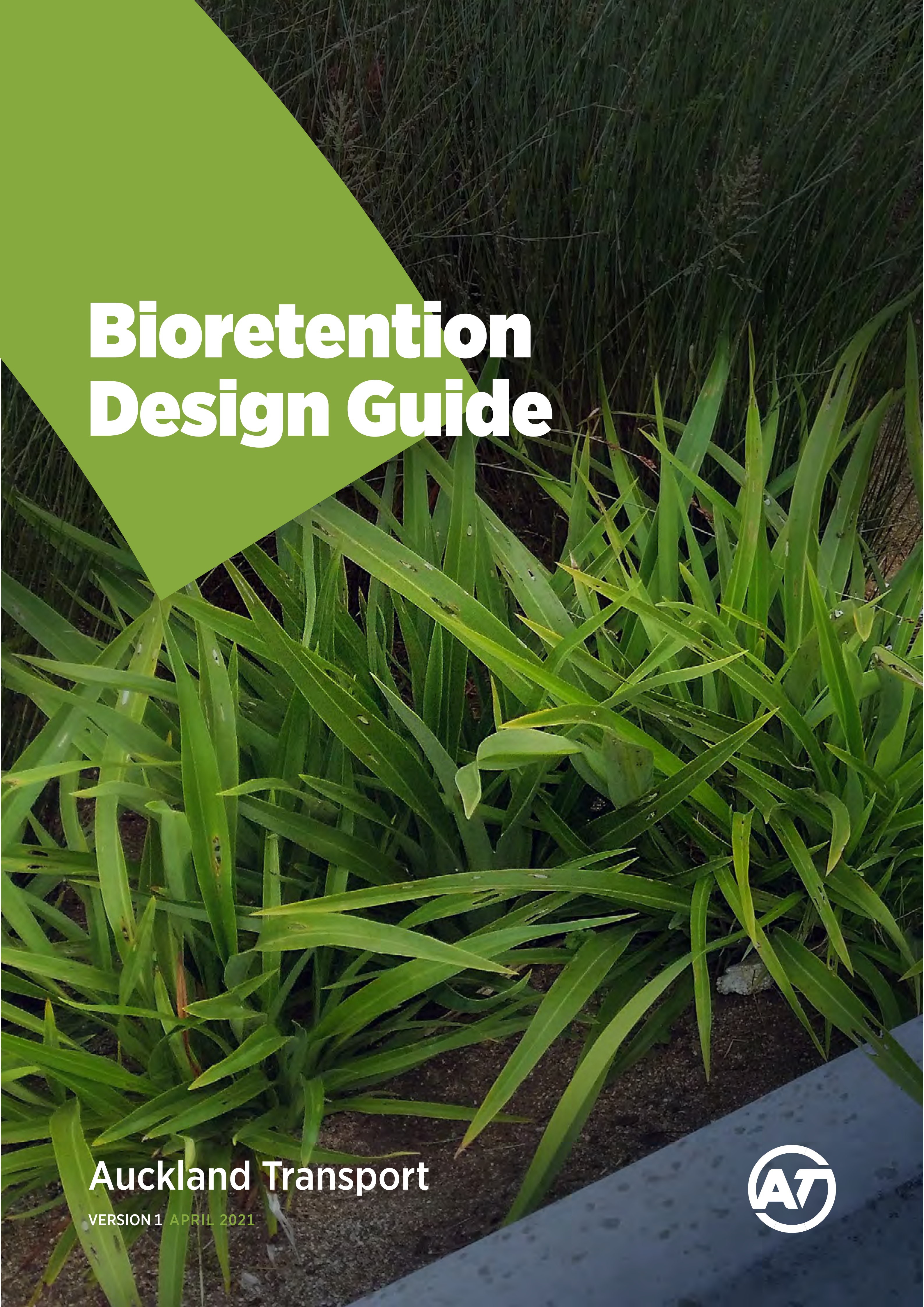

Bioretention Design Guide

Auckland Transport

VERSION 1 APRIL 2021

Contents

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Context and document purpose

This document is intended to assist with the design of raingardens located within the road corridor[1]. It provides insight into design details that Auckland Transport looks at when assessing consent and engineering approval applications for the capture and treatment of runoff from impervious surfaces.

