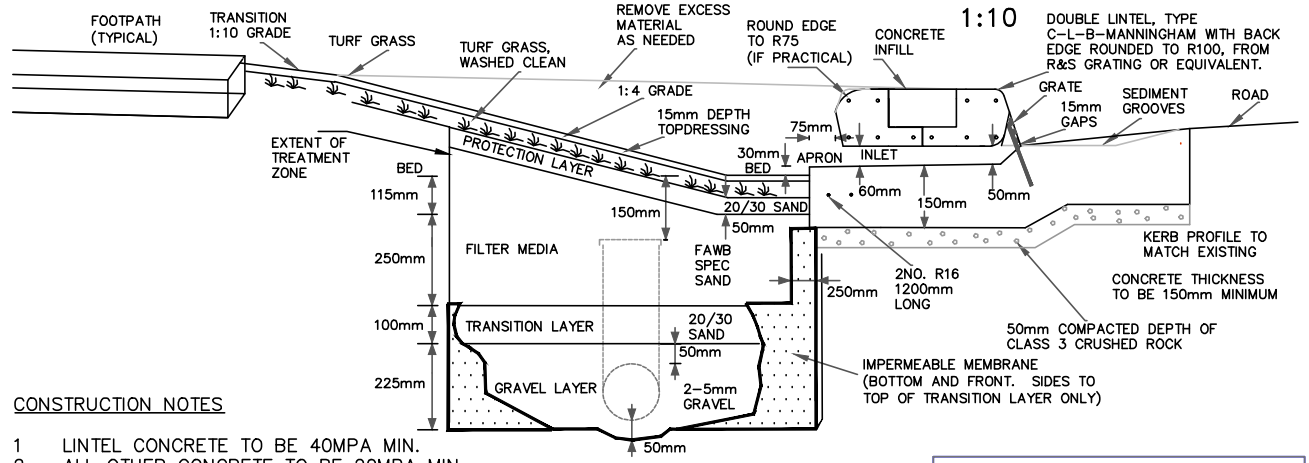
FRONT VIEW
1:20

GRATE NOTES

1. GRATE TO BE CONSTRUCTED FROM 304 STAINLESS STEEL, TYPE TR−B−MANNINGHAM FROM R&S GRATING, OR AN APPROVED EQUIVALENT.
2. CONTRACTOR TO ENSURE THAT GRATE SIZE FITS LINTEL USED.



GRATE
1:10



TYPICAL SECTION
1:20

CONSTRUCTION NOTES

1 LINTEL CONCRETE TO BE 40MPA MIN.
2 ALL OTHER CONCRETE TO BE 20MPA MIN.
3 TURF GRASS TO BE KENDA KIKUYU UNLESS OTHERWISE SPECIFIED.
4 GRASS ABOVE TREATMENT ZONE TO BE PREWASHED

WARNING

BEWARE UNDERGROUND SERVICES

CONTACT MELBOURNE ONE CALL DIAL BEFORE YOU DIG ON 1100 AT LEAST 48 HOURS BEFORE COMMENCING EXCAVATIONS.

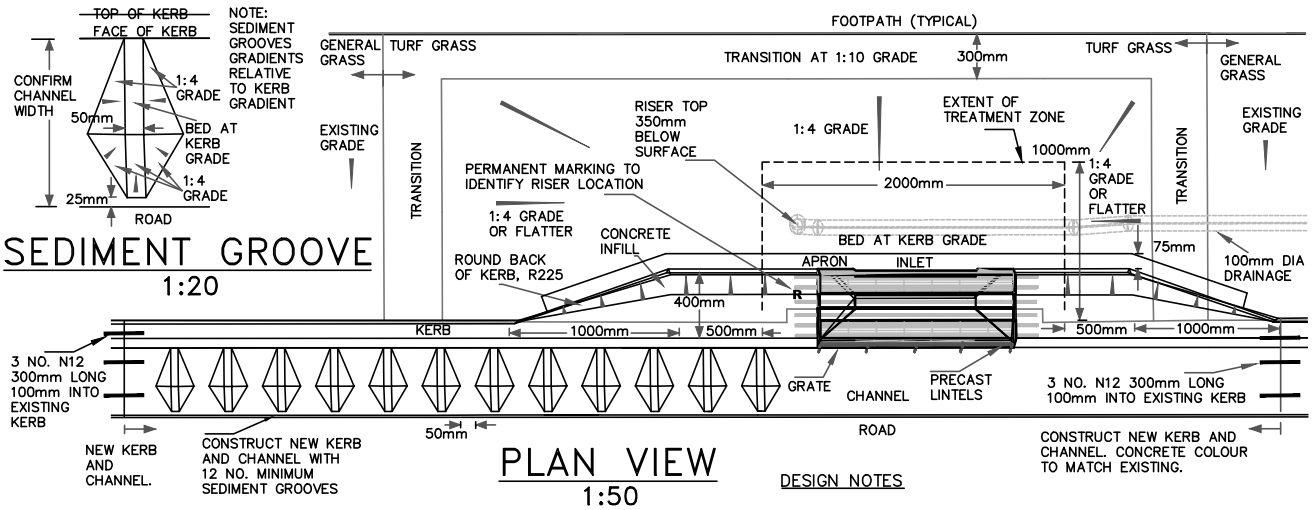
ZAM−WSUD − GRASSED − FOR BARRIER KERB

DRAWN BY: S. BRINK CHECKED:

