Wellington Water

Regional Standard for Water Services

May 2019 Version 2.0

Our water, our future.

This document was developed for Porirua, Lower Hutt, Upper Hutt and Wellington city councils and Wellington Water Limited.

Revision history

Rev No	Revision description	Date
1.0	Final	November 2012
2.0	Major revision	May 2019

Wellington Water

Table of Contents

List of Tables

1 Introduction

Wellington Water Limited is a shared service, council-controlled organisation jointly owned by Hutt, Porirua, Upper Hutt and Wellington City Councils and Greater Wellington Regional Council. Wellington Water manages the three water networks (stormwater, wastewater and potable water) on behalf of their client councils and provide advice on how to best invest in their future development.

This document was developed to consolidate the existing codes of practice for water services for Porirua City, Hutt City, Upper Hutt City and Wellington City in order to provide a regionally consistent method of design and implementation of water services across the Wellington region that will meet Wellington Water's 12 service goals.

The intention is to promote consistency in the local industry for the benefit of developers, designers, suppliers and councils. Whilst the current format still has clauses particular to each city, the intention is that these differences will reduce over time as design philosophies consolidate with more collaboration.

The document is intended to be read in parallel with the Regional Specification for Water Services, and relates only to infrastructure for stormwater, wastewater and water supply networks within the boundaries of the participating cities. It provides overall objectives and performance criteria that proposed infrastructure projects shall comply with, and a set of standard design methods and general network component specifications.

It is intended that the provisions within this document shall be applied to the design and construction of proposed infrastructure in new subdivisions, and to the maintenance, renewal and upgrades of existing council infrastructure.

1.1 Review of Standard

1.1.1 2019 Revision

The 2019 revision further consolidates requirements between the councils and transfers some requirements to the Regional Specification for Water Services to eliminate overlaps. It also incorporates recent changes in the councils' approach to seismic resilience and stormwater management.

1.1.2 Future Revisions

The standard may undergo occasional amendment as policy and technology evolves. A review will be undertaken approximately every five years or as major revisions are required. Any feedback on the standard can be made to:

Wellington Water Limited
Private Bag 39-804
Wellington Mail Centre 5045
Lower Hutt

c/- Standards

Alternatively, submissions can be made to any of the participating councils or to standards@wellingtonwater.co.nz.

2 Using the Regional Standard for Water Services

This document is subordinate to the council's district plan and is to be used in parallel with any operative subdivision or development codes of practice. Where, within the council's subdivision or development codes of practice, there is any cross-reference to the superseded sections below, or conflict with this document, the provisions within this document shall take precedence.

This standard supersedes the Regional Standard for Water Services November 2012.

2.1 Document Structure

This document is structured such that each asset class (water supply, wastewater and stormwater) is divided into four sections:

- Objectives: The objectives outline the broad, overarching objective of the network.
- Performance Criteria: The performance criteria outlines the minimum operational and functional levels of service expected from proposed developments and/or upgrades.
- Design Methods: Design methods describe the design methodology that is considered acceptable for the purposes of establishing the effectiveness of proposed solutions.
- General Specifications: General specifications describe acceptable engineering methods that constitute a standard acceptable method of compliance with the objectives and performance criteria. This section should be read in conjunction with Wellington Water's Regional Specification for Water Services as well as each council's specification.

2.1.1 Related Council Specifications

This document should be read in conjunction with the Regional Specification for Water Services as well as council's technical, construction and materials specifications.

Where there is a conflict between the Regional Specification for Water Services and each council's subdivision specification, the Regional Specification for Water Services shall take precedence over the council subdivision specification.

2.2 Definitions

For the purposes of this document, the following definitions and abbreviations shall apply.

2.2.1 Nominal Pipe Diameter

All pipe diameters referred to in this document are in millimetres (mm) and are nominal internal diameters unless specifically noted otherwise. Only polyethylene pipes are denoted with a nominal outside diameter and this should be post-fixed with the letters OD. For example:

63 OD	is 63 mm nominal outside diameter; and
100 mm	is 100 mm nominal internal diameter.

2.2.2 Definitions

The following terms are used in this document:

Term	Description
Annual Exceedance Probability	The probability of an event happening in any one year, typically expressed as a percentage (10%) as opposed to a ratio (1 in 10 years).
Aquatic Receiving Environment	Waters, including wetlands, which serve as a habitat for interrelated and interacting communities and populations of plants and animals.
Asset Class	Either water supply, stormwater or wastewater.
Council	The participating territorial authority within which the boundaries of the proposed scheme or renewal is located; or a delegated representative thereof; e.g. Wellington Water Limited.
Culvert	A pipe, typically passing under a road or embankment, which links two open watercourses.
Developer	An individual or organisation having the financial responsibility for the development project and includes the owner.
Drainage	Wastewater or stormwater pipework, channel or stream, and 'drain' has a corresponding meaning.
Grey Water	The wastewater from sinks, basins, baths, showers and similar appliances but not including any toilet waste.
Household Unit or Dwelling Unit	Any building or group of buildings, or part thereof used or intended to be used, principally for residential purposes and occupied or intended to be occupied by not more than one household.
Local/Minor Roads	All other roads which are not primary or secondary arterial roads.

Network	All pipes, pumping stations, fittings, reservoirs, structures, treatment facilities and any other appurtenant components or facilities directly associated with the asset class.
Maximum Day	Shall be a day where the water demand is greatest and the HGL of the network is drawn down to its lowest operating level. A Maximum Day would typically be a hot, dry day in the February – March period of summer.
On-site Disposal	The treatment and disposal of wastewater within the boundaries of a private lot, typically residential.
Potable Water	Drinking water as defined in the Health (Drinking Water) Amendment Act 2007.
Point of Supply	The legal boundary between private and public water supply as defined in each councils' water supply by-law.
Primary Flow	The estimated stormwater flow resulting from the event outlined by the primary level of service. Typically fully contained within the Primary Network.
Primary Network	The stormwater network designed to collect and dispose of the primary flow without surcharging/overflowing.
Primary Arterial	Roads providing interconnections between major sectors of a large area linked with external areas, and that distribute traffic from major intercity links. Defined by the roading and traffic department, but typically has traffic volumes of 7,000 to 10,000 vehicles per day with a significant number of heavy vehicles. Includes state highways.
Principal Main	A type of reticulation main, typically 100 to 200 mm in diameter, that provides the firefighting and majority of supply in a street. Sometimes called a distribution or secondary main.
Pumping Station (in water supply)	A facility for mechanically increasing pressures in a pipeline. Typically used to fill reservoirs or increase pressures in a distribution zone.
Pumping Station (in wastewater)	A facility for mechanically increasing pressure in a pipeline, or to lift effluent to a higher elevation in an adjacent manhole (lifting station). Typically used to convey collected effluent to an adjacent catchment or trunk main.
Pumping Station (in stormwater)	Similar to pumping station (wastewater) but designed to convey the stormwater to a safe discharge point.
Reticulation Main	A water main that distributes water to customer connections. Could be either a principal main or rider main.

Rider Main	A type of reticulation main, typically less than 100 mm in diameter, and secondary to any principal main in a street. Sometimes referred to as a tertiary main.
Rising Main	A dedicated pipeline running between a pump's discharge and a nominated discharge point; typically a reservoir in water supply systems, or a manhole on a gravity drain for wastewater systems.
SCADA	Supervisory Control And Data Acquisition. The council owned and operated telemetry and control systems used to remotely monitor and control facilities such as pumping stations, reservoirs, large-scale metering installations etc.
Secondary Arterial	Roads providing access to primary arterial roads. They have a dominant through vehicular movement and carry the major public transport routes. Defined by the roading and traffic department.
Secondary Flow	The excess stormwater flow that cannot be contained by the primary network, typically due to extraordinary design storm or network blockage.
Service Valve (Toby)	An isolation valve where a potable water connection is made between the Council water supply (in the street) and the private dwelling or commercial building.
Sewer	A pipe that conveys wastewater/sewage, typically using gravity. Could also be called a sewer drain.
Sewerage	The collective term for a network of wastewater/sewer pipes.
Stormwater	Rain water that does not percolate into the groundwater or evaporate, but flows via overland flow, interflow, channels or pipes into a defined channel, open watercourse or a constructed infiltration facility.
Subdivision	The subdivision of land as defined in the Resource Management Act 1991.
Subsoil Drain	A drain that is designed to control groundwater levels. It achieves this through the infiltration of groundwater into the pipe, typically through perforated walls or porous joints. It does not collect and transport surface runoff.
Trunk Main (in water supply)	A large diameter water main designed to transport water between reservoirs, distribution zones, source waters and reticulation mains. Trunk mains do not have customer connections. Sometimes called a transmission main, bulk main or primary main.

Trunk Main (in wastewater)	A large sewer that collects tributary flow from adjacent catchments and/or pumping stations.
Wastewater (sewage)	Water that has been used and contains unwanted dissolved and/or suspended substances from communities, including homes and businesses and industries.
Water Supply	Potable water; intended for human consumption. Includes water collected and used onsite for private use.

2.2.3 Abbreviations

The following abbreviations are used in this document:

Abbreviation	Description	Unit
ABS	Acrylonitrile Butadiene Styrene	
ADWF	Average dry weather flow	L/s
AEP	Annual exceedance probability	%
ARI	Average recurrence interval	years
dB(A)	Decibel A-weighted	dB
DN	Nominal diameter	mm
DICL	Concrete-lined ductile iron	
GL	Ground level in metres above datum	m
GRP	Glass reinforced plastic	
GW	Greater Wellington Regional Council	
hr	Hour	hour
H	Head (water column measured in metres)	m
ha	Hectare	ha
kPa	Kilopascal	10^3Pa
L	Litre	
m	Metre	
MHWS	Mean high water springs	m
mPa	Megapascal	10^6Pa
m/s	Metres per second	ms^{-1}
m^3/s	Cubic metres per second	m^3s^{-1}
mm	Millimetres	mm
MSL	Mean Sea Level (1953 Wellington Vertical Datum)*	m
NZBC	New Zealand Building Code	
NCD	WCC New City Datum (same datum as MSL)	m

Abbreviation	Description	Unit
NZVD2009	NZ Vertical Datum (0.44 m above MSL)	m
NZVD2016	NZ Vertical Datum (0.3407 m above MSL)	
OCD	WCC Old City Datum (-11.57 m NCD); discontinued in 1953	feet (typ.)
OD	Outside diameter	mm
PDWF	Peak dry weather flow	L/s
PE	Polyethylene (generic)	
PE80b	Medium density PE (MDPE)	
PE80c	High density PE (HDPE)	
PE100	High performance PE (HPPE)	
PGWF	Peak ground water flow (infiltration)	L/s
PN	Nominal pressure	bar
PP	Polypropylene	
PRV	Pressure reducing valve	
PSWF	Peak sewerage wastewater flow	L/s
PRWF	Peak rainwater flow (inflow)	L/s
PVC	Polyvinyl chloride (generic)	
PVC-M	Modified polyvinyl chloride	
PVC-O	Molecularly oriented polyvinyl chloride	
PVC-U	Unplasticised polyvinyl chloride	
PWWF	Peak wet weather flow	L/s
RRJ	Rubber ring joint	
RTU	Remote telemetry unit	
s	second	s
SDR	Standard dimension ratio	
SN	Stiffness number	
STCL	Concrete lined steel	

*Note: Tide levels listed in Tide Tables published by Land Information New Zealand use a Wellington Standard Port zero datum equivalent to -0.929 m MSL or 3.551 m below bench mark K80/2 (LINZ code ABPC – updated Feb 2018). The actual average measured sea level is currently measured at around 1.12 m above Wellington Standard Port datum or 0.191 m MSL (1953 Wellington Vertical Datum).

2.2.4 Pipe Gradients

This document uses a percentage to represent pipe or channel grades as opposed to a ratio; i.e. 1% instead of 1 in 100 (V:H). The percentage grade can be calculated by dividing the ratio's vertical component by the horizontal component and multiplying by 100. A conversion table is presented below.

Grade %	Grade Ratio
0.33%	1 in 300
0.5%	1 in 200
1%	1 in 100
2%	1 in 50
5%	1 in 20
10%	1 in 10

2.3 Referenced Standards

New Zealand and Australian standards have been referenced in this document. Where a standard's year has been nominated, then that specific issue is to be used. Where no year is nominated, the latest version is to be used. Standards relevant to this document are listed in the table below.

Reference	Title
E1322	Specification for the installation of Pipelines on Railway Land
SNZ HB 44	Subdivision for people and the environment
AS/NZS 1170.0	Structural design actions – General principles
AS/NZS 1260	PVC-U pipes and fittings for drain, waste and vent application
AS/NZS 1477	PVC pipes and fittings for pressure applications
AS/NZS 1546.1	On-site domestic wastewater treatment units – Septic tanks
AS/NZS 1546.3	On-site domestic wastewater treatment units – Aerated wastewater treatment systems
AS/NZS 1547	On-site domestic wastewater management
AS 1741	Vitrified clay pipes and fittings
AS/NZS 2041	Buried corrugated metal structures
AS/NZS 2280	Ductile iron pipes and fittings
AS/NZS 2566.1	Buried flexible pipelines – Structural design
AS/NZS 2566.2	Buried flexible pipelines – Installation
AS/NZS 2638.2	Gate valves for waterworks purposes – Part 2: Resilient seated
NZS 3101.1 & 2	Concrete Structures Standard
NZS 3106	Design of concrete structures for the storage of liquids
AS/NZS 3500.2	Plumbing and drainage – Sanitary plumbing and drainage
NZS 3501	Specification for copper tubes for water, gas, and sanitation
AS/NZS 3725	Design for installation of buried concrete pipes
AS 3996	Access covers and grates
AS/NZS 4020	Testing of products for use in contact with drinking water

Reference	Title
AS/NZS 4058	Precast concrete pipe (pressure and non-pressure)
AS/NZS 4130	Polyethylene (PE) pipes for pressure applications
AS/NZS 4441	Oriented PVC (PVC-O) pipes for pressure applications
NZS 4442	Welded steel pipes and fittings for water, sewage and medium pressure gas
SNZ PAS 4509	New Zealand Fire Service firefighting water supplies code of practice
NZS 4517	Fire sprinkler systems for houses
NZS 4522	Underground fire hydrants
NZS 4541	Automatic fire sprinkler systems
AS/NZS 4765	Modified PVC (PVC-M) pipes for pressure applications
AS/NZS 5065	Polyethylene and polypropylene pipes and fittings for drainage and sewerage applications

This Page Intentionally Blank

3 General Requirements

This document represents the performance and engineering requirements for the three water networks. Reference shall be made to this document when planning and designing stormwater, wastewater and water supply infrastructure for either new subdivisions, or the renewal or upgrade of existing infrastructure.

This document outlines:

- the networks' mandated levels of service
- how components of the infrastructure are expected to function
- acceptable engineering methods to comply with performance criteria.

3.1 Subdivision Requirements

Requirements relating to the overall subdivision process, urban planning, health and safety and other council utilities and services can be found in the council's existing subdivision codes and policy documents. Reference shall also be made to these documents and their requirements when planning works when using this document.

When considering the stormwater, wastewater and water supply infrastructure, this document specifically excludes:

- subdivision application and approval processes
- development contributions policy
- roading and roading reinstatement
- applications for connections to public services
- subdivision compliance certification
- detailed as-built specifications.

These requirements are detailed within each council's general subdivision codes or policy documents.

3.2 Legislative Requirements

Any proposed infrastructure project must, as a minimum, comply with the following legislation where applicable, plus any subsequent amendments:

- Building Act 2004
- Civil Defence Emergency Management Act 2002
- Climate Change Response Act 2002
- Local Government Act 2002
- Energy Efficiency and Conservation Act 2000
- Health and Safety at Work Act 2015
- Resource Management Act 1991
- The Environment Act 1986

- Forest and Rural Fires Act 1977
- Health Act 1956 and amendments
- Soil Conservation and Rivers Control Act 1941
- Land Drainage Act 1908
- Utilities Access Act 2010

3.3 Regulatory Documents

In addition to the legislative requirements, the following regulatory documents are also to be referenced where applicable:

- Council's district plans
- GW Regional Plan(s)
- council bylaws and charters
- The New Zealand Building Code.

Other documents are also referenced throughout this document at the relevant section.

3.4 Alternative Solutions

Innovative, alternative solutions are encouraged and will be considered where the proposed scheme can demonstrate compliance with both the objectives and performance criteria as set out in this document. It must be proven that the performance, maintenance and long-term economic outcomes are equivalent, if not better than the 'standard' solutions presented in the Design Methods and General Specifications sections within this document, as well as comply with the urban planning objectives set by the council.

Acceptance of alternative solutions will be at the discretion of the council. The form of alternative solutions should be discussed with the council at an early stage of design.

3.5 Health and Safety in Design Obligations

The requirements of the Health and Safety at Work Act 2015 and the Health and Safety at Work Regulations shall be observed at all times.

All designers so far as reasonably practicable must design all plant, substances or structures without risk to the health and safety of persons who use, handle, store, construct, or who carries out any foreseeable activity for inspection, cleaning, maintenance, or repair for the plant, substance or structure as designed, in accordance with the Health and Safety at Work Act 2015.

Infrastructure shall be designed so that:

- No harm shall occur to design staff
- No harm shall occur to workers during its construction
- No harm shall occur to public during its construction
- No harm shall occur to workers during its operation

- No harm shall occur to workers during its de-commissioning and removal

At the preliminary design stage, designers shall prepare a Safety in Design risk assessment addressing all these risks.

This shall include consideration of the risk posed by renewing, re-habilitating, or abandoning AC water pipe.

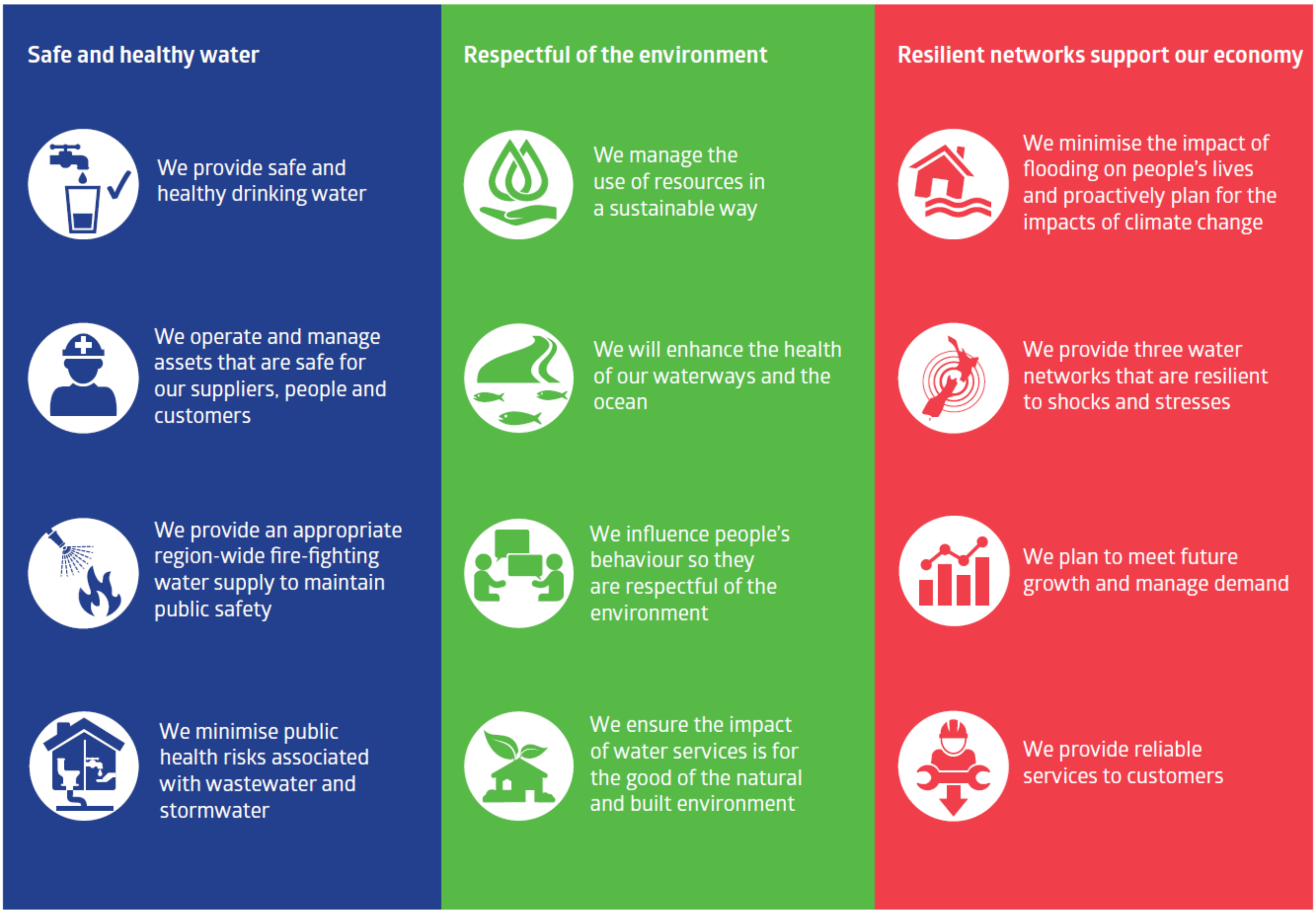
3.6 Application and Approvals

Developers are encouraged to discuss their proposed scheme with the council prior to concept design to ascertain requirements or pertinent considerations relating to their proposal.

This document does not cover the applications and approvals process. Each council has its own subdivision application and approvals process which the applicant must abide by. Compliance with the provisions in this standard does not imply acceptance of the asset for vesting or compliance with the subdivision consent.

3.7 Customer Outcomes and Service Goals

Wellington Water's customer outcomes and service goals are outlined in the following graphic.


Safe and healthy water
We provide safe and healthy drinking water
We operate and manage assets that are safe for our suppliers, people and customers
We provide an appropriate region-wide fire-fighting water supply to maintain public safety
We minimise public health risks associated with wastewater and stormwater
Respectful of the environment
We manage the use of resources in a sustainable way
We will enhance the health of our waterways and the ocean
We influence people's behaviour so they are respectful of the environment
We ensure the impact of water services is for the good of the natural and built environment
Resilient networks support our economy
We minimise the impact of flooding on people's lives and proactively plan for the impacts of climate change
We provide three water networks that are resilient to shocks and stresses
We plan to meet future growth and manage demand
We provide reliable services to customers

4 Stormwater

4.1 Objectives

To safeguard people, property, infrastructure and the environment from the adverse effects of stormwater, contaminated or otherwise, comply with the customer outcomes and service goals outlined in section 3.7, and to meet the performance requirements outlined within this document.

4.2 Performance Criteria

Any scheme must demonstrate consideration and compliance with the criteria listed below.

4.2.1 Functional

All new stormwater systems, or existing systems modified to accommodate new works, shall be designed to protect property and infrastructure from inundation or damage to the Minimum Level of Service specified in sections 4.2.7 and 4.2.8.

The stormwater system shall be designed to allow for all reasonably predictable development within the upstream catchment designed to the level of development allowed for within the council's district plan.

The network shall be a gravity network formed of defined watercourses, formed channels and pipes to approved discharge points within, as far as practicable, the catchment as it exists at the time of development.

The system shall be designed such that there is no direct cross-contamination between the wastewater and stormwater systems or any other source of hazardous substances.

No development or new drain shall cause water to be diverted from one catchment to another, either directly or indirectly.

Retention or attenuation/detention facilities are required for all new development connecting to existing infrastructure and shall be designed to limit the design peak discharge from the development (post-construction) to not greater than the existing design peak discharge (pre-development) from the site for all events up to a 10% AEP event which shall include the predicted impacts of climate change. Council has the right to nominate an alternative design event and event duration to mitigate specific downstream risks.

All structures shall be designed with adequate flexibility and special provisions to minimise the risk of damage during an earthquake or from differential settlement. Flexible joints are required at all junctions between rigid structures (wet wells, manholes, drywells, pumping stations, stream and bridge crossings etc.) and natural or engineered ground. Rigid pipelines shall have a flexible connection within the lesser of 650 mm or twice the pipe diameter of the structure wall. Manhole connectors shall be used for PVC pipes.

4.2.2 Access

Any proposed system shall not unduly restrict the location of any potential building or development, or restrict potential development elsewhere in the catchment.

Where practicable, stormwater assets shall be placed in land that is public, or is proposed to be vested. Where this is not practicable, council may request that the public stormwater asset is protected by an easement where future development could compromise access. Open watercourses and secondary flow paths shall be located on public land where practical, or protected by an easement in favour of the council.

Systems shall be designed such that reasonable access for regular maintenance can be made without significant damage or disruption to other utilities, land use activities and landscape values. Drainage easements are required to provide for the unobstructed flow of design floodwaters and removal of materials that may result in blockages downstream.

Secondary flow paths shall be clearly defined as no-building zones.

4.2.3 Maintenance and Operational

The network shall be designed such that it is compatible with the council's existing systems, materials and maintenance practices.

The network shall be designed such that gravel/debris obstructions, scouring and land instability are minimised.

4.2.4 Durability

The proposed scheme must be designed with an asset life of 100 years, although it is accepted that mechanical components such as pumps and valves, and electrical equipment are likely to have lesser durability, nominally 20 years.

In addition to longevity requirements, systems shall be designed in a way that minimises the life-cycle costs, inclusive of capital, maintenance and rehabilitation costs. For the purposes of this criterion only, the life cycle shall be taken as 100 years. The council may not necessarily accept the lowest cost option if it has a poor or limited track record for performance.

4.2.5 Health and Safety

The requirements of the Health and Safety at Work Act 2015 are to be accommodated within the design to protect the public and users of the system during construction, and over the life of the asset including its disposal. This shall include completing a Safety in Design analysis to enable potential hazards to be eliminated through careful design.

4.2.6 Climate Change

All systems shall be designed to accommodate the predicted impacts of climate change.

4.2.7 Primary Level of Service

Each system is to be designed to accommodate the design storm to a set level of service as defined by an annual exceedance probability (AEP). The required level of service for primary systems is outlined in Table 4.1. The primary system typically comprises piped drainage systems, formed drainage channels and soakage systems.

Generally, the designer shall design the overall catchment to the General Catchment Level of Service, and then demonstrate that the roads, sections and other considerations internal to the catchment are not inundated when the general catchment is subjected to the assigned internal event for each consideration.

The catchment is the entire drainage area above the design point of concentration.

Table 4.1 – Primary Level of Service (AEP)

	HCC	PCC	UHCC	WCC
General Catchment Level of Service				
Residential	10%	10%	4%	10%
Commercial/Industrial	10%	10%*	4%	10%
Rural/Rural residential	10%	10%	10%	10%
Internal Level of Service for Roads				
Arterial/State highway	5%	1%	1%	1%
Secondary Arterial	5%	5%	5%	5%
Local/Minor	10%	10%	20%	20%
Bridges	2%	1%	2%	2%
Internal Level of Service for Sections				
Open Space/Reserve	50%	N/A**	50%	50%
Private Yards	20%	10%	20%	50%
Car Parks	20%	10%	20%	20%
Internal Level of Service for Others				
Where no secondary path is available	1%	1%	1%	1%
Key public facilities, hospitals, substations etc.	1%	1%*	1%	1%
Wastewater disposal fields	5%	5%	20%	5%

* The minimum level or service may be specified differently in the building consent depending on the buildings intended purpose. Consent requirements supersede those listed here.

