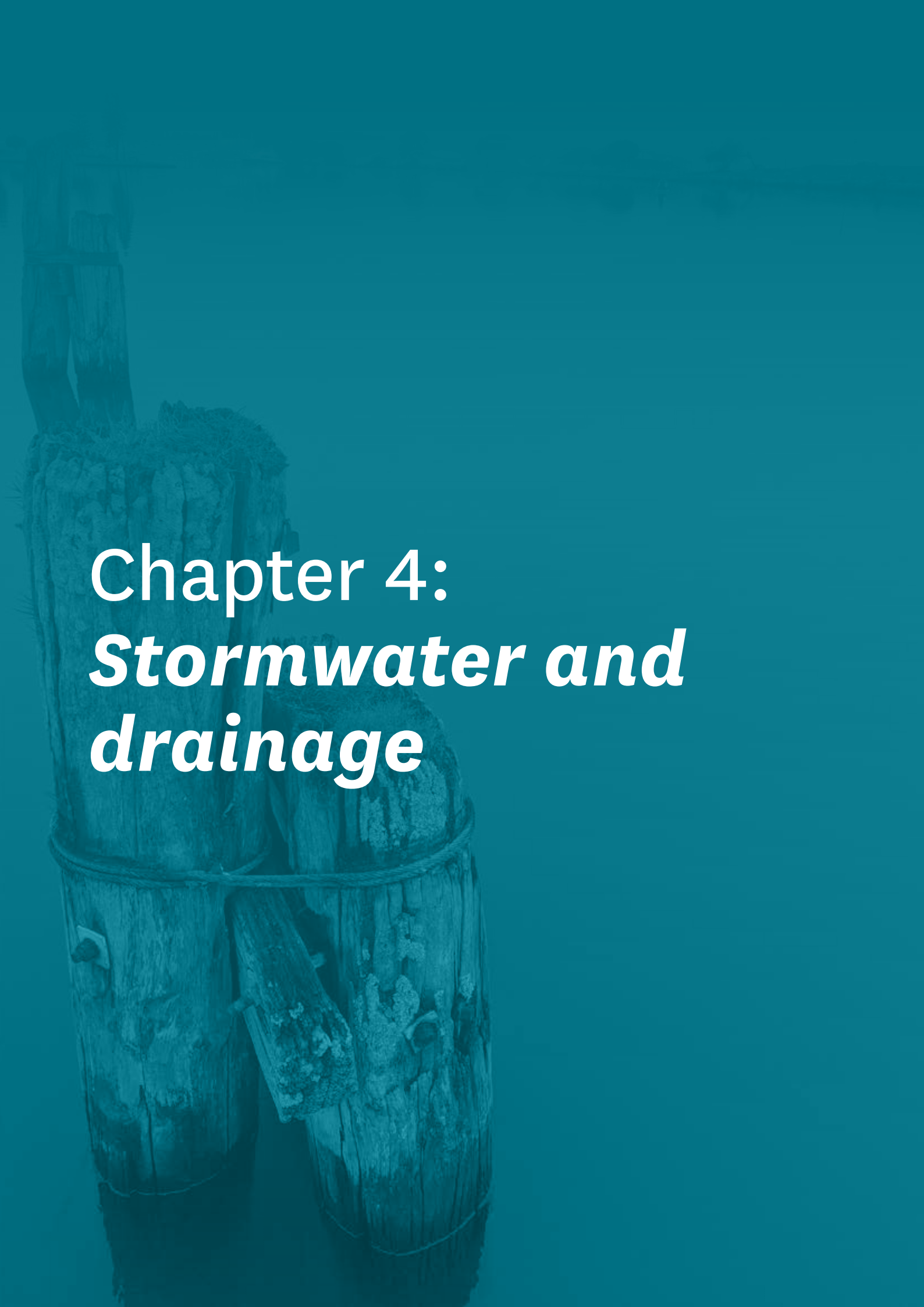


# Chapter 4: ***Stormwater and drainage***

## 4.1. Introduction

This section sets out requirements for the design and construction of stormwater systems for land development and subdivision. The ES provides high design standards to designers, with an understanding of the key design considerations, to support performance standards.

Stormwater systems and associated networks, convey flows, which frequently contain pollutants and nutrients. Additionally, they tend to increase the flow rate and the volume of water to receiving environments, such as watercourses (natural and modified), rivers, lakes, sea and groundwater features. This can result in increased rates of erosion, land instability, habitat disturbance and degradation of habitat quality.

Managing the actual or potential effects, on receiving environments, must take into account the hydro-ecology (ecological and hydrological processes) and include environmental, cultural and social values, in the design of treatment (management) systems (e.g. wetlands) to mitigate these effects.

### 4.1.1. Stormwater System Description

A stormwater system's key objective is to protect people, their activities, properties, and environmental values. A stormwater system consists of:

a. A primary network designed to accommodate a specified design rainfall event appropriate for MPD approved by the District Plan,

b. A secondary network to service catchments for stormwater runoff that exceeds capacity of the primary network, including when there are blockages in the primary network, and

c. Processes and procedures used in Asset Management practices, flood modelling and risk management.

### 4.1.2. Objectives

The primary objective of the Stormwater Chapter is to enable design and management of the stormwater system that will minimise flood damage and adverse effects on built and natural environments, people, property and ecological systems.

This can be achieved by avoiding or mitigating the adverse quality and quantity effects of stormwater resulting from development and growth of human activities. As appropriate reference is made to best practice design and management guidance, contained in existing reference guidance documents.

The stormwater system enables stormwater services to land. Regardless of whether the stormwater services are private or public, interaction between both shall be managed efficiently throughout collection, transport, treatment, attenuation and discharge stages.

Design and operational objectives include, without limitations, the following:

a. Meeting WDC Standards,

b. Design for resilience,

c. Compliance with environmental and Network Discharge Consent requirements,

d. Safety in Design,

e. Minimising flood hazards to people and properties,

f. Minimising adverse environmental impacts,

g. Minimising health and safety risk(s) for public and maintenance workers,

h. Ensuring Māori freshwater values are identified and provided for,

i. Minimising operational, maintenance and asset decommissioning risk(s),

j. Extended service life of stormwater assets with application of whole-of-life cycle cost,

k. Practising and encouraging an integrated stormwater management approach,

l. Delivering a public stormwater network that is fit for purpose and economical to operate and maintain,

m. Maintain or improve water quality,

n. Financial, environmental and community outcomes are achieved, and

o. Low impact design solutions, water sensitive systems and best practice design guidance should be used to meet these objectives.

### *4.1.3. Performance Standards*

The design of the stormwater system shall achieve the objectives and provide for a stormwater system that is fit for purpose, given site constraints and takes into design guidance.

In brownfield developments WDC may require a proposed development to connect into an existing public stormwater system if available, including where:

a. There is a public stormwater system with sufficient spare capacity available for connection: and,

b. The WDC considers it is reasonable or practicable to require connection, or that it is a logical extension to the network required to provide connection: or,

c. The WDC considers that there is a benefit, in terms of achieving the stormwater objectives of the engineering standards, or there is an environmental benefit to requiring connection.

New stormwater systems planned shall achieve the following minimum standards:

a. The stormwater system shall operate by gravity. Pumped public systems are not generally acceptable unless specific approval is obtained from the WDC Stormwater Manager before proceeding with design details (see Section 4.3.9.2 Primary Network Design Requirements).

b. The primary stormwater system shall be capable of conveying 50% and 20% AEP design storm events without surcharge (see Section 4.3.10 Hydrological Design Criteria).

c. The secondary stormwater system shall be capable of conveying the 1% AEP storm event within a defined path and without causing undue risk or damage to persons or property.

d. The stormwater system shall not connect or be able to overflow to the wastewater network.

e. Development shall not increase peak discharge rates to receiving environment. An increase may be acceptable for large events, up to 1% AEP (+ CC 20%), where it is demonstrated that there are no adverse effects (including potential, future, or cumulative effects), on the environment or downstream properties as a result of the increase.

f. The stormwater system shall provide the required amount of treatment through the use of low impact design and sustainable solutions (See WDC Urban Design Guidelines and Sections 4.3.21 Soakage Devices and 4.3.22 Stormwater Treatment and Detention Devices).

Where the existing stormwater network is affected by the development, the upgrades shall not increase risks to people or property flood hazards and no additional private properties shall be affected (i.e. new flood risks shall not extend onto previously unaffected property or increase flood risks to properties).

The design parameters and specific requirements for the performance standards listed above may differ by land use type, proposed solution (in the case of treatment and detention) and the catchment. Reference should be made to Section 4.1.5 Reference Documents, and the following document hierarchy shall be applied:

a. The District Plan,

b. Relevant WDC Stormwater Catchment Management Plans,

c. These standards, then

d. Auckland Council GD01 (the adopted design guideline for stormwater treatment and low impact design), and

e. Wellington Water- Water Sensitive Design for Stormwater: Treatment Device Guideline.

*Note: Any relevant national and or regional policies/plans take precedence over documents listed in this hierarchy.*

## 4.1.4. Alteration to Existing Infrastructure

The connection of a new development, to the existing WDC stormwater system, shall not negatively affect conveyance and operation of the network. All alterations of the existing stormwater network shall be paid for by the Developer unless otherwise agreed by WDC.

## 4.1.5. Reference Documents

The following documents are referenced in this Chapter:

*Note it is the responsibility of the Developer to ensure the most up to date referenced document is sourced*.

### 4.1.5.1 Statutory

Building Act 2004

Local Government Acts 2002 and 1974

National Policy Statement for Freshwater Management 2020

New Zealand Building Code

NRC Regional Plans

Operative District Plan

Resource Management Act 1991

WDC Stormwater Management Bylaw 2014

### 4.1.5.2 New Zealand Standards

AS 3996:2019 - Access covers and grates

AS/NZS 1254:2010 - PVC-U pipes and fittings for stormwater and surface water applications

AS/NZS 1260:2017 - PVC-U pipes and fittings for drain, waste and vent applications

AS/NZS 2566.2:2002 - Buried flexible pipelines - Installation

AS/NZS 3725:2007 - Design for installation of buried concrete pipes

AS/NZS 4058:2007 - Precast concrete pipes (pressure and non-pressure)

AS/NZS 5065:2005 -Polyethylene and polypropylene pipes and fittings for drainage and sewerage applications

ISO 13953:2001 – Polyethylene (PE) pipes and fittings - Determination of the tensile strength and failure mode of test pieces from a butt-fused joint

NZS 3114:1987 - Specification for concrete surface finishes

NZS 4402:1988/1986 - Methods of testing soils for civil engineering purposes

#### 4.1.5.3 WDC Documents

Approved Materials List - Wastewater and Stormwater (*To be provided by WDC on request*)

Land Hazard Maps

Quality Assurance / Quality Control Manual for Vested Assets - Inspection and Handover Procedures (2010)

Stormwater Catchment Management Plans (*To be provided by WDC on request*)

WDC Policy #0022 - Building Over or Near Public Sewer and Stormwater Pipelines, 2015

WDC Policy #0129 - Land Development Stabilisation 2018 and Land Development Stabilisation – Technical Design Requirements 2018

WDC Urban Design Guidelines

#### 4.1.5.4 Regional Council Documents

Regional Policy Statement for Northland May 2016

Report - Coastal Flood Hazard Assessment for Northland Region 2019-2020

#### 4.1.5.5 Other Referenced Documents

Auckland Council TR2013/018: Hydraulic Energy Management: Inlet and Outlet Design for Treatment Devices (2013)

Auckland Council GD01 – Stormwater Management Devices in the Auckland Region 2017

Auckland Council GD04 – Water Sensitive Design for Stormwater (2015)

Auckland Council GD007 – Stormwater Soakage and Groundwater Recharge in the Auckland Region (2021)

Auckland Regional Council TP108: Guidelines for Stormwater Runoff Modelling in the Auckland Region

Ministry for the Environment's National Guidelines for Crime Prevention Through Environmental Design in New Zealand, 2005

New Zealand Dam Safety Guidelines, 2015

New Zealand Fish Passage Guidelines, April 2018

NIWA High Intensity Rainfall System V4 (HIRDS)

NRCS- USDA TR-55: Urban Hydrology for Small Watersheds

Waka Kotahi F2:2013 - Pipe subsoil drain construction

The Regional Infrastructure Technical Specification (RITS) 2018 (Waikato)

Water New Zealand; New Zealand Gravity Pipe Inspection Manual Fourth Edition, 2019

Wellington Water – Water Sensitive Design for Stormwater: Treatment Device Guideline, December 2019

### 4.1.6. Managing Effects of Land Use on Receiving Environments

Impervious surfaces and piped stormwater systems associated with development have an effect on catchment hydrology. Faster runoff, reduction in base flows and accelerated channel erosion and depositions alter the hydrology and adversely affect the quality of receiving environments. Flow and contaminant increases can have implications for the biodiversity of the aquatic biological community and post development maintenance requirements on systems such as piped networks, stormwater treatment devices, streams and channels.

To mitigate these effects developments are to achieve a hydrological regime where any impacts are managed and/or minimised.

Hydrological balance can be partly maintained by limiting the maximum rate of discharge and peak flood levels for post-development to that at pre-development levels and enabling infiltration to minimise impacts on base flow and ground water recharge.

Peak flow management can be achieved using detention storage, utilising extended duration, for the duration of a limited peak flow event. Therefore, in the absence of more detailed assessment of stream stability, the discharges from detention devices into a stormwater network shall be constrained to 80% of pre-development peak flow rate. These constraints may be relaxed, subject to detailed assessments and hydrological/hydraulic modelling of the catchment being provided.

### 4.1.7. Policy Requirements

The stormwater system for a development, including any upgrading of existing downstream systems where required, shall provide:

a. Formalised conveyance systems and/or storage or an alternative low impact system, including upgrades of the existing system servicing urban areas. This may include a catchment wide intervention where necessary to enable growth.

b. Retention and enhancement of existing natural and modified watercourses through open space areas, including parks and reserves.

c. Allowance for climate change effect (s).

For all land development works (including any changes in land use or coverage) the design of the stormwater system shall include the evaluation of stormwater runoff changes on upstream and downstream properties.

a. Upstream flood levels shall not be increased by any downstream development.

b. Downstream impacts from a development to be investigated shall include changes in flow peaks and patterns, flood water levels, contamination levels

and erosion or silting effects, and effects on the capacity of the existing stormwater drainage system.

c. Where such impacts are considered detrimental by WDC, mitigation measures (e.g. peak flow attenuation, velocity control, contamination reduction approach) on or around the development site, or the upgrading of downstream stormwater systems may be required at the Developer's expense. The downstream effects need not be considered in detail if suitable mitigation measures, as identified in the ES, are implemented in the design of the development.

The piping of existing watercourses or open drains is not generally acceptable unless under specific circumstances. WDC will consider, a risk to public safety as a driver, in any such proposal, but on a case-by-case basis and approve or otherwise, at its own discretion. See Specific Design.

The building over or near public pipes is not generally acceptable and requires a specific approval from the Stormwater Manager (refer to WDC Policy #0022 - Building Over or Near Public Sewer and Stormwater Pipelines ).

### *4.1.8. Stormwater Management Hierarchy*

Disposal of stormwater from developed land must be considered to ensure that development and land-use change does not cause or contribute to adverse impacts upstream and downstream, such as increased flooding, overland flow, erosion, habitat disturbance, or damage to infrastructure e.g., roads, channels and pipe bridges.

These potential impacts can be flow related (i.e. flooding or scour) and/or water quality related (e.g. suspended solids). Any proposed disposal system must therefore respond to downstream conditions, be this natural receiving environments or existing engineered infrastructure.

