Greater Wellington Hydrological Control Guidance Note

Greater Wellington
Te Pane Matua Taiao

Title	Greater Wellington Hydrological Control Guidance Note
Issue Date	September 2025

Acknowledgements

Greater Wellington would like to acknowledge Morphum Environmental Ltd and Wood & Partners Consultants Ltd for their contributions to developing this guideline document.

Cover image from Watersmart http://www.watersmart.co.nz. All other images in this guidance have been provided by Wood & Partners Consultants Ltd and Morphum Environmental Ltd.

Disclaimer

Adopting the methods outlined in this guidance document does not guarantee compliance with the hydrological control requirements in Plan Change 1, and compliance will be assessed on a case-by-case basis. Guidance users should take advice from a suitably qualified person on whether adopting a method will achieve compliance for a particular activity.

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Contents

1. Introduction and context

1.1 Purpose of the guidelines

This guidance note is intended to support developers to provide effective and efficient hydrological control measures, where required to comply with the requirements of Plan Change 1 to the Natural Resources Plan.

This document covers the following:

- What hydrological controls are and why they are important
- Approaches to achieve hydrological control and design criteria that can be used to achieve effective hydrological control to protect downstream receiving environments

This guidance note is intended to be an interim measure to support implementation of the notified version of the plan change prior to further decisions being made on hydrological control provisions in Plan Change 1. Please refer to the Greater Wellington website for more information on the plan change process[1].

1.2 Drivers for Improved Stormwater Management

Development activities across the Wellington Region result in stormwater runoff which discharges to fresh and coastal waters at a range of scales and with varying levels of cultural, ecological and social significance. Discharge of inappropriately managed urban stormwater can adversely affect streams, rivers, wetlands, lakes, and estuaries. Changes to the natural water cycle are known to exacerbate stream degradation with loss of indigenous biodiversity and sediment/contaminant transport to fresh and coastal waters.

In undeveloped catchments, a large portion of rainfall is naturally 'retained' as a result of infiltration or lost due to evapotranspiration. After urban development, clearing of vegetation and changes to surface coverage increase the volume, frequency, response time and flow rate of stormwater runoff entering streams, rivers and other natural environments. These changes to runoff following development occur from both small, frequent rainfall events and large infrequent flooding events.

Figure 1: Owhiro Stream, Wellington

[1] https://www.gw.govt.nz/your-region/plans-policies-and-bylaws/updating-our-regional-policy-statement-and-natural-resources-plan/natural-resources-plan-2023-changes/

Figure 2: Duck Creek, Porirua

Traditional stormwater management in the Wellington region has recently focused on 'hydraulic neutrality' which is normally intended to manage peak flow rates resulting from infrequent large rainfall events. These are managed for the purposes of mitigating downstream flooding and to ease pressure on existing reticulated stormwater assets. Hydrological control focuses on development-related changes to the urbanised water cycle in small but frequent rainfall events which result in the greatest change in flow patterns and are the key driver of stream instability through both increased velocities (scour) and rapidly fluctuating water levels creating drag forces (slumping). Figures 1 through 4 show examples of streams in the Wellington Region impacted by bank slumping, erosion and sedimentation; an impact of increased volume, frequency and variability of stormwater discharges after development. Hydrological controls are focused on reducing these impacts through mimicking, as much as practical, the undeveloped water balance for catchment.

Figure 3: Mitchell Stream, Porirua

Figure 4: Waitohi Stream, Wellington

1.3 Greater Wellington Regional Council Regulatory Requirements

In October 2023, Greater Wellington notified Plan Change 1 (PC1) which proposes amendments to the Natural Resources Plan. In catchments defined as contributing to Te

Whanganui-a-Tara and Te Awarua-o-Porirua[2], most new or redeveloped impervious areas are now subject to new stormwater rules under PC1, and some will include requirements for hydrological control where there is a discharge to a river including via an existing stormwater network. For the most up to date information on the plan change process please refer to Greater Wellington's website[3].

Several policies in PC1 direct the use of hydrological control. These include:

- Policies WH.P10 in the Te Whanganui-a-Tara Whaitua and P.P10 in the Te Awarua-o-Porirua Whaitua which state that all stormwater discharges and associated land use activities shall be managed by, among other things, using hydrological control and water sensitive urban design measures to avoid, remedy and mitigate adverse effects of stormwater quantity, and maintain, to the extent practicable, natural stream flows.
- Policies WH.P14 and P.P13 set out that stormwater discharges from new and redeveloped impervious surfaces must be minimised from new greenfield development and reduced to the extent practicable from existing urban areas. This includes a requirement that where stormwater discharges will enter a river, hydrological control is provided through a stormwater treatment system either on-site or off-site.
- Policies WH.P2 and P.P2 note that the target attribute states for freshwater will be achieved in part through providing hydrological control for urban developments (as well as other stormwater measures set out in the stormwater rules and policies). As such, if a proposal is consistent with the stormwater policies, a specific assessment to determine whether a discharge will meet the objectives in WH.O9 and P.O6 is not required for the discharge of stormwater from urban areas to freshwater.

A series of rules sit under these policies which manage the use of land for the creation of new and/or redevelopment of impervious surfaces. Users should always refer to the plan change document directly to understand potential consent requirements. In addition, there is a PC1 Stormwater Rules Flowchart on Greater Wellington's website[4].

In circumstances where stormwater is discharged to land (i.e soakage basins designed for all site generated stormwater up to the primary network capacity), and no stormwater is intended to be discharged to surface water bodies (including via the primary stormwater network), this is considered full retention on site, and may be a permitted activity under rules WH.R2 and P.R2: Stormwater to land. Note, smaller scale but appropriately sized infiltration devices used as a method of hydrological control, where remnant overflows still discharge to a river (including via the primary stormwater network), will not be considered a discharge to land under those rules and other stormwater discharge rules still apply.

Where a Stormwater Impact Assessment is required in accordance with Schedule 29 of PC1, it must include a clear description of how hydrological control will be incorporated (alongside the other requirements of Schedule 29).