** Refer to PCC parks and reserves department for required levels of service.

4.2.8 Secondary System Level of Service

The secondary system comprises secondary flow paths typically overland and along carriageway surfaces. The secondary systems shall only be required should the primary system become blocked or its capacity exceeded. The secondary system level of service shall be able to be conveyed through a combination of both the primary system and the secondary flow paths.

Table 4.2 – Secondary System Level of Service (AEP)

	HCC	PCC	UHCC	WCC
Building Floors (also see 4.2.9)				
Housing and communal residential and communal non-residential	1%	1%	1%	1%
Commercial	1%	1%	1%	2%
Industrial	2%	1%	1%	2%
Rural residential	1%	1%	1%	2%
Gully traps	1%	1%	1%	2%
Roads				
Arterial*	2%	1%	1%	1%
Secondary arterial*	2%	1%	1%	5%
Local/minor*	5%	1%	1%	20%
Bridges	1%	1%	1%	1%

* Flooding is allowed at these levels of service, but the road must be passable by light vehicles. The table below indicates acceptable depths and flow velocities as measured at the road centreline.

Table 4.3 – Maximum Stormwater Flow Depths and Velocities

	Max depth	Max velocity
Primary/Secondary arterial road	0.1 m	2 m/s
Local/minor road	0.2 m	2 m/s
Steep local/minor roads	0.1 m	3 m/s
Walkways only	0.4 m	1 m/s

4.2.8.1 Secondary Flow Path

A secondary flow path is the path the stormwater would take if the primary drain was rendered inoperable or is overwhelmed by a flow exceeding the drain's design capacity.

The secondary flow path shall be shown on the submitted design and subsequent as-built plans. Designers shall demonstrate that existing and proposed dwellings are not affected by the secondary flow during the design secondary storm event.

Where the primary drain's capacity is large, and the consequence of overflow is great (primary flow is greater than secondary flow path capacity), a secondary inlet may be required by the council.

The secondary flow path is only required to convey the secondary system level of service event, less the design capacity of the primary system, regardless of secondary intakes.

4.2.9 Freeboard

Unless Wellington Water has undertaken a formal assessment of an appropriate freeboard allowance based on sensitivity testing in a validated hydraulic model, habitable building floors shall have a freeboard of 500 mm above the surface water of the secondary level of protection event. Commercial and industrial buildings shall have a freeboard of 300mm and all other building freeboards shall be 200 mm.

The minimum freeboard shall be measured from the top of the peak water level resulting from the design storm event, to the building platform level or underside of the floor joists or structural concrete slab of the building.

For open channels and streams, a minimum freeboard of 500 mm shall be adopted for the primary level of protection flow.

Vehicle bridges must have a freeboard of 600 mm to the underside of the bridge structure, or 1200 mm where there is a possibility of large trees in the waterway.

4.2.10 Building Floor Levels to be Identified

The building platform and building floor levels that are required to meet the above secondary levels of protection and freeboard shall be identified on the subdivision plans for each lot within the subdivision. The floor levels shall be expressed in terms of MSL and the local benchmark and level shall also be clearly identified. Datum for MSL are outlined in section 2.2.3 (page 7).

4.2.11 Environmental

Pre-application advice should be sought from GW if the proposed works involve the discharge of contaminants, including sediments, into an aquatic receiving environment.

For all land development work (including urban and rural subdivisions and land use change), the design shall include an evaluation of the post-development stormwater effects on the upstream and downstream existing and potential properties. Upstream increases shall be negligible or shown to have no detrimental impact. Downstream impacts to be managed and mitigated against shall include, but are not limited to, changes in peak flow and flooding, erosion, sedimentation and contamination. Works will be required to address any adverse effects.

In general, stormwater design should be commensurate with the intended character of the area, and the environmental context. Environmental quality must be taken into account in the location and design of stormwater systems. Where practicable, and unless directed otherwise by the council, sustainable stormwater techniques as outlined in section 4.2.12 should be employed to minimise the potential adverse effects of development. The following should be taken into account when considering environmental quality:

- The need to avoid adverse effects on cultural and heritage sites.
- The need to preserve or protect areas of ecological significance, areas of significant habitat for indigenous flora and fauna and outstanding natural features.
- The need to avoid, remedy or mitigate adverse effects on freshwater ecosystems, streams and watercourses, esplanade strips, harbours and coastal maritime areas.
- The need to avoid, remedy or mitigate adverse effects on visual amenity.

- The need to provide for on-site silt and sediment management, erosion control and dust control during construction.
- The need to provide passage for fish through or past proposed or existing infrastructure.

Stormwater must not be discharged to the ground in a manner that may cause or contribute to ground instability.

Consideration shall be given to pre-treatment of stormwater discharges to aquatic receiving environments, including harbours and inlets, to minimise potential adverse effects.

4.2.12 Water Sensitive Design

Water sensitive design, including the provision of stormwater treatment devices, is the recommended design approach for stormwater management to avoid adverse effects on receiving waterbodies.

The following guidance is recommended at each design phase:

Design Phase	Recommended guidance[1]
Project Scoping	Early engagement with the Wellington Water Land Development Team
Site Assessment	GD04 Water Sensitive Design (Auckland City Council)
Concept, Preliminary and Detailed Design	Water Sensitive Design: Treatment Device Design Guideline

[1] Recommended guidance materials are subject to version updates and may be superseded by the development of new guidelines.

Other treatment methods and devices will be considered on a case-by-case basis. Contact the Wellington Water Land Development Team to confirm specific design criteria.

4.3 Design Methods

The design methods presented here are considered 'acceptable solutions' for the purposes of developing solutions compliant with the objectives and performance criteria of this standard. Deviation from these methods will be considered with suitable evidence that the alternative method is equivalent in performance, cost and application to those presented here.

Stormwater design is presented in two parts in this document: hydrological design and hydraulic design. For the purposes of this document, hydrological design relates to the collection and transportation of rainfall runoff overland to a nominated point in the network. Hydraulic design relates to calculating the behaviour of the flow once inside a network.

Where the council has a catchment management plan, the proposed scheme shall be designed in line with the objectives and philosophies of the catchment management plan, as well as the design methods and specifications outlined in this document. The council should be contacted during the early stages of design to ascertain if an operative catchment management plan applies in the area of interest.

Certified calculations shall be made available to the council as part of any application.

4.3.1 Hydrological Design

The hydrological design outlined here relates to determining the peak flow for a catchment for the critical rainfall event.

For large detention structures, more sophisticated methods may need to be employed for storage routing. This may include historical event modelling and/or synthetic hydrographs. These methods are not covered within this document.

For catchments less than 100 ha, the Rational method may be used to determine peak discharge at the concentration point of a catchment. Urban catchments greater than 100 ha require specific design to account for the likely complexities of a large urban catchment. The council shall approve the method and the proposed software to be used in these instances.

Rural catchments greater than 100 ha may adopt the Modified Rational method.

Where a suitable period of measured rainfall and stream gauging data is available, these shall be used to determine peak flows for streams as opposed to the methods described below. The suitability of the hydrological data shall be at the discretion of the council.

The following standard methods of calculation can be found in Appendix 1 (page 96). Listed here are methods for:

- Rational Method
- Modified Rational Method
- Time of Concentration.

These methods require the determination of rainfall intensity and runoff coefficients specific to each city. See Appendix 1 (page 96) for more detail.

An alternative method of analysis may be nominated by Wellington Water to be used for design.

4.3.1.1 Rainfall Intensity (i)

Rainfall intensity is a function of the level of protection (AEP from Table 4.1, page 19) and time of concentration (T_c). Once these parameters have been established, the critical rainfall intensity can be determined from the appropriate Depth Duration tables in Appendix 2. Methods for determining the appropriate T_c are shown in Appendix A1.4 (page 97).

The rainfall intensity gained from the Depth Duration tables shall be increased by 20% to accommodate the projected effects of climate change[1]. Geographic zone multipliers are also required where made available. Currently, these are only available for HCC and PCC areas.

4.3.2 Hydraulic Design

The designer may use the Manning's formula for hydraulic calculations as outlined in Appendix 4 (page 103). The Colebrook-White method is not suitable for free-surface or open channel flow, but is not specifically excluded from use where a suitable situation is presented. Parts of the hydraulic design presented here are also applicable to wastewater hydraulic design in conjunction with the provisions outlined in section 5.3.2 (page 53).

The hydraulic design must consider:

- an allowance for air entrainment
- losses at bends and changes in direction
- losses at pipe entries, junctions and exits
- losses through manholes and structures
- changes in grade, invert level or pipe size
- the water level at the outlet due to design high tide, flood levels, peak channel flow or other hydraulic influences..

4.3.2.1 Air Entrainment

Where the pipe exceeds grades of 1 in 10, allowances shall be made for bulking of the flow due to air entrainment, and special precautions made to release the air and surplus energy. See Appendix 4 (page 103) for calculation methods.

Special precautions may be required to release air in subsequent tranquil drain sections.

4.3.2.2 Losses Through Structures

Losses through a structure shall be compensated for through a drop in the invert level through the manhole. The drop shall be additional to the entry and exit slopes, and shall be introduced gradually across the manhole.

The losses to be accounted for are:

[1] The Ministry for the Environment has published "Climate Change Projections for New Zealand: Atmospheric projections based on simulations undertaken for the IPCC 5th Assessment: 2nd edition" (September 2018) which suggests that the average annual temperature will increase by between 0.7 and 3.0° by 2100.

h_d head loss due to change in direction

h_j head loss due to junction (if applicable)

h_n nominal headloss across structure

Therefore the total drop (h_f) through the manhole to be accommodated shall be:

Equation 1 $$h_f = h_d + h_j + h_n$$ (in metres)

See Appendix A4.3 (page 105) for acceptable methods for determining components of h_f.

4.3.2.3 Pipe Inlets

Where an open stream or channel transitions to a pipe through a headwall or similar structure, the designer shall take into account the hydraulic head required to ensure full pipe capacity is achieved in the receiving pipe. Many pipe entries will require additional energy, with a subsequent increase in the backwater curve, to transition the flow from a channel cross section to a pipe cross section. The New Zealand Building Code, Clause E1, details appropriate methods for determining the inlet and outlet hydraulics.

4.3.2.4 Culvert Hydraulics

The hydraulic evaluation of stormwater culverts is outlined in the New Zealand Building Code, Clause E1. This method shall be used to evaluate the hydraulic performance of culverts.

Culverts under fills shall be of a suitable capacity to cope with the design storm with no surcharge at the inlet. Where the design storm is less than the 1% AEP flow, design checks shall be carried out under the 1% AEP design flow to assess the extent of the surcharge and to show that it will not present a risk to the stability of the adjacent embankments or increase the flooding risk to upstream properties. If either of these situations applies, then the culvert size shall be increased to eliminate the risks.

4.3.2.5 Backflow Effects and Downstream Level Conditions

Backflow effects shall be taken into account in design. Outlet design and water level conditions shall be considered in the design of discharges to existing stormwater systems and waterways and incorporate backflow prevention if necessary.

For discharges to the coast, assumed sea levels shall be the sum of:

- mean high water springs
- projected sea level rise through to 2110
- allowance for barometric rise from storms.

These sums are shown in table below.

Table 4.4 – Design Sea Levels Allowing for Climate Change

	Wellington Harbour[2]	Porirua Harbour
*Mean high water springs (MSL)**	*0.921*	*0.916*
+ Projected sea level rise (m)	*1.0*	*1.0*
+ Barometric allowance (m)	*0.25*	*0.25*
= Design sea level (MSL)	**2.17**	**2.17**

An additional 1.0 m for sea level rise has been added to the design sea level to account for an increased sea level rise due to climate change[3] through to 2110.

Where the proposed drain discharges to the public system, the peak flows of both the proposed and public drains are unlikely to coincide due to the difference in times of concentration. The designer is required to determine the receiving waters level during the design event to facilitate backwater curve calculations. A conservative alternative is to assume both systems peak at the same time.

For discharges to the Hutt River, discussions with GW shall be held to establish the downstream level of the river during the design event. GW has a floodplain management plan and/or flood maps for, but not limited to, the following water courses:

- Hutt River
- Waiwhetu Stream
- Pinehaven Stream

4.3.2.6 Minimum Stormwater Velocity

Pipes shall be laid at a grade that reduces the potential for sediment build-up. Where gradients are < 0.5%, the minimum velocity shall be 0.75 m/s at half the 50% AEP design event flow for trapped drains, where a trapped drain is considered as one where influent passes through a sump or sediment trap before entering the drain. For non-trapped drains, the minimum velocity shall be 0.9 m/s.

Velocities as low as 0.6 m/s may be considered in areas with flat terrain on special application.

[2] *Based on LINZ's Dec 2017 revision of Standard Port Datums*

[3] *From "Preparing for Coastal Change: A summary of coastal hazards and climate change guidance for local government" Dec 2017. Scenario D.*

4.4 General Specifications for Stormwater

The following specifications outline methods that will generally be considered as compliant with the objectives and criteria of this standard. Deviations from these specifications may be tolerated by the council if provided with suitable cause; however, the council reserves the right to decline alternatives if they conflict with the objectives and performance criteria of this standard.

These specifications may change as technology and legislation evolve and changes may be unpublished at the time of design and application. The council reserves the right to vary these specifications to suit the application and contemporary industry practice.

All materials used for stormwater drainage works shall be new, or in as new condition when placed.

4.4.1 Information to be Provided

4.4.1.1 General

In addition to the council's normal subdivision application requirements, the developer shall provide evidence demonstrating compliance with the performance criteria of this document.

Any operations and maintenance guidelines for any water quality and/or control structures shall be submitted to the council for approval along with other required documentation.

4.4.1.2 Calculations

The design details and calculations shall be prepared by a suitably qualified person and demonstrate that required levels of service will be maintained. Calculations presented as part of any application shall include, but not be limited to, catchment and sub-catchment attributes and details, rainfall intensity, time of concentration, catchment runoff coefficients, flood routing, peak discharge, pipe capacities, consideration of the receiving environment, structure losses, pipe losses and backwater calculations. All assumptions regarding the design shall be clearly listed. Structural calculations shall be provided to support the proposed pipe class based on min/max cover, traffic/construction loadings, surcharge conditions, and bedding and surrounds.

The developer shall provide calculations where scour may occur. Clause E1 of the NZBC can provide guidance on this.

All applications to build within a floodplain must be supported by detailed calculations and plans that outline the floodplain boundaries and levels relative to building floor levels.

Any impact on adjacent areas or catchments that the proposed works may have shall be clearly indicated on the drawings and supported by detailed calculations prepared by a suitably qualified person.

4.4.1.3 Design and Construction Drawings

The following items shall be included in any design and construction drawings:

- A scale plan of the catchment.

- Details of all structures, including culvert entrances and exits, secondary intakes and energy dissipating structures.
- The location and alignment of any natural waterways, overland flow paths or wetlands within the site or within close proximity to a boundary. The location, in plan, and the level of the water's edge and shoulder of the bank shall be indicated.
- Typical pre-existing and post development cross sections through any natural waterways or wetlands.
- The proposed proximity of buildings to the water's edge and/or shoulder of the banks;
- Clear identification of the extent of any river or coastal floodplains on, or in close proximity to, the site and overland flow paths within the site.
- The level datum.
- A plan showing the proposed location of existing and proposed stormwater drains in terms of datum.
- Long-sections shall be drawn with the chainage starting at the downstream end of the drain and the upstream point of the drain to the right of the drawing. This represents the way the drain would normally be constructed.
- Long-sections shall include details of all proposed and existing depths, diameters and levels of manholes, and pipe materials, diameters and grades.
- Secondary flow paths and calculated flow depths during the design event.

Proposed works shall not begin until construction plans have been approved.

4.4.1.4 Asset operations and maintenance plan

All new assets will be accompanied by an asset operations and maintenance plan which shall detail how the asset is to be operated and maintained over the life of the asset. A replacement schedule should also be included to show what works needs to be carried to ensure the asset is operable in perpetuity. The plan shall include as a minimum:

- Required inspection schedule.
- Required maintenance, both regular and occasional to ensure continued operation.
- Required replacement schedule for components with a limited lifespan, or life span shorter than the nominal life expectancy of the asset as a whole.
- How the asset is to be operated or is intended to work. Stages where operator input is required should highlighted.
- Health and Safety and operational risks intrinsic to the asset, operators and public and how they have been mitigated (through design) or how they should be mitigated (through operation).

4.4.2 On-site stormwater management and disposal

On-site stormwater management and disposal systems are required for ***all*** developments connecting to an existing stormwater system which does not meet current levels of service. The proposed system shall be designed to limit the design peak discharge from the development (post-construction) to not greater than the existing design peak discharge (pre-development) already exiting into the public network.

On-site management and disposal systems shall be privately owned and operated and generally be designed to restrict the post-development rainfall –runoff to pre-development levels.

On-site management and disposal systems servicing single lots shall be located completely within the serviced lot.

A suitable maintenance manual is required for all on-site management and disposal systems before the system is approved.

4.4.2.1 Soakage

Typically, soakage will only be considered acceptable on the elevated Hutt River terraces in Upper Hutt. All other areas within the Hutt, Upper Hutt, Wellington or Porirua cities are unlikely to be suitable for soakage.

The standard acceptable methods of on-site disposal are soak pits and soak trenches. These may only be used to dispose of runoff generated on the site and are not to accept flows from adjacent lots.

Suitably designed and constructed soak pits will be considered acceptable for residential applications and will be privately owned and maintained. Larger installations for commercial, industrial or communal use will be at the discretion of the council. A geotechnical assessment may be requested by council if the proposed soakage has the potential to affect land stability.

Care must be taken to ensure the stability of the adjacent ground is not compromised by the soakage.

The soakage facility must be sited on private property and have adequate clearance from boundaries, dwellings, buildings, retaining walls and sanitary sewers. Table 4.5 provides clearance distances for small installations.

Table 4.5 – Clearance Distances Between Soak Pits and Structures

Proximity to:	Required Clearance
Dwellings	2.0 m
Small outhouses/buildings	1.5 m
Boundaries	1.5 m
Retaining walls	Height of wall + 1.5 m
Sewers	1.0 m

The top level of the soak pit is to be above the ponding level of a 20% AEP rainfall-runoff event and the base of the soakage facility is to be a minimum of 500 mm above the winter groundwater table level.

The soakage facility will be approved upon submission of results of a suitable soakage test and design. The test, and a suitable design, is outlined in Clause E1 of the NZBC, but with the following modifications:

- Soakage devices that are the sole management device shall be designed to achieve a primary level of service as defined in section 4.2.7. The design shall consider all storms between 10 minutes and 24 hours in duration.
- All soak holes must completely drain within 24 hours of a rainfall event, to ensure they are ready for the next event.

TR2013/040 Stormwater disposal via soakage in the Auckland region can be used for guidance in the design of soakage systems.

A discharge permit may be required from the regional council for discharge to ground[4] and this shall be confirmed with GW.

Soakage pit entries or systems should be trapped to limit the amount of debris entering the soakage interface to extend the long-term viability of the system.

4.4.2.2 Discharge Detention and Attenuation

Attenuation, using on-site detention facilities, can be used to limit the discharge from the property to mitigate adverse effects on the downstream system. This may be a requirement of the council depending on the capacity of the downstream stormwater system.

These can take the form of an above-ground tank or buried tank, and may be combined with soakage. The design event duration for a proposed detention structure should be based on the time of concentration of the public stormwater above the point of connection with the proposed detention structure. Storage for larger, multiple lot developments requires special design as outlined in section 4.4.3. For residential detention structures, a 10% AEP event with a T_c of 20 minutes, or other event(s) as otherwise specified by council, shall be used to determine runoff and detention volumes.

Consideration shall be made to providing suitable access for regular maintenance of the outlet and storage volume.

The attenuation facility shall generally be privately owned and maintained and placed on private property. The facility shall be protected by private easement where required.

The secondary flow path due to outlet blockage *shall not* be a buried overflow pipe connection, but be by an appropriate and visible overland flow to an approved outfall or public system. This is to provide a visible indicator to the owner for the requirement for maintenance.

4.4.3 Stormwater Detention

Detention may take the form of oversized pipes, defined ponds, large channels/swales or ponding areas. Detention ponds or areas require specific design in conjunction with

[4] Discharge into or onto land, including stormwater collected from any road, roof, yard, paved surface, grassed surface or other structure, and discharged into a pipe which discharges into surface water.

the council. The Unit Hydrograph method[5] outlined by the NRCS (or in ARC TP 108 "Guidelines for Stormwater Modelling in the Auckland Region") shall be considered an acceptable method for use in flood routing, although others will be considered upon submission if benefits to accuracy and relevance can be demonstrated.

Detention areas/ponds must be provided with safe access for maintenance to at least the standard for intakes.

Where an open detention pond is proposed, detention depths shall not exceed 1.2 m unless access to the pond edge is restricted.

The detention structure is to be adequately designed to withstand overtopping or surcharging from an event larger than the design event.

Where detention structures are to be vested to the council as part of the public stormwater network, the designer shall liaise with council to confirm the requirements for the control, monitoring, alarm and telemetry systems specification.

4.4.4 Open Watercourses

Open watercourses shall be designed with a minimum freeboard of 500 mm above the design flow. Consideration shall be given to wave action and heading up at bends in the watercourse.

Major watercourses and their natural character shall be retained wherever possible, and be located in public reserves.

There shall be no modification of an existing stream system unless it is for flood mitigation purposes, and there are no viable alternative flood management methods available. All development work should be located away from the riparian buffer where possible, and impediments to the natural flow with barriers to fauna should be avoided.

Any work in a stream bed is likely to require resource consent and contact shall be made with Greater Wellington to confirm. Consent may also be required from the territorial authority as well. The extent of any stream improvement work shall be agreed with the council in order to achieve a satisfactory result maintaining the natural topography and vegetation, along with maintenance, hydraulic and safety considerations, including the downstream effects of the work.

Where the stream is ephemeral, and would nominally require a pipe of 600 mm diameter or less in a subdivision, then the stream is to be piped.

Any watercourse requiring a pipe over 600 mm diameter for the design event may either be piped if an approved secondary flow path is available, or remain in an open channel.

For watercourses with the equivalent 10% AEP event design capacity as that of a 600 mm pipe, the watercourse is required to be in an easement in favour of the council. The easement is to include sufficient space on at least one side of the stream and flood berm (for mean annual flood) for a 4.5 m wide strip practical for maintenance access to the stream, unless otherwise specified by the council. The cross section of any open watercourse shall be constructed to comply with the council's specific requirements.

[5] *Formerly known as the SCS Unit Hydrograph method. This can be found online in the Hydrology Chapter of the "National Engineering Handbook" (H_210_NE) published by the USDA Natural Resources Conservation Service (formerly Soil Conservation Service).*

4.4.4.1 Bridges

Where bridges or structures cross an open watercourse, the design shall allow for a freeboard of 600 mm between the design peak water level (see 4.2.7 and 4.2.8) and the underside of the bridge or structure. This shall be increased to 1200 mm where there is a possibility of large trees being carried down the waterway (from the Bridge Manual published by New Zealand Transport Authority).

4.4.5 Private Connections to the Public Stormwater System

Private connections may be made to public mains, watercourses and kerbs, and shall be a minimum size of 100 mm nominal diameter. Each proposed dwelling on a lot shall be serviced by a separate connection to the public system at a location approved by the council. Unit titled developments are exempt from this criterion and may be serviced by a single, suitably sized connection. Each connection shall be capable, as a minimum, of conveying the design level of service.

Industrial and commercial lots shall have a minimum nominal diameter of 150 mm and shall connect to a stormwater pipe, swale or, where permitted, open watercourse.

Connections provided to lots must be at sufficient depth that they can be extended to the building platform in a manner compliant with the NZBC.

Where the connection is to an empty lot, the terminal connection shall be:

- laid to within 1m of the boundary of the property
- end in a method that can accept an approved spigot
- be blanked off or sealed with a removable cap
- be marked with a securely embedded H4 treated timber post, with at least 600 mm protruding above ground, and the top 100 mm painted green.

Connections 150 mm or less can be made directly to a stormwater main, of a larger diameter, using a proprietary factory-made saddle.

Connections larger than 150 mm shall be connected to the public system via a manhole only. Connections shall be made at angles 90 degrees or less to the direction of the flow.

Connections shall not be made to public pipes with 5 m or greater cover. A shallower public drain shall be provided to collect private connections before joining the deeper main.

A private connection cannot cross an adjacent property without the permission of the council and the adjacent property owner. Where permission is obtained, in writing, an easement shall be obtained in favour of the connection’s lot.

4.4.5.1 Connections to Kerb and Channel

Connections to the public kerb and channel in an existing developed area are approved on a case-by-case basis and are limited to 100 mm diameter pipes. All greenfield developments and other connections must be to a watercourse, swale or a public stormwater pipe.

For kerb and channel connections, the pipe between the back of the footpath and the boundary may be made from an approved plastic, but beneath the footpath and to the kerb and channel must be galvanised steel or cast iron with approved steel kerb adaptors.

4.4.5.2 Abandoning and Reuse of Existing Private Laterals

Where an existing building has to be demolished or replaced, the end of the lateral is to be capped at the main or re-laid for future use. The council shall be advised of the final treatment.

The reuse of a previously used lateral over 25 years old is not permitted.

4.4.6 Public Stormwater Pipes

The stormwater system shall be designed as a separate system with no cross-connections to the wastewater system.

4.4.6.1 Minimum Size

The minimum nominal diameter for a public stormwater pipe is:

- 300 mm for stormwater mains and double sump leads
- 225 mm for single sump leads.

4.4.6.2 Minimum Cover

Stormwater pipes shall generally be laid with a minimum cover of 600 mm where practicable. The designer is required to demonstrate suitable pipe class selection and structural trench design at all depths.

The council may require additional load mitigations, such as concrete slabs, when considering a request from a designer for a lesser cover.

4.4.6.3 Materials

The permitted materials for use in the stormwater network are detailed in the Regional Specification for Water Services and supporting documents. Note that the designer should check with the latest council specification for any amendments.

4.4.6.4 Location

Where practical, pipes shall be located in public land, located where surface access for machinery and maintenance is possible at all times, and at reasonable cost and least possible disruption to the public.

Where pipes are laid in private property, they shall be protected by an easement (see section 4.4.13) and subject to the criteria outlined in section 4.2.2 regarding easements and avoidance of existing and potential building sites.

Public drains shall not be laid under permanent buildings or retaining walls and shall be laid at least 1.5 m clear of existing buildings. No building footprint or retaining wall shall impose extra load on the drain and any drain shall be placed outside the 45-degree surcharge line from the centre of the drain, unless by special design solution to the satisfaction of the council (see 4.4.14, page 43).

Drains and manholes shall not be located directly on a boundary line or where a fence is proposed.

4.4.6.5 Changes in Pipe Diameter

(This section applies to wastewater design also.)

Where the downstream pipe diameter increases, the pipe shall, as a minimum, be designed as soffit-to-soffit such that the hydraulic grade line through the structure is constantly falling (i.e. no heading up).

