C5 Rainwater tanks

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C5.0 Technical guidance: rainwater tank systems

C5.1 Introduction

1% AEP detention*	✓
50% and 10% AEP detention*	✓
Detention (SMAF)	✓
Retention	✓
Water quality	✗
*Assuming conveyance (guttering) is sized appropriately	

Rainwater tanks are used to collect and store runoff from roofs, or other impervious areas, such as driveways. They provide a simple at-source stormwater management device but do not provide direct water quality benefits. Tanks are particularly useful in areas where detention is required and may be required in subdivisions where stormwater discharges to a combined sewer[1].

Rainwater tanks may not be used as stormwater mitigation for unconnected impervious areas (such as roads, driveways and carparks).

The volume of water retained in a tank can comprise:

- **Dead storage (permanent water volume):** All rainwater tanks are required to provide a certain permanent water volume at the base of the tank in order to allow for sediment accumulation. This is the volume of water below the lowest outlet in the tank. It is recommended to be set at 150 mm from the base of the tank. This could be decreased to 50 mm, but increased maintenance frequency is then needed
- **Retention:** Water is stored for use in the house or garden. If this system is chosen, the home owner or occupier needs to commit to using the retention volumes within 72 hours (e.g. toilet flushing) so that detention volumes aren't negatively impacted in the next storm event. Appropriate plumbing needs to be installed for reuse of this water inside the house
- **Detention:** Runoff is temporarily stored in the tank prior to slower discharge to a stormwater conveyance system. This detention volume can include larger storm events where a tank can be sized to detain up to a 1% Annual Exceedance Probability (AEP) (with appropriately sized guttering).

Rainwater tank sizing involves determining the volume and orifice placement and orifice diameter for retention and detention purposes:

- **Retention**: 5 mm, 24-hour rainfall event (under Stormwater Management Area – Flow [SMAF] provisions) can be stored as a water supply.
- **Detention:**
  - Detention for stream protection (90th or 95th percentile storms)
  - Detention for flood mitigation (50%, 10% and 1% AEP detention volumes). In these cases, conveyance (such as guttering) must be sized to accommodate the higher flows.

[1] Detention of up to 10% AEP is currently a Watercare Services requirement in areas discharging to combined sewer. These tanks may not be used for in-house reuse.

Storage available for retention and smaller events can also be utilised in routing calculations for larger events (in some instances up to 1% AEP detention).

The focus of this document is stormwater management. For this reason, some considerations are not included in this design guide. This document does not discuss:

- **Tanks designed for potable water use in non-reticulated areas:** While some content is provided on the use of rainwater for on-site use, readers are directed to North Shore City Council Raintank Guidelines[2] or the Countryside Living Toolbox[3] for further information on rainwater tanks designed for potable water use. Subsequently, this document does not take into account reliability of supply, or days of storage, where the primary purpose of a tank is for potable use. Such systems must comply with the Health Act requirements.
- **Underground tank installation:** This document does not provide guidance for design, installation or maintenance of below-ground tanks.

All tank designs must comply with the requirements of the Building Code.

C5.1.1 Use in a treatment suite

Rainwater tanks are an at-source device and are generally sited on private property for detention and retention purposes. They are an important device for attenuating flows into any devices located in lower portions of the catchment.

C5.1.2 Rainwater tank system components

Rainwater tank components are presented in Table 60 and Figure 30 and may be designed for different purposes (Table 61).

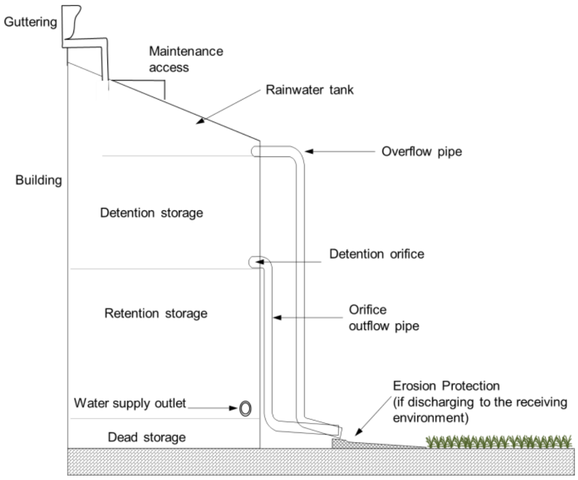

Figure 30: Key components of the rainwater tank system

[2] A key reference for this section is North Shore City Council, 2009, *North Shore City Raintank Guidelines - Second Edition*

[3] Rodney District Council and Waitakere City Council. *The Countryside Living Toolbox - Stormwater Management Device Design Details*. 2010. ISBN978-1-877540-65-3

Table 60: Rainwater tank system key components

Component	Description
Tank	• This is an impermeable structure which holds: ○ Dead storage - water not used or discharged and must be inspected and cleaned out to remove sediment build-up ○ Retention volume (optional) - volumes used on-site ○ Detention volume - water discharged into the primary conveyance over time.
Detention orifice	• This orifice discharges the detention volume into the receiving environment, or primary conveyance system.
Water supply outlet	• The outlet for water reuse, either in the household or on-site (e.g. gardening).
Access hatch	• Periodic maintenance is needed to remove sediments from the base of the tank. Safe access should be designed for (e.g. confined space and working at heights).
Guttering	• Provides conveyance from the roof into the tanks.
Overflow orifice and pipe	• The orifice and piping which discharges volumes greater than the detention volume into the receiving environment, or the primary conveyance system.
Erosion protection	• Needed to mitigate potential scour from high water velocities if the tank discharges into the receiving environment.

Table 61: Typical tank types and features for stormwater management

Tank type	Purpose	Added features	Usual capacity
Detention tank	• Reduces the peak flow of stormwater leaving a site to meet downstream stormwater infrastructure capacity constraints. • Usually used in urban areas.	• Controlled small diameter orifice regulates discharge.	>1,000 L
Dual purpose rainwater tank	• These tanks are divided into two sections – above and below a small diameter orifice; the lower volume is for retention; the upper volume is for detention. These tanks reduce: ○ The volume of stormwater from smaller events ○ The peak flows from less frequent larger events ○ Demand for potable water from the Auckland Council water supply system by providing an on-site source for households.	• Plumbing for toilet flushing and laundry supply • Can also be used for other non-potable purposes such as garden watering and car washing.	4,500 to 50,000 L

C5.1.3 Site considerations

Selected site considerations are presented in Table 62.

Table 62: Site considerations

Item	Description
Location	• Tanks should be located to allow the hard surface to drain to the tank via gravity. The location should be on stable, flat soils with no ponding. • The tank foundation must be structurally sound to support the weight of a full tank. • The tank must be located so it is sited safely (clear of overhanging branches, placed on stable soils etc.) and have easy and safe access for maintenance, especially where there is a small orifice which requires regular inspection. • Rainwater tanks should not be placed inside the drip-line of a tree canopy as root growth can damage the tank and the tree's health may be affected if rain cannot get to the roots or if the roots are disturbed. • Tanks should be placed on the southern side of a building wherever possible to reduce exposure to sunlight. Presence of buried services needs to be assessed.
Soils	• Slope, retaining requirements and groundwater must all be considered. • The tank stand or base must be able to carry the combined weight of the tank and water when it is full. • Special design by a geotechnical engineer is required in geotechnically unstable areas or close to a retaining wall or on slopes (within a 45° angle from the base of the wall).
Runoff quality	• Tanks must be directly connected to the impervious area and therefore, generally collect water from roof areas, decks or paved areas. • The impervious surface should not discharge paint, metals or other contaminants. • Leaf litter and other organic material should be prevented from entering the tank (refer to Section C5.2.4). Gutter filters are needed.

C5.2 Rainwater tank design

C5.2.1 Design considerations

Table 63 provides the design considerations for rainwater tanks systems.

