Manningham

ON-SITE STORMWATER DETENTION GUIDELINES

Infrastructure Services

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MANNINGHAM

Disclaimer

These guidelines have been developed to provide general guidance in relation to the requirements for On-Site Stormwater Detention systems. Manningham City Council expressly disclaims all liability for errors and omissions of any kind whatsoever whether negligent or otherwise for any loss, damage, injury or other consequences that may raise from any reliance on this publication. The use or representation of any product or system is not to be taken to imply approval or endorsement of the same.

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1. INTRODUCTION

• Purpose

The purpose of the guidelines is to provide technical guidance and direction to developers and engineering consultants for the preparation of engineering plans to satisfy town planning permit conditions for single and multi-dwelling, commercial and industrial developments and subdivisions. The aim of the guidelines is to ensure that Council's technical requirements for preparing engineering plans are met so that the plans can be prepared and endorsed efficiently without undue delay.

• Guidelines Objectives

The objectives of the guidelines are to:

a) Ensure that developments including single dwellings, multi-dwellings and subdivisions within Manningham meet the statutory requirements of the Manningham Planning Scheme and relevant Acts.

b) Ensure that any new council drainage infrastructure is designed and constructed in accordance with Council's standards and practise.

c) Ensure that any new OSD is designed and constructed to the relevant industry standards and in a way that does not create future problems for property owners, adjoining properties or the public, whilst allowing consideration for innovative and sustainable design approaches and new technologies.

d) Allow consultants/developers to expect appropriate consideration of engineering plans that is fair and consistent.

• Planning Permit Condition Objectives

Typical planning permit conditions that respond to the above objectives and in consideration of the relevant acts could include, but are not limited to:

a) Preparation of engineering plans to connect all developments including subdivisions to an appropriate point of discharge and to ensure that the development does not negatively impact on existing infrastructure.

b) Preparation of engineering plans to demonstrate drainage function and meet Council's standards.

c) Ensure that the habitable area is protected from flooding and neighbouring properties are not adversely affected in design storm event.

d) Undertake the required works in accordance with the approved engineering plans.

e) Ensure that appropriate measures are implemented to control pollutants from the site including construction and operation phases.

• Stormwater and OSD checklist

Council requires the submission of fully detailed engineering stormwater plans to assist in determining the likely impacts that the development may have on the existing natural and built environments, both public and private.

The purpose of the Checklist is to ensure that OSD and stormwater plans submitted to Council contain the necessary and correct information and details which enable an expedient assessment to be carried out by Council's officers. The Checklist is by no means exhaustive and OSD requirements may vary for projects according to the level of complexity of the proposed development.

Prior to completing the checklist, the Design Engineer shall read and be familiar with Council's On-Site Stormwater Detention Design Guidelines.

Please note that it is imperative that the Design Engineer carefully reads the Checklist and Guidelines, as inaccurate or incomplete checklists may result in delays with processing or possible refusal of the engineering plan submission.

The checklist is provided as **Appendix A**.

2. ON-SITE STORMWATER DETENTION SYSTEM (OSD)

Changes in land use for urban development increases impervious areas and consequently results in increased stormwater run-off. On-Site Stormwater Detention (OSD) systems are used as part of the drainage system to reduce the run-off impacts of site redevelopment on receiving drains and waterways.

Due to current land uses there are limited options available to offset the effects of increased development densities. Manningham City Council has adopted the use of OSD systems to mitigate some of the effects of higher density development.

These principles have been developed with reference to:

- Australian Rainfall and Runoff 2019 – A Guide To Flood Estimation;
- Australian Standard AS 3500.3-2018;
- OSD design methods developed by Swinburne University;
- Manningham City Council standards

• On-Site Stormwater Detention Objectives

The purpose of OSD systems is to control peak flow rates and peak time by temporarily storing some of the runoff from a site and releasing the stored runoff at a controlled rate.

• Key Elements

The key elements of an OSD system are:

- A runoff collection system consisting of pits, pipes and/ or tanks and water sensitive urban design (WSUD) treatment measures;
- A runoff storage area; and
- An outlet to control the rate of discharge from the storage to the existing Council or Melbourne Water drainage system.

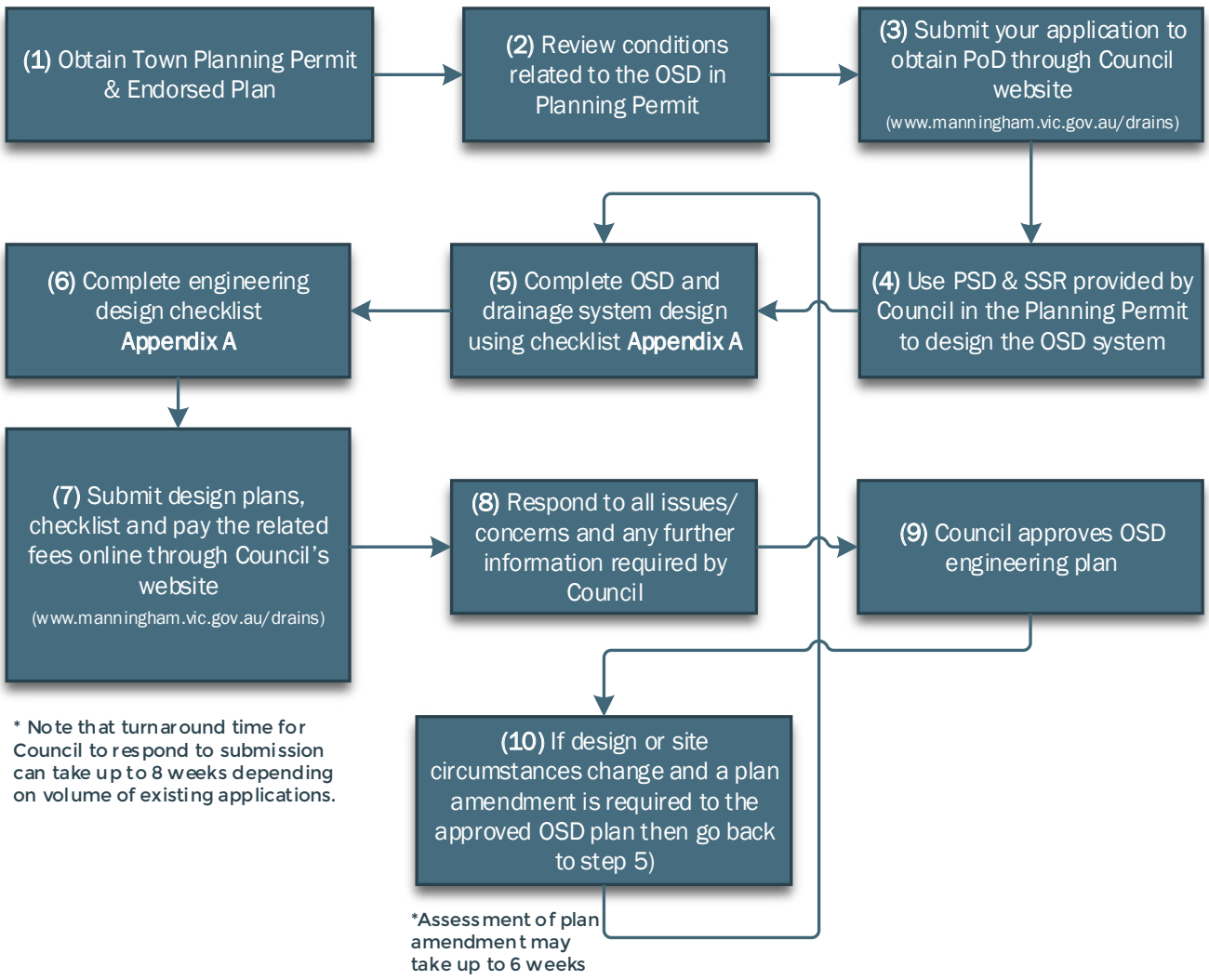
Developers and designers are encouraged to use good design principles when preparing an OSD design considering, long term viability, ease of maintenance and access to the drainage system and storage areas. It is recommended that the OSD designer, ensuring an Endorsed Plan has been issued, consults with the architect and landscape designer prior to completing an OSD design.

This will ensure that all drawings correspond in terms of location of buildings, walls, existing trees being retained and landscaping treatments proposed on site.

The property owner(s) is to be responsible for the future operation, maintenance and replacement of the OSD system.

On-site Stormwater Detention (OSD) Engineering Plan Approval Process

The following flow chart outlines the OSD approval process.



* Note that turnaround time for Council to respond to submission can take up to 8 weeks depending on volume of existing applications.

PoD – Legal Point Discharge

PSD – Permissible Site Discharge

SSR – Site Storage Requirement

3. DRAINAGE CONNECTION TO POINT OF DISCHARGE (PoD)

The Point of Discharge (PoD) is the point which is specified by Council where the stormwater leaves an individual property, and may include connection to:

a) a Council underground stormwater pipe or pit within Council land, an easement within the private land, or within the road reserve;
b) a table (open/swale) drain;
c) a Melbourne Water major drain/ creek, subject to Melbourne Water conditions.