REVISON DATE: 27th July 2016

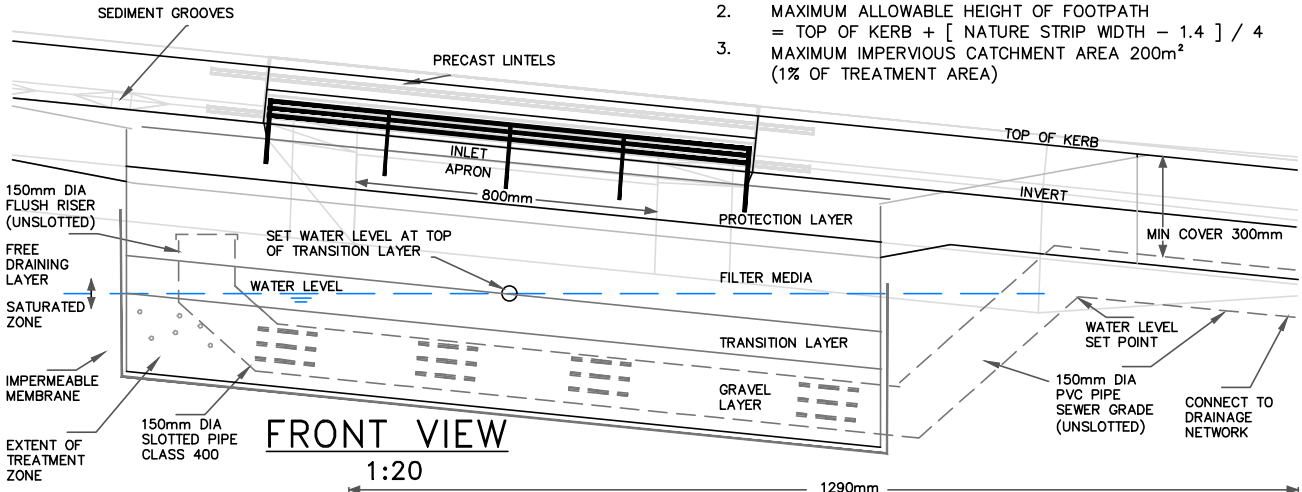
STANDARD DRAWING A4/

PRINTED: 27 July 2016 11:40 AM



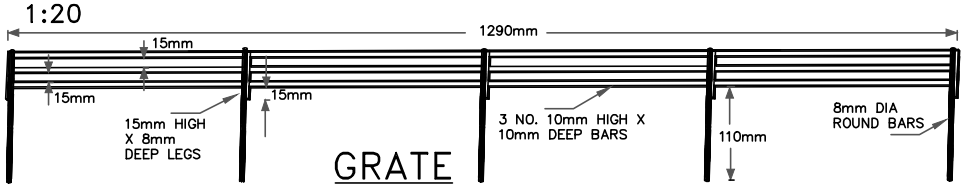
DESIGN NOTES

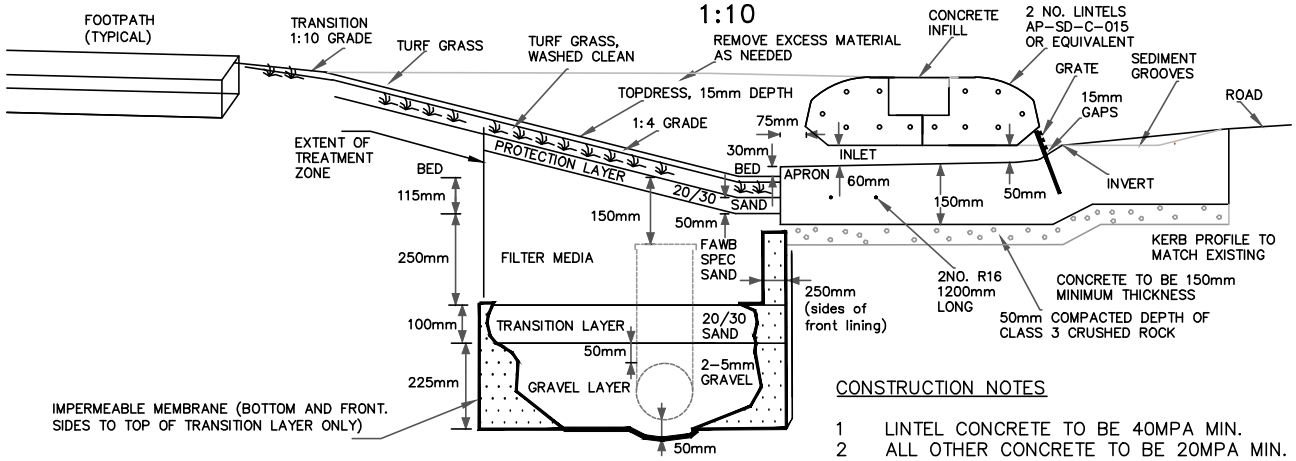
1. UNSUITABLE FOR ROAD GRADIENTS EXCEEDING 1V:10H
2. MAXIMUM ALLOWABLE HEIGHT OF FOOTPATH = TOP OF KERB + [NATURE STRIP WIDTH – 1.4] / 4
3. MAXIMUM IMPERVIOUS CATCHMENT AREA 200m² (1% OF TREATMENT AREA)



GRATE NOTES

1. GRATE TO BE CONSTRUCTED FROM 304 STAINLESS STEEL
2. CONTRACTOR TO ENSURE THAT GRATE SIZE FITS LINTEL USED.





CONSTRUCTION NOTES

1 LINTEL CONCRETE TO BE 40MPA MIN.
2 ALL OTHER CONCRETE TO BE 20MPA MIN.
3 TURF GRASS TO BE KENDA KIKUYU UNLESS OTHERWISE SPECIFIED.
4 TURF ABOVE TREATMENT ZONE TO BE WASHED CLEAN.

WARNING

BEWARE UNDERGROUND SERVICES

CONTACT MELBOURNE ONE CALL DIAL BEFORE YOU DIG ON 1100 AT LEAST 48 HOURS BEFORE COMMENCING EXCAVATIONS.

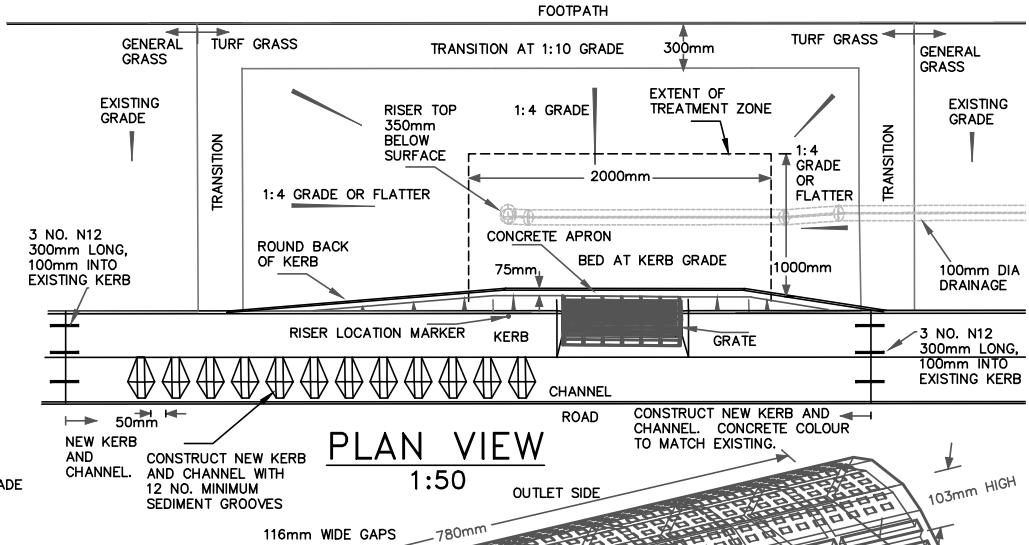
ZAM–WSUD – GRASSED – FOR SEMI MOUNTABLE KERB

DRAWN: S. BRINK CHECKED:

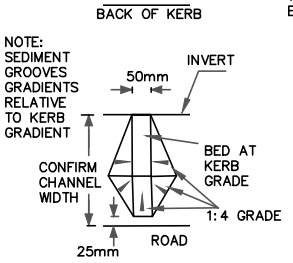
DATE: 27th July 2016

STANDARD DRAWING A4/

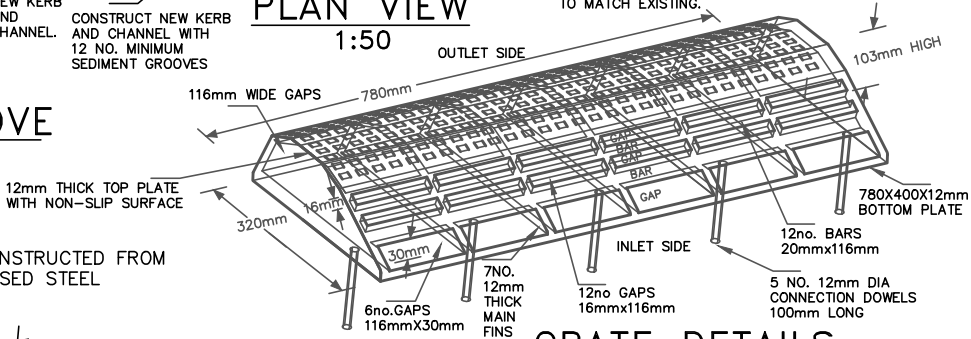
PRINTED: 27 July 2016 11:40 AM



PLAN VIEW
1:50



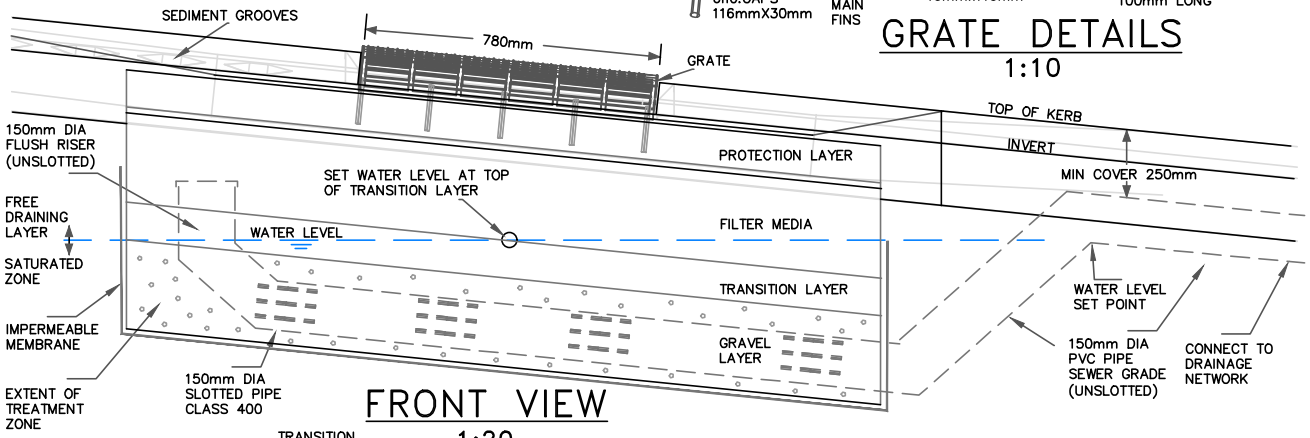
SEDIMENT GROOVE
1:20



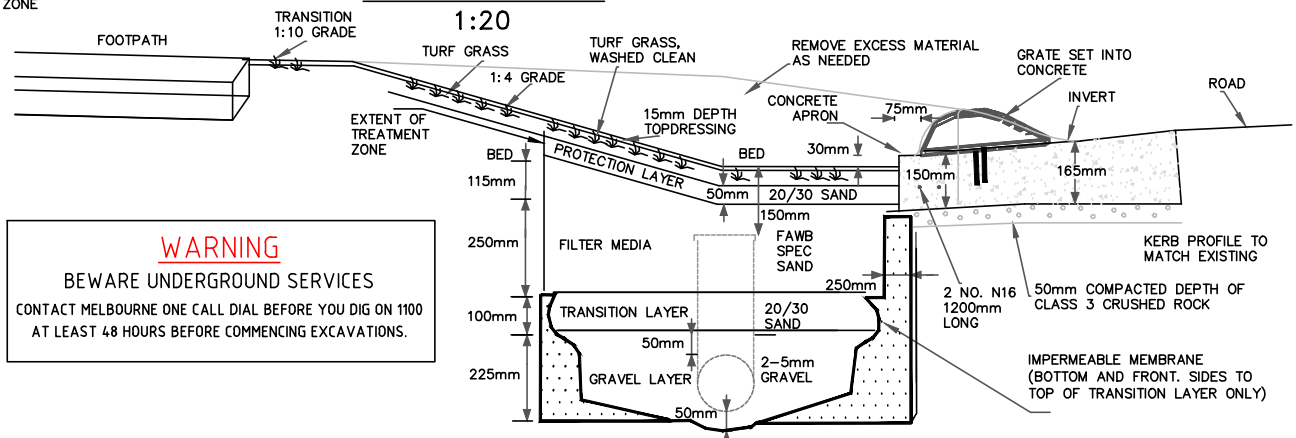
GRATE NOTE

GRATE TO BE CONSTRUCTED FROM HOT DIP GALVANISED STEEL

GRATE DETAILS
1:10



FRONT VIEW
1:20



WARNING

BEWARE UNDERGROUND SERVICES

CONTACT MELBOURNE ONE CALL DIAL BEFORE YOU DIG ON 1100 AT LEAST 48 HOURS BEFORE COMMENCING EXCAVATIONS.

TYPICAL SECTION
1:20

DESIGN NOTES

1. UNSUITABLE FOR ROAD GRADIENTS EXCEEDING 1V:10H
2. MAXIMUM ALLOWABLE HEIGHT OF FOOTPATH (0m BED WIDTH) = TOP OF KERB + [NATURE STRIP WIDTH – 1.0] / 4
3. MAXIMUM IMPERVIOUS CATCHMENT AREA 200m² (1% OF TREATMENT AREA)

CONSTRUCTION NOTES

1 CONCRETE TO BE 20MPA MIN.
2 TURF GRASS TO BE KENDA KIKUYU UNLESS OTHERWISE SPECIFIED.
3 TURF ABOVE TREATMENT ZONE TO BE PREWASHED.