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[2] Greater Wellington Regional Council, 'Maps 78 & 79: Part freshwater management units and target attribute states – Whaitua Te Whanganui-a-Tara & Te Awarua-o-Porirua Whaitua', Wellington, 2023, https://storymaps.arcgis.com/stories/ecd4158b2adf40f185f8897551b41d46

[3] Greater Wellington Regional Council, Proposed Change 1 to the Natural Resources Plan - https://www.gw.govt.nz/your-region/plans-policies-and-bylaws/updating-our-regional-policy-statement-and-natural-resources-plan/natural-resources-plan-2023-changes/

[4] https://www.gw.govt.nz/assets/Resource-Consents/Stormwater/20250407-PC1-Stormwater-Rules-Flow-Chart_FINAL.pdf

1.3 Glossary

In order to understand hydrological control and differentiate between common stormwater management terms, a description of key concepts is provided below in Table 1.

Table 1: Description of key concepts

Hydraulic Neutrality	Definition from the **Regional Policy Statement (Decisions Version)**: *"Managing stormwater runoff from subdivision, use and development through either on-site or local area disposal or storage, so that peak stormwater flows are released from the site or area at a rate that does not exceed the modelled peak flows from the site or area in an undeveloped state, in the 10% annual exceedance probability and 1% annual exceedance probability modelled design rainfall events including the predicted impacts of climate change"*.
Hydrological Control	Definition from **Natural Resources Plan – Plan Change 1 as notified**: *"Means the management of a range of stormwater flows and volumes, and the frequency and timing of those flows and volumes in a way that mimics natural processes, from a site, sites, or area into rivers, lakes, wetlands, springs, riparian margins, and other receiving environments to help protect freshwater ecosystem health and well-being"*.

Impervious Surfaces	Definition from **Natural Resources Plan – Plan Change 1 as notified**: *"Surfaces that prevent or significantly impede the infiltration of stormwater into soil or the ground, includes:* • *roofs* • *paved areas (including sealed/compacted metal) such as roads, driveways, parking areas, sidewalks/foot paths or patios,* *and excludes:* • *grassed areas, gardens and other vegetated areas* • *porous or permeable paving* • *slatted decks which allow water to drain through to a permeable surface* • *porous or permeable paving and living roofs* • *roof areas with rainwater collection and reuse* • *any impervious surfaces directed to a rain tank utilised for grey water reuse (permanently plumbed)"*
Infiltration rate	The rate at which water enters the soil surface and percolates into the underlying soil profile, typically expressed in millimetres per hour (mm/hr) or metres per second (m/s). It quantifies the capacity of the soil to absorb water and is a key parameter in the design and performance assessment of hydrological controls.
Rainwater Harvesting	Collection of rainwater from roof areas for reuse either in external irrigation or internally for non-potable purposes such as toilet flushing and cold laundry supply. For the purposes of hydrological controls, it is important to recognise the importance of ensuring that rainwater reuse services demand throughout the year. This is typically achieved through internal constant demands such as toilet flushing and laundry.
Soakage Systems/Devices	Engineered structures designed to dispose of stormwater runoff into the ground through localised, highly permeable soils or geological features, where water rapidly drains away without forming surface flows. These devices serve as stormwater disposal mechanisms and can be designed to dispose of the full primary flows (referred to herein as soakage). By virtue of their high capacity, these devices also serve an infiltration hydrological control function, by draining the smaller more frequent rainfall events.
Peak Flow Detention	The temporary storage and controlled release of flow to match a pre-determined flowrate. Whilst this typically increases the duration of discharges at the peak of the runoff hydrograph (i.e., resulting in a 'flattening' of the curve), it does not result in the extended detention, nor does it reduce the overall volume of stormwater discharged. Peak flow detention is commonly used in the Wellington Region to achieve hydraulic neutrality outcomes from large events (e.g. 10–100 year ARI) required by

	Wellington Water (and territorial authorities) for the purposes of flood mitigation.
Extended Detention	The temporary storage of stormwater runoff from small, frequent rainfall events for a defined period (typically 24 hours), with significantly reduced release rates that mitigate the risk of channelised erosion and stream instability in downstream receiving environments. Extended detention is used in the Wellington Region in conjunction with stormwater retention and / or rainwater harvesting to achieve hydrological control outcomes from moderate events (up to 30mm, 24-hour storm).
Supplementary Mitigation Runoff Depth or Volume	The additional mitigation runoff depth or volume to be provided over and above the retention runoff depth or volume (and up to the total hydrological control mitigation runoff depth or volume), which can be mitigated through extended detention or additional retention (infiltration and/or non-potable re-use).
Stormwater Retention	The management of stormwater through the controlled collection of runoff with some form of 'disposal' to reduce the post developed volume of stormwater that is discharged from the site during frequent small to moderate rainfall events. Collected stormwater can be 'disposed of' through evapotranspiration, infiltration/soakage, or reuse. Hydrological control requires stormwater retention to mitigate adverse ecological impacts from development by mimicking as much as feasible the natural undeveloped water balance through targeted reuse or infiltration.
Hydrological Control Mitigation Runoff Depth or Volume	The total runoff depth or volume required for purposes of achieving hydrological control mitigation, being the sum of the Retention + Supplementary Mitigation runoff depth or volume.

1.4 Relationship to other advice & guidelines

This guidance note should be read and understood together with any other practice notes and design guidelines relevant to your development context. It does not cover all the development requirements for water sensitive urban design, hydraulic neutrality and servicing of developments, including relevant requirements under the Building Act or a district plan.

It is recommended that the following documents are referenced in conjunction with these guidelines:

- Water Sensitive Design for Stormwater: Treatment Device Design Guideline (Wellington Water, 2019)
- Wellington Water Reference Guide for Design Storm Hydrology: Standardised Parameters for Hydrological Modelling (Wellington Water, 2019)
- Wellington Water Regional Standard for Water Services (Wellington Water, 2021)

- Wellington Water Managing Stormwater Runoff: The Use of Approved Solutions for Hydraulic Neutrality (Wellington Water, 2024)
- Relevant regional and district council plan rules
- New Zealand Building Code

If you consider that any other guidance is inconsistent with this practice note, please contact Greater Wellington for advice.