To apply for a PoD, refer to Council's website for the application process or for further information: https://www.manningham.vic.gov.au/drains

• Drainage Connections to Council Assets

a) Connection directly into a Council pipe

Connection can be made directly to a Council stormwater pipe where Council's pipe diameter is three times larger than the incoming pipe. For example a 150mm inlet pipe can only connect to a 450mm diameter or larger pipe. The connection must be made via an approved saddle adaptor (26A/27A connection) in accordance with Council's Engineering Standard Drawings: S103 & S110

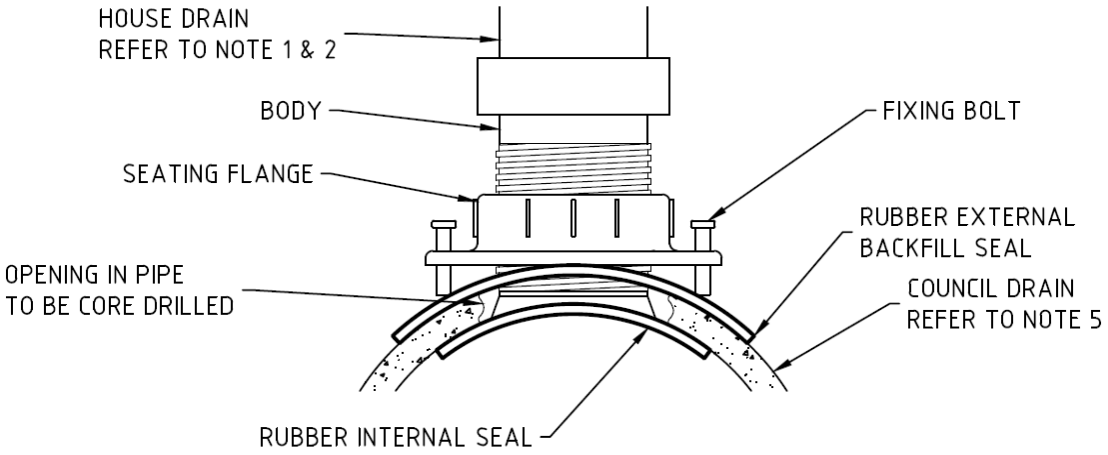


Figure 1: Typical 26A /27Aconnection

b) Connection into an existing Council pit

Connection can be made to an existing Council stormwater pit in accordance with Council's Standard.

c) Connection to a new Council pit

Connection can be made by constructing a new Council stormwater pit over an existing Council drainage pipe. The construction of a new Council pit must be in accordance with Council's Standard Engineering Drawings: S111 & S112.

Figure 2 - Junction pit construction

d) Construction of a new outfall drain

Construction of an outfall drain is required where there is no PoD within close proximity.
Council has a number of requirements for constructing a new Council stormwater asset which typically include:

- Preparation and submission of a drainage design plan to Council's satisfaction, including:
  - Plan view with set out;
  - Longitudinal section showing pipe size, slope capacity Hydraulic Gradient Line (HGL), chainage, reduced levels for invert and surface levels;
  - Pit details and pit schedule including pipe bedding details;

Figure 3 - Outfall drain construction

4. DESIGN REQUIREMENTS FOR OSD

• Design Parameters

To avoid exceedance of the capacity and surcharging of the existing drainage system based on design storm as a result of site redevelopments, the On-site Stormwater Detention system design needs to satisfy Permissible Site Discharge (PSD) and Site Storage Requirements (SSR).

The design parameters for an OSD system include:

a) Permissible Site Discharge (PSD) for 20% Annual Exceedence Probability (AEP) event;
b) Site Storage Requirement (SSR) for 10% AEP event

The above parameters will be provided by Council as part of the planning permit.

a) Permissible Site Discharge (PSD)

The Permissible Site Discharge (PSD) is typically based on a 20% AEP event. The aim of the PSD is to limit the site discharge to ensure that existing Council drains network does not surcharge more frequently as a result of site redevelopments and cause major flooding in Council's drainage network.

b) Site Storage Requirement (SSR)

A commonly used current practice for drainage standards in general businesses, commercial, industrial or high density residential areas is 10% AEP. Manningham Council has therefore set the storage requirement to ensure that OSD systems do not overflow in a 10% AEP event resulting in increased flows to drains and compromising their 10% AEP event capacity.

The requirement for a SSR based on the 10% AEP event also allows for the increased volume and duration of runoff from the redeveloped site and the possibility of this delayed flow coinciding with the peak flow from the larger catchment.

• Existing Flood Prone Areas

For sites that are upstream of known flooding problems, where habitable buildings are at risk of flooding in a major storm, then Council may require the PSD and/or the SSR to be determined based on a 1% AEP event.

• Runoff collection system

The site drainage system is to be designed to collect runoff from the site including all pervious and impervious areas and direct it to the site storage area in accordance with latest revision of AS3500.3. Surface inlets must have approved grates to prevent pollutants from getting into the underground drainage system and causing blockages.

• Site storage system

The site storage system is required to temporarily store rainwater during a storm, while the flow from the storage system is controlled.
The site storage can be provided in a number of configurations, including:

a) Below ground pits and pipes;

b) Below ground tank –Use of modular tanks must be approved by Council;

c) Above ground tank(s) in combination with (a) or (b);

NB: No storage is to be provided beneath dwellings or within Tree Protection Zones (TPZ), unless otherwise approved by Council.

If pipes are used for the storage they are to be laid on a slope no flatter than 1 in 180, **with the obvert of the pipe(s) at the upstream pit to be at or lower than the top of the baffle wall**– If site conditions require a flatter grade, please contact Council's Development Engineer to approve prior to submission.

The maximum water level in the site storage is to be at least 300mm below all habitable floor levels on site and 150mm below other floor levels including garages.

The site storage is to be free draining in that all impervious areas are to discharge to the Council drain via gravity. Stormwater runoff is not to be discharged from the site by the use of the pumps,

Any basement pumps are to discharge upstream of the baffle wall with the invert of the rising main at or above the top of the baffle wall.

In multi-unit developments separate discharge points for each lot are discouraged unless:

- There is a high point central to the property preventing a common discharge point;
- Space or layout limitations prevent additional pipes/pits.

Approval to provide separate discharge points must be obtained by the Development Engineer prior to submission.

• Flow Control

a) Permissible Site Discharge (PSD)

The flow control orifice is to be located within a baffle pit between the site storage and the Council drainage system. The orifice is to be designed to limit the flow to the Council drainage system to the PSD when the storage is at the SSR. The orifice is to be designed to have a trash grate located upstream of the outlet, or sufficient screening on all inlets to prevent blockage of the flow control outlet. A drawing of the approved trash grate and baffle arrangment is provided in **Appendix B**.

Orifice outlets must be no less than 40 mm in diameter. A simplified orifice equation is shown for reference below:

$$Diameter = 21.9 \times \sqrt{\frac{PSD}{\sqrt{Head\ Height}}}$$

* Head Height = Top of baffle wall to centre of orifice

The outlet and storage chamber are to be accessible for maintenance and clearing blockages. Outlet and storage should be designed to avoid the need to enter a confined space for checking and maintenance. This should be able to be achieved by not making the system too deep and by having sufficient access from the surface. If a storage or pit is deeper than one metre, then appropriate step irons will be required.

b) Multi-cell

The Multi-cell is also an approved outlet type. For details regarding Multi-cells, contact approved Multi-cell suppliers.

• Rainwater Tank

Rainwater tanks have the potential to control peak flows in a similar manner to OSD systems. Rainwater tanks can also control total runoff volume, pollutant loads and reduce consumption of potable water. Additional flow control may occur if tanks are not full when a storm starts. Orifice overflow outlets are less likely to block compared with orifices in below ground OSD systems as the outlets are located part way up the tank. The overflow outlet should have a removable connection to enable inspection. Orifice outlets must not be blocked and must operate as an outlet at all times.

The property owner is responsible for the future operation, maintenance and replacement of the combined rainwater tank and underground storage system. Controlled outflow from the detention of each rainwater tank is to be minimum of 25 mm diameter orifice to be connected into overflow pipe from the rainwater tank to the underground system, with the required detention provided in between the invert level of the orifice and the invert level of the overflow pipe.

A suitable volume of storage could be provided below the outlet for rainwater reuse. Reuse could take place by connecting the tank to toilet cisterns and/or irrigation purposes. Maximum rainwater tank size is to be 3000 litres unless otherwise approved by Council.

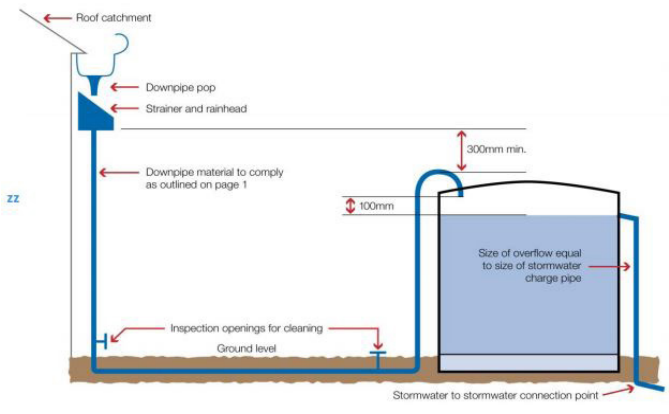


Figure 4- Typical rainwater tank cross section

a) Rainwater Tank Detention Requirements

On-site detention can be provided within the rainwater tanks for roof areas that are connected into the rainwater tank, however, an underground system is required to reduce the flow from paved areas and any remaining roof areas which are not connected into the rainwater tank. The detention volume (DV) within each tank is calculated for 10% storm event.

$$DV = SSR \times \frac{\text{Roof area connected to RWT}}{\text{Total site impervious area}}$$

b) Rainwater Reuse Dispensation

Council will provide dispensation to the Site Storage Requirement (SSR) where the rainwater tanks are connected to toilet flushing or significant year round demand.
Dispensation volume (DIV) can be calculated as below:

$$DIV = 0.25 \times SSR \times \frac{\text{Area of roof connected to RWT}}{\text{Total site impervious area}}$$

Figure 5 - Rainwater tank orifice installations

Ideally tank locations and sizes are to be shown on the Endorsed Plan and must be submitted with the engineering design plans. Tank location and sizes not in accordance with the Endorsed Plans should be confirmed by Council's relevant Planner.

