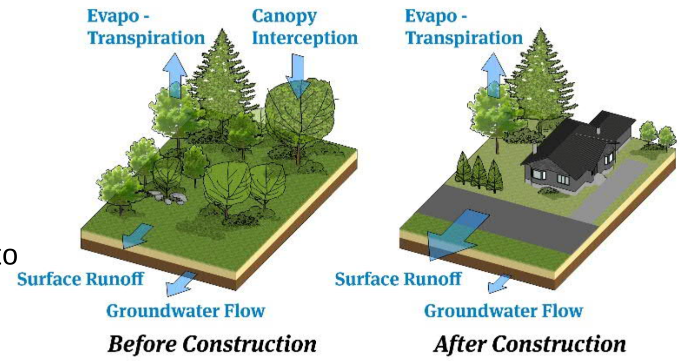
Christchurch City Council Three Waters and Waste Unit

Onsite Stormwater Mitigation Guide

Why do we need to mitigate stormwater runoff?

On undeveloped land, a large proportion of rain soaks into the ground and either flows slowly through the upper soil layers into streams or seeps down into groundwater, as illustrated in the diagram below. Development creates increased impervious (sealed) surfaces that have a number of negative effects on stormwater:

- The volume of runoff is increased as less water soaks into the ground (think of what happens to rain on a roof as opposed to a grass surface)
- The speed at which runoff reaches a stream increases, resulting in changed flows in the stream
- There are increased flows in streams which increase erosion and affect habitats
- Flooding becomes more frequent due to the increased volume of runoff and the speed with which it reaches pipes and waterways
- Urban surfaces (roofs, carparks, roads and driveways) generate or collect contaminants that can become entrained in stormwater during rainfall. Those contaminants are often toxic to aquatic life and will have immediate and long-term adverse effects on ecology and biology.



Even small sites can have a negative effect on stormwater, and the cumulative effects of hundreds of other small sites can be significant. It is therefore important to mitigate these effects to help reduce flooding and contaminants in stormwater.

Flooding can be mitigated by reducing the amount of stormwater runoff from a development site because it helps to recreate the way that rain behaves on undeveloped land. This can be achieved, in order of preference, by:

- Reducing the amount of runoff generated within the site by minimising the area of impervious surfaces;
- Increasing the amount of water soaking into soil, such as through soakage systems, permeable pavement, or rain gardens (where feasible), and/or;
- Holding back as much of the runoff as possible using a stormwater storage system and releasing it slowly back into the network.

Contaminant discharge in stormwater can be mitigated by using materials which do not leach contaminants into stormwater and by installing treatment systems which capture and remove contaminants from the discharge.

This guide presents acceptable solutions for minimising the effects of stormwater runoff from individual sites in Christchurch.

Situations covered by this guide

The solutions presented in this guide are applicable for development on small (less than 1000m²) and medium (between 1000m² and 5000m²) residential or commercial sites. Sites larger than 5000m² and sites undergoing subdivision will typically require a specific engineering design.

Not all development requires onsite mitigation, however. The criteria below are used by Council to determine whether or not a site requires onsite mitigation.

Hill sites (>5°slope) All hill sites are required to implement stormwater storage to mitigate flooding and stream erosion unless:

- The redevelopment does not increase the overall impervious surface coverage of the site, or;
- The development is part of a subdivision development which has been designed to mitigate the stormwater runoff from its allotments (advice from a Christchurch City Council Stormwater Planning Engineer should be sought).

All hill sites adding more than 150m² of new hardstand area must treat the 'first flush' of stormwater runoff from the new hardstand surfaces (or an equivalent area of other pollution-generating hardstand) unless provision of a treatment system is demonstrated to be infeasible.

Flat, urban areas Flat sites are required to provide stormwater storage to mitigate flooding effects if:

- The additional impervious area added is greater than 150m²; <u>and</u>
- The resultant impervious area covers more than 70% of the total site area; <u>and</u>
- The site is not part of a subdivision development which has been

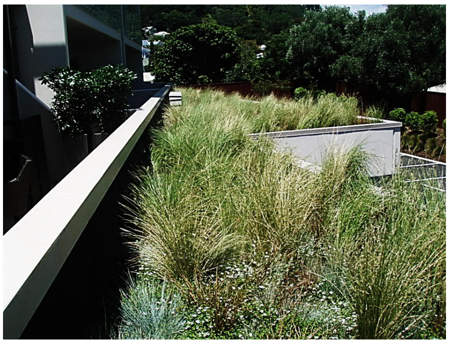
designed to mitigate the stormwater runoff from its allotments (advice from a Christchurch City Council Stormwater Planning Engineer should be sought).

