Swale Design Guide

Auckland Transport

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Contents

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01

Background and scope

Auckland Transport and Auckland Council staff report varying conditions in the device selection, design approach, quality of construction, and ease of maintenance of vested stormwater treatment assets. As a result, there are concerns around this variability and potential issues for asset integrity, ongoing operation, maintenance, and undertaking future upgrades in the road corridor.

This design guide describes preferences for swales located within the road corridor. It is intended to assist the design process by advising on the appropriateness of these devices to treat runoff from public roads and by specifying limitations on design choices. Many issues associated with swales are also true for filter strips. Therefore the scope of this guide includes both types of device.

This advice is supplementary to, and draws upon, the following documents:

- Auckland Council, Stormwater Management Devices in the Auckland Region (2017) (GD01) link
- Auckland Council, Water Sensitive Design for Stormwater (2015) (GD04) link
- Auckland Transport, Roads and Streets Framework link
- Auckland Transport, Transport Design Manual (TDM) link

The above documents address stormwater treatment device selection, siting, and design. This supplementary guidance is not a substitute for those detailed design documents.

Stormwater design is part of a wider and often iterative approach to determine the most appropriate lot and roading layout for the nature of the surrounding environment, the specific stormwater catchment, and Auckland's commitment to sustainable development and green infrastructure. The achievement of positive social, cultural and environmental outcomes should be considered. This is consistent with Auckland Council's approach, which is defined by strategic documents that include:

- Auckland Council Plan 2050–Outcomes: Environment and Cultural Heritage link
- Auckland Council Plan 2050–Outcomes: Transport and Access link
- Low Carbon Strategic Action Plan – Our built environment and green infrastructure link

02 Overview of swales

Swales in the road corridor are intended to mimic natural processes as well as adding to the streetscape. These stormwater treatment devices are primarily intended for conveyance of runoff, with some ability to provide quality treatment.

Swales can take a number of forms and may be similar in appearance to other types of stormwater treatment devices, particularly filter strips. Although there are some differences between swales and filter strips, in practice the terms may be interchanged.

Defined below are variants that may be proposed for the road corridor

2.1 Grassed swale

The traditional swale is constructed using in-situ underlying soils, with shallow battered sides and a grassed surface. Stormwater flows are directed into the swale at multiple locations along its length. Grassed swales may feature an underdrain (to dewater the swale in between rain events), check dams, and scour/erosion protection measures.

The grassed swale's primary function is to convey water whilst providing some slowing of stormwater flow. It does also provide some (limited) quality treatment, achieved via the grassed surfaces on swale sides and base. Depending on the underlying soil characteristics, and design function, some infiltration of runoff may occur.

2.2 Planted swale

A planted swale is constructed using in-situ underlying soils. The plants provide a higher level of quality treatment than grass, and potentially further slowing of stormwater flows. Planting of swale side batters can allow them to be steeper than grassed swales, as grade restrictions associated with mowing have been removed. This in turn reduces the overall space/width requirements.

Planted swales may also feature an underdrain (to dewater the swale in-between rain events), check dams, and scour/erosion protection measures.

2.3. Bioretention swale

A more engineered option is a bioretention swale, constructed with imported biofiltration media and specialised planting. The bioretention swale can provide a higher level of quality treatment and achieve greater slowing of stormwater flows than grassed and planted swales. The biofiltration media and underlying layers may also be designed to provide storage capacity. A bioretention swale may look similar in appearance to a cut side raingarden, although is typically longer and with multiple inlets.

GD01 notes that: "Bioretention swales are designed primarily to provide retention (through infiltration) and detention of flows (via the underdrain). Only flows in excess of the infiltration capacity are conveyed along the surface of the swale. Bioretention swales therefore perform a hydrological function (i.e. retention and detention of flows), as well as a water quality function."[1]

Bioretention swales are not addressed in detail within this practice note, and the "Auckland Transport Design Guidance for Bioretention Devices in the Road Corridor" should be referred to.

2.4. Filter strip

Filter strips are similar in appearance and function to swales, and may also be grassed or planted. GD04, and its predecessor TP10, states that "the principal difference between swales and filter strips is that swales accept concentrated flow while filter strips accept flow as distributed or sheet flow ..[2]"filter strips may employ a level spreader, contour drain or exfiltration trench at the point of stormwater discharge to ensure an even dispersal of flows.[3]"

To achieve distributed sheet flow, filter strips are more often located alongside uninterrupted lengths of impervious surfaces such as walkways/ cycleways, carparks, or park edge road. Although siting and inlet considerations may differ, there are similarities for construction and maintenance. Therefore, much of this practice note is applicable to both swales and filter strips.