Where other options are possible, rainwater tanks used solely for detention purposes will not be considered. Designs should avoid storing large detention volumes within above ground rainwater tanks. Council requires the majority of the volume within any rainwater tank to be for reuse purposes (eg. irrigation, toilets etc.).

Tanks are to have a minimum reuse volume of 2000 litres and a minimum roof area connected to the rainwater tank per dwelling must be 50m² to be in accordance with the Victorian Building Authority (VBA) guidelines.

No dispensation to the Site Storage Requirement will occur if reuse is only for irrigation purposes.

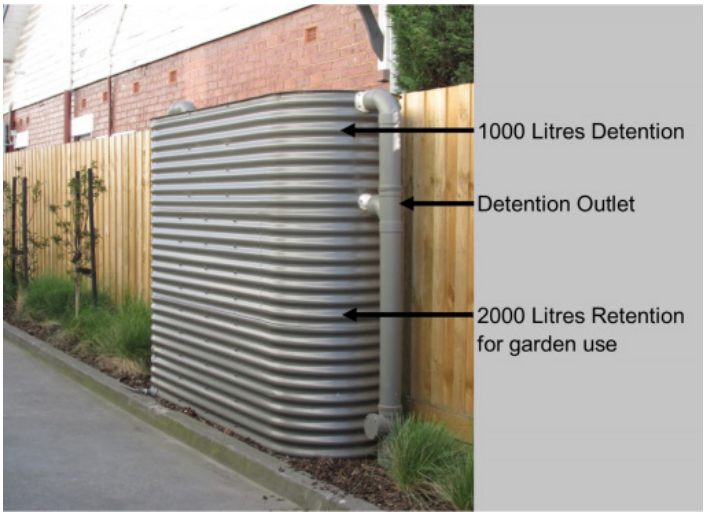


Figure 6 - Rainwater tank orifice and detention storage

• GLOSSARY

AEP
Annual Exceedance Probability - The probability that a given rainfall total accumulated over a given duration will be exceeded in any one year.

Agi
An agricultural drain is a slotted PVC pipe placed into a trench that is backfilled. The purpose of the agi pipe is to drain away any water that is in the ground.

Amendment
Plan amendments refers to changes to an Approved Plan.

CCTV
Closed-circuit television inspection is the monitoring and surveillance of pipes and drains for the purpose of checking, rehabilitation or repairs.

FRC pipe
Fibre Reinforced Concrete pipes.

IFD
IFDs are Intensity–Frequency–Duration Design rainfall intensities (mm/h) or design rainfall depths (mm) corresponding to selected standard probabilities, based on the statistical analysis of historical rainfall.

PoD
Point of Discharge is the point which is specified by Council where the stormwater leaves an individual property.

OSD
On-Site Stormwater Detention - The detaining of a portion of stormwater discharge from a site for a period of time. Aims to reduce peak flows in outfall drainage system.

OSR
On-Site Retention - The retaining of a portion of the stormwater discharge from a site which is reused on-site (eg. toilet flushing or irrigation). Aims to reduce peak flows and volume of sormwater in the downstream drainage system.

PSD
Permissible Site Discharge - The peak discharge that may be released from a site for a specified AEP Storm.

RCP pipe
Reinforced Concrete pipe.

RRJ pipe
Rubber Ring Joint pipe.

SSR
Site Storage Requirement - The volume required to be temporally stored during a storm event.

SMP/SDA
Sustainability Management Plan/Sustainable Design Assessment.

TBM
Temporary Bench Mark.

UPVC pipe
Unplasticised Poly Vinyl Chloride pipe.

SN
Nominal Stiffness is the crush resistance of a pipe or fitting, in some conditions defined in the normative EN-ISO 9969.

WSUD
Water Sensitive Urban Design is a land planning and engineering design approach which integrates the urban water cycle, including stormwater, groundwater and wastewater management and water supply, into urban design to minimise environmental degradation and improve aesthetic and recreational appeal.

• REFERENCES

The following references were used in this On-Site Stormwater Detention Design Guide

- Australian Rainfall and Runoff 2019 – A guide To Flood Estimation
- Review of the Use of On-Site Stormwater Detention for New Developments, Manningham City Council, May 2002
- City of Doncaster and Templestowe Drainage Design Guide, AGP Consulting and N. M. Craigie and Associates, 1993
- On-Site Stormwater Detention Handbook, Upper Parramatta River Catchment Trust, Revision 1, December 1999
- Manningham Drainage Strategy Review 1999-2009, Manningham City Council
- Melbourne Water instruction sheet - Building an inground raingarden
- Melbourne Water instruction sheet - Building a planter box raingarden
- Melbourne Water Water SensitiveUrban Design Guidelines
- Water Sensitive Urban Design Technical Manual- Greater Adelaide Region

• APPENDIX A
Stormwater and On-Site Detention Plan Submission Checklist

STORMWATER & ON-SITE STORMWATER DETENTION CHECKLIST					
		MANDATORY REQUIREMENTS			
1		Completed Application Form On-line (Form available from Council's website – https://www.manningham.vic.gov.au/drains)	☐Y	☐ N	☐ NA
2		One set of A1 PDF_ size plans on a preferred scale of 1:100	☐Y	☐ N	☐ NA
3		Confirmed location, levels and depths of Approved Point of Discharge are shown on OSD plan prior to commencement of design	☐Y	☐ N	☐ NA
4		Stormwater & OSD submission checklist includes design computation for outfall drain etc (compliant with latest AR&R Guidelines)	☐Y	☐ N	☐ NA
5		Engineering plan in accordance with Endorsed Plan, Approved Landscape and Sustainability Management Plan (SMP) - i.e WSUD features eg rain gardens, permeable pavement are included as per STORM or BESS report (**DO NOT** submit OSD plans prior to the issuance of Council Endorsed Plan and Nominated Point of Discharge)	☐Y	☐ N	☐ NA
6		Nominated OSD system meets Council requirements as Outlined in the OSD Guidelines	☐Y	☐ N	☐ NA
	a	Permissible Site discharge (PSD)	PSD =		
	b	Site Storage Requirement (SSR)	SSR =		
	c	Provided Storage Volume	VOL=		
7		**OSD – LAYOUT**			☐ NA
	a	Check building and retaining wall footings are located below the angle of repose and not close proximity to OSD system	☐Y	☐ N	☐ NA
	b	Design of non-standard pit sizes with depths greater than 2m is certified by a structural engineer	☐Y	☐ N	☐ NA
	c	500mm minimum offset to be provided from front title boundary and 300mm from side title boundary from edge of OSD located	☐Y	☐ N	☐ NA
	d	OSD system not to be located within TPZ or under dwellings and garages unless approved by Council Engineers under special circumstances.	☐Y	☐ N	☐ NA
	e	OSD system must not encroach into Council easements without approval	☐Y	☐ N	☐ NA
	f	All internal and existing drainage should be connected into the detention side of the OSD system	☐Y	☐ N	☐ NA
	g	Plan showing connected roof area, size of tank and correct re-use and detention volume based on Endorsed plan and STORM rating report.	☐Y	☐ N	☐ NA
	h	Plan should clearly show paved area (m2)	☐Y	☐ N	☐ NA

STORMWATER & ON-SITE STORMWATER DETENTION CHECKLIST					
	i	To ensure site layout allows passing of overland flows (for flood prone areas)	☐Y	☐ N	☐ NA
	j	Plan should clearly show landscaped area	☐Y	☐ N	☐ NA
8		**OSD - PIPES**			
		Correctly indicate on drawings:			
	a	Pipe Lengths	☐Y	☐ N	☐ NA
	b	Pipe lengths to match manufacturer's pipe lengths, to avoid small pipe sections adjacent to pit	☐Y	☐ N	☐ NA
	c	Invert levels of pipe	☐Y	☐ N	☐ NA
	d	Indicate pipe size, type, class and grade (minimum grade must not be flatter than 1:180) next to all proposed OSD pipes	☐Y	☐ N	☐ NA
	e	Drainage cross sections plans of pipes, pits, utility crossings	☐Y	☐ N	☐ NA
	f	Dual pipes – minimum 200mm gap, measured externally, between parallel pipes for pipe sizes up to 600mm diameter. (Note: for pipe sizes greater than 600mm diameter, consult Council Engineers)	☐Y	☐ N	☐ NA
	g	Pipe cover from top of pipe to underside of driveway to be minimum 300mm.	☐Y	☐ N	☐ NA
	h	Additional reinforcement required under driveway if less than 300mm cover or a higher pipe class to be utilised.	☐Y	☐ N	☐ NA
	i	Pipe Bedding – show typical trench bedding and backfill details as per Council standard (max compaction and depth)	☐Y	☐ N	☐ NA
	j	Storage pipes to be nominated with either Reinforced Concrete Pipes (RCP) or Fibre Reinforced Concrete (FRC) Class 2 minimum. For UPVC pipes, a minimum of SN4 Sewer Grade (AS1260) to be used, for example Stormpro, Blackmax, Enviro or equivalent	☐Y	☐ N	☐ NA
	k	AGI drains to bypass OSD system and discharge into outlet chamber (unless can connect into OSD system, minimum 150mm above the top level of the baffle wall	☐Y	☐ N	☐ NA
	l	AGI drains for the retaining walls are connected to detention system.	☐Y	☐ N	☐ NA
	m	Retaining walls (including AGI drains) are to be wholly within the subject site	☐Y	☐ N	☐ NA
	n	AGI drains not to be located under the driveways unless discharging into a pit under driveway but that section needs to be a solid pipe	☐Y	☐ N	☐ NA