When selecting stormwater management solutions, the following hierarchy of key principles shall be adopted:

a. Retention for reuse,

b. Recharge base flow and ground water - soakage techniques (subject to geotechnical conditions) see Section 4.3.3 Infiltration and Land Stability and Section 4.3.21 Soakage Devices),

c. Treatment, detention and controlled release to a piped stormwater system or watercourse.

Stormwater shall be managed as close to the point of origin as practicable, resulting in optimised collection and conveyance infrastructure.

# 4.2. Receiving Environment Requirements

## 4.2.1. Discharge into the Stormwater Network

Stormwater treatment and detention will be required prior to discharge to the primary and secondary network.

OLFP shall be assessed, maintained and provided, as necessary, in accordance with Section 4.3.9.3 Secondary Stormwater Network Design Requirements to cater for events exceeding the capacity of the primary system and occasions when the primary drainage system is blocked.

Outlet design and tail water level conditions shall be taken into account in the design of discharges to stormwater systems.

## 4.2.2. Discharge into a Stream or Watercourse

All new and existing discharges to an existing WDC owned and / or maintained watercourse(s) located within approximately 500 metres require specific approval from the Stormwater Manager before proceeding with design details and, if approved, WDC shall apply appropriate conditions to the discharge.

Any stormwater discharge into a watercourse shall be controlled in a manner which does not create adverse environmental effects. In areas where reuse and soakage are not sufficient, and a watercourse is accessible, then the following requirements shall be met:

a. Suitable detention and treatment devices shall be designed, constructed and maintained, and shall meet requirements of applicable WDC Stormwater Catchment Management Plan (CMP). The Developer shall be responsible for installation, operations and maintenance of the stormwater assets to provide best practice stormwater treatment efficiency at all times, until the public assets are vested in the WDC.

b. In the absence of an approved CMP the Developer shall contact WDC to discuss a site-specific Stormwater Management Plan (SMP) and requirements.

c. A suitable outlet and energy dissipating structure shall be constructed to mitigate risks of erosion. The watercourse protection structures shall be designed in accordance with **Sheet 35**, or an alternative specifically designed structure. Tail water conditions shall be taken into account in the design of discharges to watercourses.

d. The direction of the discharge shall be aligned with the natural downstream flow as far as practicable, to prevent erosion. In situations where there is risk of erosion to the banks, appropriate mitigation measures may be required.

e. No structure or items that would cause any obstructions can be placed in a watercourse, unless prior approval by Northland Regional Council.

f. Individual properties which border onto a watercourse shall discharge their stormwater in a dispersed manner, via an appropriate flow dispersal device (see Section 4.2.5 Discharge to Land), to avoid and manage erosion.

Overland flow paths shall be maintained and provided, where necessary, in accordance with Section 4.3.9.3 Secondary Stormwater Network Design Requirements to cater for events exceeding the capacity of the primary system and where there is a risk the primary drainage system could fail.

### *4.2.3. Discharge to a WDC Owned Reserve*

This section applies to public stormwater infrastructure within recreation reserves or open spaces (Reserves).

For private stormwater infrastructure within WDC owned Reserves refer to Chapter 7:Public Spaces and Landscape Works.

The Developer shall consult with WDC as to the applicability of this section to other WDC owned Reserves that may be affected by their proposed development.

In situations where a property borders onto a WDC owned Reserve and the flow of stormwater is in the direction of the Reserve, it may be appropriate to discharge stormwater to the Reserve provided that this does not adversely affect the amenity value or function of the Reserve in any way or create any stability or flooding liability issues for WDC.

Stormwater discharge to a WDC public network within a WDC owned Reserve will require the Parks and Recreation Manager's approval.

Any proposed stormwater connection into a public reserve land shall be designed to public network standards and vested to WDC.

For a new connection into a private stormwater network, including watercourse, pipe, pond or wetland, located within a Reserve and where such network is also operated by the Reserves Asset Team a specific approval from the Parks and Recreation Manager is required and considerations will be given as follows:

a. The design and construction shall be in accordance with an approved CMP. In the absence of an approved CMP the Developer shall contact WDC to discuss a site-specific SMP and what measures are required.

b. A site-specific SMP shall be submitted for approval by WDC.

c. A consultation on the SMP with other relevant landholders/affected parties may be required, subject to the District Plan and RMA.

d. Stormwater from all impervious areas on the development shall be mitigated on site to ensure that total runoff volumes and peak flow rates up to the 1% AEP event achieve the objectives (Section 4.1.2 Objectives) and performance standards (Section 4.1.3 Performance Standards).

e. The stormwater shall be discharged in a dispersed manner within the Reserve via an appropriate vegetated flow dispersal device (Section 4.2.5

Discharge to Land). If suitable vegetation does not already exist, this shall be planted according to a planting plan to be approved by the WDC.

f. The receiving Reserve area shall be well vegetated or grassed, not susceptible to erosion and have no geotechnical constraints. Where requested by WDC, a report by a suitably qualified Geo-Professional shall be provided to support any application to discharge stormwater to a Reserve area.

g. Alternatively, the stormwater discharge may be piped to an appropriate outfall point within the Reserve, subject to approval from WDC.

h. The stormwater discharge shall not compromise any existing or planned structures or parks assets and shall not impede access or reduce the amenity value of the Reserve.

i. An overland flow to the Reserve shall not create or exacerbate existing flooding or erosion problems.

j. Suitable detention and treatment devices shall be proposed, constructed and maintained in accordance with any approved CMP/SMP. The ownership of proposed stormwater devices shall be determined at the CMP/SMP stage to enable a planned vesting of the public assets.

k. The installed stormwater devices shall be operated and maintained by the Developer in the best practicable manner until the public assets are vested in the WDC.

l. All NRC requirements and any District Plan requirements or resource consent conditions for the discharge of stormwater to land and water shall also be met.

m. Easements shall be provided over parts of private land, as necessary, for rights to drain and access to the assets for maintenance.

### *4.2.4. Discharge to the Road Kerb*

Stormwater discharge from a private property to a road kerb outlet is an acceptable solution, only where alternatives are not available.

The use of kerbed roads for secondary (overland) flows is acceptable. All sites shall minimise discharges of stormwater flows onto roads.

### *4.2.5. Discharge to Land*

Subject to the requirements of the NRC Regional Plans, discharge of stormwater from the development onto land is permitted provided that:

a. Flooding levels shall not be increased due to the development,

b. New outlets to any low-lying areas shall be provided or existing outlets retained, and

c. An acceptable rate of dispersed discharge from stormwater runoff at the boundary is < 2 litres/sec/m (e.g. flow can be managed via dispersal swale or trench).

*Note: For example, for a 12 litre/second discharge from attenuation or peak runoff shall provide a 6 m linear length of dispersal swale.*

### 4.2.6. Discharge to the Marine Environment

Any new outfall or physical changes to existing outfalls in the Coastal Marine Areas may require a Resource Consent from the NRC.

The following requirements shall be satisfied when discharge of stormwater is proposed onto a beach or a WDC owned coastal reserve:

a. NRC resource consent shall be obtained (where required),

b. Compliance with the CMP or site-specific SMP for the catchment (if any),

c. Compliance with the NRC Regional Plans, and

In addition

d. The foreshore yard of private property shall form well vegetated buffer areas,

e. Where landowners have retaining or erosion control walls on the coastal edge, the landward side of the wall shall be used for wide dispersal of stormwater,

f. Where discharge through an outfall is the only alternative, the outfall shall be specifically designed to minimise beach erosion and adverse effects on beach amenities, subject to specific approval by the WDC Stormwater Manager, and

g. Where stormwater discharges to tidal waters, the design shall assume a tide level of Mean High Water Spring (MHWS) plus a storm surge of 0.35 m as tail water level.

## 4.3. Design

### 4.3.1. Capacity and Future Network Expansion

Primary and secondary stormwater networks within a development site shall provide capacity for safe conveyance of flows from the whole of the upstream catchment, including area outside of the development site, routed via the site. The Development shall extend the network (where appropriate) to a location at the upstream boundary of the development site.

As a minimum, stormwater systems shall convey both primary and secondary design flows from the upstream catchment(s) for mitigated Maximum Probable Development (MPD), for the design storms required by Section 4.3.10 Hydrological Design Criteria. In

addition, WDC may require the Developer to take account of unmitigated MPD flows from the potential development of the upstream catchment.

WDC will work together with Developers and provide information on the capacity of the downstream stormwater network, where available. The Developer shall review and interpret available information in the context of the proposed development. If the stormwater network has inadequate capacity, WDC will specify what approach would be acceptable (e.g. upgrading existing stormwater network, attenuation, detention, diversion or installation of a new SW network, as may be necessary).

In the event that WDC is unable to provide current information on the capacity of the downstream stormwater network, then the Developer shall investigate, analyse, or carry out work necessary to provide relevant information and propose a solution to the issues found, if any. WDC will review the Developer's analysis and advise the preferred approach.

All information including data files and informative reports resulting from the above shall be provided to WDC for their review and records.

### 4.3.2. Increases to Impervious Surface

Where any development increases impervious surface, the development shall be assessed in accordance with Section 4.1.2 Objectives and Section 4.1.3 Performance Standards to determine the requirements, if any, for water quality and quantity controls.

Design of new development or alteration to existing development, resulting in increased impervious surface shall also comply with the NRC.

### 4.3.3. Infiltration and Land Stability

Soakage device design must be supported by a suitable geotechnical investigation and report confirming the soils are suitable for soakage and that the land stability hazards are acceptable.

Soakage devices shall not be used in areas subject to moderate or high stability hazards.

Attenuation systems proposed within areas designated as moderate or high stability hazards shall protect against infiltration, e.g. by utilising sealed tanks or chambers.

Attenuation and/or treatment systems shall not be located within low stability hazard land adjacent to an area of moderate or high stability hazard without a specific engineering assessment of the impact of such a provision on the stability of the moderate/high hazard land.

*Note: Stability hazard classifications may be shown on WDC's Land Hazard Maps, or may have been classified as such by a site-specific Geotechnical Investigation.*

## 4.3.4. Pre-Consent Applications

### 4.3.4.1 Catchment Management Plans

Where a CMP applies to the proposed development, the development proposal shall confirm which conditions are considered to apply to the development and demonstrate how these will be met.

The Developer shall account for catchment wide issues at the Land Use, Subdivision Resource Consent and EDA stages, including the potential implications of future development upstream, and the cumulative effects of land development on water quality, flooding downstream and erosion. The development proposal shall show how these potential effects will be addressed.

Developments within catchments with operative, consented CMPs that comply with the requirements of these plans, will not require separate resource consents for stormwater diversion and discharge from NRC.

Where an operative consented CMP is not in place, or the proposal is not consistent with an operative consented CMP, then:

a. The Developer shall prepare a site-specific SMP and agree with WDC on the approach and obtain all necessary resource consents from NRC for the proposed site-specific SMP.

b. The Developer shall consult with WDC to understand requirements regarding stormwater management (e.g. flood hazard, treatment and disposal), prior to submitting the NRC consent application.

c. WDC's Stormwater Manager shall review and accept NRC Resource Consent conditions before the consent being granted.

WDC will advise whether the area of a development is covered by a CMP/CDP, and conditions associated with it. WDC may require a site-specific SMP for a development site greater than 0.5 hectares and apply conditions/discharge constraints in addition to those imposed by NRC to safeguard elements of WDC controlled downstream networks.

## 4.3.5. Hazard Assessments

### 4.3.5.1 Flood Hazard Assessment

For all sites subject to, or potentially subject to flood hazard(s), the Developer shall engage a SQEP to undertake a site-specific assessment of the flood hazard and risk associated with the proposed development, and to report on the following:

a. Desktop review of flood hazard data available, e.g. from Council(s), survey data and owners or witnesses,

b. Assess the flood risk associated with the proposed development, considering (where applicable):

   i. upstream and downstream flooding,

ii. loss of floodplain storage,

iii. peak flow,

iv. flood extents and elevations,

v. accessibility/escape during inundation,

c. Recommendations for mitigation of the identified risk, e.g. minimum floor levels (see Section 4.3.11.7 Freeboard Requirements), and

d. Assessment against section 106 of the Resource Management Act 1991.

The site-specific flood hazard assessment report shall be included with the resource consent application, (see Section 1.5.2 Information Requirements - Resource Consent Applications).

#### 4.3.5.2 Coastal Flood Hazard Assessment

Specific investigation and design shall be carried out for all coastal sites and particularly where potential development lies within coastal hazard notations, including coastal erosion (see Section 2.3.4.1 Coastal Hazards) and coastal flooding.

Minimum floor levels in coastal areas shall take into account storm surge, wave run-up, tsunami hazards, erosion potential and climate change effects (see Section 4.3.11.7 Freeboard Requirements).

## *4.3.6. Engineering Design Approval*

### 4.3.6.1 Content of Design Submission

In addition to the general requirements of Section 1.5.3 Engineering Design Approval, the information submitted for EDA for stormwater works shall provide (as applicable) the following:

a. That the design is consistent with the general requirements for the whole of the catchment,

b. That stormwater quality and quantity requirements are adequately addressed,

c. That the proposed stormwater infrastructure is fit for purpose and provides the required level of service, including demonstration that non-surcharge and freeboard requirements have been met,

d. OLFP including 1% AEP flood level, flow path extent and easement requirements clearly shown on drawings, including floor level restrictions, if any,

e. Minimum floor levels and flood hazard (depth, velocity) for residences and escape routes within 1% AEP flood inundation areas on the site are available and shown on the drawings,

f. Scour protection designed for the range of events 1% AEP, 2% AEP, 20% AEP and 50% AEP and associated flows and velocities at outlets, watercourses and along OLFP's, and

g. That the proposed stormwater system satisfies the objectives (Section 4.1.2 Objectives) and performance standards (Section 4.1.3 Performance Standards) in all other respects.

The EDA application shall also demonstrate that all effects onto the stormwater networks and/or other utility services, and neighbouring properties arising from the proposed works have been adequality mitigated, including:

a. Flow peaks (where approved) and frequency patterns,

b. Flood water levels, flood plain storage volumes,

c. Water quality,

d. Scouring and erosion of both primary and secondary stormwater system, and

e. Overland Flow Paths.

Subject to the ground conditions and complexity of the proposed works a geotechnical report addressing ground stability will be required (e.g. pipe installations in weak soils for all pipes, in any soil type for pipes over 600 mm dia, all ponds, wetlands, inlets and outlets).

Operation and maintenance manuals for any water quantity and/or quality control structures shall be provided in a final form for approval before the asset being vested.

Any departures from the ES shall be noted and fully justified. Such assessment shall be carried out by a SQEP who is working within their competencies in accordance with the requirements of Section 1.5.1.3 Risk Based Assessment Framework. The SQEP shall identify the design standards used and certify that the design complies with the referenced standards.

The SQEP shall certify that the works through all stages until completion are in accordance with the requirements of Section 1.5.1.3 Risk Based Assessment Framework.

### *4.3.7. Design Life*

All stormwater infrastructure assets to be vested to WDC shall have a design life expectancy of at least 100 years.

Where components of the stormwater system, such as stormwater detention and treatment devices, require earlier renovation or replacement, it shall be considered as an Alternative Design (see Section 1.5.1.2 Alternative Designs) and assessed as a departure from the ES, requiring specific approval by the Stormwater Manager. The proposed stormwater works shall document the asset renewal requirements for each component in the Operations and Maintenance Requirements, which shall be provided with EDA.

## 4.3.8. Approved Products Materials

Materials and products used for public stormwater infrastructure must comply with the relevant NZ standards and be from the WDC Approved Materials List - Wastewater and Stormwater.

The use of material not listed in the WDC Approved Materials List - Wastewater and Stormwater shall be considered an Alternative Design, refer to Section 1.5.1.2 Alternative Designs.

The WDC Approved Materials List - Wastewater and Stormwater will be updated from time to time at the discretion of WDC.

