Road Drainage

In this chapter

01 Introduction

PURPOSE

This chapter gives guidance for the design of drainage in the road reserve. It specifies limitations on design choices to achieve consistency across the region, while catering for local conditions. It aims to promote efficiency, effectiveness and economy of capital investment and operational management water sensitive design.

SCOPE

The situations covered include:

- Drainage of surface water within road reserves.
- Collection, conveyance and treatment of run-off from roads.
- Management of stormwater discharging from land onto road reserves.
- Discharge of stormwater from road reserves.
- Subsurface drainage of roads.
- Diversion and culverting of watercourses within road reserves.

TERMINOLOGY

Road refers to the legal road, i.e. from boundary to boundary, as defined in the Auckland Unitary Plan.

Water Sensitive Design (WSD) has been renamed “Integrated Stormwater Management” (or ISM) in the AUP, however WSD is still used and referred to in many associated guidelines and documents.

Other terms are defined in the Auckland Council Guideline Document: Stormwater Management Devices in the Auckland Region, GD2017/001.

Storm characteristics for design are generally expressed as the % AEP (Annual Exceedence Probability) or the ARI (Annual Return Interval). In this manual, % AEP is used, to underline the risk management basis of drainage design.

RUN-OFF CALCULATIONS

Road surface run-off calculations are required for:

- All arterial and collector roads.
- Roads with channel gradients outside the range 1.5-10%.
- Roads drained to stormwater treatment systems.
- Roadways of more than 8m wide that fall to a channel.

COMPLIANCE

Auckland Transport (AT) manages the road assets for Auckland as a Council Controlled Organisation of Auckland Council. Except where stated otherwise in this manual, road drainage design must comply with:

- Local Government Act (1974 and more recent updates)
- The Auckland Code of Practice for Land Development and Subdivision
- Auckland Transport: Transport Design Manual
- The Resource Management Act (1991)
- Consent conditions and the Auckland Unitary Plan rules
- Permitted activity rules imposed by the AUP
- Stormwater Bylaw, Auckland Council, 2015
- Guideline documents.

STANDARD ENGINEERING DETAILS AND DESIGN TOOL BOX

The Tools and Details published by AT in the Engineering Design Code should be used for design and detailing. Other tools and drawings published by Auckland Council should be used along with these. Design tools and drawings provided by suppliers of products and systems may be used, subject to approval by AT Chief Engineer

DEPARTURES

Where any deviations from the standards are necessary, they must be clearly documented and must follow the AT Departures from Standard process.

INFORMATION SOURCES

Before designing road drainage, the following design documents and guidelines should be read:

- Other sections of ATs Transport Design Manual (TDM).
- Water Sensitive Design for Stormwater, Auckland Council Guideline Document GD2015/004.
- Stormwater Management Devices in the Auckland Region, Auckland Council Guideline Document GD2017/001.
- Auckland Council Stormwater Code of Practice (AC SW CoP).
- Green Infrastructure: Auckland Council CoP for Land Development and Subdivision, Chapter 7, 2016.
- Watercare Services Wastewater Code of Practice (WSL WW COP), where required in combined sewer catchments.
- Austroads Guide to Road Design Part 5, Part 5A and Part 5B.
- TR2013 040 Stormwater Disposal via Soakage in the Auckland Region, Auckland Council, 2013.
- TR2009/084 Fish Passage in the Auckland Region, Auckland Regional Council, 2009.
- TP131 Fish Passage Guidelines for Auckland Region, Auckland Regional Council, 2000.
- Coastal inundation by storm-tides and waves in the Auckland region, Auckland Council technical report, TR2016/017.
- Coastal Hazards and Climate Change, Ministry for the Environment, 2017.
- AP-R481-15 Safety Provisions for Floodways over Roads (Austroads, 2015)
- Floodplain Development Manual (NSW Government, 2005)

02 Design principles

2.1 Water sensitive design (WSD) or Integrated Stormwater Management (ISM)

APPROACH

AT strongly supports the use of Water Sensitive Design (or ISM) principles and requires road drainage designs to demonstrate an inter-disciplinary approach to stormwater management. This approach is clearly defined and explained in detail in Guidance for Water Sensitive Design, GD04.

AT recognises the value of the street tree canopy to attenuate the effects of rainfall events and reduce peak flows. Planting street trees is encouraged at the time of development and the use of shrubs and amenity plantings to contribute to the management of stormwater.

PURPOSE

Water sensitive design seeks to protect, enhance, and ultimately use natural systems and processes for enhanced stormwater management, ecosystem services, and community outcomes. It aims to avoid adverse effects of stormwater or manage them as close to the source as possible.

This is achieved through:

- Promoting inter-disciplinary planning and design.
- Protecting the values and functions of natural ecosystems.
- Utilising natural systems and processes for stormwater management.

All road construction and improvement should be designed in line with water sensitive design principles.

DESIGN PRINCIPLES

The implications for Water Sensitive Design in the road reserve include:

- Road layouts should be designed to **retain existing landforms** and drainage patterns where possible.
- The **impervious surface** ratio should be kept as low as possible within the road reserve and on adjoining land, consistent with the road use.
- Stormwater management systems and treatment suites should reflect **natural water management systems** as far as possible. Methods such as groundwater recharge, tree canopy and vegetated strips should be used in conjunction with designed treatment trains.
- **Earthworks should be minimised** and design choices should align with sustainability and economic objectives.

2.2 Integration of drainage

ENVIRONMENT

Following WSD principles, road drainage management should be integrated with that of the surrounding area. Where it is economical and effective to treat road run-off in conjunction with stormwater from a developed area, shared public stormwater facilities may be used with the approval of Healthy Waters, AT and AC Operations teams. However, separate treatments will be necessary if:

- The requirements for treatment of road run-off differ significantly from those for developed land, or
- Where existing treatment is not of appropriate standard for the road run-off.

Greenfield developments should consider intensified or clustered development to minimise land disturbance and earthworks, to protect and enhance the natural environment.

PLANS AND CONSENTS

Treatment should fit with watershed catchment management plans (CMP) or network discharge consents (NDC) where these are in place, or with the requirements of a resource consent for stormwater discharge. This will also help determine the feasibility of integrated management.

CATCHMENT PLANNING

Consult with Auckland Council Healthy Waters early on if:

- Existing road run-off is managed under a network discharge consent and an alteration in road drainage is proposed.
- A new connection increases the peak flow to an existing drainage network that discharges in to the public stormwater network.
- New road design or improvement to an existing road is proposed that is not covered by an existing current discharge consent.
- Where substantial downstream flooding has been identified.
- A Catchment Management Plan exists that identifies issues relevant to road design.

Auckland Council Healthy Waters can be contacted at: HWdevelopment@aucklandcouncil.govt.nz

CONNECTING PRIVATE DRAINAGE

Where approval is sought to connect private drainage discharge to an existing Auckland Transport road drainage asset (e.g. pipeline, manhole or treatment device), the Auckland Transport asset will have to be vested as an Auckland Council public drain asset. The condition of the asset must be investigated. The applicant may have to bear the cost of the investigation, as well as any reasonable cost of bringing the asset to an acceptable condition.

Where a pipeline to be vested as public drain is located in private land in a front or side yard, provision should be made to connect road drainage from the road reserve boundary in future. In this case, an easement in favour of Auckland Council must be provided.