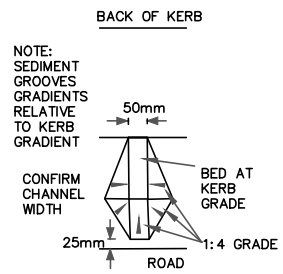
ZAM–WSUD – GRASSED – FOR ROLL OVER KERB

DRAWN: S. BRINK CHECKED:

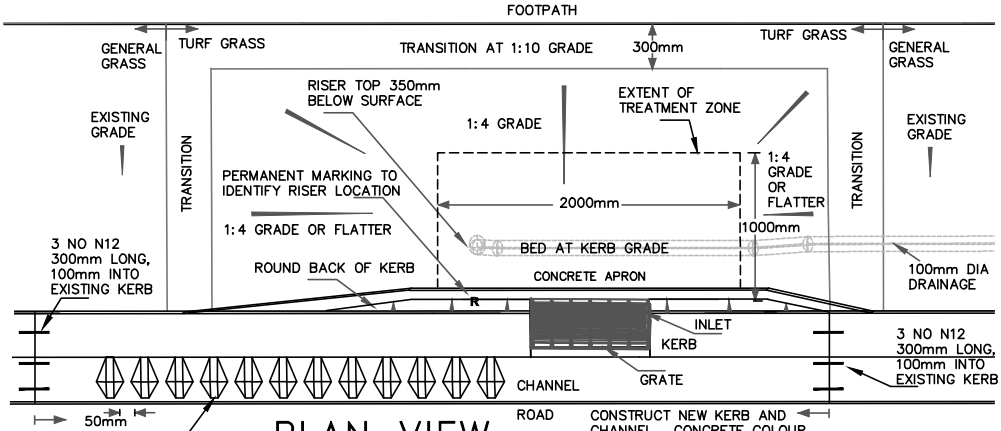
DATE: 27th July 2016

STANDARD DRAWING A4/

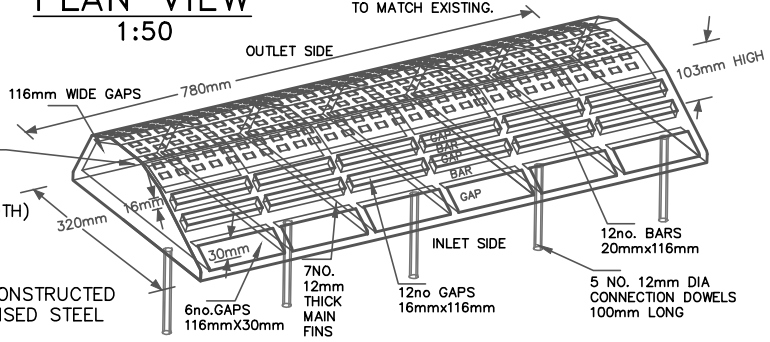
PRINTED: 27 July 2016 11:40 AM



SEDIMENT GROOVE
1:20



PLAN VIEW
1:50

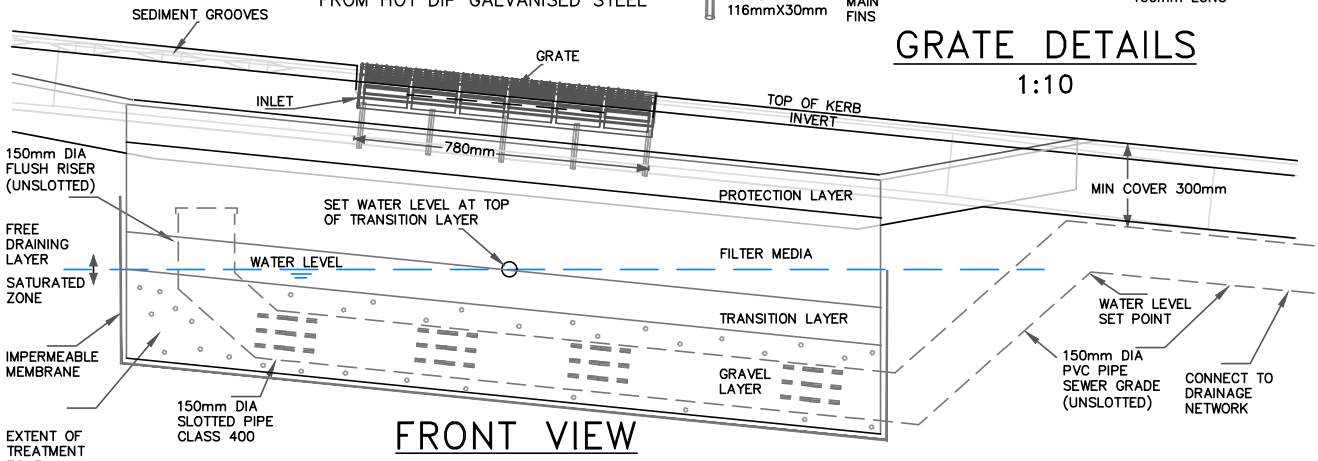


DESIGN NOTES

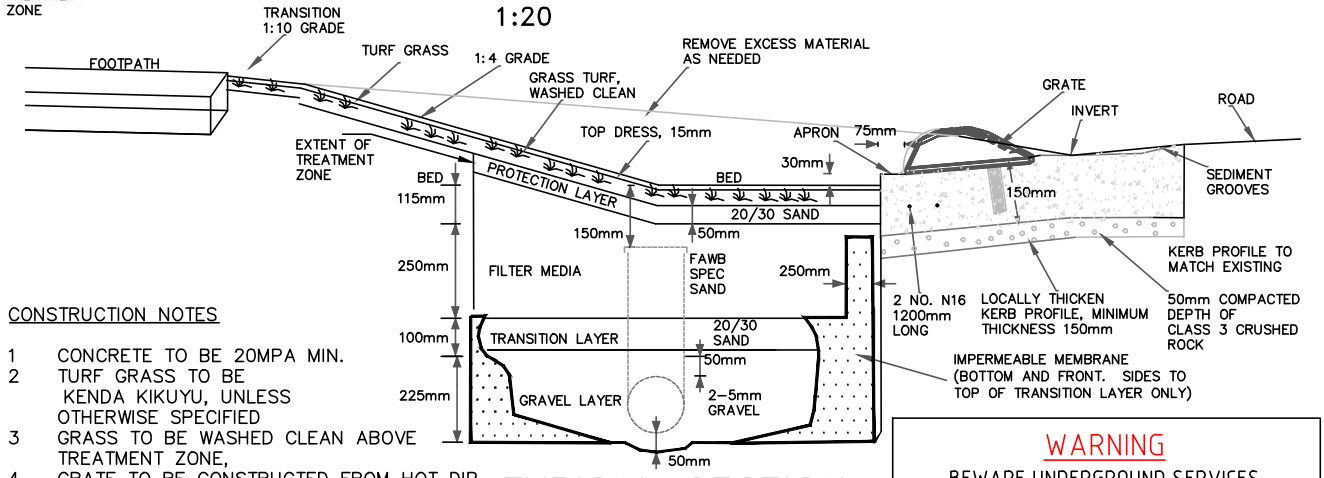
1. UNSUITABLE FOR ROAD GRADIENTS EXCEEDING 1V:10H
2. MAXIMUM ALLOWABLE HEIGHT OF FOOTPATH (0m BED WIDTH)
   = TOP OF KERB + [NATURE STRIP WIDTH − 0.8] / 4
3. MAXIMUM IMPERVIOUS CATCHMENT AREA 200m²
   (1% OF TREATMENT AREA)

NOTE: GRATE TO BE CONSTRUCTED
FROM HOT DIP GALVANISED STEEL

GRATE DETAILS
1:10



FRONT VIEW
1:20



TYPICAL SECTION
1:20

CONSTRUCTION NOTES

1 CONCRETE TO BE 20MPA MIN.
2 TURF GRASS TO BE
KENDA KIKUYU, UNLESS
OTHERWISE SPECIFIED
3 GRASS TO BE WASHED CLEAN ABOVE
TREATMENT ZONE,
4 GRATE TO BE CONSTRUCTED FROM HOT DIP
GALVANISED STEEL.