## 4.3.9. Stormwater Network Design

### 4.3.9.1 General

The network design shall be in accordance with Table 4-1 below unless the approved CMP or site-specific SMP (see Section 4.3.4.1 Catchment Management Plans) allows different inputs.

***Table 4-1: Minimum Design Summary***

| Criteria | Design Parameter | When Required |
|---|---|---|
| Design calculations | Modified Rational Method or TR-55 for catchment areas up to 8 ha (Rainfall intensity can be determined as a function of time concentration Tc).<br>For catchments greater than 8 ha refer to Section 4.3.10.2.1 Catchments Larger Than 8 ha. | Always. |
| Runoff coefficients | Pre-development runoff coefficients shall be based on existing imperviousness.<br>Post-development runoff coefficients shall be based on allowable imperviousness based on the MPD by the District Plan. Refer to Table 4-3. | Always. |
| Design Rainfall | Refer to Design Rainfall (Section 4.3.10.4 Design and Section 4.3.10.5 Design Storm). | Current rainfall (i.e. not climate change adjusted) shall be used for the following:<br>• Sizing temporary works where climate change is not relevant.<br>Climate change adjusted rainfall shall be used for the following:<br>• Determining pre- and post-development stormwater runoff flows and volumes for stormwater infrastructure design. |
| Time of concentration | Determined in accordance with Section 4.3.10.4 Design . | Always. |

| Criteria | Design Parameter | When Required |
|---|---|---|
| Flood Control<br>(1% AEP event) | Detention required, limiting the post-development 1% AEP event flow rates to 80% of the pre-development 1% AEP event flow rates. | Where downstream flooding hazard has been identified.<br>Where there is no CMP or site-specific SMP.<br>Refer to Flood Hazard Areas in the District Plan and any known downstream restrictions causing flooding. |
| Flow attenuation<br>(Attenuation of the 50% and 20% AEP events) | Pre- and post-development flows shall be calculated with climate change allowance.<br>Limit the post-development 50% and 20% AEP event flow rates to 80% of the pre-development flows through controlled attenuation and release. | Where there is no CMP or site-specific SMP<br>Catchment location dependent.<br>Typically required in the upper catchment. This may not be required where a development site is located in proximity to the catchment outlet, discharging to a watercourse with sufficient network capacity, and where flow attenuation may worsen flooding hazards due to relative timing of peak flows. This is subject to assessment demonstrating no negative impacts would occur.<br>If the proposed stormwater discharge is into a tidal zone, then no attenuation is required. |
| Volume | Limit pre-development volume runoff through reduced runoff by best practice and sub catchment management, where practicable (e.g. allowing infiltration and ground water recharge, enabling water reuse and diverting into wastewater system).<br>If this cannot be achieved, mitigation within the receiving environment will be required, such as channel stabilisation. | When discharging directly into a natural stream or modified channel. |

| Criteria | Design Parameter | When Required |
|---|---|---|
| Stormwater quality treatment | Stormwater management hierarchy (Section 4.1.8 Stormwater Management Hierarchy)<br>• Provide treatment of the water quality flow or volume.<br>• Managing at source where possible.<br>• Designing for correct storm size.<br>• Use a suite of water sensitive design devices, including pre-treatment where practical.<br>• Design parameters shall be based on a selected device's effectiveness to remove pollutants and in accordance with GD01. | Always. |
| Water Quality Rainfall (WQR) | 90$^{th}$ percentile of a 24-hour storm event (approx. 25 mm). | Always.<br>Refer to Auckland Council GD01 for details. |
| Water Quality Volume | Based on 90$^{th}$ percentile of a 24-hour storm event (approx. 25 mm). | When discharging directly into a natural stream or manmade channel. |

| Criteria | Design Parameter | When Required |
|---|---|---|
| Primary and Secondary Network Level of Service Requirements | As per Table 4-2. Secondary overflow as per Section 4.1.3 Stormwater Management Hierarchy). | Always.<br>The primary system shall be designed to ensure gravity flow with capacity to accommodate the peak flows, without surcharge.<br>The secondary system shall be designed for safe conveyance of 1% AEP. |
| Minimum Floor Levels | Freeboard requirements (Section 4.3.11.7 Freeboard Requirements). | Always. |
| Whole-of-life | Shall demonstrate that the proposed system provides the most cost-effective whole-of-life outcome for WDC.<br>(e.g. providing an operation and maintenance manual) | Always. |

In addition to key design criteria, the following shall be considered and where appropriate included in the design:

a. Quality and quantity requirements of any discharge,

b. How the roading stormwater design is integrated into the overall stormwater system,

c. The type and class of material proposed to be used,

d. System layouts and alignments including route selection, topographical and environmental aspects, easements, clearances from underground services and structures, provision for future extensions, location of secondary network and overland flow paths,

e. Hydraulic adequacy Section 4.3.11 Hydraulic Design, and

f. Where applicable, location of service connections.

The following documents provide general guidance in the design of pipes, culverts, detention and treatment devices and open channel hydraulics:

a. The NZ Building Code compliance document Clause E1 – Surface water (NZBC Clause E1)

b. Auckland Council GD01Stormwater Water Management Devices Design Guidelines Manual

c. Wellington Water– Water Sensitive Design for Stormwater: Treatment Device Guideline

d. The Regional Infrastructure Technical Specification (RITS) 2018 (Waikato)

e. Auckland Council GD04

*Note: NZBC Clause E1 provides guidance on runoff coefficients, which are not acceptable for the design of public infrastructure under the ES.*

### 4.3.9.2 Primary Network Design Requirements

A primary stormwater network within a development site shall be capable of serving the upstream catchment (Section 4.3.1 Capacity and Future Network Expansion) and shall also mitigate impacts from the development on downstream, and adjoining properties, if any. The primary system design shall consider conditions of any approved CMP or site-specific SMP including:

a. The runoff characteristics of upstream areas shall be based on the development that is compatible with the MPD (under the District Plan) of the land at the time of engineering design.

b. The stormwater network shall be capable of serving the whole of the development site. Where the proposed primary network is to be connected

to the public network, it shall, as a minimum, cater for the impervious surfaces constructed at the site, and/or within each new lot.

c. Each lot shall have a single stormwater connection, unless approved otherwise by the Stormwater Manager.

d. To cater for a concentrated stormwater runoff from upstream and through the site, to protect downstream properties and people from nuisance and hazardous flooding.

e. The stormwater system shall be extended in accordance with Section 4.3.1 Capacity and Future Network Expansion to the upstream boundary of the development site.

f. The preferred means of stormwater management shall be to adopt stormwater control measures that retain the pre-development catchment regime for ground recharge and runoff.

g. Where soakage, evapotranspiration and/or reuse cannot fully mitigate an increase in stormwater from a development, detention shall be provided to restrict the peak runoff from the site.

h. For the purposes of determining the increase in flow between pre and post-development reference shall be made to Table 4-1 and Section 4.3.10 Hydrological Design Criteria.

Proposed stormwater ponds or wetlands are generally an acceptable treatment approach, provided that:

a. The ponds or wetlands comply with the requirements of the NRC Regional Plans,

b. The ponds or wetlands, including associated lands shall be contained within its own land title(s) and it can be vested to WDC for drainage purposes at no costs to WDC, or can be retained in private ownership, subject to a specific approval by the Stormwater Manager.

c. The ponds or wetlands shall not be included in Local Purpose Reserves without specific prior approval from the Parks and Recreation Manager, and

d. The ponds or wetlands shall be designed in accordance with Auckland Council GD01, or an alternative design can be submitted to WDC for consideration.

(Refer to Section 4.3.22.8 Constructed Ponds and Wetlands for additional requirements for constructed ponds and wetlands).

Note: Stormwater shall not be directly connected to ANY wastewater system.

*4.3.9.2.2. Stormwater Pumping*

WDC considers that pumping of stormwater is rarely a practicable option because of the size of pumps and facility required, also power demand and continuity of supply issues.

The public stormwater pumping option is not generally acceptable. WDC may consider a private stormwater pump to service a development.

Applications for pumping stormwater shall demonstrate, that all practicable alternatives have been investigated, and provide sufficient risk assessment and mitigation for pump malfunction and power outages.

*4.3.9.2.3. Availability/Capacity of The WDC Stormwater Reticulation*

Where a development will result in an increase in stormwater flow, Developers shall investigate the availability of capacity in the existing stormwater system so the proposed additional flows can be managed. WDC may require additional capacity to be provided in the existing or proposed system, if either system is critical for the long-term planning of growth. Additional capacity in the proposed system (if required) shall be at the Developer's cost (see also Section 4.3.9.4 WDC Design Input).

### 4.3.9.3 Secondary Stormwater Network Design Requirements

A Secondary stormwater network comprising of OLFP and watercourses may be under either public ownership or control.

The secondary network conveys excess runoff not catered for by the primary network.

The development proposal shall include a full analysis of OLFP. Engineering design shall include plans, long sections and cross sections showing water levels for a 1% AEP storm.

Where the secondary network is in private property, consideration to either vest the subject land to WDC or provide an easement or otherwise record any limitations or public interests on the title shall be at the WDC's discretion.

Consideration shall be given at the design stage to ensure that flow paths and watercourses shall be used as a basis for the design of the secondary network flow path and that restrictions, such as new diversions into adjacent properties and sharp turns, are not acceptable.

The design of secondary network shall include a ground stability and erosion assessment. Mitigation may include reduced flow velocities and/or reinforcing channel banks with suitable material. Ponding of the runoff on roads shall not cause hazards to traffic and/ or public, and the carriage ways shall be passable.

Where a secondary network is not available, the primary network shall be designed to provide an adequate conveyance to mitigate flood hazards. The design shall include an analysis of the effects of blockages of pipes and culverts. This is particularly important with smaller culvert sizes, or where there are grates on culvert inlets, and/or the culvert is in a location where it is likely to receive silt, vegetation or rubbish.

### 4.3.9.4 WDC Design Input

Notwithstanding the outcome of Specific Design, WDC may require additional stormwater requirements including:

a. The diameters and classes of pipes to be used for all reticulation within the development,

b. Connection points and reticulation alignment.

c. Limit discharge rates and volumes from the development to the lesser of the existing runoff from the site at its pre-development levels, or any calculated limits, based on the capacity of the immediate downstream network.

## 4.3.10. Hydrological Design Criteria

### 4.3.10.1 Design Rainfall Event

All new stormwater systems shall be designed for post-development flows based on climate change adjusted design storm for the Event Probabilities / Recurrence Intervals set out in Table 4-2 below, unless specific approval has been obtained from the WDC Stormwater Manager.

***Table 4-2: Design Rainfall Event***

| 1 For primary design flows (all environments) | % AEP | ARI (years) |
|---|---|---|
| a. Piped network no surcharge | 50 | 1:2 |
| b. Piped network allowing discharge within 0.3 m of the lid level | 20 | 1:5 |
| **2 For secondary systems (all environments)** | | |
| c. Overland flowpaths, watercourses | 1 | 1:100 |
| **3 For flood protection (all environments)** | | |
| d. All areas | 1 | 1:100 |

The Climate Change allowance shall be an addition of 20% to rainfall data for the design event.

Note: The current rainfall pattern (not adjusted for climate change) shall be used to determine detention requirements for brownfield developments where existing infrastructure may be considered, an ‘existing use rights’ and also for temporary works where climate change rainfall is not relevant.

### 4.3.10.2 Stormwater Flow Estimate

Rainfall runoff curves are used to describe rainfall losses. The curves used in TP108 and methods were developed by the US National Resource Conservation Service, previously known as Soil Conservation Service (SCS). Curve numbers (CN) were determined based on the hydrological soil group, cover type, soil treatment, hydrological condition and antecedent ground condition.

Values from the summary sheets in TR-55 and TP108 have been adopted for typical Northland soils encountered in the Whangārei District. Table 4-3 below sets out the typical values to be applied. For more detailed information refer to the original tables in TR-55 or Table 2-2 of TP108.

Runoff Coefficients (C) represents the proportion of rainfall resulting in physical runoff for calculation of flow. The values given in E1 of the NZ Building Code are considered low for Northland conditions during significant rainfall events. The WDC has adopted figures developed from the formula C= CN/ (200-CN) from TP108. These values are listed side by side in Table 4-3 below.

The (Rational Method) runoff coefficients in Table 4-3 are for peak flow rate and may be modified for slope as discussed in NZ Building Code Clause E1.

The variability of soils within the Whangārei District and wider Northland, are borne out by changes in runoff characteristics in addition to that caused by vegetation cover. The four hydrologic soil groups are:

D Very low permeability such as clay (e.g. Northland Allochthon/Onerahi Chaos)

C Low permeability such as loam (e.g. Maunu and Glenbervie volcanics)

B Medium permeability, coastal wind-blown sands (e.g. Ruakaka and Waipu coastal sands)

A High permeability such as fractured rock and deeply bedded scoria deposits.

Soil type A is not usually encountered at surface levels and typically is only used for discharge to ground solutions by deep infiltration. Soil type A should not be used for the calculation of surface runoff.

***Table 4-3: Curve Numbers and C Values for Typical Whangārei District Conditions (CN - C)***

| Land Use | % impervious | Type B soils | Type C soils | Type D soils |
|---|---|---|---|---|
| **Open space (lawns, parks etc)** | | | | |
| Fair condition (grass cover 50-75%) | | 69 - 0.53 | 79 - 0.65 | 84 - 0.72 |
| Good condition (grass cover >75%) | | 61 - 0.44 | 74 - 0.59 | 80 - 0.67 |
| **Impervious areas** | | | | |
| Paved parking lots, roofs, driveways, curbs, channels etc (excluding right-of-way) | | 98 - 0.96 | 98 - 0.96 | 98 - 0.96 |
| Roads and streets | | | | |
| Paved: open ditches (incl. right-of-way) | | 89 - 0.80 | 92 - 0.85 | 93 - 0.87 |
| Unsealed/Gravel (incl. right-of-way, accessway & parking areas) | | 85 - 0.74 | 89 - 0.80 | 91 - 0.83 |

| Land Use | % impervious | Type B soils | Type C soils | Type D soils |
|---|---|---|---|---|
| **Urban development** | | | | |
| Commercial and business | 85 | 92 - 0.85 | 94 - 0.89 | 95 - 0.90 |
| Industrial | 72 | 88 - 0.79 | 91 - 0.83 | 93 - 0.87 |
| Landscaped | 0 | 70 | 75 | 80 |
| **Residential by average lot size** | | | | |
| 500 m² or less | 65 | 85 - 0.74 | 90 - 0.82 | 92 - 0.85 |
| 1000 m² | 40 | 75 - 0.60 | 83 - 0.71 | 87 - 0.77 |
| 2000 m² | 25 | 70 - 0.54 | 80 - 0.67 | 85 - 0.74 |
| 4000 m² | 20 | 68 - 0.52 | 79 - 0.65 | 84 - 0.72 |
| 10,000 m² (1 ha) | 10 | 65 - 0.48 | 77 - 0.63 | 82 - 0.69 |
| **Rural development** | | | | |
| Pasture, grassland (m²) | | 61 - 0.44 | 74 - 0.59 | 80 - 0.67 |
| Grass and bush | | 48 - 0.32 | 65 - 0.48 | 73 - 0.57 |
| Trees and grass combination (orchards) | | 58 - 0.41 | 72 - 0.56 | 79 - 0.65 |
| Forest | | 55 - 0.38 | 70 - 0.54 | 77 - 0.63 |

#### *4.3.10.2.1. Catchments Larger Than 8 ha*

For larger catchments (greater than 8 ha), or where significant attenuation elements are incorporated, surface water runoff should be determined using an acceptable hydrological or hydraulic modelling technique or software.

A list of acceptable hydraulic modelling software can be found in WDC Approved Materials List - Wastewater and Stormwater. Alternative modelling methods require specific approval by the Stormwater Manager.