ADJOINING LAND

The catchment of run-off from land next to roads must always be considered. Flood hazard management requires that roads be integrated with land upstream and downstream, as set out in AC SW COP 4.2.8. The capacity of primary drainage of developed land may be exceeded in events less than 10% AEP due to blockage or where the existing network has been constructed to have a lower capacity. Probable catchment run-off needs to be calculated in accordance with AC SW COP for road drainage design.

KERB DISCHARGES

Where no other discharge options are available for buildings on private land, a kerb discharge may be approved by exception. Run-off calculations should allow for existing kerb discharges present in a street. New kerb discharges are required to demonstrate that the net peak flow discharged to the road is not increased.

PUBLIC RETICULATION

Where there is a new connection or increased discharge to an existing connection, the effects of road stormwater discharge into public reticulation have to be investigated. Integration of peak flow discharges and times of concentration may be able to provide capacity management on the network.

SPECIAL AREAS

In certain areas, the ground conditions require stormwater drainage to meet specific policies or code conditions.
These include:

- Combined sewer reticulation
- Soakage discharge
- Groundwater recharge.

In these areas, road drainage must comply with the relevant policy or code requirements. As far as possible, design for road run-off should be integrated with the design for land use run-off. Where land use drainage is not being changed in a way that can be integrated with road run-off, then design for road run-off and existing land drainage may be more difficult. It is best to discuss this with the relevant consenting teams at Auckland Transport and Auckland Council early on.

CHOOSING DESIGNS

When choosing designs for drainage assets for roads to vest in Auckland Transport, consider the design objectives and environmental outcomes alongside the whole-of-life asset cost, including maintenance costs. Follow published guidelines as described in Section 1, otherwise early discussion with Auckland Transport Chief Engineer is recommended.

2.3 Tiered objectives for stormwater management design in road reserves

DESIGN OBJECTIVES

Drainage design requires attention to a range of different objectives. For each of these objectives, the range of rainfall intensities and the appropriate design solutions may differ. The design should demonstrate how each is dealt with.

ENVIRONMENTAL MANAGEMENT DESIGN

Environmental management design focuses on environmental design for everyday conditions. These designs typically cater for 90th/95th percentile 24-hr of rainfall as given in Auckland Council Stormwater Guidelines. Rainfall from most of any year should be managed through Water Sensitive Design to reflect natural processes for quality treatment, volume reduction, groundwater recharge, attenuation and dispersed discharge. Environmental objectives should be determined from unitary or regional/district plans or network discharge consent requirements, as well as stormwater governing principles. These may be quality requirements for heavily-trafficked roads or flow management requirements for sensitive stream catchments (defined in the Auckland Unitary Plan for greenfield sites and SMAF overlays) or quality objectives for consolidated receiving environments.

SERVICEABILITY MANAGEMENT DESIGN

Serviceability management design focuses on road safety during occasional events. Design typically caters for rainfall up to the 10% AEP design storm, but varies for different road users. Rainfall run-off should be managed within the road reserve to maintain acceptable levels of service for road users, while limiting hazards and nuisance. This has to include surface water management and serviceability for walking and cycling at appropriate lower rainfall intensity. (See Section 3 below.)

Rainfall intensity and depth should be obtained according to the methods defined in AC SW COP, making use of TP108 and applying current allowance for climate change. An example showing the process can be found in GD01 - Swale design.

Serviceability criteria in Tables 1 and 2 should be met. Design objectives should be determined from the safety and service requirements set out in Austroads Guide to Road Design Part 5A.

Where the outlet of road drainage may be drowned, such as by tide levels allowing for sea level rise or other constrained discharge capacity or high hydraulic head level, backflow prevention devices may be considered in conjunction with in-pipe storage capacity.

MAJOR EVENT MANAGEMENT DESIGN

Major event management design focuses on personal safety, protection of property and survival and recovery of infrastructure for extreme events. Design typically caters for storms up to the 1% AEP, to ensure survivability or recovery of infrastructure, accessibility for emergency services and protection of personal safety and habitable or commercial property. In coastal areas the effects of sea-level rise and coastal inundation from storm surge should also be considered (including backflow protection) under this design event. See Information Sources in Section 1 for more information.

Also consider:

- Significant consequences of run-off exceeding the design peak flow.
- Greater protection for identified critical infrastructure (0.5% AEP or less).
- Effects of coastal inundation from tides and storm surge coinciding with heavy rainfall, sea-level rise or a tsunami.

Major event flow should meet criteria in Table 3. Design should follow methodologies set out in Austroads Guide to Road Design Part 5A. Rainfall and run-off should be calculated according to AC SW COP (including specified allowance for climate change).

TABLE 1 ALLOWABLE SPREAD WIDTHS AND GUTTER FLOWS – TRAFFIC LANES

Number of traffic lanes in any one direction	Speed environment	
	≤ 70 km/h	> 70 km/h
1	1.0m	0.75m
2+	1.5m	1.25m

Where shoulders have been constructed, the actual flow width is in addition to the shoulder width.

Where the kerbside traffic lane is greater than 3.5m, additional width (i.e. actual width of kerbside lane minus 3.5m) may be added to the allowable spreads shown above.

Where the kerbside traffic lane is less than 3.5m, deficit width (i.e. 3.5m minus actual width of kerbside lane) must be deducted from the allowable spreads shown above. Where a combined purpose lane is being utilised, e.g. a bus lane and cycle lane, at 4m wide, the maximum allowable spread is 1m depth at the kerbside should be no greater than the top of kerb, and the product of gutter flow depth by average velocity (d_g x V_{ave}) should not exceed 0.4m^2/s.

TABLE 2 ALLOWABLE SPREAD WIDTHS AND GUTTER FLOWS – ROAD TYPES

Situation	Requirement
Arterials with sealed shoulder	Surface flows should be confined to the shoulders.
Collector and local roads	At least one lane each way on collector roads, and at least one lane width on local roads should be trafficable during a 10% AEP storm.
Arterials	There should be no need to change lanes during the design storm. Where traffic lanes of less than 3.5m are used, it may not be practical to achieve the goal of not changing lanes during the design storm when trucks and buses are considered. Where commercial vehicles comprise a significant proportion of the traffic, consider redistribution of lane widths to give a wider outer lane.
Auxiliary and turning lanes	Spread at the commencement of auxiliary/turning lane tapers should be limited to 1.5m, except where cycle lanes or sealed shoulders are extended through the taper. In such cases up to 1m of the cycle lane may be used for spread allowance for the 10% AEP storm.
Pedestrians	Maximum spread from the kerb immediately upstream of pedestrian crossing points should be 0.5m. At pedestrian crossing points, spread should be restricted to less than 1m in the 10% AEP storm. Maximum spread into the kerbside lane adjacent to bus stops (or other locations where pedestrians are expected in significant numbers) should be 0.75m. Design rainfall intensity to use for pedestrian facilities should be the 1.58 year ARI, ten-minute intensity.
Cyclists	Where a road contains separate bicycle lanes, the flow spread should be limited to 0.5m. For a shared bicycle and vehicle lane, the flow spread width should be limited to 1m. Design rainfall intensity to use for on-road cyclist facilities is the 20% AEP, ten-minute intensity.
On-street parking and car parks	Flow width should be restricted to 2.0m for the 50% AEP.