A downstream reduction in pipe diameter will generally not be accepted. Where a reduction in diameter is justified through a significant increase in grade, the change shall be made in an appropriately smooth transition structure (a manhole as a minimum).

Where a reduction in diameter is approved, specific engineering is required to eliminate heading up in the manhole, and detrimental backwater curves in the approaching pipe.

Reductions to less than a 300 mm diameter pipe will not be considered.

4.4.6.6 Pipes at Steep Grade

(This section applies to wastewater design also)

Pipes laid at a steep grade shall be designed for air entrainment (see 4.3.2.1) and shall have sufficient protection to protect the drain from UV light, erosion and physical damage. The protection shall be visually acceptable within the context of the surrounds.

Appropriate downstream energy dissipation is required where the design velocity exceeds 3 m/s and the flow undergoes a sudden reduction in grade; or where hydraulic design suggests significant turbulence will occur. Energy dissipation shall be designed to protect the receiving structure from erosion and damage.

Pipes at steep grade shall require water stops (see 4.4.6.7).

4.4.6.7 Water Stops

(This section applies to wastewater design also.)

Water stops are required to reduce movement of groundwater along trenches and minimise the potential for trench scour. Manholes can be considered as water stops if constructed in a manner that restricts the passage of water past the structure.

Water stops shall be constructed of 17.5 MPa concrete, be 150 mm thick and keyed 150 mm minimum into the trench walls and base. Water stops shall extend 300 mm above the pipe (see also standard drawings in Regional Specification for Water Services).

The spacing of water stops shall be as per Table 4.6.

Table 4.6 – Water Stop Spacing

Pipe Grade	Spacing (metres)
> 20%	5
20% to 12.5%	7.5
12.51% to 6.7%	15
6.71% to 1%	90

Subsoil drains may be required where a high water table or excessive infiltration is expected. These drains shall discharge to an appropriate facility, typically a downstream manhole and above nominal design flow levels. Where the subsoil drain passes through a water stop or similar, it shall be sealed to restrict bypass flow through the water stop.

4.4.6.8 Pipe Junctions

(This section applies to wastewater design also.)

All public pipe junctions shall be made using a manhole. This does not necessarily include laterals, which are subject to provisions in section 4.4.5.

Junctions shall be appropriately benched as outlined in the Regional Specification for Water Services.

4.4.7 Subsoil Drains

Permanent subsoil drains shall be installed in earthfills except where all of the following criteria can be demonstrated:

- There are no natural springs that will discharge at the base of the fill.
- Positive provisions (e.g. cut-off subsoil drain) are made to prevent surface runoff entering the fill at the exposed fill/natural ground contact.
- The natural ground on which the fill is to be placed is contoured and scarified prior to the placement of fill to ensure that, over the whole base of the fill, the fill can be fully compacted to specification and continuity achieved between the fill and natural ground.
- The fill material is uniform, of relatively low permeability and is not erodible.

Private subsoil drains servicing earthfills (excepting those behind retaining walls) shall be laid to the same standard as if they were public drains and a permit for them shall be obtained. The requirements for a public drain will in general apply, though access requirements may be eased.

Subsoil drains shall be constructed as follows:

- They shall connect to a manhole structure at both ends. The upstream manhole can be a maintenance shaft.
- They should be laid in a narrow trench, though if the loading permits, they may be laid in the cleaned out bed of the old watercourse with gentle horizontal and vertical curves.

- There shall be no abrupt changes in grade.
- The drains in the main gullies shall be established through design and shall be at least one pipe size larger than any connecting branch drain,
- Branch drains shall be laid in all adjacent gullies and adjacent to any wet areas such as a spring.
- Branch drains shall be a minimum of 100 mm diameter and shall be connected to the main by means of Y junctions only. Open butt joints will not be permitted.
- Where the design load allows, perforated concrete, HDPE or ceramic pipes may be used.
- These pipes must all be bedded and surrounded with a minimum of 150 mm of suitable graded filter material. Alternatively a suitable permanent filter fabric may be placed around granular pipe bedding in lieu of the graded filter material,
- Where the design load precludes the use of these pipes or where significant localised inflows or ground water are to be intercepted then the drain shall be laid as a sealed drain of adequate strength and may have multiple branches with multiple inlets to collect ground water.
- Where perforated pipes cannot be used, stones larger than the pipe diameter shall be hand placed over the inlets. The larger stones are to be covered with 50 mm of ballast. A suitable graded filter material shall be placed over this ballast.
- Where perforated pipes are used, the ends of the branch drains shall be sealed off and the drain backfilled as normal.
- Subsoil drains shall be clearly identified on as-built plans.
- There shall be no direct stormwater connection or opening to a subsoil drain.

4.4.8 Manholes

(This section applies to wastewater design also; section 5.4.4.)

4.4.8.1 Types

The two types of manholes outlined in this section are:

- manholes; and
- maintenance shafts (also known as cleaning eyes, rodding points or lamp hole cleaning eyes).

Manholes are required to allow physical entry of a person and equipment to the pipe for purposes of maintenance, investigation or connection.

Manholes shall be constructed in pre-cast reinforced concrete with minimum number of risers to minimise risk of infiltration. Other materials may be accepted by the council upon application and with suitable reason.

Manholes shall generally be used on all public drains at:

- junctions of public drains;
- changes in grade; and
- changes in direction.

Branch pipelines 300 mm or smaller may be saddled onto pipes 1200 mm diameter or larger without the requirement for a manhole, provided a manhole is constructed on the branch line within 50 m of the junction.

Maintenance shafts are designed to provide access to rod or jet obstructions clear of the pipe. Maintenance shafts shall not be used unless dispensation has been granted by the council.

Maintenance Shafts may be considered at the upstream termination of a short section of 150 mm drain section, typically 50 m or less.

In some circumstances, a maintenance shaft may be used at the top of a steep change of grade where a manhole is likely to be in an unsafe or precarious position.

The council may also consider approving maintenance shafts at subdivision terminal staging points or where the developer can justify their use for a special circumstance.

There shall be no customer connections to a maintenance shaft.

4.4.8.2 Design for Floatation

In areas of high water table, manholes shall be designed against floatation using a factor of safety of 1.25. The weight of the manhole risers, lid, slab and base shall be used for calculating the resistance against floatation and the manhole shall be assumed to be empty. The weight and effects of the surrounding soil shall be ignored except where integrated flanged manhole bases are used, whereupon the volume and net density of the soil (density of dry soil minus the density of water) above the flange can be used to calculate additional resisting force.

4.4.8.3 Manhole Size

Manholes shall be a minimum of 1050 mm diameter.

Manholes with a depth to invert between 2 and 4 metres shall be 1200 mm minimum diameter.

Manholes with a depth to invert greater than 4 metres shall be 1500 mm minimum diameter.

Manholes shall be the same diameter for the full depth of the manhole.

Notwithstanding the above minimum requirements, the manhole shall also be sized to accommodate the minimum dimensions outlined in Figure 1, where the dimension X is the greater of:

- 0.75 x OD of inlet/outlet pipe where pipes are same diameter; or
- 0.65 x OD of largest inlet/outlet pipe where pipes are different diameter; or
- 300 mm.

The manhole shall be large enough to appropriately admit connecting pipelines and any required change in direction. Manholes shall also be large enough to accommodate landings with room for manoeuvring and equipment if required.

600 mm diameter manholes may be used where the pipe invert is less than 1 m from the finished ground level, and the manhole is not located in the carriageway. 600 mm manholes can accept a maximum of two incoming pipes. Notwithstanding this, manholes less than 1050 mm will generally not be considered unless special circumstances are presented.

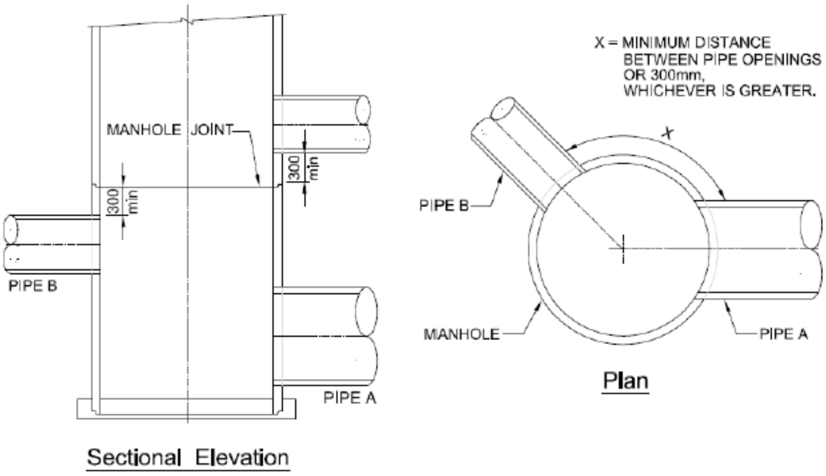


Figure 1 – Manhole layout (from CPAA Guidance Note: Loads on Circular Precast Concrete Manholes and Access Chambers: March 2016)

4.4.8.4 Deep Manholes

Deep manholes are considered to be manholes greater than 5 m in depth. Manholes shall be specifically designed to take into consideration access, health and safety, maintenance and rehabilitation. Deep manholes shall typically have:

- landing or landings to reduce potential fall to less than 5 m;
- the level of the lowest landing must be *at least* 2 m above the level of the benching; and
- hinged hatches in the landings above the manhole rungs arranged such that a person can be safely winched to the surface from the manhole base without requiring manoeuvring.

Permanent ladders may be used in lieu of rungs, but final requirements will shall be determined in conjunction with through a Safety in Design analysis with council.

4.4.8.5 Connections to Manholes

A 1050 mm manhole shall have no more than 3 incoming pipes and 1 outgoing pipe. This includes sump leads, private connections and main pipelines. Where more connections are required, a larger manhole may be required to comply with the manufacturer’s recommendations for connection spacings.

4.4.8.6 Drops at Manholes

All pipe entries shall be haunched to the manhole invert to avoid cascades, although sump leads, or normally dry stormwater laterals 300 mm in diameter or less, may enter above the benching as a cascade.

Haunched drops are not to exceed 500 mm and consideration shall be given to the hydraulic grade line and surcharging where super-critical flows transition to tranquil sub-critical flows.

For wastewater pipes, drops greater than 500 mm may be made using an internal drop structure.

4.4.8.7 Internal Drop Structures

External drop structures are not permitted within either the stormwater or wastewater network.

Internal drop structures will not normally be considered for stormwater applications, but are acceptable within wastewater systems.

Drop structures shall be avoided where possible, by laying the approaching drain at a shallow grade, then descending to the manhole invert through a steep section of pipe at the final approach. A manhole is required at either end of the steep approaching inlet drain.

For wastewater systems, internal drop structures are required where the approaching inlet grade is greater than 45 degrees. Internal drop pipework shall be designed to be clear of the design flow and the discharge shall be to a haunched channel. Internal drop pipes shall not be larger than 225 mm in diameter. The minimum size for a manhole with an internal drop structure is the nominal manhole diameter plus the drop pipe outside diameter.

4.4.8.8 Spacing

Manholes shall be spaced not more than 90 m in road reserve for pipe less than 1050 mm in diameter, or 90 times the pipe diameter for pipes 1050 mm in diameter or greater.

Manhole spacing shall reduce to 60 m in private property.

4.4.8.9 Changes in Grade

Notwithstanding the provisions in 4.4.8.1 (page 36) regarding manholes at the top of steep banks, changes of grade shall be made at a manhole.

4.4.8.10 Changes in Direction

Any change in direction or bend shall be completely contained within the interior of the manhole. The maximum change of direction shall be 90 degrees.

An exception to this may be made where a manufactured mitred bend is required, generally on large pipes, typically 750 mm in diameter or larger, provided:

- there is no compelling reason not to form the bend within a manhole;
- there is a downstream manhole within 5 m of the bend;
- there are no proposed or potential connections to the bend; or
- the location of the bend is shown, accurate to ±100 mm in the required co-ordinate system, on the drain's as-built plan.

Maintenance structures shall not be used for changes in direction.

4.4.9 Pipe Intakes

Intakes shall be designed to accept the design flow without scour or erosion of the pipe surrounds. Wing walls are a minimum requirement for stormwater intakes directly into a pipe.

Suitable barriers/fences shall be required above an intake where a fall of 1 m or greater is possible from above the intake headwall, and where public access is possible.

An all-weather access track must be provided to the entrance of all intakes. The access shall be at least 4 m wide and no steeper than 1:5 (v:h) and suitable for use by trucks. There must also be room for machinery to work at the intake. The access shall be in public land or protected by an easement.

Provision shall be made so that no water can bypass the inlet structure and flow into compacted fill or areas where damage may occur.

See also section 4.3.2.3 (Page 25) for hydraulic design requirements.

Grills are not typically required for culvert entries unless specifically requested by the council. Culverts are required to have access provisions for clearing similar to those of pipe intakes, and debris arrestors may be required. Provisions to protect the structure against scour and erosion at the inlet and outlet shall be provided and supported by calculations where requested.

4.4.9.1 Intake Grills

Grills shall be placed on intake pipes 675 mm in diameter or smaller, and shall have vertical bars spaced no greater than 115 mm apart. Pipes greater than 675 mm in diameter shall have bar spacing either smaller than 115 mm or greater than 450 mm. In addition to this, the grills shall:

- be bolted to the wall with either hot dipped galvanised or stainless steel bolts in a fashion that will allow the grill to be readily replaced;
- consist of a vertical front face of a height at least equal to the pipe diameter, and a sloping top. The angle of the top shall be greater than 1 in 4 (v to h);
- be sufficiently strong to resist the impact of any debris that may come down the watercourse;
- be sufficiently designed to withstand cleaning with an excavator bucket (where appropriate);
- not allow the top grill to protrude beyond the vertical grill (to avoid excavator buckets from catching on the top grill).

4.4.9.2 Debris Traps

Debris arrestors may be required upstream of the intake at the request of the council. The debris arrestor shall be a coarse screen designed to restrict the entry of large objects into the intake structure. These are typically constructed from vertically set steel railway sections or similar. The screen’s bar spacing shall be approximately 0.75 times the diameter of the intake pipe.

A catch-pit may also be required immediately upstream of the debris arrestor to arrest sediments and heavier debris. The dimensions of this trench or pit shall be based on catchment characteristics, approaching flow velocity and maintenance restrictions.

4.4.9.3 Secondary Intakes/Paths

Secondary intakes shall be considered in all cases where there is serious consequence of damage should the intake be overtopped. The preferred form of a secondary intake in a confined ponding area is a mushroom intake where entry of floating debris into the intake is minimised.

The design of the secondary intake should be based around the assumption that the primary intake is blocked.

Provision shall be made for flows greater than the design capacity of the intake and pipe to overflow to an overland flow path that meets the minimum AEP as described in section 4.2.8.1.

4.4.10 Outlets

The outlet or outfall from a public or private drain shall be to the public stormwater network or an approved alternative.

Discharging to land sloping down to receiving waters is to be avoided where possible. Discharging to land may be considered where the designer can demonstrate that the flows can be controlled, there are no adverse environmental effects and overland flow is contained to within the developer's property before reaching a receiving body of water. Discharging to land will not be considered where scouring is likely.

Where significant turbulence is likely, such as at a large change in cross-sectional area, specific measures shall be taken to eliminate scour and erosion of the receiving drain and surrounds. This may take the form of protective aprons and linings of the receiving channel or flow calming or energy dissipating structures. As a general rule, exit velocities in drains of up to 1.8 m/s may be tolerated without specific energy dissipation structures. Short duration flows up to 3 m/s may be tolerated if it can be shown that the channel is in stable and strong ground, potential maintenance has been considered and addressed, and the consequences of erosion are small.

Where the outlet discharges to a natural stream or channel, the outlet shall, as a minimum, be protected by a proprietary wing wall structure, concrete apron and concrete embedded downstream riprap with the intention of reducing scouring velocities.

Any structure should be designed to minimise the collection of debris. Where collection of debris is likely, access considerations equivalent to those of an intake (see section 4.4.9, page 39) shall be incorporated into the design to allow for removal of the debris.

Direct outfall to specific rivers, streams or the sea may require permission from Greater Wellington. Consideration towards the Freshwater Plan and Coastal Plan should be made when proposing direct discharges to streams, rivers and coastal areas.

4.4.11 Sumps

Sump requirements and detailing for PCC and WCC are covered under the Roading sections of WCC and PCC codes of practice. Section 4.4.11 applies to UHCC and HCC only.

High capacity sumps may be required in some instances. The intake capacity of these sumps shall be determined in consultation with the manufacturer.

Sumps shall:

- connect to a manhole, or to an open watercourse where no stormwater reticulation is available;
- utilise a rear entry and cycle friendly grate;

- be double sumps at the end of cul-de-sacs, at low points in the road or where slopes are steeper than 1 in 20;
- be clear of vehicle crossings and access ways;
- be placed where there is the potential for water to leave the road and enter a private property, typically upstream from vehicle crossings, or sudden changes in grade or direction;
- be placed in areas where ponding of water is possible; and
- be spaced no greater than 90 m apart, but close enough to adequately accept the contributing flows.

Sump leads shall have a flexible connection within 300 mm of the sump. Standard single sumps shall be serviced by a 225 mm nominal diameter lead, and double sumps shall be serviced by a single 300 mm nominal diameter lead.

Special design shall be required where a lead is proposed to discharge to a pipe running full to ensure the sump lead is of a suitable size.

4.4.12 Stormwater Pumping Stations

4.4.12.1 General

Publicly owned stormwater pumping stations will be considered only at the sole discretion of the council and only where, in the opinion of the council, there are no practicable alternatives.

The council shall be contacted prior to design to establish any materials or design conventions that have been established in addition to those outlined in the Regional Specification for Water Services.

Pumping systems shall be designed using a multi-pump system to best balance the need for regular pump operation against the relative infrequency of major storm events. The peak storm frequency (AEP) shall be set to match the upstream and downstream stormwater system, but shall be not less than:

- the AEP specified in the Performance Criteria (see section 4.2.7) when an overland secondary flow path can be identified that will ensure the minimum level of service is not exceeded; or
- 1% AEP when no overland secondary flow path is available.

The Regional Specification for Water Services shall be consulted for current pumping station requirements.

4.4.13 Easements

(This section applies to wastewater design also.)

Where an easement is required, the easement shall be a minimum 3 m wide. For drains larger than 300 mm nominal diameter, the easement width shall be 2.7 m plus the outside diameter of the drain. The drain shall be laid along the centreline of the easement.

Where more than one public main is laid in an easement, the easement shall extend 1.35 m from the outside edge of each outside drain.

The cross section of the drainage easement shall, wherever possible, be designed and constructed as an access for maintenance (including mowing if appropriate). The easement may also be used for secondary overland stormwater flow if required.

Unless otherwise approved, easements shall be within one lot and shall not straddle a boundary line. The pipe centreline shall not be laid less than 1.0 m from the boundary.

The council will at all times retain a 24-hour access right to all services contained within the easement without impediment, and without prior notice to the property owner. Under no circumstances shall any building, or obstruction to access or overland flow path, be constructed in a drainage easement or underground service easement. The easement shall be secured over all public services crossing private property at development stage whether services are existing or new.

4.4.14 Pipes near Buildings

(This section applies to wastewater design also.)

Where a building or retaining wall already exists, public drains shall not be laid within 1.5 m of the building or retaining wall (see Location, section 4.4.6.4, page 33).

Where a pipe is laid deeper than 1.5 m, a building line restriction shall be defined by a 45-degree line between the base of the trench and in-line with the outside of the pipe, to the closest underside of the foundation (see Figure 4.2). The building line restriction illustrated can be described as a 45-degree line, starting from a point 300 mm below the pipe invert and 0.5 times the pipe's outside diameter towards the foundation.

The design shall ensure no additional surcharge load is imposed on the pipe and an excavation could be made to maintain or replace the pipe without undermining the foundations of any building.

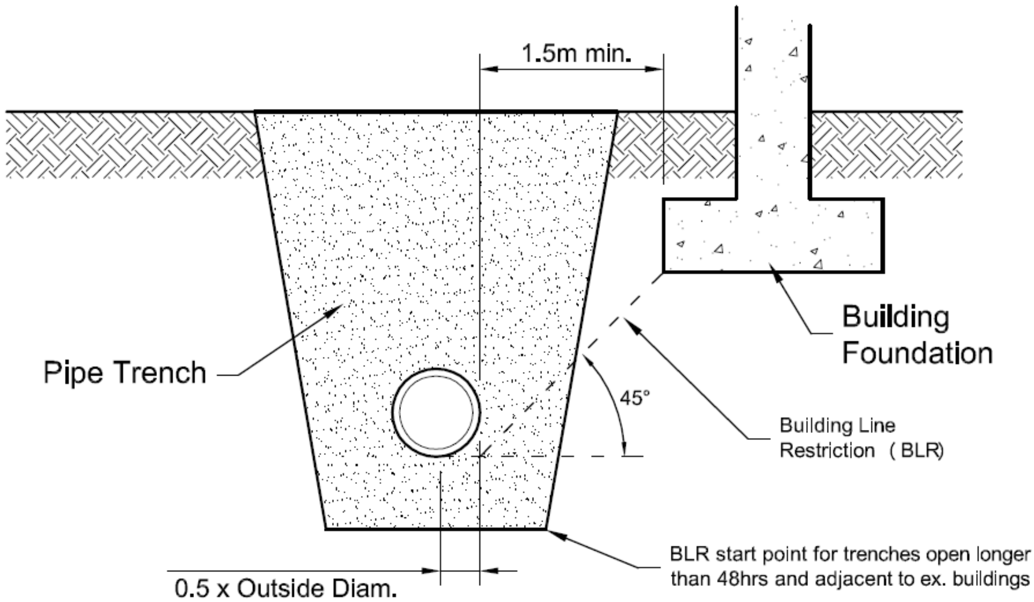


Figure 4.2 – Building Line Restriction

When laying a drain alongside an existing structure, and the trench is likely to be open for more than 48 hours, the pipeline design shall assume the building restriction line begins at the ***trench*** invert plus half the trench width (see Figure 4.2).

Notwithstanding the building line restriction, the foundation shall not be closer than 1.5 m to the outside edge of the pipe barrel. Dispensation may be considered for foundations between 1.5m and 1m and will require foundations to be 300mm below invert of pipe.

4.4.15 Testing

(This section relevant to wastewater design also.)

For subdivisions, and depending on the council's specific requirements, all wastewater and stormwater drains will be tested upon completion of construction at the applicant's expense and as part of part of the council's approval process. The council's representative shall be present during the test, and will sign the appropriate documentation provided by the council to verify the test if successful. A minimum of 24 hours of notice is required to be given to the council prior to the test being carried out. The developer shall provide all fittings and materials to carry out the test.

For subdivisions, the developer is required to have met the following requirements prior to pipe testing and council arriving on site:

- Trenched and pipes laid.
- Bedding and surround material, top and bottom shall have been laid over the pipe. Minimum 100mm top and bottom of pipe.
- All pipe junctions exposed including laterals and inspection eyes.
- Lines flushed and all residual debris cleaned out.
- All fittings and connection to have been installed prior to pressure test.
- Lines to have been pressurised overnight to the required pressure prior to the test commencing.

All mains and branch pipelines, including manholes and connections shall be tested after backfilling. The test shall be either the Water Test or Low Pressure Air Test as outlined in the Regional Specification for Water Services.

4.4.15.1 CCTV Inspection

The council may require the drain to also be inspected with a colour CCTV camera. This inspection shall be additional to the water or air test. Any defects detected by the camera inspection shall be made good and the relevant section of pipeline tested again. Contractors are advised to carry out their own test before backfilling the trench.

Acceptance of the drain will not be given until it has passed the water or air test and any CCTV inspection required.

4.4.16 Benchmarks (WCC Only)

(This section applies to wastewater also.)

All as-built levels are to be taken from an approved permanent benchmark such as a WCC benchmark or LINZ survey marks with the required accuracy.

All new developments shall require a new council benchmark or benchmarks to be established if:

- there is no existing benchmark within 1 km of the development; and/or
- the total area of the development is greater than 1 km^2.

The council shall determine the requirement and placement of new benchmarks.

New benchmarks shall be:

- levelled and certified, in writing, by a licensed cadastral or registered professional surveyor. The certificate shall be accompanied by a finder diagram and shall list the survey method;
- established in NZTM coordinates;
- Levelled to MSL;
- documented with a finder diagram showing at least three measurements from known permanent features to the new benchmark.

The council has the sole discretion to grant dispensation, in the form of cost sharing, upon consideration of:

- total development size (not just individual stages);
- location;
- ongoing development in the area;
- distance from existing bench marks; and
- benefit to WCC.

4.4.16.1 Installation

The council shall take the following factors into account when siting a new benchmark;

- Likelihood of future disturbance, permanence.
- Ground stability.
- Services.
- Survey visibility, line of sight.
- Accessibility (clear of traffic, road reserve, council easement).
- Ongoing development.

A standard WCC benchmark plaque will be issued by the Council on application.

There are two types of installation depending on the ground conditions. The two types are:

- **good ground:** typically consists of weathered greywacke parent material and soils less than 300 mm thick
- **adverse ground:** typically consists of soft colluviums, deep soils and/or sands.

Benchmarks established in good ground shall be set in a 350 x 350 mm square concrete block poured to a minimum depth of 500 mm. The plaque base shall be recessed into the concrete block and the block surface shall be flush with the finished ground level to the tolerances set out by the roading department's reinstatement requirements.

For benchmarks established in adverse ground, the concrete block's base shall be increased to a minimum of 550 x 550 mm square. The block may be stabilised with steel stakes (waratahs) or reinforcing rods set into the block and angling out into the surrounding ground below the block's base.

These installation types are detailed in the Regional Specifications for Water Services.

This Page Intentionally Blank

5 Wastewater

5.1 Objectives

To provide a system for the safe treatment and disposal of wastewater that safeguards people and communities from injury or illness caused by infection or contamination resulting from exposure to wastewater, while at all times avoiding, remedying or mitigating adverse effects on the environment.

5.2 Performance Criteria

5.2.1 Durability

The wastewater network shall:

- minimise adverse environmental effects and comply with all consent conditions set under the Resource Management Act;
- be designed and constructed with materials suitable for the intended use, with a proven performance record, and commensurate with a nominal structural and operational life of 100 years; notwithstanding the nominal operational network life, items with a lesser expected operational life, such as mechanical and electrical equipment, shall be selected and installed with consideration to maximising longevity, compatibility with existing systems, and economic replacement; and
- be designed in a way that minimises the overall renewal and maintenance life-cycle costs. For the purposes of calculation, the lifecycle costs shall be determined using a life of no less than 100 years.

5.2.2 Maintenance and Operational

The wastewater network shall:

- minimise the risk of flood water ingress without unduly restricting maintenance access;
- be compatible with the existing wastewater drainage network;
- be laid out in such a way as to minimise the potential for blockage and facilitate on-going maintenance or development;
- minimise the likelihood of leakage and infiltration and the penetration of roots;
- minimise the likelihood of blockage; and
- withstand all anticipated superimposed loads.