For the purposes of this guide, filter strips are considered to be a variant of a swale.

[1] Source: Auckland Council stormwater guidance document GD01, C6.0 Technical guidance: swales

[2] Source: Chapter 9 of Auckland Council stormwater guidance document TP10 – link

[3] Source: Filter strips section of Auckland Design Manual – link

03

What is considered appropriate for the road corridor?

It is essential that the decision to construct swales within the road corridor is made on the basis of a comprehensive options assessment for stormwater treatment devices. This assessment is required to follow evaluation principles and desired outcomes (for management of water quality, water quantity, or both) as prescribed within Auckland Council stormwater guidance, including GD04, GD01, and the Auckland Network Discharge Consent (NDC).

Auckland Transport will consider not only the effectiveness of the swale's stormwater function, but also asset integrity and maintenance requirements, life cycle costs, and health and safety (to road users and during maintenance etc.). Consideration is given not only to internal design elements, but also to implications for the construction, maintenance and use of adjacent road space e.g. the berm, footpath, kerb and channel, and pavement. This multi-faceted approach brings together a range of environmental and effect-based objectives established under the Resource Management Act (1991)[4], as well as asset owner and value for money considerations established under the Local Government Act (2002).

As an overview, Auckland Transport reviews proposals for roadside swales in terms of:

- appropriateness of swale selection for the specific location/site
- ability to ensure effective entry and exit of runoff to/from road
- safety implications of other road users at the device edge
- ease to maintain – addressing both safety in design, and capital and operational costs
- structural integrity – of both the swale and the adjacent road pavement

[4] RMA objectives filtering down through various national and regional statutory documents

Table 1 outlines constraints that limit the suitability of swales and filter strips for the road corridor. If the stated design approaches are unable to be achieved, then Auckland Transport considers swales unsuitable for use in the road corridor.

TABLE 1 CONSTRAINTS ON THE SUITABILITY OF SWALES WITHIN THE ROAD CORRIDOR

Type	Implications	Design approach
Catchment properties	• determines overall stormwater approach, including suitability of swales – both in general, and by specific type	• as per GD04, NDC requirements etc.
Longitudinal slope / road grade	• affects runoff flowrate and ability to provide any treatment or detention	• grassed roadside devices are limited to 5% longitudinal slope and planted devices to 8% • road grades above 8% are not considered suitable for swales or filter strips. This aligns with maximum grade for new footpaths[5]
Density & form of development	• can increase competing demands on space available for devices • may create more interruptions to swale length	• integrated design approach is required between layout and stormwater design – e.g. rear access lots can overcome competing use and length interruptions • frequent vehicle crossings limits ability to achieve minimum length requirements (e.g. GD01: 30m minimum swale length)
Road characteristics	• practicality of design – what type of swale will fit? • traffic safety – errant driver recovery • high contaminant loads increase maintenance requirements	• consider available width and swale type, as a combination of: ◦ batter slope ◦ width between traffic lanes and device edge ◦ presence of kerb / edge protection • apply safe system approach[6], ensure that drivers can safely recover should their vehicle leave the road and enter the device • device selection assessment, including life cycle costings for contaminant removal
Compatibility with other road infrastructure[7]	• competing space requirements • health and safety considerations, e.g. drop-off from footpath • ease of maintenance – refer below	• provide a suitable buffer or edge treatment, in accordance with the TDM • Issues may arise with grassed swales used for parking - some form of physical barrier required
Maintenance	• safety of workers • ongoing cost, including traffic control • potential disruption to the community	• grassed devices require shallow batter slopes for mowing - no more than 1:5 gradient (V:H). • planted swales and filter strips are maintainable up to 1:3 batter gradient (V:H) • life cycle costings for maintenance to inform device selection

[5] TDM Section 3.4 Footpath Gradients, Link

[6] Link

[7] Footpaths, walk/cycleways, parking, street lighting, street furniture, space for kerbside waste bin collection etc.

04

What are Auckland Transport's design considerations?

If it can be demonstrated that the potential constraints outlined in Table 1 are able to be overcome, Auckland Transport then considers specific design elements for swales.

Figure 1, illustrates internal design elements of a grassed or planted swale.

