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5. STORMWATER

5.1 INTRODUCTION

- a) Construction in accordance with the standards is intended to ensure that stormwater runoff is managed effectively and efficiently, stormwater runoff is minimised and is managed in a sustainable manner.
- b) The purpose of this section is to provide design guidance and minimum standards for the design and construction of stormwater management infrastructure.
- c) Effective stormwater management is important to minimise inundation, flooding and property damage and to avoid degradation of aquatic environments.

5.2 OBJECTIVES

- a) The Council is seeking to have a stormwater system that is capable of accommodating stormwater from rainfall events in an efficient and sustainable way whilst ensuring that the cultural, economic, ecological, recreational values and natural structures of waterways are recognised and enhanced.

5.3 PERFORMANCE CRITERIA

The design of a stormwater system shall include the following:

- a) Provide for the collection and/or control of stormwater, allowing for ultimate future development potential¹ within the catchment or adjoining catchments.
- b) Stormwater generated by a 2% Annual Exceedance Probability (AEP) (1 in 50 year) storm event shall be accommodated within the primary and secondary stormwater management system in a way that does not cause any significant damage to people and property.
- c) Stormwater generated by more frequent, but significant rainfall events of 6.67% AEP (1 in 15 year) shall be accommodated within the primary stormwater management system in a way that does not cause damage to or nuisance effects on people and property.
- d) Stormwater infrastructure is constructed in a manner that results in a robust, durable network, and which is able to be efficiently maintained.
- e) Stormwater is managed and disposed of in a way that avoids, remedies or mitigates adverse effects on water quality, and the aquatic environments that affect the habitats of flora and fauna.

¹ Development potential means the likely future development within the Services Overlay taking into account the Council's Strategic City Development Plan and the LTCCP, and the provision of services in a manner that integrates with and does not foreclose this likely future development.

- f) Stormwater infrastructure is designed and constructed in a way that maintains or enhances the amenity and ecological values of the locality and makes use of available natural features and processes on site wherever possible.
- g) Create a multifunctional landscape where the design integrates with other aspects of site planning and provides multiple benefits.
- h) The stormwater infrastructure network is cost-effective and efficient in delivering the required level of service over the entire life-cycle of the network (benefits to the environment shall be factored when assessing Low Impact Design Methods).
- i) The management of stormwater meets the needs and expectations of the community in terms of the LTCCP and Council's Sustainability Policy.
- j) All stormwater is managed in compliance with resource consent(s) for the discharge of water onto land or into water, or the discharge can be accommodated within an existing consented system, in accordance with the NRMP.

5.4 KEY REFERENCES

- a) Table 5-1 sets out external standards and other documents that are relevant to the management of stormwater. These apply and must be taken into account in the design and construction of any stormwater management asset in Nelson City. Where an Act or Standard is referenced this shall be the current version including any associated amendments.

Table 5-1 Minimum Standards for Stormwater Design, Materials, Construction and Maintenance

Number/Source	Title
AS/NZS 1254	PVC pipes and fittings for stormwater and surface water applications
AS/NZS 2032	Installation of PVC pipe systems
AS/NZS 2566	Part 1: 1998 Buried flexible pipelines – Structural design Part 1 Supp 1: 1998 Buried flexible pipelines – Structural design – Commentary Part 2 – Buried flexible pipelines - Installation
AS/NZS 4058	Pre-cast concrete pipes for (pressure and non-pressure)
AS/NZS 3725	Design for installation of buried concrete pipes
NZS 3109	Concrete construction
NZS 3121	Specification for water and aggregate for concrete
NZS 4442	Welded steel pipes and fittings for water, sewage, and medium pressure gas
NZS 4404	Land development and subdivision

Number/Source	Title
NZ Building Act	Clause E1 "Surface Water"
	New Zealand Pipe Inspection Manual 3rd edition
Auckland Regional Council TP 10	Design Guideline Manual Stormwater Treatment Devices
Auckland Regional Council TP 124	Low Impact Design Manual for the Auckland Region
NZWERF	On-site stormwater management guideline
SNZ HB 44:2001	Subdivision for people and the environment

5.5 GENERAL DESIGN REQUIREMENTS

5.5.1 Design Methodology

a) There are a variety of ways that the stormwater management performance criteria may be achieved. Council intends to pursue a more sustainable approach to stormwater management which includes the use of Low Impact Design (LID) approaches where appropriate.

b) Unless otherwise approved the design of the stormwater system shall be in accordance with one or more of the current versions of the following publications:

- 1) NZS4404 Land Development and Subdivision
- 2) The Building Industry Authority's (E1 Surface Water)
- 3) TP10 (Stormwater Management Devices; Design Guidelines Manual)
- 4) TP124 (Low Impact Design Manual)
- 5) An approved catchment/stormwater computer modelling system

5.5.2 Allowance for Climate Change

a) Information published in March 2009 by the Ministry for the Environment (MfE,) on climate change 'Preparing for Coastal Change' indicates that:

- 1) Extreme rainfall events for the Nelson/Tasman area are predicted to increase by about 16% by 2090. Therefore for a mid-range scenario, a 1-in-100 year event now could become a 1-in-50 year event by the end of the century.
- 2) A base value sea-level rise of 0.5m relative to the 1980-1999 average be used, along with an assessment of potential consequences from a range of possible higher sea-level rise

values. At the very least, all assessments should consider the consequences of a mean sea-level rise of at least 0.8m relative to the 1980-1999 average. For longer planning and decision timeframes beyond the end of this century, it is recommended an additional allowance for sea-level rise of 10mm per year beyond 2100.

5.5.3 Stormwater Disposal Requirements

- a) The type of primary system installed will be dependent on factors such as quantity, quality, aquatic resource protection, topography, soil type, location and space constraints.
- b) The design requirements specified in this document and the documents referred to above will provide the design elements required for each of the options.
- c) Alternative (LID) methods will be considered by Council. Each situation will be assessed on a case by case basis but will need to provide the minimum stormwater control standards stipulated in this document.

5.5.3.1 Stormwater to soakage only in suitable areas

- a) Due to the unstable nature of Nelson hill soils, it is expected that in most situations a combination of alternative (LID) methods coupled with conventional (piped) systems will be the most appropriate for hillside developments and sites with unsuitable soils.
- b) Where disposal of stormwater to soakage is proposed then detailed site specific geotechnical investigation, including comprehensive soakage testing, must be undertaken to assess the suitability of the site for stormwater disposal by soakage.
- c) All proposals for on-site stormwater disposal by soakage must be supported by clearly legible, detailed calculations, drawings and field soakage test results. On-site disposal systems must be designed to have no adverse effects on ground stability or on downstream properties and shall be designed and constructed in accordance with the requirements of the Building Act 2004 and the Building Code. Refer to Verification Method E1/VM1: 9.0 Disposal to Soakage. (New Zealand Building Code Compliance Document E1, Surface Water.)
- d) The developer shall undertake detailed calculations to demonstrate that the proposed soakage system is suitable for the disposal of stormwater from a 6.67% AEP event. In addition, overland flow paths shall be provided in accordance with Table 5-1 to cater for events exceeding the capacity of the primary system and occasions when the primary drainage system fails.

NOTE: Rain gardens and similar bioretention devices are not soakage devices and should not be proposed for that purpose. Rain gardens shall be provided with an under-drain and overflow mechanism connected to a suitable stormwater outfall.

5.5.3.2 Discharge into the Public Stormwater Network

- a) The Council currently provides a public stormwater network to most areas of the city, however it does not cover the whole city and in some areas the system is already at capacity.
- b) Where a public stormwater network is accessible from the site the developer shall determine whether the stormwater network has sufficient capacity and ascertain from Council whether there are any other known constraints.
- c) Where there are capacity constraints on the existing public stormwater network the developer may seek to remove all the constraints on and downstream of their property, or else must provide on-site detention to attenuate peak flows to pre-development levels.
- d) Overland flow paths shall be provided in accordance Table 5-1 to cater for events exceeding the capacity of the primary system and occasions when the primary drainage system fails.