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
- Auckland Transport Bioretention Planting Guide

The above documents address stormwater treatment device selection, siting, design and plant selection. 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

[1] Road corridor: area between opposite private boundaries, including the road pavement, footpaths, berm, cycle facilities (if applicable) and vehicle crossings

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Overview of raingardens

Raingardens in the road corridor are intended to mimic natural processes to treat road runoff, as well as adding to the streetscape. These stormwater treatment devices are primarily intended for quality treatment, due to their ability to remove pollutants by absorbing and filtering runoff through carefully selected plants and soil media. This quality treatment role is particularly relevant for runoff from high vehicle usage roads, e.g. for the removal of heavy metals from wear on tyres and brake pads, and polycyclic aromatic hydrocarbons ('PAHs') originating from vehicle exhausts and oil leaks.

Raingardens are sometimes proposed to help reduce the volume of road runoff into the receiving environment. However, their ability to do so is dependent on the nature of the underlying soils. Auckland Council's Healthy Waters unit are (anecdotally) seeing issues with the ability of roadside raingardens to store runoff[2]. It is understood that this is a result of low infiltration rates, particularly where development areas are heavily earth-worked, underlying soils have low permeability, or the raingarden media itself has low permeability (specification/construction issue).

Raingardens are traditionally constructed in-situ, cut into the natural ground with battered sides and a trapezoidal cross-section. An alternative to the cut batter raingarden is a purpose built concrete 'box' raingarden[3], which can be pre-fabricated or cast in-situ. There has been a marked increase in the uptake of pre-fabricated concrete box raingardens for use in the road corridor. There are a number of concerns around this emerging trend, particularly where many small concrete box raingardens are proposed with limited evidence of other options being considered, and limited consideration of potential adverse community impacts–e.g. increased time, costs and disruption to maintain many small roadside raingardens.

It is essential that the decision to construct raingardens 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).

In addition, Auckland Transport considers concrete box raingardens to be proprietary devices, classified as a Tier 2 treatment / management option under Auckland Transport's TDM. Tier 2 proprietary devices are assessed for acceptance by Auckland Transport on a case by case basis. Discussion is required to ensure the proposed design requires this option and how/where it will be located within the road corridor.[4]

[2] Personal correspondence with S. Speed and C. Giannakidou, Healthy Waters, Auckland Council, Zoom discussion 22.07.2020.

[3] 'Box' is considered to also include structures created onsite from concrete panels, on some but not necessarily all sides.

[4] Source: TDM, Road Drainage Chapter

What does Auckland Transport consider?

If raingardens are deemed to be appropriate via a suitable options assessment, Auckland Transport will consider not only the effectiveness of the raingarden'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 raingarden 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)[5], 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 raingardens in terms of:

- appropriateness of raingarden 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 raingarden edge – e.g. drop-off from kerb and footpath, potential risk for pedestrians and people on bikes
- ease to maintain – addressing both safety in design, and capital and operational costs
- structural integrity – of both the raingarden and the adjacent road pavement

Figure 1: 'Typical raingarden cross section / internal design elements' has been adopted from GD01, with a focus on the internal workings and design elements of a raingarden. The figure is based on a traditional cut batter side raingarden, suitable for use roadside (space dependent), in carparks, or in greenspace. Auckland Council is primarily responsible for ensuring that proposed raingarden designs, including those within the road, meet design parameters set out within GD01.