2. Importance of Hydrological Control

2.1 What happens in the natural water balance?

In undeveloped grassed and vegetated catchments, an initial portion of rainfall is intercepted by plant matter and/or surface soils where it is used by plants, transferred to the atmosphere through evapotranspiration or infiltrated into the ground where it contributes to stream baseflow and groundwater recharge. Once the storage capacity of the vegetation and soil is exceeded, water will begin to leave a site as surface runoff which contributes to flow in surface waterbodies.

In an undeveloped catchment, typically 20-30% of total annual rainfall is retained within the catchment via evapotranspiration. Infiltration rates vary significantly due to factors including shallow/deep soil types, landform (slope/aspect) and the intensity of rainfall. Considering both infiltration and evapotranspiration, in Wellington typically 30-40% of the annual rainfall depth/volume is discharged from catchments as direct surface runoff with small frequent rainfall events almost entirely retained within the catchment. The quantum of natural rainfall retention varies due to vegetation, surface soil types and seasonal climate.

When a catchment (or part thereof) is developed and impervious surfaces introduced, the site loses retention capacity for rainfall and has reduced ability to support infiltration or evapotranspiration. Because the impervious surfaces of roofs, driveways, roads and hardstand have limited capacity to retain water, rainfall quickly flows off the site, and downstream receiving waterbodies experience highly variable and 'flashy' flow rates even in small rainfall events that would otherwise not generate any surface discharges prior to development.

These changes to catchment hydrology cause increased volume, frequency and variability of stormwater discharges to receiving streams and estuaries, which are observed as rapid fluctuations in the depth and velocity of stream flow in even small rainfall events. The unmitigated discharge of stormwater has been shown to contribute to adverse ecological effects through repeated scour and bank slumping as well as reduced aquatic habitat viability due to the flushing of substrate (including in intermittent/ephemeral reaches), increased velocities affecting biota's natural behaviour and the effects of the stormwater itself in terms of contaminants, temperature and dissolved oxygen. These effects are often referred to as 'urban stream syndrome' and result in a reduction in indigenous biodiversity, degraded mauri of streams and increased requirements for expensive engineered remedial works to mitigate streambank slumping, which can threaten roading and other infrastructure.

3. How can hydrological control be achieved?

3.1 Hydrological control interventions

'Hydrological control' is a term that describes interventions which intentionally collect the initial portion/depth of rainwater from a site's impervious surfaces and retain it within the site so that it does not contribute to surface runoff. This mimics the portion of rainfall that would naturally be 'lost' to evapotranspiration or enter the ground as infiltration on an undeveloped site.

Hydrological control interventions focus on the following two separate processes:

a. Volume reduction in frequent small rainfall events to replicate natural water cycle processes of interception/evapotranspiration and infiltration to ground. This reduces the frequency and magnitude of 'flashy' stormwater discharges (which are key driver of instability and ecological disturbance), protects headwater stream processes, supports baseflow in headwater streams and mitigates the impacts of contaminants entrained in stormwater.
b. Flowrate management through extended detention to reduce the impact of frequent channel forming flows arising from impervious surfaces in small to moderate rainfall events.

3.2 Types of hydrological control measures

Designing for hydrological control may include the following stormwater management measures, in order of importance and priority:

1. **Rainwater harvesting practices** such as non-potable water re-use through rainwater tanks to mitigate the effects of increased runoff volumes;
2. **Land disposal practices** such as full soakage of primary flows or infiltration of initial flows only through devices such as infiltration wells, bioretention with internal water storage (IWS) or landscaped infiltration beds; these measures are subject to geotechnical suitability and viability.
3. **Extended detention devices** which temporarily store and release a portion of stormwater runoff over an extended period (normally 24 hours), to mitigate channelised stream erosion risks.

3.3 Design criteria for hydrological control

The size of a stormwater runoff event to be captured and treated is a critical factor in the design of hydrological control mitigation devices. A simple and consistent approach should be used to determine the hydrological control design storm, which forms the basis to size hydrological control mitigation measures. Using the water quality storm (measured as one third of the 2-year ARI storm event, as per the Wellington Water WSUD guidelines or similar approach can be a practical metric to estimate the hydrological control design storm.

Based on the historic 2-year ARI 24-hour rainfall depth data in Te Whanganui-a-Tara and Te Awarua-o-Porirua whaitua obtained from NIWA HIRDS V4, the approximate water quality 24-hour storm depth ranges from about 23mm to 39mm, or an approximate rounded average rainfall depth of 30mm.

The 30mm rainfall depth is used to determine the hydrological control design runoff depth, which is based on the difference between impervious runoff depth (estimated as 25mm approximately), and the pervious runoff depth. The pervious runoff depths corresponding to a range of undeveloped soil conditions, and their corresponding design runoff depths, are summarized in **Table 2** below (note: "undeveloped" soil conditions in this context assume the modelled grassed (pastoral or urban open space) state of the site prior to urban development. The undeveloped soil curve number can be used to determine the total runoff depth mitigated. The Wellington Water Reference Guide for Design Storm Hydrology[5] can be referenced when determining the appropriate curve number.

Table 2: Hydrological Control Design Runoff Depths for a range of soil conditions

	Undeveloped Soil Curve Number CN		
	28 to 54	55 to 72	73 to 87
Pervious Runoff Depth Corresponding to 30mm rainfall (mm)	0	2	5
Total Hydrological Control Design Runoff Depth (25mm minus perv. runoff depth) (A) (mm)	**25**	**23**	**20**
Retention Runoff Depth (B) (mm)	15	15	15
Supplementary MitigationRunoff Depth ((A) – (B)) (mm)	10	8	5

[5] Wellington Water Reference Guide for Design Storm Hydrology, April 2019 https://qpulse.wellingtonwater.co.nz/QPulseDocumentService/Documents.svc/documents/active/attachment?number=SWG_0003

The following criteria can be used to determine the volume of hydrological control required to meet the outcomes sought by PC1:

1. Determine the undeveloped soil curve number[6] and select the hydrological control design runoff depth from Table 2.

2. Retain the first 15mm of runoff depth using:
    a. rainwater reuse practices such as rainwater reuse tanks, or
    b. infiltration or bioretention devices with internal water storage (IWS), or
    c. a combination of the two.