Flat sites adding more than 150m^2 of new hardstand area must treat the 'first flush' of stormwater runoff from the new hardstand surfaces (or an equivalent area of other pollution-generating hardstand) unless provision of a treatment system is demonstrated to be infeasible.

Recommended solutions to mitigate flooding effects

Reducing impervious area

Reducing the impervious area is the most efficient way to reduce runoff. This stops the problem (increased hard surfaces) right at the source. A number of options can be considered as shown below. The applicability of each solution to either flat or hill sites is given also.



Green roofs

A green roof is a roof that is covered by vegetation and a growing medium (e.g. soil). Green roofs can be applied on anything from a garage to a skyscraper.

Green roofs reduce runoff from rainfall by trapping it on the leaves, in the soil, or in the plants themselves. They can also help to slow down the rate of runoff, mimicking natural systems.

Areas covered by a green roof will be considered fully pervious for the sites covered in this guide.

Applicability: Flat and hill sites.

Permeable paving

Permeable pavements are paving systems that allow stormwater to soak through to an underlying coarse gravel layer, before slowly draining away into the natural underlying soils, providing the underlying soil is suitably free draining and the paving is installed in accordance with manufacturers' recommendations.

Permeable paving significantly reduces runoff compared to conventional hardstand surfaces, and can improve stormwater quality. However, the feasibility of permeable paving must be demonstrated. Permeable paving may not be appropriate for sites which have very high groundwater and/or very low-permeability underlying soils.

Areas covered by an approved permeable paving system will be considered fully pervious for the sites covered in this guide, and also do not require treatment.

Applicability: Flat sites only.

Open-slat decking

Open-slat decking is an alternative to paved areas that allows rainfall to drain through the slats and be soaked up by the ground.

Allowing rainfall to soak into the ground substantially reduces the amount of runoff from hard landscaped surfaces.

It is critical that where open-slat decking is relied upon, that the underlying soils remain in a natural, uncompacted and unsealed condition.

Areas covered by open-slat decking will be considered fully pervious for the sites covered in this guide.

Applicability: Flat and hill sites.

Infiltration/Soakage to ground

Soakage to ground is a preferred option in flat urban areas where the underlying site soils are permeable and groundwater is 1m deep or greater. An experienced professional needs to be engaged for advice on.

Applicability: Flat sites only.

Onsite Rainwater Storage

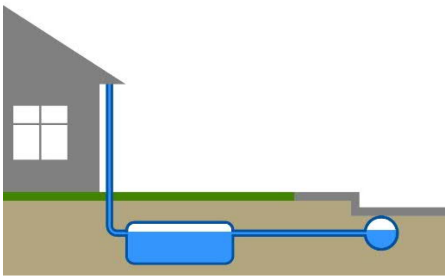
If it is not possible to reduce the impervious area or to soak to ground, then an alternative means of reducing runoff will need to be installed. Because of the limitations of other measures, onsite rainwater storage is likely to be the most feasible solution for new developments and re-developments adding over 150m^2 of new impervious surfaces.

Ideally, onsite rainwater storage will be sufficient to attenuate post-development peak flows back to pre-development flows for all storms up to and including the critical duration storm for the catchment. Critical durations of rivers in Christchurch range from 9 hours in the Upper Ōtākaro/Avon to 60 hours in the Huritini/Heathcote.

It is acknowledged, however, that long duration, low intensity storms will be difficult to mitigate as the flow rates generated by small impervious catchments are minimal, and would require very small outlets which are not practical and could be prone to blockage. The net stormwater attenuation volumes presented in this document are designed to effectively mitigate the widest range of storms practical, while maintaining simple storage and outlet configurations. They can therefore be considered to represent an 'acceptable solution' to achieve the Council's overall attenuation objectives. In general, the guidance here seeks to attenuate the post-development peak flows to pre-development levels for 20%, 10% and 2% AEP events with 1hr, 2hr, 3hr and 6hr storm durations.

Net stormwater attenuation volumes have been determined for both below-ground and above-ground stormwater attenuation devices, recognising that servicing constraints may dictate how storage is provided within a site. In all but extreme cases, pump systems should be avoided and systems should be designed to operate by gravity, with minimal moving parts and avoidance of electronically or mechanically controlled systems.