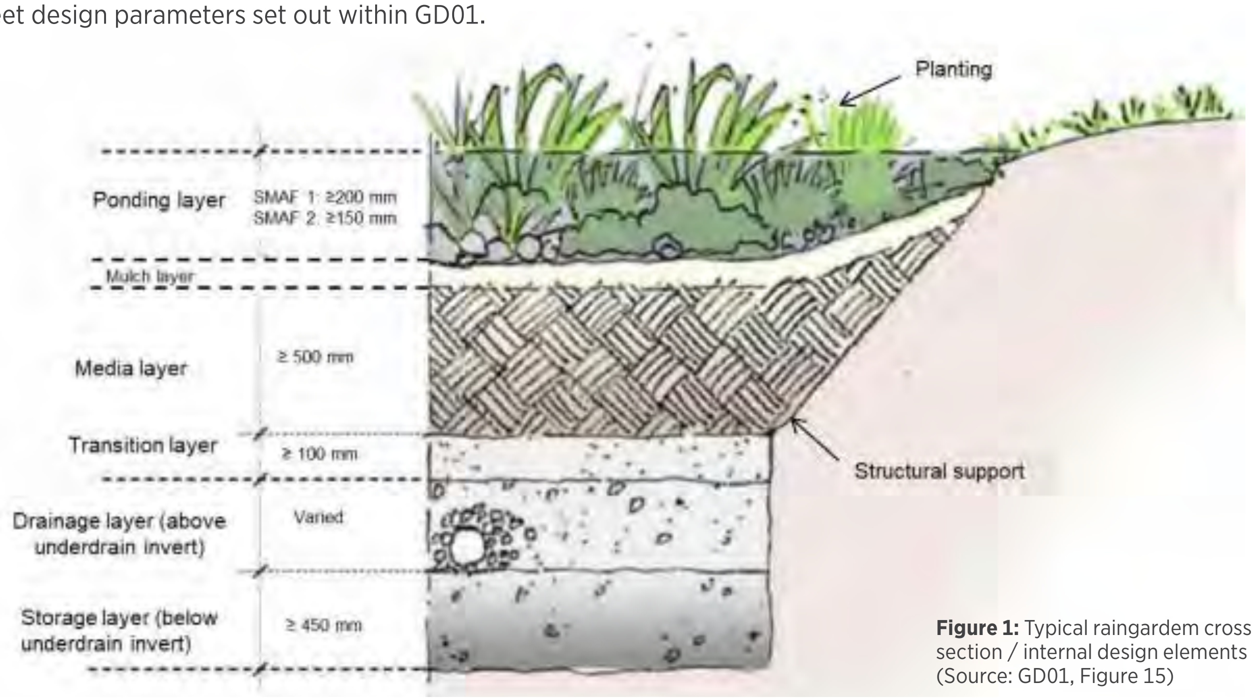

Figure 1: Typical raingardem cross section / internal design elements (Source: GD01, Figure 15)

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

The only extent to which Figure 1 addresses external design features is the broad identification of the need for structural support at the raingarden edge. This will vary according to the raingarden location, soil properties etc. Auckland Transport has identified further specifics for structural support requirements in the road corridor, e.g. to support the road and the footpath. Auckland Transport also focuses on the design for, and relationship between, the raingarden and the adjacent road space, addressing a range of safety, structural, maintenance and operational aspects.

Table below 'Auckland Transport defined design elements of raingardens in the road corridor' combines these internal and external design elements. The internal design elements of raingardens, as established under GD01 and considered by Auckland Council from a wider stormwater treatment perspective, are identified as internal elements, while external / road related elements focused upon by Auckland Transport are identified as external elements.

AUCKLAND TRANSPORT DEFINED DESIGN ELEMENTS OF RAINGARDENS IN THE ROAD CORRIDOR

Internal design elements, common to all raingardens	External design elements, for raingardens in the road corridor
Inlet erosion material	Interface with kerb and channel, including inlet / outlet (bypass flow)
Ponding area	Interface with footpath edge
Mulch layer	Interface with grass berm / adjacent parking / vehicle crossing / pram crossing, for both upstream and downstream ends
Media	Structural support – for the road pavement / carriageway, and the raingarden fill material/s
Overflow (bypass system)	Underdrain pipe connection to outlet (catchpit)
Underdrain (perforated / slotted pipe)	Check dam – only required where a multi-unit / bay stepped raingarden is proposed to suit the road slope
Planting	
Optional internal elements	
Transition layer	
Drainage layer	
Storage layer	

04

What does Auckland Transport want?