3. For the supplementary mitigation runoff depth, the same approach can be applied, but with the additional option to use extended detention to complement any volume shortfall if required. Only where retention via reuse or infiltration is not viable, extended detention may be appropriate to complement the shortfall.

3.4 Rainwater harvesting & reuse tanks

Rainwater harvesting practices (such as non-potable water reuse through rainwater tanks) mitigate the effects of increased runoff volumes. Rainwater harvesting tanks are used to collect and store runoff from impervious areas such as roofs. The tank should be configured to be plumbed to internal toilets, cold water laundry devices and any external hose taps as a non-potable water supply. Tanks and associated plumbing must comply in all instances with the NZ Building Code and requirements from city councils/water authorities including compliant backflow prevention and top up from mains water when tank storage is not sufficient to meet non-potable demand. External taps should be labelled 'non-potable' where connected to rainwater reuse.

3.5 Infiltration devices

Infiltration devices allow water to infiltrate into the ground, provided that the subsoil is sufficiently permeable. Advice from a suitably qualified and experienced geotechnical engineer should be sought where hydrological controls include dedicated infiltration.

Infiltration devices will not be appropriate for certain areas in the Wellington Region due to low permeability clay soils, compacted engineered fill, contaminated land or development on sloping and unstable sites. It is recommended that infiltration systems are not implemented where verified site infiltration rates are less than 10mm/hr, or where geotechnical advice indicates it is not appropriate to infiltrate stormwater to ground.

Site infiltration rates can be tested using the methodology outlined in GD2021/007 (Stormwater Soakage and Groundwater Recharge in the Auckland Region) or another recognised method. Design of any infiltration device should account for the fully developed

[6] Wellington Water Reference Guide for Design Storm Hydrology, April 2019
https://www.wellingtonwater.co.nz/assets/Resources/Developing/Reference-Guide-for-Design-Storm-Hydrology-April-2019.pdf

condition, and should be protected against contamination during earthworks, infrastructure or building construction processes.

For the design of infiltration devices for hydrological controls only, seasonal groundwater must be below the base of the device; however, additional clearance is not required. All other clearances and design for full scale primary flow soakage devices (which are designed for the disposal of primary storm events) should be in accordance with Wellington Water Regional Standard for Water Services (2021).

Where stormwater is entirely or partially discharging to infiltration devices from pavement surfaces (i.e. not roofs), pre-treatment to remove gross pollutants, sediment and any other contaminants, should be undertaken upstream of the device to improve efficiency and reduce maintenance requirements of the infiltration device.

3.6 Extended detention

Extended detention devices temporarily store and slowly release runoff from small, frequent events over an extended period of time (typically over 24 hours or more).

Extended detention can be a useful option where full retention or reuse is not practical, particularly where the opportunity for non-potable reuse is limited (i.e. some commercial or industrial developments). Extended detention options can be used to complement any volume shortfall to achieve the total design runoff depth specified in **Table 2**, noting that rainwater harvesting or infiltration practices are the preferred approach to mitigate at least the first 15mm of runoff depth (or as much as practical, if the full 15mm cannot be achieved).

It should be noted that extended detention is separate from peak flow detention required for hydraulic neutrality purposes. The Wellington Water guidelines, *Managing Stormwater Runoff: The Use of Approved Solutions for Hydraulic Neutrality,* should be referenced to check if approved solutions also meet hydraulic neutrality requirements.

3.7 Combined systems

Having the option of a combined retention and extended detention approach provides a practical way to address hydrological control objectives in a way that mitigates the entire design storm depth, as extended detention can offer complementary hydrological control mitigation where there are limitations around the amount of infiltration or rainwater reuse that can be practically achieved on a given site. Refer to Section 5 for illustrations showing device configuration and interaction.

Peak flow detention, extended detention and rainwater reuse functions can be included within a single device. For example, a rainwater tank can have permanent storage at the bottom to incorporate a non-potable water reuse function, in addition to providing extended detention in the intermediate part of the tank, and peak flow detention through live storage at the top part of the tank.

4. Design considerations for hydrological control

4.1 Reducing the total impervious surface area

Consider reducing the total impervious footprint of the development.

The following are not considered impervious surfaces and therefore do not contribute to the total impervious area of your development:

- grassed areas, gardens and other vegetated areas
- unlined porous or permeable paving
- slatted decks which allow water to drain through to a permeable surface
- swimming pools
- living roofs
- roof areas with rainwater collection and plumbed internal non potable reuse, including for internal toilets and any external hose taps as a non-potable water supply

4.2 Stormwater device selection

When selecting a device to achieve the requirements for hydrological control, the following should be considered:

- Site layout and development type
- Likely occupancy of standalone or multi-unit dwellings; to confirm that stored water can be used in a timely manner
- Whether the site is part of a larger development that may include large public devices where hydrological controls can be implemented
- Infiltration capacity of site soils (infiltration for purposes of hydrological control is not recommended when the infiltration rate is less than 10mm/hr).
- Groundwater levels and how this may impact the design of below ground devices and available infiltration
- Legal ownership arrangements post subdivision, including how these impact on ownership, maintenance and operation.

4.3 Commercial & Industrial Developments

Hydrological control can be complex where warehousing or similar land use can result in large roof areas with low reliability of non-potable water demand and restricted infiltration. These conditions may make full retention through rainwater reuse and/or infiltration unfeasible. In this situation, developers of commercial or industrial land use can consider the use of extended detention devices to complement any volume shortfall if required.

Other considerations for commercial and industrial developments should include the following:

- Can any infiltration be implemented on site (even where only low infiltration rates are achievable)?
- What non-potable water demands are present? This can include toilet flushing, cold water laundry facilities, washdown processes including backwashing on filters (with consideration of required water quality), cooling processes, or irrigation schemes.

- Based on the non-potable demands, is there an appropriate storage volume that can be reliably used?
- Can non-potable demands be increased through the provision of non-potable water to adjacent users?