5.2.3 Level of Service

The wastewater network shall:

- adequately service the catchment including all current and future lots ultimately possible under the operative district plan; this includes potential expansion of the network beyond the developer's initial development;
- consist of an underground piped reticulation system where an adjacent public reticulation is available;
- be of capacity suitable for carrying peak flows anticipated during the lifetime, without surcharge, and with due allowance for ground and surface water infiltration and inflow;
- be designed to minimise blockage and sediment deposition;
- maintain adequate self-cleansing velocities to ensure a daily flush at dry weather flow at both existing and fully developed stages. Where inadequate flows are expected, such as within some industrial areas, or during initial stages of development, special flushing facilities shall be required at the discretion of the council;
- adequately convey wastewater to an approved discharge point;
- utilise gravity drainage wherever practicable;
- where utilising mechanical or electrical equipment, have adequate emergency provisions and alarm systems to minimise the possibility of discharge to land or water;
- be adequately vented to reduce the build-up of hazardous gases and prevent siphoning of private drainage or gully traps. Ventilation should be provided in such a manner that it does not cause a hazard to property owners or members of the public;
- provide alarm and telemetry systems that are compatible with those being used by the council at the time of project implementation;
- not be connected to the stormwater network. Wastewater systems shall be designed and constructed to minimise the risk and extent of stormwater inflow and infiltration. Where the wastewater network is within a flood plain, or overland flow path, it shall be designed to prevent floodwaters entering the network;
- ensure all gully traps are above the 1% AEP event surface level and at least 150 mm above the nearest opening (e.g. manhole or cleaning eye) in the wastewater network; and
- ensure overflow protection is provided at pumping stations to allow for pumping failure. This shall take the form of 6 hours' average dry weather storage or suitable approved alternative. Notwithstanding this, emergency relief overflows and venting shall be provided for extreme events in addition to any storage provisions.

Where the existing network is affected by the development, system upgrades shall meet the following minimum standards (which may need to be assessed in the wastewater model):

- Overflows at unconstructed locations shall not be made worse (volume or frequency)
- Detention, if approved by Council, should provide storage for 24 hours average dry weather flow for non-pumped systems.

5.2.4 Access

The wastewater network shall:

- be located within the road reserve except where special difficulties preclude this;
- be protected by easement where special difficulties necessitate the placing of reticulation pipes on private property;
- not unduly restrict the location of any future buildings or development; and
- be located and designed to provide reasonable access for maintenance without significant damage or disruption to other network utility services, land use activities and landscape values. Covers, barricades, fences and sign-posting shall be provided as appropriate to provide for public safety and prevent public access to hazardous areas.

5.2.5 Environmental Quality

Ensure that environmental quality is considered in the location, design and construction of all components of wastewater systems.

In considering environmental quality, the following should be considered:

- The need to avoid adverse effects on cultural and heritage sites and to respect cultural values, particularly the cultural values of tangata whenua relating to wastewater treatment and disposal.
- The need to preserve or protect areas of ecological significance, areas of significant habitat for indigenous flora and fauna and outstanding natural features.
- The need to avoid, remedy or mitigate adverse effects on freshwater ecosystems, watercourse margins, esplanade strips, harbours and the coastal marine area.
- The need to avoid, remedy or mitigate adverse effects on visual amenity.
- The need to provide for on-site silt and sediment management, erosion control and dust control during construction.

5.2.6 On-site Disposal

On-site disposal shall be designed to enable the safe hygienic disposal of all household wastewater by surface or subsurface land disposal without creating any adverse environmental impact outside the bounds of the lot. Such systems may only be used in rural or rural residential developments where a connection to the existing reticulation is not considered reasonable by the council. A resource consent may be necessary so reference to GW's discharge to land policies are required.

Grey-water reuse schemes in urban areas are considered an alternative solution and will be considered under special application (refer to section 3.4).

On-site wastewater treatment and disposal systems shall:

- provide an appropriate and safe treatment and disposal facilities in accordance with any regional plans developed pursuant to the Resource Management Act;
- have a life expectancy in line with the best available systems of the time;

- satisfy all consents granted under the Resource Management Act;
- be adequately separated from private water supplies, watercourses and boundaries such that there are no adverse effects within or outside the lot served;
- have minimum maintenance needs and be as fail safe as practicable;
- demonstrate that there are suitable management systems in place for their long-term operation, maintenance, replacement, upgrading and funding; and
- be unobtrusive.

Design shall be based on field testing and any other site investigations necessary to demonstrate that these requirements can be met.

Reference can be made to:

- GW “Guideline for on-site sewage systems in the Wellington Region” (Dec 2000);
- AS/NZS 1546.1 “On-site domestic wastewater treatment units - Septic tanks”;
- AS/NZS 1546.3 “On-site domestic wastewater treatment units - Aerated wastewater treatment systems”; and
- AS/NZS 1547 “On-site domestic wastewater management”.

See also section 5.4.10 for general specifications for on-site disposal.

5.3 Design Methods

The design methods presented here are considered to be acceptable for the purposes of developing solutions compliant with the objectives and performance criteria of this standard. Deviation from these methods will be considered with suitable evidence that the method is equivalent in function and outcome to the standard solutions presented in this document.

Wastewater design is presented in two parts in this document; wastewater design flows and hydraulic design. For the purposes of this document, wastewater design flow relates to determining the hypothetical design parameters for the collection system. Hydraulic design relates to calculating the behaviour of the flow within the system.

Certified calculations shall be made available to the council as part of any application.

5.3.1 Wastewater Design Flow

The design flows determined in this section are to be used in the hydraulic design of the wastewater collection network. Reference to the council's current district plan will be required to ensure all potential development upstream, downstream and within the development is accommodated in any proposed works.

5.3.1.1 Wastewater Catchment

The catchment used for all wastewater design calculations shall be all the area that drains/discharges wastewater or could physically and legally drain/discharge wastewater to the point under consideration. When determining the design flow, the catchment shall be, as a minimum, considered to be developed to the full extent permitted by the district plan.

Where future development is possible (i.e. if a district plan change is pending, or flows are possible from an adjacent development), the potential for additional wastewater flow shall be accommodated.

Sewer catchment areas will usually need to be calculated manhole to manhole so the network pipelines are not unnecessarily oversized.

5.3.1.2 Population

The population to be used for wastewater design in typical residential developments shall be based on a people per dwelling basis. Where the proposed number of dwellings cannot be determined, the minimum density per hectare figure outlined in Table 5.1 shall be adopted.

Alternative means of estimating occupation and/or flows will be considered and may be discussed with the council.

Table 5.1 – Residential Development Population Density

Council	Population per Dwelling	Min. Density People per Ha*
HCC	3.5	60
PCC	3.5	50
UHCC	3.5	45
WCC	3.1	Residential – 140 Inner city – 400 Suburban centre - 1200
WCC CBD	3.1	400/ha of floor area**

* gross area including streets, but excluding reserves.
** assuming 3 m between floor levels and maximum building height and coverage as per district plan. Ninth floors and above can assume 50% occupancy.

5.3.1.3 Residential Design Flows

For the design of residential wastewater pipelines, the Peak Wet Weather Flow (PWWF) shall be determine by:

PWWF = (**ADWF** x **PF**) + **Direct Inflow** + **Infiltration**

Where:

Average Dry Weather Flow **ADWF**	= 0.0023 L/s/person (L/s)
Peaking factor **PF**	= 7.23 x $\text{Area}^{-0.2}$ (area in hectares)
Direct inflow	= 0.55 L/s/km of pipeline in catchment upstream of point of analysis.
Infiltration (per km pipe length)	= 0.06 L/s/km (low groundwater table)
	= 0.43 L/s/km (high groundwater table)
	= 0.25 L/s/km (unknown water table)

Where the pipe length within a collection area is unknown and in a proposed greenfield development, assume 0.8 km of pipeline per hectare of developed land. Typically, pipes in rock or clay slopes are anticipated to have low ground water tables, and pipes in flat, valley floors or in coastal areas with an invert below 3 metres MSL are anticipated to have a high ground water table.

5.3.1.4 Industrial/Commercial Design Flows

Flow from large industrial or institutional complexes, wet industries, large residential buildings or commercial developments shall be by specific design and pertinent to the activity. The basis of design for this shall be submitted for approval to the council and prior to final design.

Consultation with the council is required when designing flows for the following areas:

- Hospitals and nursing homes.
- Abattoirs or significant wet industries.
- Institutional complexes such as universities.
- Commercial port areas.
- Central business districts.

Where specific activities are *not* known, the following factors from Table 5.2 may be used:

Table 5.2 – Industrial and Commercial Design flows (L/ha/sec)

Council		ADWF	PDWF	PWWF
HCC	Indust/Comm.	0.52	1.56	1.56
PCC	Heavy			1.3
	Medium			0.7
	Light			0.4
UHCC	Industrial	1.0		3.0
	Light industrial	0.08		0.23
	Commercial	0.25		1.0
WCC	Apply WCC residential method as outlined in section 5.3.1.3 to obtain ADWF and PWWF.			

5.3.2 Hydraulic Design

Manning's formula shall be used in the hydraulic design of sanitary sewers. The method outlined in section A4.1 (page 103) shall be used with the following amendments:

- Section 4.3.2.5: Backflow effects for wastewater pipes should assume downstream pumping station wet well levels are at normal operational maximum (duty pump start level).

In addition to this, gravity wastewater pipelines shall not be designed to operate at pipe full capacity and pipes shall allow for a 15% air space in the design, i.e.

$$\frac{\text{Area of sewage}}{\text{Area of pipe}} = 0.85$$

For circular pipes, this is equivalent to a pipe flowing at a depth of 80% of the pipe diameter. This air gap is required to maintain airflow through the sewers and eliminate the discharge of odours at manholes.

5.3.2.1 Downstream water level

For wastewater design, the terminal downstream level for network design shall be taken as the pumping station's wet well maximum 'duty pump start' level.

5.3.2.2 Self-cleansing Velocities

Notice should be taken of the requirement for new sewers to maintain self-cleansing velocities during subdivision staging. The design shall allow for interim measures for self-cleansing where these cannot be achieved during the initial stages of the development.

Self-cleansing velocities can be demonstrated by:

- calculating the expected PDWF for the proposed pipe section and ensuring flow velocity exceeds the minimum requirement of 0.75 m/s; ***or***
- adopting the minimum pipe grades in Table 5.3.

Table 5.3 – Minimum Grades for Wastewater Pipes

Pipe DN	Minimum Grade	
150	1.11 %	1/90
225	0.69 %	1/145
300	0.44 %	1/230

These values are based on pipes flowing at 52% depth (PDWF) and assuming a peaking factor of 2. Steeper grades may be required for areas with greater peaking factors.

Shallower grades may be permitted at the discretion of the council provided the applicant can demonstrate cleansing velocities can be achieved or the effects mitigated.

5.3.2.3 Maximum Velocity

Velocities during PWWF should not exceed 3 m/s. Where velocities exceed 3 m/s, special provisions shall be made such as drop manholes (see Internal Drop Structures; section 4.4.8.7, page 39) to flatten the approaching grade, or by increasing pipe diameter.

5.4 General Specifications for Wastewater

5.4.1 Information to be Provided

5.4.1.1 General

In addition to the council's normal requirements for subdivision application, the developer shall, as a minimum, provide the following information with any wastewater design:

- drawings and calculations as outlined below;
- operations and maintenance guidelines for any pumping station, odour treatment or effluent treatment facility to be vested to the council.

5.4.1.2 Calculations

The design details and calculations shall be prepared by a person qualified in wastewater design and demonstrate that required levels of service will be maintained. Calculations presented as part of any application shall include, but not be limited to, those for the peak and daily flows, structure losses, pipe losses and backwater calculations. All assumptions regarding the design shall be clearly listed. Any deviation should be documented and the written council approval for the deviation attached.

Analyses, results, reports and calculations prepared by a suitably qualified person shall be submitted for pumping stations and on-site disposal fields proposed.

Structural calculations shall be provided to support the proposed pipe class based on min/max cover, traffic/construction loadings, surcharge conditions, and bedding and surrounds.

5.4.1.3 Design and Construction Drawings

Design and construction drawings shall show details of all structures, including energy dissipating structures, internal/external drops and typical trench cross sections. The following shall be included within the submitted drawings:

- Long-sections shall be drawn with the chainage starting at the downstream end of the drain and the upstream point of the drain to the right of the drawing; this represents the way the drain would normally be constructed.
- The level datum.
- The long-sections shall show levels, grades and material of proposed pipelines in terms of datum as well as material, depth and diameter of manholes and maintenance structures.
- The long-sections and plan drawings shall show proximity to any other existing or proposed services.
- Where on-site treatment is proposed, drawings are required outlining the effluent treatment areas proposed, flood levels in design event, the proximity of any natural body of water, and the method and layout of irrigation.

Proposed works shall not begin until construction drawings have been approved.

5.4.1.4 Asset operations and maintenance plan

All new assets will be accompanied by an asset operations and maintenance plan which shall detail how the asset is to be operated and maintained over the life of the asset. A replacement schedule should also be included to show what works needs to be carried to ensure the asset is operable in perpetuity. The plan shall include as a minimum:

- Required inspection schedule.
- Required maintenance, both regular and occasional, to ensure continued operation.
- Required replacement schedule for components with a limited lifespan, or life span shorter than the nominal life expectancy of the asset as a whole.
- How the asset is to be operated or is intended to work. Stages where operator input is required should highlighted.
- Health and Safety and operational risks intrinsic to the asset, operators and public and how they have been mitigated (through design) or how they should be mitigated (through operation).
- Compliance and auditing requirements as well as a renewal schedule for any regulatory permissions.

5.4.2 Private Connections to the Wastewater Network

The minimum nominal diameter for a private connection shall be 100 mm. Each proposed dwelling on a lot shall be serviced by a separate connection to the public main and at a location approved by the council. Unit titled developments are exempt from this criterion and may be serviced by a single, suitably sized connection.

Connections provided to lots must be at sufficient depth that they can be extended to the building platform in a manner compliant with the NZBC.

All 100 mm connections to the public main shall be via a proprietary 'Y' junction. Connections 150 mm diameter or greater shall be made at a manhole, except in Wellington CBD where connections 225 mm diameter or greater shall be made at a manhole. The minimum length of a connection shall be 1 m.

Y junctions, and connections in general, shall not be made to a sewer pipe deeper than 3.5 m to the crown. Each lot's 'Y' connection shall be made to a shallower branch sewer which will join with the deeper main at a manhole.

Where the connection is to an empty lot, the terminal connection shall be:

- laid to within 1m of the boundary of the serviced property;
- end in a method that can accept an approved spigot;
- be blanked off or sealed with a proprietary removable cap painted red; and
- be marked with a securely embedded H4 treated timber post, with at least 600 mm protruding above ground, and the top 100 mm painted red.

A private connection cannot cross an adjacent property without the permission of the council and the adjacent property owner. Where permission is obtained, in writing, an easement shall be obtained in favour of the connection's lot.

Minimum grades for private connections up to the property boundary shall be as outlined in Clause G13 of the NZBC, but with a minimum grade of 1:60 unless otherwise justified.

Connection to the public network shall be carried out by a contractor approved by the council.

Electrofusion tees to be used on all polyethylene pipework.

5.4.2.1 Abandoning and Reuse of Existing Private Laterals

Where an existing building has be demolished or replaced the end of the lateral is to be capped at the main or re-laid for future use. The council shall be advised of the final treatment.

The reuse of a used lateral over 25 years old is not permitted. .

5.4.3 Public Wastewater Pipes

The wastewater system shall be designed as a separate system with no cross-connections to the stormwater system.

5.4.3.1 Minimum Size

The minimum nominal diameter for a public wastewater gravity pipe is:

- 150 mm.

5.4.3.2 Minimum Cover

Main wastewater pipes shall generally be laid with a minimum cover of 900 mm where practicable. The designer shall take into consideration traffic loading and structural design when asking the council for a reduction in minimum cover.

Customer laterals shall be no shallower than 600 mm at the boundary.

5.4.3.3 Location

Where practical, pipes shall be located in public land, preferably carriageways, footpaths and berms, and where surface access for machinery and maintenance is possible at all times, at reasonable cost and with the least possible disruption to the public.

Where public drains are laid in private property, they shall be subject to easements as outlined in section 4.4.13 (page 42) and shall not impinge on potential building sites within the development.

Public drains shall not be laid under permanent buildings or retaining walls and shall be laid at least 1.5 m clear of existing buildings (see also 4.4.14, page 43). No building footprint or retaining wall shall impose extra load on the drain. Drains shall be placed above the 45 degree surcharge line projected downwards from the nearest bottom edge of the adjacent foundation or footing, unless by special design solution to the satisfaction of the council (see Figure 4.2).

Drains and manholes shall not be located directly on a boundary line or on the alignment of a proposed fence or retaining wall.

5.4.3.4 Pipe Materials

The permitted materials for use in the wastewater network are detailed in the Regional Specification for Water Services. Note that the designer should check with the latest council specification for any amendments.

Materials for stream crossings, elevated pipelines and pumping station pipework shall be discussed and approved by the council prior to detail design.

5.4.3.5 Pipeline Design

The following sections are to be applied to both wastewater and stormwater designs:

Changes in Pipe Diameter	- 4.4.6.5 (page 34)
Pipes at Steep Grade	- 4.4.6.6 (page 34)
Water Stops	- 4.4.6.7 (page 34)
Pipe Junctions	- 4.4.6.8 (page 35)

5.4.4 Manholes

Refer section 4.4.8 (page 36).

5.4.5 Venting

Venting of structures is required to eliminate the collection of noxious gases and corrosive conditions within the structure's air space. The venting structure must be constructed on public land with the location being approved by the relevant council. Venting shall be required at all:

- pumping station wet wells;
- manholes that receive a rising main discharge;
- manholes where inverted siphons enter or discharge; and
- terminal upstream manholes on any branch line (this is deemed satisfied for pipes in subdivisions if at least one property is connected to the most upstream manhole in the branch).

Odour treatment will be required where vents discharge to urban areas. Odour treatment can be in the form of activated carbon filters or odour beds. Solutions for odour treatment shall be discussed with, and approved by, the council prior to detail design.

5.4.6 Easements

Refer section 4.4.13 (page 42).

5.4.7 Wastewater Pumping Stations

Pumping stations will only be considered for approval by the council where gravity drainage is not feasible. Pumping stations serving more than 10 urban lots may be vested to the council.

The design is required to be approved by the council before construction begins. The designer shall liaise with the council pumping station engineer prior to detail design to establish acceptable methods and materials.

The developer shall bear all costs of design, construction and commissioning of pumping station including SCADA, controls, flow metering, power supply and integration of the station into the wastewater network.

Pumping stations that are to be vested to the council shall comply with this document and the Regional Specification for Water Services.

5.4.8 Private Wastewater Pumping Stations

Where connection to the council network is not possible, and where the council has given written permission, private wastewater pumping stations may be considered provided they comply with the minimum criteria as set out here, and in the Regional Specification for Water Services. Council requires that:

- The design of the station is to be carried out by a suitable professional and be submitted to the council for approval.
- Pumps shall have an open multi-channelled impellor with a macerator/grinder on the intake (allowing maximum 8 mm free passing). Pumps shall also have thermal overload protection and a liquid temperature rating of 40°C.
- Materials and design shall have minimum 50 years durability.
- The rising main shall be a minimum of 63 OD PE100 SDR11.
- Wet well design and pumps shall be based on 12 starts per hour and peak wet weather flow.
- Chambers shall be designed against floatation and chamber hatches shall be designed to be impervious to inflow and infiltration.
- All controls, electrical equipment and cables are to be provided with suitable weatherproof enclosures and sited above 1% AEP flood level.
- The station shall be fitted with an audible and visual alarm system indicating pump failure and overflow.
- Non-return valves *shall not* be installed on the private discharge main in a way that prevents the un-discharged effluent to return to the wet well when pumping stops. This avoids septic conditions in the rising main. Notwithstanding this, the rising main discharge shall be placed and designed to eliminate the potential for sewage from the main pipeline to surcharge and backflow down the rising main and overflow the wet well.
- The rising main shall discharge to a public manhole.
- The wet well shall be of a size to hold 24 hours of ADWF (section 5.3.1, page 51), plus the volume of the rising main, above the pump start level.

The resource consent may require additional emergency storage or an emergency disposal field depending on the surrounding environs and scope of the development.

The Developer shall take the responsibility to alert any future owners of the site and the station that:

- the site is serviced by a private pumping station;
- the owners are fully responsible for the maintenance and operation of the station;

- the owners are responsible for any fines or consequences from a failure adequately to maintain the station;
- a 24-hour message service and on-going maintenance contract must be acquired for the station; and
- the station must be kept to a standard acceptable to the council and does not cause a nuisance to other property owners, adverse effects to the surrounding environment, or discharge material that may damage or cause negative effects to the council's sewer network and the environment.

Notices shall be placed on the resource consent outlining the maintenance obligations of the private owner, and equivalent notices shall be placed on the certificate of title for the serviced properties.

5.4.9 Pressure Sewerage Systems

Pressure sewerage systems may be accepted by council where gravity networks are not practicable due to high water tables, flat topography or areas with a high liquefaction potential.

Pressure sewerage systems shall be designed in conjunction with this document and WSA07 "Pressure Sewerage Code".

Ownership, maintenance, operational and life-cycle cost considerations need to be fully evaluated and presented in any situation where pressure systems are being proposed.

5.4.10 On-site Disposal

On-site disposal for residential waste may be approved in rural and rural residential areas where there is no available potential for a connection to the public wastewater network, and the provision of a community system for vesting to the council is not considered appropriate by the council. There are three levels of treatment discussed:

Primary treatment may typically consist of:

- improved multi-chamber septic tank; or
- home treatment plant such as aerated tanks or rotating disc systems.

Secondary treatment may typically incorporate discharge to land and consist of:

- soakage trenches, commonly dose loaded; or
- evapo-transpiration and seepage beds or trenches; or
- mounded evapo-transpiration and seepage beds; or
- land irrigation by low pressure spray or drip system.

Tertiary treatment includes options such as chemical or ultra-violet treatment where discharge to waterways is proposed. All discharges to waterways will require a resource consent.

5.4.10.1 Application

For any subdivision for which on-site disposal is proposed, proof of the ability to provide a suitable system for each lot shall be submitted with the resource consent application.

The preliminary design and supporting report shall be based on field testing carried out on each lot.

Any design shall comply with the council's wastewater bylaw, and shall provide for, but not be limited to, the following points:

- site assessment carried out by a suitably qualified person;
- design and installation undertaken by a suitable professional;
- effluent to have primary and secondary treatment as a minimum;
- a test on the system is carried out by the installer or manufacturer within a 4-month period of its installation to demonstrate its compliance with AS/NZS 1547;
- a copy of the compliance results shall be sent to the council;
- on-site system capacity designed for occupancy based on the number of bedrooms in the dwelling – as per Table 4.3A1 AS/NZS 1547, but shall be not less than 4500 litres;
- an outlet filter to a standard prescribed in AS/NZS 1547;
- even distribution of effluent to the entire disposal field by either pump or dosing siphon; and
- a minimum 3-year service/maintenance contract with the supplier or its agent post-installation.

The minimum features of any design shall include:

- manufactured to contemporary New Zealand standards;
- minimum 24-hour emergency capacity;
- audible and visual alarm;
- full-height primary wall (to prevent solids washing through to the high performance chambers during surge flows);
- groundwater entry prevention lids;
- irrigation filter (regular blockage would indicate tank is not performing well);
- flush valves (to clean lines);
- 24-hour call or message service;
- service contract; and
- routine servicing.

Effluent disposal fields shall comply with the following location requirements:

- Have at least 20 m separation distance between neighbouring disposal fields.
- Located not closer than 50 m from valley floors, ephemeral streams, storm drains, any type of open waterbody, or down-slope land boundaries, and 20 m down-gradient (i.e. with respect to groundwater flow) from drinking water bores.
- Located in an area where the ground surface is free of inundation in a 5% AEP flood event,
- Have the underside of the disposal bed be not less than 600mm above the highest water table,
- Located no closer than 1.5 m from any boundary.
- disposal into the top soil, preferably.
- Located in a designated area free from slopes over 18 degrees (3 horizontal: 1 vertical).

Effluent disposal fields shall comply with the following site requirements:

- A primary effluent disposal field of not less than 250 m^2 (average 3 bedroom home).
- A 'reserve area' of equivalent size to the designed effluent disposal area shall be set aside on the same lot for future expansion or replacement of disposal area.
- Maximum discharge to land not to exceed 1500 litres/day per primary disposal field.
- With suitable soils and groundwater conditions, for lot sizes under 5,000 m^2, the aerial effluent-loading rate shall not exceed 3.5 litres/m^2/day.

With suitable soils and groundwater conditions, for lot sizes 5,000 m^2 and above, the aerial effluent-loading rate shall not exceed 5 litres/m^2/day.

Other requirements for effluent disposal fields include:

- suitable plants and shrubs shall be planted and maintained in the disposal field; and
- fencing of the disposal field from children and animals as a protection for public health.

If, at subdivision stage, an existing effluent disposal system on any lot within the proposed development is found to be more than 10 years old, it must then be proven to comply with the current minimum requirements for on-site effluent disposal.

5.4.10.2 Soil Considerations

In situations of high permeability soils and/or high water table, where potential for environmental contamination is high, further treatment by filtration and/or disinfection will be required.

In special circumstances the use of other than water-based sewage systems may be proposed. Such systems shall be designed according to current guidelines and supported by relevant design data. In such cases grey water shall be disposed of to land and adequate soil testing and design shall be provided to support the proposal for grey water disposal. The council will consider grey water disposal to land where adequate soakage can be shown from soil testing and any potential adverse public health effects/nuisance conditions can be minimised.

5.4.10.3 Design

Design inputs shall include:

- testing of site soils;
- obtaining winter groundwater surface levels; and
- topographical survey of the relevant part of the lot to enable the system to be accurately located in terms of ground contours and features.

Reference shall be made to the current versions of the following standards:

- NZS 1546.1 On-site domestic wastewater treatment units - Septic Tanks;
- NZS 1546.3 On-site domestic wastewater treatment units – Aerated wastewater treatment systems;
- NZS 1547 On-site domestic wastewater management.

5.4.11 Testing

Testing and acceptance of sewer systems is covered within the provisions of section 4.4.15 (page 44).

This Page Intentionally Blank

6 Water Supply

6.1 Objectives

To safely and reliably collect and adequately distribute water for domestic, commercial, industrial and firefighting purposes in a manner that protects public health, promotes sustainability, and complies with the performance criteria outlined in this document.

6.2 Performance Criteria

Any scheme must demonstrate consideration and compliance with the criteria listed below.

6.2.1 Seismic Resilience

Pipelines

The behaviour of pipelines laid in liquefiable ground is significantly different to pipelines laid in non-liquefiable ground. Experience during previous earthquakes is that approximately 80% pipe failures occurred in liquefiable ground.

Designers shall consider ground conditions when designing new pipelines and choose a seismically resilient solution appropriate to the ground conditions.

<u>Definition of pipeline seismic resilience</u>

A "seismically resilient pipeline" refers to an underground pipeline that can:

- reasonably be expected to remain in operation following a severe movement[6] of the Wellington Fault without significant deformation or leakage.
- be easily repaired with fittings and limited plant that can reasonably be expected to be available following a severe seismic event
- be easily maintained during the normal operation life of the pipeline

This definition excludes the pipelines, or sections of pipeline that are:

- immediately adjacent to any fault (which is considered to be within 50 m) [1]
- laid across any fault [1]
- laid along any fault [1]
- installed inside host, encasement, or carrier pipes[7].