5.5.3.3 Discharge into a stream or watercourse

- a) In areas where no public stormwater network is available, but a stream or watercourse is accessible from the site, the stormwater may be drained to the water course provided that the following conditions are met:
 - 1) A suitable outfall and dissipating structure shall be constructed at the outlet to ensure no localised erosion of the watercourse occurs. This structure shall be specifically designed in such a way as to blend in with the immediate natural surroundings.
 - 2) The direction of the discharge shall be aligned with the natural downstream flow as much as practicable so as to prevent erosion of the opposite stream bank. In situations where erosion of the opposite bank is unavoidable, appropriate mitigation measures will be required.
 - 3) No obstructions are to be placed in a watercourse that will impede the natural flow unless these are installed as part of an approved stormwater management system.
 - 4) Individual properties which border onto a stream should discharge their stormwater in a dispersed manner, via a well vegetated flow dispersal device, into the stream to avoid causing erosion.
 - 5) Any stormwater peak flow attenuation, volume control or water quality requirements specified in the Nelson Resource Management Plan, proposed plan changes or approved Council policies shall be met.
 - 6) Where the downstream primary stormwater drainage system consists of lined channels only (i.e. no natural streams or

watercourses) and the stormwater constraints relate solely to a lack of capacity in the primary drainage system, the discharge from the site for the 6.67% and 50% AEP runoff events shall be attenuated to the predevelopment flows.

- b) Overland flow paths shall be provided in accordance with Table 5-1 to cater for events exceeding the capacity of the primary system and occasions when the primary drainage system fails.

5.5.3.4 Discharge to a Council owned reserve

- a) Where appropriate the provision of recreational open space and stormwater management can be combined within a development, see 12.2.2.2 f) of the Reserves and Landscaping section.

- b) In situations where a property borders onto a Council owned reserve and the natural flow of stormwater is in the direction of the reserve it may be appropriate to discharge stormwater to the reserve provided that this does not adversely affect the amenity value or function of the reserve in any way or create any geotechnical or flooding liability issues for the NCC Parks Department. There is no automatic right to discharge stormwater to a Council owned reserve, but it may be allowed subject to the following:

- 1) Stormwater from all impervious areas on the lot should be mitigated on site by way of dual purpose rainwater tanks (reuse and detention) and bioretention to ensure that total runoff volumes and peak flow rates up to the 6.67% AEP event are mitigated to as close to the pre-development levels as possible.
- 2) The stormwater should be discharged in a dispersed manner within the lot via a well vegetated flow dispersal device. If suitable vegetation does not already exist, this will need to be planted according to a planting plan to be approved by the NCC Parks Department.
- 3) The receiving reserve area should be well vegetated or grassed, not susceptible to erosion and have no geotechnical constraints. Where requested by the Council, a report by a suitably qualified professional geotechnical engineer may be provided to support any application to discharge stormwater to a reserve area.
- 4) Alternatively, the mitigated stormwater discharge may be piped to an appropriate outfall point within the reserve approved by the Parks Department for that purpose. The Parks Department may, at its discretion, require that any such pipe be installed by thrusting techniques to minimise damage and disruption to the reserve.
- 5) The stormwater discharge shall not compromise any existing or planned structures or parks assets and shall not impede access or reduce the amenity value of the reserve.

- 6) Overland flow from the reserve shall not create, or exacerbate existing, flooding or erosion problems.
- 7) Prior approval shall be obtained in writing from the NCC Parks Department.

5.5.3.5 Discharge to the road (bubble-up sump)

- a) Stormwater discharge to a road carriageway via a bubble-up sump as a primary means of disposal is not an acceptable solution for stormwater disposal from new developments in "Greenfields" areas. However the use of roads as overland flow paths is acceptable.
- b) In some areas there is a public stormwater drainage system which serves the road network and some properties currently discharge their stormwater onto the roads and ultimately into the road drainage network. This system was generally not designed for the additional stormwater flows and there is no right to utilise the road for drainage purposes. As a principle, all sites should minimise discharges of stormwater onto the city's roads.
- c) In infill development where there is no other means available for stormwater disposal and where there is sufficient capacity in the road drainage system, then properties may be permitted to discharge stormwater to a road as per SD 522 provided the following conditions are met:
 - 1) The lot area is less than 1,000m².
 - 2) Street sumps are at 100m centres or less, and the road is less than 9m wide with a road grade no steeper than 1 in 8.
 - 3) There are no more than five bubble-up sumps between successive street sumps.
 - 4) The street has a uniform centre-crowned carriageway cross-section with a minimum kerb height of 125mm.
 - 5) Downstream private driveways that fall away from the road have adequate 'lips' at the back of the channel and the initial portion of the crossing is shaped to prevent kerb and channel water from flowing down the driveway.
 - 6) The downstream infrastructure capacity is checked and found to be satisfactory.
 - 7) The construction of the bubble-up sump is carried out to the requirements of SD 522.
 - 8) A Corridor Access Request (CAR) is obtained for the excavation works within the road reserve (see section 8-Trenching and Reinstatement)

- d) Under exceptional circumstances, situations not meeting one or more of the above criteria may be considered, subject to approval by the Council.

NOTE: Stormwater discharge to a road kerb via a kerb outlet is generally not permitted, see section 5.9.10 b).

5.5.4 Primary and Overall System Capacity

- a) The primary system for stormwater shall be designed to cope with the runoff from the design storm as outlined below.
- 1) The stormwater system may include:
 - pipe systems
 - lined open channels
 - swale drains
 - open channels; or
 - alternative methods (LID)
 - b) The secondary system (flowpath) is the route taken by stormwater when the primary system is unable to cope either because of blockages or because the hydraulic capacity of the primary system is exceeded by a larger-than design storm.
 - c) In designing the stormwater system, both the primary and secondary system (overall system capacity) should be identified to ensure the stormwater management system provides a minimum standard of flood protection according to the following criteria:

Table 5-2 Stormwater System Capacity Requirements

Stormwater System Type	Primary System Capacity	Overall System Capacity
Conventional pipe system design	6.67% AEP (Q15, 15 year return period)	2% AEP (Q50 ,50 year return period)
Low impact design (LID)	6.67% AEP	2% AEP
Minor streams*	6.67% AEP	2% AEP
Major streams and rivers**	2% AEP (Q50 ,50 year return period)	1% AEP (Q100 ,100 return period)

*A minor stream is one where it has a width, top of bank to top of bank, of less than 3.0m. For clarification, the bank-to-bank width for streams is generally at mean annual flood flow (Q2.3). This area may include areas of vegetation which go under water at various storm events (consistent with Esplanade provisions of the RMA).

** Major streams and rivers (wider than 3.0m at the top of bank) including: - Reservoir Creek, Saxton Creek, Orphanage Creek, Orchard Creek, Poormans Valley Stream, Arapiki Stream, Jenkins Creek, York Stream, Maitai River, Brook Stream, Oldham Creek, Todds Valley Stream, Wakapuaka River and its tributaries, Whangamoia River and its tributaries.

5.5.5 Rainfall Intensity

- a) For urban stormwater design the Nelson City Council Urban Design Rainfall Intensity Curves Table 5-3 shall be used. These curves are based on an analysis of actual rainfall data for Nelson which were encapsulated into a High Intensity Rainfall Design System (HIRDS) in 2008. Allowance for climate change has been incorporated. The rainfall intensity curves shown in Table 5-3 and SD 502 have been increased by 16% (from 2008 data) to allow for increasing temperature and extreme rainfall predictions for Nelson to 2100.

5.5.6 Runoff Coefficient

- a) The following standards apply to the calculation of run-off:
 - 1) Determination of catchment run-off is the key basis for stormwater network design, and must be assessed carefully for each site. Designers are referred to Verification Method E1/VM1 of the Building Code for guidance on the determination of run-off coefficients. These coefficients are reproduced in Table 5-5.
 - 2) In all cases the assumptions used (and the basis of these assumptions) in the calculation of run-off shall be clearly stated. Specifically, the calculation of impervious area and runoff coefficients shall be based on site specific data and account for the ultimate development of the site.

5.5.7 Time of Concentration

- a) In large or flat catchments the critical rainfall intensity is likely to vary for different sections of the network and should be determined using the time of concentration at the particular point being considered.
- b) The time of concentration shall be calculated in the determination of critical rainfall duration for a given network, and the assessment of this shall include the calculation of time of entry (including surface flow) and the time of pipe or channel flow.
- c) Calculation of the time of concentration may be made explicitly, through the use of manual calculations, or via a hydrological / hydraulic model.
- d) Designers are referred to Section 2.3 of Verification Method E1/VM1 of the Building Code for guidance in the calculation of the time of concentration. Note the time of concentration should be no less than 10 minutes.
- e) Where the stormwater system includes detention facilities, Designers must consider the dynamic effects of attenuation through the facility to work out the critical duration this will cause and the greatest flooding during design storm events. Design of the area downstream of the detention facility will also be critical to mitigate erosion and downstream flooding.