Situation	Requirement
Cross carriageway flows	Flows across the carriageway, such as those occurring at superelevation changes, median breaks, T-intersections of local streets and at the ends of traffic islands, must be less than $0.005m^3/s$ to reduce the risk of aquaplaning. The rainfall intensity to use for this situation should be 50mm/h. (See Section 3.)
Local road intersections	Flows past terminating local roads must be limited to $0.030m^3/s$ for the 10% AEP storm.
Safety: Arterial roads	Maximum flow depth x velocity $d_g \times V_{ave} = 0.3m^2/s$.
Safety: Kerbside	For pedestrian safety, the maximum depth at the kerbside should be no greater than the top of kerb, and the product of gutter flow depth by average velocity $d_g \times V_{ave}$ should not exceed $0.4m^2/s$.
Safety: Braking areas	Water depth and width should be restricted at the approaches to traffic signals, freeway ramp gores and in other areas where braking would be expected.

Source: Based on Alderson (2006)

TABLE 3 ROADWAY FLOW LIMITATIONS – MAJOR STORM

Situation	Requirement
Where floor levels of adjacent buildings are above road level	Total flow contained within road reserve. Freeboard from peak flow level to habitable floors in accord with Building Code and unitary plan.
Where floor levels of adjacent buildings are less than 350mm above the top of the kerb, and the fall on the footpath towards the kerb is..	**Greater than 100mm:** Water depth must be limited to 50mm above top of kerb. **Less than 100mm:** Water depth must be limited to top of kerb in conjunction with a footpath profile that prevents flow from the roadway entering onto the adjacent property. In these cases, compliance with Building Code and unitary plan may require separate approvals.
Where no kerb is provided	Above depths must be measured from the channel lip level plus 100mm.
Pedestrian safety[1]	**No obvious danger:** $d_g \times V_{ave} \leq 0.6m^2/s$. **Obvious danger:** $d_g \times V_{ave} \leq 0.4m^2/s$.
Vehicle safety	Maximum height of energy line300mm above roadway surface for areas subject to transverse flow. The exception is specific floodway design and additional vehicle warning and protection, where ${}_{dg} \times {}_{Vave} \leq 0.3m^2/s$. On-street parking is not to be permitted where overland flow exceeds $0.3m^2/s$.

1 Obvious danger is interpreted as areas where pedestrians are directed to, or most likely to cross water paths, e.g. marked crossings and corners of intersections.

d_g = flow depth in the channel adjacent to the kerb, i.e. at the invert (m).

V_{ave} = average velocity of the flow (m/s).

Source: Adapted from DNRW (2007a)

2.4 Major/minor drainage

MINOR SYSTEM

The minor system, or primary drainage, caters for the first two design considerations above, i.e. environmental and serviceability.

It is intended to capture and convey run-off from frequent rainfall events to maintain road safety and avoid nuisance to road users and or impacts on adjoining land. The frequency of events for primary drainage design is generally defined by unitary or district plan to be the 10% AEP design storm. Where network capacity or discharge is limited by circumstances such as existing network limitations, or tidal outfall level affected by sea level rise, a departure from standard on the return probability (AR) would be considered.

MAJOR SYSTEM

The major system, or secondary drainage, is designed for severe storm events, generally the 1% AEP design storm. This system must be designed to:

- Maintain safety for people.
- Protect infrastructure from significant damage.
- Protect habitable property from damage.
- Provide access for emergency services.

RURAL AREAS

In rural areas, the design objectives are to:

- Protect infrastructure from significant damage during major events.
- Limit interruption of service in line with the traffic or lifeline significance of the road.
- Allow major event stream flow to cross the line of a road without significant diversion, flooding or scour.

URBAN AREAS

In urban areas, the design objective is to retain major event run-off within the road reserve and convey it to defined overland flow-path discharge points. To this end, roads should be laid out to facilitate control of major event run-off. Excessive flow and velocity should be avoided, and consideration must be given to momentum where the flow changes direction.

Urban areas also benefit from tree canopy cover which provides a further option to reduce flow rates. Tree canopy cover has a higher value in areas of low permeability and can help reduce flow rates into stormwater systems in both raingarden and tree planter pits.

The 1% AEP storm run-off should generally be contained within the road reserve, with sufficient freeboard at the boundary to limit risk of discharge towards vulnerable property. Care should be taken to avoid ponding or spread flow that may obscure hazards to road users, especially at intersections and at drop-offs from the roadway.

Flood flow should be directed to discharge from the road reserve at natural low points. Ensure that a weir discharge from road to Overland Flow Path is specifically designed.

MAJOR SYSTEM WITH LIMITED CAPACITY

In some locations, such as in the central isthmus of Auckland, the topography does not provide a natural flow path that can be used to convey major run-off in surface channels. This may also occur where existing vulnerable property obstructs the flow path. In such cases, it may be necessary to provide sufficient ponding capacity for later discharge through the available means, whether primary piped system or discharge to groundwater. To alleviate such issues at the bottom of the catchment, consider the extent to which road design can contain and attenuate the concentration of overland flow.

MINOR SYSTEM IN MAJOR EVENTS

During heavy rainfall, the inlets and pipes of the minor drainage system may become blocked by debris. To determine the consequences of such a major event, the discharge flow, velocity and depth of overland flow should be checked for effects on properties on the assumption that the primary system is fully blocked. However, the effects on road users may consider discharge of 50% of the nominal inlet or pipe capacity of the primary system (whichever is smaller). This will be satisfactory, unless particular risk due to blockage is identified.

MAJOR SYSTEM – PIPED FLOWS

Where constraints to the road network result in surface flows exceeding safety criteria and no overland flow path discharge is available, high-capacity inlet systems may be used to reduce overland flow. Piped discharge from these devices should be kept separate from the primary piped network as far as possible, to reduce risk of blockage. The risk of debris blocking inlets should be considered.

03 Surface water management

Geometric design of roads must include consideration of surface drainage.

ROAD SAFETY

The prime consideration for surface drainage is road safety. High-speed roads (operating speed > 50 km/h) must be designed with regard to the potential for aquaplaning, and also for the effects of spray. Intersections must also be designed with consideration of these effects. For lower speed roads, special attention should be given to changes of direction and gradient.

SERVICEABILITY

The second consideration is for serviceability. Long drainage paths across paved areas may result in excessive water film, or puddling on uneven surfaces. This may be unsatisfactory for pedestrians and cyclists.

SURFACE MATERIAL

Surface materials influence the hydraulic performance of water as it flows across the surface. It is necessary to check that the surface material proposed is suitable to convey the water to the drainage points rapidly to reduce the risk of ponding and / or aquaplaning.

GRADIENTS

Longitudinal gradients of kerbed channels must be at least 0.5%. Any length of road with a gradient less than this must have provision to avoid ponding. This can be achieved with:

- a sag curve catchpit inlet, in which case the length of road channel less than 0.5% must be minimised
- crossfall away from channel
- sheet flow discharge over the road edge, or
- a grated drain channel or combined kerb and drain block.

CROSSFALL

Crossfall and longitudinal gradient must be considered together, to limit the length of any drainage path before water is concentrated into a channel or discharged from the paved surface.

- Steep roads (>8%) should have maximum crossfall to shorten the drainage path to roadside collection.
- Roads with a flat grade should have sufficient crossfall to clear surface water.
- Transitions from camber to superelevation should be developed at or away from sag and summit curves, to avoid flat areas.
- Avoid flat areas at intersections.

OTHER GUIDES

Road design for aquaplaning should follow the Austroads Guide to Road Design Part 5A Section 4. Where concentrated flow crosses a carriageway, it must be less than the maximum flow in Table 3.