This definition focuses on the structural resilience of the pipeline rather than the configuration of the network. For example, redundancy loops and location of valves are not relevant to this definition.

---

[6] *A severe movement of the Wellington Fault is defined as an event where ground displacements up to 4-5 m in the horizontal direction and 1 m in the vertical direction occur.*

[7] *These pipelines are expected to experience ground shear and shall be assessed individually. The shear conditions entering and exiting are uncontrolled.*

Also, this definition applies to the pipelines rather than ancillary structures such as pump stations and large valve chambers, which constitute transitions between mobile and fixed elements. Bedding types also result in specific vulnerabilities. These must be assessed individually.

General

Pipelines shall be designed to resist the effects of:

- liquefaction
- lateral spreading
- slope failure (including under-slip and over-slip)
- Tsunami (including inundation by the advancing wave and scour due to the receding wave)

Trunk pipelines with a nominal diameter 400 mm or greater, and reservoirs, shall be designed for an Importance Level 4 as determined in AS/NZS 1170.0.

Pipelines connected to structures such as valve chambers, scour chambers, pump stations, and reservoirs shall be able to accommodate differential settlement and differential lateral movement without failing at the connection point.

Mechanisms allowing the pipeline to accommodate significant differential lateral movement, or differential settlement, shall be considered on pipelines greater than 300 mm nominal bore. Where the magnitude of the expected movement results in such mechanisms being impractical, the risk of failure shall be mitigated by other means so that breaks in the main can be easily isolated and repaired.

GW publishes seismic hazard maps highlighting the areas at risk.

Structures

New critical structures are to be designed as an Importance Level 4 as determined in AS/NZS 1170.0. This includes pumping stations, reservoirs, telemetry buildings, treatment plants and emergency stores.

The structure shall be designed with a 100 year life expectancy and the design shall comply with contemporary design codes which shall include, but not be limited to, the NZBC, NZS 3106 and AS/NZS 1170.

6.2.2 Durability

The water supply network shall be designed and constructed with materials suitable for the intended use, with a proven performance record, and commensurate with a nominal structural and operational life of 100 years.

Notwithstanding the nominal operational network life, items with a lesser expected operational life, such as mechanical components, pumps, control valves and electrical equipment, shall be selected and installed with consideration to longevity, compatibility with existing systems, technological and operational upgrading, and economic replacement.

Consideration of the operating conditions shall include but not be limited to:

- ground conditions
- corrosion conditions
- pressure
- fatigue

Operating conditions shall be considered during selection of pipeline materials to provide the specified levels of service required by this standard.

The water supply network and its components shall be designed in a way that minimises the overall life-cycle costs. For the purposes of calculation, the life-cycle costs shall be determined using a life of no less than 100 years.

Designs shall accommodate anticipated demand growth and network expansion ultimately possible under the council's current district plan. This includes potential expansion of the network beyond the developer's initial development.

Network components shall be designed to be resilient to the appropriate level outlined in the relevant standard. Pumping stations, reservoirs and supporting structures for trunk mains should be designed to Importance Level 4 as defined in AS/NZS 1170.0.

6.2.3 Maintenance and Operation

The network shall be designed to be water tight to the required test pressures set out in the Regional Specification for Water Services, which includes allowances for surge and fatigue.

Components shall be compatible with the existing network.

Pipework shall be laid underground at the depths set out in the Regional Specification for Water Services.

The network shall be designed to minimise the extent of water supply outage required for any planned or unplanned maintenance activities.

Pumping facilities shall have adequate standby pumping and emergency provisions to mitigate the consequences of pump or power failure. All pump stations shall have 100% standby capacity.

Drinking water systems shall be designed and equipped to prevent back-flow into the pipeline during operation or maintenance.

6.2.4 Functionality

The system shall at all times comply with the provisions of the Health (Drinking Water) Amendment Act 2007 and the Drinking Water Standards for New Zealand.

The council will not provide an on-demand supply from the reticulated water supply system in residential areas unless a reticulated wastewater system of suitable capacity is available.

In any development, the reticulated supply shall be capable of providing uninterrupted flow and pressure when measured at the downstream outlet of the service valve and to all existing and potential lots allowed for within the council's current district plan. Uninterrupted flows and pressures shall be as set out in the Regional Standard for Water Services.

Any shared, or private, reticulated water supply system shall comply with the objectives and performance criteria of this standard, and shall have sufficient capacity to supply simultaneously to all properties, the flows and pressures set out in the Regional Standard for Water Services.

The network shall provide firefighting flows and pressures in compliance with SNZ PAS 4509 *Code of practice for firefighting water supplies.* During firefighting scenarios the pipeline pressure in elevated areas of water distribution zone shall remain positive. Any private firefighting mains shall be constructed to the performance requirements of this standard.

Trunk mains shall not have customer connections direct from them. All customer connections shall be from reticulation mains, which may in turn be connected to trunk mains.

Pressure to all customer points of supply, in a reticulated network, shall be provided by gravity and from a council storage reservoir. Alternatives such as pressure boosting stations will not typically be considered.

Pressure surges from demand or mechanical facilities shall be minimised through suitable design and provision.

The network shall be designed so that no more than 50 lots will be isolated when isolating any reticulation pipe section for the purposes of maintenance.

Rider mains shall not back-feed around mainline valves used to isolate a section of water main. Valves and rider mains shall be arranged so that a section of main can be isolated for maintenance by closing the water main valves only, and without having to close rider main valves.

6.2.5 Access

Provisions shall be made to allow suitable access for firefighting appliances and equipment to the firefighting water supply.

Public pipelines shall be placed in road reserve wherever possible, with suitable access for maintenance and operation. Where this is not possible, the pipe shall be placed on publicly owned land or land that is protected by an easement in favour of the council.

Provisions shall be made so that that all facilities, such as reservoirs, flow/pressure monitoring stations, treatment facilities or pumping stations, are on publicly owned land, and accessible by vehicle during all weather conditions. Such packets of land shall not be land-locked and shall have a corridor of publicly owned land so that suitable vehicle access and pipeline access to the facility can be developed that does not cross private land.

The access performance criteria in this document applies to any existing, private water main that is proposed to be vested to council.

6.2.6 Environmental

The network shall be designed and operated in a way that eliminates or minimises adverse effects on the environment and complies with the requirements of the Resource Management Act. This includes the need to avoid, remedy or mitigate:

- adverse effects from mechanical plant;
- adverse visual effects, particularly from reservoirs;
- adverse effects on cultural and heritage sites; and
- adverse effects on stream and watercourse margins and the coastal marine area.

Areas of ecological significance, significant habitats for indigenous flora or fauna, and outstanding natural features shall also be protected or preserved.

6.2.7 Contamination of the Network

The network and its components shall be designed to eliminate or minimise, as far as practicable, any risks of contamination of the water supply as required by the Health (Drinking Water) Amendment Act.

6.2.8 Levels of Service

6.2.8.1 Network Pressure

The maximum pressure in any part of the water supply network shall not exceed 90 m head of pressure.

The minimum pressure available at the downstream outlet of the point of supply shall not be less than those set out in Table 6.1.

The minimum pressure shall be the pressure available immediately downstream of the point of supply when the property is continuously drawing water.

The water supply network shall be capable of providing the minimum levels of service at peak demand as calculated in Section 6.3.1.1.

Where the water pressure is less than 10 m head of water at the final level on the building platform a private boosting pump station may be permitted provided pressures compliant with Table 6.1 can be achieved at the point of supply. Such pump stations shall be sized so that they cannot deliver flows and pressures greater than the specified minimum levels of service at the final level of the building platform. The pump station shall be fitted with an approved double-check valve to prevent back-flow from the property into the water supply. A private booster station serving multiple lots shall have the facility to connect a standby generator.

Table 6.1 – Mandated Levels of Services for Pressure at point of supply

Maximum pressure*	Minimum pressure**	Comment
90 m	25 m	10 m min. pressure may be accepted for highest properties adjacent to reservoir

* Gauge pressure as measured at any point in the public network.

** As measured during peak demand flow assuming reservoir level is at the reservoir floor (bottom water level).

Note that both commercial and residential fire suppression sprinkler systems may have a flow and pressure requirement greater than the council's minimum standards. It is the designer's responsibility to demonstrate that the council network can supply the sprinkler system's flow and comply with all relevant standards.

6.2.8.2 Reservoir volume

Reservoirs shall be designed to accommodate the storage as outlined in Table 6.2 below.

Table 6.2 – Mandated Levels of Services for Storage Volumes

Method	Storage (L/person)	Scenario
1	700	Where actual consumption is not known such as new developments
2	2 x Average Day Demand	Used when demand statistics are available from Wellington Water. The designer to use the greater of the volume determined by each method.
3	Peak Day Demand + 20% + SNZ PAS 4509 firefighting requirements	

Where required by Wellington Water, the designer shall ensure the reservoir has adequate storage for seismic resilience to provide minimum levels of service after a significant earthquake. The minimum level of service shall be:

- Days 1 to 7 – Emergency state

  People and businesses will be self-sufficient, relying on their own stored water supplies, their communities, and Civil Defence centres.

- Days 8 to 30 – Survival and stability

  Residents collect up to 20 litres per person per day from Distribution Points while Critical Customers begin to receive water to their boundary.

- Day 30 onwards – Restoration and recovery

  The region moves towards restoration of normal service through provision of reliable reticulated supplies.

The designer shall consult with Wellington Water to confirm the methodology for determining the storage for seismic resilience.

6.2.9 Point of Supply

The point of supply for a potable water connection is the boundary where the council responsibility ceases and private ownership begins. The legal definition of the point of supply is detailed in each council's by-laws. The by-law definition takes precedence over the descriptions given here.

The point of supply, or the boundary between public and private responsibility, is typically the customer side of the service valve (toby) unless otherwise specified. The council shall own and maintain all pipework and fittings up to and including the point of supply.

The point of supply shall be located in the road reserve 500 mm from the boundary. Where site constraints or other services prevent this, the point of supply shall be located in the public road at a greater off-set from the road boundary. Where neither of these options are practicable for reasons of maintenance, access or boundary anomalies, alternative locations shall be discussed with the council.

Service valves (or meters) shall not be located in driveways or areas where vehicle traffic is likely. Where a meter cannot be accessed safely, a remote display shall be installed in a location that is safe and has ready access for meter readers and is either on the boundary or public land.

See also section 6.4.11, page 83.

6.3 Design Methods

The design methods presented here are considered to be acceptable for the purposes of developing solutions compliant with the objectives and performance criteria of this standard. Deviation from these methods will be considered with suitable evidence that the method is equivalent in function and outcome to the standard solutions presented in this document.

Certified calculations shall be made available to the council as part of any application.

As a minimum, the designer shall conduct flow and pressure tests on the council main, and have calculations prepared by an appropriately qualified engineer, to demonstrate the proposed scheme will comply with the requirements of both SNZ PAS 4509 and the requirements of the Regional Standard for Water Services. The test results shall be provided by the applicant to the council.

For larger subdivisions, or those that may have a significant impact on the existing network, the council may also require that numerical network modelling is used to determine the scheme's compliance with the performance criteria of this document.

6.3.1 Hydraulic Design

6.3.1.1 Peak demand

The peak demand is based on the *ultimate* population or number of dwellings expected in the development/area. The ultimate population for a development can be determined from section 5.3.1.2 (page 51).

The peak instantaneous residential demand Q_{peak} shall be determined using the following equation:

$$Q_{peak} = 0.0162 \text{ x } Population$$

Peak day demand volume per person shall be assumed to be the litres per head figures presented in Table 6.2 (page 70) and excluding firefighting volumes.

Where an area has predominantly industrial demand, and the demand is unknown, the designer may use the average dry-weather wastewater flow calculated in section 5.3.1.4 (page 52) multiplied by a factor of 8, as the design demand for the water supply analysis.

The peak demand shall be used to calculate minimum peak demand pressures within the network, and firefighting pressures.

6.3.1.2 Operating Pressure

The maximum operating pressure for any reticulation pipeline delivering potable water to domestic or commercial properties shall be 90 m.

Any new pipeline required to operate at greater than 90 m to supply potable water to elevated areas remote from the supply reservoir shall be constructed as dedicated high pressure trunk mains. Except, as agreed with Wellington Water, and where there is no practical alternative connection, service connections to private or commercial properties shall not be made to these trunk mains.

Subdivisions shall be designed so that the maximum mains pressure in any part of the new subdivision does not exceed 90 m.

Where an existing main exceeds an operating pressure of 90 m, preference shall be given to designs that result in the new main being parallel to high pressure mains operating at pressures less than 90 m. In the renewal section all service connections shall be disconnected from the high pressure main and re-connected to the new main. The new main shall be retained to supply elevated areas downstream, or shall be replaced with a dedicated new high pressure trunk main.

During design, consideration shall be given to inter-connection of subsequent renewals to create well networked pressure zones around high pressure trunk mains.

All fittings and pipelines shall comply with the minimum pressure class specified in the Regional Specification for Water Services.

An allowance for surge shall be made where the main is subjected to automated closing valves or the influence of pumps. The design operating pressure for any point in the system shall be calculated as:

- maximum possible static pressure + allowance for surge (see Appendix 7, page 113)

6.3.1.3 Firefighting Flows

Firefighting flows shall be as outlined in the latest revision of SNZ PAS 4509. Compliant pressures shall be calculated with the firefighting flows being delivered simultaneously during a 2/3rds peak demand period on a maximum demand day.

6.3.1.4 Domestic Sprinkler Systems

Domestic sprinklers may be proposed where the existing reticulation cannot meet the requirements of the FW2 water supply classification of SNZ PAS 4509. The requirement for domestic sprinklers shall be noted on a consent notice provided the reticulation can meet the FW1 requirements of SNZ PAS 4509. The designer shall conduct tests on the council main, and have calculations prepared by an appropriately qualified engineer, to demonstrate the proposed scheme will comply with the requirements of both SNZ PAS 4509 and the requirements of the proposed sprinkler system. The test results shall be provided by the applicant to the council. All domestic sprinkler systems are to be privately owned, operated and maintained.

6.3.1.5 Allowable Pipeline Losses

The allowable head losses for a pipeline due to friction and turbulence, including fittings, at design peak demand shall be:

- ≤ 50 m/km for rider mains; or
- ≤ 5 m/km for principal mains; or
- ≤ 3 m/km for trunk mains.

Amendments to these allowable pipeline losses may be considered at the discretion of the council where it can be demonstrated that there are no detrimental pressure or surge effects. Pipeline losses are permitted to exceed the above during firefighting scenarios.

Pipeline losses shall be calculated using the Darcy-Weisbach method outlined in Appendix A4.4 (page 106).

For pump station fed systems designers shall consider the hydraulic effects of new, clean pipe, as well as mature pipe on the operation of the pump station.

6.3.2 Re-Rating of PVC and PE Pipelines

Where PVC or PE pipelines are pressurised by pump the pressure rating of the pipe shall be increased so that the re-rated pipe is suitable for the design operating conditions, as specified in the Regional Specification for Water Services.

Where PVC or PE pipelines are installed above ground, or are subject to operating temperatures greater than 25 °C the pressure rating of the pipe shall be increased so that the re-rated pipe is suitable for the expected operating conditions, as specified in the Regional Specification for Water Services. Designers shall note that black PE pipe exposed to solar loading can have a wall temperature exceeding 55 °C.

Designers shall note that re-rating for temperature and for fatigue are cumulative.

6.3.3 Pipe surge

A surge analysis shall be carried out for any areas where a surge within the network is possible due to an automated valve, pump or other proposed facility capable of inducing surge. Where a surge is identified, the effect of the surge shall be mitigated.

For metallic pipes, surge analysis shall be carried out as described in the rising main section 6.4.8 (page 82).

Where plastic pipes are proposed in a cyclic environment, such as rising mains or direct-on-line pumping into the reticulation, provisions for a potential increase in pipe class shall be made due to fatigue and/or surge. Appendix 7 (page 113) outlines an acceptable method for determining the effects of surge and fatigue on plastic pipes.

6.3.4 Network Modelling

Network modelling shall typically use the values in Table 7.3 (page 108) for pipe roughness except where modifications are made for other pipe types such as unlined cast iron or asbestos cement. The council may also request the modelling to be carried out using particular software or format. The council may be able to provide modelling services to the developer, or wish to conduct the modelling in-house. The developer is to discuss council requirements with the council prior to carrying out any modelling to confirm process and requirements.

Where the model incorporates existing infrastructure, the model shall be calibrated against recent data. The council may be able to provide some network data for this purpose. The WaterNZ Modelling Special Interest Group has published the National

Modelling Guidelines for Water Distribution Network Modelling. Models shall be developed and calibrated in accordance with these guidelines.

The developer shall submit a modelling report outlining the scenarios, assumptions, verification and results from the modelling activities. The council may require a peer review of the model to be carried out at the developer's expense.

6.3.5 Hydraulic Report

All scheme designs shall be accompanied by a hydraulic report. The hydraulic report shall demonstrate how the proposed scheme complies with the performance criteria of this document and shall include, but not be limited to:

- demonstration of compliance with minimum pressures at points of supply during peak demand;
- demonstration of compliance with minimum pressures during firefighting scenarios (multiple firefighting scenarios may be required to demonstrate suitable coverage of all proposed lots); minimum pressures in the network shall not fall below 10 m during firefighting scenarios and shall be compliant with the requirements of SNZ PAS 4509;
- the maximum pressures achieved in the network (including any allowances for surge where relevant);
- life-cycle costs analyses (especially for pump selection and rising main sizing etc.);
- headlosses per kilometre for each pipe during peak demand flow;
- hydraulic calculations;
- fatigue and pipe de-rating calculations;
- reservoir sizing report;
- the modelling report where numerical network modelling has been carried out; and
- results of any surge/transient analyses.

The report shall include all assumptions made regarding the scheme.

6.4 General Specifications for Water Supply

6.4.1 Information to be Provided

6.4.1.1 General

In addition to the council's normal requirements for subdivision application, the developer shall, as a minimum, provide with any water supply design:

- evidence that the performance criteria outlined in this document can be met with the proposed design;
- calculations and drawings as outlined below; and
- operations and maintenance guidelines for any reservoir, pumping station or any other mechanical facility to be vested to the council.

Any developer considering an extension or modification to the existing network should arrange a meeting with the council prior to concept design to determine the scheme's water supply needs.

6.4.1.2 Calculations

The design details and calculations shall be prepared by a professional, qualified to a tertiary level and experienced in water supply design, and demonstrate that required levels of service will be maintained. Calculations presented as part of any application shall include, but not be limited to:

- demand calculations (both staged and projected ultimate demands);
- hydraulic calculations;
- network modelling reports;
- structural calculations for reservoirs and pumping stations;
- pump curves and duty points;
- economic evaluations; and
- structural trench design.

All assumptions regarding the design shall be clearly listed.

Hydrant testing shall be mandatory for the design of any firefighting supply, whether private or public. Wellington Water may waiver this requirement where existing information is held demonstrating the network has adequate capacity.

6.4.1.3 Design and Construction Drawings

Drawings shall show:

- the layout of the proposed reticulation including service connections, valves, hydrants, air valves, scour points, easements, stage termination points and any pertinent topographical features that may impact on the operation or future expansion of the network;
- proposed materials, sizes and pressure class of all pipes;
- typical and specifically engineered trench and installation details;
- typical and specifically engineered thrust block details;

- junction and jointing details; and
- where any anchor blocks, bulk heads, water stops, above ground pipelines, steep pipelines, or where any non-standard installation is required.

Specific construction drawings for specific facilities such as reservoirs, PRVs or pumping stations will also be required. Any building consents shall be sought under the council's building compliance regulatory role. Proposed works shall not begin until construction plans have been approved.

6.4.1.4 Asset operations and maintenance plan

All new assets will be accompanied by an asset operations and maintenance plan which shall detail how the asset is to be operated and maintained over the life of the asset. A replacement schedule should also be included to show what works needs to be carried to ensure the asset is operable in perpetuity. The plan shall include as a minimum:

- Required inspection schedule.
- Required maintenance, both regular and occasional to ensure continued operation.
- Required replacement schedule for components with a limited lifespan, or life span shorter than the nominal life expectancy of the asset as a whole.
- How the asset is to be operated or is intended to work. Stages where operator input is required should be highlighted.
- Health and Safety and operational risks intrinsic to the asset, operators and public and how they have been mitigated (through design) or how they should be mitigated (through operation).

6.4.2 Network Layout

Public mains shall, as far as practicable, be laid in the road reserve and be arranged to:

- avoid dead ends and minimise friction losses, tendencies for surge and zones of stagnant water;
- allow easy access for repairs and maintenance;
- typically be parallel with property boundaries;
- maintain adequate clearance from buildings, structures and other infrastructure to avoid collateral damage from failures;
- cross other services as close to perpendicular as practicable and not place undue load on adjacent services;
- take into consideration flexibility of distribution zone boundary changes and potential outage areas;
- where practicable, limit the number of affected residents from any valve closures to 50 lots;
- minimise the length of household connections and ensure that they do not cross carriageways; and
- provide a fully networked system to minimise disruption when any section is shut down for maintenance.

Principal mains shall be provided on both sides of the road in:

- major roads and dual carriageway roads;

- split level roads;
- state highways and motorways;
- roads with railway lines;
- CBD and suburban centres;
- roads with a central dividing island; and
- industrial/commercial areas.

Where practicable, for ease of maintenance, reticulation mains with service connections shall be laid in the berm as opposed to the footpath or carriageway. Mains shall not be laid under commercial verandas.

New mains shall not be placed near mature trees, or proposed tree planting locations.

Where a hydrant on a principal main is required in a private right-of-way in order to comply with SNZ PAS 4509, the main shall be a public main. The main shall be placed in an easement in favour of the council, clear of wheel tracks and constructed to the same standard as if laid in the public carriageway.

Where a main is required to be laid in private land, the main shall have an easement registered over it on the property title.

6.4.2.1 Loops

The network layout shall be designed to avoid dead ends as far as practicable to minimise water age and prevent the deterioration of water quality. Where a road or cul-de-sac terminates at a dead-end, and an access way or road reserve carries through to an adjacent street, the principal main shall be carried through to connect to the main in the adjacent street. The through-main shall be a minimum nominal diameter of 100 mm.

Alternatively, the council may accept a looped rider main at the end of a short cul-de-sac.

6.4.2.2 Maximum Branch Main Length

The maximum length of a branch, single-end fed reticulation main is 135 m long for a 100 mm pipeline, or 450 m long for a 150 mm diameter or larger pipeline. Dispensation for this clause may be applied for on a case-by-case basis taking into consideration minimum firefighting pressures, allowable pipeline losses and minimum peak pressures. Coastal roads where network loops are not practical are an example where dispensation may be considered.

6.4.2.3 Mains with No Flow (Dead Ends)

A pipe may be supplied by two water supply zones; one from each end. In normal operation, a normally closed valve shall separate the supplied resulting in a length of main that has no flow, but is under full operating pressure. The closed valve and adjacent pipe forms a dead-end.

The maximum length of a dead end shall not exceed 10 m.

Hydrants shall be placed either side of the shut valve to facilitate scouring of stale water either side of the shut valve.

Where, for operational reasons, dead-end longer than 10 m is formed, a second shut valve shall be installed such that the section of "dead" pipe shall have a valve at both ends fully isolating the dead pipe. Hydrants shall be placed either side of both shut valves.

6.4.2.4 Rail / Motorway / Stream Crossings

A water main, as far as is practical and where necessary, shall cross streets, railway lines, streams and underground services at right angles.

Mains shall be installed within a steel encasement pipe when crossing beneath railway lines, motorways, or beneath structures such as embankments or monuments. Pipes are not permitted to be laid beneath residential or commercial buildings. The steel encasement pipe shall be designed to the requirements of the latest revision of the Specification for the Installation or Pipelines on Railway Land.

When installed in an encasement pipe the water main shall be constructed in such a way that the main can be withdrawn and replaced without excavation of the road corridor, carriageway, or railway. The steel ducting shall be epoxy or concrete lined for protection against corrosion. Kiwirail's document E1322 "Specification for the Installation of Pipelines on Railway Land" shall be complied with for pipes in railway land.

Special design, in consultation with the council, is required where a pipeline crosses above or beneath a stream and resource consent may be required.

6.4.3 Easements

Public water pipes shall not be laid in private property. However, where this is not practicable, easements in favour of the council shall be required for any public water supply assets proposed to be laid in private land, right-of-way or private road. This includes any mains, service valves, service connections, chambers or facilities. The pipe shall be laid along the centre of the easement such that it can be practically accessed, serviced and replaced at any time in the future.

Easements for council owned **service pipes** in private property shall be 1 m wide.

Easements for **rider mains** shall be a minimum of 1.8 m wide.

Easements for **principal** pipelines shall be the greater of:

- 3 metres; or
- The pipe's outside diameter plus 2 x the depth to invert.

Easements for **trunk** mains shall be assessed on a case–by-case basis to ensure provisions for future access, maintenance and renewal are accommodated.

Easements shall be surveyed and lodged against the title following completion of main laying in private property.

6.4.4 Distribution Zones

Distribution zones are discrete water networks, typically supplied from a common source, that occupy separate topographical areas with different operating elevations.

The distribution zones have a discrete boundary that is generally denoted by closed valves, and/or PRVs.

Moving of a distribution zone boundary is not permitted without written dispensation as it affects water quality compliance, existing customers and may increase the risk of failure of existing pipes.

Creation of a distribution zone supplied solely through a PRV is at the sole discretion of the council.

6.4.5 Water Mains

New water supply networks for new subdivisions, or renewal of the existing water supply network shall only be constructed using pipe sizes, materials and fittings, and construction methods complying with the requirements of the Regional Specification for Water Services.

Where non-complaint sizes and/or materials, or construction methodology are proposed written application shall be made to council. Acceptance of non-complying sizes or materials or construction methodology shall be at the sole discretion of council.

6.4.5.1 Materials

The permitted pipe materials for use in the water supply network are detailed in the Regional Specification for Water Services.

Other items to note when considering pipe materials are:

- pipe bridges, and exposed aerial pipes shall be STCL or DICL;
- pipes on banks with a slope greater than 1:5 (v:h) shall be laid in STCL or axially restrained DICL; these pipes shall also be anchored using anchor blocks (see Anchor Blocks, section 6.4.22.2, page 91).
- PE or PVC pipes shall not be used in areas that are contaminated, or may be potentially contaminated, with hydrocarbons.

6.4.5.2 Pipe Sizes

Regardless of the minimum hydraulic requirements for providing adequate firefighting and peak demand flows and pressures, the **minimum** nominal internal diameter of pipes shall be:

- 20 mm for customer service connections
- 50 mm for rider mains
- 100 mm for principal mains in residential areas
- 150 mm for principal mains in industrial/commercial and CBD areas

In addition to the minimum diameters above, the allowable nominal pipe sizes permitted for use in the network are detailed in Table 6.3.