STORMWATER & ON-SITE STORMWATER DETENTION CHECKLIST					
9		**OSD - PITS**			
		Location correctly indicated on drawings:			
	a	Numbering of pits matching pit schedule	☐Y	☐ N	☐ NA
	b	Pit sizes (standard sizes preferred)	☐Y	☐ N	☐ NA
	c	Pit Invert Levels	☐Y	☐ N	☐ NA
	d	Finished Surface Levels	☐Y	☐ N	☐ NA
	e	Pit Lids / Covers	☐Y	☐ N	☐ NA
		· In accordance with AS/ NZS 3996 specification	☐Y	☐ N	☐ NA
		· within driveway – Class B Gatic/ Grate or Class C Terra Firma	☐Y	☐ N	☐ NA
		· Vehicle crossover and side entry – Class C Terra Firma or within Gatic/ Grate	☐Y	☐ N	☐ NA
		· For landscape areas – use concrete lids or Terra Firma Class B	☐Y	☐ N	☐ NA
		· For backyard areas- use Class A Terra Firma or Gatic/ Grate	☐Y	☐ N	☐ NA
		· Pit lids to match with existing or finished surface level particularly where pits are located in lawn area	☐Y	☐ N	☐ NA
		· The slope of all pit lids must match the surrounding finished surface	☐Y	☐ N	☐ NA
		·Special consideration for baffle pit in driveways with significant grade	☐Y	☐ N	☐ NA
	f	Minimum 10mm nominal fall through detention pit shown	☐Y	☐ N	☐ NA
	g	Pit Schedule is included on plan	☐Y	☐ N	☐ NA
	h	Show step irons/ detail reinforcement, minimum SL81, if pit is deeper than 1 metre Standard Drawing S136 and S111	☐Y	☐ N	☐ NA

STORMWATER & ON-SITE STORMWATER DETENTION CHECKLIST					
10		**Baffle Pit**			
	a	Provide in-situ baffle wall (orifice plates will not be accepted)	☐Y	☐ N	☐ NA
	b	Correct Orifice diameter – chose nearest standard pipe diameter available on the market +/ - 2mm. Refer to Appendix D.	☐Y	☐ N	☐ NA
	c	Correct baffle wall height and thickness adopted (150mm thick if depth is more than 1m)	☐Y	☐ N	☐ NA
	d	Height, width and RL at top	☐Y	☐ N	☐ NA
	e	300mm below FFL for habitable areas	☐Y	☐ N	☐ NA
	f	150mm below FFL for garages	☐Y	☐ N	☐ NA
	g	Outlet pipe from baffle pit to be minimum 150mm diameter, SN4 (min) and minimum grade 1 in 80 for up to a 1000 m2 development site otherwise to be determine by hydraulic calculation.	☐Y	☐ N	☐ NA
	h	The outlet pipe must have the capacity to convey 1%AEP storm event to the council drainage system	☐Y	☐ N	☐ NA
	i	Outlet pipe with 90 degree bends require an Inspection Opening (IO)	☐Y	☐ N	☐ NA
	j	Correct detention chamber size			
		· If baffle wall is less than 1.2m – (900 x 600),	☐Y	☐ N	☐ NA
		· If greater than 1.2m – (900 x 900)	☐Y	☐ N	☐ NA
	k	Correct outlet chamber size			
		· If baffle wall is less than 1.2m – (900 x 600),	☐Y	☐ N	☐ NA
		· If greater than 1.2m – (900 x 900)	☐Y	☐ N	☐ NA
	l	Surcharge over top of baffle wall Provide minimum 100mm gap between top of baffle wall to underside of pit lid and 600mm minimum width weir	☐Y	☐ N	☐ NA
	m	Correct lids specified	☐Y	☐ N	☐ NA
	n	If levels allow trench grate to drain into detention side of baffle wall; Top of the trench grate must be min 150mm higher than top the baffle wall	☐Y	☐ N	☐ NA

STORMWATER & ON-SITE STORMWATER DETENTION CHECKLIST					
	o	Trash grate indicated on plan Standard Drawing A4/ S101	☐Y	☐ N	☐ NA
	p	Step irons/ detail reinforcement, minimum SL81, if pit is deeper than 1.0metre - shown on plan Standard Drawing S136 and S111	☐Y	☐ N	☐ NA
	q	Show Offset from title boundaries	☐Y	☐ N	☐ NA
11		**Multi-cell:**			
	a	Type to be clearly nominated on plans	☐Y	☐ N	☐ NA
	b	Location and details of flow control outlet, including size and invert levels (inlet and outlet) of Multi-cell (plus inclusion of risers on all inspection openings of the Multi-cell unit.	☐Y	☐ N	☐ NA
	c	If IOs in driveway, the 200X200 Jenco steel covers to match finished surface of the driveway	☐Y	☐ N	☐ NA
	d	Pit covers or grated covers must be higher than the top of the baffle wall to avoid surcharge	☐Y	☐ N	☐ NA
12		**Rainwater Tanks**			
	a	Total Storage Volume – as per Endorsed Plan	☐Y	☐ N	☐ NA
	b	Volume used for detention and re-use (toilet flushing/ irrigation)	☐Y	☐ N	☐ NA
	c	Tank shown on plan including size and dimensions of tank	☐Y	☐ N	☐ NA
	d	Show section details of tank if being used for detention to highlight levels for detention overflow and orifice arrangement- refer to Victorian Building Authority (VBA) for example, including levels and off takes	☐Y	☐ N	☐ NA
	e	Indicate the height of the detention component within the rainwater tank, including the orifice size and invert level	☐Y	☐ N	☐ NA
	f	Specify the reuse option on OSD plan – show cisterns schematically	☐Y	☐ N	☐ NA
13		**GENERAL**			
	a	Provide roof plan of all proposed buildings	☐Y	☐ N	☐ NA
	b	Existing house drainage directed into OSD system Downpipe locations are clearly indicated for all buildings	☐Y	☐ N	☐ NA

STORMWATER & ON-SITE STORMWATER DETENTION CHECKLIST					
	c	Indicate all stormwater pipes in thicker line type from downpipes and pits to the outlet connection point into Council's drainage system	☐Y	☐ N	☐ NA
	d	Outfall Drain pipes to be a minimum UPVC SN4 or RCP/ FRC class2/ RRJ	☐Y	☐ N	☐ NA
	e	Trench grate to be minimum 150mm with metal lid Class C	☐Y	☐ N	☐ NA
	f	Driveway central invert unless WSUD elements require one way cross fall - show notation on plan	☐Y	☐ N	☐ NA
	g	All driveway drainage directed into the OSD system If driveway falls to the front – trench grate required at front title boundary and drained into OSD system (if above compromises head height, then first 5 metres of driveway can drain into street)	☐Y	☐ N	☐ NA
	h	Provide solid pit lids in grassed areas/ garden areas	☐Y	☐ N	☐ NA
	i	Show existing Council drain/ pits including size and location	☐Y	☐ N	☐ NA
	j	Show outlet, Invert Level of approximate pit depth	☐Y	☐ N	☐ NA
	k	Vehicular crossings to be located a minimum of 1.0metre clear of power poles and other utility services.	☐Y	☐ N	☐ NA
	l	Size and layout of vehicular crossing complies with Council's Vehicular Crossing Policy – refer to Council website for Policy	☐Y	☐ N	☐ NA
	m	No filling or excavation within Tree Protection Zone	☐Y	☐ N	☐ NA
	n	Outfall drain through adjoining property	☐Y	☐ N	☐ NA
	o	During construction, plan notation has pre-written notice to adjoining owner and sign off upon satisfactory completion	☐Y	☐ N	☐ NA
	p	FCR backfill for OSD pipe trenches under driveway	☐Y	☐ N	☐ NA
	q	Backfill any on-site stormwater detention trench under pavement with 20mm nominal size Class 3 FCR and compact in 150mm layers to 95% of modified compaction (AS 1289 5.2.1)	☐Y	☐ N	☐ NA
	r	Storage pipes and pits located near buildings requires deepening of the foundation to the satisfaction of the relevant building surveyor	☐Y	☐ N	☐ NA
14		**CONNECTION INTO EXISTING COUNCIL DRAIN**			
	a	Outlet pipe to be a minimum of 150mm diameter unless otherwise agreed by Council Engineer Outlet pipe must connect into an existing pit/ drain/ open channel	☐Y	☐ N	☐ NA

STORMWATER & ON-SITE STORMWATER DETENTION CHECKLIST					
	b	Connection into existing Council pit Match to the obvert of the existing Council outlet pipe	☐Y	☐ N	☐ NA
	c	If connecting into existing Council drain :			
		• Use house connection type 26A/ 27A' if existing drain is 450mm dia. or greater Connection to be into top of pipe otherwise a pit is required	☐Y	☐ N	☐ NA
		• Grind the letter 'H' into the top of the kerb	☐Y	☐ N	☐ NA
	d	Construct new pit if existing drain is less than 375mm diameter	☐Y	☐ N	☐ NA
		• 600 x 600 (Council standard size if d < 800)	☐Y	☐ N	☐ NA
		• 900 x 600 (if d >800)	☐Y	☐ N	☐ NA
	e	The outlet flow direction to be consistent with flow direction in Council drains.	☐Y	☐ N	☐ NA
15		**PLAN REQUIREMENTS**			
	a	Show North Point	☐Y	☐ N	☐ NA
	b	Site dimensions	☐Y	☐ N	☐ NA
	c	Title dimensions, boundaries in thicker line	☐Y	☐ N	☐ NA
	d	Existing trees to be retained/ removed	☐Y	☐ N	☐ NA
	e	No pits proposed under tree canopies	☐Y	☐ N	☐ NA
	f	TBM level and location	☐Y	☐ N	☐ NA
	g	Existing site levels including RL at corner of property	☐Y	☐ N	☐ NA
	h	Location and width of easement(s) marked with dashed lines	☐Y	☐ N	☐ NA
	i	All street names indicated	☐Y	☐ N	☐ NA