Table 5-3 Nelson City Council Urban Design Rainfall Intensity (mm/hr)

Annual Exceedance Probability (AEP)	Return Period (years)	Duration (minutes)									
		10	20	30	60	120	360	720	1440	2880	4320
							(6 hr)	(12 hr)	(24 hr)	(48 hr)	(72 hr)
50%	2	51.5	38.3	32.2	24.0	15.9	8.3	5.5	3.6	2.2	1.6
10%	10	79.3	58.1	48.5	35.6	23.1	11.6	7.5	4.8	2.9	2.1
6.67%	15	89.6	65.3	54.4	39.7	25.5	12.7	8.2	5.3	3.1	2.3
5%	20	96.7	70.3	58.5	42.6	27.3	13.5	8.6	5.5	3.3	2.4
2%	50	127.4	91.9	76.1	54.9	34.7	16.7	10.6	6.7	4.0	2.9
1%	100	160.8	114.8	94.7	67.7	42.3	20.0	12.5	7.8	4.6	3.4

Table 5-4 Nelson City Council Urban Design Rainfall Depth (mm)

Annual Exceedance Probability (AEP)	Return Period (years)	Duration (minutes)									
		10	20	30	60	120	360	720	1440	2880	4320
							(6 hr)	(12 hr)	(24 hr)	(48 hr)	(72 hr)
50%	2	8.6	12.8	16.1	24.0	31.8	49.5	65.5	86.8	103.8	115.3
10%	10	13.2	19.4	24.2	35.6	46.2	69.5	89.9	116.3	139.0	154.2
6.67%	15	14.9	21.8	27.2	39.7	51.1	76.2	98.0	126.0	150.4	166.7
5%	20	16.1	23.4	29.2	42.6	54.5	80.9	103.6	132.8	158.3	175.5
2%	50	21.2	30.6	38.0	54.9	69.4	100.5	126.9	160.4	191.1	211.6
1%	100	26.8	38.3	47.3	67.7	84.6	120.3	150.2	187.7	223.2	247.1

Table 5-5 Recommended Runoff Coefficients for Design

Natural surface types	C	Developed surface types	C
Bare impermeable clay with no interception channels or run-off control.	0.70	Fully roofed and/or sealed developments	0.90
		Steel and non-absorbent roof surfaces	0.90
Bare uncultivated soil of medium soakage.	0.60	Asphalt and concrete paved surfaces	0.85
Heavy clay soil types: – pasture and grass cover – bush and scrub cover – cultivated	0.40	Near flat and slightly absorbent roof surfaces	0.80
	0.35	Stone, brick and pre-cast concrete paving panels – with sealed joints	0.80
	0.30		– with open joints
Medium soakage soil types: – pasture and scrub cover – bush and scrub cover – cultivated	0.30	Unsealed roads	0.50
	0.25	Unsealed yards and similar surfaces	0.35
	0.20		
High soakage gravel, sandy and volcanic soil types: – pasture and scrub cover – bush and scrub cover – cultivated	0.20 0.15 0.10	Land use types	
		Industrial, commercial, shopping areas and town house developments	0.65
		Residential areas in which impervious area is less than 36% of gross area	0.45
		Residential areas in which impervious area is less than 36% of gross area	0.55
Parks, playgrounds and reserves: – mainly grassed – predominantly bush	0.30 0.25	Slope correction factor	
		Slope	Adjustment factor
		5-10% 10-20% 20% or steeper	subtracting 0.05 no adjustment adding 0.05

5.5.8 Calculation of Runoff

- a) The determination of the necessary capacity for the purpose of design should be based on the following design parameters:

- 1) Calculation of runoff for stormwater network design shall be determined using an appropriate, recognised, design methodology. In the first instance the determination of design flows lies with the Designer of the proposed network, however

Council reserves the right to require adoption of Council calculations at the Engineering Manager's discretion.

- 2) Calculation of runoff using the Rational Method will generally be accepted. Alternative runoff methodologies may be approved by the Engineering Manager on application. In all cases all underlying assumptions used in the calculation should be stated.
 - 3) The Rational Method formula is: $Q = CIA \times 2.78$
 - 4) Where
 - Q = runoff in litres per second
 - C = runoff coefficient (See Table 5-5)
 - I = rainfall intensity in millimetres per hour (See Table 5-3)
 - A = area of catchment in hectares
 - 5) Fixed runoff models (such as the Rational Method) will not generally be accepted for detention dam design or inundation assessment.
 - 6) In larger network design, or where the proposed works integrate into an existing stormwater network, the determination of design flows may be most efficiently determined using a hydrological or hydraulic model.
 - 7) When the design process includes the use of a hydrological or hydraulic model, all underlying assumptions (such as runoff coefficients, time of concentration and catchment areas) should be clearly stated so that a manual check of calculations is possible. Council reserves the right to request a copy of the model for review.
- b) The system capacity for the design of stormwater networks in Nelson are shown in Table 5-2.

5.5.9 Stormwater Consents

- a) In addition to other requirements relating to permanent discharges of stormwater to a natural watercourse or the sea and onto land, the consent holder shall be responsible for obtaining any consent(s) relating to the construction or ongoing operation of the development.
- b) The Developer is responsible for obtaining all necessary consents for the discharge of stormwater. These include, but may not be limited to, Council consents for the discharge, both during and after construction, and the permissions from landowners where additional stormwater is being discharged to their properties as a result of development.

- c) The Developer must consult with NZTA where there is the potential for additional stormwater to be discharged to land administered by NZTA, or designated by NZTA under the RMA 1991, as a result of the development. Where it is confirmed that additional discharges of stormwater will enter land administered by NZTA, or designated by NZTA under the RMA 1991, as result of the development, the Developer must obtain the written approval of NZTA.

5.5.10 High Groundwater Level

- a) In areas of high or potentially high groundwater, designers shall provide a method for allowing excess groundwater into the stormwater system in a controlled manner. Such a solution may incorporate perforated inlet pipes together with drainage rock and geotextile.
- b) Ground water lowering is not permitted where this practice may present a risk of subsidence.

5.6 MINIMUM GROUND/FLOOR LEVEL REQUIREMENTS

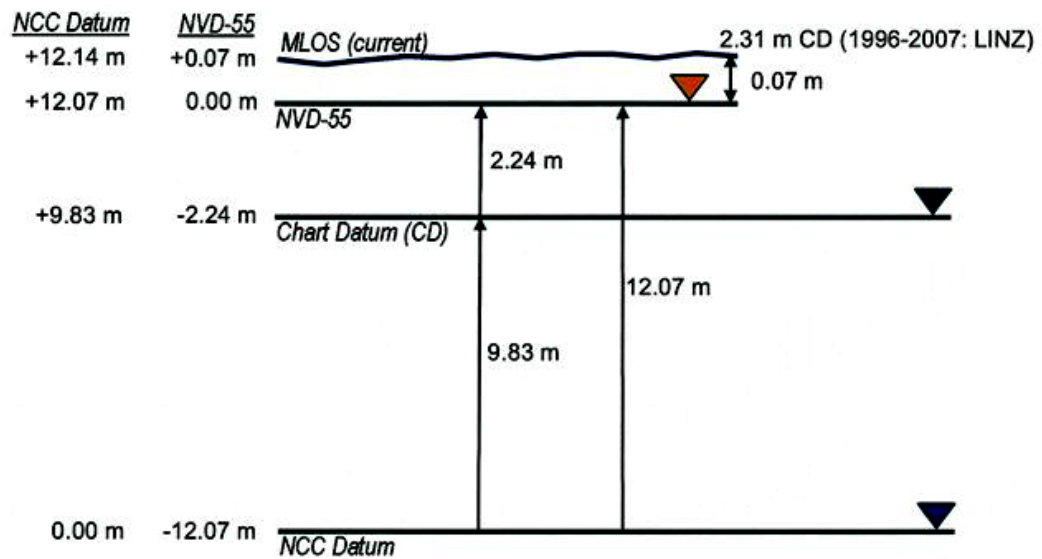
- a) It is imperative that properties (assets) and, in most instances, land be protected from inundation from stormwater, high tides or a combination of both and including potential climate change characteristics.
- b) The higher of the following minimum ground level requirements for tidal and stormwater inundation shall be used as the basis for the absolute minimum ground level for green field and, where practical, infill development.