4.1 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 raingardens may not be a suitable option.

Desired approach	Design basis
Check that supporting documentation demonstrates clear reasoning and justification for the selection of raingardens over other stormwater treatment options.	This is in accordance with a best practicable option (BPO) approach, guided by whether treatment goals for the site relate to quality, quantity, or both.
Check that raingarden design demonstrates a site-specific basis.	A site specific, BPO approach is required. A repeated reliance on prefabricated concrete box raingardens is unlikely to reflect a site specific and holistic approach to stormwater design.
Check that supporting documentation demonstrates consideration of whole of life costs, and long-term implications / impacts for maintenance and renewal.	Raingardens can be more expensive to maintain in the road corridor than other types of treatment devices. Applicants need to demonstrate a considered decision-making process, including life cycle costings and provision of an O&M[6] guide.
Check that the proposed type of raingarden aligns with Auckland Transport design requirements. As per the TDM, concrete raingarden structures should be avoided where possible.[7]	Auckland Transport's preference is for cut batter raingardens. Concerns with concrete box raingardens include compromised plant health due to concrete's high thermal mass and heat adsorption properties.
If concrete box raingardens are proposed, ensure that Auckland Transport's approval process for proprietary devices has been followed.	Auckland Transport considers concrete box raingardens to be proprietary devices. Therefore, their proposed use for roadside raingardens will be assessed via the TDM's proprietary device approval process. Refer to TDM, Road drainage chapter for further detail.
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.
If multiple raingardens are proposed, check that approach aligns with Auckland Transport TDM requirement whereby drainage design favours fewer, larger raingardens.[8]	Auckland Transport will not accept many small raingardens when fewer larger raingardens are possible. Catchment per raingarden should be maximised.
Check that the proposed raingarden sizing aligns with Auckland Transport requirements for minimum raingarden size, as per the TDM (Road Drainage Chapter, Section 4: Stormwater management devices). Also check that internal width is no less than 2m.	Auckland Transport has concerns around plant health in small raingardens, particularly for concrete box devices. Narrow rain gardens (1-1.5 m wide) with hard surfaces on each side and steep banks have more plant damage, compromising effective rain garden function. Small raingardens are also considered more problematic for efficient and cost-effective maintenance and renewals.
Check that raingarden design takes into account advice provided to support plant growth and optimise survival rates, as set out with Auckland Transport's Bioretention Planting Guide.	Compromised health in raingarden plants cause concern for Tikanga Maori principles, effective stormwater treatment, and replanting costs.
Check that maximum longitudinal road slope of 5 percent is not exceeded, and that raingarden bed is designed to be flat with the inlet positioned to enable overflow back to the kerb.	Auckland Transport will not accept raingardens on roads greater than a 5 percent slope. This limit is based on achieving balance between required ponding depth and frequency of check dams.
Check that any proposed design for stepped raingardens meets Auckland Transport's design requirements.	Stepped raingardens introduce additional complexities, especially for concrete box raingardens. The drop from an adjacent footpath (and roadside parking) into the raingarden increases and the associated mitigation can be problematic.

[6] Operations and Maintenance guide
[7] TDM, Road Drainage Chapter, Section 4 Stormwater management devices
[8] TDM, Road Drainage Chapter, Section 4 Stormwater management devices

4.2 Internal design elements

Below are internal raingarden design features that Auckland Transport gives consideration to, on the basis that they can lead to poor outcomes if not appropriately addressed during design. Auckland Transport's requirements for these specific internal design elements are outlined below. In addition to this 'checklist', both GD01 and the TDM (Road Drainage chapter, plus accompanying standard details and specifications) should also be referred to as part of the design process.