The calculations for storage systems require that a "pre-development" impervious area be established. Unless otherwise directed by the Council engineer, pre-development site coverage should be based on the existing development extent or development extent prior to the Canterbury earthquake sequence for sites where buildings have been demolished. The pre-development condition of a site may in many cases be assessed using aerial photographs or topographic survey.

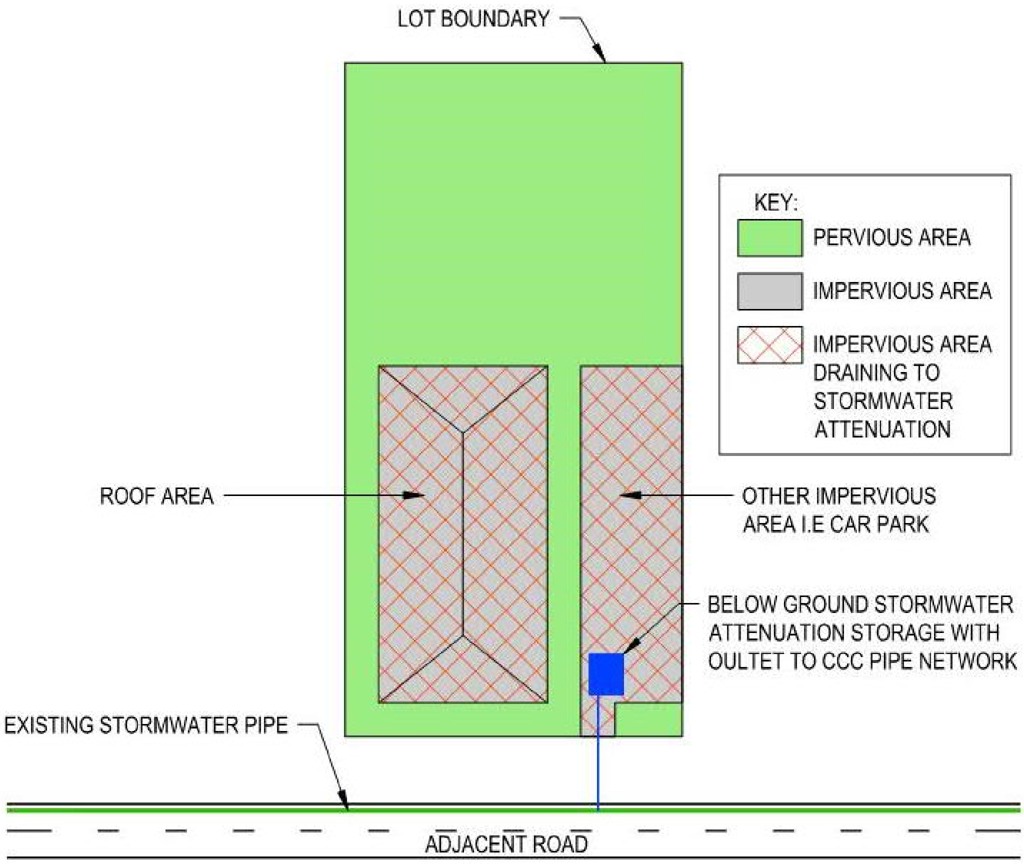


Below ground storage

The use of below-ground stormwater attenuation is preferred as this allows all impervious areas within the site to drain to the attenuation device. However, below-ground stormwater attenuation devices are not always viable in Christchurch due to shallow stormwater networks and kerb-only outfalls.

Below ground storage in the form of tanks, bladders, cells or pipes can collect runoff from both roofs and paved areas. These work where there is a stream or a pipe outfall that is deep enough to which to discharge.

Applicability: Flat and hill sites.



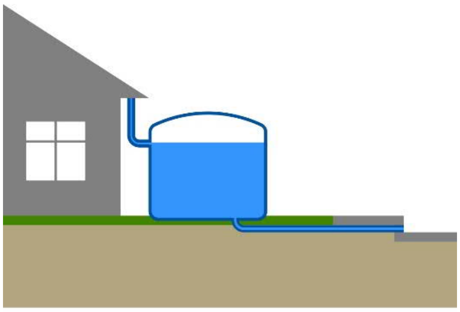
Net stormwater attenuation volumes for below-ground attenuation devices are presented below in Table 1.