Table 6.3 – Allowable Nominal Pipe Diameters

Type	Permitted Nominal Internal Diameters (mm)	Allowable Pipe Material
Customer services	20, 25, 32, 40, 50	PE100 SDR11
	100, 150	PVC, STCL, DICL
Rider mains	50	PE100 SDR11
Principal mains (with customer connections)	100, 150, 200	PE100 SDR11, PVC, DICL, STCL
Trunk mains (no customer connections)	300, 400, 450	PE100 SDR11, STCL or DICL
	500+, 600+, 750	PE100 SDR11, STCL, DICL
Trunk mains greater than 750 mm nominal diameter	Sized in agreement with WWL	STCL or DICL

+ Pipes may be PE100 for specific technical reasons only.

6.4.5.3 Minimum Cover

No water main shall be laid at a depth of cover less than the minimum scheduled in the Regional Specification for Water Services.

New water mains shall be designed to cross under existing services where possible.

Where it can be shown that it is not possible cross under other services council may agree to reduce the depth of cover to the minimum special case stated in the Regional Specification for Water Services.

If the minimum special case depth of cover cannot be achieved a specific design shall be prepared for consideration by council. This design shall consider pipe material and class, ground conditions, external loadings and connections to the pipeline either side of the crossing to maintain pipeline resiliency.

If crossing under existing services requires the new water main be laid at a depth exceeding the maximum depth allowed by the Regional Specification for Water Services, options to reduce depth of cover to less than those specified may be considered and approved by council. The reduced depth of cover shall not be less than 300 mm below the listed minimum cover.

6.4.5.4 Maximum Cover

The acceptable depth of cover shall, to some extent, be determined by method of installation and the health and safety risks that result from installation method.

Generally the maximum depth of cover to water mains shall not exceed those specified in the Regional Specification for Water Services.

6.4.5.5 Terminal Mains

Terminal mains (those terminating at the end of a cul-de-sac or similar) shall end at a hydrant, preferably situated in the carriageway.

Any customer or rider main connections shall be positioned upstream of the terminal hydrant so the entire length of the principal main can be flushed through the hydrant.

The length of pipe between the last service connection, or rider main connection, and the terminal hydrant flange/socket shall be between 500 mm and 1000 mm .

6.4.5.6 Bends and Curves

Pipes shall, wherever possible, be laid parallel to the kerb or carriageway centreline.

To achieve small angles of deflection rubber-ring jointed pipe may be laid with deflections at the joint up to the manufacturer's recommended safe deflection.

Curvature using the pipe barrel will not be tolerated except in polyethylene pipes.

Where deflections greater than those obtainable on rubber ring joints are required they shall be achieved using pipe fittings as specified in the Regional Specification for Water Services.

6.4.6 Rider Mains

Rider mains are required to service groups of adjoining properties that do not have road frontage adjacent to a principal main. Individual services that cross the carriageway centreline are not permitted.

Rider mains shall:

- be 50 mm nominal diameter (as per 6.4.5.1);
- be supplied from a principal main at both ends, except for private roads or right-of-ways;
- have intermediate connections for rider mains longer than 100 m;
- have at least one flushing point; and
- have a valve installed at all connections to principal mains.

6.4.7 Above Ground Mains

Reticulation mains shall not typically be laid above ground, except where:

- the main crosses over a stream,
- the main crosses over a railway or vehicle lane via a pipe bridge or attached to the deck of another bridge;
- the main is built within a tunnel; or
- the main is attached to the face of a retaining wall or steep bank.

Materials

PVC: PVC shall not be used to construct any aboveground water main.

PE: Although suitable for use above ground PE shall not be used to construct water mains above ground except where specifically approved by the council.

PE water mains shall not be attached to steel or concrete bridges.

STCL: STCL may be used to construct any above ground water main.

STCL above ground pipelines shall be protected from atmospheric corrosion by application of 150 microns (minimum) of zinc metal spray with a sealer coat applied over the sacrificial corrosion protection.

DICL: DICL may be used to construct any above ground water main.

DICL above ground pipelines shall be protected against atmospheric corrosion as recommended by the manufacturer.

Pipes installed in the vertical axis (or on a grade exceeding 1 in 2 (V:H)) shall be flange jointed, and be suitably restrained to walls or structures to withstand seismic loading plus normal service loads.

Pipes installed on flatter grades may be rubber ring jointed. All rubber ring joints shall be tied and capable of rotation, extension, and contraction.

Where the pipes cross a bridge abutment, they shall be able accommodate movement that results in both longitudinal and vertical or lateral offset. This shall be achieved using a mechanical joint and not a rubber bellow.

Where the pipe crosses an expansion joint interface, suitable means shall be provided to allow for longitudinal movement. This may be a sliding expansion joint or bellows. Provision must again be made to allow for protection, maintenance and replacement.

Generally, any exposed pipeline must be approved by the council in principle and design.

6.4.8 Rising Mains

Rising mains shall be designed in consideration with the design duty of existing or proposed pump sets. The length, material and diameter of the rising main have a significant influence on the dynamic head on the pumps.

The pumps and/or rising main shall be selected to enable the pumps to operate as close as possible to the best efficiency point.

Rising mains and materials shall be designed to accommodate anticipated surges and test pressures. A transient analysis may be required by the council for rising mains longer than 300 m; or with a flow greater than 30 L/s and a dynamic head greater than 14 m; or a high lift (~50 m or greater) system with a check valve. Surge scenarios shall include sudden loss of electricity (sudden stop) and direct-on-line starting (sudden start). Surge protection devices will be considered to mitigate the effects of surge. Variable frequency drives may be considered to mitigate the surge effects of sudden start, but not for sudden stop surges as power failure is still a credible risk.

Due to the cyclical loading nature of rising mains, the main shall generally be of STCL or DICL. Butt-welded PE100 pipe may be considered for pumped mains 100 mm to 300 mm diameter, and shall be used for pumped mains less than 100 mm nominal diameter. PE pumped mains shall be re-rated to allow for fatigue and, where appropriate, temperature (see Appendix 7, page 113).

The proposed rising main option shall be shown to be the most economical through a net present value analysis (NPV) comparing capital and operating costs over a 50-year period. A sensitivity analysis on the interest rate used shall also be shown. This may simply be varying the rate by 1% to 2% either side of the interest rate to demonstrate the effect this has on the preferred economic option. The interest rate used should be the average long-term lending rates published by the Reserve Bank of New Zealand unless otherwise specified by the council.

Rising mains shall be designed as normal buried water supply pipelines allowing for anchor and thrust blocks, trench stops, bulkheads and suitable jointing.

6.4.9 Suction Mains

Suction mains are the pipes that are laid continuous between the upstream network and the pumpset inlet. These pipes shall be designed to the same standard as rising mains. An analysis of the upstream network is required to ensure the pumping station's operation does not create detrimental or nuisance surges within the upstream network, and that satisfactory suction pressures can be maintained at the pump inlet under all design scenarios.

6.4.10 Commercial Service Connections

(See also section 6.2.9 Point of Supply page 70)

6.4.10.1 General

Each commercial property on a lot, proposed, anticipated or otherwise, shall require a separate, single potable service connection from the public main up to and including the agreed point of supply.

The size, depth of cover and material of the service pipe and the connection shall comply with the requirements of Regional Specification for Water Services.

6.4.10.2 Water Metering

A single revenue meter shall be installed at the boundary to each lot.

The meter shall be installed on the Council side of the boundary.

For existing commercial service connections, where the meter is inside private property, the meter shall be relocated to the Council side of the boundary during renewal of the meter.

6.4.11 Residential Service Connections

6.4.11.1 General

Each residential dwelling on a lot, proposed, anticipated or otherwise, shall require a separate, single potable service connection from the public main up to and including the agreed point of supply.

Front sections (or dwelling units with individual street frontage) shall have the point of supply located adjacent to the street boundary as outlined in section 6.2.9, page 70.

For properties supplied from a public main in a right-of-way or private land, the service valves shall be located in shared property.

The location of all service valves and service pipes shall be shown on the construction drawings for approval. Service valves shall not be placed in driveways.

The size, depth of cover and material of the service pipe and the connection shall comply with the requirements of Regional Specification for Water Services.

Unit titled developments are exempt from this requirement and may be serviced by a single suitably sized service connection.

6.4.11.2 Residential Water Meters

A meter may be required to be installed as part of the connection. (See 6.4.24)

Water meters shall comply with the requirements of the Regional Specification for Water Services.

6.4.11.3 Connection to rural properties

Water supply connections from the reticulated water supply to rural or rural residential will not be approved if the property is not connected to a reticulated municipal wastewater system. This is to limit the potential for an on-site wastewater system to be hydraulically overloaded.

Connections may be considered by council if the supply is a restricted flow supply and is metered.

6.4.12 Back-flow Prevention

The council's policy on back-flow prevention shall be complied with at all times. Typically, all commercial and industrial services greater than 20 mm shall require a back-flow preventer installed downstream of the service valve and meter and close to the point of supply. A service shall be installed on the downstream side of the back-flow preventer and meter to allow the back-flow preventer to be isolated for maintenance purposes.

An approved back-flow preventer may be required and shall comply with the New Zealand Building Code. The council, at its discretion, may also request additional back-flow prevention to meet their obligations under the Health (Drinking Water) Amendment Act.

6.4.13 Fire Services

Fire services for both private firefighting networks and automatic fire suppression sprinkler systems require specific consideration and approval and shall be applied for, and designed, outside the provisions of this document.

Notwithstanding this, if a standard 20 mm nominal diameter domestic customer connection is inadequate to provide both the demand requirements of this standard, and those of NZS 4517:2010 "Sprinkler Systems for Houses", a separate metered connection to the public main shall be designed and applied for to supply the sprinkler system and a single water closet. The size of the connection shall be sufficient to meet the requirements of NZS 4517:2010.

6.4.14 Secure Connections

A customer, such as a hospital or commercial development, may require a secure supply which will reduce the potential for water outages due to maintenance activities. This may be in the form of:

- a dual connection from the same main, separated by a line valve and a minimum horizontal separation of 2 m; or
- connections to two separate individual principal mains, both with backflow preventers on them to avoid cross-connection.

The form of the secure connection shall be discussed and approved at the discretion of council.

It is up to the designer to ascertain the design's compliance with NZS 4541 *Automatic Fire Sprinkler Systems* if the connection is provided for the purpose of firefighting.

6.4.15 Pumping Stations

Pumping stations shall be provided by the developer to supply water to a reservoir at a higher hydraulic elevation than the sourced distribution zone.

The designer shall discuss standard pumping station requirements with the council prior to preliminary design and shall comply with any council technical specifications. Typically, pumping station design shall, as a minimum, include:

- consideration of rising main design (section 6.4.8, page 82) and surge potential and mitigation;
- consideration of available suction pressures and the detrimental effects the station may have on suction pressures when running;
- electrical supply and pump controls including protection measures and terminals for emergency generator connection;
- pumpset selection and installation;
- magnetic flow metering;
- manual and electronic pressure monitoring;
- seismic restraint systems for all equipment;
- consideration of practical maintenance of all equipment and pipe work;
- SCADA (using council-specified equipment and I/O conventions) with viable radio link; and
- permanent station building with suitable security, access, ventilation, acoustic dampening, lifting provisions (overhead gantry), drainage, parking and external visual mitigation.

The design specifications shall be approved by the council along with acceptable pump makes. The developer shall provide all electrical connections and electricity accounts for the station. Switchboards will require terminals to allow the station to be powered by a mobile stand-by generator.

Pipework within the station shall generally be flange jointed, of either DICL or STCL.

The station shall be placed completely within a separately titled lot or within road reserve. A sealed access of not less than 3.5 m width shall be provided to the nearest public street. The immediate area around the station's titled lot (if applicable) shall be fenced and provided with a locked gate. The station shall be designed such that it complements the surroundings through the use of architectural featuring and/or landscaping and planting. The final design shall be approved by the council.

Operation and maintenance manuals will be required for all pumping stations as part of the completion documentation.

Liaison with GW is required if the station is to be connected to part of the wholesale water supply network.

6.4.15.1 Pumping Station Serving a Reservoir

Pumping stations shall be designed with a minimum of two pumps in a duty/standby arrangement (100% standby capacity). Three pumps may be allowed in larger stations with council approval. Where three pumps are installed, they shall be in a duty/assist/standby arrangement (with 50% standby capacity). All pumps, whether in a two or three pump arrangement, shall be of the same make, model and duty size.

Small stations shall be designed to allow all pumps to run simultaneously.

The duty points of the pumps shall be selected with consideration to the following criteria:

- downstream reservoir set at 85% capacity;
- upstream reservoir set at 85% capacity; and
- network demand equivalent to the peak period average day demand.

The pumps shall be sized to pump the greater of the full reservoir storage volume or the peak day volume without using the standby unit, over an 18-hour period. Small stations (daily pumping volume less than 2500 m^3/day) shall pump the receiving reservoir volume over 15 hours.

6.4.15.2 Booster Pumping Stations

Booster pumping stations will not typically be permitted for developments. Special permission is required from the council before booster pumping stations will be considered.

If permitted, they shall be designed to provide, as a minimum, firefighting and peak consumer demands using variable frequency drives and compatible pumpsets.

Booster pumping stations used for firefighting shall only be provided in areas where an underground electricity reticulation is available.

6.4.16 Reservoirs

Reservoirs shall, as a minimum, retain the volume outlined in Table 6.2 (page 70) including firefighting volume and in conjunction with the ultimate development population outlined in section 5.3.1.2 (page 51).

Council reserves the right to refuse developments that shall be served by a small reservoir, typically those serving less than 100 sections and/or smaller than 250 m^3 in size.

Only designers that have been approved by Wellington Water Limited are permitted to design reservoirs.

The designer shall approach the council prior to preliminary design to ascertain current council specifications for reservoirs which will supersede any requirements outlined in the Regional Specification for Water Services.

Reservoirs shall be funded and constructed by the developer to the above specifications.

The council reserves the right to construct the reservoir at the council's expense, with a contribution from the developer, if there is an additional purpose for the reservoir. Inversely, the council may contribute to any reservoir being constructed by a developer if that reservoir is suitably sized to supply an area outside the proposed development.

Reservoirs shall be sited on a separately titled and fenced lot and with a minimum 3.5 m wide gated and sealed vehicle access. The separately titled lot and and reservoir shall be vested to council. Security to the site and structures shall be to current council standards. The reservoir shall be suitably screened and visually mitigated to complement the surrounding environment.

Operational and maintenance manuals are required as part of the completion documentation.

6.4.17 Water Fittings

6.4.17.1 Fire Hydrants

Hydrants shall comply with the requirements of the Regional Specification for Water Services.

Hydrants shall only be placed on mains 100 mm nominal diameter or greater and may be used for:

- providing water for firefighting;
- flushing water from terminal mains;
- allowing air to enter, and discharge from, the main during mains filling or draining;
- scouring;
- introducing water to the mains from adjacent zones or for disinfection; and
- introducing chlorine disinfection solution.

Placement

Maximum spacing shall be as per SNZ PAS 4509:2008 – *Firefighting Water Supplies Code of Practice* suitable for the highest risk fire hazard class in the vicinity.

Special note shall be made of SNZ PAS 4509 requirements for hydrant spacing with regards to distance lines and access to buildings set back from the carriageway.

Notwithstanding the requirements of SNZ PAS 4509, hydrants shall be:

- spaced at intervals not exceeding 90 m in commercial and industrial areas, and 135 m in residential areas;
- placed at intersections and adjacent to special fire risks;
- in front of long right-of-ways;

- at high points in the reticulation for scouring of air;
- at low points in the reticulation for emptying and re-filling the pipeline;
- placed adjacent to all line and network valves;
- placed with due consideration to the safe operation of the hydrant;
- placed at the end of terminal mains and at reticulation low points to allow for scouring; and
- placed either side of a distribution zone boundary valve.

Terminal hydrants shall be placed in the carriageway unless discharge can be made to a suitable sump or drain without flowing over unsealed public land and without nuisance. The terminal hydrant shall be mounted on a hydrant bend.

Hydrants shall not typically be placed on rising mains or trunk mains where these mains are without services and there are adequate parallel principal mains available. For the purposes of this clause, a trunk main is any main with a nominal diameter of 250 mm or greater.

6.4.18 Valves

Only valves complying with the Regional Specification for Water Services and listed in the Approved Products Register shall be installed within the potable water supply network.

Butterfly valves shall not be used in the water supply network except where approved by the Regional Specification for Water Supply.

Where butterfly valves are approved for use valves shall comply with all specified requirements.

Valves are used to isolate sections of the network for operational or maintenance purposes. They shall be located:

- in a manner that minimises the number of properties affected by a mains closure;
- at the beginning of any branch or rider main;
- in locations that enable safe operation, taking into account traffic and access considerations;
- in a manner that minimises the number of valves or hydrants required at intersections, whilst still achieving operational objectives;
- either side of aerial pipelines and other pipeline structures that require separate maintenance, or are expected to require inspection and/or repair following a seismic event; and
- at distribution zone boundaries.

All buried valves shall be housed in a surface box in a manner approved by the council.

At intersections, valves shall be placed on all branch pipelines and at least one placed on the through pipeline to maintain operational flexibility and limit potential customer disruption.

6.4.18.1 Gate Valves 100 mm diameter or Greater (Sluice Valves)

Gate valves 100 mm and greater shall comply with the requirements of the Regional Specification for Water Services.

Because of the height of the valve bonnet on gate valves, typically butterfly valves would be used in preference to gate valves on pipelines exceeding 500 mm diameter.

6.4.18.2 Gate Valves 80 mm diameter (Sluice Valves)

80 mm pipelines do not comply with the size requirements of the Regional Specification for Water Services.

Except in exceptional circumstances new 80 mm diameter pipelines shall not be constructed. This shall not apply to renewal of existing 80 mm rising main where the pump station is sensitive to pipe ID.

80 mm gate valves shall only be used for repair and maintenance of existing 80 mm mains or on 80 mm service valves.

6.4.18.3 Gate Valves 50 mm diameter or Less

Gate valves 50 mm or less shall comply with the requirements of the Regional Specification for Water Services.

6.4.18.4 Zone Boundary Valves

Where a closed valve (100 mm diameter or greater) is used as a boundary between two distribution zones, a hydrant shall be installed either side of the valve to permit the scouring of stale water and use of a mobile PRV installation if required.

The surface box of the boundary valve shall be painted red.

6.4.19 Air Valves

Air valves and their installation shall comply with the requirements of the Regional Specification for Water Services.

Generally air valves shall not be installed on distribution mains that are not trunk mains, or bulk mains. Hydrants shall be used to manually introduce or expel air in these cases.

6.4.20 Pressure Reducing Valves

The use of pressure reducing valves (PRVs) shall be avoided if at all practicable, and shall only be used with the approval of the council. Reduced capital costs shall not be the sole justification for their use.

Where PRVs are approved they shall comply with the requirements of the Regional Specification for Water Services.

6.4.21 Scour Valves

Scour valves are generally required to drain the pipe for maintenance purposes, scour air from pipes or to flush potentially stagnant water from ‘dead end’ mains. Scour valves are required at:

- the end of all public and private rider mains;
- the end of all terminal reticulation mains (hydrants are acceptable); and
- the low point between line valves of all mains with a nominal diameter greater than 200 mm.

Hydrants on pipelines ≤ 200 mm may be used to scour the main instead of a dedicated scour branch and valve.

Scour pipes shall discharge to a visible location such as a stream, kerb, open channel or pump-out chamber, to reduce the risk of the valve being inadvertently left open without detection. Scour pipes must not discharge to a closed stormwater structure such as a stormwater pipe.

Facility shall be provided to prevent damage, channel scour or flooding due to operation of the scour valve. If discharge is to a stream or other water body, then potential impacts on water quality must be addressed.

Valves shall be sized to drain the main by gravity over a period not greater than 1 hour. Minimum scour sizes are:

Main size	Scour size
50 mm	50 mm
100 to 200 mm	100 mm
250 to 300 mm	150 mm
350 to 375 mm	200 mm

Backflow prevention shall be provided immediately downstream of the scour valve. A double spring check non-return valve shall be used for scour valves up to and including 50 mm. Swing check valves shall be used for scour valves larger than 50 mm.

6.4.22 Thrust and Anchor Blocks

All concrete for thrust or anchor blocks shall be minimum strength 20 MPa at 28 days.

6.4.22.1 Thrust Blocks

Thrust blocks shall be designed to resist the total unbalanced thrust and transmit all load to the adjacent ground. Calculation of the unbalanced thrust shall be based on the pressures experienced during pressure testing.

Where the thrust block will not experience loads due to pressure testing, calculation of the unbalanced thrust shall be based on the design pressure.

For PE water mains calculation of the unbalanced thrust shall be the thrust due to Poisson's Response less the thrust due to hydraulic pressure.

Calculation of unbalanced thrust shall include a factor of safety of 1.8.

Thrust blocks are required regardless of any joint restraints employed in the pipework. Except that thrust blocks shall not be required on changes of direction on PE water mains.

Special engineering design is required for thrust blocks on nominal pipe sizes greater than 300 mm. The design shall consider in-situ soil properties when designing the thrust blocks.

6.4.22.2 Anchor Blocks

Anchor blocks are designed to prevent the movement of pipe bends in a vertical direction. These are typically installed on vertical bends on banks and employ the weight of mass concrete to restrain the pipework.

Where possible vertical changes in direction shall be designed so that anchor blocks are not required.

6.4.23 Water Stops (Bulkheads)

Water stops, also known as bulkheads, are required where the potential for trench scour is high, or where the surrounding natural ground prevents sufficient natural drainage of the trench (if the trench is susceptible to water infiltration).

The bulkheads shall be keyed into the adjacent, natural ground by a minimum of 150 mm and shall be spaced as per the requirements of section 4.4.6.7 (page 34).

6.4.24 Water Meters

6.4.24.1 Customer Meters

All non-residential properties, or mixed residential and non-residential properties, extraordinary users as defined in the council's bylaws or charter, may be required to be metered at the point of supply.

Developers should check the current metering policy with the council before submitting designs.

Meters shall be installed to council specifications. The meter and meter box shall be of a type approved by the council.

6.4.24.2 District and Area Meters

District and area meters are large non-revenue meters designed to measure the gross community consumption.

These are typically designed and installed by the council, but the council may require the developer to install an area meter as part of any large multiple lot development.

The area meter shall be an approved magnetic flow meter which shall be connected to the council's SCADA system. The arrangement of the meter installation shall be discussed with the council prior to detail design, but it shall typically include:

- a pressure tapping with ball valve and, potentially, a pressure transducer;
- a suitably large chamber, preferably outside traffic lanes;
- suitable operator access provisions;
- suitable chamber drainage;
- upstream and downstream valves within a suitable vicinity; and
- suitable roadside control cabinet.

The developer shall arrange the power supply for the meter operation.

6.4.25 Testing and Commissioning

For subdivisions, all water supply pipes, pumping stations, reservoirs and any relevant appurtenant structures and fittings will be tested upon completion of construction at the applicant's expense, and as part of the council's approval process, prior to the issue of any S.224c certificate. The council's representative shall be present during the tests, and will sign the appropriate documentation provided by the council to verify the test if successful. A minimum of 24 hours of notice is required to be given to the council prior to the test being carried out. The constructor shall provide all labour, fittings and materials to carry out the test.

6.4.25.1 Pipes

All water mains shall be tested in accordance with the requirements of Regional Specification for Water Services before commissioning.

Before commissioning the following shall be shown by testing to be to have been achieved:

- All welds on PE pressure mains shall comply with the performance requirements for PE welds set out in the Regional Specification for Water Services.
- The water main, including all connections and fittings, is drip tight at the specified test pressure.
- All internal surfaces of the water main, including connections and fittings, has been exposed to sterilising water. The concentration of free, available chlorine, and the contact time shall be as specified in the Regional Specification for Water Services.
- The water main is free from pathogens as specified in the drinking water standards.

Commissioning, sometimes referred to as cutting-in, shall be carried out by a contractor approved by the council. The developer is not permitted to operate any council network valves without approval.

6.4.25.2 Pumping Stations

All pump stations shall tested and certified in accordance with the Regional Specification for Water Services before being commissioned.

A commissioning plan for pumping stations shall be submitted to, and approved by, the council prior to completion.

All building and electrical work shall be tested and provided with a code of compliance certificate to the satisfaction of the council in its building regulatory role.

The council will accept the station once the station has satisfactorily met all the requirements of the commissioning plan and any relevant building and resource consents. Submission, in hard copy and electronic form, of operational and maintenance manuals comprise part of the commissioning requirements.

6.4.25.3 Reservoirs

All water reservoirs shall tested, disinfected and certified in accordance with the Regional Specification for Water Services, and in accordance with the Drinking Water Standards before being commissioned

This Page Intentionally Blank

7 APPENDICES

Appendix 1 Hydrological Design

The following provides technical accompaniment to section 4.3.1. These pages relate specifically to stormwater design.

A1.1 Runoff coefficients

Runoff coefficients are empirical factors used to estimate the portion of runoff from different land types. The factors presented here are to be used with the Rational Method and Modified Rational Method as outlined in the following sections. They are considered conservative and are intended for application to gross catchment areas. Detailed analysis of catchment areas may use the factors and adjustments outlined in the New Zealand Building Code Clause E1 – Surface Water.

Table 7.1 – Runoff Coefficients to be used with Hydrological Design

Area Type	Coefficient C
Fully paved or roofed areas, CBD areas or urban, industrial or commercial areas with greater than 65% coverage permitted by the district plan.	0.95
Industrial/commercial areas with paved plus roof area up to 65% coverage permitted by the district plan.	0.70
Urban areas allowing between 36% and 65% impervious site coverage (inner residential, infill housing, intensive residential development).	0.65
Urban areas allowing coverage up to 35% (residential or outer areas).	0.50
Parks, reserves, green spaces, rural areas.	0.35

A1.2 Rational Method

The Rational Method is described by Equation 2 below.

Equation 2 $$Q = \frac{CiA}{360}$$

Where:

Q = Peak discharge (m^3/s)

C = Runoff coefficient

i = Rainfall intensity (mm/hour)

A = Area of catchment (hectares)

Determination of rainfall intensity (i) requires analysis of the time of concentration (T_c) which is covered further in section A1.4.

A1.3 Peak Flow Determination: Modified Rational Method

The Modified Rational Method is described by Equation 3 below.

Equation 3 $$Q = \frac{CiASF}{360}$$

Where:

Q = Peak discharge

C = Runoff coefficient (dimensionless)

i = Rainfall intensity (mm/hour)

A = area of catchment (hectares)

S = Shape factor

F = Area Factor

S and F can be determined using the formula below.

Equation 4 $$S = 0.4253 + 1.266k - 0.3952k^2$$

Equation 5 $$k = \frac{A}{100L^2}$$

Equation 6 $$F = 0.6 + 0.4e^{\left(\frac{-A}{7700}\right)}$$

Where L (kilometres) is the straight line length to the catchment head.

A1.4 Time of Concentration (T_c)

The time of concentration (T_c) is required to ascertain a catchment's critical rainfall event for a chosen level of protection. Every catchment has an intrinsic T_c which can be described by:

Equation 7 $$T_c = T_e + T_f$$

Where

T_c = Time of concentration (minutes)

T_e = T_o + T_g and is a minimum of 5 minutes

T_o = Time of overland flow (minutes)

T_g = Time of gutter flow (minutes)

T_f = Time of pipe and channel flow to design point (minutes)

T_c shall be no less than 10 minutes.