WARNING

BEWARE UNDERGROUND SERVICES

CONTACT MELBOURNE ONE CALL DIAL BEFORE YOU DIG ON 1100
AT LEAST 48 HOURS BEFORE COMMENCING EXCAVATIONS.

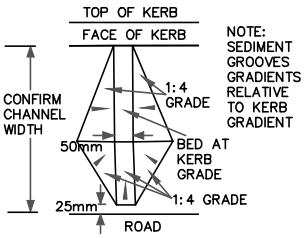
ZAM−WSUD − GRASSED − FOR MOUNTABLE M2 KERB

DRAWN: S. BRINK CHECKED:

DATE: 27th July 2016

STANDARD DRAWING A4/

PRINTED: 27 July 2016 11:41 AM

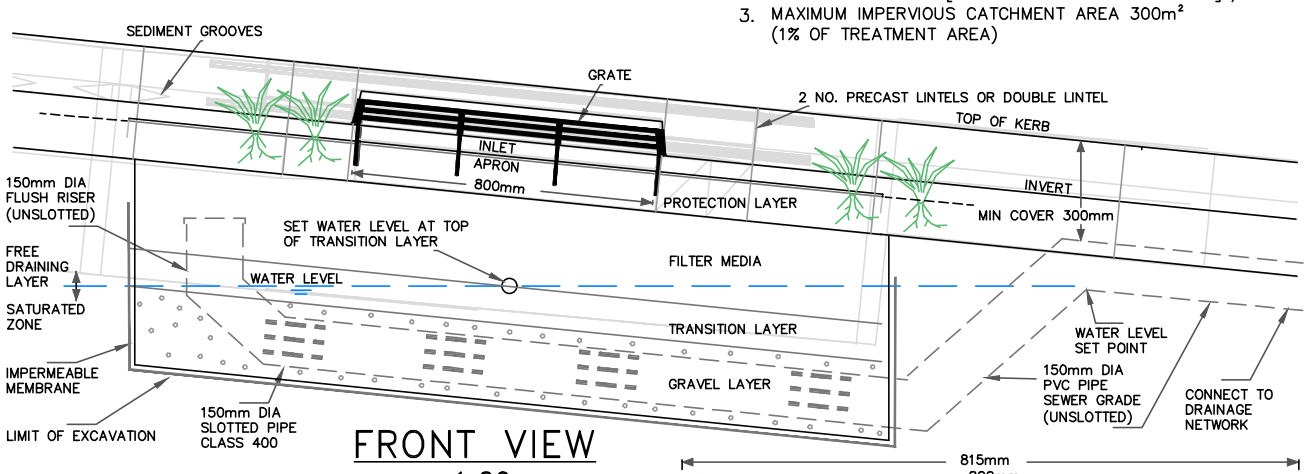


SEDIMENT GROOVE
1:20

PLAN VIEW
1:50

DESIGN NOTES

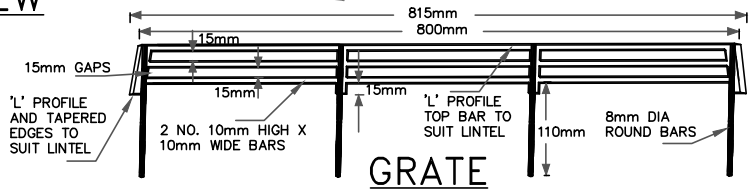
1. UNSUITABLE FOR ROAD GRADIENTS EXCEEDING 1V:10H
2. MAXIMUM ALLOWABLE HEIGHT OF FOOTPATH = TOP OF KERB + [NATURE STRIP WIDTH − 1.0] / 4
3. MAXIMUM IMPERVIOUS CATCHMENT AREA 300m² (1% OF TREATMENT AREA)



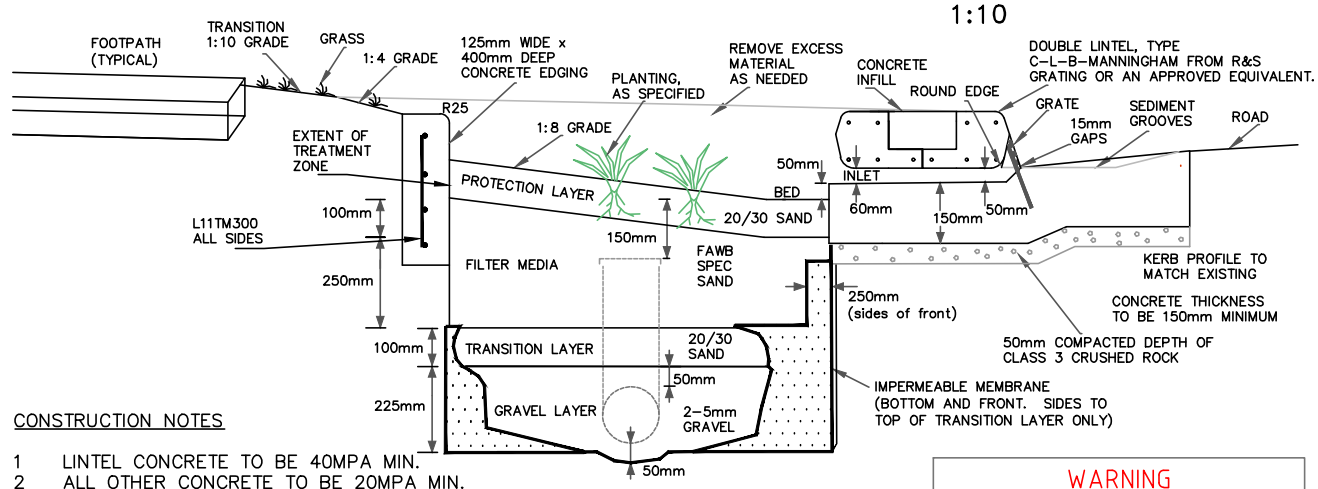
FRONT VIEW
1:20

GRATE NOTES

1. GRATE TO BE CONSTRUCTED FROM 304 STAINLESS STEEL, TYPE TR−B−MANNINGHAM FROM R&S GRATING OR AND APPROVED EQUIVALENT.
2. CONTRACTOR TO ENSURE THAT GRATE SIZE FITS LINTEL USED.