Table 63: Rainwater tank system design considerations and specifications

Item	Requirements
Impervious area draining to tank	• The catchment area relates to the impervious area draining to the tank only (i.e. excludes offset mitigation). • The roof must be above the overflow level of the tank to allow stormwater to flow into the tank under gravity.
Tank	• The tank must be impermeable, durable (25+ years for private, 100+ years for those vested to Auckland Council), located on suitable, stable and level soils and be gravity-fed. • Detention tank sizes must be >1,000 L. • Dual purpose retention and detention volumes must be sized as described in Section C5.2.3. • All tanks must have a dead storage volume (the recommended minimum is 150 mm depth from the base of the tank).
Detention orifice	• The minimum orifice diameter must be 10 mm to minimise the chance of clogging. The orifice must be sized to discharge detention volumes over 24 hours (as described in Section C5.2.3.2).
Water supply outlet	• Retention volumes must be used on site within 72 hours. This connection must comply with all regulations pertaining to water reuse.
Maintenance access	• All tanks must allow access for maintenance and cleaning with consideration for safety (e.g. confined space and working at heights). • Reasonable and safe access to the interior of the tank must be provided for inspection and maintenance purposes and due consideration given to how to collect and dispose of sediment. • Refer to AS/NZS 2856 "*Safe working in confined spaces*".
Guttering	• Guttering should be sized for conveyance of the storm event designed for retention and detention volumes. Excess to this sizing should bypass the tank. • Primary screening devices (~6 mm wire mesh) should be placed close to the downspout to prevent the entry of leaf litter. • A first flush diversion may also be included to improve the quality of water entering the tank.
Overflow orifice and pipe	• The overflow pipe outlet must be lower than the roof and there must be sufficient fall for the water to flow into the tank at the designed discharge rate.
Cover	• A secure, tight-fitting top cover is needed to prevent evaporation, mosquito breeding and to keep insects, rodents, birds or people from entering or falling into the tank.
Pipe work	• All plumbing must comply with the relevant New Zealand standards. • Backflow prevention measures must be included if water is being plumbed to the house. Pipe work should be minimised by locating the tank as close to the roof as possible.

Item	Requirements
Tank height	• Above-ground tanks that are located close to a boundary should be less than 1.8 m in height.
Outlet	• The outlet of the tank must be located above the level of the stormwater reticulation, or other proposed receiving environment into which it will discharge. • An approved connection point to the primary stormwater system should be identified. • Discharge from rainwater tanks must not result in flows onto adjacent properties (causing nuisance or flooding). • Erosion protection must be provided at all outlets entering the receiving environment.
Private connection	• Connection must comply with the Building Code and include backflow prevention. • Conveyance (guttering) must be sized for largest designed event.
Vector control	• Tanks should have adequate ventilation. • Vents must have screens to prevent mosquitoes and other insects entering the tank.

C5.2.2 Design for safety

It is the designer's obligation to identify hazards throughout the life of the rainwater tank system and take all reasonable steps to eliminate them in the design process. Some safety considerations for rainwater tanks include:

Safe access

- Safe access into the tank for inspection and maintenance should be designed for; noting that entry into any water tank is considered to be confined space entry
- Access to the tank should be within safe and easy reach for maintenance (including sediment removal), renewal and decommissioning
- There should be some access to guttering and pipework for inspection and maintenance.

Fall prevention

- Access into and out of the tank should be managed to prevent falls
- Guttering may get clogged reducing water flows into the tank and may require periodic cleaning. Fall prevention measures should be in place to reduce risk during this maintenance.

C5.2.3 Device sizing

This section presents two different approaches for rainwater tank design:

- **Simplified method:** Designed for use by plumbers and drainlayers who might purchase off-the-shelf tanks for retrofits or small subdivisions requiring some on-site stormwater mitigation. Rainwater tank sizing methods are provided as graphs which determine detention and retention volumes, as well as orifice sizing and location

- **Calculation-based**: Designed for use by design engineers who provide rainwater tanks for complex designs (such as commercial installations or subdivision developments) requiring detention devices needed for the provisions under the Auckland Unitary Plan.

With either method, a number of parameters need to be determined, including:

- The total impervious area to be mitigated
- The impervious area that the rainwater tank will service
- The allowable ground area for the tank installation
- The purpose of the tank (detention, non-potable reuse etc.) and the volume of water the tank will need to store
- Local rainfall patterns: For the simplified method presented in this section, a number of rainfall averages have been used for the range of conditions in the Auckland region. Methods for assessing rainfall are presented in Section B.

Determine the rainfall in your area

Using the maps provided in Section B of this document, determine estimated rainfall in your area. The 24-hour rainfall depth is required to determine hydrology mitigation requirements:

- SMAF 1 – use 95th percentile rainfall depth
- SMAF 2 – use 90th percentile rainfall depth.

Rain tanks may also be sized to detain water from larger events (e.g. 50%, 10% and 1% AEP).

Measure connected impervious area

The total impervious area discharging to the tank must be calculated on the horizontal plane. Multiple tanks may be installed to provide the required mitigation from segmented areas. Only the area draining to the tank should be included in the connected area calculation (Figure 31).

The connected impervious area discharging to the tank should be increased such that the achievable captured runoff volume is equal to, or greater than, the required total hydrology mitigation volume (detention and retention).

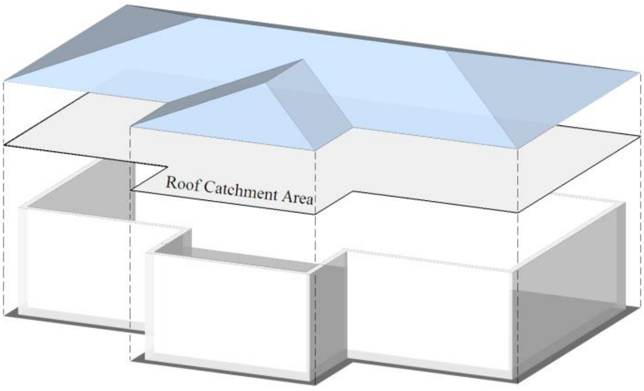

Figure 31: Illustration of impervious catchment area measurement in horizontal plane

C5.2.3.1 Device sizing - simplified method

The simplified method is designed for rapid assessment of tank needs; this may include a household retrofit where a plumber or drainlayer is asked to provide a tank size for retention and detention use. The data are presented as graphs developed for different rainfall events, and roof areas.

Two different tank designs are provided:

- Detention only tanks
- Dual-purpose tanks – for retention (reuse) and detention.

C5.2.3.1.1 Detention tank design

Detention tanks capture and slowly release stormwater runoff from hard surfaces so that the peak flows leaving the site after development are no more than those that would occur pre-development. Detention tanks can be designed to mitigate peak flows for a range of rain events, but are generally not suitable for controlling rainfall events greater than the 10% AEP event because of the limited capacity in the guttering and stormwater reticulation.