4.2.1 INLET EROSION MATERIAL

- Check that inlet erosion material is not set too high relative to inlet invert level, with top of erosion material to be at least 50mm below inlet invert level. This is to avoid the risk of inlet blockage due to sediment build up between maintenance cycles.
- Check that inlet erosion material can readily facilitate the removal of accumulated sediment, and that is of sufficient size and appropriate design to stay in place over time.

4.2.2 PONDING AREA

- Check that the top of the ponding level matches to the kerb inlet invert. This is to ensure that water flows into the raingarden and an unnecessarily large drop is not created by setting the ponding level too low.
- GD01 specifies a minimum ponding layer depth of 100mm for water quality only, 200mm for SMAF 1, and 150mm for SMAF 2 areas. Check that this is appropriately designed for.

4.2.3 MULCH LAYER

- Check that sufficient drawing detail is provided for the mulch layer, particularly near the raingarden inlet. This is to avoid overfilling of mulch during construction, and resulting issues for inlet blockage.
- Check that design and specifications for the mulch layer are in accordance with the Auckland Transport Bioretention Planting Guide and Auckland Council technical report TR2013/56 (TR56): Mulch specification for Bioretention Stormwater Treatment Devices. This is to achieve a consistent and high-quality approach, maximising opportunities for plant health and long-term device performance.

4.2.4 MEDIA

- Check that proposed raingarden design shows media placed in horizontal layers, to facilitate an even flow of water.
- Check that design and specifications for the media layer are in accordance with GD01 requirements for drainage media.

4.2.5 OVERFLOW (BYPASS SYSTEM)

- AT preference is for no cascade flow between raingarden 'units/cells' and for water to overflow back to the kerb.
- Check that overflow (bypass system) has been designed and constructed to provide the required ponding depth.

4.2.6 UNDERDRAIN (PERFORATED / SLOTTED PIPE)

- Check that pipe size/material corresponds to Auckland Transport's requirement of 150mm diameter slotted uPVC pipe manufactured to AS2439.1.
- Check that only a nominal longitudinal slope of 0.5% to match drainage layer slope.
- Check that design shows how access is provided for flushing and cleaning.
- Check that raingarden pipework bends are 45 degrees or less, to facilitate maintenance.

4.2.7 PLANTING

- Check that design and specifications for plant selection, planting and care are in accordance with the Auckland Transport Roadside Bioretention Planting Guide.

4.2.8 TRANSITION LAYER (OPTIONAL)

- Check that transition layer meets requirements under GD01, i.e. clean, well graded gravel (2-7mm dia.) with minimal fines, and 100mm depth. A geotextile must not be used.

4.2.9 DRAINAGE LAYER (OPTIONAL)

- Check that drainage layer meets requirements under GD01, i.e. clean, washed peas gravel (~10mm dia.) with little/no fines and a minimum infiltration rate of 4,000mm/hr. Layer depth is to be at least 200mm, graded at a minimum of 0.5% towards the outlet and with a minimum of 50mm cover above the underdrain.

4.2.10 STORAGE (RETENTION) LAYER (OPTIONAL)

- Check that drainage layer meets requirements under GD01, i.e. clean, washed peas gravel (~10mm dia.) with little/no fines and a minimum infiltration rate of 4,000mm/hr. Layer depth is to be at least 450mm, with no impervious liner.

4.3 External design elements ✓

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 raingarden and surrounding road features).

Auckland Transport's requirements for these specific external design elements are outlined below. In addition to this 'checklist', both GD01 and the TDM (Road Drainage chapter, plus accompanying standard details and specifications) should also be referred to as part of the design process.