4.4 High Density Residential Developments

Where higher density developments result in shared or directly connected roof area the sizing relationships in section 5 can still be applied. Rainwater reuse tanks and extended detention volumes should be sized based on the total roof area with plumbed connections to individual dwellings. Where appropriate this can be achieved with a single combined tank rather than multiple smaller tanks.

4.5 Other Design Considerations

Due to the water supply and geotechnical components of hydrological control methods, health and safety considerations and ongoing operations are key aspects when considering the design. The following considerations and guidance should be considered in design:

- Safe access must be provided to ensure that the landowner and any person responsible for maintenance can undertake long term operation of the device. No device shall be inaccessible for cleaning or inspection.
- Where a device services multiple units, there must be a legal entity (such as a body corporate or residents society) that can take responsibility for the maintenance and continued operation of the device. The legal entity must be made aware of the operational & maintenance requirements of the device.
- All designs must comply with the building code and industry standards, including requirements for suitable backflow prevention.

5. Design Approach/Acceptable Methods for Hydrological Control

The sections below provide practical sizing guidance for the design of hydrological controls to mitigate the effects of creating new roof and pavement impervious surfaces including the initial 15mm retention runoff depth and supplementary mitigation runoff depth (extended detention or additional retention) requirements discussed in Section 3.2.

5.1 Hydrological Control Sizing Guidance

Tables 3 to 5 below provide guidance for sizing hydrological controls, for a range of impervious surface areas and under three different undeveloped soil conditions. Note that "undeveloped" soil conditions in this context assume the modelled grassed (pastoral or urban open space) state of the site prior to urban development.

Table 3: Hydrological Control Sizing, undeveloped Soil CN = 28 to 54

Connected Impervious Area (m^2)	Retention Volume (L)	Supplementary Mitigation Volume (L)	Total Hydrological Control Storage (L)
50	750	500	1250
100	1500	1000	2500
150	2250	1500	3750
200	3000	2000	5000
250	3750	2500	6250
300	4500	3000	7500
350	5250	3500	8750
400	6000	4000	10000
450	6750	4500	11250
500	7500	5000	12500

Table 4: Hydrological Control Sizing, undeveloped Soil CN = 55 to 72

Connected Impervious Area (m^2)	Retention Volume (L)	Supplementary Mitigation Volume (L)	Total Hydrological Control Storage (L)
50	750	400	1150
100	1500	800	2300
150	2250	1200	3450
200	3000	1600	4600
250	3750	2000	5750
300	4500	2400	6900
350	5250	2800	8050
400	6000	3200	9200
450	6750	3600	10350
500	7500	4000	11500

Table 5: Hydrological Control Sizing, undeveloped Soil CN = 73 to 87

Connected Impervious Area (m^2)	Retention Volume (L)	Supplementary Mitigation Volume (L)	Total Hydrological Control Storage (L)
50	750	250	1000
100	1500	500	2000
150	2250	750	3000
200	3000	1000	4000
250	3750	1250	5000
300	4500	1500	6000
350	5250	1750	7000
400	6000	2000	8000
450	6750	2250	9000
500	7500	2500	10000

5.2 Hydrological Control Device Selection

The retention and supplementary mitigation hydrological control volumes specified above can be achieved either in the same device or in separate devices, depending on whether flows originate from roof or pavement surfaces, and whether suitable conditions are available for infiltration to ground.

Roof Areas

Connected roof areas can use rainwater tanks with permanent retention storage at the lower part of the tank for non-potable water re-use with supplementary mitigation volume stored above the permanent storage. This supplementary volume can then be discharged to infiltration or managed as live storage for extended detention or additional retention storage.

Non-potable water uses include toilet flushing, cold water tap, laundry, and external taps which can be used for external washing or garden watering. The non-potable outlet should be located 50mm above the tank base, to allow for deposition of sediments and reduce the risk of blockage.

In multi-unit or apartment situations, it may not be necessary to connect all units to the rainwater harvesting system. In such cases, applicants should provide justification for connecting a smaller number of units to the system.

Where verified infiltration rates of 10mm/hr or greater exist and where adequate space and geotechnical conditions are available, then supplementary mitigation runoff depth can be provided for via an infiltration device.

If extended detention is used for the supplementary mitigation volume, discharges should be directed to the stormwater network.

Extended detention outlets should be sized with a minimum orifice size of 10mm or as otherwise required to fully drain the full extended detention volume over a 24-hour period. All extended detention outlets should be fitted with a mesh screen (or equivalent filter), located in the tank to allow for safe inspection and cleaning access.

A tank overflow should be provided to service flows in excess of the hydrological control design storm and up to the 10-year ARI primary storm event, with flows directed to the stormwater network. This overflow can also be configured as the controlled outlet for any further hydraulic neutrality storage above the retention depth.

Figure 5 illustrates a typical roof runoff hydrological control mitigation approach, where infiltration is a viable option.

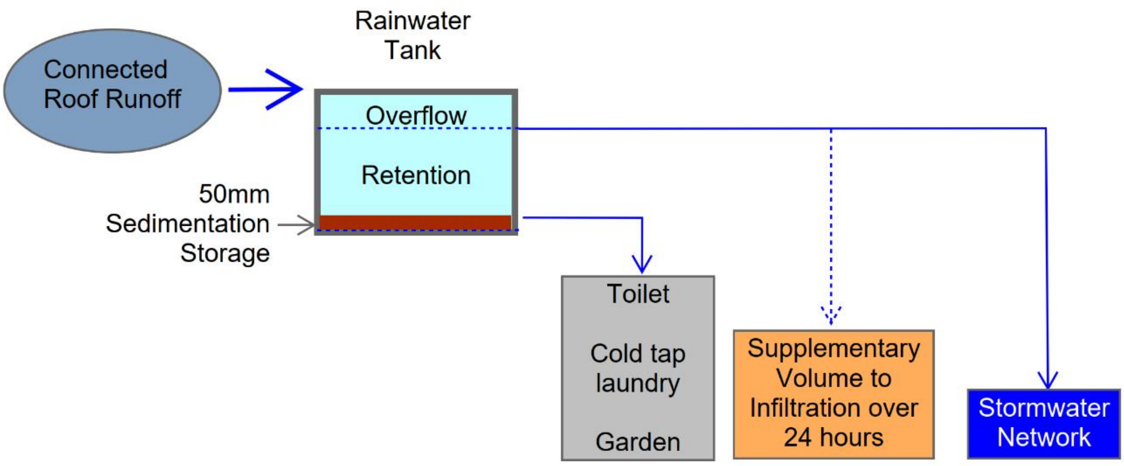

Figure 5: Roof runoff with infiltration

Figure 6 illustrates a typical roof runoff hydrological control mitigation approach, with no infiltration allowance.