A complete electronic copy of the hydrological/ hydraulic model shall be provided to WDC at no charge. The model shall be accompanied with a report containing all underlying assumptions (e.g. land cover, losses, time of concentration, and sub-catchment areas, existing stormwater network) shall be clearly stated so that a full check of calculations is possible.

### 4.3.10.3 Time of Concentration

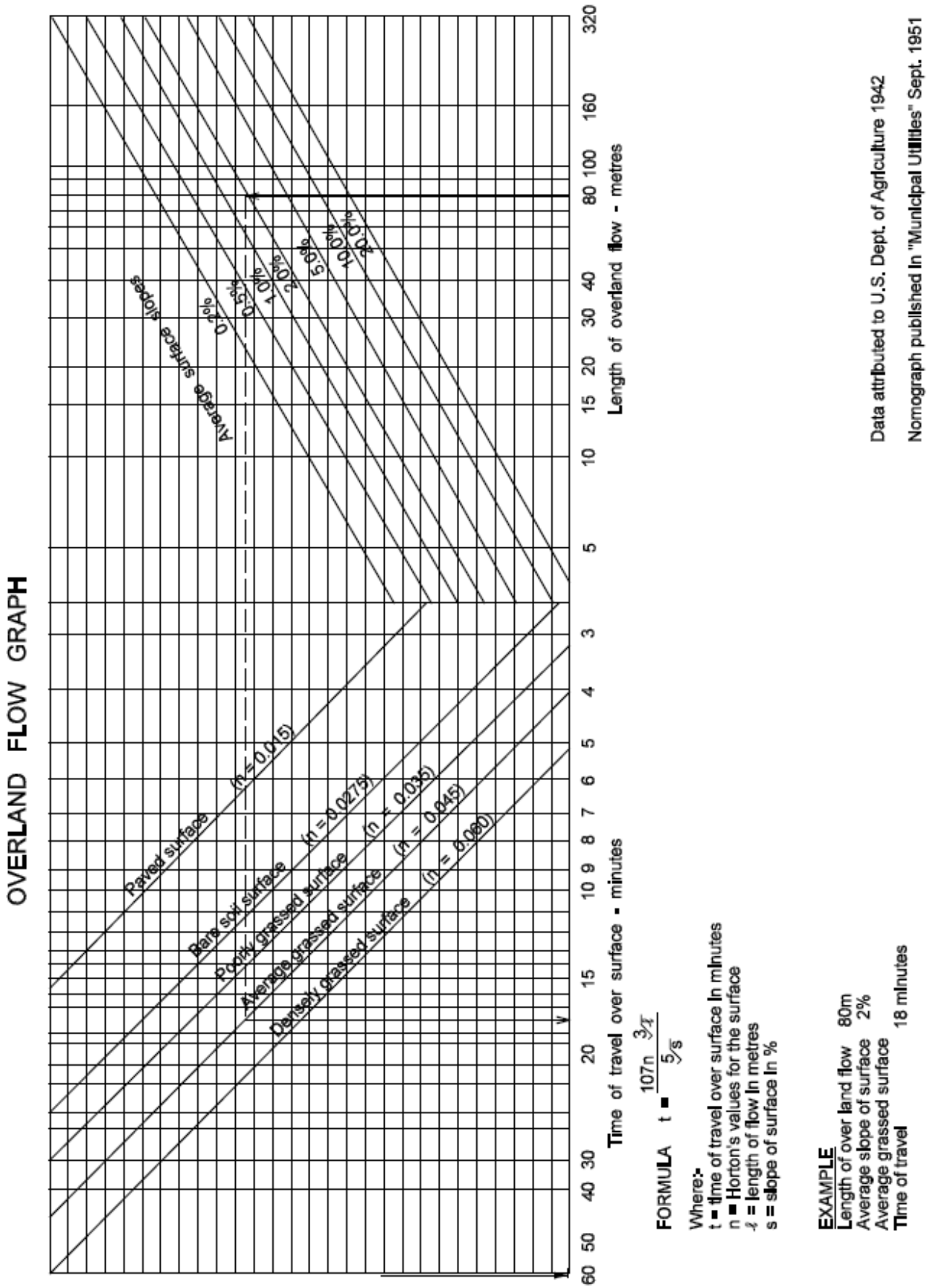
The time of concentration shall be determined as the ‘time of entry’ plus the ‘time of flow’ from the furthest point of the whole catchment to the point of discharge.

Time of entry to the system shall be calculated from Figure 4-1 or an equivalent method.

Time of flow can be calculated from the velocity in pipes and channels.

*Note: Since the time of concentration is not known initially, an iterative solution is necessary with time of concentration recalculated from the catchment flow calculation.*

***Figure 4-1: Overland Flow Graph***



#### 4.3.10.4 Design Rainfall

Acceptable sources for rainfall data for design within the Whangārei District are:

a. Rainfall depth data from the NIWA High Intensity Rainfall System. In addition (where appropriate) other acceptable alternatives include analysis of a specific site based on information provided by verified research studies of particular soil or site conditions.

The current rainfall pattern (not adjusted for climate change) shall be used to determine detention requirements for brownfield developments where existing connections generate 'existing use rights' and also for temporary works where climate change rainfall is not relevant.

#### 4.3.10.5 Design Storm

For analysis of rainfall events either the Modified Rational Method (variable duration, uniform profile), or a TR-55 **type 1A storm profile** (fixed duration, variable profile) are acceptable for determining peak flow and runoff volumes, subject to the criteria set out below.

The minimum duration of the design storm for the pre-developed flow consideration using Modified Rational Method shall be 60 minutes (all environments). The post-developed design shall be tested for critical duration, taking into account the effects of attenuation and detention on the discharge.

*Notes: This critical duration is unlikely to be the same as that used for the pre-development assessment.*

*The use of the TP108 profile for estimation of pre-development peak runoff in the Whangārei District is not acceptable.*

### *4.3.11. Hydraulic Design*

#### 4.3.11.1 Energy Loss through Structure

Energy loss is expressed as velocity head: $He = kV^2/2g$ (where k is the entrance loss coefficient and V is velocity).

The entrance loss coefficient table and energy loss coefficient graph in NZ Building Code E1 provide k values for flow through inlets and access chambers respectively (See Table 4-4).

For bends, see

Table 4-5.

***Table 4-4 Entrance Loss Coefficients***

| Design of Entrance | | Entrance Loss Coefficients ($k_e$) |
|---|---|---|
| Pipe Culverts | Pipe projecting from fill - Square cut end | 0.5 |
| | Pipe projecting from fill- Socket end | 0.2 |
| | Headwall with or without wing walls- Square cut end | 0.5 |
| | Headwall with or without wing walls- Socket end | 0.2 |
| | Pipe mitred to conform with fill slope- Precast end | 0.5 |
| | Pipe mitred to conform with fill slope- Field cut end | 0.7 |
| Box culverts | No wing walls, headwall parallel to embankment - Square edge on three edges | 0.5 |
| | No wing walls, headwall parallel to embankment - Three edges rounded to 1/12 of barrel dimensions | 0.2 |
| | Wing walls at 30° to 75° to barrel- Square edge at crown | 0.4 |
| | Wing walls at 30° to 75° to barrel- Crown rounded to 1/12 of culvert height | 0.2 |
| | Wing walls at 10° to 30° to barrel- Square edge to crown | 0.5 |
| | Wing walls at 10° to 30° to barrel- Wing walls parallel (extension of sides) square edge at crown | 0.7 |

### 4.3.11.2 Determination of Water Surface Profiles

Stormwater systems shall be designed by calculating or computer modelling backwater profiles from an appropriate outfall tail water level.

On steep gradients both inlet control and hydraulic grade line analysis shall be used, and the more severe relevant condition adopted for design purposes.

For pipe networks at manholes and other nodes, water levels computed at design flow shall not exceed finished ground level. Calculations shall also allow for existing and future MPD connections to function satisfactorily.

***Table 4-5: Loss Coefficients for Bends***

| Bends | | K |
|---|---|---|
| MH properly benched with radius of bend | 1.5 x pipe diameter | 0.5 to 1.0 |
| Bend angle | 90 | 0.90 |
| | 45 | 0.60 |
| | 22.5 | 0.25 |

#### 4.3.11.3 Minimum Pipe Diameters

The following minimum pipe diameters shall apply:

a. Public stormwater branch line: 150 mm.

b. Main line: 225 mm

c. Private / Lateral connection:100 mm.

In no circumstances shall the pipe size be reduced on any downstream section.

#### 4.3.11.4 Minimum Gradients and Flow Velocities in Pipes

Pipe gradients should be determined on the basis of a minimum velocity of 0.6 m/s for a 50% AEP design flow. This is to prevent silt deposition.

For velocities greater than 3.0 m/s Specific Design to resist pipe erosion is required.

Details shall be provided by a SQEP to demonstrate compliance with these design conditions.

#### 4.3.11.5 Minimum Pipe Roughness

The minimum ‘Colebrook-White’ roughness coefficient shall be 0.06 for design of both Reinforced Concrete and uPVC pipes.

Alternatively, the minimum Manning’s roughness coefficient shall be 0.011 for design of both Reinforced Concrete and uPVC pipes.

#### 4.3.11.6 Pipe Surcharge

New pipelines shall be designed without surcharge during the 20% AEP.

Surcharge in the proposed stormwater network may be approved under specific circumstances, subject to impacts on the existing network performance and risks, and at the discretion of the Stormwater Manager.

#### 4.3.11.7 Freeboard Requirements

Freeboard above the secondary flow level is required to cater for inaccuracies in flow estimation and practicable blockage/failure of the primary system.

The minimum freeboard above the calculated 1% AEP storm shall be:

a. 0.5 m for habitable building floors, and,

b. 0.3 m for commercial and industrial buildings,

Unless specific assessment demonstrates that a different freeboard is appropriate.

Minimum floor levels shall be identified for all lots within the area of the site where flood risks are for 1% AEP or lesser event. This assessment shall consider flooding caused by different sources including:

a. Rivers,

b. Tides,

c. Elevated groundwater, and

d. Surface water ponding.

Minimum floor levels in tidal areas shall take into account current information on natural hazards including storm surge, wave run-up tsunami, and sea level rise.

Development proposals shall demonstrate Safety in Design principles and may be required to provide for escape routes from the flood hazardous areas/ properties within the development. The appropriate information shall be included in the engineering drawings.

The NRC Regional Policy Statement for Northland states that within the coastal environment:

- Any new habitable dwelling has a minimum floor level of 3.3 m above One Tree Point datum on the east coast and 4.3 m above One Tree Point Datum on the west coast.
- New non-habitable buildings will have a minimum floor level of 3.1 m above One Tree Point datum on the east coast and 4.1 m on the west coast.

However, specific assessment shall be carried out for **all sites** to determine the floor levels dependant on local conditions. Development proposals should include reference to the NRC Regional Policy Statement for Northland and NRC Coastal Flood Hazard Assessment for Northland Region Report .

## *4.3.12. Watercourses*

### 4.3.12.1 General Requirements

Where watercourses become a receiving environment for a development site and become incorporated in the stormwater system the associated land may be vested to

WDC as a Drainage Reserve (Section 4.3.12.4 Drainage Reserves), protected by an easement or remain in private ownership. The watercourse area shall be of sufficient width to contain the design storm flow from 1% AEP.

Existing watercourses with natural character shall be retained and enhanced, where possible.

Where works in the bed or bank of a waterway occurs, the following should be considered to achieve a satisfactory solution:

a. Design to improve habitat and ecosystem function by designing naturalised channel(s) and banks e.g. mimic natural form and pattern.

b. Avoiding hard lining (e.g., with concrete) and straightening, in favour of natural channel meander, planting and the use of rocks in a complex matrix to increase channel complexity and shear strength.

c. Plant waterways to increase riparian vegetation diversity, density and quality.

d. Protect against scour and erosion using natural materials e.g. avoid concrete structures.

e. Create three dimensional habitats to enable fish and invertebrates to find their preferred velocity and habitat type(s).

f. Consider current and potential ecological values e.g. fish and insects present in the waterway and how their habitat could be improved.

The watercourse works shall be designed to achieve a satisfactory solution recognising:

g. Flood protection,

h. Bank and bed stability,

i. The retention of the natural topography, morphology and ecological values,

j. Maintenance requirements such as access,

k. Fish passage requirements (See Section 4.3.15 Fish Passage)

l. Hydraulics; including downstream effects of any works, and

m. Safety in Design considerations for the proposed works.

The piping of existing watercourses, constructed channels or open drains is not generally acceptable. Watercourses may be piped if there are justifiable engineering or design considerations. Ecological impacts must be considered, and a Northland Regional Council approval obtained, where necessary. The EDA should be presented accordingly.

Where watercourses become a receiving environment for discharge from a development site, inevitably they become a part of the stormwater system and it may be vested to WDC as a Drainage Reserve (Section 4.3.12.4 Drainage Reserves) or require an easement.

The watercourse shall be of sufficient width to contain the full design storm flow from a 1% AEP event plus 500 mm of freeboard. Where a watercourse is being naturalised, the design must ensure that there is no increased risk of erosion and/or scour and the ecological health of the watercourse is maintained or enhanced by the works.

Riparian margins shall be provided each side of the watercourse and shall consider appropriate landscaping, bank stability and public safety.

If the constructed watercourse shall be in private property, discussions shall be held with WDC to determine responsibility for maintenance. At a minimum the constructed watercourse shall be protected by an easement and constructed in compliance with **Sheet 36**, or an approved equivalent.

### 4.3.12.2 Natural Open Stream Systems

The development proposal shall demonstrate, in addition to requirements outlined in Section 4.3.12.1 General Requirements, that the watercourse:

a. Is suitable for a proposed discharge,

b. Has a maximum velocity in an unprotected open channel in accordance with Table 4-7, otherwise channel protection and mitigation may be required,

c. Is cleared of all weedy vegetation and replanted as per a landscape design approved by the WDC,

d. Has had the consequences of any blockage assessed and adequate mitigation has been provided,

e. Has both site specific and catchment wide factors (e.g. removal of riparian vegetation), which may cause an increase in the water temperature and silt migration, mitigated by landscape design, where practicable.

Refer to Section 4.3.14 Culverts in Water if a section of watercourse is proposed for piping (e.g. for road crossings).

Where unmodified watercourses, or formed channels, are to be incorporated in the stormwater network, they shall be located within a drainage reserve vested to WDC or protected by an easement, of sufficient width to contain the catchment design flow.

### 4.3.12.3 Open Channel Flow Calculations

Open channel flow calculation shall generally be carried out as set out in NZ Building Code Clause E1 using the Manning's equation and corresponding roughness 'n'. The WDC acceptable 'n' values are set out in Table 4-6.

***Table 4-6: Manning's Values***

| Description | Manning's value 'n' |
|---|---|
| Open stream with straight uniform channel in earth & gravel in good condition | 0.0225 |

| Description | Manning's value 'n' |
|---|---|
| Unlined channel in earth and gravel with some bends & in fair condition | 0.025 |
| Channel with rough stony bed or with weeds on earth bank & natural streams with clean straight banks | 0.030 |
| Winding natural streams with clean bed but with some pools & shoals | 0.035 |
| Winding natural streams with irregular cross sections & some obstruction with vegetation and debris | 0.045 |
| Irregular natural stream with obstruction from vegetation & debris | 0.060 |
| Very weedy irregular winding stream obstructed with significant overgrown vegetation & debris | 0.100 |

Maximum velocities for open channels (including overland flow paths) shall be as set out in Table 4-7.