For lengths less than 1 km, T_o (in mins) can be determined using Friend's Equation and Equation 9:

Equation 8 $$T_o = \frac{100\,nL^{0.333}}{S^{0.2}}$$ *(Friend's Equation)*

Where n is Manning's 'n' (see Appendix 4, page 103), L is length in metres, and S is slope in % (i.e. 3.0 for 3% slope).

Gutter flow T_g (in mins) can be estimated using the Manning's derived equation

Equation 9 $$T_g = 0.025\frac{L}{S^{0.5}}$$

Where L is length in metres and slope is calculated as a % integer (i.e. S = 3.0 for 3% slope)

Time for pipe flow T_f can be based on the following velocities:

3 m/s for low gradients (less than 5%)

5 m/s for moderate to steep gradients

Note that the resulting time should be converted to minutes for Time of Concentration calculations.

For rural catchments, the Bransby-Williams formula (Equation 10) can be used to calculate T_c (in mins).

Equation 10 $$T_c = \left(\frac{FL}{A^{0.1}S^{0.2}}\right)$$ *(Bransby-Williams formula)*

Where L is length in kilometres, and F is 57.2, area A is in km^2, and S is the equal area slope of the main stream projected to the catchment divide (m/km).

Alternatively, Clause E1/VM1 of the NZ Building Code can be used to determine T_c for small catchments.

Appendix 2 Depth Duration Tables

Depths are derived from historical observations interpolated by HIRDS version 4. They are in mm per hour and require adjustments for use, for example:

A 50% AEP with a duration (Time of Concentration T_c) of 10 minutes in Camborne, Porirua, has a nominal peak intensity of 49.4 mm/hour or an intensity (i) of:

49.4 mm/hr x 1.20 x 1.1 = 65.2 mm/hour

Climate change factor (1.20) — Zone factor (PCC only) (1.1)

Note: The current factors must also be applied to the relevant tables:

- Zone factors for PCC tables (See Appendix 3)
- Climate change multiplier of 20% to **ALL** tables (See 4.3.1.1, page 24)

Porirua City (rainfall intensity in mm/hour - From HIRDS v4)

NZTM Coordinates 1754392E 5444631N (Cobham Court)

		Duration									
ARI (y)	**AEP**	**10m**	**20m**	**30m**	**60m**	**2h**	**6h**	**12h**	**24h**	**48h**	**72h**
1.58	63%	45.0	30.2	24.1	16.5	11.3	6.1	4.1	2.6	1.7	1.2
2	50%	49.4	33.1	26.3	18.0	12.3	6.7	4.4	2.9	1.8	1.3
5	20%	64.6	43.1	34.3	23.3	15.9	8.6	5.7	3.7	2.3	1.7
10	10%	76.2	50.7	40.3	27.4	18.6	10.0	6.6	4.3	2.6	2.0
20	5%	88.3	58.6	46.5	31.5	21.4	11.5	7.6	4.9	3.0	2.2
30	3.3%	95.7	63.5	50.3	34.1	23.1	12.3	8.1	5.2	3.2	2.4
40	2.5%	101.0	67.0	53.1	35.9	24.4	13.0	8.5	5.5	3.4	2.5
50	2%	105.0	69.8	55.2	37.3	25.3	13.5	8.9	5.7	3.5	2.6
60	1.7%	109.0	72.1	57.0	38.5	26.1	13.9	9.1	5.8	3.6	2.7
80	1.2%	115.0	75.7	59.9	40.4	27.4	14.5	9.5	6.1	3.8	2.8
100	1%	119.0	78.6	62.2	41.9	28.4	15.0	9.9	6.3	3.9	2.9

Wellington City (rainfall intensity in mm/hour - From HIRDS v4)

NZTM Coordinates 1748125E 5428277N (Kelburn Weather Centre)

		Duration									
ARI (y)	**AEP**	**10m**	**20m**	**30m**	**60m**	**2h**	**6h**	**12h**	**24h**	**48h**	**72h**
1.58	63%	38.4	27.3	22.5	16.1	11.4	6.4	4.3	2.8	1.8	1.3
2	50%	42.1	30.0	24.6	17.6	12.5	7.0	4.7	3.1	1.9	1.4
5	20%	55.3	39.2	32.2	22.9	16.2	9.1	6.1	3.9	2.5	1.8
10	10%	65.2	46.3	37.9	26.9	19.0	10.6	7.1	4.6	2.9	2.1
20	5%	75.7	53.6	43.9	31.1	21.9	12.2	8.1	5.3	3.3	2.4
30	3.3%	82.2	58.1	47.5	33.7	23.7	13.1	8.8	5.7	3.5	2.6
40	2.5%	86.8	61.4	50.2	35.5	25.0	13.8	9.2	6.0	3.7	2.8
50	2%	90.5	63.9	52.3	37.0	26.0	14.4	9.6	6.2	3.9	2.9
60	1.7%	93.6	66.1	54.0	38.2	26.8	14.8	9.9	6.4	4.0	2.9
80	1.2%	98.5	69.5	56.8	40.1	28.2	15.6	10.4	6.7	4.2	3.1
100	1%	102.0	72.2	58.9	41.7	29.2	16.1	10.7	6.9	4.3	3.2

Hutt City (rainfall intensity in mm/hour - From HIRDS v4)

Use the closest of either Hutt Valley or Wainuiomata charts depending on location.

Hutt Valley: Hutt City Civic Buildings

		Duration									
ARI (y)	**AEP**	**10m**	**20m**	**30m**	**60m**	**2h**	**6h**	**12h**	**24h**	**48h**	**72h**
1.58	63%	41.5	28.5	23.0	16.1	11.2	6.2	4.2	2.8	1.8	1.3
2	50%	45.7	31.4	25.3	17.6	12.3	6.8	4.6	3.0	1.9	1.5
5	20%	60.4	41.3	33.3	23.1	16.0	8.8	5.9	3.9	2.5	1.9
10	10%	71.6	48.9	39.3	27.2	18.8	10.3	6.9	4.5	2.9	2.2
20	5%	83.5	56.9	45.7	31.5	21.7	11.9	7.9	5.2	3.3	2.5
30	3.3%	90.8	61.8	49.6	34.2	23.5	12.8	8.5	5.6	3.5	2.6
40	2.5%	96.1	65.3	52.4	36.1	24.8	13.5	9.0	5.9	3.7	2.8
50	2%	100.0	68.1	54.6	37.6	25.8	14.0	9.3	6.1	3.8	2.9
60	1.7%	104.0	70.5	56.5	38.8	26.7	14.5	9.6	6.3	3.9	3.0
80	1.2%	109.0	74.2	59.4	40.8	28.0	15.2	10.1	6.6	4.1	3.1
100	1%	114.0	77.1	61.7	42.4	29.1	15.7	10.4	6.8	4.3	3.2

Wainuiomata: Wainuiomata Shopping Centre

		Duration									
ARI (y)	**AEP**	**10m**	**20m**	**30m**	**60m**	**2h**	**6h**	**12h**	**24h**	**48h**	**72h**
1.58	63%	41.9	28.7	23.4	16.7	12.0	7.1	4.9	3.3	2.2	1.6
2	50%	46.0	31.5	25.6	18.2	13.1	7.7	5.4	3.7	2.4	1.8
5	20%	60.3	41.2	33.4	23.8	17.1	10.0	7.0	4.7	3.0	2.3
10	10%	71.2	48.6	39.4	27.9	20.0	11.7	8.1	5.5	3.5	2.7
20	5%	82.6	56.3	45.6	32.3	23.1	13.5	9.4	6.3	4.1	3.1
30	3.3%	89.5	61.0	49.4	34.9	25.0	14.5	10.1	6.8	4.4	3.3
40	2.5%	94.6	64.4	52.1	36.9	26.3	15.3	10.6	7.1	4.6	3.5
50	2%	98.6	67.1	54.3	38.4	27.4	15.9	11.0	7.4	4.8	3.6
60	1.7%	102.0	69.3	56.1	39.6	28.3	16.4	11.4	7.6	4.9	3.7
80	1.2%	107.0	72.9	58.9	41.6	29.7	17.2	11.9	8.0	5.1	3.9
100	1%	111.0	75.7	61.2	43.2	30.8	17.9	12.4	8.3	5.3	4.0

Upper Hutt City (rainfall intensity in mm/hour - From HIRDS v4)

Use the closest of either Kaitoke or Wallaceville charts depending on location.

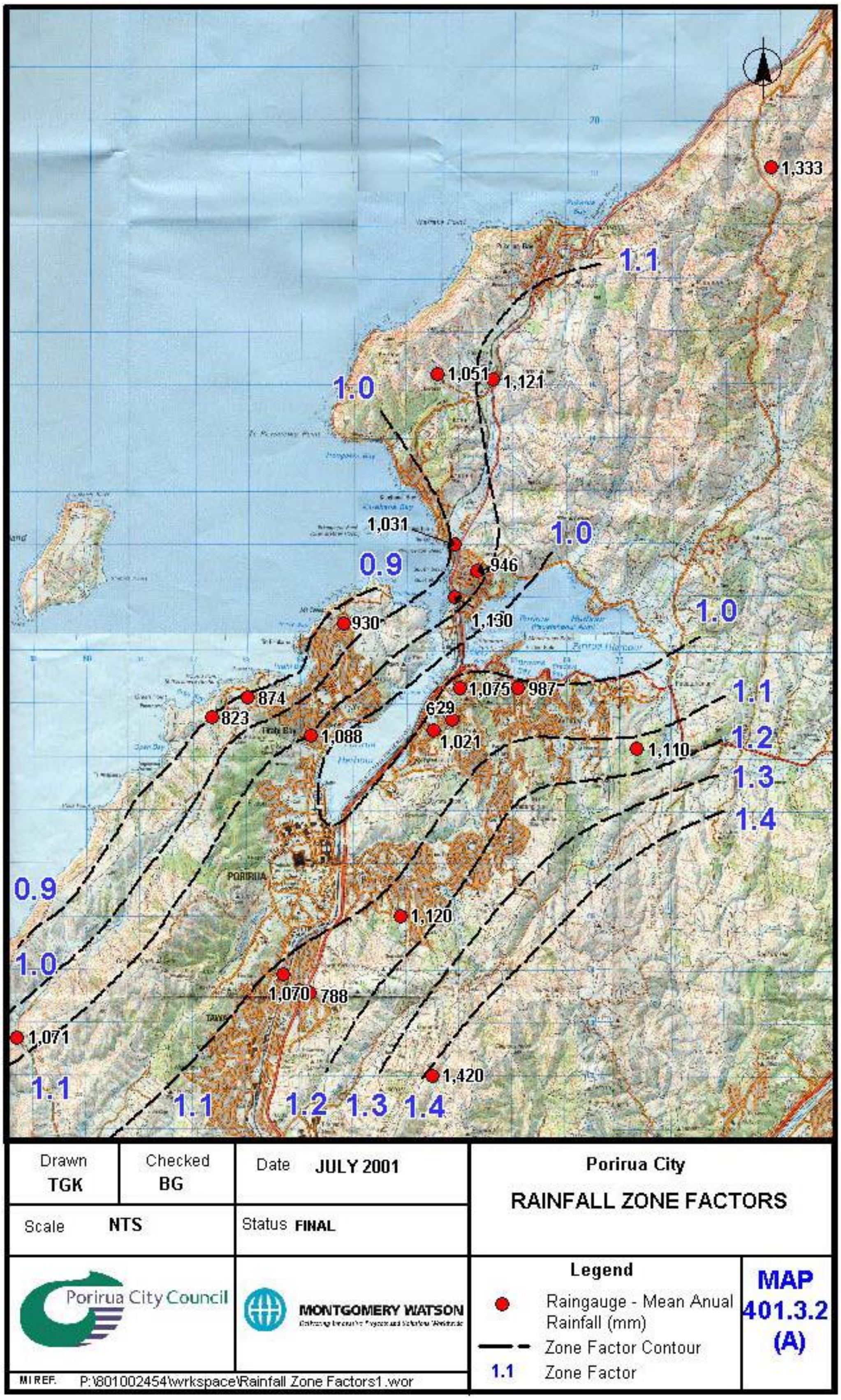
KAITOKE: (Kaitoke Weather Station Niwa ref: E15011)

		Duration									
ARI (y)	**AEP**	**10m**	**20m**	**30m**	**60m**	**2h**	**6h**	**12h**	**24h**	**48h**	**72h**
1.58	63%	42.1	30.8	25.8	19.1	14.1	8.5	5.9	4.0	2.5	1.9
2	50%	46.1	33.7	28.2	20.9	15.5	9.3	6.5	4.3	2.8	2.1
5	20%	60.1	43.8	36.6	27.1	19.9	11.9	8.3	5.5	3.5	2.6
10	10%	70.6	51.4	42.9	31.7	23.3	13.8	9.6	6.4	4.1	3.0
20	5%	81.6	59.3	49.5	36.4	26.7	15.9	11.0	7.3	4.6	3.5
30	3.3%	88.3	64.0	53.4	39.3	28.8	17.1	11.8	7.9	5.0	3.7
40	2.5%	93.1	67.5	56.3	41.4	30.3	17.9	12.4	8.3	5.2	3.9
50	2%	96.9	70.2	58.5	43.0	31.5	18.6	12.9	8.6	5.4	4.0
60	1.7%	100.0	72.5	60.4	44.4	32.5	19.2	13.3	8.8	5.6	4.1
80	1.2%	105.0	76.1	63.4	46.6	34.1	20.1	13.9	9.2	5.8	4.3
100	1%	109.0	78.9	65.7	48.2	35.3	20.8	14.4	9.5	6.0	4.5

WALLACEVILLE (Wallaceville Weather Station Niwa ref: E15102)

		Duration									
ARI (y)	**AEP**	**10m**	**20m**	**30m**	**60m**	**2h**	**6h**	**12h**	**24h**	**48h**	**72h**
1.58	63%	39.4	27.0	21.9	15.5	11.1	6.5	4.5	3.0	1.9	1.4
2	50%	43.2	29.5	24.0	17.0	12.2	7.1	4.9	3.2	2.0	1.5
5	20%	56.5	38.5	31.2	22.0	15.7	9.1	6.2	4.1	2.6	1.9
10	10%	66.5	45.2	36.6	25.8	18.4	10.6	7.2	4.8	3.0	2.2
20	5%	77.1	52.3	42.3	29.8	21.1	12.1	8.3	5.5	3.4	2.5
30	3.3%	83.5	56.6	45.7	32.1	22.8	13.0	8.9	5.9	3.7	2.7
40	2.5%	88.2	59.7	48.2	33.9	24.0	13.7	9.4	6.2	3.9	2.9
50	2%	91.9	62.2	50.2	35.2	24.9	14.2	9.7	6.4	4.0	3.0
60	1.7%	94.9	64.2	51.8	36.4	25.7	14.7	10.0	6.6	4.1	3.0
80	1.2%	99.8	67.5	54.4	38.1	27.0	15.4	10.5	6.9	4.3	3.2
100	1%	104.0	70.0	56.4	39.6	28.0	15.9	10.8	7.1	4.4	3.3

Appendix 3 PCC Rainfall Intensities Zone Factors



Appendix 4 Hydraulic Design for Drainage Pipes

The following provides technical accompaniment to sections 4.3.2 and 5.3.2. These pages relate specifically to stormwater and wastewater design.

A4.1 Manning's Formula

Manning's formula can be used to estimate the capacity of the drain being designed.

Equation 11
$$Q = \frac{1}{n} A R^{\frac{2}{3}} \sqrt{S}$$

Where Q = flow m^3/s

n = roughness coefficient (see Table 7.2.)

A = cross-sectional area of water in pipe (m^2)

R = Hydraulic radius (A / wetted perimeter) m

S = decimal slope (m/m)

For circular pipes running partially full, the roughness coefficient Manning's n should be modified for pipes using Equation 12.

Equation 12
$$n' = n\left(\frac{\left(1-\frac{d}{D}\right)-\left(1-\frac{d}{D}\right)^{7}}{2}+1\right)$$

Where n' = modified Manning's n

n = Manning's n (from Table 7.2)

d = depth of water in pipe

D = diameter of pipe

See Appendix 6 for graphical representations of pipe capacities for pipes running 80% and 100% full including an allowance for air entrainment.

Table 7.2 – Hydraulic Roughness Factors for Manning's Formula

Pipe Material	Manning's n
Vitreous Clay	0.013
Precast Concrete Pipe	0.013
Cast in situ Concrete	0.015
PVC/PE	0.011
Corrugated Aluminium, PE or PP	0.025
Open Channel	
Straight uniform channel in earth and gravel in good condition	0.0225
Unlined channel in earth and gravel with some bends and in fair condition	0.025
Channel with rough stony bed or with weeds on earth bank and natural streams with clean straight banks	0.03
Winding natural streams with generally clean bed but with some pools and shoals	0.035
Winding natural streams with irregular cross sections and some obstruction with vegetation and debris	0.045
Irregular natural stream with some obstruction with vegetation and debris	0.060
Very irregular winding stream obstructed with significant overgrown vegetation and debris	0.100

A4.2 Air Entrainment

Where the pipe exceeds grades of 1 in 10, allowances shall be made for bulking of the flow due to air entrainment, and special precautions made to release the air and surplus energy.

The air to water ratio may be calculated from:

Equation 13 $$\frac{air}{water} = \frac{kV^2}{gR}$$

Where k = coefficient of air entrainment:

0.004 for smooth concrete pipes

0.008 for cast in-situ concrete pipes

g = gravity (9.81 m/s^2)

R = hydraulic radius

V = velocity

A4.3 Losses Through Structures

Losses through a structure shall be compensated for through a drop in the invert level through the manhole. The drop shall be additional to the entry and exit slopes, and shall be introduced gradually across the manhole.

The losses to be accounted for are:

h_d Head loss due to change in direction

h_j Head loss due to junction (if applicable)

h_n Nominal headloss across structure

Therefore the total drop (h_f) through the manhole to be accommodated shall be:

Equation 14

$$h_f = h_d + h_j + h_n \quad \text{(in metres)}$$

Head losses due to a change in direction (h_d) shall be determined using Equation 15 where the loss coefficient (K_d) shall be determined from the figure presented in Appendix 8.

Equation 15

$$h_d = K_d \frac{V_i^2}{2g}$$

Alternatively, the loss coefficients in the table below can be used.

Bend Loss Coefficient (conservative)

Angle	K_d
22.5°	0.25
45°	0.60
90°	0.90

Pipe junctions and laterals joining the main flow increase turbulence in the manhole and the change in flow volume changes the flow momentum. Losses due to a junction shall be described by the equation below:

Equation 16

$$h_j = \left(\frac{D_L}{D_i}\right)^2 \frac{V_i^2}{2g}$$

Where D_i and V_i is the incoming pipe diameter and velocity and D_L is joining lateral diameter. ***Alternatively,*** the momentum equation, shown by Equation 17 and Figure 7.1, may be used to determine h_j.

Equation 17 $$h_j = \frac{Q_1V_1 - Q_2V_2 - Q_3V_3\cos\theta_3 - Q_4V_4\cos\theta_4}{0.5(A_1 + A_2)g}$$

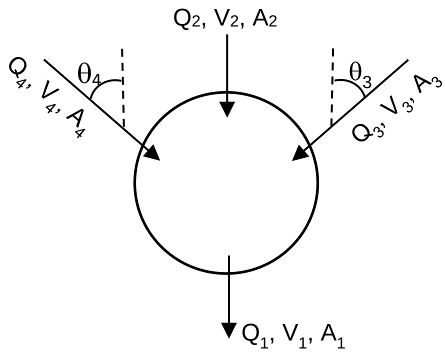


Figure 7.1 – Variables for use with Equation 17

The nominal loss h_n across the structure accounts for the changes in cross-section area as the pipe transitions from circular to open channel and back again as well as discontinuities and increased roughness of the haunching.

Equation 18 $$h_n = 0.1\frac{V_i^2}{2g}$$

A4.4 Darcy-Weisbach Calculation (pressure pipes)

Pipeline losses shall be calculated using the Darcy-Weisbach equation where the Moody friction factor f can be determined using the Moody diagram or calculated using the Colebrook-White or Swamee-Jain method. The Swamee-Jain method is non-iterative and simpler to solve and differs from the iterative Colebrook-White method by less than 1% for turbulent flow. These methods should not be used where the Reynolds number exceeds 10^8 or pipe roughness is greater than 5% of the diameter.

Appendix 9 provides head loss charts for standard PVC pipes using the Swamee-Jain method and the roughness coefficients in Table 7.3.

Equation 19 $$h_f = f\frac{L}{D}\frac{V^2}{2g}$$ (Darcy-Weisbach Equation)

where: h_f = headloss

f = friction factor determined by Equation 20 or Equation 21

L	= length of pipe (m)
D	= internal diameter of pipe (m)
V	= fluid velocity (m/s)
g	= gravity (9.81 m/s^2)

The friction factor f can be determined using either the Colebrook-White method (Equation 20) or the Swamee-Jain equation (Equation 21). Table 7.3 provides the roughness factors ε to be used in either the Colebrook-White or Swamee-Jain equations. The roughness factors allow for fittings and ageing of a typical reticulation or trunk pipeline. Calculations for pump stations or areas with a large number of fittings may require special consideration.

Equation 20 $$\frac{1}{\sqrt{f}} = -2\log_{10}\left(\frac{\varepsilon / D}{3.7} + \frac{2.51}{R\sqrt{f}}\right)$$ (Colebrook-White method)

Equation 21 $$f = \frac{0.25}{\left[\log_{10}\left(\frac{\varepsilon / D}{3.7} + \frac{5.74}{R^{0.9}}\right)\right]^2}$$ (Swamee-Jain method)

where	ε	= pipe roughness (mm) from Table 7.3
	D	= internal pipe diameter (mm)
	R	= Reynolds number = (V x D)/10^{-6} for water (D in metres)

Table 7.3 – Colebrook-White Pipe Roughness (mm)

Material	Age of pipe (see notes below) < 10 years+	10-25 years+	> 25 years*
Asbestos Cement (AC)	0.03	0.06	0.5
PVC / Polyethylene	0.06	0.06	0.15
Clay/earthenware	0.06	0.15	0.15
Cast iron	0.3	0.6	3
Concrete lined ductile iron (DICL)	0.06	0.15	0.15
Concrete lined steel (STCL)	0.06	0.15	0.15
Copper (Cu)	0.03	0.06	0.5
Ductile iron (unlined)	0.045	0.06	3
Galvanised iron (GI)	0.3	0.6	3.0
Steel (unlined)	0.03	0.06	3
Reinforced concrete (RC)	0.15	0.6	3
Unknown	0.03	0.06	0.5

+These factors should only be used for the simulation and calibration of existing networks and pipelines. They shall NOT be used for the design of new pipelines.

*For the design of new/replacement pipelines, roughness factors for pipes >25 years shall be used to ensure network performance can be maintained throughout the lifespan of the pipeline/network.

Appendix 5 Porirua design sea-level determination

The design sea-level is based on the assumption that mean high water springs (MHWS) is used as the design, plus an allowance for sea-level rise and potentially storm surge and reduced atmospheric pressure.

Land Information NZ provide tidal information to Chart Datum (CD) reference. Porirua Harbour (@ Mana Cruising Club) is a secondary port based on the Port Taranaki standard port tidal predictions. The Mean High Water Springs and tide predictions for the standard and secondary ports are published in terms of local Chart Datum.

Chart Datum (CD) differs from standard "mean sea level" (MSL) as Chart Datum is typically to a local datum near the tide gauge and is situated such that the tide is never measured as a negative. This means CD is typically much lower than local vertical datum which have a datum at or around MSL. Local vertical datum are the datum usually used for engineering surveying and contour mapping, eg: Wellington Vertical Datum 1953 (WVD).

A conversion from CD to WVD was established during the Porirua Harbour Bathymetric Survey 2009 by Discovery Marine Limited. The survey determined that:

Wellington Vertical Datum is 0.85 metres above Chart Datum (Mana Cruising Club).

Therefore, RL (WVD) = CD Level (Mana C1K1) – 0.85 m

New Zealand Vertical Datum 2016 (NZVD 2016) is also used in some places. WVD 1953 is 388 mm below NZVD 2016.

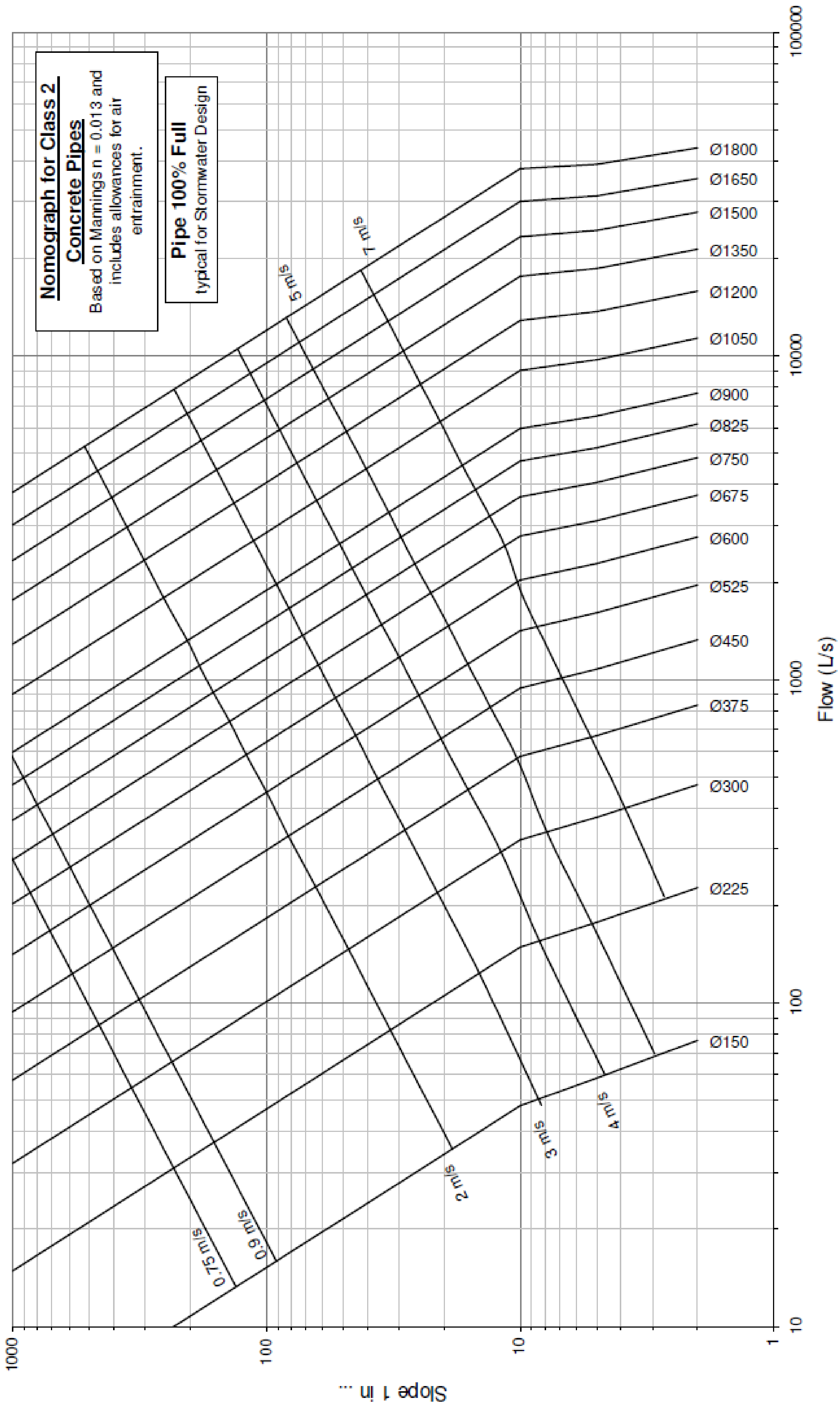
The standard design scenario requires an allowance of 1.0 metres for sea-level rise, and 250 mm for barometric pressure/storm surge. This results in the following design sea levels.