5.6.1 Datums

- a) Nelson City historically defined a drainage datum that was set well below low tide to ensure Reduced Levels were always positive values even for pipe networks in the ground. The NCC Datum is 9.83 m below the Chart Datum (approximately the Lowest Astronomical Tide) at Port Nelson, as shown in Figure 5-1.
- b) In recent years (1996-2007), the actual mean level of the sea (MLOS) has been at an average of 12.14 m above NCC Datum or 2.31 m above Chart Datum (CD) as determined by Land Information NZ (LINZ).²
- c) The LINZ local vertical datum, Nelson Vertical Datum-1955 (NVD-55), was set up in 1955 based on sea level measurements from 1939 to 1942. Since that time, sea levels have risen, with MLOS now at 0.07 m relative to NVD-55. NVD-55 is 2.24 m above Chart Datum at Port Nelson.

² <http://www.linz.govt.nz/hydro/tidal-info/tide-tables/tidal-levels/index.aspx>

Figure 5-1 Nelson City: conversions between the various local vertical datums.



5.6.2 Sea Outfall Design Level Criteria

- a) For the purpose of pipe and open channel design the hydraulic grade line at the sea outfall shall start at 14.00m (Surveyed to NCC datum).

5.6.3 Minimum Ground Levels (Tidal Inundation)

- a) See Table 5-6 below. Also, refer to the appropriate zone section of the Nelson Resource Management Plan for rules relating to subdivision, earthworks, building on low lying sites, and Inundation Overlays.

Table 5-6 Minimum Ground and Floor Level Requirement Related to Tide Levels to NCC Datum

Tide Levels		RL Surveyed to NCC Datum	
Maximum Predicted Spring Tide		14.40	
Maximum Tidal Surge Expected		0.60	
Sea Level Rise at year 2050		0.30	
<i>Tidal Surge Level at Year 2050</i>		<i>15.30</i>	
	Ground Level	Concrete Floor	Timber Floor
<i>Tidal Surge Level at Year 2050</i>	<i>15.30</i>	<i>15.30</i>	<i>15.30</i>
Safety Margin	0.05	0.20	0.35
Minimum Finish Level to Year 2050 excluding Monaco and Wood Area served by stormwater Pump Station	15.35	15.50	15.65
Monaco 200mm wave set	0.20	0.20	0.20
Minimum Finish Level to Year 2050 for Monaco (including 200mm wave set)	15.55	15.70	15.85
Minimum Finish Level to Year 2050 for Wood Area served by stormwater Pump Station	15.20	15.35	15.50

Note: - The minimum ground level requirements in relation to tide levels and predicted sea level rise is currently being reviewed. An amendment to this section of the LDM is expected to be made before 2011.

- In addition to the absolute minimum levels above, floor levels shall also be in accordance with the requirements of the Building Act.

5.6.4 Minimum Ground Levels (Stormwater Inundation)

- a) See section 5.6.3.
- b) Where building platforms are raised above adjoining ground levels, these shall not significantly impede overland flow or locally raise flood risk. To obtain subsequent floor levels refer to the Building Act.
- c) Where possible and practicable, secondary flood routes shall be via roads, public walkways or right of ways rather than through private lots.
- d) To reduce the rate of catchment stormwater flowing into the site either as backflow via stormwater connections or as surface runoff inundation, the site shall be contoured as necessary to ensure that:

- 1) Where practicable, the minimum finished level is greater than the crown level of the road/street to which the piped stormwater from the allotment is drained.
- 2) Stormwater shall not flow from the road reserve into the lot (either as backflow via stormwater connections or as surface run-off).
- 3) No fill shall be placed which interferes with the natural run-off from neighbouring land. Where filling of the site obstructs the natural run-off from an adjoining property then provision shall be made for the drainage of that property.
- 4) There is continuous fall towards the road/street that the site is draining to. Provision shall be made for potential development and filling of any intermediate sites.

5.6.5 Freeboard to Finished Ground Level

- a) Freeboard is a provision for flood level design estimate imprecision, construction tolerances and natural phenomena (e.g. waves, debris, aggradations, channel transition and bend effects) not explicitly included in the calculations.
- b) The minimum freeboard from the hydraulic grade level of the primary system capacity, as determined by Table 5-7 to the finished ground level (i.e. sump or manhole lid level) shall be 400mm.

5.6.6 Freeboard to Finished Floor Level

- a) The minimum freeboard from the hydraulic grade level of the overall system capacity, as determined by Table 5-7, to the finished floor level (or structure over a stream) shall be as follows:

Table 5-7 Freeboard to Finished Floor Level

Type of Structure	Freeboard above Overall System Capacity
Non-habitable residential buildings, garage floors etc	0.2m
Commercial and industrial floors	0.3m
Habitable dwelling floors	0.5m
Major communal facilities related to supply of electricity, telecommunications and water supply and wastewater disposal systems	0.6m
Bridges and buildings over Streams (freeboard to underside of structure)	0.7m

- b) In addition to the absolute minimum floor levels above, floor levels shall also be in accordance with the requirements of the Building Act.

5.7 HYDRAULICS

5.7.1 Pipelines (Gravity and Pressure)

- a) Pipe sizes and grades shall be calculated using standard hydraulic formulae (Manning, Colebrook-White), or an approved hydraulic calculator based on the above.
- b) A pipe roughness equivalent to one of the following shall be adopted to account for velocity head within the pipe line, gravel and grit deposits and other insitu variables such as construction performance and pipeline deterioration with age.

	Pipe Roughness
Mannings formula	n = 0.013
Colebrook-White formula	ks = 1.5mm
Mears Water Flow Calculator	Rough Concrete

- c) In addition, appropriate allowances shall be made for changes in direction, inlet and outlet losses and obstacles. The following table gives typical energy loss coefficients (k) (excluding changes in hydraulic grade line due to changes in velocity head which should also be allowed for).

Energy loss $h_e = K v^2/2g$ (h in metres, v in m/s)	
Type	k
Sharp pipe entry (from reservoir)	0.5
90° manhole (depending on radius)	0.5 to 1.0
Velocity head loss at outlet	1.0

- d) For short culverts and intake structures, refer Ministry of Works and Development Culvert Manual, Volume 1, CDP 706/A.

5.7.2 Calculation of Flow in Steep Pipelines

- a) Where a pipe gradient exceeds 1-in-10 an allowance for the bulking of the flow due to air entrainment shall be made. This allowance is made by increasing the area of the pipe for the additional volume of air in the flow. The air-to-water ratio may be calculated from the formula:

$$\frac{\text{Air}}{\text{Water}} = \frac{kV^2}{gR}$$

- b) Where:

- K = coefficient of entrainment (dimensionless)
= 0.004 for smooth pipes
= 0.008 for cast-in-situ concrete culverts
- V = velocity (m/s)
- R = hydraulic radius (m)
- g = acceleration due to gravity (9.81 m/s)

5.7.3 Sumps – Collection of Water from Side-Channels

- a) Sumps shall be located to ensure that the total system design flow can enter the pipe system and that surface flows across intersections are minimised. In hill areas the total system design flow will include run-off from any upslope hillsides that are not specifically drained. In many cases this will mean the use of closely spaced sumps or Toothed Connectors to ensure that the flow to which the piped system is designed can actually get into the system.
- b) Unless specific capacity of a sump intake is known or derived from first principles, the design capacity shall be as follows. Allowance has been made for partial blockage.

Sump	Location	Design Capacity (litres per second)
Single back entry	Installed in kerb and channel with a continual falling grade less than 1 in 8	30
Single back entry	installed in a low sag position in kerb and channel	75
Single back entry with toothed connector	In kerb and channel where grades exceed 1 in 8	40

5.7.4 Open Channels

a) Mannings formula $Q = \frac{AR^{2/3} S^{1/2}}{n}$ is usually satisfactory

- Q = flow m³ / s
- R = hydraulic radius (m)
- S = slope of surface
- A = water section area, m²

b) Typical Mannings n values are:

Concrete	0.011 to 0.017
Channels – with weeds	0.025 to 0.04
Frame and slab	0.035

c) Extra freeboard should be allowed in steep channels where roll waves can occur.

5.8 RETICULATION LAYOUT AND ALIGNMENT

a) The layout of the stormwater system shall take into account the requirement to minimise surface water infiltration of the foul sewerage system.

b) Generally deep pipelines exceeding 2.5m deep shall be avoided. Over depth pipelines are difficult to access in the future for maintenance and renewal works.

c) Where possible and practical, existing open waterways should be retained on their existing alignment in order to reduce works within the waterway to a minimum.