4.3.1 INTERFACE WITH KERB AND CHANNEL, INCL. INLET / OUTLET

- Check that lateral support/kerb and channel design will withstand vehicle wheel impact.
- If concrete box raingardens are approved (via proprietary device process), check that they align with Auckland Transport's preference to be located behind the kerb and channel.
- Check for areas where concrete infill is required at small gaps between adjacent concrete features such as kerb and channel.
- Check that the kerb inlet channel invert is well-shaped to direct flow into the raingarden.
- Check that kerb inlet is designed to support ease of maintenance, e.g. minimum of 300mm wide to fit shovel/spade (for clearing).
- Check that Auckland Transport TDM requirements for kerb interruptions are achieved, i.e. interruptions (e.g. inlet) no more than 300mm wide and no closer than 600mm apart, with inlet capacity designed as a weir.
- Check that no catchpit is proposed to be located within the extent of raingardens.
- Check that there are no potential conflicts between roadside parking and raingardens, including any safety risk to people exiting from a parked vehicle adjacent to a roadside raingarden. Either a 500mm buffer should be provided, or parking should not be permitted.

4.3.2 INTERFACE WITH FOOTPATH EDGE OR CYCLE FACILITY

- Check that Auckland Transport design preference is met for a 500mm buffer between the edges of the raingarden and an adjacent footpath/cycle facility. This is to mitigate safety risk to pedestrians and people on bikes, and eliminate the need for path thickening.
- Check that the buffer design considers what is proposed either side of the raingarden, and makes appropriate provisions. For example, consider buffer infill material required. If insufficient space is available to provide a buffer, a concrete upstand may be approved for use. However, design justification (for the lack of width for the buffer) and further discussion with Auckland Transport will be required.
- Check that a connection detail is provided for securing any impermeable liner edges to a suitable fixing point/s.

4.3.3 INTERFACE WITH OTHER ROAD FEATURES BERM, PARKING, VEHICLE / PRAM CROSSINGS, UPSTREAM AND DOWNSTREAM ENDS

- Check that raingarden's impact on, and relationship with, other road features has been considered, e.g. grass berm, adjacent parking, vehicle and pram crossings.
- Check that Auckland Transport design preference is met for a 500mm buffer at either end of raingarden. This is to mitigate safety risk to pedestrians[9], and provide a buffer for vehicles using parking or a vehicle crossing.

[9] Safety concerns arise from drop-off height between footpath and rain garden surface, and risk of pedestrians inadvertently 'falling' from kerb into the raingarden.

4.3.4 STRUCTURAL SUPPORT

- For cut batter raingardens, check that raingarden sides are designed to ensure slope stability. This is to allow for partial or full removal/replacement of raingarden (layers) during maintenance/renewal, as well as the period between excavation and filling.
- If concrete box raingardens are approved, check that the raingarden wall is designed as a retaining structure. This is to allow for partial or full removal/replacement of raingarden (layers) during maintenance/renewal, as well as prior to filling of box.
- If concrete box raingardens are approved, check that raingarden structure meets requirements for a 100-year design life, and for static and seismic loading demands (as per NZTA Bridge Manual on retaining structures).
- If concrete box raingardens are approved, check that the raingarden wall complies with NZBC requirements B1-Structure and B2-Durability, and is seated on top of a wall pad–as the foundation to mitigate the differential settlement and spread the loads evenly.

4.3.5 UNDERDRAIN PIPE CONNECTION TO OUTLET (CATCHPIT)

- Check that catchpit locations are optimised for efficient collection of road runoff first and foremost, rather than as a connection point for a raingarden.
- Check that pipework is non-perforated/ slotted uPVC and bends are no more than 45 degrees, to facilitate maintenance.
- Check design for connection between the raingarden outlet and downstream stormwater network. The use of a solid carrier type pipe to connect to a catchpit is acceptable, as is the use of short lengths of solid carrier type drain to join raingardens. Check if additional maintenance access points are required for rodding/flushing (dependent on pipe length).
- Check if a downstream catchpit is readily available for connection. If not, then consider connection to a nearby stormwater manhole. If this is not practical then connection to a nearby stormwater line may be acceptable–check that connection detail meets Auckland Council requirements.