Table 1: Net Volumes for Below-ground Stormwater Storage

Site Size	Storage Depth	Orifice Size	Net Storage Volume per 100m² Increase in Impervious Area (m³)
Small <1,000m²	0.7m	100mm	5m³
	1.5m	75mm	6m³
Medium 1,001m² – 5,000m²	0.7m	100mm	8.3m³
	1.5m	75mm	10m³
Large >5,000m²	Site-Specific Engineered Design is Required		

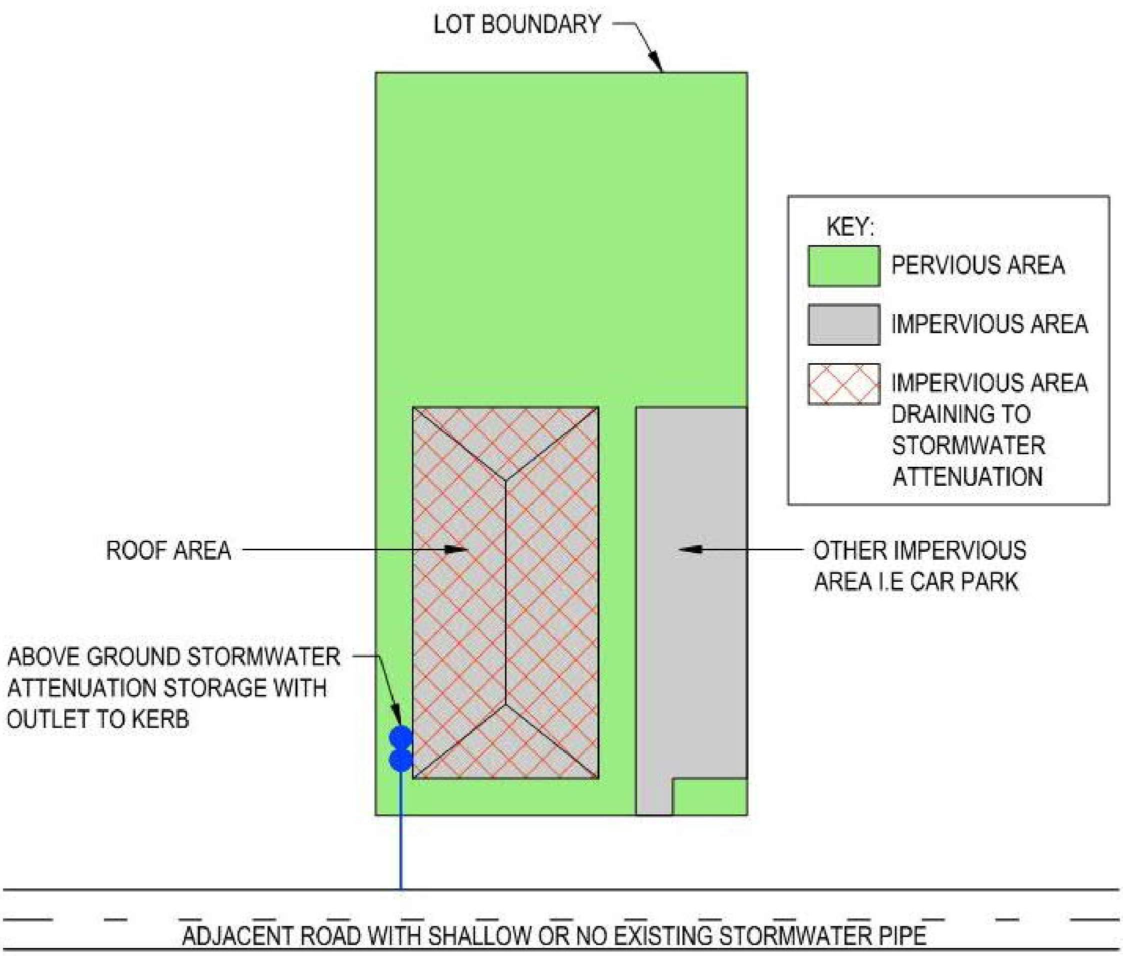
For below-ground stormwater attenuation tanks with a storage depths between 0.7m and 1.5m, the net stormwater attenuation volume can be interpolated from the values provided in Table 1. Below-ground tanks with a storage height exceeding 1.5m will require specific design.