04 Stormwater management devices

Apart from the requirements for water sensitive design set out in Section 2.1 above, drainage design for roads should also meet the requirements below.

CONTEXT

Combining complementary features in a treatment suite can provide everything needed in the particular context. The water sensitive design context is provided by the AC Guideline documents referred to in Section 1.

The preferred options for new developments and existing environments are shown in 4.1.

TREATMENT TOOL BOX

A treatment train approach involves combining a suite off treatment options taking road run-off from collection to discharge. Appropriate treatment may include a combination of bio-retention, wetlands or other suitable practices. Treatment should generally be as close to the source as possible, and reproduce the effects of natural drainage as far as possible, while minimising the number of small separate devices and operating costs.

The treatment tool box options in some instances are complimentary but should be considered separately as well as together when completing calculations for quality and hydrology.

OTHER BENEFITS

Where possible, devices should provide for other design objectives such as passive amenity and biodiversity.

OPTION SELECTION

Alternative stormwater treatment options should be compared for capital and operational costs to determine the best option in terms of life cycle costs and benefits. A template for the life-cycle calculations does not form part of the Design Manual but calculators are expected to be available through the Activiating Water Sensitive Urban Design website.

RETENTION DEVICE RISKS

Any devices that store water on or below the ground surface close to roads for an extended period must be designed with regard to:

- structural support for traffic loads,
- protection from infiltration into pavement formation, and
- geotechnical stability hazards.

INFILTRATION

Infiltration to ground may be appropriate in some locations, while tanking will be necessary in others. Always consider whether the device might interact with subsoil drains. Soil testing should be used to determine what infiltration capacity is available.

CONSTRUCTION

Devices constructed close to live load areas (roadways, paved areas, vehicle crossings) may require structural support which must be designed to carry appropriate horizontal or vertical loads. Precast or in-situ concrete walls or cells may be used where necessary.

Underdrains should generally be not less than 100 mm Internal Diameter rigid, smooth-bore pipes, perforated to inlet from coarse drainage material. Bends, junctions and inspection ports should be arranged to enable CCTV inspection, flushing and jetting.

Flexible perforated pipe should only be used for underdrains to tree planting pits or as subsoil drains.

Geotextile cloth should only be used for mudstop at the perimeter of drainage devices constructed on clay or similar subgrade, not between elements of bio-retention devices. Filter socks should only be installed on perforated pipes used for subsoil drainage in inert materials.

Other uses of geotextiles in devices must be approved by AT Chief Engineer.

OPERATION & MAINTENANCE MANUAL

Design of treatment devices or a treatment suite must include a draft operation and maintenance manual as per the Auckland Council Stormwater Guidelines. This should include a brief statement of the function of the device or suite in its local stormwater management context. The manual must include a schedule of inspections, cyclic and planned maintenance operations, which must be used to estimate operational costs for the selected option. The completed O&M manual for all treatment devices must be provided to AT for all assets to be vested.

4.1 Treatment /Management Options Tool Box

TREATMENT TOOLBOX

AT relies primarily on the technical information and design specifications provided in the Stormwater Management Devices in the Auckland Region, Auckland Council Guideline Document GD04/GD01. However, there are instances where GD001 designs may not be the most appropriate option to be located in the road.

Treatment options for existing road runoff or road runoff from new road surfaces have been grouped into three Tiers:

- Tier 1 (T1): AT will accept these devices/design options although most will have design constraints around them to ensure the right size and right place in the corridor.
- Tier 2 (T2): AT will accept these options on a case by case basis. Discuss with AT to ensure the design actually requires this option and how/where it will be located.
- Tier 3 (T3): AT will only accept these options by exception. Definitely not a preferred option by AT but will be considered as a last resort.

TABLE 4

Treatment /Management Option	New Roads	Existing Roads
Pond	T3	T3
Wetland	T2	T2
Swale /Vegetated swale	T1*	T1*
Sand filter	X	X
Bioretention (lined/unlined)	T1	T1
Pervious paving (lined)	X	T3
Pervious paving (unlined)	X	T3
Raintanks	X	X
Gravel trenches	T3	X
Soakage pits	T1	T1
Detention tanks	T3	T3
Dry ponds	T2	T2
Proprietary Devices	T2	T2
Catchpit filters/filter screens	T2	T2

*This would be T2, if private lots are to discharge to swale.

4.2 Bio-retention swales, rain gardens and tree pits

PRINCIPLE

Bio-retention devices that are required to perform hydrological function, are required to detain the 90th or 95th percentile volume determined in accordance with GD01, and drain it down over 6 to 24 hours, through low infiltration rate media.

Bio-retention practices on Auckland roads must be designed to ensure that traffic loads to road pavements are transferred to subgrade without the need for support from uncompacted filter materials. Edge beams and channels should be designed to provide restraint against lateral movement. Concrete structures should be avoided where possible, but may be required in some cases. Proprietary structures may be used, subject to approval of the type and specific design details.

RAINGARDENS

Stormwater runoff enters a raingarden through vegetation layers at the surface, before it soaks into soil media. Depending on underlying subsoils, stormwater may then infiltrate to groundwater or be collected and piped to a discharge point. Ponding on the surface of the raingarden is called 'live storage' and is designed to dissipate over a period of 24 hours as a function of media permeability and evapotranspiration rates.

While AT strongly supports the use of raingardens for stormwater treatment, raingardens should be designed to maximise the size of each device. Drainage design should seek to reduce the number of smaller devices in favour of fewer, larger raingardens, particularly where these are located within the road.

BIORETENTION SWALES

Bio-retention swales may provide a conveyance function in addition to retention, detention and stormwater treatment. This treatment option is often easier to accommodate within the linear infrastructure of the road corridor. Flow needs to be uniformly distributed over the full surface area of the filter media to achieve maximum pollutant removal performance. The type of vegetation used in a bio-retention swale varies according to the landscape requirements, where the denser and higher the vegetation within the swale, the greater the filtration provided.

TREE PITS

Tree pits require a sufficient quantity of soil media to support trees through maturity, in addition to biofiltration volume allowing for volume of root structure. Minimum soil volumes and requirements are shown in the Footpath and Public Realm chapter.

Tree pits often have bypass systems to avoid localised ponding from surface runoff. Tree pits may also require increased drainage such as perforated coiled pipes to avoid continuous saturation of root zones and to aerate soils. Where the area around the tree roots is likely to be trafficked, additional structural support may be required, such as a concrete wall, structural soils or specialised root cells.

Tree pits should be located within the berm, using root cells to minimise impact on services. Selecting the right tree for the right location is important and guidance is provided in Section 1.

OTHER GUIDES

See also:

- Design and sizing of treatment devices, as well as vegetation plans, should be as per Auckland Council GD01, however that Auckland Transport will not accept many small raingardens where a fewer larger devices are possible. The minimum device size shall be $5m^2$ for raingardens in the road corridor.
- Vegetation plans must also be as per the Footpath and Public Realm chapter.
- Where the design requires a drop-off from the roadway or footpath into a device, kerbing may be required as per Section 5 below.

4.3 Pervious paving

APPLICATION

AT does not support the use of pervious paving in the road without a specific departure from standard being applied for. If granted, then the following requirements apply.

Surface materials may be:

- In situ porous concrete
- Pervious block paving systems
- Reinforced grass or gravel systems.

ROADBASE

Roadbase material for conveyance and storage must meet pavement strength design specifications. The use of pervious paving is limited by the strength of available materials, or the use of structural cells capable of transmitting traffic loads to the sub-base. All pavement design should assume a saturated sub-grade except in sealed systems.