GRATE
1:10



TYPICAL SECTION
1:20

CONSTRUCTION NOTES

1 LINTEL CONCRETE TO BE 40MPA MIN.
2 ALL OTHER CONCRETE TO BE 20MPA MIN.
3 LOOSE SOIL TO BE REMOVED FROM ROOTS PRIOR TO PLANTING.

WARNING

BEWARE UNDERGROUND SERVICES

CONTACT MELBOURNE ONE CALL DIAL BEFORE YOU DIG ON 1100 AT LEAST 48 HOURS BEFORE COMMENCING EXCAVATIONS.

ZAM−WSUD − VEGETATED − FOR BARRIER KERB

DRAWN BY: S. BRINK CHECKED:

REVISON DATE: 11th May 2016

STANDARD DRAWING A4/

PRINTED: 11 May 2016 11:40 AM

ZAM-WSUD

Zero Additional Maintenance Water Sensitive Urban Design

Technical Specification

1. General

Zero Additional Maintenance Water Sensitive Urban Design (ZAM-WSUD) installations shall be constructed in accordance with these technical specifications, except where otherwise noted on the design plans.

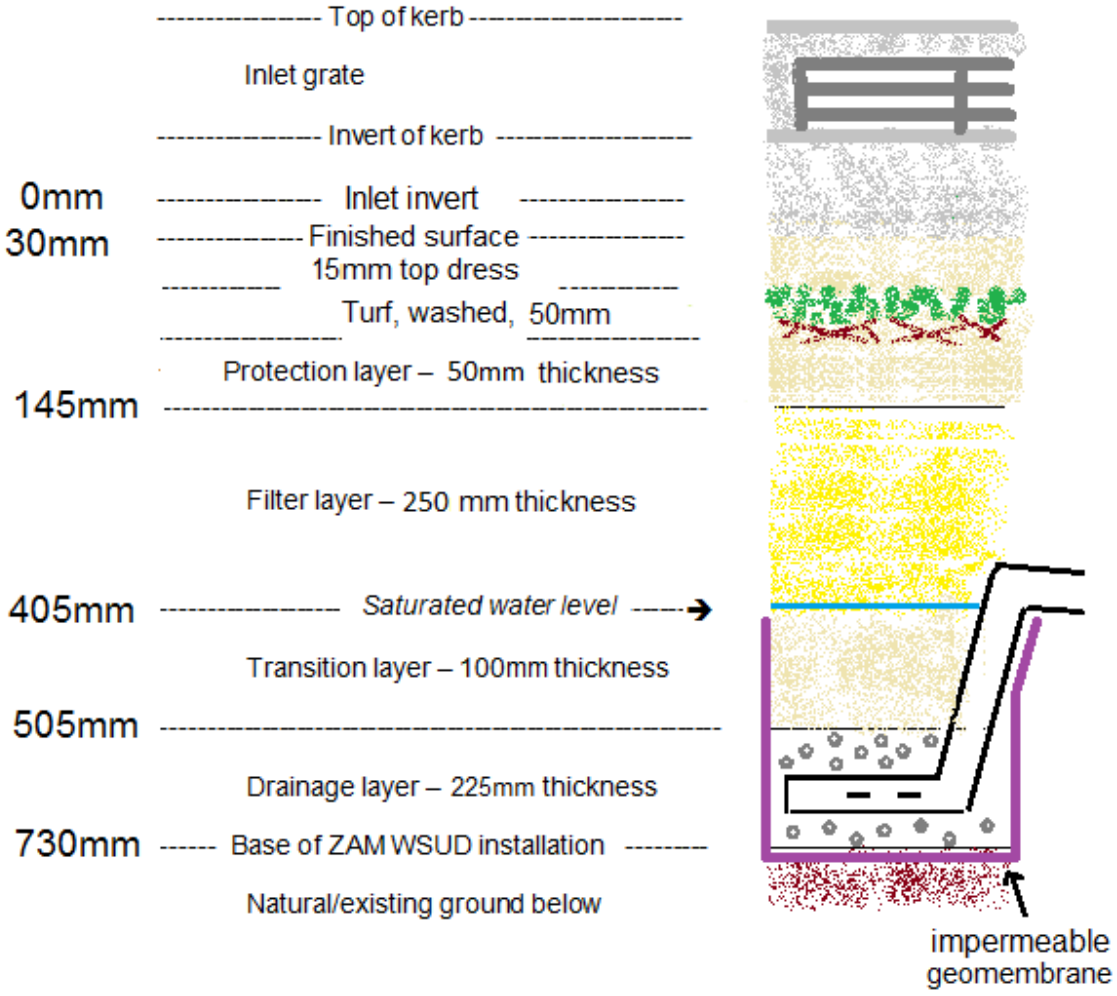
2. ZAM-WSUD Filter Media Profile

The filter media profile shall be in accordance with the following schematics, unless otherwise noted on the plans.