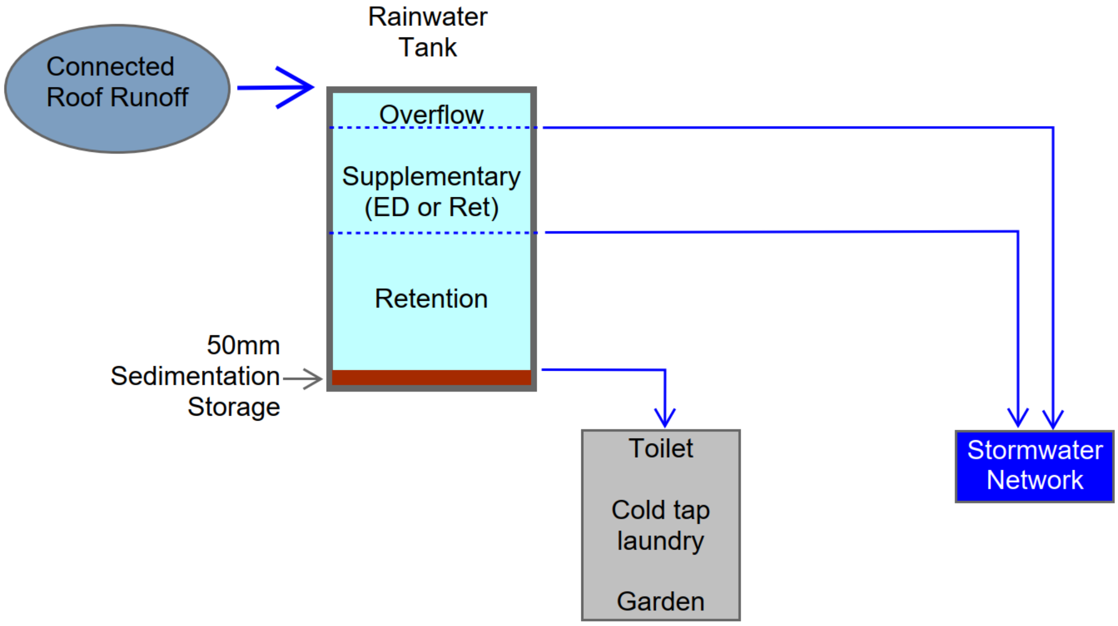

Figure 6: Roof runoff without infiltration

Pavement Areas

Hydrological control for connected impervious pavements can be provided for by infiltration devices or raingardens with internal water storage (IWS) if verified infiltration rates are 10mm/hr or greater and where space and geotechnical conditions allow.

If infiltration is not technically viable, then the full hydrological control volume (retention plus supplementary mitigation volume) should be mitigated through appropriately sized and lined IWS systems or extended detention practices.

Non-potable water re-use of pavement runoff needs to consider the higher contaminant levels likely to arise from pavement surfaces (and the need to provide treatment of these flows). However, subject to providing suitable pre-treatment, non-potable re-use of pavement runoff will be considered on a case-by-case basis.

Figure 7 illustrates a typical pavement runoff hydrological control mitigation approach, where infiltration is a viable option.

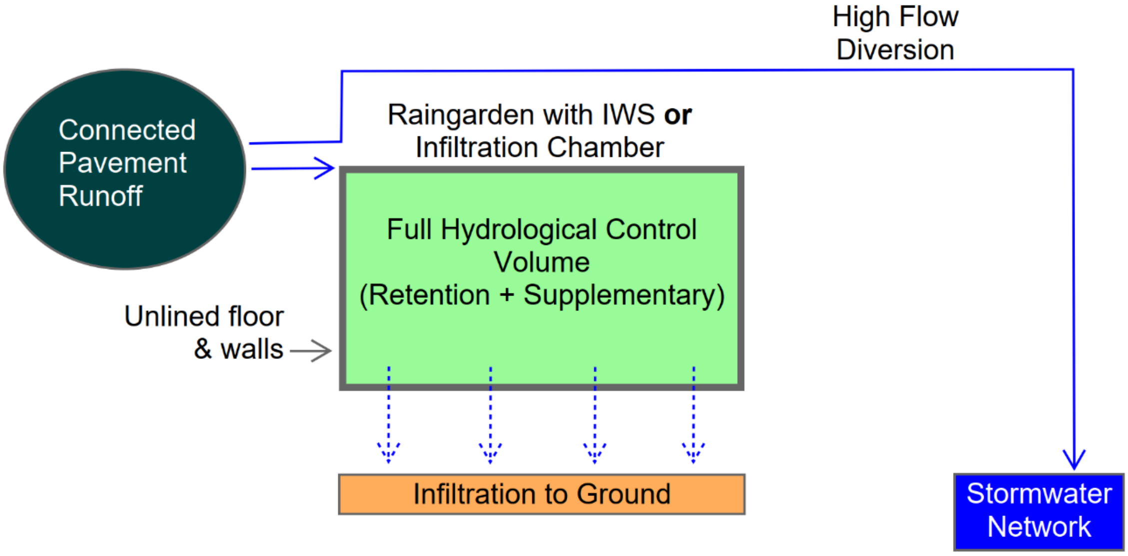

Figure 7: Pavement runoff with infiltration

Figure 8 illustrates a typical pavement runoff hydrological control mitigation approach, with no infiltration allowance.