INFILTRATION AND COLLECTOR DRAINS

Where pervious paving is used simply to reduce the impervious area by retaining all rainfall and infiltrating to subgrade, the retained water volume must be isolated from the road foundation and road subsoil drainage for a period of 24 hours in a lined system. The subgrade must be capable of infiltrating the retained volume within 72 hours.

Where pervious paving is designed to capture and manage run-off from more than its own surface area, a suitable collector drain must be provided with connection to a designed discharge.

Where geotechnical or other considerations require that there should be no infiltration to subgrade from a pervious paving installation, it must be designed with a sealed liner, collector drain and discharge connection.

MAINTENANCE

Pervious paving design must include an operational maintenance plan that includes cleaning. Layout of the boundaries of pervious paved areas must consider access for maintenance equipment such as vacuum sweepers.

GRASS

Reinforced grassed systems must only be used where traffic loading and sediment deposition are limited, so the grass can thrive.

OTHER GUIDES

Design and detailing of surfacing, drainage capture, conveyance, and pavement structure must meet the suppliers' system requirements as well as Auckland Council Stormwater Guidelines.

4.4 Sand filters, gravel trenches and rain tanks

APPLICATION

Sand filters and gravel trenches are not acceptable treatment devices to be located within the road. AT will not accept these devices as vested assets for the treatment of stormwater drainage. Gravel trenches and sand filters may be suitable in other drainage environments and designers should comply with the design requirements in Section 1.

Rain tanks may be utilised to detain runoff in areas of new development only where no other detention options are available. Designers are required to seek approval/guidance from Auckland Transport Chief Engineer early in the design process. Rain tanks are not suitable detention devices to be located within the existing road.

Underground detention tanks might be acceptable on a case by case basis and designers are required to seek approval from Auckland Transport Chief Engineer before designing these tanks.

4.5 Ponds and wetlands

APPLICATION

Constructed wetlands are generally placed in the lower areas of a catchment, as a final stage of the treatment suite. Wetlands can occupy a relatively large space and should incorporate some form of sediment pre-treatment to improve longevity (some of which may be provided by a forebay). Because they can provide both detention and water quality treatment, they are a versatile device where land space is available.

WET POND

A pond that has a standing pool of water with a permanent water level (PWL). The wet pond provides some level of water quality treatment as the sediments (especially larger particles) can settle over a long period of time. However, increased water temperature can have a significant negative impact on receiving waters.

DRY POND

A dry pond (also called a detention basin) temporarily stores stormwater runoff to control the peak rate of discharges without having a standing pool of water. Dry ponds empty between rainfall events, depending on the time interval between the rainfall events. These areas can usually be incorporated with other amenity and landscape features.

WETLANDS

AT acknowledges the value of a wetland system for treating stormwater runoff from roads and larger catchment areas, however, the land area required to construct a suitable wetland is typically unavailable within the road. Where land is available and the wetland will treat primarily road runoff, designers considering this treatment method should seek advice from Auckland Transport Chief Engineer early in the design process.

PONDS

While ponds are a useful treatment device for allowing settlement of suspended sediment, the land area required means that ponds are typically not suitable for treatment of stormwater runoff within the road. While AT will consider accepting a pond as a vested asset in the road, this is by exception, only where alternative treatment options are not available and prior approval must be obtained from the Auckland Transport Chief Engineer.

Dry ponds may be suitable on paper roads or in drainage reserves as a passive amenity feature. Designers considering these options should seek advice from Auckland Transport Chief Engineer early in the design process.

OTHER INFORMATION

See Information Sources in Section 1 for design information, including GD01.

4.6 Swales and vegetated swales

APPLICATION

Swales are broad, shallow channels designed to convey and infiltrate stormwater runoff. The swales are grassed or vegetated along the bottom and sides of the channel, with side vegetation at a height greater than the maximum design stormwater level.

Swales may be effective for environmental design, including reducing discharge volume, and for serviceability design. Check dams may be required to limit the gradient of the base of the swale to 5% or less. Swales will not normally be suitable where the road gradient exceeds 8%.

Swales may combine the functions of table drains with treatment. The treatment requirement may lead to choice of either a standard swale or a bio-retention swale. (See Section 4.2 above.)

GRASSED SWALES

Grassed swales can be damaged by parking vehicles, and may be compromised by inappropriate and unauthorised care by frontage occupants. They should not be used in residential local roads, or other roads where berm parking is likely to occur, unless protected by interrupted vertical kerbs. Parking within the swale profile may be permitted with protection by concrete or reinforced grass within the parking bay. Swales with approved vegetation other than grass may be acceptable in such roads. Street trees may be planted in conjunction with swales, subject to requirements of the Footpath and Public Realm chapter.

INTEGRATED DRAINAGE

Where swales are used to reduce the need for piped public stormwater systems, discharge from private lots may be permitted, (see Table 4 footnote) subject to retention and detention on-site. Connections utilising a kerb discharge pipe from an inspection chamber on the property boundary may be permitted.

SERVICE TRENCHES

Where services are to be laid under swales, they must be clear of any subsoil collector drain, and access pits and covers must not obstruct the designed waterway.

OTHER GUIDES

Swale design must comply with:

- Auckland Council GD01 and
- Section 9 below.

4.7 Soakage pits

APPLICATION

Soakage pits generally refer to high capacity systems in areas without stormwater reticulation where all runoff is discharged through soakage pits into fractured basalt. These systems have performance specifications that are limited to only a few areas within the Auckland region. Design standards are available in TR2013 040 referenced in Section 1.

4.8 Proprietary devices

APPLICATION

In some cases, it will not be feasible to meet stormwater consent treatment requirements using the systems listed above. Where proprietary devices are appropriate, they must be selected from devices approved by Auckland Transport. Proprietary devices should be chosen to meet treatment requirements and demonstrate economical operating costs.

Applications for approval of new devices should be submitted to the Auckland Transport Chief Engineer with supporting information.

MAINTENANCE

Access and the nature of operations required for maintenance of proprietary devices can affect operating costs, in addition to dependence on specialist plant, contractors or on suppliers for components. The cost of operation must be balanced with the environmental benefits obtained.

05 Kerbs and channels

APPLICATION

Kerbing may be required for surface water control:

- As part of a surface water channel for collection and conveyance to an offlet, a catchpit or a treatment device such as a rain garden or filter.
- On all roads where the channel gradient exceeds 8%.
- On all roads where the channel gradient exceeds 5%, unless a side drain system is provided that collects surface water effectively along its length.
- To contain overland flow and ponding within the roadway for the protection of property or the safety of footpath users.
- Roads with side drains/water tables where the road passes through a cutting and the side drain is interrupted.

PLANS

The surface water kerb and channel profile should be selected from one of the details in plans GD008 - GD015. Selection must suit both the streetscape design and the drainage design. It must be able to collect and convey the minor design storm run-off to the point of discharge, and meet the criteria in Section 2.3 for major event drainage.

KERB TYPES

For drainage systems using catchpits as per Section 6, kerb types 1 or 3 will normally be suitable. Other kerb types may require transition over at least 600mm between the kerb and a catchpit lintel. For further design information see the Urban and Rural Roadway Design document of the Engineering Design Code.

KERB DISCHARGE PIPES

Where existing or new kerb discharges are present, they are to be constructed or renewed as shown in the Standard Engineering Details.