4.3.6 CHECK DAM

- Check that a clear design basis is shown for proposed use of check dams, related to road slope and raingarden size.
- Check that material used for check dam is appropriate for use in a raingarden, e.g. durable, inert / non-toxic, readily available (for replacement).

Roadside raingarden examples

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Shown below are a variety of roadside raingardens in the Auckland region. They are at differing levels of completion and growth but do illustrate some of the design features desired by Auckland Transport, as well as some that are not so desirable.

Cut batter roadside raingarden, with concrete border 1

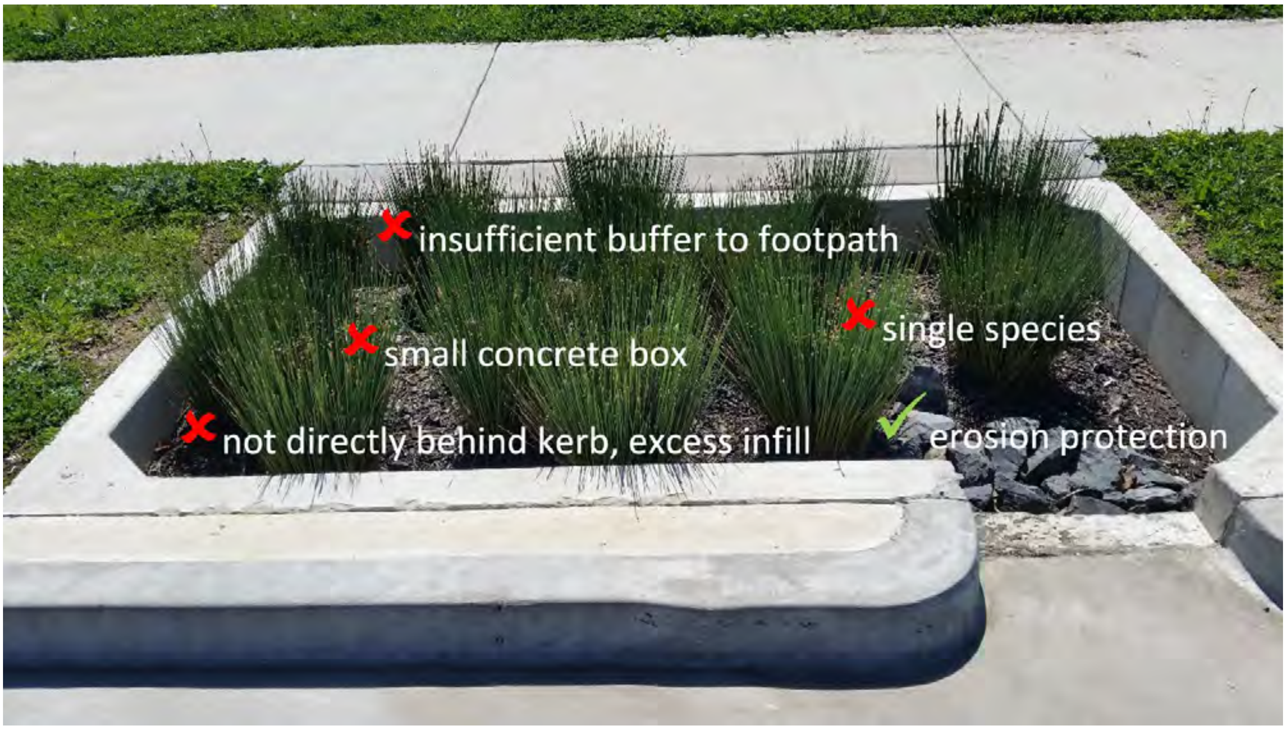
Cut batter roadside raingarden, with concrete border 1

Raingarden with inlet issues

Concrete box roadside raingarden 1

Concrete box raingarden 2

Concrete box roadside raingarden 3



Concrete box raingarden 4