***Table 4-7: Maximum Velocities in Channels (in all discharge conditions)***

| Description | Max velocity (m/s) |
|---|---|
| Earth channels – no bed vegetation | 0.6 |
| Fully vegetated channels (e.g. swales) | 1.0 |
| Rock spall lined channels | 2.0 |
| Fine sand, colloidal | 0.4 |
| Sany loam, noncolloidal | 0.5 |
| Silt loam, non collodial | 0.6 |
| Alluvial silts, noncollodial | 0.6 |
| Ordinary firm loam | 0.8 |
| Volcanic ash | 0.8 |
| Stiff clay, very colloidial | 1.1 |
| Alluvial silts, colloidal | 1.1 |
| Shales and hardpans | 1.8 |
| Fine gravel | 0.8 |
| Graded loam to cobbles, noncolloidal | 1.1 |
| Graded silts to cobbles, colloidal | 1.2 |

| Description | Max velocity (m/s) |
|---|---|
| Coarse gravel, noncolloidal | 1.2 |
| Cobbles and shingles | 1.5 |

#### 4.3.12.4 Drainage Reserves

Drainage Reserves include a land planned to be vested to WDC for stormwater management purposes. Reserves can be formed over existing and constructed, watercourses, wetlands and ponding areas. Design for a drainage reserve shall consider the flowing inputs:

a. Provide for ease of maintenance and operation.

b. Maximum and minimum terrain slopes shall be 1:5 and 1:50 respectively,

c. Formed and natural channels and dams may have slopes steeper than 1:5, subject to specific design,

d. A maintenance accessway from a public road which is at minimum 4 m wide and bear traffic loads for up to 8.2 tonne axle weight vehicle and include provision for turning vehicles where applicable,

e. Enable public cycle/foot paths and links with other reserves and traffic networks, where practicable, and

f. Be of sufficient width to contain the catchment design flow.

## *4.3.13. Outlets and Inlets*

### 4.3.13.1 General

All culvert and pipeline inlets and outlets shall be provided with adequate wing walls, headwalls, aprons and scour protection for erosion control, fill retention around the pipeline, and pipeline support. Adequate energy dissipation shall be provided.

Open-ended manholes to serve as high flow inlets shall have adequate grates or scruffy domes installed.

Approved structures for use at the inlets and outlets of pipelines are shown on **Sheet 35**. Alternative structures shall be considered under Section 1.5.1.2 Alternative Designs.

With respect to health and safety, the following is required:

a. All inlets to the stormwater network greater than 375 mm diameter shall be fitted with a safety grille.

b. The inlet grille shall be provided for in the EDA.

c. The grille shall be vertical and have a clear opening of maximum 100 mm between bars.

d. Note that grilles are not required on manholes and will only be required at the inlet to a culvert in special circumstances as required by the WDC.

e. Safety in Design principles shall be applied.

Outlets' or inlets' surrounding area shall be designed to maintain and/or enhance in-stream values. Outlet and inlets structures shall be constructed to not restrict the flows in the watercourse and to not form a barrier to fish passage.

### 4.3.13.2 Outlet Design

Outlet structures shall be designed in general accordance with Auckland Council TR2013/018, or Auckland Council GD01, whichever is most relevant to the outfall, and shall not adversely impact the flows in the receiving watercourse.

Outlet design shall ensure non-scouring velocities can be achieved at the point of discharge. Acceptable outlet velocities will depend on the channel soil conditions but should not exceed 2 m/s without specific provision for energy dissipation.

Where the proposed discharge to a watercourse represents more than 10% of the watercourse flow rate for an equivalent event, adequate energy dissipation shall be provided.

Outlet designs shall take into account, in addition to guidance contained in Auckland Council TR2013/018 and Auckland Council GD01, the following:

a. Alignment with a CMP or site-specific SMP,

b. Fit for purpose over the design life,

c. Watercourse levels and flow,

d. Extending outlet works below the water surface,

e. Safety in Design principles,

f. Achieving natural character, amenity and aesthetics of the watercourse,

g. Appropriate planting and landscaping of indigenous species and

h. Retaining and enhancing remnant areas of indigenous watercourses' bank vegetation, where applicable.

### 4.3.13.3 Inlet Design

The inlet design shall take into account particular circumstances at each site using the following evaluation:

a. Direction of upstream flow,

b. Signs of erosion both lateral and down cutting,

c. Height of headwall,

d. General aesthetics,

e. Hydraulic efficiency, and

f. Fish passage.

Screens are required where flow from watercourse, detention and treatment systems enters into a piped network.

All screens shall be constructed from hot-dipped galvanised steel and the horizontal gap shall not exceed 100 mm. Specific Design is required to demonstrate requirements of Safety in Design, including the provision of access for maintenance and inspections. Screens shall be designed to be self-cleansing; to have the net flow area of minimum 2 times area of the pipe; and to withstand the loads from debris and hydraulic head. Where the consequences of a screen blockage are likely to be severe, a backup overflow bypass shall be provided allowing the flow to enter the stormwater system without causing hazards.

## *4.3.14. Culverts in Watercourses*

### 4.3.14.1 General Requirements for Culverts

For the purposes of this document, a culvert is defined as any conduit that transfers the flows of a watercourse across a road or embankment and does not connect directly to a reticulated piped stormwater network. The design of culverts shall comply with this ES, as provided following:

If the culvert embankment can be considered a dam under the dam safety regulations (See NZ Dam Safety Guideline, 2015), the requirements of those regulations shall take precedence over those stated in this document. A structure is considered a dam where:

a. Vertical height from the downstream toe of the embankment to the top is more than 4 m, or

b. The total stored volume of fluid is more than 20,000 $m^3$, or

c. The contributing upstream catchment is more than 20 ha.

The culvert shall be designed to cater for the flows and water levels generated by the 1% AEP event without adversely affecting upstream or downstream property.

The headwater pond created by the culvert during the 1% AEP event shall have a depth not exceeding 3.0 m above the invert of the pipe and shall provide 500 mm freeboard to the edge of the seal of the road (or similar feature) at the top of the embankment. For cases where the approach velocity is greater than 2 m/s, the freeboard shall be at least 1.5 times the velocity head at the entrance.

The following general design criteria shall be applied to culverts:

d. Culverts shall be designed, such that the maximum velocity within the culvert generated by the 1% AEP event does not exceed 6.0 m/s. Higher velocities in culverts require approval from WDC.

e. High outlet velocities are likely to cause scour and erosion of natural channels and reference shall be made to Auckland Council TR2013/018.

Note that energy dissipation shall be required at far lower velocities than the maximum allowed within the conduit stated above.

f. Culverts shall be designed such that for the 50% AEP design storm, an absolute minimum velocity of 0.6 m/s and desired minimum of 1.0 m/s is achieved.

g. Culverts shall have a minimum internal diameter of 375 mm (for vehicle crossing standards refer to Chapter 3:Transportation).

h. A suitable transition structure is required at both the inlet and outlet to the proposed culvert which shall ensure that there is no scour or erosion in the watercourse, private property and/or the road formation.

i. A secondary flow path shall be kept unobstructed at all times. The secondary flow path design shall assume the total blockage of the culvert in cases where it is less than DN1,500, and 50% capacity. Reduction if the culvert is greater than or equal to DN1,500, unless demonstrated by specific WDC approval that a lower blockage factor can be applied.

j. Allowance for 100% blockage of pipes greater than DN1,500 may be necessary in some circumstances. The risk of blockage resulting from the contributing catchment shall be assessed on a case-by-case basis (this includes situations where a safety grille or debris screen is used) to determine if specific culvert design (including consideration of a secondary inlet) is required.

k. For culverts whose inlets may be difficult to locate if submerged, green retro-reflective raised pavement markers shall be required to mark the presence of the culvert under the roadway. For all culverts associated with roads, markings shall be in accordance with Chapter 3:Transportation.

l. Safety in Design principles shall be demonstrated including provision of safety measures as required, e.g. a barrier along the culvert headwall.

m. Culverts under road fencing or barriers are to be designed to WDC requirements.

n. Adequate provision shall be made for maintenance. This shall include, but not be limited to, access to inlet and outlet for inspection, debris removal and scour protection maintenance, and any other activities stated in the operation and maintenance manual.

o. Fish passage shall be provided for.

p. The need for debris screens shall be subject to specific design, considering the likelihood of debris flowing from the upstream catchment and any potential impact on the culvert.

q. Culverts shall be single barrelled unless Specific Design is approved by WDC.

r. All culverts transferring flow across the road reserve, roadside drains and water table are owned and maintained by WDC or Waka Kotahi. Note that

culverts for private vehicle crossings (i.e. serving a private property) within the road reserve will be owned and maintained by the property owner.

s. For transportation requirements refer to Section 3.2.19 Bridges, Culverts and Other Structures for culvert design requirements in respect of roading and access-ways.

t. Culverts in watercourses shall be designed to cater for post-development events in Table 4-8. The effects and options of inlet and outlet tailwater controls shall be considered. All culverts shall be provided with adequate wingwalls, headwalls, aprons, scour protection, removable debris traps or pits to prevent scouring or blocking.

u. Where culverts are formed with multiple openings (e.g. pipes, arches) placed side-by-side, resulting in a culvert width greater than 6.0 m, the culvert is then defined as a bridge-culvert and shall be designed in accordance with the Section 3.2.19 Bridges, Culverts and Other Structures and best practice guidance for fish passage (refer to New Zealand Fish Passage Guidelines (April 2018)).

v. Where existing or proposed road culverts are discharging onto adjoining properties the culverts shall be extended to the road reserve boundary to enable continuous unrestricted pedestrian access.

w. Batter slopes shall be topsoiled and grassed or if necessary, hydroseeded.

It is usual for resource consents conditions to require that culvert construction in watercourses be accompanied by sediment control measures as set out in an Erosion and Sediment Control Plan. Refer to NRC Regional Plans.

#### 4.3.14.2 Catchment Design Parameters

The following information shall be provided for culvert crossing design:

a. Catchment topography including main channel length, slope and area to drain through the culvert,

b. MPD based on land use description under the District Plan,

c. Any specific requirements from an applicable CMP or site-specific SMP, and

d. An assessment of the impacts on fish passage.

#### 4.3.14.3 Culvert Design Rainfall Event

Culverts shall be designed as a minimum to accommodate storms as per Table 4-8. The design shall not cause any increase in upstream water levels that will cause flooding on neighbouring properties.

***Table 4-8: Culvert – Design Rainfall Event***

| Design case | AEP year storm to pass without surcharge (design flow) | AEP year storm not overtopping structure (peak flow) |
|---|---|---|
| Driveway or private access-way | 50% | NA |
| Pedestrian or cycleway walk | 20% | 10% |
| Local or Collector Road | 20% | 5% |
| Arterial roads and railways | 5% | 1% |

## *4.3.15. Fish Passage*

The Northland Regional Council should be contacted to determine the ecological value of the watercourse, when considering any watercourse disturbing activities.

In some cases, fish barriers will be desired because of their ability to prevent migration of pest fish. Where the Northland Regional Council does not identify this as an issue then fish passage through culverts in the watercourse shall be maintained. This is achieved by ensuring that the invert level is set below the stream bed level and the outlet is flooded at all times.

If a watercourse capacity is reduced, the velocity along the banks at base flow conditions shall be maintained at less than 0.3 m/s to allow for passage of indigenous fish and trout.

Where multi-barrel culverts shall be used for wide channels that have low flows but occasional high flow events, consideration shall be given to setting each barrel at a different level to allow base flows and ensure appropriate watercourse area at various flows.

The New Zealand Fish Passage Guidelines (April 2018), sets out recommended practice for the design of instream infrastructure to provide for fish passage. This should be used to inform the design of potential barriers to fish passage.

## *4.3.16. Piped System Layout*

### 4.3.16.1 General

Stormwater pipes shall in general be located within the Transport Corridor, see Table 4-9.

The order and layout of pipes and other underground services shall be in accordance with **Sheet 29**. The minimum clearance between stormwater pipes and other services shall be in accordance with **Sheet 30**.

***Table 4-9: Pipe Locations***

| Area | Location |
|---|---|
| Residential | Within the Transport Corridor and within the berm, at 2 m offset from the kerb except where the properties served are below road level. |
| Industrial | Within the Transport Corridor and within the berm, at 2 m offset from the kerb or alternatively in the front yard area with specific approval from the WDC Stormwater Manger. |
| Business | Within the Transport Corridor and within the berm, at 2 m offset from the kerb or alternatively in the rear service lane specific approval from the WDC Stormwater Manger. The major reticulation and trunk lines, however, shall be in the Transport Corridor (as for Residential Zones). |
| Other Areas | Within the Transport Corridor (as above) except where the properties served are below road level. |
| Private Property | If no other option is available, pipelines may be laid within private property. Where a pipeline is within a property, it is required to be parallel to the boundary and no more than 1.5 m from the boundary . No new private drains shall pass between one lot and another. If crossing of private property is unavoidable, those parts of the pipeline serving more than one lot shall be WDC mains with service connections to the property boundaries. |

The pipelines shall also meet the following requirements:

a. Where a stormwater pipeline changes location within a street, crossings of roads, railway corridor, and underground services shall, as far as practicable, be at an angle of 45 degrees or greater. Pipes shall be located and designed to minimise maintenance and crossing restoration.

b. The location of pipes shall be governed by topography. The pipe layout shall conform to the existing surface gradients as far as practicable to remove the need for deep installation due to gravity pipelines operating against the fall of the ground.

c. Any aerial pipes and pipe bridges shall be designed by a SQEP and considered an Alternative Design (See Section 1.5.1.2 Alternative Designs) and approval shall be at the discretion of the Stormwater Manager.

d. Pipes shall have a sealed joint, as per manufacturer specifications for various pipe materials and joint types.

e. Curved pipelines shall be considered an Alternative Design (Section 1.5.1.2 Alternative Designs) and approval shall be at the discretion of the Stormwater Manager.

f. Pipes shall not be installed within the tree dripline.

i. Where pipe joints lie within 5 m of a tree with girth exceeding 0.5 m (as measured 1.0 m above the ground), pipe joints shall have root ingress protection.

### 4.3.16.2 Minimum Cover

All pipelines, other than those in private property, shall be specifically designed to support the likely loading in relation to the minimum cover to be provided in accordance with the terms of AS/NZS 3725:2007.

The minimum cover over pipes shall be:

a. 600 mm in berms and any other areas not subjected to traffic loading, or

b. 1000 mm under carriageways and trafficked areas.

Any pipelines that cannot achieve the minimum pipe cover requirements shall:

a. Be specifically designed by a SQEP to support the likely loading in relation to the actual cover to be provided, or,

b. Be provided with pipe protection in accordance with the reinforced concrete slab protection shown on **Sheet 32**.

### 4.3.16.3 Clearance from Structures

Pipes adjacent to existing buildings and structures shall be located clear of the 'zone of influence' of the building foundations. If this is cannot be avoided, a Specific Design shall be undertaken to address the following:

a. Protection of the pipeline through both construction and a lifetime period,

b. Long term maintenance access for the pipeline, and

c. Protection of the existing structure or building.

Any such proposals shall be considered an Alternative Design (Section 1.5.1.2 Alternative Designs). Approval shall be at the discretion of the Stormwater Manager.

Sufficient clearance for laying and access for maintenance is also required. Table 4-10 may be used as a guide for minimum clearances for mains laid in public streets.

***Table 4-10: Minimum Clearance from Structures***

| Pipe Diameter DN (mm) | Clearance to Wall or Building (mm) | Public SW Mains within Private Property (mm) |
|---|---|---|
| <100 | 600 | 1000 |
| 100 – 150 | 1000 | 1400 |
| 200 – 300 | 1500 | 1900 |
| 375 + | 1500 + 2 x diameter | 1900 + 2x diameter |

#### 4.3.16.4 Steep Pipes

Where the pipeline grades are 1:3 or steeper, and pipes do not exceed 450 mm diameter, anchor blocks (bulkheads) shall be constructed in accordance with **Sheet 32** and shall have concrete bedding of 20 MPa. Specific Design by a SQEP is required where pipe diameters exceed 450 mm.