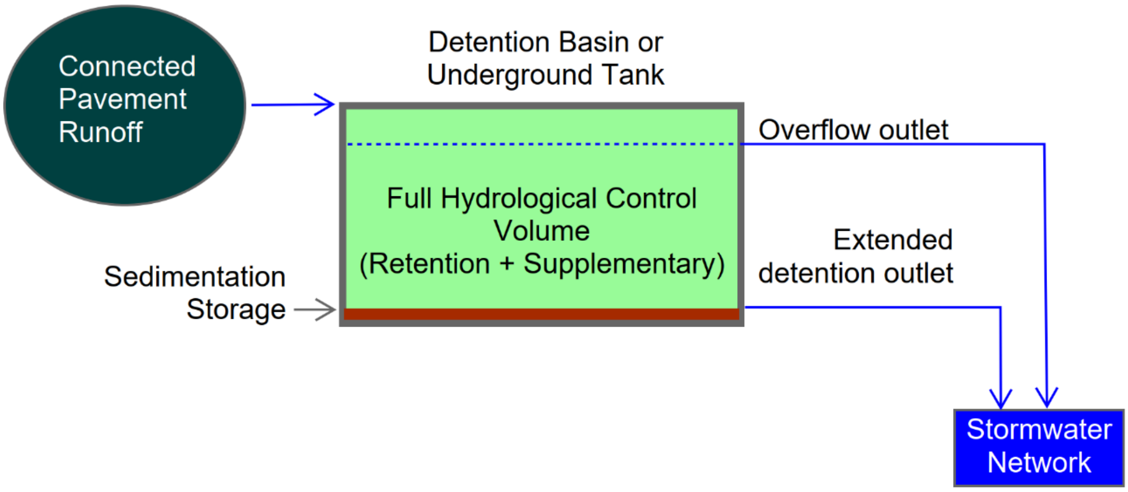

Figure 8: pavement runoff without infiltration

5.3 Design Example – 150m2 Roof

The example below illustrates a hydrological control mitigation design approach for a connected roof area, using a rainwater harvesting tank.

Parameters:

- Roof area connected to tank: 150m2
- Soil Curve Number, undeveloped conditions: CN=66
- Non-potable re-use available through toilet flushing, cold tap laundry and garden use

Step 1: Determine hydrological control volume (retention and extended detention)

- Undeveloped CN = 66, therefore refer to Table 4 (CN = 55 to 72) to obtain:
  - Retention volume (RV) = 2250L;
- Supplementary mitigation volume (SMV) (extended detention used in this case) (EDV) = 1200L
  - Total Hydrological Control volume = 3450L

Step 2: Tank selection

- Search for available tank products in the market, select a 4000L upright cylindrical tank, with the following dimensions:
  - Tank diameter: 1.9m
  - Tank height: 1.4

Step 3: Determine retention volume depth:

- From Table 4, RV = 2250L = 2.25m^3
- Tank area $= A = \pi r^2 = \pi(1.9/2)^2 = 2.835\ m^2$
- From where retention depth = RV / A = 2.25 / 2.835 = 0.79, **say 0.8m**.

Note: A dead storage depth allowance of 50mm provides for sedimentation at the bottom of the tank. The non-potable outlet should therefore be placed 50mm above the tank floor.

Step 4: Extended detention design:

- From Table 4, EDV = 1200L = 1.2m^3
- Tank area = 2.835m^2
- From where extended detention depth = EDV / A = 1.2 / 2.835 = 0.423, **say 0.45m**
- Determine EDV orifice outlet size:
  - Maximum flow in orifice, at maximum EDV storage depth is:
    - Qmax = 2 x Qave, where:

- Qave = EDV / 86400 [m^3/s] = 1.2 / 86400= 0.000014 m^3/s

- So Qmax = 2 x 0.000014 = 0.000028 m^3/s
- EDV orifice diameter is determined from the following formula:
    - $D = (4Qmax/(0.62\pi(2gh)^{0.5}))^{0.5}$
    - Where Qmax = 0.000028 m^3/s
    - g = 9.81 m/s^2
    - h = 0.45m
    - From where the outlet diameter D = 0.0044m or 4.4mm
    - Because 4.4mm < 10mm (recommended minimum), **adopt 10mm**.

Figure 9 illustrates the design solution showing indicative tank components.

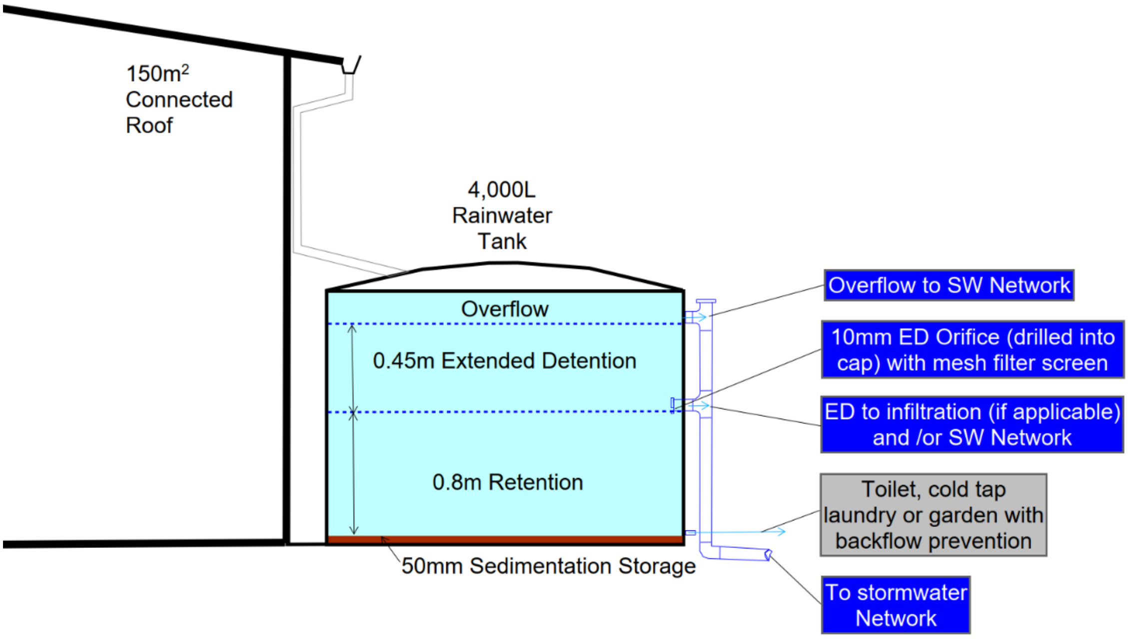

Figure 8: Tank design for 150m² roof

5.4 Design Example – 300m2 Pavement Area

The example below illustrates a hydrological control mitigation design approach for a connected pavement area draining to a raingarden, with infiltration capability.