Step 1 - Determine the runoff volume into rainwater tank

This is the volume that can be captured by the rainwater tank across the 24-hour rainfall period, given the size of the connected impervious area. To capture a greater runoff volume, the connected area should be increased (Figure 32 and Figure 33). For ease of use (should the user need a value that lies outside of these graphs), the volume can be calculated using rainfall depth multiplied by the roof area, using Equation 14. It should be noted that this simplified method is more conservative than that provided in the calculation method (which uses the TP108 method).

$$V_{(det)} = V_{(total)} = \frac{A_{(connect)} \times \text{rainfall depth}}{1000} \qquad \text{Equation 14}$$

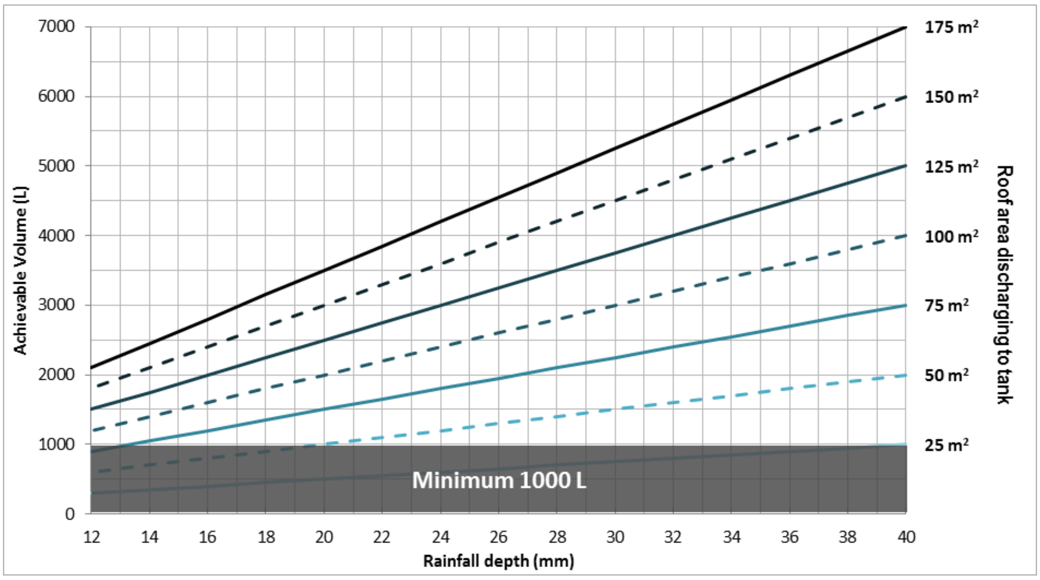

Figure 32: Total detention volume for impervious surface area 25 m² to 175 m² based on rainfall depth and connected area (for detention tank)

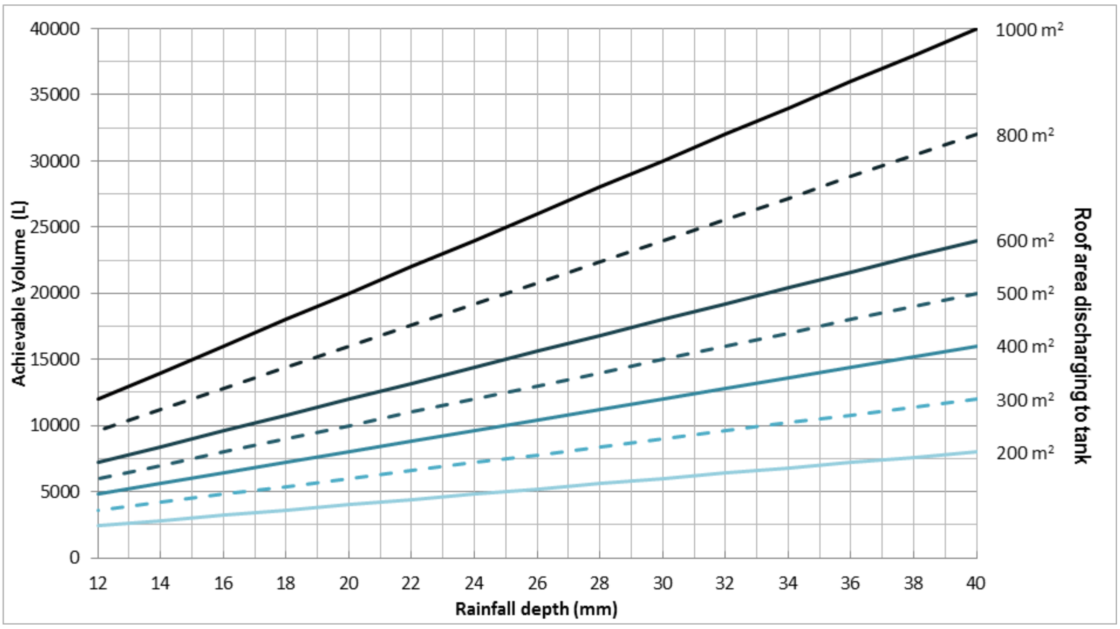

Figure 33: Total detention volume for impervious surface area 200 m² to 1000 m² based on rainfall depth and connected area (for detention tank)

The runoff volume is the volume contained between the small orifice at the bottom of the tank and the level of the overflow. For detention tanks, this corresponds to the total detention volume.

Step 2 – Determine appropriate tank size

The detention tank should be sized to hold the entire achievable detention volume, including a recommended minimum 150 mm of dead storage below the level of the small orifice to allow for sediment build-up. A minimum tank size of 1 m^3 (1,000 L) should be used.

Step 3 – Identify tank depth

This is the height between the centre of the outlet orifice and the overflow level (as specified by the tank manufacturer). It is important to ensure that the level of the detention orifice allows it to drain into the stormwater reticulation (or other proposed outfall).

Step 4 – Determine orifice size

The orifice size depends on tank volume and tank depth. The orifice in a detention tank acts to detain the water flow for slow release over a 24-hour period.

For the simplified method, an orifice diameter of 10 mm should be used.

C5.2.3.1.2 Dual purpose tank design

Dual-purpose rainwater tanks combine the benefits of rainwater retention for non-potable purposes and detention into a single rainwater tank.

This approach has been developed to simplify the design of dual-purpose rainwater tanks for typical residential developments by providing standard minimum rainwater tank volumes which are acceptable to meet the mitigation requirements for specific impervious areas.

Step 1- Determine the runoff volume into rainwater tank

Refer to Step 1 for detention tanks (using Figure 32 and Figure 33 or Equation 14).

For dual-purpose tanks, this volume is divided into retention and detention.

Step 2 - Allocate runoff volume

The runoff volume should be allocated to retention and detention volumes to meet required hydrology mitigation requirements.

For example, with a total runoff volume of 5 m^3, and required retention and detention volumes of 2.5 m^3 and 4.2 m^3 respectively, 2.5 m^3 can be used to achieve retention with the remaining 2.5 m^3 used for detention. This leaves an outstanding detention volume of 1.7 m^3 to be achieved by other means. Alternatively, the connected impervious area can be increased to achieve a greater runoff capture volume.

Step 3 - Determine appropriate tank size

The tank must have sufficient capacity for both retention and detention volumes to sit above the dead storage height. The tank diameter and height can be identified as per the tank manufacturer’s specifications. The tank height refers to the height between the water-use outlet (or dead storage) and the overflow level.

Step 4 – Determine detention orifice height

The orifice invert is positioned above the retention volume and can be determined using Figure 34 and Figure 35.

If retention volume is greater than 6 m^3, the orifice height should be at least one-third of the height.

Step 5 - Determine detention orifice size

For the simplified method, an orifice diameter of 10 mm should be used.