Bulkhead details shall be included in the drawings.

Bulkhead spacing shall be as per Table 4-11.

***Table 4-11: Bulkhead Spacing***

| Grade % | Requirement | Spacing (S) (m) |
|---|---|---|
| 15 - 35 | Concrete Bulkhead | S = 100 / Grade (%) |
| > 35 | Special Design | 3.0 |

Where a pipeline shall be laid in soft ground (i.e. ground that is likely to settle, deflect and/or subside) WDC may require specific engineering design including geotechnical investigations by a SQEP. The design requirements for Specific Design shall address pipe bedding and backfill in accordance with Section 4.3.17.7 Manholes Requiring Specific Design.

*Note: Pipes laid to minimum grades will NOT be accepted in ground liable to settlement.*

## *4.3.17. Manholes*

### 4.3.17.1 General Requirements

Manholes shall be located:

a. On WDC property or Transport Corridors whenever practicable. If located within the carriage way, manholes shall be located 2 m out from the kerb.

b. Out of hollows, dips or any area that may be subjected to inundation or identified as a secondary flow path.

c. Clear of all boundary lines by at least 1.5 m from the outer edge of the manhole chamber plus the height of any nearby retaining walls if they exist.

d. 2 m clear of new structures in private property as per WDC Policy #0022 - Building Over or Near Public Sewer and Stormwater Pipelines.

Manholes are required at the following locations:

e. Intersection of pipes except for junctions between mains and lateral connections,

f. Changes of pipe size,

g. Changes of pipe direction, except where horizontal curves are approved,

h. Changes of pipe grade, except where vertical curves are approved,

i. Combined changes of pipe direction and grade, except where compound curves are approved,

j. Changes of pipe invert level,

k. Changes of pipe material, except for repair/maintenance locations, and

l. Permanent ends of a pipe.

For infill developments, manholes are not required at 150 mm branch connections onto 150 mm mains provided that:

m. a manhole exists on the main within 100 m of the connection point: and,

n. a manhole is provided on the branch upstream of the connection point: and,

o. the manhole is immediately within the boundary of the property being served or within 20 m of the connection point, whichever is the lesser.

#### 4.3.17.2 Spacing

For reticulation pipes, the maximum distance between any two manholes shall be 120 m.

#### 4.3.17.3 Allowable Deflection through Manholes

A maximum allowable deflection through a manhole for pipe sizes 150 to DN 225 is 90 degrees. The maximum allowable deflection for pipe sizes greater than DN 225 is 110 degrees.

#### 4.3.17.4 Internal fall through Manholes

All manholes shall have a minimum drop of 50 mm plus 5 mm per 10 degrees of the angle of change of flow within the manhole and between inlet and outlet.

The construction tolerance for drop through the manhole shall be:

a. Constructed Manhole Drop = Manhole Drop (as calculated above) +/- 5 mm

b. Grading the channel shall be limited to falls through manholes of up to 150 mm.

#### 4.3.17.5 Size of Manholes

Manholes shall be a minimum of 1050 mm diameter for depths of 1.2 m or more.

Where two or more incoming pipes are connected to the manhole, larger diameters shall be used.

Non-access chambers of 600 mm diameter are approved to be used for depths up to 1.2 m at the upstream end of public stormwater networks.

#### 4.3.17.6 Materials and Parameters

Pre-cast concrete manholes with external flanged base are acceptable provided that:

a. They shall be installed in accordance with **Sheet 39**,

b. Manholes up to 2.4 m deep shall be constructed using a single riser with a pre-cast external flange base,

c. Manholes in excess of 2.4 m deep shall be constructed using a 2.4 m deep pre-cast riser with external flange base, and then completed to final ground level using no more than a single riser for manholes up to 4.0 m deep.

d. In no case shall a series of short risers be used,

e. The joints of all abutting units shall be sealed against the ingress of water,

f. The cover frame shall be set over the opening and adjusted to the correct height and slope using adjustment rings and mortar so as to conform to the surrounding surface,

g. The cover frame shall be held in place with concrete haunching in accordance with **Sheet 39**.

Manholes constructed and installed using alternative materials and methodologies shall be in accordance with WDC Approved Materials List - Wastewater and Stormwater and installation details.

### 4.3.17.7 Manholes Requiring Specific Design

Any manhole with the following parameters shall be subject to Specific Design:

a. Depth greater than 4.0 m, or

b. If affected by the high-water table, or

c. Is bedded in suspected or proven aggressive grounds.

If the manhole is affected by the high-water table, the manhole shall include a factor of safety against flotation of 1.25.

### 4.3.17.8 Connections to Manholes

The invert of a lateral property connection to a manhole shall be at a level no lower than the average of the soffit levels of the main inlet and outlet pipes.

The invert of other lateral (pipeline) connections shall achieve the internal fall requirements of Section 4.3.17.4 Internal fall through Manholes. Maximum angle of deflection of lateral connection into the manhole main channel shall be 90 degrees.

External drops shall require Specific Design.

Cascades are only permitted under the following conditions:

a. Where the manhole is more than 2.0 m deep.

b. Where the cascade inlet pipe diameter will be a maximum of 300 mm.

c. Where the cascade will not discharge onto any steps or ladders.

d. Where the drop height will not exceed 1.0 m (from the invert of the cascade inlet pipe to the top of the benching within the manhole).

#### 4.3.17.9 Covers

Watertight manhole covers with a minimum clear opening of 600 mm in diameter, complying with AS 3996:2019, and included on the WDC Approved Materials List - Wastewater and Stormwater shall be used.

'Non-rock' covers shall be used on all State Highway and Level 2 roads (roads with average traffic of 10,000 or more vehicles per day).

**Class D** covers to AS 3996:2019 shall be used in the Transport Corridor, carriageway, commercial and industrial properties and all public areas.

**Class B** and **Class C** covers to AS 3996:2019 may only be used on residential properties.

*Note: bolted down covers shall not be used.*

#### 4.3.17.10 Manhole Steps

All manholes greater than 1.2 m in depth shall be provided with manhole step rungs. Step rungs shall be stainless steel. Encapsulated rungs with galvanized steel or a stainless-steel core shall be fully coated with an industrial grade PE or an approved alternative may be used. Approved products are as per the WDC Approved Materials List - Wastewater and Stormwater .

Manhole steps shall be provided in accordance with **Sheet 39** and **Sheet 40**.

Manhole steps shall be provided at 300 mm centres vertically (refer **Sheet 39**). The top step shall not be more than 450 mm below the top of the top slab and the lowest step shall be no more than 375 mm above the bench, or such lower level if specified by manufacturers of proprietary manholes.

### *4.3.18. Connections*

#### 4.3.18.1 General Requirements

The lateral connection should be designed to suit the existing situation and any future development.

For connections to an open watercourse, resource consents from NRC may be required.

See Section 4.2.4 Discharge to the Road Kerb.

#### 4.3.18.2 Lot Connections

Each lot within the subdivision shall be provided by a public or private stormwater connection to the primary or secondary system.

The following design requirements shall be met:

a. Stormwater management as per hierarchy in Section 4.1.8 Stormwater Management Hierarchy.

b. Where no other option is available, a kerb outlet can be considered under Specific Design, and it shall be installed at least 1.0 m clear of any vehicle crossing.

c. The preferred depth at the boundary, of a stormwater connection to a piped network, is 1.2 m (allowable range 0.9 m - 1.5 m) where practicable, subject to the following:

   i. The connection shall satisfy the pipe size, material, cover, depth and self-cleansing velocity requirements of the ES,

   ii. The connection shall be able to service the whole area of the lot and,

   iii. The connection shall be able to convey the expected flow from the whole developable area.

d. To determine whether a connection can clearly serve the whole lot, the invert level should be calculated at grade of 1:80 from the pipe invert to the lot boundary and then at 1:100 to the furthest point within the lot. If after allowing for the pipeline diameter, the depth of soil cover over the pipeline is less than 0.5 m the final design shall be to the satisfaction of WDC.

e. Existing connections, if found on site, which may not be documented on WDC records, may be reused subject to confirmation of existing asset condition.

f. A minimum connection diameter of 100 mm is required for each residential allotment, or

g. A minimum connection diameter of 150 mm is required for a commercial/industrial lot.

h. The connection shall be designed to service the property runoff.

Where discharge flow rate controls are applied, WDC may approve alternative connection sizes.

All connections, which shall be made directly to the primary stormwater network, shall be designed using a factory manufactured ‘wye’ or ‘lunden-junction’ and shall be watertight.

Connections shall be sited clear of obstructions and known developments and accessible for maintenance.

Direct connection of branch pipelines to main pipelines is acceptable, provided:

i. Connection is via a suitable junction or saddle where the branch pipe diameter is not greater than half the main pipe diameter (see **Sheet 37**),

j. The distance between the pipeline connection and the closest inspection point is not greater than 25 m.

k. Connections shall be sealed with removable caps until required. The caps are to be painted green and have 'SW' painted/fixed onto the end cap.

#### 4.3.18.3 Services in Accessways, Access Lots, Rights of Way or Multi-Unit Properties

Refer to the WDC Stormwater Management Bylaw 2014 for requirements.

## *4.3.19. Catch-Pits*

The design of stormwater networks shall include catch-pits for public roads and other areas where nuisance flooding might be expected. The design proposal shall be based on the following principles:

a. Shall generally be in accordance with AS 3996:2019.

b. Stormwater calculations shall allow for 50% blockage of the inlet grate.

c. Catch-pits are not generally considered as part of stormwater treatment, unless being fitted with filter bags. Any such proposal shall be considered an Alternative Design (See 1.5.1.2 Alternative Designs) and specific approval by the Stormwater Manager will be required.

d. Catch-pits shall be positioned so as not to adversely impact traffic, and flow in kerb and channel.

e. Catch-pits shall be fitted with removable grates, which allow maintenance while preventing accidental access, and that are suitable for crossing by bicycles.

f. Catch-pits shall be placed:

   i. at maximum 90 m intervals on roads,

   ii. where the location prevents primary flow from bypassing the catch-pit inlet, e.g. upstream of right of way crossings or pram crossings, at tangent points, and discharging overland, and,

   iii. to capture the design runoff flow from the identified contributing area, including adjacent road, paths and public or private land.

g. Catch-pit leads shall be at minimum pipe gradient of 1%, and minimum 225 mm diameter for a single catch-pit, and minimum 375 mm diameter for a double catch-pit,

h. Catch-pit leads up to 225 mm diameter and not more than 20 m in length may be saddled on to pipes 600 mm diameter and larger, without manholes,

i. Larger (double) catch-pits shall be placed at sags/low points, with the potential for ponding or for flow to escape channels.

Catch-pits on private access-ways shall be capable of accepting the flow from a proprietary catchment area. The minimum grate size shall be 300 x 300 mm. Where an

access way is steep, or stormwater connections discharge onto the access-way, larger catch-pits or a cut off channel with a grate may be required. A minimum diameter for private catch-pit leads shall be 150 mm.

Refer to **Sheet 34**.

## *4.3.20. Subsoil Drains*

All subsoil drains to provide land stability are considered private and should be self-contained within the individual property. Subsoil drains shall be installed to control groundwater levels, where required.

All subsoil drains shall be designed in accordance with WDC's Policy #0129 Land Development Stabilisation 2018 and Land Development Stabilisation – Technical Design Requirements 2018.

Refer to **Sheet 14**.

## *4.3.21. Soakage Devices*

Soakage devices such as soak pits and soak holes may be considered for managing stormwater from roofs, parking areas, and roads.

The ability of the ground to accept stormwater can vary enormously within soakage areas, even within individual properties. Because of this, at least one percolation test shall be required for every soakage device that is constructed and this should be done where the device is likely to be placed.

Soakage devices (with storage) shall be utilised where infiltration test results exceed 150 mm/hr, as determined using the NZ Building Code E1 Method, and where other conditions (e.g. stability, groundwater) do not preclude their use. Infiltration rates may be determined using the test and calculation procedure set out in the worksheet in Appendix E Permeability Test Sheets.

*(Design shall be subject to satisfactory percolation testing in accordance with Auckland Council guideline document GD2021/007: Stormwater Soakage and Groundwater Recharge in the Auckland Region).*

Calculations of soakage device and storage volumes shall identify the most severe combination of rainfall and infiltration/discharge for a design rainfall event. The outputs shall then be used to determine the size of the infiltration vs storage requirements.

Soakage devices shall be accessible for maintenance and shall consider geotechnical conditions for the proposed location.

Soakage device proposal requires Specific Design as follows:

a. Permeable pavement and associated porous sub-base shall be specifically designed.

b. Specific engineering design is required for soakage device in soils with infiltration rates less than 150 mm/hr.

Specific matters to be considered in soakage system design include:

c. Soakage devices shall be designed for 20% AEP (+CC 20%) flows from impervious areas.

d. Capacity adequate for the maximum potential impermeable area and located in such a way to maximise the collection of site runoff.

e. Soakage devices shall be located away from overland flow paths.

f. Rate of infiltration determined through an infiltration test with an appropriate reduction factor (at least 0.25) applied to accommodate loss of performance over time.

g. Secondary flows shall be provided for the water which will follow during events that exceed the design capacity of the soakage device.

h. Confirmation that the soakage device will not create adverse effects on surrounding land and properties (e.g. stability, seepage, or flooding issues).

i. Pre-treatment device to minimise silt, litter and other pollutant ingress.

j. Access for maintenance.

Specific matters to be considered when determining location for soakage devices include:

k. Soakage devices shall not be located close to buildings or boundaries. A clearance of 3.0 m is required, but this can be reduced to 1.0 m for porous paving or can be reduced to 1.5 m where the neighbouring property is required to have a 1.5 m setback to any new building. Setbacks to roadside boundaries shall be 0.5 m (to avoid fence footings). Further encroachment will require a Specific Design.

l. Soakage devices should not be located beside retaining walls. For walls less than 2.0 m high, the clearance shall not be less than a horizontal distance that is equal to the retaining wall height plus 1.5 m, unless a Specific Design is carried out. For walls higher than 2.0 m, a Specific Design shall always be carried out.

m. Soakage devices shall not be located within 2.0 m of public sanitary sewers or 1.0 m of private sewers.

n. Soakage devices shall not be positioned on unstable slopes (refer Section 4.3.3 Infiltration and Land Stability).

o. Soakage devices shall be positioned above the ‘winter’ high water table unless specifically approved to operate as predominately summer soakage devices. In the absence of specific field data, the position of the high-water table can be estimated from boreholes or test pit observations of soil colouration and wetness.

p. Soakage devices shall be servicing a single property.

A discharge permit may be required from the NRC.

## *4.3.22. Stormwater Treatment and Detention Devices*

### 4.3.22.1 General

There are a number of treatment and detention options available. The preferred solution will either be identified in an approved Catchment Management Plan, site-specific Stormwater Management Plan, or for small sites through discussions with the WDC.

The WDC will assess a preferred approach based on the following considerations:

a. The lifecycle maintenance cost to the WDC,

b. Land limitations such as location, available area, stability or ownership,

c. The performance of the device,

d. A level of optimisation of stormwater detention and treatment with the MPD, and,

e. Proposed engineering and landscape designs or works for treatment and detention solutions shall be approved at the sole discretion of WDC.

Where proposed stormwater treatment and detention solutions may impact on the operation or maintenance of other WDC assets, e.g. road, public reserves, and utility services, a specific approval from the affected asset owner Manager is also required.

Design shall generally follow the guidance provided in Auckland Council GD01. The specific requirements as set out in this Section take precedence over Auckland Council GD01. Additionally, where it can be explained to the satisfaction of WDC that there is a benefit in an alternate design that meets or exceeds Auckland Council GD01, an appropriately selected and sized treatment option, it can be considered, when using the following industry guidelines; including but not limited to:

a. Wellington Water- Water Sensitive Design for Stormwater: Treatment Device Guideline

b. The Regional Infrastructure Technical Specification (RITS) 2018 (Waikato)

If WDC shall be ultimately responsible for maintenance the treatment or detention device shall be located on land owned by, or to be vested in WDC.