Above ground tanks



In areas where below-ground stormwater attenuation devices are not viable above-ground stormwater attenuation tanks should be used. These tanks will capture runoff from roof areas only and discharge attenuated stormwater flows to the adjacent kerb and channel. It is important that 100% of roof areas drain to the stormwater attenuation tanks where possible. Stormwater runoff from external impervious areas can be discharged to the adjacent stormwater network or kerb without attenuation after treatment has been provided. There is a large range of water tanks commercially available that can be used as above-ground stormwater attenuation tanks. Common locally available tank sizes are 3, 5, 9, 10, 25 and 30m3. These tanks typically have heights ranging between 2 – 3m with a large range in diameters. There is also a range of Slimline tanks available with volumes typically ranging between 2 – 5m3.

Applicability: Flat and hill sites.



Net stormwater attenuation volumes for above-ground attenuation devices are presented below in Table 2.

Table 2: Net Volumes for Above-ground Stormwater Storage

Site Size	Tank Height	Orifice Size	Net Storage Volume per 100m^2 Increase in Impervious Area
Small <1,000m^2	1.8m-3m	15mm	5m^3
Medium 1,001m^2 – 5,000m^2	1.8m-3m	20mm (15mm where multiple independent tanks are used)	5.7m^3
Large >5,000m^2	Site-Specific Engineered Design is Required		

The following are design requirements for above-ground stormwater attenuation tanks:

- A volume of 1m^3 is required below the low-flow outlet to hold down any unsecured stormwater attenuation tank. This volume is not required for tanks that are secured to the ground or to structures.
- For small sized sites, a single 15mm internal diameter low-flow outlet is required to drain the stormwater attenuation tank. The outlet should be provided at an elevation above the 1m^3 storage volume. Therefore the height of this outlet will vary depending on the base area of the tank selected.
- For medium sized sites, a single 20mm internal diameter low-flow outlet is required to drain the stormwater attenuation tank. The outlet should be provided at an elevation above the 1m^3 storage volume. Therefore the height of this outlet will vary depending on the base area of the tank selected.
- Orifice outlets should be designed to be "always open" and not fitted with taps or valves, to ensure that the tanks function without any operator input.
- For small or medium sites when more than one tank is used, each tank should have a 15mm internal diameter low-flow outlet.
- Installation of a single 100mm diameter high-flow outlet for each tank with 400mm (maximum) driving head i.e. height between the high-flow outlet invert and the top of tank.
- The net stormwater attenuation volume must be provided between the low-flow and high-flow outlets from the tank.

The net stormwater attenuation volumes are not significantly affected by the low-flow outlets since they have a small capacity. Therefore stormwater attenuation can be provided using a number of attenuation tanks provided the total required net stormwater attenuation volume is achieved. The number of tanks should however be minimised where possible, or hydraulically linked together for shared storage in order to reduce the combined capacity of the high-flow outlets. Note that stormwater attenuation designs with more than four tanks require specific design.

The stormwater attenuation objectives can only be achieved when the proportion of impervious area that is roof (and drains to the tank) is over 50% of the total impervious area at the site. This is expected to be achievable for most urban intensification projects, however for sites where the proportion of impervious area that is roof (and drains to the tank) is less than 50% at the site, consideration should be given to reducing external impervious areas, increasing the proportion of roof that drains to the tank and/or alternative stormwater management measures such as permeable pavement for external impervious areas. If none of the above options are viable, and dispensation is given by the Council engineer, then an above-ground stormwater attenuation tank sized as per the values in Table 2 may be used.

Recommended solutions to mitigate stormwater contaminants

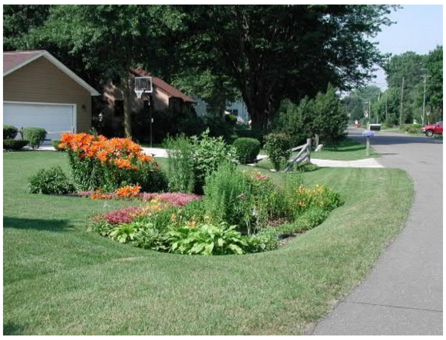
Use non-polluting building materials

Copper, steel and other metal roofing and cladding materials can leach dissolved metals into stormwater. Once dissolved in water, metals are difficult to remove and can have adverse short and long-term effects on the environment. Avoid using copper or galvanised roofing, cladding or downpipes. Steel and zinc-treated materials should be painted or enamel coated. Coated steel products such as Colorsteel® generate very little zinc if they are maintained and replaced in accordance with the manufacturer recommendations. Other non-metal roofing materials such as timber or clay also do not generate significant contaminants into stormwater and should be considered.