STORMWATER & ON-SITE STORMWATER DETENTION CHECKLIST					
	j	Driveways grade has appropriate drainage, vehicle crossover width shown, cross sectional plans indicating any crossing utilities	☐Y	☐ N	☐ NA
	k	Build Over Easement approval is obtained, if applicable	☐Y	☐ N	☐ NA
	l	Footings has minimum of 300mm offset from existing infrastructure within Council easement	☐Y	☐ N	☐ NA
	m	Include the mandatory requirement and notes below on all plans:	☐Y	☐ N	☐ NA
		• No works are to commence on site until Manningham City Council has approved the design of the OSD system; and elevation permits obtained	☐Y	☐ N	☐ NA
		• The contractor must contact Council on 9846 0500 to arrange for an inspection at the start of work on the OSD system.	☐Y	☐ N	☐ NA
		• Provide a blank space (12cm x6cm) bottom corner of every A1 PDF size drawings sheet for stamping of plans	☐Y	☐ N	☐ NA
		• Summary table of PSD, SSR and Total Storage shown on plan	☐Y	☐ N	☐ NA

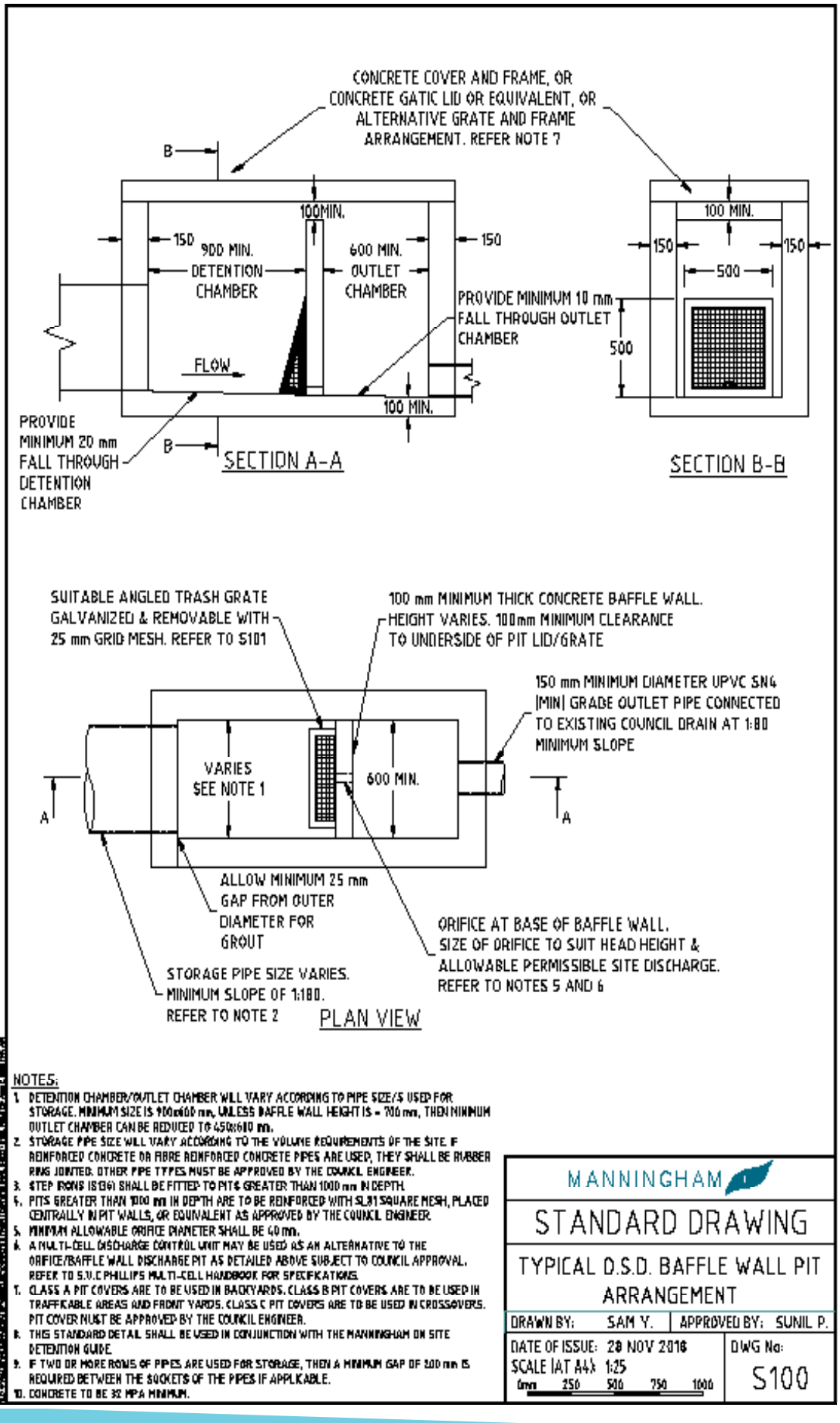
I,……(**full name and position title**)

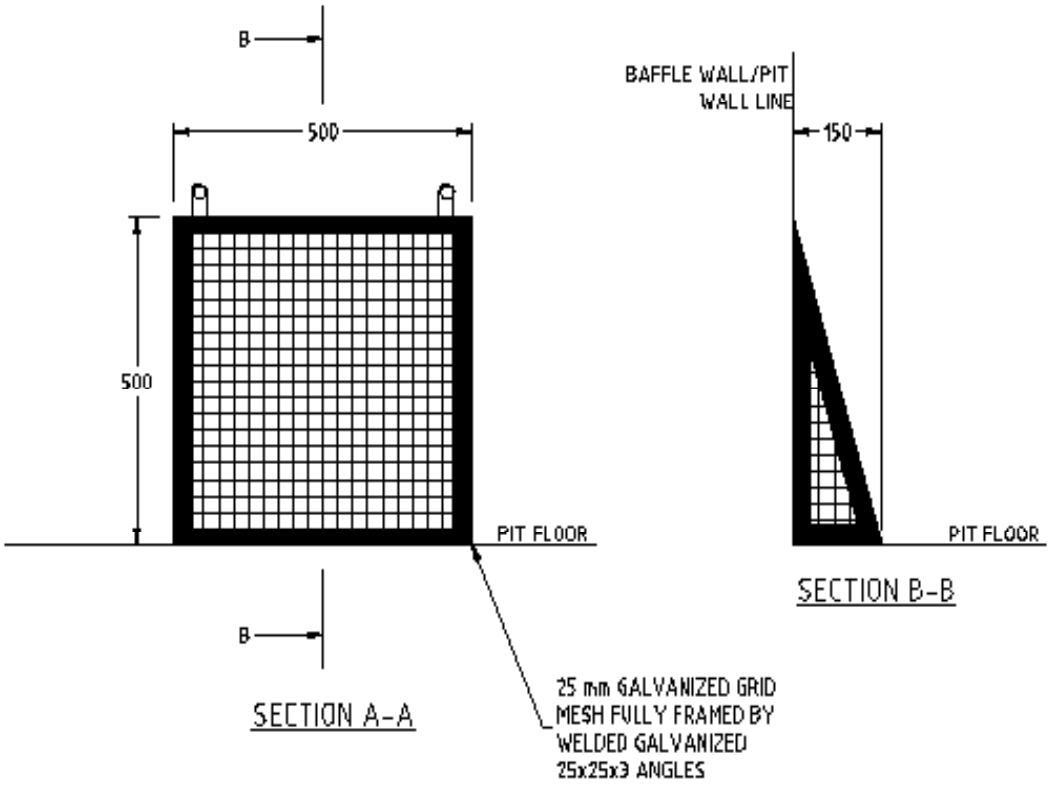
……(**Name of Consulting Company**) as the designer of this OSD system, am a qualified and experienced civil engineering professional with delegation to sign this OSD Checklist and I take responsibility for ensuring compliance with the preparation of the OSD system.

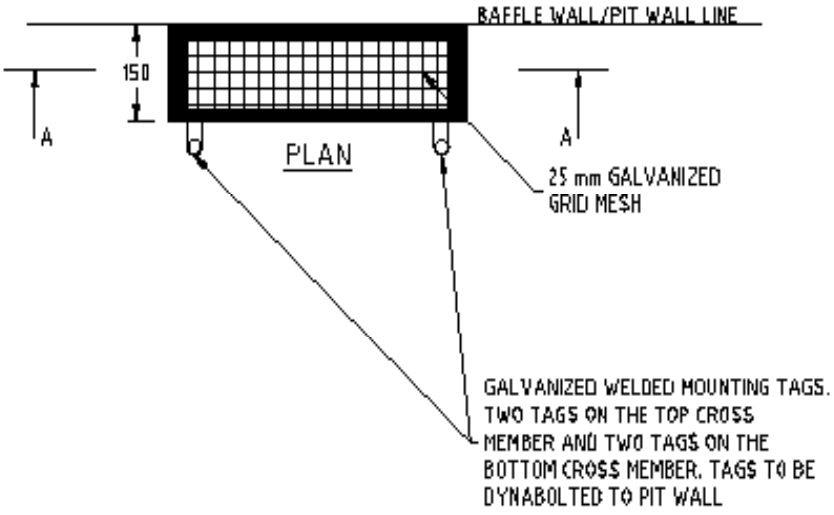
Signature …… Date …….