Parameters:

- Pavement area draining to raingarden: $300m^2$
- Soil Curve Number, undeveloped conditions: CN=52
- Verified infiltration rate k=15mm/hr and no geotechnical constraints, therefore infiltration is deemed viable and included in the design.

As we are proposing a raingarden, there are two functions to be considered:

- A water quality treatment function, which is achieved through the raingarden media and for which a footprint area of 2% of the contributing impervious area is required = $300m^2$ x 0.02 = $6m^2$
- A hydrological control function, achieved by infiltration through the internal water storage (IWS) portion of the raingarden.

Step 1: Determine hydrological control volume (retention and extended detention)

- Undeveloped CN = 52, therefore refer to Table 3 (CN = 28 to 54) to obtain:
  - Retention volume (RV) = 4500L;
  - Supplementary mitigation volume (SMV) = 3000L
  - Total Hydrological Control volume = 7500L

Step 2: Infiltration design:

- In this case, we are using an IWS infiltration chamber backfilled with open graded aggregate, beneath a $6m^2$ raingarden (refer above)
- Infiltration Design parameters:
  - Assumed IWS depth = 0.8m
  - Assumed IWS footprint area = say 4% of the contributing impervious area is required = $300m^2$ x 0.04 = $12m^2$
  - Void ratio for IWS layer: 0.35
- Check how much volume can infiltrate over 24 hours, assuming the site infiltration rate of k=15mm/hr
- $V_{Infiltration}$ = $12m^2$ * 24 hours * 0.015m/hr = $4.3m^3$
  - This means that out of the $7.5m^3$ Hydrological Control Volume, $4.3m^3$ will infiltrate to the ground in the 24-hour design period.
  - The IWS volume that is therefore required to mitigate the full retention volume of $4.5m^3$ is:
    - V_{IWS} = 7.5 - 4.3 = $3.2m^3$
  - Check for minimum IWS depth:
    - $12m^2$ (IWS footprint) * 0.8m (IWS depth) * 0.35 (void ratio)

- = 3.4m^3 >3.2m^3 => therefore IWS depth is adequate.

Figure 10 illustrates the design solution showing indicative raingarden and infiltration device components for a 300m² pavement.

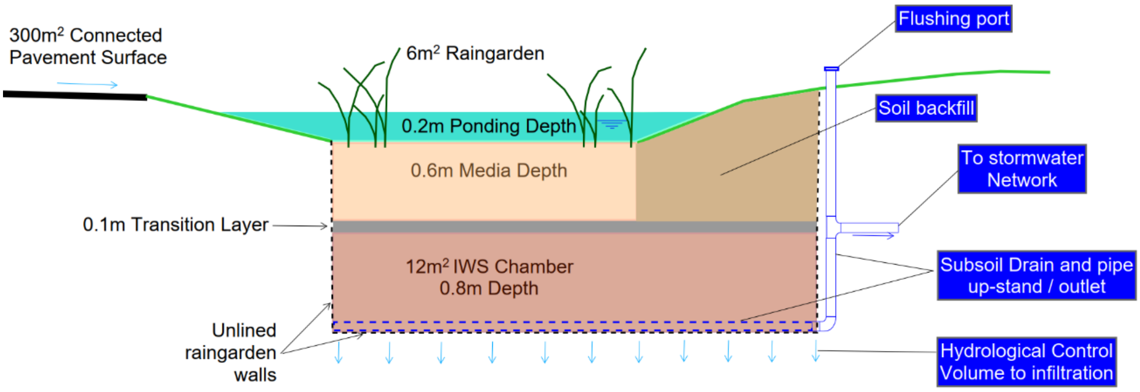

Figure 10: Raingarden design for 300m² pavement

6. Other Stormwater Requirements

Along with hydrological controls, a number of other requirements to manage stormwater may exist for developments. Two key requirements, stormwater quality and hydraulic neutrality, are discussed below.

6.1 Hydraulic Neutrality

Hydraulic neutrality may be required for developments to protect downstream properties from flooding. This will be in addition to any hydrological control measures outlined in this document. Approved solutions for hydraulic neutrality are outlined by Wellington Water (*Managing Stormwater Runoff: The use of approved solutions for hydraulic neutrality, Wellington Water*). Peak flow detention volumes listed in their guidance are required in addition to volumes required for hydrological control, unless extended detention is proposed, in which case the extended detention portion should be modelled in conjunction with the peak flow detention live storage volume.

Hydraulic neutrality can be provided in a separate tank to hydrological controls, with initial flow into the hydrological control tank and overflow to the subsequent hydraulic neutrality tank. Alternatively, if both are provided in the same tank, the volume for hydrological controls (e.g., rainwater harvesting and/or extended detention) should be provided in the lower portion of the tank, with hydraulic neutrality peak flow detention provided above the hydrological control volume. The detention orifice for hydraulic neutrality should then be installed above the hydrological control volume to allow the extended detention portion to function as intended (if applicable) and prevent the tank from fully emptying after rainfall events (in the case of the tank also performing a rainwater harvesting function).

6.2 Stormwater Quality

Schedule 28 of Plan Change 1 to the Natural Resources Plan specifies the level of treatment that must be achieved for zinc and copper (as a proxy for all urban stormwater contaminants) under some PC1 rules. Some city and district council requirements also specify requirements for water sensitive urban design and stormwater treatment.

While this document does not specify how devices can be designed for stormwater quality treatment, several of the solutions listed in this document have positive impacts for water quality as they capture the first flush and divert this water to wastewater (through reuse).

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