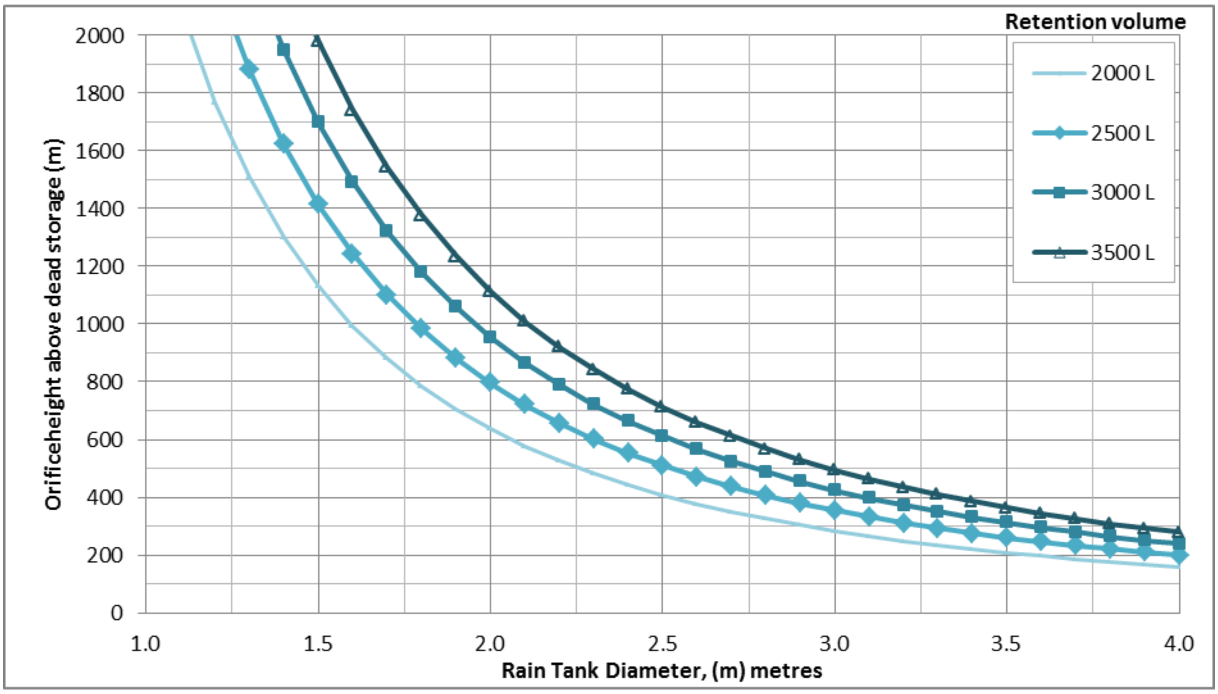

Figure 34: Orifice height for dual-purpose tanks, retention volume from 2000 L to 3500 L

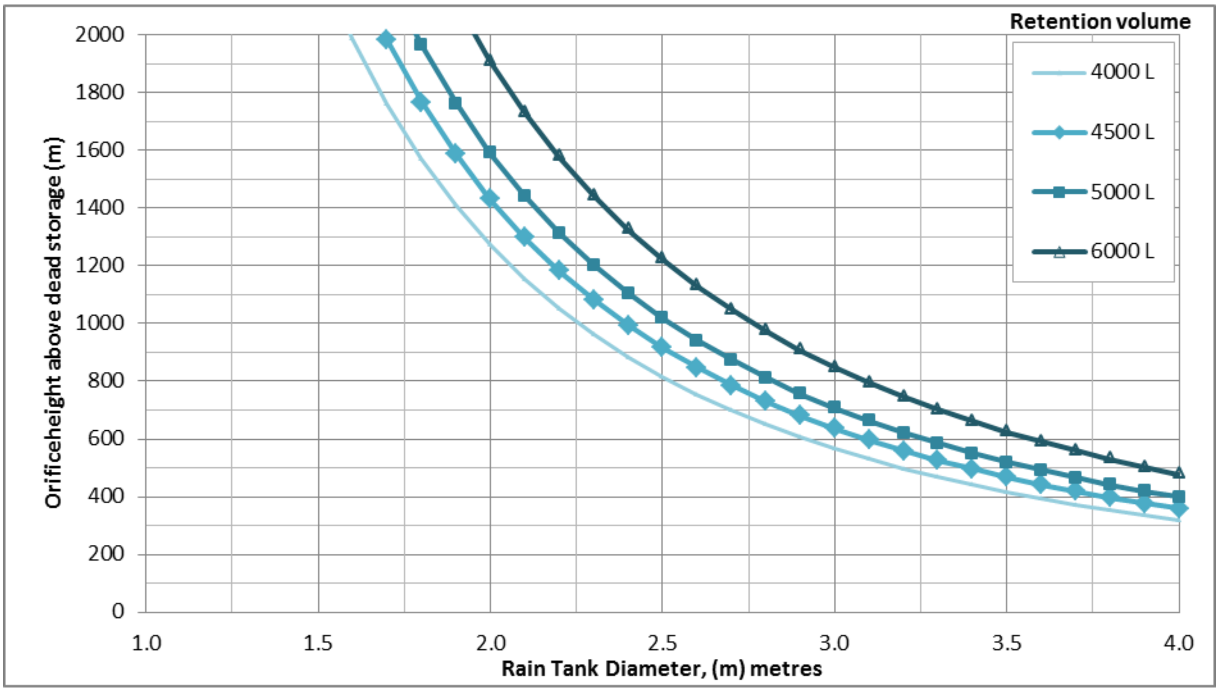

Figure 35: Orifice height for dual-purpose tanks, retention volume from 4000 L to 6000 L

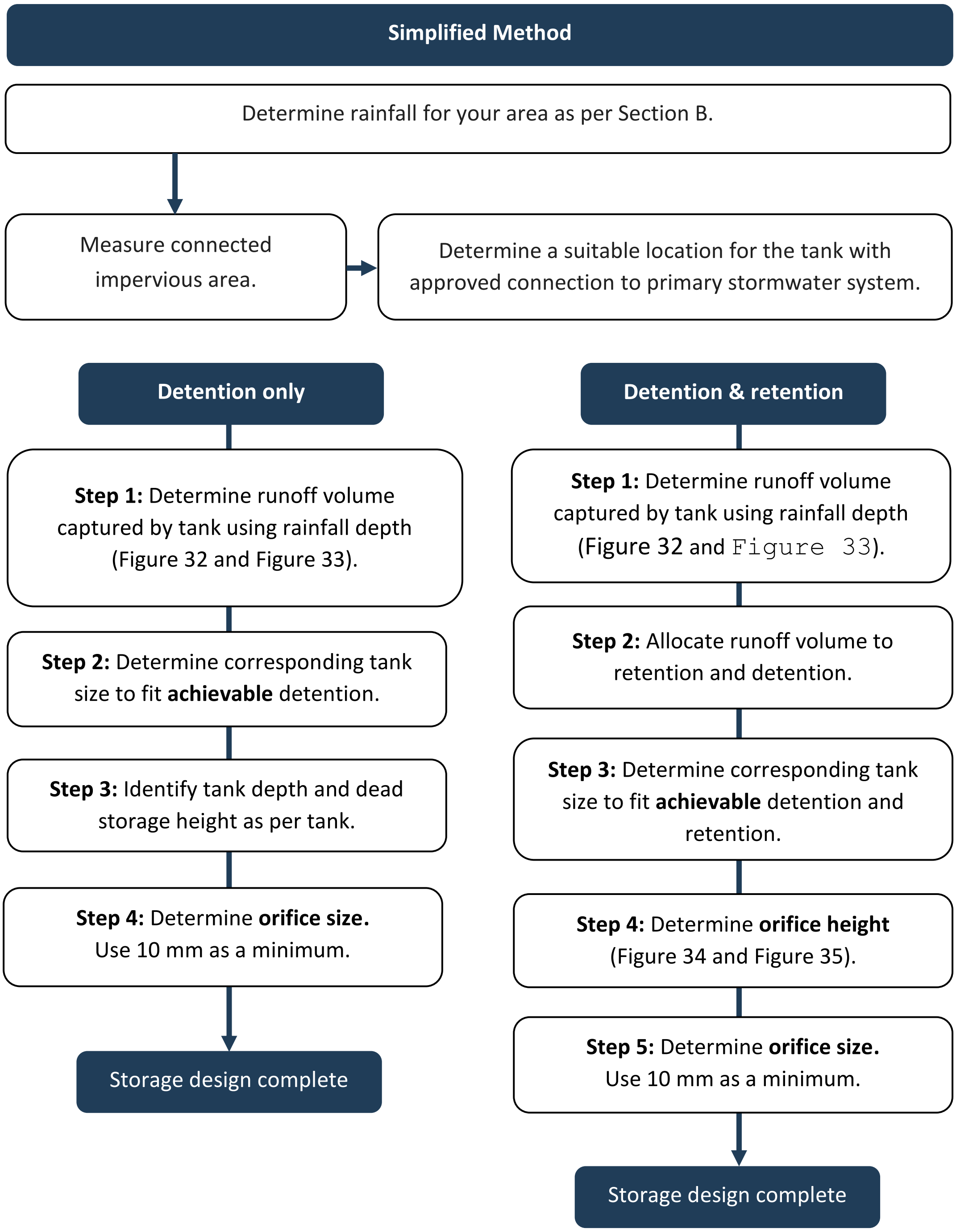

Figure 36: Flow diagram of design process using simplified method

C5.2.3.2 Device sizing – Calculation method

This method is provided for design engineers and is most likely to be useful where large-scale developments require detention. The different tank parameters are presented in Figure 37 and Table 64.