The WDC encourages early consultation between the Developer and WDC to achieve mutually beneficial design outcomes. Of particular note WDC seeks design outcomes that meet operational, environmental and amenity requirements.

### 4.3.22.2 Rainwater Tank for Water-Use

Rainwater tanks can provide a significant contribution to stormwater attenuation when they provide water supply for a domestic use.

Table 4-12 sets out the percentage reduction of the required attenuation volume attributable to the dwelling roof. The table is based on a water consumption of 250 litre/person/day.

***Table 4-12: Percentage Reduction of Required Attenuation Volume***

| Roof Area (m²) | Reduction of required Attenuation Volume (%) | | | | | |
|---|---|---|---|---|---|---|
| | Rainwater Tank Size (litres) | | | | | |
| | 200 | 1,000 | 3,000 | 4,500 | 9,000 | 25,000 |
| 150 | 20 | 35 | 45 | 45 | 50 | 50 |
| 200 | 20 | 25 | 35 | 35 | 35 | 40 |
| 250 | 10 | 20 | 30 | 30 | 35 | 35 |
| 300 | 10 | 15 | 20 | 20 | 25 | 25 |
| 500 | 5 | 10 | 10 | 10 | 15 | 20 |

*Note: Reduction figures relate only to the roof portion of the attenuation and do not include other impervious surfaces.*

Where the rainwater tank attenuation shall be used to offset direct discharges from external impervious areas, once paved areas exceed 50-60% of the roof area, the incremental increase in roof runoff attenuation storage volume effectiveness becomes limited. Therefore, where the 'other' impervious areas exceed 120 m², a suitable, combined attenuation system shall also be provided.

For commercial and/or body corporate installations, the water use volume and its contribution to reduction of design discharge flow can be allowed. This shall be recorded on the title or as a land use consent condition.

If after some time attenuation can no longer be provided through water-use, the property owner will be obliged to provide an alternative attenuation system as required by the resource consent and before decommissioning the water-use system.

#### 4.3.22.3 Proprietary Treatment Systems

The treatment of stormwater using proprietary systems is approved when:

a. The proprietary system meets or exceeds the minimum treatment requirements of Auckland Council GD01, and,

b. The proprietary system is on WDC Approved Materials List - Wastewater and Stormwater, and

c. The proprietary system is installed in accordance with the supplier's specifications and/or recommendations.

Use of a proprietary system that is not a WDC Approved Treatment System shall be considered an Alternative Design and, as such, the process in Section 1.5.1.2 Alternative Designs shall be followed.

The use of proprietary systems that require frequent replacement of treatment media will not be accepted as vested assets.

### 4.3.22.4 Swales

The design of swales shall be undertaken by a SQEP in accordance with design guidelines contained in Auckland Council GD01 / Wellington Water- Water Sensitive Design for Stormwater: Treatment Device Guideline.

The design of swales shall ensure that they are able to convey the required design flows in a controlled manner, are not subject to ongoing erosion/scour and are able to be maintained in a safe and practicable manner with consideration given to traffic management.

Refer to Section 3.2.13.4 Swales for use of swales within the Transport Corridor as road pavement drainage controls.

### 4.3.22.5 Raingardens

The design of raingardens (often referred to as bio-retention) shall be undertaken by a SQEP in accordance with design guidelines contained in Auckland Council GD01 / Wellington Water- Water Sensitive Design for Stormwater: Treatment Device Guideline.

The design of raingardens shall ensure that they can detain and treat the required water quality volume, can adequately drain between events through underdrainage and are able to be maintained in a safe and practicable manner with consideration given to traffic management.

Refer to Section 3.2.13.4 Swales for use of bio-retention within the Transport Corridor as road pavement drainage controls.

### 4.3.22.6 Underground Stormwater Storage

Typical specifications for underground stormwater are provided in Table 4-13. A gross pollutant trap may be required for protection and maintenance purposes.

***Table 4-13: Proprietary Underground Storage Applications***

| Parameter | Application |
|---|---|
| Landuse | All land use types, all paved areas<br>It shall sustain traffic loads, which are anticipated over the subject area. |
| Performance | Can provide retention (infiltration)and/or detention storage. |
| Sizing | Provide to achieve requirements of Section 4.1.3 Performance Standards and Table 4-1 as required.<br>Consult manufacturer's guidance for detailed sizing information.<br>The minimum cover depths will apply. |

### 4.3.22.7 Catch-Pit Filter System

Table 4-14 summarises design requirements for typical catch-pit filter system (CFS) applications.

As systems are manufacturer specific, general specifications have been provided. Catch-pit filter systems require Specific Design.

***Table 4-14: Catch-Pit Filter Application***

| Parameter | Application |
|---|---|
| Landuse | Heavy traffic paved areas, including shopping malls, schools, carparks, and roads |
| Catchment area | Less than 1 ha |
| Performance | Gross pollutant removal.<br>Some course sediment removal.<br>Can be part of a treatment train. |
| Sizing | Installed into a curb inlet or catch-pit and can be customized to meet specifications.<br>High flows can bypass the filter.<br>Drainage design should account for reduced inlet capacity. |

### 4.3.22.8 Constructed Ponds and Wetlands

The design of constructed ponds and wetlands shall be undertaken by a SQEP in compliance with the design guidelines contained in Auckland Council GD01 and consideration of Wellington Water- Water Sensitive Design for Stormwater: Treatment Device Guideline. Additionally, ponds and wetlands shall comply with the following minimum requirements:

a. Maximum permanent water depth is 1.5 m,

b. Maximum external slopes shall be 1v:4h,

c. Maximum internal slopes shall be 1v:4h,

d. The pond shall be contained within the legal boundaries of a drainage reserve,

e. Where ponds and wetlands are not fenced, safety benches are constructed around the full perimeter in accordance with section 4.3.22.9 Pond and Wetland Safety Requirements,

f. All weather, legal access to the drainage reserve from a road shall be provided for maintenance,

g. Vehicle/machinery access into the fore-bay of wet ponds, or the main bay of dry ponds, shall have a min width of 2.5 m and a max gradient of 35% (1/3),

h. Perimeter access and access to inlet and outlet structures for maintenance should be provided,

i. Safety in Design principles shall be applied,

j. A draft version of Operation Maintenance Manual shall be submitted to WDC for acceptance at the resource consent stage and its final version at the asset vesting stage.

Specific approval is required from the Parks and Recreation Manager where a pond or wetland is proposed within a Local Purpose Reserve.

In addition to Auckland Council GD01 the following should be considered:

k. That site levels and hydraulics provide for the overall proposed design integrates seamlessly with the existing or proposed network.

l. A safe maintenance access should be provided to allow for machinery operations.

m. That the wetland must be easily drained via gravity without any or only minor pumping (i.e. for the purposes of maintenance).

n. That underground services and other utilities may be located at the subject site. Developers should check with WDC for locations of underground services in the area.

o. The design of the wetland should prevent velocities that result in resuspension of sediment and physical damage to wetland plants (e.g. flattening).

p. That any forebay should have a bund constructed to separate the forebay from the main wetland area. This could also be vegetated (with suitably selected wetland plants) and be arranged with a 1000 mm wide crest set to the PWL.

q. That design of inlets must consider potential for erosion from all design flows. The design should comply with Auckland Council GD01 or Auckland Council TR2013/018.

r. Outlet structures should allow for drawdown of the wetland volume for management and maintenance purposes. This is important when wetland plants are establishing. Lowering water levels to support robust and vigorous plant growth, may be required.

### 4.3.22.9 Pond and Wetland Safety Requirements

The following safety requirements shall be provided in addition to, or in preference to, the safety requirements in Auckland Council GD01/ Wellington Water- Water Sensitive Design for Stormwater: Treatment Device Guideline:

a. Pond or wetland embankments can be considered a dam under the dam safety regulations (See NZ Dam Safety Guideline, 2015) the requirements of those regulations shall take precedence over those stated in this document. A structure is considered a dam where:

- Vertical height from the downstream toe of the embankment to the top is more than 4 m, or
- The total stored volume of fluid is more than 20,000 $m^3$, or
- The contributing upstream catchment is more than 20 ha.

i. The dam shall be designed to cater for the flows and water levels generated by the 1% AEP event without adversely affecting upstream or downstream property.

b. Safety in Design assessment shall consider impacts on the adjacent properties or the community in relation to the, National Guidelines for Crime Prevention through Environmental Design in New Zealand and particularly to Section 7.2.1.1 Crime Prevention Through Environmental Design.

c. Embankments shall be permanently planted if the slope is steeper than 1v:4h or as it may be otherwise advised by the WDC.

d. A safety bench shall be provided around the PWL perimeter where water depth is greater than 0.9 m. The safety bench shall be between 0.3 m and 0.5 m below PLW and between 1.0 to 2 m wide

e. The main safety measure for constructed wetlands is a 2 m wide densely planted safety bench with a 1v:8h grade to a depth of 250 mm form the PWL. The slope of the internal banks below the safety bench must be no steeper than 1v:3h, to allow easier access from the wetland should someone fall in. At PWL a safety bench 2 m wide must be provided at a maximum slope of 1v:8h.

f. Safety benches are not required where fencing is applied as per g. below. Benches shall be stabilised with emergent wetland plants and wet seed mixes.

g. Any part of stormwater structures having either a vertical drop of 0.9 m or the ability to fall directly into standing water of depth greater than 0.9 m shall be fenced in 50% permeable format and otherwise compliant with the Building Act 2004.

*Note: Fencing across overland flow paths requires Specific Design by a SQEP and approval by the WDC.*

### 4.3.22.10 Planting and Aesthetic Requirements

Wetlands can support a diverse range of plant species. Plant selection is to consider the conditions at the site, including aspect, wind effects and changing water levels. Species should be selected from local sources.

The following shall be provided:

a. Planting plans shall be submitted to WDC for approval.

b. Plant species allocations shall be specific to soil type and conditions, site topography and exposure, post-development groundwater table levels and alignment with local indigenous native plant species.

c. Plant species shall be indigenous to the Northland Region, and eco-sourced, if practicable, although native (non-invasive) New Zealand grasses are permitted. Perennial species, that don't die back seasonally (e.g. raupo) are a requirement.

d. During the wetland plant establishment phase (first 3-6 months), water levels should be monitored and actively managed to support robust plant growth and to avoid the plants being submerged.

Plant selection should avoid those plants whose root structure will interfere with, damage or otherwise compromise, the integrity of any structural elements of the design e.g., root incursion in liner. In particular:

a. Woody vegetation and trees are not to be planted within 3.0 m of the slope of the toe of wetlands and ponds.

b. Planting shall be provided to shade those areas of the wetland with a sun exposure, to reduce thermal warming.

Aesthetic design elements shall be in keeping with local character. Developers are to consider:

c. Integrating planting into the wider environment such as streetscape and/or park setting so that the planting is seamless (where this is desired),

d. Extending the footpath into wetland area as a boardwalk, and

e. Making the wetland shape and edges aesthetically appealing

Landscaping shall:

f. Comply with engineering requirements and Safety in Design Principles,

g. Take into account landscaping design guidance contained in Auckland Council GD04 and WDC Urban Design Guidelines.

h. Minimise ongoing maintenance,

i. Improve stormwater water quality discharge,

j. Retain existing bush areas and tree stands where practicable, and

k. Provide, where practicable, forage and habitats for native flora and fauna.

*4.3.22.10.2. Planting Zones*

In addition to the aesthetic appeal and ecological benefits, plants in and around detention and treatment devices contribute to the functional requirements such as trapping sediment and preventing scouring of the embankments.

The following planting zones (Table 4-15) define the planting regimes for any detention and treatment devices. While Table 4-15 is intended for wetlands it can be applied to other devices when considering plant tolerances to wet/damp roots and frequency of inundation.

Planting Zones are provided as a guide, the developer shall provide a landscape plan for consultation and approval by the WDC.

***Table 4-15: Planting Zones***

| Zone | Description |
|---|---|
| Wet Zone | This area is where the pond ground surface is capable of being permanently submerged and where the plant roots may be permanently waterlogged |
| Marginal Zone | This area is likely to be submerged or partially submerged in a 50% AEP return storm event |
| Lower Bank Zone | This is the planting zone between the Marginal Zone and Upper Bank Zone where plants may be occasionally submerged (in storm events more severe than the 50% AEP return period storm). Plants are able to withstand inundation for short periods of time |
| Upper Bank Zone | This planting zone is above the spillway level. Plants are able to sustain damp roots for periods but should not be fully inundated |

#### *4.3.22.10.3. Plant Sourcing and Grade*

Plants shall be eco-sourced from the Northland Region where practicable, from reputable nursery stock with grades that minimise potential mortality rates. It is strictly prohibited to transplant vegetation from existing wetlands and other such environments.

Plant grades shall be of a suitable size to ensure vegetation establishes rapidly with minimum mortality rates and/or replacement requirements. Trees shall be a minimum grade of 1.5 m high.

#### *4.3.22.10.4. Species Selection*

Species shall be selected with regard to good conformation, healthy robust root systems and low maintenance. Species selection considerations shall include those listed in Section 7.2.7.3 Species Selection and:

a. Compliance with Section 3.2.6.7 Sight Distance in regard to sight distances where the treatment and detention device is within or near the Transport Corridor,

b. Engineering requirements, including improving post-treatment stormwater water quality,

c. Minimal leaf fall in autumn (which can reduce efficiency),

d. Ensuring no species that drop branches, debris, or may in any other way cause damming and/or unplanned flooding in and adjacent to watercourses (such as streams and spillways) are planted within 5.0 m of watercourses.

Where trees, shrubs and groundcovers shall be planted within a Transport Corridor, reference shall be made to Section 3.2.24 Trees and Landscaping.

*4.3.22.10.5. Swales Planting*

Swales are used for stormwater conveyance, primarily as roadside drains in areas without kerbs and channels. They are typically turfed or grassed to ensure rapid establishment and mitigate channel scouring. Grass should be maintained at heights between 50 mm and 150 mm, depending on engineering design parameters.

Where engineering requirements permit, *Carex virata* or *Carex geminata* may be planted in the Wet and Marginal Zones. No other groundcover, shrub or tree species are permitted in these Zones. These shall be planted with mulch rounds.

***Table 4-16: Swale Planting - Velocity/Grade Matrix***

| Type | Grade | Velocity |
|---|---|---|
| Swale – Roll on Turfing | Less than 2% | Less than 1.5 m/s at 20% AEP flow |
| Swale – Vegetated (Carex grasses) | 2-5% | Less than 2.0 m/s at 20% AEP flow |
| Swale – Rocks | Greater than 5% | 2.0 m/s or greater at 20% AEP flow |

Turfed swales shall be prepared, established and maintained as per the Section 7.3.7 Grassing, Sowing and Turfing. Both during and post-establishment, the height of the turf shall be consistently maintained at least fortnightly to the designed stormwater engineering requirements. Turf shall be of a drought- resistant hard-wearing rye-grass based variety.

Swales planted with Carex species shall be planted according to Section 7.3 Landscape Works.

*4.3.22.10.6. Bio-Filter Planting*

Bio-filters (e.g. raingardens and tree pits) can be planted with a mix of WDC approved groundcovers, shrubs and trees, as site conditions and engineering requirements permit.

### 4.3.22.11 Maintenance Requirements

Access to wetlands and ponds shall be as follows:

a. A 4.0 m wide access driveway and platform (as applicable) with all-weather surface suitable for an 8.2 tonne axle weight vehicle, at a grade of less than 1:12 shall be provided,

b. Maintenance access shall be located within any perimeter safety fencing,

c. The excavator working platform shall be level and adjacent to the clean out area,

d. The excavator working platform shall be no higher than 2.0 m above the base of the clean out area, and

e. If the access path is greater than 50 m long, then a 3-point turning area for a 10-tonne rigid truck adjacent to device (in addition to the excavator working platform): shall be provided.