INTERRUPTIONS

Where kerbing is required for vehicle containment or the safety of path users, and drainage goes to an extended device such as vegetated strip, swale or rain garden, the kerbing may be interrupted at intervals to allow drainage. For vehicle kerbing, interruptions must normally not exceed 300mm in length and be at least 600mm apart, with inlet capacity designed as a weir. The operating speed environment should be 60km/h or less.

PROTECTION FOR DROP-OFF FROM FOOTPATH

For footpaths, protection must be provided where there is a drop-off or steep batter adjacent to the footpath edge. An upstand kerb must not be less than 75mm, with short interruptions for inlet. Where edge rails are used, the bottom rail must have a gap of 75mm or less below the rail. Alternatively, drop-off can be limited to no more than 25mm to a paved margin 500mm wide, or a side slope not exceeding 1:3 within a rain garden.

PAVED AREAS WITHOUT KERB

Where an upstand kerb is not provided in paved areas, a concrete drainage channel must be provided. The standard concrete V-channel profile should be used. A drainage channel should usually be at the left and/or right side of all traffic lanes. One may be located between traffic lanes and parking or other paved areas that fall towards the roadway or, in special circumstances where kerb containment is not required, between the roadway and the path.

In low-speed traffic and shared use areas, a channel may cross or be between expected vehicle movement tracks, subject to other design objectives.

Where a channel is within a large paved area subject to crossing by path users, a shallow V-shaped or trapezoidal channel may be suitable.

FLOW LIMITATION

If the acceptable width of channel flow is likely to exceed the capacity of the channel, capture by catchpits or grated channels should be considered.

RUN-OFF FROM ADJOINING LAND

Where adjoining land falls towards a road, and the road surface falls away from the road edge (superelevation or single crossfall), a channel profile is required to intercept:

- significant sheet flow from a wide paved area or
- prolonged surface flow from a pervious landscaped area.

In this case, the length of channel flow to a catchpit must be limited by the capacity of the channel profile. It may be sufficient to design channel flow capacity for 50% AEP, where prolonged surface flow is the problem.

OTHER GUIDES

Provision of kerbs and selection of kerb profile for traffic purposes should be as described in the Urban and Rural Roadway Design Chapter.

06 Catchpits

APPLICATION

Catchpits are provided to drain the carriageway and to retain sediment or silt.

APPROVALS

Road drainage is managed jointly by Auckland Transport and Auckland Council. Approval is required from both organisations for any work affecting this system. In combined sewer areas, approval from Watercare is needed as well.

TECHNICAL REQUIREMENTS

Catchpits used in all public roads must comply with this manual, including:

- All catchpits draining to combined networks must have a water-trap discharge to prevent odours from the combined sewer system escaping from the catchpit. This should generally be in the form of a half-siphon as shown in Standard Engineering Details.
- All catchpits must include a silt trap sump of at least 450mm deep.
- Catchpits in town centres, or discharging directly to streams, public beaches or amenity water, including ponds and wetlands, must be fitted with approved gross pollutant traps.
- Catchpits discharging to soakage should include inserts to trap gross pollutants.

6.1 Catchpit location

BEST PLACEMENT

Catchpits should generally be located:

- At spacing determined by road surface drainage calculations, particularly for very flat or very steep gradients.
- In channels draining one lane, so that the water run in any channel is no longer than 90m, unless specific calculation is done.
- In channels draining two lanes, so that the water run in any channel is no longer than 60m, unless specific calculation is done.
- At sag points in road channel.
- Upstream of pedestrian and cycle crossings, at least 10m from the approach side of the crossing
- At raised tables.
- At least 10m from the kerb line tangent points, if the road falls to an intersection.
- At changes of gradient or direction in the channel, where there may be a tendency for water to leave the channel or to pond.
- At changes of crossfall, where significant flow will leave the channel and cross the roadway.
- Avoiding locations likely to conflict with future vehicle crossings.

For all above cases, the location should allow for safe operation when cleaning pits, and minimize traffic management requirements.

INTEGRATED DESIGN

Where devices for environmental management are provided, run-off exceeding the flow rate that must be captured for treatment may bypass inlets and continue as channel flow to a catchpit, located to capture 10% AEP maximum serviceability flow. Catchpit spacing may be increased, depending on residual bypass flow. Catchpits may not be needed at all pedestrian crossings.

GRATED CHANNEL DRAINS

Grated channel drains or slot drains may be appropriate to drain some areas, especially flat areas with wide sheet flow, or to intercept surface flow to protect vulnerable property below the paved area. Channel or slot drains may only be used where areas cannot be laid to fall to surface channels or to spread-entry treatment devices. (This could be due to trip hazards, excessive gradients, or excessive surface water in areas of heavy pedestrian activity.) Every channel or slot drain must discharge to a catchpit designed to suit that channel system.

COMBINED KERB AND DRAIN BLOCKS

Combined kerb and drain block systems may be appropriate for flat or steep road edges. They can drain intersection areas where conventional kerb and channel would require catchpits that would be difficult to maintain safely. They can be used to drain areas that would pond due to vertical traffic calming features, with discharge either returned to road channel downstream of the feature or to a catchpit sump for connection to an outlet. Proprietary systems may be used subject to approval by AT Chief Engineer.

6.2 Catchpit design

PRINCIPLE

Catchpit inlets should be designed to intercept and convey all stormwater run-off from a minor drainage design storm, while limiting risk and degree of interference with traffic, safety risk and risk of flooding due to blockage.

DESIGN GUIDELINES

Catchpits should be designed to provide for the safety of the public from being swept into the stormwater system. Openings must not pass an object greater than 100mm in its smallest dimension. Openings must be small enough to prevent entry of debris that would clog the stormwater system, or must include a screening element to protect the discharge pipe from debris.

Catchpits located on gradients must be designed for their inlet capture capacity, and any bypass flow must be added to the flow in the next sub-catchment.

LOW POINTS IN ROAD

A catchpit located at the lowest point in a sag vertical curve, or at the end of a cul-de-sac where water falls to the end, must be designed for a sump condition inlet with sufficient capacity to handle bypass flow that concentrates to that point and must allow for blockage.

They must be either:

- Double standard catchpits
- Splay catchpits
- Street catchpits of 500x800mm.
- Megapit or
- Another pit type with sump inlet capacity that allows for sufficient flow, even with blockage.

Where ponding would lead to road safety risk or property flood risk, consider a second catchpit and separate lead near the sag point.

INLET CAPACITY

Inlet capacity should be taken from manufacturers' or suppliers' data for approved types, or from verified testing of data for new types, or from approved design charts.

- Standard Catchpit 460x675mm should be taken to have nominal inlet capacity of 28 l/s installed on a gradient.
- Corrections must be made for crossfall less than 3%.
- Calculated catchpit inlet capacity must be reduced to allow for partial blockage of the inlet as follows.
- Where existing catchpits are in good condition, and could be retained during rehabilitation or upgrade works, grate and back entry may be replaced with new items. Drainage design must be checked for inlet capacity and location in all works where existing catchpits might be retained, as current design run-off may exceed existing capacity. Increased inlet capacity may need to be provided.

TABLE 5 ALLOWANCE FOR INLET BLOCKAGE

Location	Inlet type	Proportion of theoretical capacity
Sag point	Kerb inlet	80%
	Grate	50%
	Combined	100% of kerb inlet only
	Continuous	100%
On-grade	Kerb inlet	80%
	Grate	50%
	Combined	90%
	Continuous	100%

Notes: Combined means a grate with kerb inlet or back entry. Continuous means a grated or slot channel or combined kerb drainage blocks with close-spaced inlets.