• APPENDIX B

Detention Pit Standard Drawings







NOTES:

1. TRASH GRATE IS TO BE FIXED TO THE BAFFLE WALL, AT THE FOUR MOUNTING TAGS, BEFORE THE ORIFICE IOR FIXED TO THE WALL OF PIT, AT THE OUTLET, BEFORE DISCHARGING TO THE MULTI-CELLI USING DYNABOLTS.
2. ENTIRE TRASH GRATE ARRANGEMENT IS TO BE HOT DIP GALVANIZED (AS/NZS 4680:2006) AFTER MANUFACTURE.
3. REFER TO S101 FOR DETAILS OF THE TYPICAL O.S.D BAFFLE WALL PIT ARRANGEMENT.
4. THIS STANDARD DETAIL SHALL BE USED IN CONJUNCTION WITH THE MANNINGHAM ON SITE DETENTION GUIDE.

MANNINGHAM

STANDARD DRAWING

TYPICAL O.S.D. TRASH GRATE ARRANGEMENT

DRAWN BY: SAM Y.	APPROVED BY: SUNIL P.
DATE OF ISSUE: 28 NOV 2018 SCALE IAT A4): 1:10 0mm 100 200 300 400	DWG No: S101

• APPENDIX C

Water Sensitive Urban Design (WSUD)

Introduction to WSUD

Stormwater is rainwater that has fallen onto roads or roofs and often contains chemicals or pollutants. Water Sensitive Urban Design (WSUD) is an approach to planning and designing urban areas to make use of this valuable resource and reduce the harm it causes to our rivers and creeks.

WSUD uses better urban planning and design to reuse stormwater, stopping it from reaching our waterways by mimicking the natural water cycle as closely as possible.

Impacts of Stormwater on Waterways

In natural environments, rainwater mostly evaporates, gets absorbed by plants or soaks into the ground. Urban development dramatically changes these processes, clearing land of vegetation and covering it with 'hard' or impervious surfaces that cannot let water through. As a result, rainwater runs off these surfaces, through stormwater drains and straight into our waterways as polluted stormwater in a very short time. This changes the timing, speed and volume of water flows, which can affect our waterways and bays.

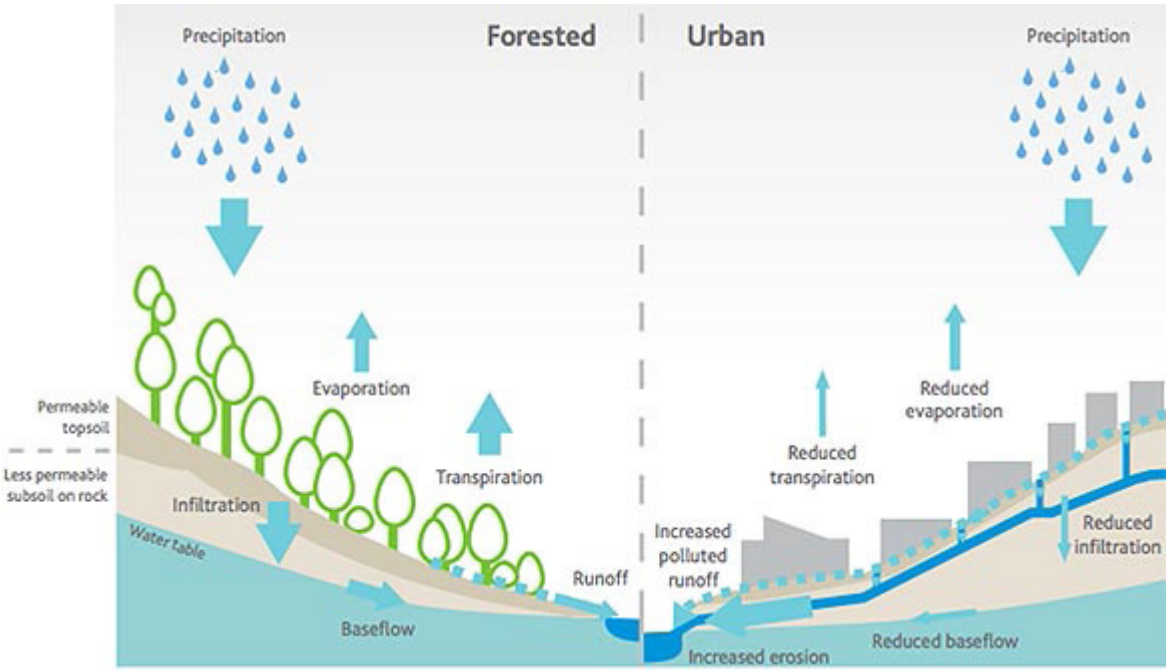


Figure 7 - Water cycle in urban and natural environment area

Clause 56 and Council Permits

Clause 56.07-4 of the Victorian Planning Provisions, commonly referred to as Clause 56, sets stormwater management objectives that residential subdivisions must meet. These objectives are designed to reduce the harm to our waterways, bays and ocean. (Local councils and the Victorian Government are responsible for Clause 56).

Manningham Local Planning Provisions (Planning Scheme Clause 22.12)

Stormwater management should be considered in the earliest stages of planning, ideally in the master planning stage, long before subdivision permit applications. For example, setting aside land for stormwater treatment in road or drainage reserves can meet the objectives for subdivisions of more than a few lots. Council has its own local planning provisions (Planning Scheme Clause 22.12) that apply to new buildings and extensions. To prove the design of the development achieves these objectives, as well as Clause 56, Maninngham will require a software model such as MUSIC, the STORM calculator or other approved water quality assessment software packages for new multi-dwelling developments and subdivisions.

Provision of WSUD Elements to Achieve Best Practice

WSUD shall be prepared in consultation with Council's engineering and planning departments and in accordance with the requirements of Melbourne Water's publication "WSUD Engineering Procedures". Designs should meet Urban Stormwater: Best Practice Environmental Management Guidelines, CSIRO 1999 and WSUD Engineering procedures Stormwater CSIRO 2005 to achieve the following water quality standards:

a) 80% retention of the typical urban annual load for Total Suspended Solids 45% retention of the typical urban annual load for Total Phosphorus;
b) 45% retention of the typical urban annual load for Total Nitrogen;
c) 70% retention of the typical urban annual load for Gross Pollutants;

WSUD Options

a) Rainwater tanks

Rainwater tanks can reduce the harm to our waterways caused by too much stormwater. Tank water can be used to flush toilets, wash clothes, water gardens and wash cars, significantly reducing demand on drinking water.
Rainwater tanks collect stormwater run-off from roofs, reducing the amount that enters our waterways. They are fitted with an overflow mechanism, meaning that once a tank is full the excess water is redirected into the stormwater drainage system.
Rainwater tanks that are only used for watering gardens are much less efficient than tanks used for flushing toilets.
The amount of water that a rainwater tank captures could be maximised by properly designing roofs, downpipes and tank location.

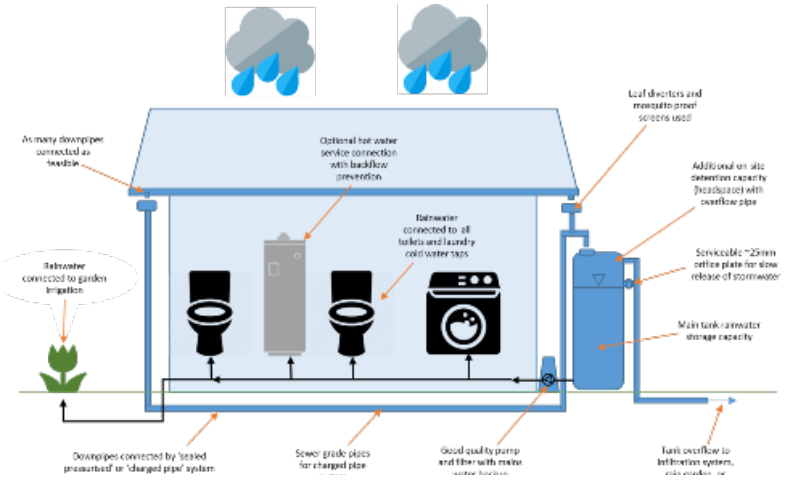


Figure 8 - Simplified diagram of rainwater tank installations

b) Raingardens

Raingardens are specially designed garden beds that filter stormwater runoff from surrounding areas or stormwater pipes. Raingardens are also called bioretention systems because they use soil, plants and microbes to biologically treat stormwater.
Although they may look similar to a normal garden, raingardens are designed to stop stormwater run-off from polluting our waterways with nutrients, rubbish and sediment:

- Water collects and settles on the garden surface.
- Water soaks through the plants and filter media, trapping rubbish and sediment on the surface.
- Plants use the nutrients in the stormwater, and toxins stick to the soil.
- The soil and plant roots work together to naturally filter the water and remove pollutants.

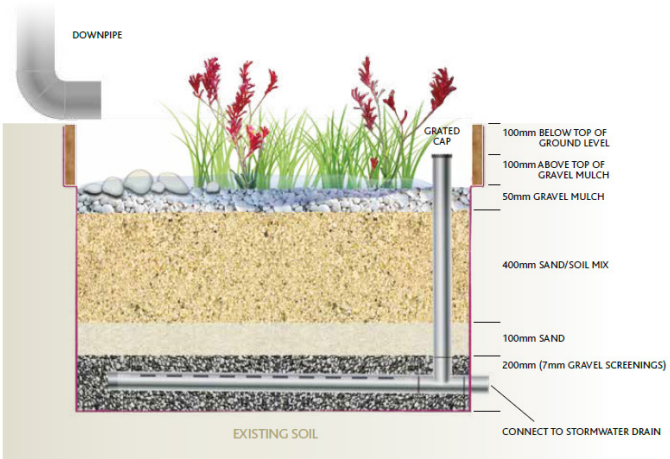


Figure 9 - typical raingarden cross section

Designing a raingarden

Depending on how much water is collected, raingardens range in size from 1 to over 100 square metres, and are usually 1–2% of the catchment area.
They are usually installed after the upstream catchment is 95% developed because poorly managed construction sites create sediment and clog the raingarden.