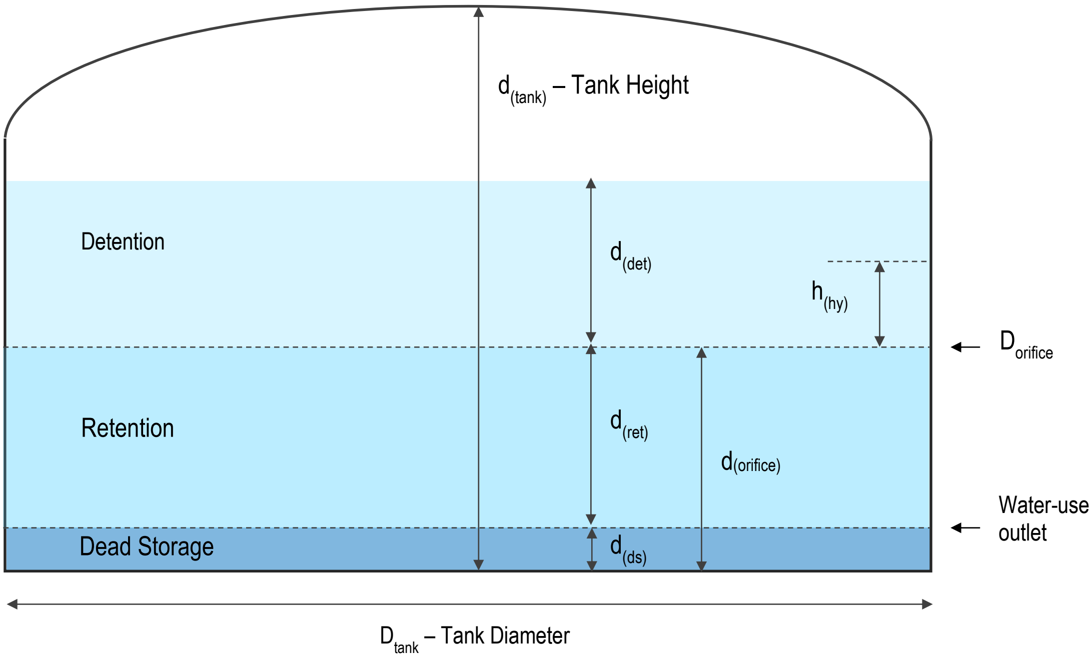

Figure 37: Illustration of tank parameters

Table 64: Tank dimension parameters

Parameter		Ref	Parameter		Ref
Total runoff volume into rainwater tank	m^3	$V_{(total)}$	Required hydrology mitigation volume	m^3	-
Allocated retention volume	m^3	$V_{(ret)}$	Required retention volume	m^3	-
Allocated detention volume	m^3	$V_{(det)}$	Required detention volume	m^3	-
Connected impervious area	m^2	$A_{(connect)}$	Tank base area	m^2	$A_{(tank)}$
Average discharge rate	m^3	$Q_{(avg)}$	Hydraulic head	m	$h_{(hy)}$
Discharge coefficient (0.62)	-	μ	Gravity (9.81 m/s^2)	m/s^2	g

C5.2.3.2.1 Design event/s

Hydrology mitigation requirements (retention and detention volumes) should be calculated prior to commencing with the calculation-based method (using the TP108 method provided in Section B).

C5.2.3.2.2 Detention tank design

The general design guidelines for an upright cylindrical detention tank are as follows:

Step 1 – Calculate the achievable runoff into rainwater tank – $V_{(tot)}$

Use the methodology provided in Section B1.7.1 (using TP108 method) to calculate the total runoff, and retention and detention volumes from the impervious area.

Step 2 - Calculate tank height - $d_{(tank)}$

Once the runoff volume is determined, the required storage height can be calculated using the tank area.

$$d_{(det)} = \frac{V_{(det)}}{A_{(tank)}}$$ **Equation 15**

$$A_{(tank)} = \pi \times \left(\frac{D_{(tank)}}{2}\right)^2$$ **Equation 16**

As a general guideline, tanks should have a dead storage (recommended as 150 mm from the base of the tank). The total depth of tank ($d_{(tank)}$) should be at least the sum of the dead storage ($d_{(ds)}$) and the storage height for the detention volume ($d_{(det)}$).

$$d_{(tank)} = d_{(det)} + d_{(ds)}$$ **Equation 17**

Step 3 - Calculate average discharge rate - $Q_{(avg)}$

The required detention should be released over 24 hours. This will provide a discharge rate as (Equation 18).

$$Q_{(avg)} = \frac{V_{(det)}}{86400\ s}$$ **Equation 18**

Step 4 - Calculate orifice diameter - $D_{(orifice)}$

Using the average discharge rate and the tank height, the area of the orifice ($A_{(orifice)}$) can be calculated as (Equation 19), with hydraulic head ($h_{(hy)}$) calculated using Equation 20. The orifice diameter is then determined from the required orifice area (Equation 21). When sizing the orifice, a minimum orifice diameter of 10 mm is required.

$$A_{(orifice)} = \frac{Q}{\mu \times (2g \times h_{hy})^{0.5}}$$ **Equation 19**

$$h_{(hy)} = \frac{d_{(det)}}{2}$$ **Equation 20**

$$D_{(orifice)} = 2 \times \left(\frac{A_{(orifice)}}{\pi}\right)^{0.5}$$ **Equation 21**

C5.2.3.2.3 Dual purpose tank design

In situations where both retention and detention are required, the outlet/orifice locations are:

- Retention outlet: At dead storage height
- Detention orifice: At water storage height for retention.

Step 1 – Calculate the achievable runoff into rainwater tank – $V_{(tot)}$

Use 90th or 95th percentile rainfall (based on SMAF zone) and TP108 to calculate the achievable detention volume.

Step 2 - Allocate runoff volume

The runoff volume should be allocated to retention and detention volumes to meet required hydrology mitigation requirements.

For example, with a total runoff volume of 5 m^3, and required retention and detention volumes of 2.5 m^3 and 4.2 m^3 respectively, 2.5 m^3 can be used to achieve retention with the remaining 2.5 m^3 used for detention. This leaves an outstanding detention volume of 1.7 m^3 to be achieved by other means. Alternatively, the connected impervious area can be increased to achieve a greater runoff capture volume.

Step 3 – Calculate tank diameter - $D_{(tank)}$

The tank diameter, $D_{(tank)}$, can be determined either:

- By the tank dimensions, or
- By the ground area.

It is important to note that these calculations are based on a cylindrical tank. The tank base area ($A_{(tank)}$) can then be calculated with Equation 16.

Step 4 – Calculate orifice height – $d_{(orifice)}$

The detention orifice is situated above the water storage height for retention. This height can be calculated using the tank base area ($A_{(tank)}$).

$$d_{(ret)} = \frac{V_{(ret)}}{A_{(tank)}}$$ **Equation 22**

$$d_{(orifice)} = d_{(ret)} + d_{(ds)}$$ **Equation 23**

As a general guideline, all tanks should have a 150 mm depth for dead storage ($d_{(ds)}$).