5.8.1 Drains in Roads

a) Main drains shall be aligned within public areas such as roads wherever possible providing stormwater is dealt with generally in its own catchment area.

b) Drains in roads shall be aligned parallel to kerb lines within the carriageway to ensure they do not clash with other services or occupy the full carriageway width. Adequate clearance from other services and kerb lines shall be maintained to allow for:

- 1) Excavation on existing services
- 2) The future relaying of the drains
- 3) The provision of additional future services

- c) In curved roads, drains shall generally follow the road alignment in straight lines between manholes on such alignment that they do not occupy the full carriageway width.

5.8.2 Drains Through Private Property

- a) The catchment area to be served by main drains aligned through private property shall be kept to a minimum.
- b) In planning the layout of drains through private property consideration shall be given to preserving access to drains for:

- 1) Maintenance purposes
- 2) Preserving the route for relaying the drains in the future
- 3) Avoiding likely positions for buildings, garages, carports and retaining walls
- 4) Secondary flood paths

- c) The preferred alignments of drains on private property shall be:

- 1) Within R.O.W.s or driveways
- 2) Outside probable building envelopes
- 3) Clear of fence lines and kerb lines
- 4) Adjacent to boundaries
- 5) Parallel to boundaries

- d) Where main drains must be aligned through private property, easements in favour of the Council may be required.

5.8.3 Easements Over Drains

- a) Where as part of a subdivision or development proposed pipes greater than or equal to 300mm diameter will be located in private property an easement shall be required in favour of the Council. The minimum width of easement shall be 3.0m.
- b) The standard wording required on Land Transfer Plans shall be:

"Memorandum Easement in Gross shall be provided in favour of NCC to convey stormwater in a pipe and to provide unrestricted access along the line of the pipe for maintenance and renewal work."

- c) Similar easements may be required over private common drains in favour of the lots served. Pipelines deeper than 2.5m may require easement widths greater than 3.0m to allow for wider than normal trench widths needed to access the pipe in the future.

5.8.4 Crossing Other Services

- a) Diagonal crossings of other services, including kerb lines and boundaries or fence lines, at acute angles less than 45 degrees shall be avoided wherever possible.

5.8.5 Building over or alongside a common private or public stormwater drain

- a) Building over or alongside any Common, Private or Public Stormwater Drain is only a Permitted Activity if it complies with the rules in the appropriate zone section of the Nelson Resource Management Plan.
- b) The engineering requirements for building over or alongside drains are as follows:

1) Structures:

- Must be located no closer than 1.0 metre measured horizontally from the centreline of any public or common private stormwater pipe or drain where the pipe or pipe equivalent (in the case of a drain) is less than or equal to 300mm in diameter.
- Must be located no closer than 1.5 metres measured horizontally from the near side of any public or common private stormwater pipe or drain where the pipe or pipe equivalent (in the case of a drain) is greater than 300mm in diameter.
- Which are balconies, may overhang the line of the pipe or drain, provided the balcony is cantilevered and its height above ground level is not less than 1.8m.
- Which are located within 3 metres measured horizontally from the near side of the pipe or drain must have the base of the foundations deeper than a line drawn at 30 degrees from the horizontal from the invert (bottom) of the pipe or drain (or between 30 degrees and 45 degrees if the design has been certified by a suitably qualified engineer).

2) Carports may be constructed over pipes or drains (but not watermains or other pressurized pipelines) provided that:

- The foundations are located in accordance with 1) above; and
- The fixture to the ground/floor is a bolt-down type design which permits quick and easy removal of the structure; and
- The carport is not closed in; and
- The floor is not concreted to a depth greater than 150mm; and

- An encumbrance is registered on the certificate of title for the property acknowledging the location of the pipe or drain under the building and reminding future owners that the above requirements apply and that access to the pipe or drain for maintenance and repair (and reinstatement afterwards) must be made available at the building owner's cost.

c) As an alternative to 1 and 2 above, structures may be located over common private or public drains, if they comply with Table 5-8 (Acceptable Techniques for Building Over Stormwater Pipes or Drains).

Table 5-8 Acceptable Techniques for Building Over Stormwater Drains

Technique A Applicable in the following zones: Industrial, Suburban Commercial, Open Space and Recreation, and Inner City	Technique B Applicable in the following zones: Industrial, Suburban Commercial, Open Space and Recreation, Inner City, and Residential
Structures may be located over common private or public stormwater drains or pipes, if:	Structures may be located over common private or public stormwater pipes, if:
<ul style="list-style-type: none"> • There are no changes in direction or junctions in the portion built over; and • The pipe is proven to be in good condition by internal inspection or a water test; and • The floor is constructed with lift out sections, and all foundations are designed to allow the entire drain or pipe to be readily exposed for maintenance and replacement work; and • Where the diameter of the pipe is 300mm or less, the design and use of the structure is such that an appropriate sized excavator could readily gain access along the line of the pipe for maintenance and replacement work, or appropriate access is available for hand digging; or • Where the diameter of the pipe is greater than 300mm, the design and use of the structure is such that a 12 tonne excavator and truck could readily gain access along the line of the pipe for maintenance and replacement work. 	<ul style="list-style-type: none"> • The diameter or width of the pipe is 150mm or less; and • The length of pipe built over is no more than 6 metres; and • There are no changes in direction or junctions in the portion built over; and • The length of pipe built over is relaid using a continuous length of pipe without joints, sleeved inside a 225mm diameter class 4 concrete pipe; and • There is practical access and the foundations are designed to allow the pipe to be readily exposed at both ends of the sleeve for maintenance and replacement work; and • There is a minimum 6-metre clear length at one end of the sleeve to allow replacement of the pipe.

d) Detailed Engineering Drawings of the proposed work are required.

5.9 PIPED SYSTEM SPECIFICATIONS

5.9.1 Pipe Design

- a) All systems shall be designed to accept flows from above a proposed development, and shall be of sufficient capacity to provide for flows from maximum probable development.
- b) Pipe capacity matching that of the pre-developed state, will only be accepted if appropriate mitigation measures (such as detention structures or on-site detention) approved by Council are constructed by the developer.
- c) Any mitigation measures must be designed so that flows in the entire downstream network are attenuated for the appropriate design event(s). Refer to the detailed requirements for detention basins/ponds in this standard.
- d) Table 5-9 sets out the minimum specifications for public stormwater pipe design.

Table 5-9 Minimum Specification for Public Stormwater Pipes

	Concrete pipe	uPVC pipe
Permitted size	Minimum 225mm ID Thereafter in 75mm increments	Minimum DN 225mm ID Maximum DN 500mm ID
Minimum standard	NZS 4058	AS/NZS 1254
Material strength	Minimum Class 2 and in accordance with AS/NZS3725	Minimum SN 4 Specific design to AS/NZS2566 method for depth >5.0m, or traffic wheel loads >96 kN
Cover depth	Refer Table 5-10	Refer Table 5-10
Joints	Rubber ring jointed	
Pipe capacity	6.67% AEP (1 in 15 year)	
Flow velocity	Minimum 0.75m/s* Maximum 6.0m/s	
Pipe location (in preference)	Road reserve	
Clearance from other services	Minimum 200mm vertical Minimum 500mm horizontal (lesser clearance on approval of the Engineering Manager)	
* Gravel or silt traps may be required to be installed in low velocity flow situations.		

5.9.2 Calculation of Pipe Capacity

- a) Pipe sizes and grades shall be calculated using standard hydraulic formulae (Manning, Colebrook-White), or an approved hydraulic calculator or model.
- b) Piped stormwater systems should generally be designed to flow full or part full under gravity at design flows with pipes aligned soffit-to-soffit.
- c) Except at intake structures, it will not be permitted to reduce the diameter of pipe even where changes in grade would produce the required capacity in a smaller diameter of the downstream pipe. This is due to the potential for debris/sticks which could enter the system to block at the reduced orifice.
- d) A pipe roughness calculated using either the Mannings ($n = 0.013$) or Colebrook-White formulae ($k_s = 1.5\text{mm}$ – up to 450mm dia/ $k_s = 0.6\text{mm}$ – over 450mm dia) shall be adopted, to account for gravel and grit deposits and other in-situ variables (such as construction performance and pipeline deterioration with age). Losses due to bends, manholes and sumps shall be incorporated into the design of pipe systems.