Grassed installations

Depth Below

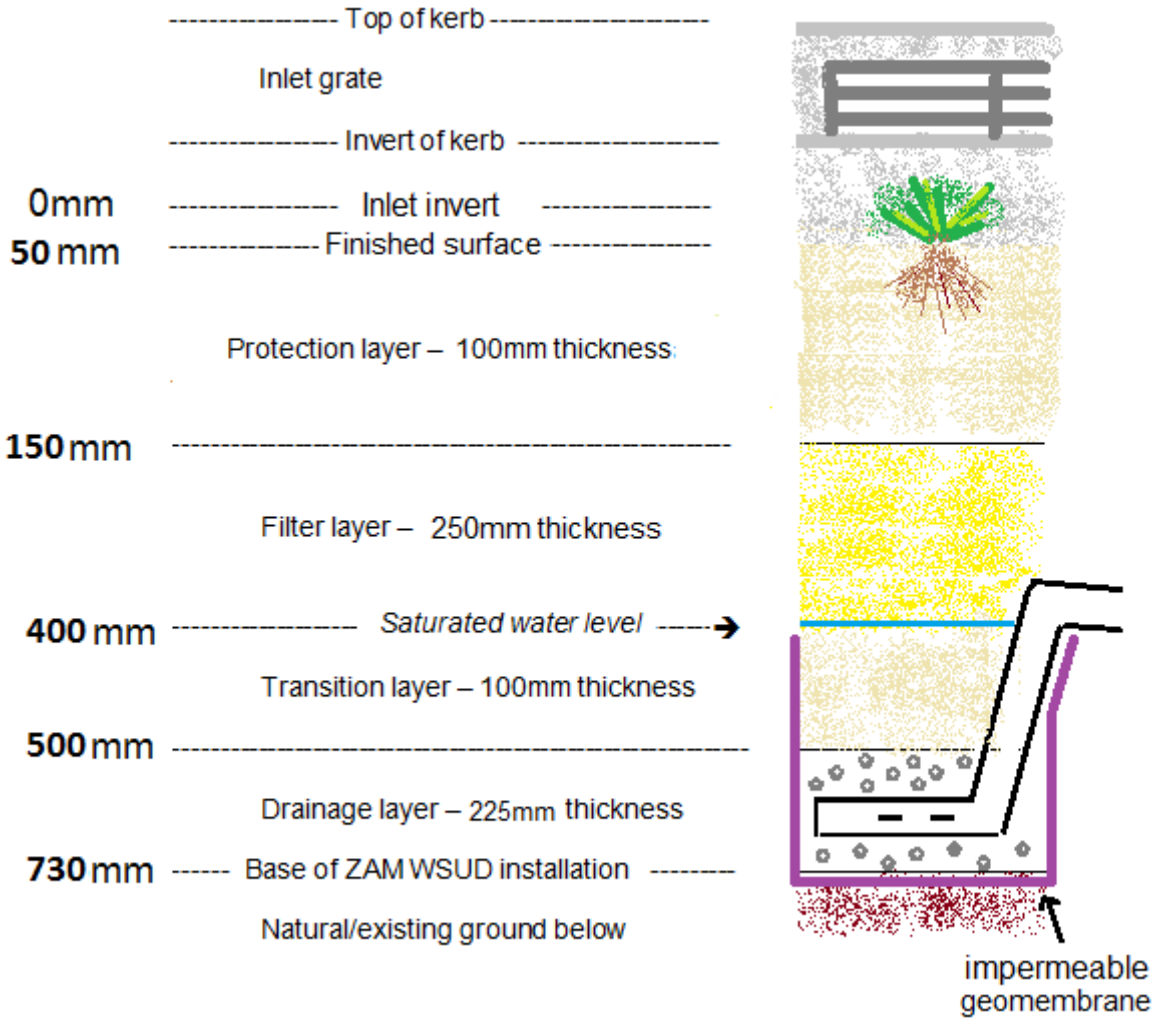
Invert of Inlet



Vegetated installations

Depth Below

Invert of Inlet



For landscaped ZAM-WSUD installations featuring larger vegetation such as shrubs over 1.0m in height, the depth of the filter layer and/or transition layer may be increased to provide additional volume for plant roots.

3. Lintel Details

Lintels are to be reinforced concrete, prefabricated. Concrete for precast lintels shall to be 50MPa minimum. Concrete lintel supports are to be provided where required and where shown on standard drawings.

4. Inlet grates

Inlet grates for barrier and SM2 kerb shall be constructed from 304 stainless steel and shall be in accordance with the standard drawings. Any bolts or fixings in contact with the grate must also be 304 stainless steel (or a similar compatible stainless steel).

Suitable product: R&S Grating – Trash Rack - TR-B-MANNINGHAM

Inlet grates for rollover and mountable kerb shall be hot dip galvanized steel and shall be in accordance with the standard drawings. Any bolts or fixings in contact with the grate must also be hot dip galvanized.

Suitable product: R&S Grating - Trash Rack - TR-SM-MANNINGHAM

Note: SM2 kerb requires a TR-B grate not a TR-SM grate.

Samples of all fabricated steel grates shall be approved by the superintendent/ superintendent's representative prior to installation.

5. Turf

Description: Turf grass, grown in a sandy loam media. 50mm turf grass sod thickness.

Suitable products:

Site Characteristics	Suitable Grass Species
Sunny	Kenda Kikuyu (male sterile), Empire Zoysia
High pedestrian traffic	Kenda Kikuyu (male sterile)
Part Shade	Empire Zoysia
Very shady or moist soils	Soft leaf buffalo – Palmetto SS100 (Victoria, Tasmania, Canberra) Soft leaf buffalo – Sapphire B12 (Queensland, Western Australia, NSW – lowland and coastal areas)
Environmentally sensitive areas	Nara Native Zoysia Soft leaf buffalo – Palmetto SS100

Turf placed directly above filter media profile must be made free of significant amounts of loose clay soil material by pressure washing to the satisfaction of the superintendent/ superintendent's representative prior to placement. Turf placed elsewhere does not need to be washed.

Turf should be grown in a sand or sandy loam media to allow ease of cleaning prior to placement. Note that turf survival time is relatively short, so contractors need to ensure that all turf is planted within 24 hours of delivery to best ensure turf survival. It is recommended that the contractor contract turf suppliers as early as possible to ensure supply at the required time.

Turf must be well watered immediately after planting, every day for the first ten days (twice per day if conditions are dry and warm), and every two to three days subsequently (unless significant rain has fallen) for the first month after planting. Grass needs to be thoroughly watered. Minimum watering volumes can be determined by Bureau of Meteorology evapotranspiration (ETo) data from the closest weather station available at www.bom.gov.au/watl/eto/ Watering volumes must exceed net rainfall deficit (Net = Rainfall – ETo). If planting is done in late spring or summer, turf must be watered regularly for the first three months. Watering is the contractor's responsibility, unless otherwise specified.

6. Planting

The *Adoption Guidelines for Stormwater Biofiltration Systems – Summary Report*, CRC for Water Sensitive Cities, 2016, recommends that at least 50% of the vegetation cover in WSUD systems should be plants that have been confirmed as high nutrient uptake plants. The remaining plants can be selected for other attributes such as aesthetics, local biodiversity, etc.

Potentially suitable plant species that have been confirmed as high nitrogen uptake plants include:

Species	Origin	Height	Comments
Baumea juncea Bare Twigrush	Southern coastal	0.2m-1.2m	Salt tolerant Full sun of semi shade
Baumea rubiginosa Soft Twig Rush	Widespread	0.3m-1.2m	Damp areas Full or part sun

Species	Origin	Height	Comments
Carex appressa Tall sedge	Widespread	to 1m	Very robust High P uptake also Supports native fauna Sharp leaves
Carex tereticaulis Rush sedge	Widespread	to 1m	Spiky, can poke eyes. Full sun.
Ficinia nodosa Knotted Club Rush	Widespread	to 1m	Spiky, can poke eyes. Fast growing.
Goodenia ovata Hop goodenia	Southeast Australia	to 2m	Quick growing. Can look weedy. Prefers part shade.
Juncus amabilis Gentle rush	Southern Australia	to 1.2m	Spiky Full or part sun
Juncus flavidus Rush	Widespread, inland	to 1m	Prefers wet conditions
Juncus pallidus Grey soft rush or pale rush	East Australia	0.7m to 1.4m	Spiky Prefers wet conditions Full or part sun
Juncus subsecundus Finger rush	Widespread	to 1m	Full or part sun

Species	Origin	Height	Comments
Melaleuca incana Grey Honey Myrtle	Southwest Western Australia	2m to 3m	Suitable for east coast also. High P uptake also Full sun Salt tolerant
Melaleuca ericifolia Swamp Paperbark	Southeast Australia	to 9m	Frost tolerant Drought tolerant once established Full or part sun
Melaleuca lateritia Robin Red-breast Bush	Southwest Western Australia	to 2m (generally) to 1.5m (ACT)	Shape can benefit from pruning Prefers damp conditions Full sun preferred

7. Impermeable Membrane

A 100 micron (minimum) thick geofabric impermeable membrane shall be provided, EDPM or similar:

- At the base and all sides of the ZAM-WSUD installation up to or above the bottom of the filter media layer to form the saturated zone, and
- On any side of the ZAM-WSUD asset facing a road pavement up to the bottom of kerb level, including on adjacent sides to a minimum of 0.25m width.