# 4.4. Construction

## 4.4.1. Pipeline Installation

The installation of pipelines shall be carried out in accordance with AS/NZS 2566.2:2002 (where applicable) and **Sheet 31** and **Sheet 32**.

## 4.4.2. Materials

Materials shall be in accordance with the requirements of Section 4.3.8 Approved Products Materials.

## 4.4.3. Pipe Installation by Trench

### 4.4.3.1 Pipe Embedment

Where a pipeline is to be constructed through areas with unsuitable foundations, such material shall be removed and replaced with approved material. Alternatively, other methods of construction may be carried out with approval from WDC to ensure adequate foundation and side support is provided.

Pipe bedding and protection must be specified on the design drawings and shall be in accordance with **Sheet 31** and **Sheet 32,** AS/NZS 3725:2007, and the manufacturer's specifications.

The trench design shall be of sufficient width, and in accordance with **Sheet 31**, to allow pipes to be safely laid and all embedment material properly compacted.

Embedment and fill shall be installed so that not more than 15 m of pipes shall be left exposed in the open trench at any time.

The trench's subbase shall be able to support all expected design loads over the pipe. Geotechnical investigations and report by a SQEP are required for all pipes laid in known weak grounds and/or any pipe with a diameter greater than 600 mm.

A SQEP shall inspect and record the trench ground condition before embedment material is placed or pipes are laid.

Where pipelines have protruding projections such as sockets, flanges or couplings, a suitable recess shall be provided, in the supporting material, to ensure the pipeline is fully supported along the pipe barrels.

Pipes made of plastic materials shall be laid with product labelling uppermost in the trench.

All trenches over 1.5 m depth shall be secured from collapsing.

### 4.4.3.2 Tolerances

Pipes shall be accurately laid to the lines, levels and gradients shown on the approved drawings using pipe-laying laser equipment. The allowable tolerances are shown in Table 4-17.

***Table 4-17 Tolerances***

| Alignment | Tolerance |
|---|---|
| Vertical Alignment | There shall be no steps at the junctions between successive pipe segments and no point in the pipeline shall be lower than any downstream point. |
| Horizontal Alignment | ± 100 mm |
| Invert levels (IL) | ± 50 mm, subject to the downstream IL being lower than upstream IL. |
| Gradient | 50 mm from a straight line between the inverts of successive manholes. |

Where the installed pipes exceed the tolerances in Table 4-17, WDC may order the removal and relaying of any affected pipes.

### 4.4.3.3 Backfilling and Reinstatement

*4.4.3.3.1. General*

The trench or embankment fill material and trench reinstatement shall be as specified on the approved drawings and in accordance with **Sheet 31**.

Trench bedding and backfill material shall be compacted in layers to the designed ground level.

In public areas, backfilling shall be installed so that no more than 15 m of trench is open at any time.

Mechanical compaction of the backfill material directly above the pipe shall not be applied until sufficient cover is reached above the pipe to prevent damage to the pipe.

Displacement of the laid pipes during backfilling and compaction shall be prevented. Compaction or vibration equipment which can produce horizontal or vertical forces, which can cause damage or excessive distortion of the pipeline, shall not be used.

The Contractor shall reinstate trenches within seven days of backfill completion unless agreed otherwise by a SQEP. The surface level of the reinstated trench shall match the surrounding surface level.

Compaction test results shall be submitted to WDC for approval, as applicable.

#### *4.4.3.3.2. Backfill Materials*

Selected material excavated from the trench may be used for backfilling trenches subject to SQEP approval.

In roads and paved areas, where material excavated from the trench cannot meet the compaction standards in Section 4.4.3.3.3 Compaction, imported granular material shall be used.

Surplus and unsuitable material from the excavation shall be appropriately disposed of.

#### *4.4.3.3.3. Compaction*

*Within the Transport Corridor*

Trenches in the Transport Corridor, or under private access or paved (vehicular) areas, shall be backfilled and compacted in layers of thickness commensurate with the compaction equipment to a density of at least 95% of the maximum dry density. Field compaction shall be tested as follows:

a. For cohesive soils - New Zealand standard compaction test, nuclear densometer and shear vane.

b. For non-cohesive soils - New Zealand standard compaction test, nuclear densometer or dynamic cone penetrometer (Scala Penetrometer).

Testing by other means shall be subject to the approved ITP or conditions of the EDA.

Compaction testing of sub-base and base course shall be in accordance with requirements 3.3.4 Pavement Testing.

The SQEP shall specify a testing regime to verify the compaction effort meets the density specified to support the designed traffic loading.

The Contractor shall undertake tests in accordance with the approved ITP or conditions of the EDA, to demonstrate that the specified compaction standards have been achieved throughout.

*Outside of the Transport Corridor*

Trenches outside of roads or paved (vehicular) areas shall be backfilled and well compacted with mechanical equipment in layers not exceeding 300 mm thick to the specified finished ground level.

Under no circumstance shall the bearing capacity of the backfill material be less than that of the material prior to excavation, for the full depth of the trench. Scala Penetrometer tests may be used to establish the criteria for compliance, with a minimum of one test per 50 m of trench or 50 $m^3$ of trench backfill, whichever is greater.

Compaction testing of fill material shall be in accordance with NZS 4402:1988/1986. The Contractor shall undertake tests to demonstrate that the specified compaction standards have been achieved throughout.

## 4.4.4. Trenchless Construction

### 4.4.4.1 General

Trenchless technology may be preferable or required as appropriate for alignments passing through or under

a. Environmentally sensitive areas:

b. Built-up or congested areas to minimise disruption and reinstatement:

c. Railway and major road crossings:

d. Significant vegetation:

e. Vehicle crossings.

Trenchless construction shall only be used for applications in which the specified tolerance can be achieved.

Pipes used for trenchless installation shall have suitable mechanically restrained joints, specifically designed for trenchless application, which may include integral restraint, seal systems, or heat fusion welded joints.

Any trenchless technology and installation methodology shall be chosen to be compatible with achieving the required gravity pipe gradient.

### 4.4.4.2 Installation Methods

Trenchless installation methods for new pipes include

a. Horizontal directional drilling (HDD) (PVC with restraint joint/fusion welded PE):

b. Uncased auger boring/pilot bore micro-tunnelling/guided boring (PVC with restraint joint/fusion welded PE):

c. Pipe jacking (GRP/ reinforced concrete).

## 4.4.5. Joints

### 4.4.5.1 General

Specification of joints on gravity mains shall be as follows.

a. All pipes shall have flexible joints of an approved type, such as Rubber ringed joints:

b. Steel pipes shall be flexibly jointed (bolted unrestrained mechanical coupling ‘denso’ wrapped and sealed with approved outer wrapping or approved rubber ring):

c. Joints shall be provided adjacent to manholes to the requirements of AS/NZS 2566.2:2002 with the exception of PVC where proprietary connections may be used.

#### 4.4.5.2 Rubber Ring Joints

Rubber ring joints shall be installed strictly in accordance with the manufacturer's instruction. Care should be taken to ensure that the rubber rings are located evenly around the joint with no twists in them. The pipe shall be pushed up firm and tight to the joints.

#### 4.4.5.3 Welding PE Pipes

Butt or electrofusion welding of PE pipes shall be undertaken by a WDC approved contractor using calibrated and data logged welding machines. Only employees of an approved contractor who have successfully completed a Water New Zealand approved welding course for polyethylene pipe, or re-fresher in the past two years, shall be permitted to physically undertake welding.

Prior to commencing work, the following shall be provided:

a. Copy of current calibration certificate(s) of the welding machine (not more than 12 months old)

b. Registration number of welder, and current certification (not more than 24 months old).

All welding of PE pipes shall be data logged.

Welding shall take place in a covered environment to avoid contamination of weld faces and prepared pipe.

For all electrofusion welds, including tapping saddles, a mechanical scraper with winding mechanism shall be used to ensure even finishing. Hand scraping of pipe ends, with the appropriate tools, will only be permitted if mechanical scraping is not practicable and with prior permission from the Distribution Engineer. Electrofusion welds shall be undertaken using clamps and the equipment correctly calibrated.

*4.4.5.3.2. Butt Welded Jointing*

In addition, welders may be required to carry out satisfactory test welds for each joint type and to stamp the welder's number on each joint. Butt welds shall be, at least, 90% of the tensile strength of the parent pipe material, when tested in accordance with ISO 13953:2001.

All internal weld beads shall be removed in an approved manner, to be smooth and flush with the pipe inner surface, without compromising the strength of the pipe joint.

## *4.4.6. Manholes*

### 4.4.6.1 Channels and Benching

A semi-circular channel shall be formed in the concrete floor of the manhole. Benching shall then rise vertically from the spring line of the pipe to the height of the soffit and then be sloped back at a gradient of 1:3 (refer **Sheet 39**). A U3 standard of finish as specified in NZS 3114:1987 shall be achieved.

The flow channel shall be formed so that it presents an evenly curved flow path through the manhole. The cross section of the flow channel shall be uniform.

Benching shall be floated to a dense, smooth hard surface using 3:1 sand cement mortar and a steel float. Side branches shall be similarly formed with a smooth bend into the main channel.

Use of pre-formed benched manhole bases from WDC Approved Materials List - Wastewater and Stormwater is an acceptable alternative to formed in-situ benching.

### 4.4.6.2 Flexible Joints

All pipes, other than PE pipes, shall have a flexible joint adjacent to the manhole on all incoming and outgoing pipes not more than 600 mm away from the manhole wall. The upper part of the pipe inside the manhole shall be cut back to the wall, the reinforcement cut out and the ends plastered with a cement mortar to a neat finish. Where the pipe is cut using a power saw the ends of the steel reinforcement shall be protected from corrosion by the application of epoxy before rust has developed. Refer to **Sheet 39**.

### 4.4.6.3 PE Pipe Connections

PE pipe shall be connected to the manholes with sliding joints, as per **Sheet 33**.

### 4.4.6.4 Sealing of Manholes

Where precast manhole units are used, the joints of abutting units shall be sealed against ingress of water with an approved sealant and with epoxy mortar on the inside and outside of the joints.

Plastic manholes shall be sealed, where required, in accordance with the WDC Approved Materials List - Wastewater and Stormwater.

### 4.4.6.5 Manhole Steps

The steps shall be bolted through the walls using properly formed and recessed bolt holes.

The step shall have a washer welded to it on the appropriate angle to seat flush against the inside of the manhole chamber.

Prior to tightening, BM100 shall be placed around the stainless-steel shank both inside and outside the manhole riser. After the steps have been tightened in place the outside recess which houses the nut shall be sealed with Expocrete ‘UA’ or acceptable equivalent

in accordance with the manufacturer's directions. Plastering of the recess will not be approved. The sealant shall be applied at least 48 hours before the manhole risers are required for construction.

#### 4.4.6.6 Concrete

All concrete used for manufacturing manholes shall have a minimum crushing strength of 20.0 MPa at 28 days, unless otherwise specified or detailed by WDC.

### *4.4.7. Connections*

Connections will preferably be made into manholes.

Direct connection of a minor pipeline into a major pipeline shall be in accordance with the following:

a. The minor pipe diameter shall not be greater than half of the major pipe diameter:

b. Connection is made via a suitable prefabricated junction or saddle:

c. The distance between the pipeline connection and the closest inspection point shall not exceed 25 m:

d. Saddling of catch-pit leads into primary lines is permitted provided that the connection is made at 45º or less to the direction of primary flow:

e. Saddling of double catch-pits is not permitted:

f. Connections shall be sealed with removable caps until required.

g. Connection/cap and locations, and depths to invert shall be accurately measured and shown on As-Built Plans in accordance with the requirements of Section 1.7.2 As-Built Plans, Asset Information Schedules, Operation and Maintenance Manuals:

h. The cap position shall be marked with a wooden stake (100 x 50 mm) with green 'SW' painted/fixed onto the stake and extending from the invert of the connection to a minimum of 600 mm above ground level.

i. Connections shall be constructed as per **Sheet 37**.

j. All connections to WDC piped network or work on WDC piped network shall be undertaken by a Licensed Contractor.

### *4.4.8. Catch-Pits*

The connection of the lead into the catch-pit shall be constructed as detailed in **Sheet 34**.

### 4.4.9. Outlets

The Developer shall be responsible for the structural integrity and maintenance of the bank stabilisation/erosion protection structures and for any erosion control works that become necessary to preserve the integrity and stability of the stream, river, channel or water course and/or to control erosion until the structure is vested to WDC.

### 4.4.10. Stormwater Treatment and Detention Devices

Planting, protection, site preparation, spacing, and mulching shall be in accordance with the WDC Approved Landscape and Parks Specification.

## 4.5. Completion of Works

### 4.5.1. Testing and Inspections for Pipelines

A pipelines pressure test shall not normally be required however WDC reserves the right to require a low-pressure air test of the pipes.

#### 4.5.1.1 Low Pressure Air Test

a. Introduce air to the pipeline till a pressure of 300 mm of water is reached. (This shall be measured by a manometer such as a 'U' tube, connected to the system):

b. Wait until the air temperature is uniform (indicated by the pressure remaining steady):

c. Disconnect the air supply:

d. Measure pressure drop after five minutes:

e. The pipeline/manhole is acceptable if the pressure drop does not exceed 50 mm.

#### 4.5.1.2 Inspections

The Developer/Contractor shall ensure that any progress inspections and associated approvals are granted before continuing with the installation. Failure to follow this process may result in the Developer/Contractor removing items or excavating a competed work to allow inspection. The progress inspections include:

a. Set out:

b. Excavation and bedding:

c. Backfill:

d. Pre-pour Form and Reinforcing:

e. Pre-Cover Installation:

f. Water Tightness:

### 4.5.2. Manholes

Manholes shall be visually inspected to ensure the standard of construction and finishing is acceptable.

## *4.5.3. CCTV Inspections*

### 4.5.3.1 General Requirements

CCTV inspection shall be carried out on every new system to vest in Council. The timing of CCTV inspection shall be determined by WDC.

CCTV inspections and deliverables shall be in accordance with The New Zealand Gravity Pipe Inspection Manual, Fourth Edition.

All defects shall be remedied to the satisfaction of WDC. Where defects are found and repaired the section of pipe shall be inspected to ensure that there are no further problems.

CCTV inspection shall be carried out for all existing stormwater pipes before and after the construction works, which may affect the pipes by either directly interfering with the network or indirectly by using machinery and/ or plant at the site which may impose heavy loads and vibrations onto the stormwater network.

CCTV inspection shall be carried out in dry weather and where there is no flow which may affect the quality of video and still images

If there are pipe blockages and debris found the contractor shall apply to WDC to flush the pipe with water prior to the CCTV being completed.

The CCTV camera shall travel upstream.

CCTV maps with log sheets (showing the pipe GIS identification references, still images of critical locations with distances form the stat node, and indication of defects types and severity) shall be submitted to the WDC.

### 4.5.3.2 Deliverables

The following deliverables are required:

a. As-built plans and/or WDC GIS maps for existing assets, showing pipes and nodes being inspected.

b. Computer generated log sheets showing the pipe identification references for new and existing assets; still images of critical distances from the starting node; and indication of defect types and severity.

c. CCTV inspection record in digital video format.

d. CCTV footage shall also be referenced to the node unique numbers and shown on As-Built Plans and/or WDC GIS maps.

e. Still images shall be in a source file and a PDF format.

f. CCTV inspection summary sheets in a PDF digital format.

### 4.5.3.3 Header Information Required

Refer to WDC QA/QC Manual 2010 for CCTV header information requirements.

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