5.9.3 Pressurised Pipelines

- a) A pressurised stormwater system shall be subject to the Engineering Manager's approval. Stormwater pumping is not generally permitted. Any stormwater pump station design must be specifically approved by the Engineering Manager and generally be in accordance with Council's wastewater pump station design standards.
- b) Where a non-pumped pressurised stormwater system is deemed to be necessary (for a 6.67% AEP design storm) the hydraulic grade line shall be plotted on the longitudinal section. Reduced levels and the hydraulic gradient shall be quoted for the entire length of the pipeline. In no cases shall the hydraulic grade line be above finished ground level.

5.9.4 Pipe Cover

- a) Pipe systems shall be designed to ensure the minimum cover over the barrel in accordance with Table 5-10.
- b) Generally deep pipelines exceeding 2.5m deep should be avoided. Over-depth pipelines are difficult to access in the future for maintenance and renewal works.

Table 5-10 Pipe Cover Standards

Location of Pipe	Minimum Cover Required	
	Concrete Pipe	PVC Pipe
Areas subject to highway traffic loading e.g., within road carriageway.	600mm	750mm
Areas subject to light traffic loading outside road e.g. ROWs, driveways, car parks and berms.	450mm	600mm
Areas never subject to traffic loading.	300mm	450mm
Under continuous concrete encasement for full circumference (specific design required to mitigate expansion of pipe material).	300mm	300mm

- c) Minimum cover may be reduced providing the pipe is concrete encased for concrete pipes and concrete capped for PVC and subject to the Councils' approval.
- d) Where pipes with inadequate cover require concrete encasement or capping this shall be to the requirements of SD No 618 and the extent and thickness of concrete and concrete strength shall be specified on the drawings.
- e) To avoid reflective cracking of pavements and differential settlement concrete encasement and capping shall not be permitted to penetrate the basecourse or pavement construction.
- f) No concrete protection shall be placed around the pipe until the line has been inspected and approved by the Council.
- g) Reduced cover on pipes may be approved providing the appropriate class of pipe is specified and cover is according to the manufacturer's specification.

5.9.5 Pipe Access Openings

5.9.6 Manholes

- a) Where site conditions require close spacing of manholes, consideration will be given to the use of roding points or mini-manholes in between standard 1050mm diameter manholes.
- b) Manholes shall be provided at minimum intervals of 100m, at changes of grade, direction or pipe size and at junctions and end points of public stormwater pipes.
- c) A fall of no less than 50mm shall be provided through all manholes.
- d) All pipe soffits shall be matched to the soffit of the outgoing pipes incorporating the 50mm fall noted above when working with different pipe diameters.

Table 5-11e) Table 5-11 sets out the minimum specifications for manholes, mini-manholes and roding points.

5.9.7 Manholes

- e) Where site conditions require close spacing of manholes, consideration will be given to the use of roding points or mini-manholes in between standard 1050mm diameter manholes.
- f) Manholes shall be provided at minimum intervals of 100m, at changes of grade, direction or pipe size and at junctions and end points of public stormwater pipes.
- g) A fall of no less than 50mm shall be provided through all manholes.
- h) All pipe soffits shall be matched to the soffit of the outgoing pipes incorporating the 50mm fall noted above when working with different pipe diameters.

Table 5-11 Required Pipe Access Openings and Limiting Requirements

	Manholes	Mini-manholes	Roding Point
Locations where pipe access must be provided	Manholes to be provided at: change in grade change in direction change in size pipe junctions end of public pipe 100m max spacing	Mini Manholes to be provided at: private connections, out of areas subject to traffic loading.	Roding Point to be used at: Change in grade at top of steep sections.
Maximum pipe size	450mm (1050 mm dia) 750mm (1350 mm dia) 1075mm (1500 mm dia) 1200mm (1800 mm dia)*	225mm ID	225mm ID
Maximum depth	2.5m	1.0m for public pipe	2.5m
Maximum deflection angle	90° for pipe to 375mm 60° for pipe >375mm	45°	
Maximum distance between centres	100m	100m	50m
Approved materials	Concrete	PVC, PE Concrete	uPVC
Standard Drawing	602 – 609 and 507	605	610 and 611

* Factory-made "T" manholes will be permitted for pipes of 1350mm diameter and over, subject to the approval of Council.

5.9.8 Mini-manholes

- a) Shallow concrete mini-manholes shall be in accordance with the requirements set out in SD 605.
- b) Prefabricated PVC or PE mini-manholes shall only be used on approval by Council.

- c) Mini-manholes are not to be used in areas subject to vehicular traffic, except where formed in residential driveways or rights-of-ways open to light domestic vehicles. In this instance they shall be located out of usually trafficked areas.

5.9.9 Roding Point

- a) The use of roding points shall be limited to changes in pipe grade or alignment, at the top of steep banks where installation of a manhole or mini-manhole would not be practicably feasible.

5.9.10 Sumps

- a) Sumps shall be to Nelson City Council standard (i.e., 900mm x 450mm) and constructed in accordance with SD 510 and in accordance with the requirements of Table 5-12.
- b) The standard sump to be incorporated with all kerb and channel or mountable kerb and channel is the Back Entry Sump as detailed on SD 510 - 514.

Table 5-12 Required Sump Locations and Limiting Requirements

	Standard Back Entry Sumps	Standard Back Entry Sumps with toothed connectors	Double Back Entry Sump
Approved locations	At each tangent point of the channel on the upstream side of road intersections where the grade is flatter than 1:10. At any low spot in a channel. Serving any right-of-way. Bubble sump in channel (TDC approved only).	At each tangent point of the channel on the upstream side of road intersections where the grade is steeper than 1:10. Where the channel upslope of the sump is steeper than 1 in 10. Where area of the catchment warrants the provision of adequate stormwater entry.	Where the length of kerb and channel draining to a low point is excessive. At a low point at the head of a cul-de-sac or street where secondary flow paths flow through private property.
Minimum lateral pipe size	225mm ID	225mm ID	300mm ID
Standard Drawing	510 - 514	508 and 509	Use 510
Maximum depth	1300mm		
Maximum distance between sumps*	Standard kerb: 100m Mountable kerb: 60m (Subject to specific design on a case-by-case basis)		
Approved materials	Concrete		
Note: - Closer spacing of sumps may be required depending on the rate of runoff expected. Sumps shall not be positioned at vehicle crossings or pram crossings.			

- c) Sumps draining private right-of-ways can be provided with a minimum lateral pipe size of 150mm ID subject to suitable catchment design and a secondary flow path being directed to the road carriageway.
- d) Where a sump unavoidably coincides with a vehicle crossing (and back entry is not feasible) an additional standard (back entry) sump or a side entry shall be constructed on the upstream side of the crossing and the pipe extended into the sump.
- e) The tolerance for the location, alignment and level of a sump shall be as follows:
 - 1) Lateral alignment of the sump top shall be within a maximum of plus or minus 10mm of the design line of the kerb and channel.
 - 2) The skew of the sump top in relation to the kerb and channel alignment shall be within 10mm of being parallel.
 - 3) The sump shall be placed within 20mm of being vertical.
 - 4) The maximum depth of a sump shall be 1300mm as per SD 510.
 - 5) The finished level of the sump shall ensure compliance with the tolerance requirements for kerb and channel finished level as per the roading network section.
- f) The vertical alignment of kerb and channel shall be designed to ensure that no low point requiring a standard sump will coincide with any kerb and channel curve of less than 50m radius (except at the turning heads of cul-de-sacs).
- g) Sumps which are located in tidal areas or in areas subject to flooding may require non-return systems as shown on SD 516 to prevent backflow up the line. Other designs will be assessed on a case-by-case basis.
- h) Sump connections may be made to the stormwater pipe by use of saddle connections as in the following sections, where this is physically possible.

5.9.11 Individual Site Connections

- a) Connections to each site shall meet the following standards:
 - 1) In all subdivisions a stormwater connection of a minimum 100mm diameter shall be provided to each property and terminate at least 1.0m inside the boundary of each lot. (This does not apply to sections fronting existing legal streets where the wastewater network are available in the street and are within 15m of the lot boundary and provided that the drain will not cross any lot other than the one being served) The pipe end shall be painted green to denote that it is a stormwater

pipe and each connection shall be marked by a 75mm x25mm marker stake suitably identified.