TABLE 6 TYPICAL USE OF CATCHPIT TYPES

Type	Use
Standard catchpit	Local streets and other locations where spacing is determined by factors that limit catchment to less than 28 l/s. Where kerbside bus or cycle use is likely, cycle-friendly grates and aprons must be used, which will reduce inlet capacity.
Street catchpit 500 x 800mm	Any street where channel flow can exceed inlet capacity of standard catchpit.
Grate only	Locations where a back entry cannot be provided, such as V-channel or Kassel kerb. Care is needed to provide for by-pass flow due to risk of blockage. Use should be avoided by locating catchpits where upstand kerb can be installed.
Semi-recessed	All catchpits with grates should be semi-recessed to ensure the channel lip line continues straight at apron, unless a recessed kerb line would create a hazard for footpath users.
Splay pits and similar	Pits without grates may be used where semi-recessed pits would be hazardous to footpath users. These types of higher-capacity inlet can also be used with catchpit manholes, sized to suit the pipeline running from them. This can reduce the number of chambers and leads required in a drainage system.
Megapit or similar	High inlet capacity used where flood flows must be captured fully or partially to piped drain, to ensure overland flow does not exceed acceptable criteria.
Field catchpit	For use away from roadway, adjacent to footpaths or landscaped areas that cannot be drained otherwise.
Other types	Innovative designs should be discussed with Auckland Transport before being proposed.

6.3 Catchpit approved types

APPROVED DESIGNS

Public catchpits for all new development must be selected from the following approved catchpit designs as per Table 6.

APPROVALS

Catchpits of other types must be submitted to Auckland Transport Chief Engineer for type approval before they may be used. Where site conditions prevent one of the approved types being used without modification, the modified design must be approved by Auckland Transport before use.

6.4 Catchpit selection criteria

CONTEXT

Catchpits must be selected with regard to the context for their use. Selection may be affected by site constraints and design inlet flow, including spacing related to the acceptable width of channel flow. Limitations on possible locations for connections to the network or discharge from road reserve may influence the location, and thus the type selected. Consider factors such as run-off from adjoining land, litter in public areas or debris from trees that may affect the type or location of effective catchpits. Choice of catchpit type may be affected by existing utility services, which may constrain where a pit may be installed.

Take care when sizing the outlet and designing the downstream network capacity of the stormwater pipe system, watercourse culverts or stormwater soakage system. Catchpit inlet capacity may exceed downstream capacity of the existing network. Effects need to be evaluated and mitigated if necessary.

6.5 Catchpit inlet selection

APPROVED TYPES

Inlet weirs and grates should be selected from the types shown in EDC - Standard Engineering Details or the list of approved types kept by Auckland Transport. This section also covers grates and slots for channel drains.

CATCHPIT GRATES

New and replacement grates and frames must meet Auckland Council and Auckland Transport safety requirements.

Grates should be:

- spring-latched;
- captive hinged;
- flat topped;
- frame support allowing closure without clogging by debris.

CATCHPIT LINTELS

The standard concrete lintel for 675 x 450 mm catchpit has a limited capacity. If the inlet capacity required exceeds this, especially for an existing catchpit, the capacity can be increased by installing an extended concrete lintel, which may be effective on steep gradients, or a galvanised steel lintel.

A mountable galvanised steel lintel may only be used with prior approval by AT Chief Engineer, usually at a vehicle crossing where the catchpit cannot be relocated clear of the crossing.

CYCLES AND BUSES

Any catchpits on a road used by cyclists or buses close to the drainage channel line must be provided with cycle-friendly inlets. Where other catchpit types are used, the grate must be replaced by one that is approved by Auckland Transport. The apron must be reshaped to the same profile as the road and the frame must not be more than 5mm below the level of the road. Check the inlet capacity. An extended lintel may be appropriate.

Where V-channel between traffic lane and parking lane occurs, a field catchpit with dished grate is acceptable if required for sub-catchment size, but only with cycle-friendly configuration.

PEDESTRIANS

Any catchpits in locations with foot traffic (e.g. paths, plazas, shared use areas and pedestrian crossing areas) must be provided with pedestrian friendly inlets. Take care to avoid fall hazards with semi-recessed inlets, where the footpath is paved to the back of the kerb.

6.6 Catchpit leads

MINIMUM DIAMETER

All leads must be at least 225mm diameter, except as indicated below. Where catchpits are located at sag points in the road, leads must be at least 300mm diameter.

Leads from certain devices specify minimum sizes larger than 225mm. This specified size will determine the minimum size of pipes downstream from that lead. Any proposed connection to a pipeline of smaller diameter requires approval from the Auckland Council stormwater unit.

Leads from some channel drains may be less than 225mm in diameter, as shown on supplier design charts. Approval is needed to use smaller diameter leads. Consider their capacity, security against blockage, effects of blockage and ease of maintenance.

MAXIMUM LENGTH

Catchpit leads should not exceed 30m in length.

CONNECTION

A catchpit lead should not normally connect to another catchpit. However, where pipe maintenance access for jetting is available from the inlet and subject to pipe capacity, it may connect to another catchpit lead, using a fabricated 90° or 135° junction.

Catchpit leads connecting to a piped stormwater network should normally be connected at a manhole. Where connection to a manhole

- would require an excessively long lead,
- the gradient is insufficient, or
- the connection is difficult because of manhole integrity or obstruction of the direct line,

a saddle or branch connection to the pipeline may be considered, subject to AC SW COP requirements.

Connections between concrete pipes or chambers and pipes of other materials must be designed and constructed to be watertight, allowing for deformation. For example, a concrete stub pipe may be used from a concrete catchpit chamber to allow a flexible lead to be used, with a proprietary connector. All connections should be finished or inspected from inside and outside of the pipe.

BENDS

If a catchpit lead cannot be laid straight due to obstructions, its length should not exceed 15m and large-radius bends should be used to allow maintenance.

OUTLET

Catchpit leads discharging to land, to a watercourse or to an open channel drain must be provided with a suitable outlet structure complying with AC SW COP requirements.

07 Manholes

DESIGN

The Design of manholes should be in accordance with the AC SW CoP with the following additions.

LOCATION OF COVERS

Manhole covers within the road reserve must be located so that maintenance vehicles can get to them. Consider the temporary traffic management that will be required for maintenance access. Where possible, manholes must be located in the berm or footpath. Where this is unavoidable, manholes in the roadway should be located within parking lanes, or between wheel tracks in traffic lanes. Manholes at intersections must be located in the safest position where there is safe access using economical traffic management.

LIDS

Hinged lids must be installed to close in the direction of traffic movement. Avoid placing hinged lids in a traffic lane in the opposite direction to an overland flow path with significant depth and velocity.

08 Rural road drainage

URBAN ROADS

Rural drainage features may be found within urban areas, however these are by exception only and a departure from standard application must be made to and approved by the Chief Engineer of Auckland Transport

WATERCOURSES

Rural roads must be designed with regard to topography and existing land drainage. An existing or diverted watercourse may lie within or abutting the road reserve. If this is the case, a drainage concept must be agreed with the Auckland Council and Auckland Transport to determine:

- how the road is to drain,
- what discharge points or sheet flow may be considered, and
- what treatment may be required.