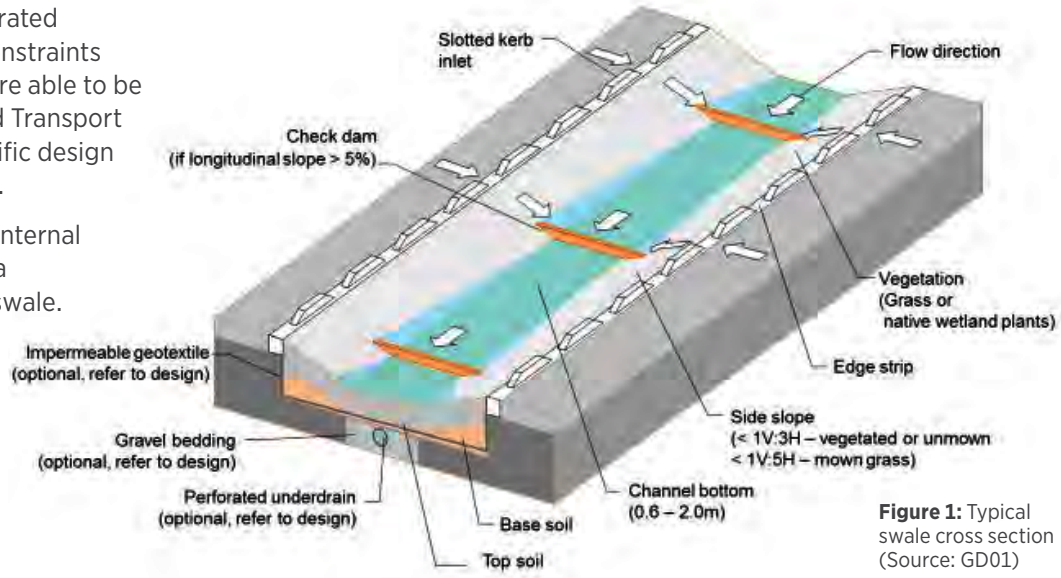


Figure 1: Typical swale cross section (Source: GD01)

TABLE 2 AT DEFINED DESIGN ELEMENTS OF SWALE IN THE ROAD CORRIDOR

Internal design elements, common to all swales
Inlet
Edge strip
Channel bottom
Side slope
Vegetation
Optional internal elements
Underdrain (including gravel bedding)
Impermeable geotextile
Check dam (slope dependent)

External design elements, for swales in the road corridor
Interface with edge strip (road carriageway side)
Interface with edge of footpath or cycle facility
Interface with vehicle crossing / pram crossing
Structural support (for both the device and the road carriageway)
Swale outlet (including underdrain connection if applicable)

A bioretention swale has additional design features that are addressed within Auckland Transport's "Bioretention Design Guide".

Auckland Transport also considers the relationship between the swale or filter strip and other road features, referred to as 'external' design features. Table 2 describes the combination of internal and external design elements that are considered.

05

What does Auckland Transport want?

5.1 Overarching design approach

Consideration of stormwater early in the development design process is crucial to ensure an appropriate road layout that does not result in compromised stormwater management. If Auckland Transport's overarching design preferences cannot be achieved, roadside swales may not be a suitable option.

Desired approach	Design basis
Check that supporting documentation demonstrates clear reasoning and justification for selection over other stormwater (treatment) options.	This is in accordance with a best practicable option (BPO) approach, guided by whether stormwater goals for the site relate to quality, quantity, conveyance.
Check that supporting documentation demonstrates consideration of whole of life costs, including implications for maintenance and renewal.	Applicants need to demonstrate a considered decision-making process, including life cycle costings and provision of an O&M[8] guide. Traffic management is to be considered, as costs may exceed that for maintenance itself, particularly for mowing of grassed swales.
Check that road layout and device design are considered together to achieve an integrated stormwater management design	Device effectiveness can be optimised by well-considered layout and roading design, e.g., single crossfall road directing flows to a continuous swale alongside a park edge, walk and cycle facility etc.
Check that geotechnical aspects have been adequately considered.	This is for infiltration ability (if required) and to ensure that structural integrity of the road corridor is maintained, particularly during construction and maintenance or renewals.
Check that aftercare is provided for.	Anecdotally, devices are being damaged during house construction phase. Suitable provision may include: fence during house building, bond for damage repair, and conditions for protection of road assets passed on to Building Consent stage. Compromised plant health causes concern for Tikanga Maori principles, effective stormwater treatment, and replanting costs.