- 2) On generally flat land, sloping at 1-in-50 or less, each connection shall be capable of serving the entire building area of the section by gravity.
 - 3) On land steeper than 1-in-50 every effort shall be made to serve the entire section. Where this proves to be impossible and the servicing of the site is limited the area on each lot capable of being serviced shall be shown on the Engineering Drawing.
- b) Kerb entries are generally not permitted in the Nelson City Council area. Where specific approval is given by Council for stormwater disposal via kerb entries, then these may only be installed using approved kerb entry adapters. Where cover is inadequate to permit the use of PVC pipe, or hot mix is to be laid over the pipe, then pipes under footpaths and berms should be 100mm diameter galvanised steel.
 - c) In some areas and special cases (i.e. free-running gravels and sands), on application and subject to Building Code requirements soakage disposal may be an approved option. Note these may be required to be over-designed to cater for the lack of a secondary flow path.
 - d) On-site requirements for stormwater management systems, such as special sumps and filters, are governed by the Building Act and its regulations.

5.9.12 Contaminated Stormwater

- a) Stormwater discharges to the Nelson City Council stormwater network must comply with the requirements of the Nelson City Council Stormwater Bylaw. Those that discharge to freshwater bodies must comply with the requirements of the NRMP and require resource consent.
- b) When requested by the Nelson City Council Manager Infrastructural Assets, the operator of any industrial or trade processes shall prepare a site or operation specific Pollution Prevention Plan as defined by the Nelson City Council Stormwater Bylaw.

5.9.13 Discharge from Oil and Silt Traps

- a) Effluent that contains a combination of detergent and/or degreasing agents with oil and/or silt shall be directed to the wastewater after first passing through a silt and oil trap built to SD 520. To ensure stormwater does not enter the wastewater system the area being served by the silt and oil trap must be roofed and have a low bund around the perimeter with a minimum height of at least 50mm.
- b) Any proposal to make such a discharge to the wastewater system shall require a Trade Waste application.

- c) In some locations a gravity connection to the wastewater may not be possible and the discharge may have to be pumped into the wastewater system. This shall require specific design and approval.
- d) Bunded areas around fuel storage areas should discharge to the stormwater via a suitably designed oil interceptor with an appropriate shut off valve system to contain fuel spills.
- e) Where it is considered that there is a high risk of yard runoff being contaminated with oil and silt, an oil and silt trap shall be required with a connection to the stormwater system. This shall require specific design and approval. An appropriate mechanically or electronically operated wastewater diversion system may be required to be incorporated. Stormwater shall not be allowed to discharge to the wastewater system.
- f) Building consents are required for all works.

5.10 SECONDARY SYSTEM OF OVERLAND FLOWPATH

- a) A secondary system of overland flowpath is to be designed to safely convey excess stormwater to maintain the overall capacity requirements as specified in Table 5-2 without undue nuisance.
- b) Where possible, secondary systems shall be located on land that is, or is proposed to become public land. If located on private land, the secondary system shall be protected by legal easements in favour of Council.
- c) Acceptable solutions include:
 - 1) Temporary ponding and/or flow on local and collector roads.
 - 2) Where roads are designed as part of a secondary flow path, adequate access and egress should be provided to affected properties. Light vehicles should be able to pass along the road in a 50 year ARI event, and large 4WD in a 100 year ARI event. Ponding should be limited to a 100mm maximum height at the centreline.
 - 3) Flow across private property must be in a defined channel or swale, clear of existing or future building sites and protected by an easement in favour of Council and a Consent Notice which prohibits ground reshaping and the erection of any barriers to the secondary flows.
 - 4) Fencing shall not be permitted across overland flowpaths unless it is approved by Council.
- d) Piped secondary systems are discouraged due to the risk of blockages. These may only be used where no other option exists and are subject to approval of the Engineering Manager.

5.11 OPEN CHANNEL DESIGN

- a) Where natural open drain systems or artificially formed channels (open drains) are to be incorporated in the stormwater drainage system, they shall be located within a drainage reserve of sufficient width to contain the full design flood flow together with a freeboard of appropriate engineering design.
- b) The flow characteristics of open drains shall be based on the likely long term stream condition in terms of density of vegetation and take due account of the possibility of blockage under peak flood conditions.
- c) Designed open channels must have a “natural” appearance, incorporating natural flow regimes including planting, that encourage and support native plants, fish, invertebrate and bird habitat. A comprehensive design and Resource Consent may be required by Council to fulfil these design criteria.
- d) Where natural open drain areas form part of the stormwater drainage system they shall be cleared of all unsuitable plant growth and replanted to an appropriately approved landscape design (See section 12 Reserves and Landscaping). These works shall include protection of the low flow channel against scour and erosion of the bed where necessary. Access from public carriageways shall be provided for maintenance purposes.
- e) The natural flow conditions of the open drain should not be changed by the discharge of stormwater resulting from development or a new discharge to the stream. Flow rate characteristics of the open drain should be maintained to avoid erosion of the open drain embankments. Catchment or detention factors that may lead to an increase in the temperature of the stormwater (e.g. large sealed areas) also need to be considered.

5.11.1 Access

- a) Reserves, as required by 5.11a), shall have maximum batters of 1 vertical to 5 horizontal and when access for maintenance is required, shall include:
 - 1) An all weather surface
 - 2) 4m wide berm able to be accessed by a 8.2t axle weight vehicle for its entire length
- b) Drawings of the proposed access shall be submitted to Council for approval prior to commencing construction of the access

5.11.2 Drainage Reserves

- a) To encourage the best use of the Drainage reserves the drainage reserves shall be linked with other reserves and other public open spaces, to accommodate off road pedestrian and cycle access. Access points for public use and maintenance shall be provided at regular intervals along the system together with footpath and pedestrian bridges, as may be defined in the resource consent.

5.11.3 Piping of Watercourses

- a) The piping of natural watercourses should be avoided. Continuously flowing and ephemeral water courses should be retained as natural drainage features where practicable.
- b) Retention of existing open channels is preferred and the design and layout of a development will therefore need to factor in access and maintenance requirements.
- c) Where piping of watercourses is necessary, the following standards shall apply:
 - 1) Resource consent will be required
 - 2) Should a watercourse be piped (such as in an intensively developed area), a subsoil drain shall be laid at the invert level of the pipe and connected to manholes, to ensure groundwater levels are not forced to rise. Where pipe routes differ from the original stream course, sufficient protection from seepage in the original stream bed shall be provided.
 - 3) Secondary flow paths shall be provided. These shall be shown on the Engineering Drawings and protected by easements.
 - 4) Where a continually flowing or ephemeral stream is culverted or piped, allowance shall be made for fish passage, and provision of an in-stream environment. As a minimum, pipes and culverts shall be increased in size above that normally required and shall be embedded such that the invert is 50mm below the stream bed.

5.12 PIPED INLET STRUCTURES

5.12.1 General Design Requirements

- a) Every inlet to a piped stormwater system shall be provided with a suitable inlet structure and grill. Refer to SD 503 for details of the Standard Stormwater Inlet Structure.
- b) In general, the minimum height of headwall above the design stream flow should be 300mm. Barriers complying with Building Act may be required if the drop is greater than 1m.

- c) In general, structures are to be constructed in reinforced concrete and where possible be modified to provide an aesthetically pleasing appearance suitable to the particular site.
- d) Where appropriate intakes are to be constructed to allow fish passage to enable the fish to migrate further upstream.
- e) Refer to SD 510 and 512 for details of the Standard Sump. (For use as a minor intake only and where the risk of blockage is minimal.)
- f) Under no circumstances shall a grill be placed flush over the intake/inlet of a stormwater pipe.
- g) Pipeline and culverts requiring an inlet structure shall take account of the inherent hydraulic losses associated with flow transition to ensure the inlet is appropriately sized to convey the design flow without heading up and overtopping.

5.12.2 Secondary Intakes, Deep Trap Sumps and Catchpits

- a) Apart from the requirements for inlet structures and grills as detailed on SD 503, modified intakes may be required at specific locations to provide additional protection to the pipe inlet against the risk of blockage by solids and floating debris, see SD 504 - 506.
- b) SD 504 and 505 provides details of general examples of deep trap sumps and railway iron trash racks and catchpits. Each case will require specific design to suit the site with regard to peak flows, secondary intakes, expected debris and access for maintenance. Final details shall be submitted to the Council for approval.

5.12.3 Temporary Intakes

- a) In the case of a temporary intake, the structure shall be adequate for the estimated period before the permanent extension. Temporary intakes and outlets shall be designed to cope with individual requirements including fish passage.

5.12.4 Access to Intake Structures

- a) An all weather access track for trucks and wheeled excavators shall be provided to the location of all intakes, deep trap sumps and catchpits. The access shall consist of a 3m minimum width all weather surface no steeper than 1 in 5 with an easement or right of way in favour of NCC for pipe systems 300mm diameter or greater.
- b) Where the piped system is less than 300mm diameter the Engineering Manager may approve an access suitable for pedestrian and plant only. Under no circumstances though, will approval be given for an access steeper than 1 in 2. An easement may be required to protect the access-way.
- c) There must be sufficient space provided adjacent the intake structure for operation of plant to work at the intake.