Treatment of stormwater runoff from driveways and car parking

Sites of any size that are adding more than 150m2 of new hardstand area must treat the 'first flush' of stormwater runoff from the new hardstand surfaces (or an equivalent area of other pollution-generating hardstand). The Council may exercise discretion on these treatment requirements where hardstand areas are not trafficked by vehicles and discharge into landscape areas via "sheet flow" (not concentrated by drains or kerbs), or where a treatment system is demonstrated to be hydraulically infeasible without the use of pumping.

Treatment systems broadly fall into two categories, volume-based treatment systems and flow-based treatment systems. For volume-based treatment systems, the *first flush* is defined as the volume of stormwater generated from the first 25mm depth of rainfall on the impervious areas of the site. For flow-based treatment systems, the *first flush* is the flow rate generated from rainfall intensities up to 5mm/hr.

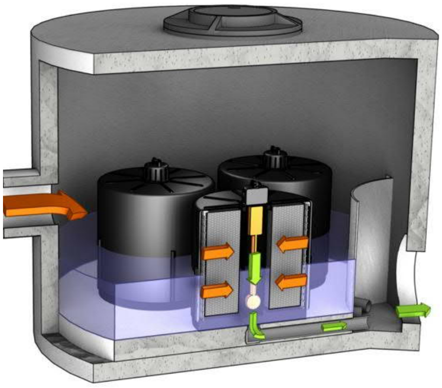


Rain Gardens

Rain gardens are designed to capture stormwater runoff and let it slowly seep into a specially designed soil mixture. Plants also soak up the water to reduce runoff and absorb contaminants.

Rain gardens should be designed in accordance with the Christchurch City Council Rain Garden Design, Construction and Maintenance Manual (2016).

Applicability: Flat sites only.



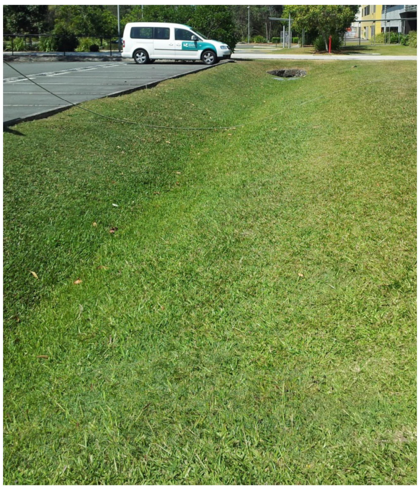
Proprietary Treatment Devices

Proprietary Treatment Devices are engineered systems which remove contaminants using a variety of physical and chemical means. Because the Council is targeting both suspended sediments and dissolved metals, devices that remove both types of contaminants are preferred. Pre-approved proprietary treatment devices are:

Stormwater360® Stormfilter™ with ZPG Media
Hynds UpFlo® Filter with CPZ Media
SPELFilter
SPEL Hydrosystem
Stormwater360® Filterra™

For any other devices, specific approval from the Council Engineer will be required.

Applicability: Flat and hill sites.



Swales and Filter Strips

Swales and Filter Strips can be effective at treating small or narrow areas of hardstand. Swales and filter strips are designed to capture contaminants by slowing the flow of stormwater along a densely-vegetated channel.

Swales and Filter Strips should be designed in accordance with Auckland Council TP10 – Design Guideline for Stormwater Treatment Devices, except for the following design parameter adjustments:

- Water quality design storm shall use the flow rate generated from 5mm/hr rainfall intensity.
- Swales may be flatter than 1% longitudinal grade, but

subsoil drainage is recommended. Swales flatter than 1V:300H (0.3%) are not recommended without specific engineering design.

Applicability: Flat sites only.

Other treatment systems such as soil adsorption basins and wetlands are accepted but will require a specific design from an experienced engineer.

Where to go for more advice

Christchurch City Council can provide advice to developers about how to reduce the harmful effects of runoff from residential, commercial and industrial properties. More details and advice can be found at www.ccc.govt.nz/services/stormwater-and-drainage/ or by emailing stormwater.approvals@ccc.govt.nz.