[8] Operations and Maintenance guide

5.2 Internal features

Below are internal swale design features that Auckland Transport gives consideration to, on the basis that they can lead to poor outcomes if not appropriately addressed during design.

5.2.1 INLET

- For intermittent kerb and channel inlets, check that inlet is specifically shaped to direct flows from the channel to the side slope.
- For sheet flow entry, check that there is sufficient fall (minimum of 2 degrees) to direct runoff to the side slope.
- Check that there is a definite drop off from the road edge to mitigate the effect of vegetation growth/sediment build up between maintenance cycles, which can restrict road run off from entering the swale.
- Check whether erosion protection will be required. If needed, check that inlet erosion material can facilitate the removal of accumulated sediment, and that is of sufficient size and appropriate design to stay in place over time.

5.2.2 EDGE STRIP

- Check edge strip requirements, based on swale type and desired inflow characteristics. As per the TDM, "For vehicle kerbing, interruptions must normally not exceed 300mm in length and be at least 600mm apart..".[9]
- Check that edge strip / edge beam has been designed to provide restraint against lateral movement.

5.2.3 CHANNEL BOTTOM

- Check that the channel bottom has a minimum longitudinal grade of 1%.
- Check that there are no streetlights or trees located in the channel bottom.
- Check that that are no stormwater or wastewater lines underneath that will result in manholes in the swale.
- If an underdrain is provided, check that the channel bottom uses sand-amended topsoil to facilitate drainage through the topsoil to underdrain.

5.2.4 GEOTEXTILE

- Check that design takes into account geotechnical conditions. The need to use an impermeable geotextile liner would suggest that a swale may not be appropriate.

5.2.5 SIDE SLOPE

- Check that side slope does not exceed 1:5 gradient (V:H) for grassed swales, or 1:3 gradient (V:H) for planted swales.
- Check that the start of the side slope is offset from the back of kerb by 300mm, to minimise slumping at back of kerb.
- Check that swales are well defined so that they are recognisable as swales but still shaped to allow neighbouring owners to mow them.
- Check that there are no streetlights or trees located within the side slopes.

5.2.6 VEGETATION

- Check that design takes into account ability to support plant growth and optimise survival rates – refer to Auckland Transport's Bioretention Planting Guide.
- Check that any grass or planting on slide slopes will not result in vegetation encroaching over adjacent road features and/or impacting on visibility.

5.2.7 UNDERDRAIN

- Check that pipe size/material is 100mm internal diameter perforated drain pipe, and complies with NZTA/TNZ Specification F/2.
- Check if the underdrain needs a steeper grade than the channel bottom minimum grade, to avoid ponding in flat areas.
- Check that an intermediate flushing point is provided for long lengths of underdrain.
- Check that design shows how access is provided for flushing and cleaning.
- Check that bends are 45 degrees or less, to facilitate maintenance.

5.2.8 CHECK DAM

- Check that a clear design basis is shown for proposed use of check dams (including frequency), related to road slope and swale / filter strip type – not appropriate for grassed devices, due to mowing issues.
- Check that material used for check dam is appropriate for use in a swale / filter strip, e.g. durable, inert / non-toxic, readily available (for replacement).

[9] TDM EDC Road Drainage, Surface Water Control, Section 5 Kerbs and channels

5.3 External features

Below are external design features that Auckland Transport gives consideration to, in terms of how the device interacts with the surrounding road corridor. These elements have been identified as those that, if not adequately addressed during design, can lead to poor outcomes for construction and use, and maintenance and renewal (for both the swale and surrounding road features).

5.3.1 INTERFACE WITH EDGE STRIP (ROAD CARRIAGEWAY SIDE)

- Check that lateral support/kerb and channel design will withstand vehicle wheel impact.
- Check that the kerb inlet channel inverts are well-shaped to direct flow into the swale.
- Check that inlet is suitably shaped/sized for ease of maintenance – e.g. shovel width.
- Check that there are no potential conflicts between roadside parking and swales, including any safety risk to people exiting from an adjacent parked vehicle. Either a 500mm buffer should be provided, or parking should not be permitted.
- Check that the risk of swales being inappropriately used for parking has been considered, particularly if grassed. Some form of protection is required, particularly in more populated areas and where street parking is commonly used – e.g. no parking zones combined with intermittent kerb, dense planting alongside the device, or other physical barrier. Parking within swales is expected to be less of a risk for planted devices. NSAAT markings alone are insufficient as these rely on compliance.