ROAD SAFETY

The shape and location of the roadside drain must consider road safety. Preferred side slopes should be 1:6, with a 1.2m wide level base. Where this cannot be achieved, design must be as per Austroads Guide to Road Design Part 6. Steep-sided ditches, or deep channels will not be accepted within the clear zone of the road, unless a safety barrier is provided.

CAPACITY

Adequate drainage channels must be formed, so that the design water level is below subgrade level. The capacity must meet requirements for serviceability design for the road.

Where appropriate, Auckland Transport may require that the road drainage channel be enlarged to deal with the run-off from 10% AEP or 1% AEP events. The consequent sizing of vehicle crossing culverts will have to reflect this run-off. Particular provision may need to be made to reduce velocities and thereby minimise erosion within the channel and at cut-off inlets.

CUT-OFF

Adequate cut-off must be provided, so that the maximum length of the flow path in the road drainage channel does not exceed 200m. Table drain blocks within the channel downstream from a cut-off drain should be provided to ensure the flow is captured by the cut-off drain.

The cut-off must discharge to a natural watercourse, by way of an open drain along a lot boundary. Open drains through the body of the lot will generally not be acceptable. All such cut-off drains through private property must be protected by way of a drainage easement registered on the title of the property or properties affected. Where the easement is a specific one, i.e. not an easement in gross, it must be a minimum width of 3m to allow for easy maintenance access. Where discharge is through a residential lot, all or part of its length may need to be piped. Access for outlet inspection and maintenance must be demonstrated.

GRADES

The minimum longitudinal grades of water tables must be 1:100 (1%). Where this may lead to unacceptably deep water tables, alternative options must be investigated and agreed with Auckland Transport.

CONSENTS

Relevant consent conditions from Auckland Council may require erosion and sediment control management to be demonstrated.

EROSION

All road discharges should be fitted with erosion protection measures. In steep terrain, stormwater fluming may be necessary.

Where the gradient of a roadside drain channel exceeds 5%, provision should be made for velocity control and erosion protection. This may take the form of armouring of the base and side slopes, or of providing check dams and stepped channel grades.

Auckland Transport may require drainage channels along the top of fill batters to control erosion. The road drainage channel must be designed to consider the whole of the contributory catchment.

SEDIMENT

Where roadside drains discharge to a stream or coastal discharge, sediment control should be provided as per resource consent or network consent conditions. If no specific controls for the discharge are set, then sediment control should be provided by an appropriate device, e.g.:

- Vegetated channel, strip or swale between the road run-off and the point of discharge or run-off to the stream.
- A length of rock filter drain in the channel approaching the cut-off pipe or channel.

09 Subsoil drains

WHERE NEEDED

Piped subsoil drains must be provided at all locations where water may pond, or where groundwater may rise to the subgrade, e.g. natural springs or concentrated flow under steep roads. This can also happen near under-verticals or other areas where the footpath will otherwise be exposed to wet sheet flow from groundwater in the berm. The road pavement design may require subsoil drains.

ROOTS

Where subsoil drains pass within the planned root growth zone of trees, unperforated pipes with sealed joints must be used for the length of the zone, unless otherwise protected by their design.

DOCUMENTATION

A CCTV inspection of completed underchannel drains must be arranged for, after kerbs have been poured. The inspection log and disk/tape must be provided with completion documentation for the work. If any underchannel drains cross a carriageway, an as-built drawing to 1:200 or 1:500 scale must be provided, along with completion documentation for a record of their location.

OTHER GUIDES

The principles of subsoil drainage design are detailed in Austroads Guide to Road Design Part 5.

- Subsoil drains should be as shown in RD025.
- Design for subsoil drains must be as per New Zealand Transport Agency (NZTA) specification F2:2013 (Specification and Notes).

10 Minor culverts

DEFINITION

Minor culverts are those conveying storm water under roads, with a cross sectional area less than 3.4m2. (Refer SWCoP Section 4.3.9.8 for more details.) Major culverts are dealt with in the Structures chapter of the Transport Design Manual. See SWCoP for further design requirements.

FAUNA

The designer must obtain confirmation from Auckland Council whether any waterway to be culverted, or any culvert that is to be modified, needs to incorporate fauna passage. Such culverts must incorporate provision for the passage of fish as per Auckland Council guidelines, TR2009/084 and TP131. AT expects that road crossings will cater for fish passage unless it can be demonstrated that none is required (no habitat for diadromous native fish exists upstream) and this includes perennial and intermittent streams. Culverts should be designed with sufficient redundancy so at least 20% of the internal volume is recessed below bed level.

Installation of the culverts for fish passage also requires maintenance of the devices installed for fish passage over the design life of the culvert.

LENGTH

A culvert conveying a watercourse under a roadway should generally extend so that inlet and outlet are outside the road boundaries. Where road embankment side slopes are within the road reserve, inlets and outlets must be at least outside the width of the level berm on approaches.

INLETS AND OUTLETS

The safety of all road users should be considered in designing inlets and outlets. Fencing around inlet/outlet structures is required unless it can be demonstrated that human access to the inlet/outlet structure is unlikely and/or the height of the structure is less than 1.0m.

Inlet or outlet structures must be provided with vehicle restraint protection as described in the Urban and Rural Roadway Design document of the Engineering Design Code.

If they are within the clear zone, inlet or outlet structures for pipes that cross roads should be sloped to match the drain or embankment slope. Pipes under side road intersections or driveways should have traversable ends if they are within the clear zone.

Inlets and outlets must be provided as per AC SW COP.

CUT-OFF DRAINS

Culverts conveying run-off from roadside drains under the roadway or away from the roadway to discharge points as minor drainage, must be designed to provide capacity for at least 10% AEP flow. Inlets must be designed to capture this design flow without significant bypass.

Culverts designed as part of the major drainage system, must have capacity for 1% AEP flow.

VEHICLE CROSSING CULVERTS

Where a vehicle crossing is to be constructed or redeveloped to cross a roadside drain or swale, and there is less than 200m of roadside drain upstream from the crossing without a cut-off drain, a crossing must be installed. Vehicle crossings paved to the profile of the swale is permitted where subsoil drainage prevents prolonged seepage flow across the crossing, and is required for swale capacity for 10% and 1% AEP run-off.

The minimum internal diameter of a vehicle crossing culvert is 300mm. Where the vehicle crossing crosses a stream or other natural water course then the minimum internal diameter for the culvert shall be as per the AC SWCoP. Culverts for vehicle crossings must also comply with requirements for fish passage as described in Auckland Council TR 2013/018 and Fish Passage Guidance for State Highways, 2013 NZTA.

For any other roadside drain or watercourse, a crossing culvert pipe should be designed with a capacity of 20% AEP flow without exceeding the capacity of the upstream drain, and so that 10% AEP flow does not exceed the allowable channel flow width, or spill from the road boundary. Culvert capacity is to be determined for run-off from the Maximum Probable Development of land upstream.

11 Special areas

APPLICATION

Waiheke Island and other Hauraki Gulf Islands, together with the Waitakere Ranges have special requirements associated with stormwater drainage. The geography, the lack of reticulated services, bush cover and special legislation require that stormwater drainage is considered on a fit for purpose and case by case basis.

Designers must contact the Chief Engineers and Asset Management Group for advice on designing/implementing appropriate stormwater drainage in these areas.

OTHER INFORMATION

Refer to Waitakere Ranges Heritage Area Act (2008) and the AT Waitakere Ranges Design Guide.