Step 5 - Calculate detention storage height – $d_{(det)}$

$$d_{(det)} = \frac{V_{(det)}}{A_{(tank)}}$$ **Equation 24**

Step 6 – Calculate orifice diameter - $D_{(orifice)}$

The allocated detention volume should be released over 24 hours. This will provide a discharge rate as:

$$Q_{(avg)} = \frac{V_{(det)}}{86400\ s}$$ **Equation 25**

Using the average discharge rate and the tank height, the area of the orifice ($A_{(orifice)}$) can be calculated as (Equation 26), with hydraulic head ($h_{(hy)}$) calculated using Equation 27. The orifice diameter is then determined from the required orifice area (Equation 28).

$$A_{(orifice)} = \frac{Q}{\mu \times (2g \times h_{hy})^{0.5}}$$ **Equation 26**

$$h_{(hy)} = \frac{d_{(det)}}{2}$$ **Equation 27**

$$D_{(orifice)} = 2 \times \left(\frac{A_{(orifice)}}{\pi}\right)^{0.5}$$ **Equation 28**

A minimum orifice diameter of 10 mm is required.

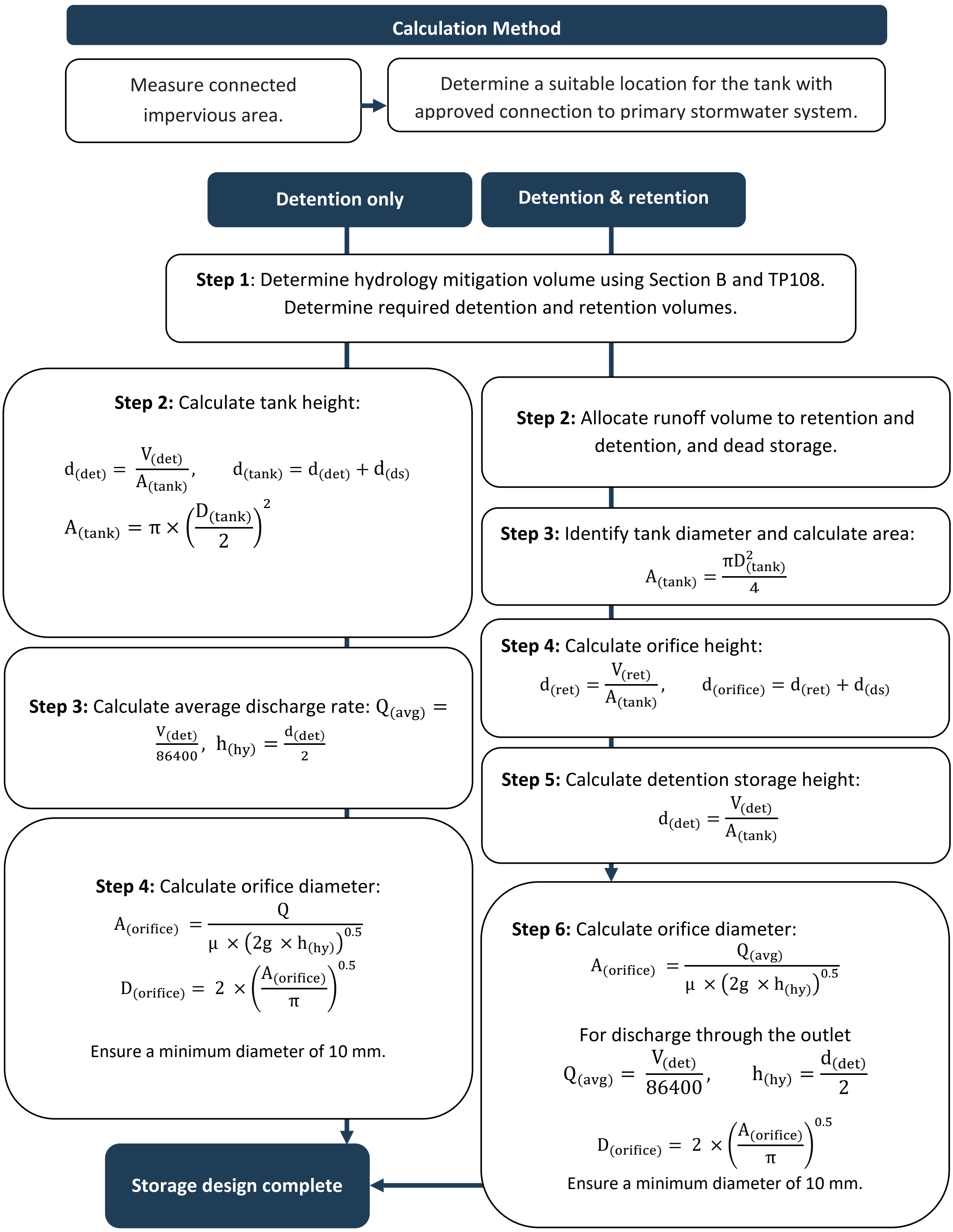

Figure 38: Flow diagram of design process using calculation method

C5.2.4 Component design

All plumbing and pipework must be installed by a registered or certified plumber or drain layer and comply with the Building Code.

C5.2.4.1 Outlet mesh screens

With a minimum detention outlet orifice size of 10 mm, there is potential for clogging; all orifices should be protected from clogging by using mesh screens (Figure 39). Designers should consider the following when choosing the mesh screen:

- The mesh opening must be substantially smaller than the outlet opening to ensure that all particles that pass through the mesh can be flushed through the outlet
- It is important to design the mesh screen large enough to ensure that the flow capacity of the mesh screen is a magnitude higher than the design outlet capacity.

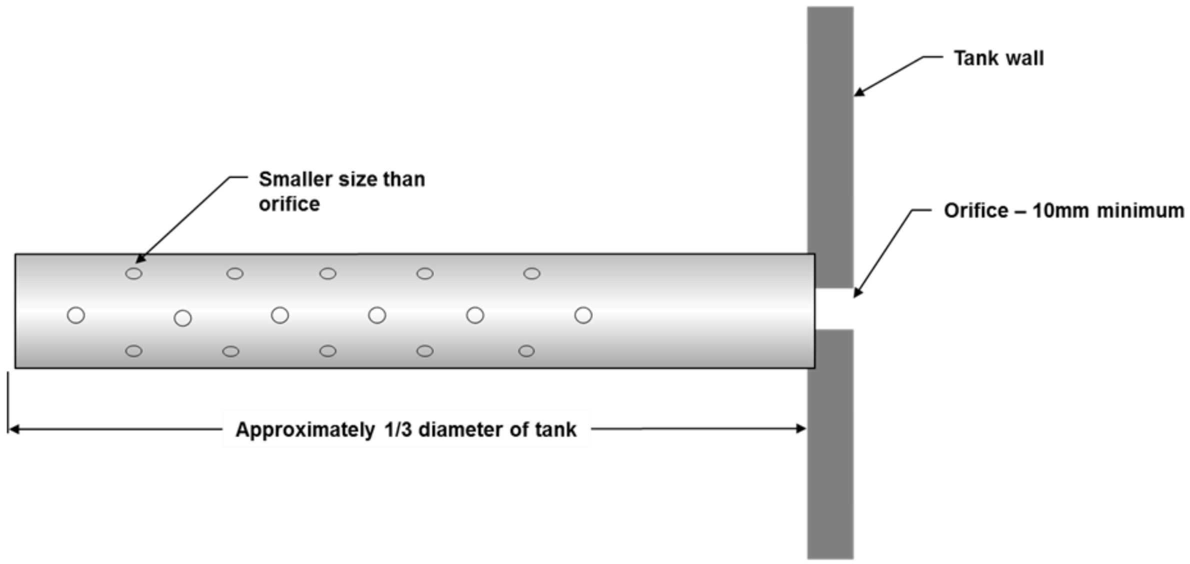

Figure 39: Outlet mesh screen

C5.2.4.2 Between the roof and tank

Additional considerations should include:

- **Plumbing pipes and fittings:** These should be light-proof to minimise daylight penetration and algal growth in the water
- **Gutter connections:** Guttering should be sized for conveyance of the design storm event. Attention needs to be paid to the potential presence of standing water and associated vectors. Fitting gutter outlets on the underside of the roof gutter is recommended to minimise sludge build-up and water retention in the gutter
- **Gutter screens:** Fitting of gutter screens is recommended to prevent a build-up of debris in the gutters

- **Litter diverters:** In-line leaf and debris diverters should be fitted to downpipes to improve water quality, reduce the risk of orifice blockage and reduce tank maintenance requirements
- **First flush diverter:** A 'first flush' device to divert the first portion of roof run-off from the rainwater tank will help to improve water quality
- **Flow diverters:** The installation of flow diverters in the downpipes is recommended to prevent dirty water from entering the tank when cleaning gutters
- **Vector screens:** Should be fitted to all tank openings
- **Sediment traps and inlet controllers:** Discharge of water into the tank in a manner which does not stir up the sediment which has collected at the bottom of the tank
- **Inlet controllers:** These control flows into the tank and reduce the risk of sediment re-suspension.

C5.2.4.3 Between the tank and building

This section applies in all instances where rainwater is collected for use in the house. All aspects of this section should be undertaken or reviewed by a certified plumber.

Considerations include:

- **Power supply**
- **Pump flow rate:** Selection of flow rate is important and differs between applications
- **Pressure:** The pressure to the most disadvantaged fixture outlet (the highest and/or farthest from the pump) needs to be calculated. The minimum pressure should not be less than 50 kPa and the maximum pressure in the system should not exceed 500 kPa
- **Constant or variable pressure:** Variable pressure systems usually work between 140-280 kPa or between 210-345 kPa and rely on a pressure vessel. This means that when a tap is turned on, water is supplied from the pressure vessel and the pump only starts when the pressure drops below 140 kPa and then shuts off again once the pressure reaches 280 kpa. This reduces the number of times the pump starts; however the pressure vessel requires periodic maintenance. Constant pressure systems rely on a special pressure control valve and every time a tap is opened, and the pressure drops, the pump starts, and it shuts off when the tap is closed. To work out which system is best suited to your situation, it is best to speak to a professional pump dealer
- **Type of pump**: Dry pumps are located outside the tank, while submersible pumps are located inside the tank. A number of factors should be considered including whether the tank is above or below ground, access for maintenance, noise and cost
- **Pump noise:** Minimising the noise of the pump is important. This can include installing a submersible pump, locating it as far away as possible from frequently used living spaces and neighbours, installing an acoustic enclosure or fencing (while still allowing access and ventilation)
- **Water supply outlet:** it is recommended that the water supply outlet be located at least 150 mm above the bottom of the tank to allow for silt build-up in the tank. The outlet can be fitted with a floating inlet that floats 50 mm below the surface of the water in the tank. If a submersible pump is used, then a water supply outlet is not required to be fitted to the tank

- **Filtration**: The need for filters will depend on the use of the harvested rainwater, level of contamination on the roof, other interventions employed and sensitivity of the fixtures. Filtration (together with regular maintenance) is recommended if the water is to be used for potable purposes. They should be easily accessible and well labelled, with spare cartridges available
- **Signage**: Certain signage may be required (e.g. where water is not suitable for drinking, where a backflow device is installed, and where a filter is installed).

C5.2.4.4 Plumbing and pipework between the tank and outfall

This includes the pipework, overflow and orifice outlets which facilitate the flow of water from the tank to the stormwater outfall. Dual-purpose rainwater tanks and detention tanks have both overflows and small diameter orifices, whereas water supply and single-purpose rainwater tanks only have overflows.

Design considerations for the pipework between the tank and stormwater outfall include:

- All plumbing and pipework must be installed by a registered drain layer. This work requires a building consent
- Rainwater discharged from the tank via the overflow and/or orifices must be directed to an approved local stormwater collection system
- Locate the top overflow pipe to maximise the tank's volume
- Install inspection caps on small-diameter orifice discharge pipes to allow for inspection and cleaning
- Prevent backflow into the tank from the stormwater system. This is especially important for below-ground tanks
- Provide vector screens on overflow where appropriate
- Provide erosion control for any areas where water will discharge from the tank and pipework system.

C5.2.5 Construction design considerations

The following construction considerations should be addressed during design and specification:

- The tank should be durable, watertight, opaque with a clean, smooth exterior with a tight fitting top
- The tank should be installed in a way that protects existing infrastructure
- The tank should be installed in a way that protects existing soils and vegetation, including:
  - The drip line of surrounding trees
  - Ensuring soil stability is not changed through construction works
- Installation must comply with regulated setbacks from buildings, structures and boundaries
- Care should be taken to ensure the tank retains imperviousness during installation
- The edges of the orifice should be strengthened to prevent fraying.

C5.2.6 Operation and maintenance design considerations

The following operation and maintenance considerations should be addressed during design and specification. It is essential that appropriate access is provided to all components of the rainwater tank system to enable regular inspection and maintenance (at least annually) to be carried out with the minimum of effort. Regular maintenance is essential to ensure on-going, trouble-free operation of the system and to ensure good water quality.

These considerations include:

- Providing inspection points and access to:
    - All below-ground components, including wet-system pipes
    - Any float valve for the backup water supply so that any overflows are visible, and failure of the valve can be easily detected
    - The small diameter orifice, so that it can be inspected and cleaned even when the tank is full.
- Providing easy access to:
    - The tank (and ensuring the tank is secure from unauthorised access)
    - Pre-screening devices (e.g. gutters screens, in-line leaf and debris diverters, first flush diverters and sediment traps etc.)
    - The pump with sufficient room to enable the pump to be removed and replaced
    - Any backflow devices
    - In-line filters.
- Providing easy-to-follow instructions close to the pump which explain the step-by-step procedure required for pump priming (where required).

C5.3 Design examples

C5.3.1 Large rainwater tank to meet SMAF 1 criteria – calculation method

A large community hall is required to meet SMAF 1 hydrology management criteria. Both retention and detention requirements will be met with a rainwater tank. The total connected impervious area is 80% of the 800 m^2 roof area (the other 20% is mitigated through other means). Assumed rainfall is 35 mm.

Step 1 – Determine hydrology management requirements

Using the method described in Section B and TP108 methods, the following volumes are calculated:

Parameter		Value	Unit
Hydrology management volume	(V_{total})	14.7	m^3
Retention volume	(V_{ret})	3.2	m^3
Detention volume	(V_{det})	11.5	m^3

The difference in pre- and post-runoff volumes is **14.7 m^3**. This volume should be entirely mitigated through retention (3.2 m^3 to be used on-site over 72 hours) and detention (11.5 m^3 over 24 hours).

Step 2 – Determine tank dimensions

The total tank volume should be at least **14,700 L**. The next larger available tank size is 15 m^3 or 15,000 L. The diameter of the tank is 3.5 m ($D_{(tank)}$), with height ($d_{(tank)}$) is 2.0 m.

The tank area (A_{tank}) $= \frac{1}{4}\pi D^2$ = 9.6 m^2

Step 3 – Determine detention orifice height

The retention orifice is pre-installed at 150 mm for dead storage ($d_{(ds)}$). The detention orifice height should be calculated as shown:

Parameter	Calculation or selection method	Value	Unit
Detention orifice height	$d_{(orifice)} = \frac{V_{(ret)}}{A_{(tank)}} + d_{(ds)} = \frac{3.2}{9.6} + 0.15$	0.483	m

Step 4 - Determine detention orifice size

The orifice should be designed to release the detention volume over a 24-hour period. From the calculations below, the orifice size is 8.8 mm; this is less than the 10 mm minimum orifice diameter. Therefore, an orifice diameter of 10 mm should be used.