5.3.2 INTERFACE WITH EDGE OF FOOTPATH OR CYCLE FACILITY

- Check that there is a 500mm buffer between the edges of the swale and any adjacent footpath / cycle facility. This is to mitigate safety risk to pedestrians and people on bikes[10], and eliminate the need for path edge thickening. This item is more applicable to vegetated swales with steeper sides.

5.3.3 INTERFACE WITH VEHICLE CROSSING / PRAM CROSSING

- Check that there are no pedestrian 'bridges' across swales.
- Check that vehicle crossing detail minimises the risk of standing water.

5.3.4 STRUCTURAL SUPPORT

- Check that the side slopes of planted swales are designed to ensure slope stability, particularly adjacent to/within the zone of influence of the road carriageway.

5.3.5 SWALE OUTLET

- Check that sufficient outlets are provided at suitable locations/frequency.
- Check that scruffy dome manholes are used. Catchpits in swales are a maintenance issue.
- Check that provision is made for connection of underdrain (where used).
- Check if there is a need for an alternative path for stormwater flow in the event of blockage, to avoid flood risk to downstream properties.

[10] Safety concerns arise where there is a drop-off height between path and swale bottom, and risk of path users inadvertently 'falling' into the swale.

06

Roadside swales examples

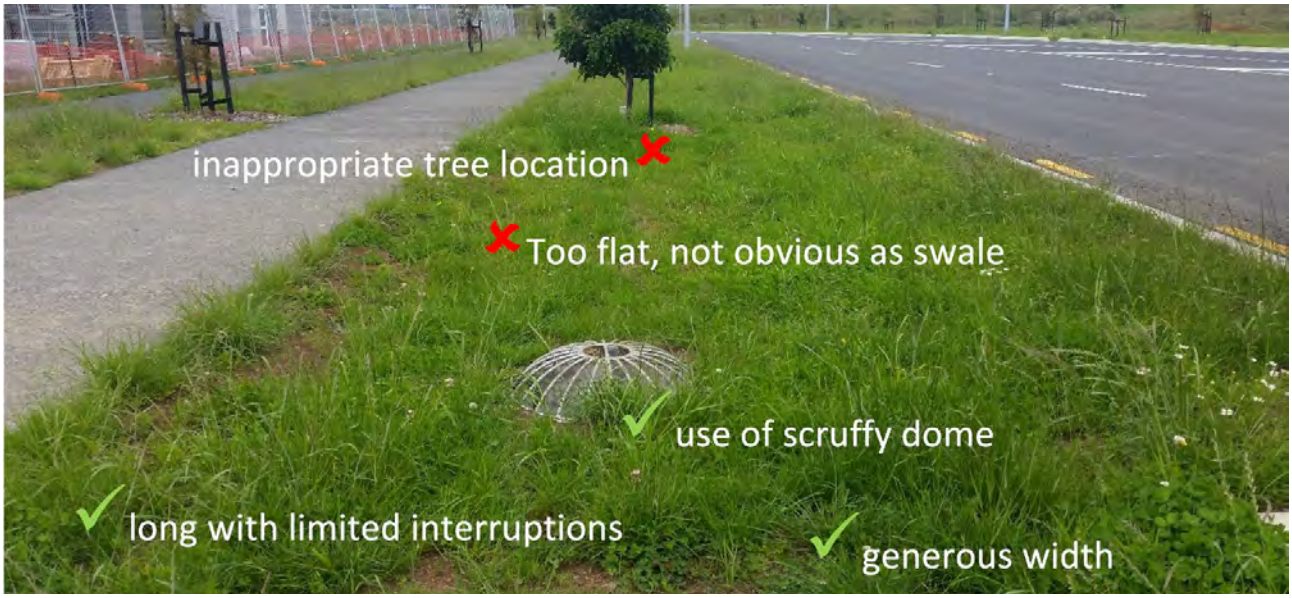
Shown below are a variety of roadside swales in the Auckland region. They illustrate some of the design features desired by Auckland Transport, as well as some that are not so desirable.

Grassed roadside swale

Planted roadside swale

Wide planted roadside swale

Grassed roadside swale, next to shared path



Long planted roadside swale

Well shaped & sized planted roadside swale

Planted roadside swale, outlet

Planted roadside swale, park edge