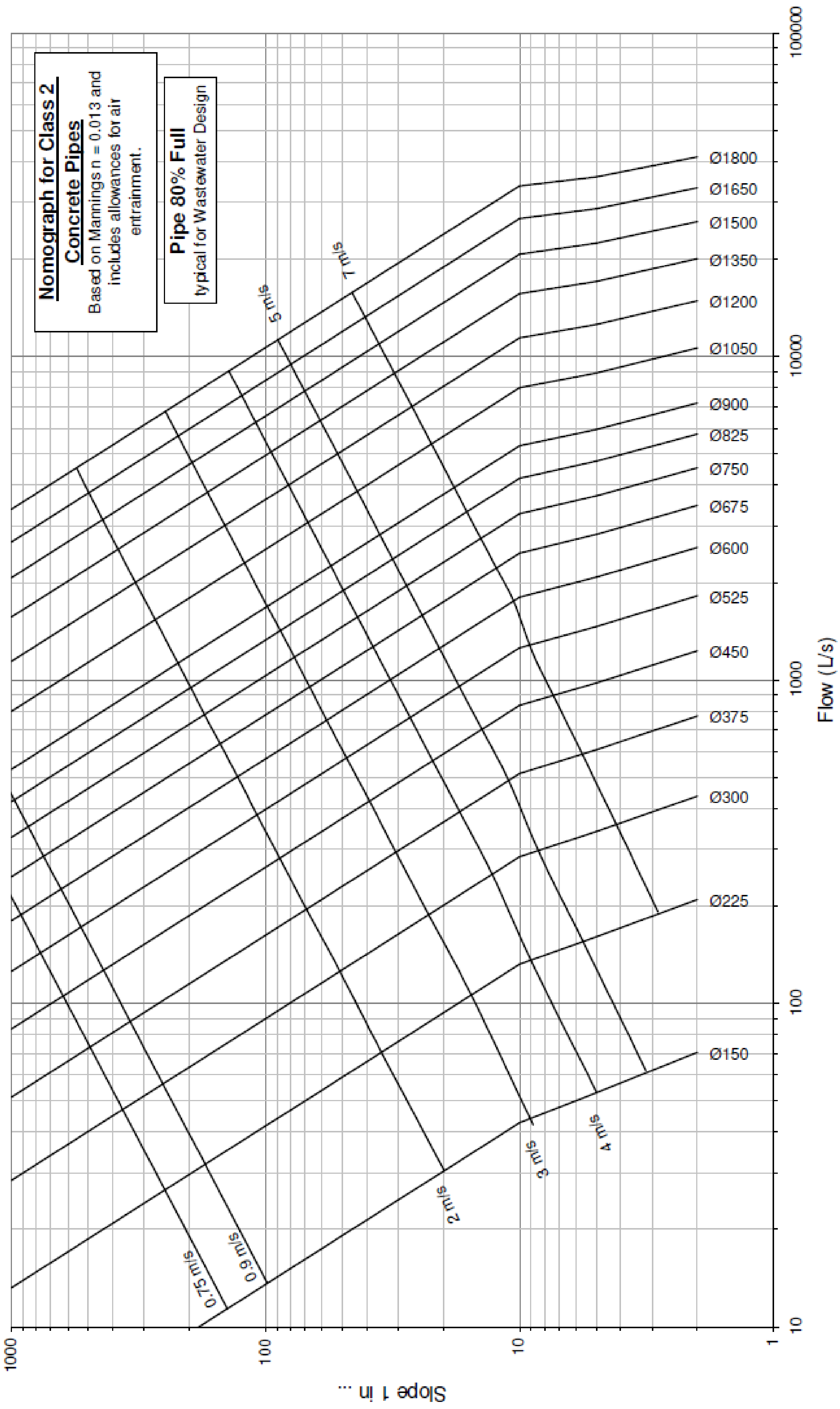
Table 7.4 – Mean High Water Springs Level in different datums

Datum	MWHS (m)	Seal level rise (m)	Barometric allowance (m)	Design Level (m)
Chart Datum (Mana CC)	1.7	1.0	0.25	2.95
NZ Vertical Datum 2016	0.462	1.0	0.25	1.712
Wellington Local Datum 1953	0.85	1.0	0.25	2.10

Appendix 6 Nomographs for Drainage Pipes

The following charts are a graphical representation of the calculations from A4.1 and A4.2 in Appendix 4 for Manning's formula and air entrainment for Class 2 pre-cast concrete pipes.


Nomograph for Class 2
Concrete Pipes
Based on Mannings n = 0.013 and includes allowances for air entrainment.
Pipe 100% Full
typical for Stormwater Design
0.75 m/s
0.9 m/s
2 m/s
3 m/s
4 m/s
5 m/s
7 m/s
Ø150
Ø225
Ø300
Ø375
Ø450
Ø525
Ø600
Ø675
Ø750
Ø825
Ø900
Ø1050
Ø1200
Ø1350
Ø1500
Ø1650
Ø1800
Flow (L/s)
10
100
1000
10000
100000
Slope 1 in ...
1000
100
10
1


Nomograph for Class 2 Concrete Pipes
Based on Mannings n = 0.013 and includes allowances for air entrainment.
Pipe 80% Full
typical for Wastewater Design
Ø1800
Ø1650
Ø1500
Ø1350
Ø1200
Ø1050
Ø900
Ø825
Ø750
Ø675
Ø600
Ø525
Ø450
Ø375
Ø300
Ø225
Ø150
0.75 m/s
0.9 m/s
2 m/s
3 m/s
4 m/s
5 m/s
7 m/s
Flow (L/s)
10
100
1000
10000
100000
Slope 1 in ...
1000
100
10
1

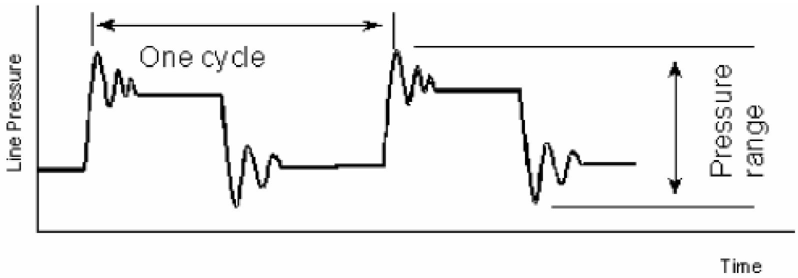
Appendix 7 Surge and Fatigue Calculations

Where plastic pipes are proposed in a cyclic environment, such as rising mains or direct-on-line pumping into the reticulation, provisions for a potential increase in pipe class shall be made due to fatigue and/or surge.

Surge is the sudden change in pressure caused by sudden changes in fluid velocity; for example, an unanticipated power failure resulting in the pumps shutting down and uncontrolled pressure transients (water hammer) in the pipeline. A transient analysis shall be carried out on all rising mains to ensure transients do not exceed the working pressure of the pipeline and fittings. Where transients are excessive, measures such as soft-starters or variable frequency drives on the pumps, surge control valves or increased pipe classes shall be considered.

Fatigue is a result of a large number of repetitive surge events. Generally, a larger number of smaller events can be tolerated than a lesser number of large surges.

Gradual diurnal changes in pressure due to normal consumer demand, as typically experienced by most reticulations, generally do not require specific fatigue design.



Definition of a pressure cycle and surge range (from PIPA publication POP101)

Where plastic pipes are used, and fatigue is expected, the following formula should be used to determine equivalent operating pressures. Note that these can be used for water or wastewater pumping applications.

Equation 22 $$Cycles_{100} = Cycles_{day} \times CF \times 36500 \text{ (kPa)}$$

Where $Cycles_{100}$ = equivalent cycles over 100 years

$Cycles_{day}$ = expected number of cylces per day

CF = 2 for pumped systems,

= 1 for non-pumped systems

$Cycles_{100}$ is to be used to determine the Fatigue Cycle Factor (F) from the following table.

Equation 23 $$OP_{equiv} = \frac{\Delta P}{F}$$

Where OP_{equiv} = equivalent Operating Pressure (kPa)

ΔP = Max surge pressure – Min surge pressure (kPa)

F = Fatigue Cycle Factor from the following table

The pipe class shall be based on the greater of the nominal working pressure or the OP_{equiv}.

Fatigue Cycle Factors[8]

Total Cycles over 100 year pipe life ($Cycles_{100}$)	PE80b PE100	PVC-U	PVC-M	PVC-O
26,400	1	1	1	1
100,000	1	1	0.67	0.75
200,000	1	0.81	0.54	0.66
500,000	0.95	0.62	0.41	0.56
1,000,000	0.88	0.50	0.33	0.49
2,500,000	0.80	0.38	0.25	0.41
5,000,000	0.74	0.38	0.25	0.41

Alternative specific design is required for more complex situations, such as common rising mains or temperatures greater than 20 degrees.

A7.1 Example Fatigue Calculation

The pressure in a pumped rising main surges to 950 kPa when started, to gradually stabilise at 400 kPa. When the pumps stop, the pressure in the pipe drops to a minimum of 100 kPa. The nominal working pressure in the pipe is 950 kPa and theoretically requires a minimum PVC-M pipe class of PN12.

The pump is expected to start 8 times a day ($Cycles_{day}$) which is equivalent to 292,000 over 100 years. As it is a pumped system, $Cycles_{day}$ is multiplied by 2 which provides a $Cycles_{100}$ of 584,000. This translates into a Fatigue Cycle Factor of around 0.40 from the table above.

[8] *From Plastic Pipe Industry of Australia Ltd (PIPA) Guidelines POP010A and POP101 available from www.pipa.com.au*

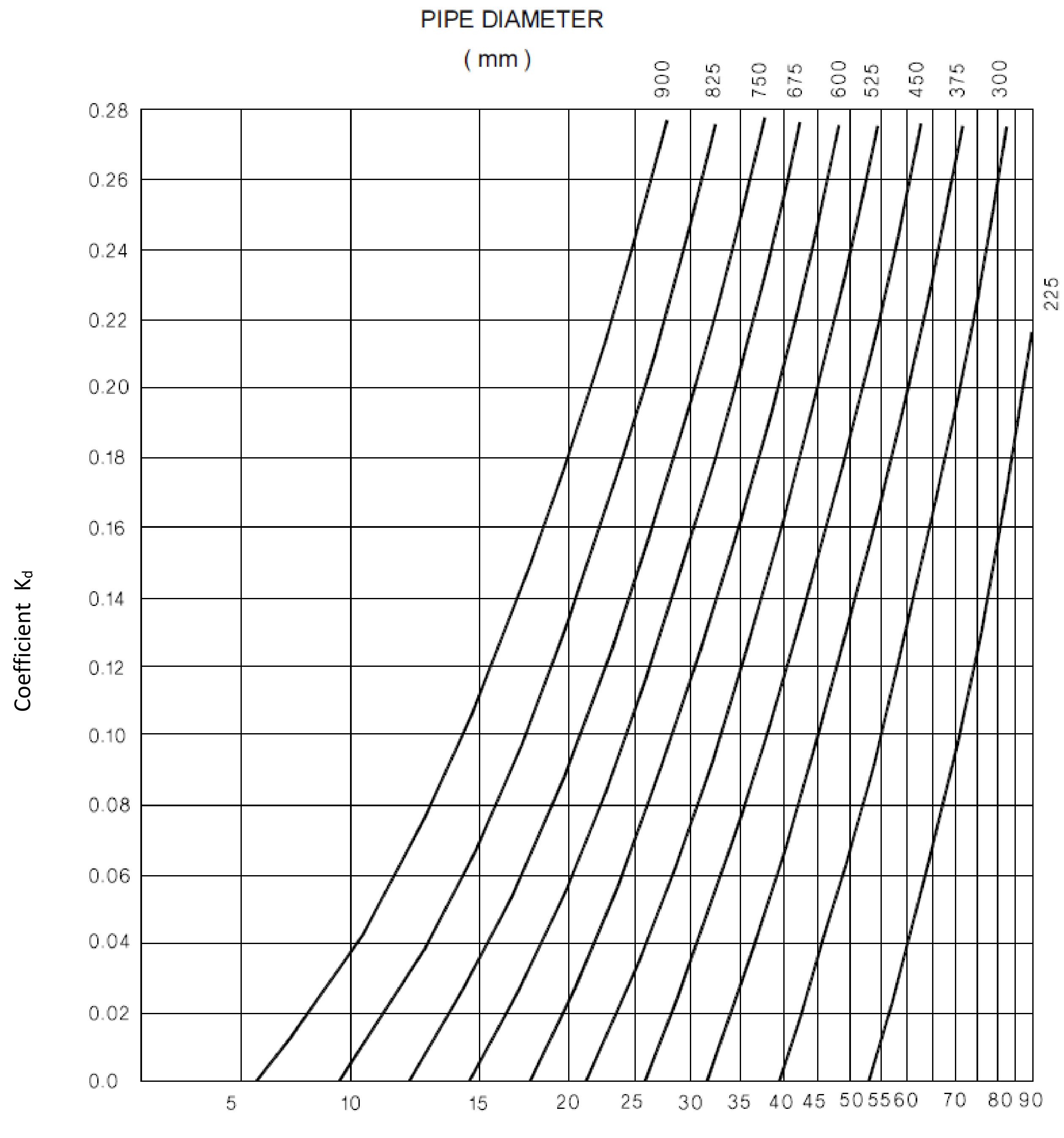
The surge pressure ΔP = 950 kPa – 100 kPa = 850 kPa. This means the equivalent operating pressure is:

$$OP_{equiv} = \frac{850}{0.40} \text{ which = 2,125 kPa}$$

This suggests a minimum PN25 pipe is more appropriate as the OP_{equiv} of 2,125 kPa is greater than the original PN12 working pressure.

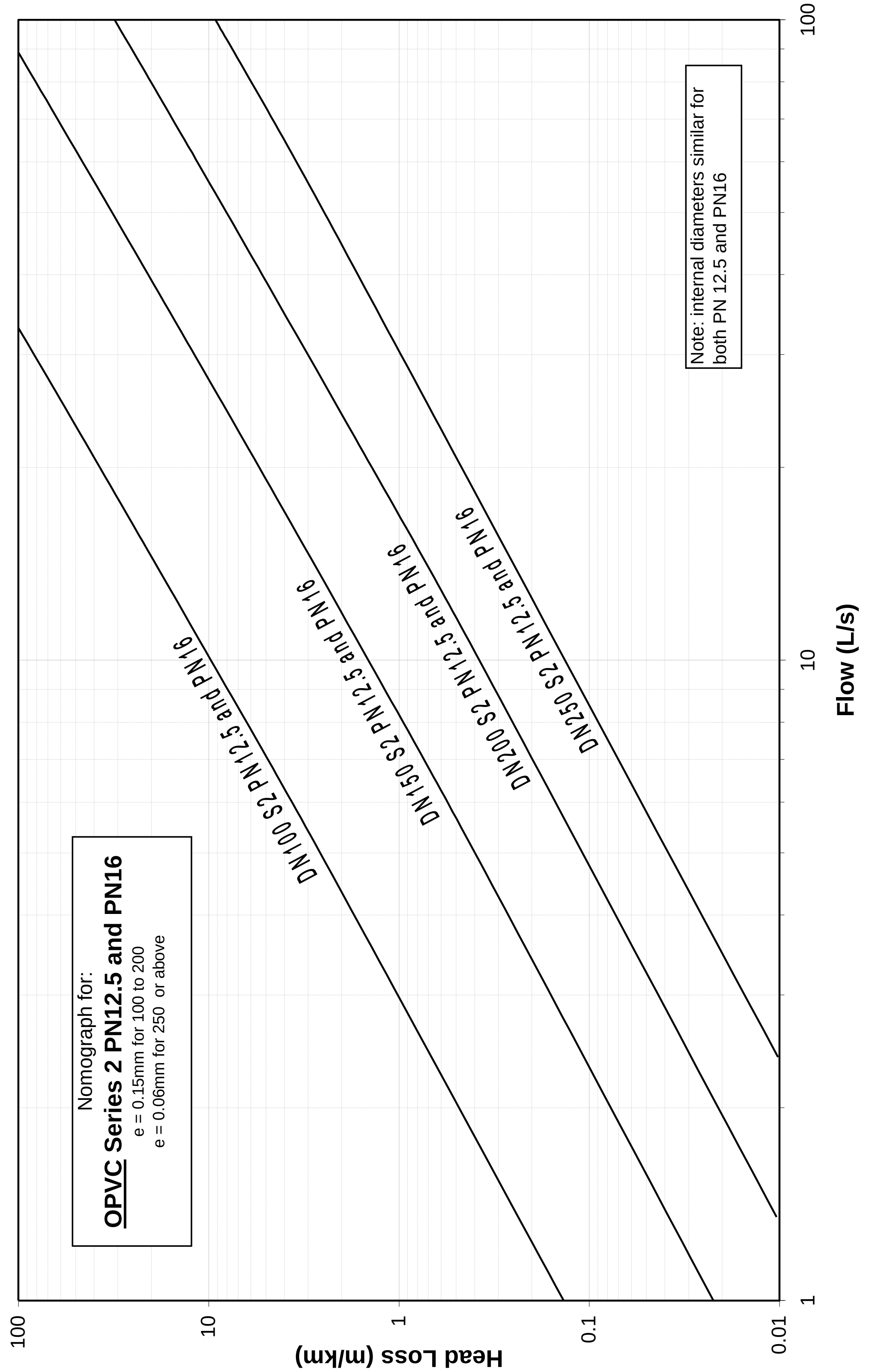
Appendix 8 Losses Through 1050 Manhole

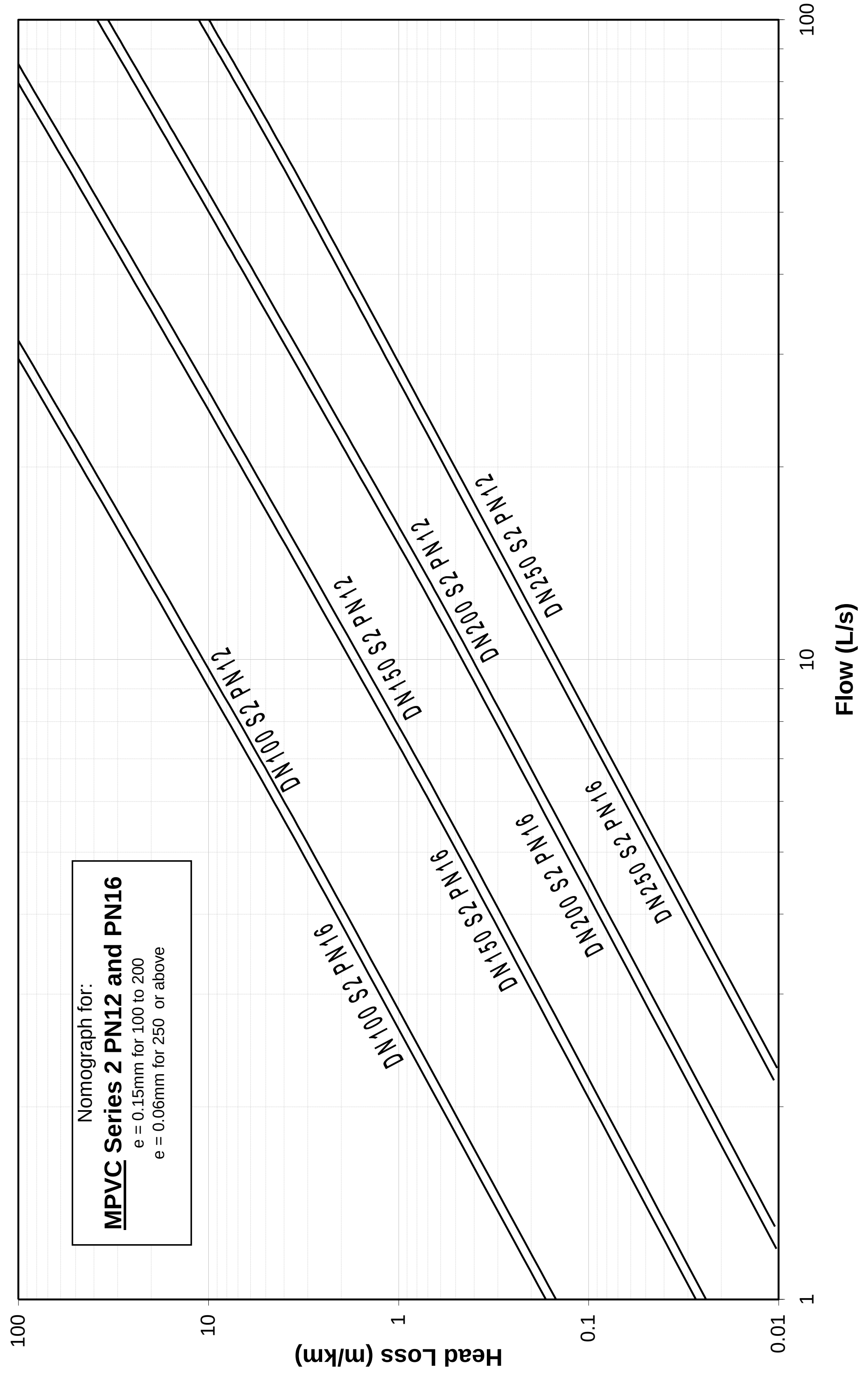
(Chart adopted from NZBC)

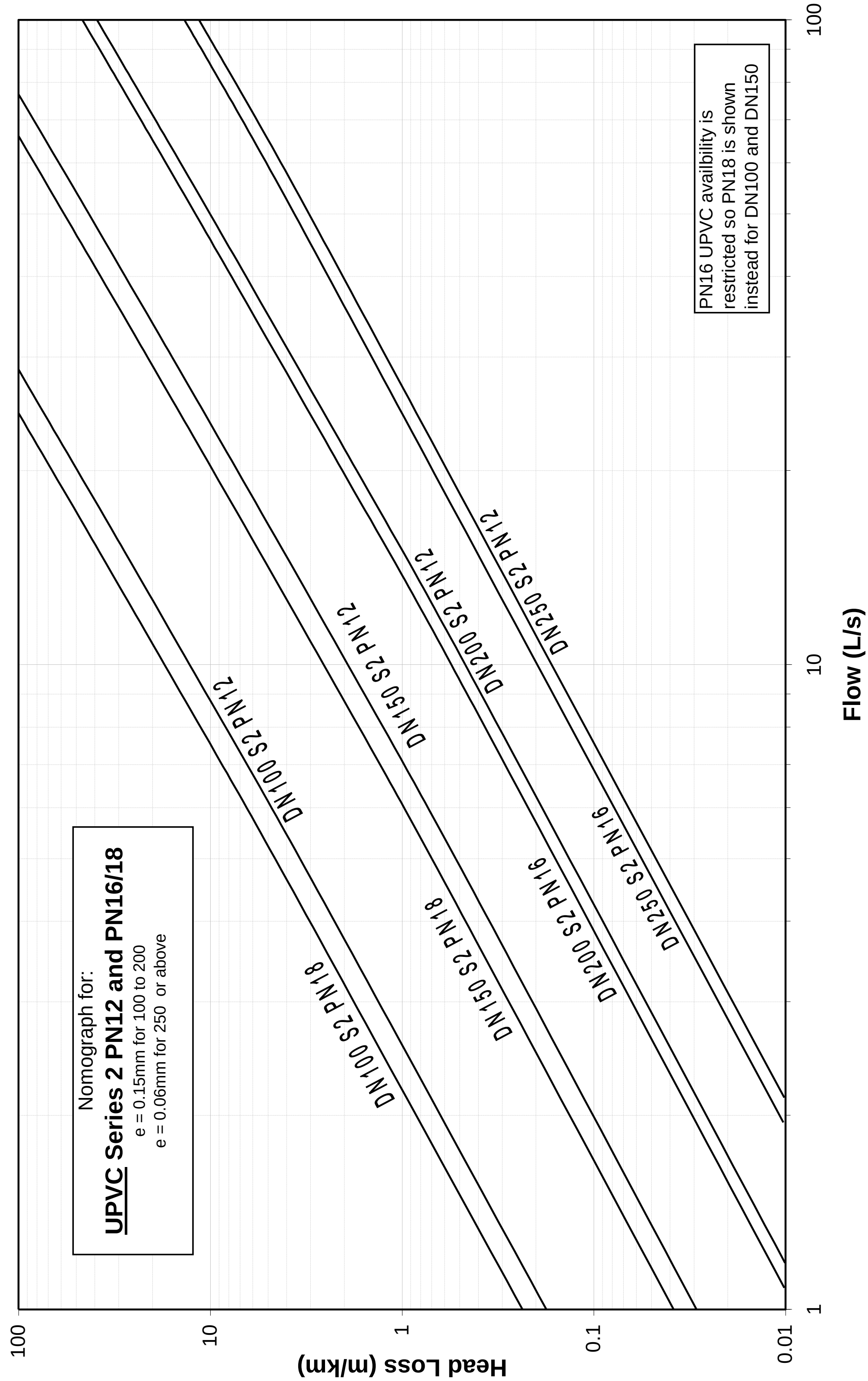


Change in Direction (degrees)

Appendix 9 Standard PVC Water Pipe Head Losses




Nomograph for:
MPVC Series 2 PN12 and PN16
e = 0.15mm for 100 to 200
e = 0.06mm for 250 or above
DN100 S2 PN12
DN100 S2 PN16
DN150 S2 PN12
DN150 S2 PN16
DN200 S2 PN12
DN200 S2 PN16
DN250 S2 PN12
DN250 S2 PN16
Head Loss (m/km)
100
10
1
0.1
0.01
Flow (L/s)
1
10
100


Nomograph for:
UPVC Series 2 PN12 and PN16/18
e = 0.15mm for 100 to 200
e = 0.06mm for 250 or above
PN16 UPVC availbility is restricted so PN18 is shown instead for DN100 and DN150
DN100 S2 PN12
DN100 S2 PN18
DN150 S2 PN12
DN150 S2 PN18
DN200 S2 PN12
DN200 S2 PN16
DN250 S2 PN12
DN250 S2 PN16
Head Loss (m/km)
100
10
1
0.1
0.01
Flow (L/s)
1
10
100

Appendix 10 Engineering Drawings

Standard network layouts and engineering details are included in the Regional Specification for Water Services which is available on the Wellington Water Limited website www.wellingtonwater.co.nz