A sediment pond or swale is a good temporary solution to manage sediment during construction.
When designing and building a raingarden, make sure:

- it is designed to treat stormwater runoff from 1 in 3 month storm events – runoff from heavier storms events should bypass the raingarden into the drainage system;
- the base of the raingarden is above the surrounding groundwater level;
- the filter media is tested before installation to confirm it meets hydraulic conductivity and plant growth standards, and holds adequate moisture to support the plants.

Plants

Raingardens need particular plants with roots that help keep the filter media absorbent, and break down the pollution. Only use plants that can grow in sandy soils and tolerate dry conditions for several weeks in between rains.
For further advice on designing raingardens, refer to Melbourne Water website and Adoption Guidelines for stormwater biofiltration systems - CRC for Water Sensitive Cities.

When not to use raingardens

Raingarden should not be used in the following circumstances:

- A small residential development where rainwater tanks can be utilised;
- Catchments with high sediment loads, such as industrial areas with disturbed surfaces, or an area where sediment clogging is considered a high risk;
- Areas with construction sites upstream;
- Areas with constant catchment flows which may stop the raingarden from drying out which encourages algae growth;

- Areas where frequent maintenance is not possible;
- Sites that are too steep(>6%).

Figure 10 - Planter box raingarden

c) Permeable Pavement

Permeable pavements are alternative paving surfaces that allow stormwater runoff to filter through voids in the pavement surface into an underlying stone reservoir, where it is temporarilystored and/or infiltrated. Porous paving systems have several design variants. The four major categories are:

- pervious concrete;
- modular block systems;
- porous asphalt;
- grass and gravel pavers.

Figure 11 - Pervious concrete

Figure 12 - Modular block systems

Figure 13 - Porous asphalt

Figure 14 - Grass and gravel pavers

Advantages

- Can increase aesthetic value;
- Provides water quality treatment;
- Dual use for pavement structure and stormwater management;
- Retrofit existing developed areas, especially highly impervious areas;

Disadvantages

- Cost;
- Maintenance;
- Potential issues with handicap access;
- Infiltration can be limited by underlying soil type;
- Not effective if not constructed to specification;
- Not effective on steep slopes (>6%).

Design requirements

The applicant must provide a complete hydraulic design and a structural certificate for the permeable pavement with detail and cross section showing designed layers, access pit and observation well (inspection pipe).

The hydraulic calculations must include the following items:

- Ponding time for 10% event
- Aggregate Depth for the Runoff Reduction Volume (RRV)

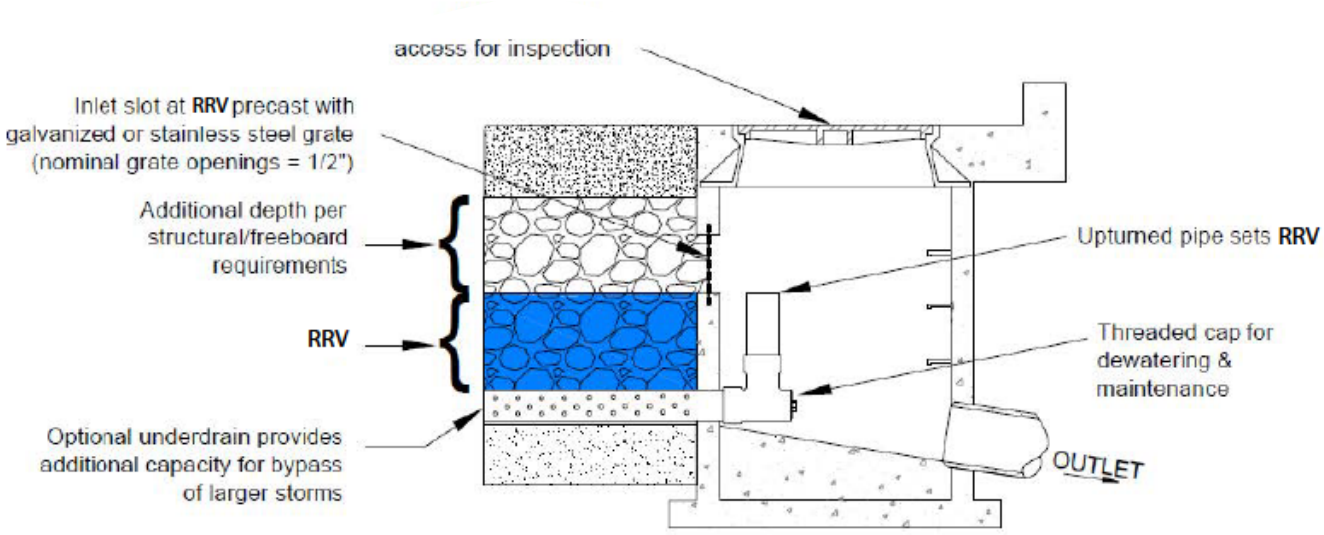


Figure 15 - Permeable pavement and inspection pit typical cross section detail

Maintenance

For efficient operation of pervious pavements it is essential that the gaps between the paver and the underlying bedding layer do not become clogged by fine sediment. To prevent this from occurring, pervious pavements require the following maintenance activities:

- High pressure hosing, sweeping or vacuuming (depending on the manufacturer's specifications) to remove sediments and restore/ maintain porosity;
- Repair of potholes and cracks;
- Replacement of clogged/water logged areas;
- Rectification of any differences in pavement levels;
- Maintenance of the surface vegetation (if present) including weeding or mowing where appropriate; and
- Periodic replacement of aggregate layer (about every 20 years) and replacement of geotextile fabric.

Following construction, pervious pavements should be inspected every month (or after each major rainfall event) for the initial six months of operation to determine whether or not the infiltration zone requires immediate maintenance. After the initial six months, inspections may be extended to the frequencies shown in the example Inspection and Maintenance Checklist for Pervious Pavements in **Appendix D.**

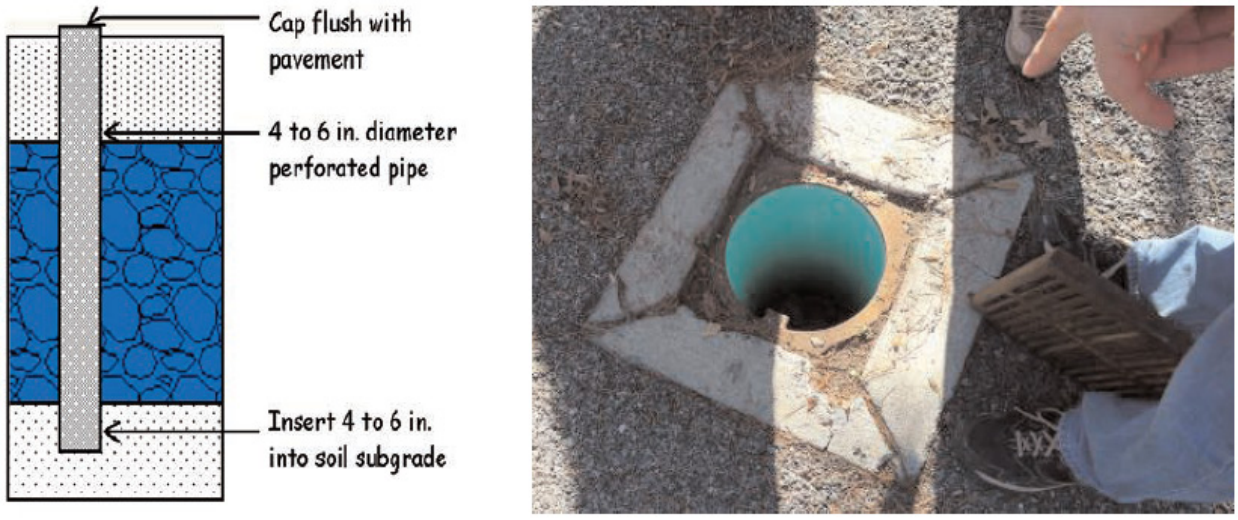


Figure 16- Observation well enables inspection of water infiltration

• APPENDIX D

Permeable Pavements- Inspection Maintenance Form

Items Inspected	Checked Y/ N	Maintenance Needed Y/ N	Inspection Frequency
Debris Cleanout			3 months
1. Pavement surface clear of debris			
Pavement Surface			3 months
2. Sediment build up			
3. Potholes			
4. Cracking of pavement			
5. Significant pavement deflection			
6. Damage/ vandalism			
Dewatering			3 months
7. Pavement surface dewatering between storms			
8. Replacement required of clogged pavement			
Outlet / Overflow			annual
9. Outlet condition			
10. Evidence of erosion downstream			
Comments On Inspection			
Actions Required			
1.			
2.			
3.			
4.			
5.			