Refer to standard drawings for details.

8. Protection Layer

Description: 20/30 sand with a hydraulic conductivity between 1,000mm/hour and 1,600mm/hour ameliorated with organic matter, fertiliser and trace elements.

Suitable products (sand)

- Burdetts - 20/30 sand (preferred) Contact: (03) 9789 8266 Andrew Burdett

Note: Some of the protection layer sand is to be placed prior to turf placement. Refer to cross sections for depths. The remainder is to be placed on top of turf as top dressing (approximately 15mm depth).

	20/30 sand
Particle Size (mm)	
Fine Gravel (2.0mm)	2
Very Coarse Sand (1.0mm)	13
Coarse Sand (0.5mm)	61
Medium Sand (0.25mm)	21
Fine Sand (0.15mm)	1
Very Fine Sand (0.05)	2
Silt and Clay (<0.05mm)	trace
Hydraulic Conductivity (mm/hr) Drainage	1316
Texture	Off white sand
Sample No	**662**

Burdetts - 20/30 sand – Particle Size Distribution

Amelioration (in protection layer)

Constituent	**Quantity (g/m^2 of biofilter area)**
Granulated poultry manure fines	500
Superphosphate	20
Magnesium sulphate	30
Potassium sulphate	20
Trace element mix	10
Fertiliser N:P:K (16:4:14)	40
Lime	200

9. Filter Layer

Description: FAWB specification sand

FAWB Specification

Description	Allowable Proportion	Particle Size
Clay/silt	<3%	<0.05mm
Very fine sand	5-10%	0.05-0.15mm
Fine sand	10-25%	0.15-0.25mm
Medium to Course sand	60-70%	0.25-1.0mm
Course sand	7-10%	1.0-2.0mm
Fine gravel	<3%	2.0-3.4mm
Other gravel	0%	>3.4mm

FAWB Specification – Particle Size Distribution

Suitable products

- Daisys - Bio Drain Filter Sand

	Bio Drain Filter Sand
pH (1:5 water)	5.6
Electrical conductivity (mS/cm)	0.012
Total Salts (ppm)	36
Particle Size (mm)	
Fine Gravel (2.0mm)	1
Very Coarse Sand (1.0mm)	7
Coarse Sand (0.5mm)	21
Medium Sand (0.25mm)	39
Fine Sand (0.15mm)	23
Very Fine Sand (0.05)	7
Silt and Clay (<0.05mm)	2
Hydraulic Conductivity (mm/hr) Drainage	297

Daisys - Bio Drain Filter Sand – Particle Size Distribution

10. Transition Layer

Description: 20/30 sand with a hydraulic conductivity of at least 1,000 mm/hour.

Suitable products

- Burdetts - 20/30 sand Contact: (03) 9789 8266 Andrew Burdett

Refer to particle size distribution information above.

11. Drainage Layer

Description: No fines gravel, 2.5mm nominal diameter screenings. Screenings generally range in size between approx. 1.5mm and 4mm diameter.

12. Finished Surface Profile

The contractor shall ensure that the finished surface profile of grassed areas are suitable for the mower type used to mow the grass at the location of the installation.

Mower type	Mowing width	Gradient
Hand	0.5m	1V:4H or flatter
Small ride on	1.1m	1V:5H or flatter
Kabota	2.0m	1V:6H or flatter

Grade transitions are to be smooth enough to ensure that the mowers do not bottom out and cause damage to grass and/or mowers.

To ensure pedestrian safety, cross fall within 300mm of footpaths is not to be steeper than 1V:10H gradient.

13. Plumbing

Drainage pipes to be 150mm diameter PVC, sewer grade.

Slotted drainage pipes shall be either:

- 100mm diameter PVC, sewer grade, slots to be 1mm width, 100mm long, 12 slots per meter minimum, or
- Class 400 agi drain, 100mm diameter.

14. Concrete Apron

For grassed installations, to allow maintenance of grass directly behind the back of kerb without requiring the use of an edge trimmer, a concrete apron shall be provided at the back of the kerb. The concrete apron shall be 75mm wide minimum, 150mm thickness. Top of the concrete shall match the finished surface level of the 20/30 protection layer prior to the placement of turf.

A concrete apron is not required for vegetated installations.

15. Number of Sediment Grooves

Twelve sediment grooves are recommended for ZAM-WSUD installations to provide adequate storage for up to 50% of total suspended solids based on a 6 week street sweeper frequency.

For catchments with an impervious area greater than 200m^2, additional sediment grooves are recommended to ensure that adequate sediment storage capacity is available for up to 50% of total suspended solids.

The number of sediment grooves to be provided is as follows:

Catchment Size	Number of Sediment Grooves
Up to 200m^2	12 no.
200m^2 – 320m^2	18 no.
> 320m^2	24 no.

16. Construction Inspections

The superintendent/superintendent's representative shall be provided with the opportunity to inspect works at each site at the following stages:

- At set out.
- Completion of impermeable membrane placement and plumbing works, prior to placement of gravel drainage material.
- Completion of placement of any subsequent layers at the request of the superintendent/superintendent's representative.

A minimum of 24 hours notice is to be given by the contractor prior to any inspections.

Photos shall be taken at the completion of each layer, including showing evidence of the finished level of the top of each layer using a tape measure of similar.

17. Site Clean Up and Maintenance

Contractors are responsible for restoration, clean up and maintenance of all sites at the completion of construction and throughout the defects liability period to the satisfaction of the superintendent/superintendent's representative.

This includes:

- watering of planted turf and grass for 6 weeks after planting (unless otherwise specified).
- the replacement of grass in any areas where establishment has been unsuccessful.
- Providing additional 20/30 sand fill material to any areas where subsidence has occurred.

18. ZAM-WSUD Trial Site Inspection

Contractors and construction workers shall, where practical, inspect at least one previously completed ZAM-WSUD site prior to commencing construction.

Refer to the ZAM-WSUD handbook for ZAM-WSUD installation locations.