Parameter	Calculation or selection method	Value	Unit
Average discharge rate	$Q_{(avg)} = \frac{V_{(det)}}{24 \times 60 \times 60} = \frac{11.5\ m^3}{86400\ s}$	0.00013	m^3/s
Head above detention orifice	$d_{(det)} = \frac{V_{(det)}}{A_{(tank)}} = \frac{11.5\ m^3}{9.6}$	1.2	m
Average hydraulic head	$h_{(hy)} = \frac{d_{(det)}}{2} = \frac{1200}{2}$	0.6	m
Orifice area	$A_{(orifice)} = \frac{Q_{(avg)}}{\mu \times (2g \times h_{(hy)})^{0.5}} = \frac{0.00013\ m^3/s}{0.62 \times (2 \times 9.81 \times 0.60)^{0.5}}$	6.11×10^{-5}	m^2
Calculated orifice diameter	$D_{(orfice)} = 2 \times \left(\frac{A_{(orifice)}}{\pi}\right)^{0.5} = 2 \times \left(\frac{6.26 \times 10^{-5}}{\pi}\right)^{0.5}$	0.0088	m
Required orifice size	8.8mm < minimum orifice size 10mm, use:	10	mm

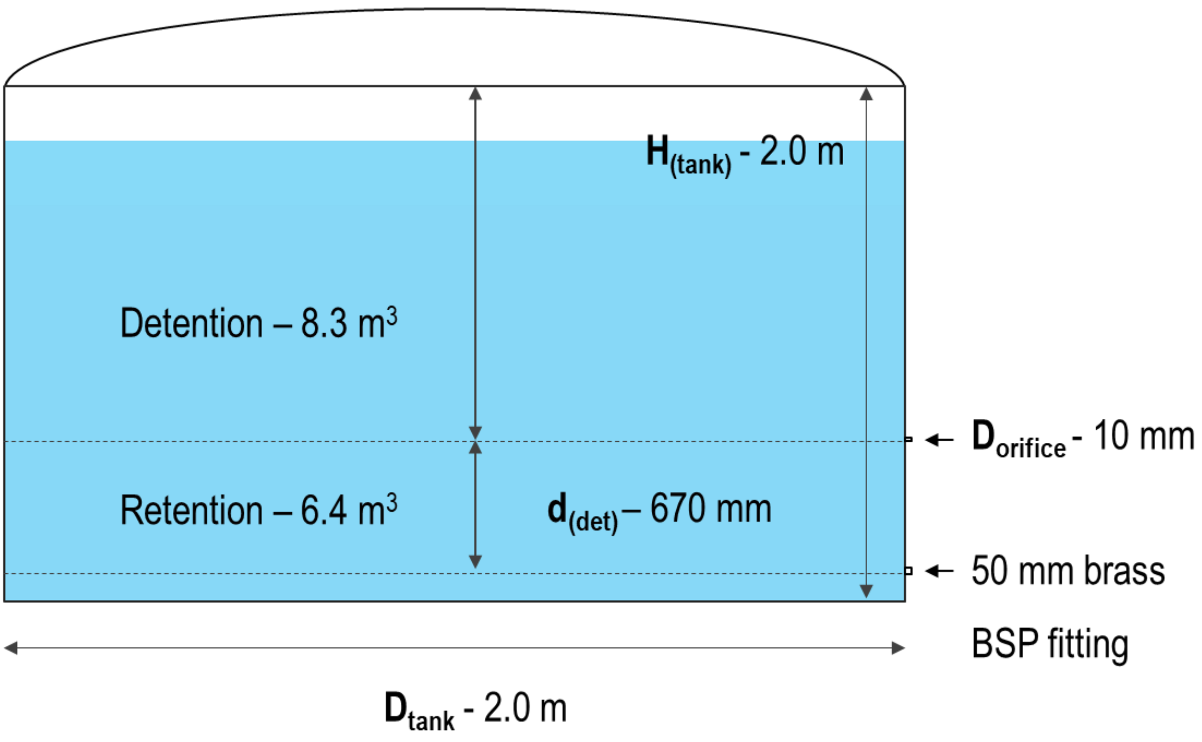

Figure 40: Rainwater tank specifications for mitigation of 800 m^2 roof (15000 L)

C5.3.2 Residential rainwater tank to meet SMAF 2 criteria – simplified method

A small residential development is required to meet SMAF 2 hydrology management criteria. Both retention and detention requirements will be met with a rainwater tank. The total roof area is 500 m^2, with 80% connected to the rainwater tank.

Step 1 – Determine hydrology management requirements

Parameter	Calculation or selection method	Value	Unit
Rainfall depth		23	mm
Retention		5	mm
Detention	23 mm – 5 mm	18	mm
Roof area connected to tank ($A_{(connect)}$)	$80\% \times 500\ m^2$	400	m^2

The total runoff volume was determined using Figure 33.

Step 2 – Allocate runoff volume

The total mitigation volume was then divided into retention and detention volumes:

- Detention volume: 18 x 400 = **7200 L**
- Retention volume: 5 x 400 = **2000 L**.

It should be noted these volumes are larger than those calculated using TP108 but represent a more conservative volume appropriate for a simplified method. Therefore, the total tank volume should be at least **9200 L.** Note that this roof-to-tank set-up can achieve only a maximum hydrology mitigation volume of 9200 L. Therefore, if the hydrology mitigation volume is greater than 9200 L, other devices must be used to meet the balance or, if possible, increasing the connected roof area.

Step 3 – Determine appropriate tank size

The next larger available tank size is assumed to be **10,000 L** (assume 2.5 m diameter, 2.2 m height to overflow). The tank has a dead storage of 150 mm.

Step 4 – Determine detention orifice height

Based on Figure 34, the orifice height is 400 mm above dead storage. Therefore, the detention orifice height is 550 mm.

Step 5 – Determine detention orifice size

A minimum orifice size of 10 mm is used. The final design is illustrated in Figure 41.

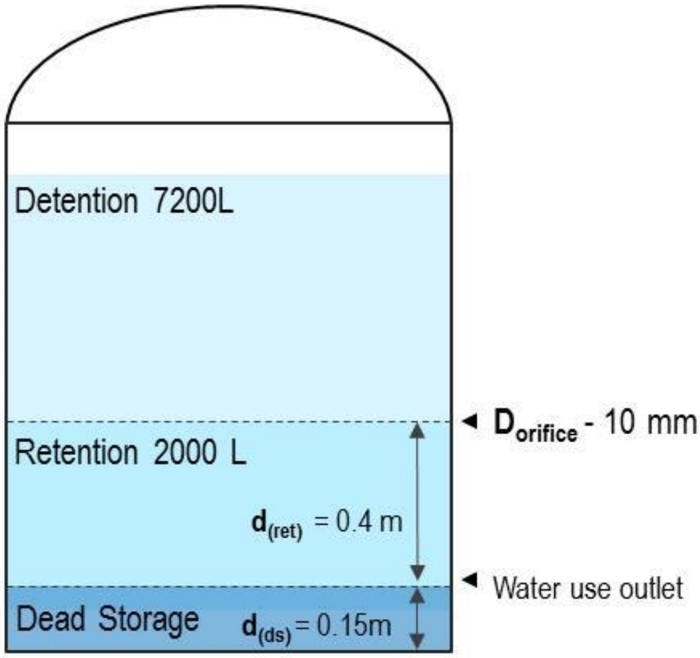

Figure 41: Rainwater tank specifications for mitigation of 500 m^2 roof (10000 L)