Standard PE100 pipe size table (AS4130)

SDR	41				26				21				17				13.6				11				9				7.4				SDR
PN for PE100	4				6.3				8				10				12.5				16				20				25				PN for PE100
DN	Min Wall	Mean ID	Ovality Max	Weight Ave kg/m	Min Wall	Mean ID	Ovality Max	Weight Ave kg/m	Min Wall	Mean ID	Ovality Max	Weight Ave kg/m	Min Wall	Mean ID	Ovality Max	Weight Ave kg/m	Min Wall	Mean ID	Ovality Max	Weight Ave kg/m	Min Wall	Mean ID	Ovality Max	Weight Ave kg/m	Min Wall	Mean ID	Ovality Max	Weight Ave kg/m	Min Wall	Mean ID	Ovality Max	Weight Ave kg/m	DN
16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.6	12.7	1.2	0.08	1.8	12.3	1.2	0.08	2.2	11.4	1.2	0.10	16
20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.6	16.7	1.2	0.10	1.9	16.0	1.2	0.11	2.3	15.2	1.2	0.13	2.8	14.2	1.2	0.16	20
25	-	-	-	-	-	-	-	-	-	-	-	-	1.6	21.7	1.2	0.12	1.9	21.0	1.2	0.14	2.3	20.2	1.2	0.17	2.8	19.2	1.2	0.20	3.5	17.7	1.2	0.24	25
32	-	-	-	-	-	-	-	-	1.6	28.7	1.3	0.16	1.9	28.0	1.3	0.19	2.4	27.0	1.3	0.23	2.9	26.0	1.3	0.27	3.6	24.5	1.3	0.33	4.4	22.8	1.3	0.39	32
40	-	-	-	-	-	-	-	-	1.9	36.1	1.4	0.24	2.4	35.0	1.4	0.30	3.0	33.8	1.4	0.36	3.7	32.3	1.4	0.43	4.5	30.6	1.4	0.52	5.5	28.5	1.4	0.61	40
50	-	-	-	-	-	-	-	-	2.4	45.0	1.4	0.38	3.0	43.9	1.4	0.46	3.7	42.4	1.4	0.55	4.6	40.4	1.4	0.67	5.6	38.4	1.4	0.80	6.9	35.7	1.4	0.95	50
63	-	-	-	-	2.4	58.1	1.5	0.48	3.0	56.9	1.5	0.59	3.8	55.2	1.5	0.73	4.7	53.3	1.5	0.88	5.8	51.0	1.5	1.07	7.1	48.2	1.5	1.28	8.6	45.1	1.5	1.50	63
75	-	-	-	-	2.9	69.2	1.6	0.68	3.6	67.7	1.6	0.83	4.5	66.8	1.6	1.03	5.5	63.7	1.6	1.23	6.8	61.0	1.6	1.49	8.4	57.6	1.6	1.79	10.3	53.6	1.6	2.13	75
90	-	-	-	-	3.5	83.0	1.8	0.99	4.3	81.3	1.8	1.20	5.4	79.0	1.8	1.48	6.6	76.5	1.8	1.77	8.2	73.0	1.8	2.16	10.1	69.1	1.8	2.59	12.3	64.5	1.8	3.05	90
110	2.7	104.7	2.2	0.95	4.3	101.3	2.2	1.48	5.3	99.2	2.2	1.80	6.6	96.5	2.2	2.20	8.1	93.3	2.2	2.66	10.0	89.4	2.2	3.20	12.3	84.5	2.2	3.84	15.1	78.6	2.2	4.57	110
125	3.1	118.9	2.5	1.24	4.8	115.4	2.5	1.86	6.0	112.9	2.5	2.30	7.4	109.9	2.5	2.80	9.2	106.1	2.5	3.42	11.4	101.5	2.5	4.16	14.0	96.1	2.5	4.96	17.1	89.5	2.5	5.88	125
140	3.5	133.2	2.8	1.56	5.4	129.2	2.8	2.35	6.7	126.5	2.8	2.87	8.3	123.0	2.8	3.52	10.3	118.9	2.8	4.29	12.7	113.9	2.8	5.17	15.7	107.6	2.8	6.23	19.2	100.2	2.8	7.39	140
160	4.0	152.3	3.2	2.02	6.2	147.6	3.2	3.00	7.7	144.5	3.2	3.77	9.5	140.7	3.2	4.69	11.8	136.9	3.2	5.60	14.6	130.0	3.2	6.78	17.9	123.0	3.2	8.11	21.9	114.7	3.2	9.62	160
180	4.4	171.5	3.6	2.51	6.9	166.3	3.6	3.84	8.6	163.1	3.6	4.74	10.7	158.3	3.6	5.81	13.3	152.8	3.6	7.10	16.4	146.3	3.6	8.58	20.1	138.5	3.6	10.26	24.6	129.1	3.6	12.16	180
200	4.9	190.5	4.0	3.08	7.7	184.6	4.0	4.76	9.6	180.6	4.0	5.87	11.9	175.8	4.0	7.16	14.7	170.0	4.0	8.71	18.2	162.5	4.0	10.57	22.4	153.7	4.0	12.68	27.3	143.4	4.0	15.00	200
225	5.5	214.4	4.5	3.90	8.6	207.9	4.5	5.98	10.8	203.3	4.5	7.42	13.4	197.8	4.5	9.09	16.6	191.0	4.5	11.06	20.5	182.9	4.5	13.39	25.1	173.2	4.5	16.00	30.8	161.3	4.5	19.02	225
250	6.2	238.0	5.0	4.89	9.6	230.9	5.0	7.41	11.9	226.0	5.0	9.08	14.8	220.0	5.0	11.14	18.4	212.4	5.0	13.63	22.7	203.4	5.0	16.46	27.9	192.5	5.0	19.73	34.2	179.2	5.0	23.48	250
280	6.9	266.7	9.8	6.06	10.7	258.7	9.8	9.25	13.4	253.0	9.8	11.46	16.6	246.3	9.8	13.99	20.6	237.9	9.8	17.08	25.4	227.8	9.8	20.64	31.3	215.4	9.8	24.80	38.3	200.7	9.8	29.44	280
315	7.7	300.2	11.1	7.62	12.1	290.9	11.1	11.78	15.0	284.9	11.1	14.40	18.7	276.6	11.1	17.72	23.2	267.6	11.1	21.64	28.6	256.3	11.1	26.13	35.2	242.4	11.1	31.38	43.0	226.1	11.1	37.16	315
355	8.7	338.2	12.5	9.69	13.6	327.9	12.5	14.89	16.9	321.0	12.5	18.28	21.1	312.1	12.5	22.55	26.1	301.6	12.5	27.43	32.2	288.8	12.5	33.16	39.6	273.3	12.5	39.76	48.5	254.6	12.5	47.24	355
400	9.8	380.0	14.0	12.26	15.3	369.5	14.0	18.88	19.1	361.5	14.0	23.31	23.7	351.9	14.0	28.50	29.4	339.9	14.0	34.79	36.3	325.4	14.0	42.10	44.7	307.8	14.0	50.55	54.6	287.0	14.0	59.92	400
450	11.0	428.9	15.6	15.49	17.2	415.8	15.6	23.87	21.5	406.8	15.6	29.49	26.7	396.9	5.6	36.11	33.1	382.4	15.6	44.07	40.9	366.1	15.6	53.31	50.2	346.5	15.6	63.90	61.5	322.8	15.6	75.92	450
500	12.3	476.3	17.5	19.28	19.1	462.0	17.5	29.45	23.9	452.0	17.5	36.37	29.6	439.9	17.5	44.48	36.8	424.9	17.5	54.38	45.4	406.8	17.5	65.78	55.8	385.0	17.5	78.86	POA	POA	POA	POA	500
560	13.7	533.6	19.6	24.00	21.4	517.4	19.6	36.91	26.7	506.4	19.6	45.52	33.2	492.7	19.6	55.89	41.2	475.8	19.6	68.22	50.8	455.8	19.6	82.40	62.5	430.3	19.6	98.93	POA	POA	POA	POA	560
630	15.4	600.4	22.1	30.37	24.1	582.1	22.1	46.77	30.0	569.8	22.1	57.50	37.3	554.4	22.1	70.62	46.3	535.5	22.1	86.23	57.2	512.6	22.1	104.42	70.3	484.1	22.1	125.20	-	-	-	-	630
710	17.4	676.5	24.9	38.65	27.2	656.9	24.9	59.45	33.9	641.9	24.9	73.22	42.1	624.6	24.9	89.62	52.2	603.4	24.9	109.55	64.5	577.6	24.9	132.64	79.3	545.5	24.9	158.13	-	-	-	-	710
800	19.6	762.3	28.0	49.01	30.6	739.2	28.0	75.29	38.1	723.4	28.0	92.80	47.4	703.9	28.0	113.89	58.8	680.0	28.0	138.96	72.5	651.0	28.0	168.11	89.3	615.9	28.0	201.90	-	-	-	-	800
900	22.0	857.8	31.5	61.81	34.4	831.7	31.5	95.23	42.9	813.9	31.5	117.42	53.5	791.7	31.5	144.55	66.2	764.9	31.5	176.04	81.7	732.4	31.5	212.91	-	-	-	-	-	-	-	-	900
1000	24.5	952.9	35.0	76.54	38.2	924.1	35.0	117.50	47.7	904.2	35.0	145.07	59.3	879.8	35.0	178.06	72.5	852.1	35.0	214.41	90.3	814.9	35.0	261.40	-	-	-	-	-	-	-	-	1000
1200	29.4	1143.1	42.0	110.14	45.9	1108.5	42.0	169.18	57.2	1084.7	42.0	208.73	67.9	1052.7	42.0	245.17	88.2	1020.0	42.0	312.54	-	-	-	-	-	-	-	-	-	-	-	-	1200
1400	34.4	1332.6	49.0	150.19	53.2	1293.1	49.0	239.54	66.7	1266.1	49.0	283.64	82.4	1233.1	49.0	346.07	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1400
1600	39.3	1522.3	56.0	195.75	61.3	1476.1	56.0	300.95	76.2	1447.0	56.0	370.23	94.1	1409.4	56.0	451.49	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1600
1800	43.8	1716.0	-	245.95	69.1	1662.8	-	382.16	85.7	1628.0	63.0	468.94	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1800
2000	48.8	1906.4	-	304.41	76.9	1847.4	-	472.24	96.2	1808.9	70.0	578.91	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2000

Note:
1) All dimensions are in millimetres and mass in kg/m.
2) Nominal Diameter (DN) equals outside diamter.
3) These dimensions also apply to THERMAPIPE®.