5.13 SURFACE CUT-OFF CHANNELS

- a) Approved cut-off channels may be required parallel and adjacent to the uphill boundaries of upper sections to protect them from surface water runoff. When required, these shall be located within the upper boundary of the property to be protected and covered by suitable easements.
- b) In this case a consent notice shall be placed on the section outlining that the property owner is responsible for maintaining the cut-off channel.

5.14 CULVERTS UNDER FILL

- a) Culverts shall be of sufficient strength to support all designed super imposed loads in accordance with NZS/AS 3725 and culvert design manuals. Note – minimum 375mm diameter for rural access crossings.
- b) Culverts shall have adequate wingwalls, headwalls, aprons, approved grills, traps and/or pits to prevent blockage, scouring and erosion.
- c) Inlets shall be designed to ensure adequate intake capacity and provide headwalls no lower than maximum surcharge levels.
- d) Sufficient erosion protection shall be provided in the event of flow over an embankment.

5.15 SUB-SOIL DRAINS

- a) The recommendations of NZS 4431: 1989, Code of Practice for Earthfill for Residential Development shall be followed except where otherwise specified in the Nelson City Council Land Development Manual.
- b) Sub-soil drains are not to be considered as part of the surface water drainage system.
- c) To avoid the appearance of seepage in dry weather, sub-soil drains shall not discharge to the kerb and channel or road surface.

5.16 LOW IMPACT DESIGN (LID)

5.16.1 General

- a) As far as practicable all development should apply the principles of Low Impact Design (LID) and the application of "Best Management Practices" to reduce stormwater runoff volumes and peak flow rates and to improve the quality of stormwater runoff entering the receiving environment.

- b) Due to the unstable nature of Nelson hill soils, it is expected that in most situations a combination of alternative (LID) methods coupled with conventional (piped) systems will be the most appropriate for hillside developments and sites with unsuitable soils.
- c) Where disposal of stormwater to soakage is proposed then detailed site specific geotechnical investigation, including comprehensive soakage testing, must be undertaken to assess the suitability of the site for stormwater disposal by soakage.
- d) The desired outcomes of using a LID approach to stormwater management include:
 - 1) A more natural approach towards stormwater management.
 - 2) A reduction in stream erosion.
 - 3) Preservation and if possible the enhancement of river and marine water quality.
 - 4) An integrated approach towards residential design.
 - 5) The methods and detailed design of stormwater management systems support the amenity of the area and are appropriate for adjacent land uses, in particular with town centres.
- e) The above principles are best considered during the initial planning, design and construction stages of the project. Good planning and design early in the development process maximises the cost-effectiveness of LID.
- f) Guidance on the implementation of LID can be obtained from the following sources:
 - 1) ARC TP10 Design Guideline Manual Stormwater Treatment Devices
 - 2) ARC TP124 Low Impact Design Manual for the Auckland Region 2000
 - 3) NZWERF On-site stormwater management guidelines
 - 4) SNZ HB44:2001 Subdivision for People and the Environment
- g) The Council encourages a holistic approach towards LID including combinations of the following in a "Treatment Train" approach:
 - 1) Minimising site disturbance
 - 2) Revegetation
 - 3) On-site stormwater mitigation
 - 4) Larger, communal off-site stormwater mitigation

5.16.1.1 On-site stormwater mitigation

- a) The Council's preferred methods for on-site stormwater mitigation are those methods which provide multiple benefits. These include:
 - 1) Rainwater harvesting using single or dual purpose rainwater tanks
 - 2) Bioretention using rain gardens, tree pits, stormwater planting and bioretention swales
- b) Other methods of on-site mitigation include:
 - 1) Permeable paving
 - 2) Green roofs
 - 3) Flow attenuation device
 - 4) Infiltration devices (soak pits)
 - 5) Proprietary filtration devices
 - 6) Oil and grease separators
 - 7) Sand filters
 - 8) Detention tanks

5.16.1.2 Off-site stormwater mitigation

- a) Off site stormwater mitigation includes stormwater mitigation which treats multiple freehold lots and which usually vests in the Council as public infrastructure. Preferred methods include:
 - 1) Bioretention – filter strips with planted swales, tree pits, rain gardens.
 - 2) Wetlands
 - 3) Ponds
- b) Other devices could include:
 - 1) Detention basins/ponds
 - 2) Proprietary filters
 - 3) Sand filters

5.16.2 Planting Associated with Stormwater Devices

- a) Refer to 12.4.4 of the Reserves and Landscaping Section and ARC TP10 for further information.

5.16.3 On-Site Retention of Stormwater

- a) Water is a valuable resource and land owners are encouraged to retain and reuse stormwater collected on their site.
- b) Retention of stormwater can be achieved via holding tanks on site. The lower two-thirds of a tank can be used for stormwater reuse and the top one-third of the tank for detention and slow discharge to Council's reticulation system if available. SD 526 gives a working example for stormwater retention design. For further details, refer to Auckland Regional Council's Technical Publication 10.

5.16.4 Detention Basins/Ponds

- a) Detention basins/ponds that are to be vested in Council must have the prior approval of the Engineering Manager. Detention basins/ponds may be needed for the control of stormwater flows should downstream systems be substandard.
- b) Detention basins/ponds must be designed and constructed to a standard acceptable for it to be incorporated into local purpose reserve areas where possible. See 12.2.8 of the Reserves and Landscaping section.
- c) If detention basins/ponds are approved they should be designed to the requirements of Auckland Regional Council's Technical Publication 10, and including the following criteria:
- d) Detention basin design shall mitigate any actual or potential adverse effects by addressing the following points:
 - 1) side slope stability and safety considerations;
 - 2) ease of access and maintenance, including mowing and silt cleanout;
 - 3) shape and contour for amenity value;
 - 4) the effectiveness of the inlet and outlet structure;
 - 5) secondary overflow options;
 - 6) dam or bank failure;
 - 7) silt traps;
 - 8) fish passage, habitats and birdlife enhancements;
 - 9) road frontage of not less than 30m width;
 - 10) pedestrian links to other reserves;
 - 11) safety fencing;
 - 12) vegetation islands, shading.

- e) Detention basins/ponds shall comply with the requirements of the Reserves and Landscaping section of the Manual and to the approval of the Nelson City Council Divisional Manager Community Services prior to vesting as 'reserve'.
- f) The 50%, 20%, 6.67% and (where required) 2% AEP design storm peak flood flow from the developed catchment shall be no greater than would have occurred from the undeveloped catchment at the critical downstream location(s) in the network. This requirement may result in design for a number of duration rainfall events. Where necessary, additional storage volume shall be provided to mitigate potential effects of any additional total flow from the development.
- g) A freeboard of 400mm minimum shall be provided above the maximum design storage level to the spillway crest.
- h) The spillway shall be capable of passing the Probable Maximum Precipitation (that the catchment would discharge into the structure) without risk of overtopping the structure or eroding the spillway.
- i) In locations where the majority of the flow into the structure would be via overland flow and open channels, then a stormwater intake structure will be required. An acceptable 'indicative only' example is shown on SD 503. The intake structure must be designed and constructed to provide an aesthetically pleasing appearance suitable to the particular site.
- j) In locations where the majority of the flow into the structure would be via piped systems the systems shall be extended through the dam basin with surcharging capabilities to allow:
 - 1) Multi-use (recreational) options for the dam basin area
 - 2) Peak flood flows to surcharge out of the pipe system into the storage basin
 - 3) Stored water to drain away once the flood peak has passed
- k) In all cases a secondary intake shall be provided. An 'indicative-only example' is shown on SD 504 Type C. The top of the intake shall terminate 400mm below spillway crest level. The intake structure must be designed and constructed to provide an aesthetically pleasing appearance suitable to the particular site.
- l) An all weather access track shall be provided from legal road reserve to the basin and intake structures. The track shall be no steeper than 1 in 7 (steeper gradients up to 1 in 5 may be permitted if provided with permanent sealed surface), have a physical width of not less than 3.0m and be provided with stormwater control.

- m) A design and construction certificate shall be provided for each structure by a suitably experienced, Chartered Professional Engineer stating that the dam has been designed and constructed in accordance with the appropriate standards.

5.16.5 Vegetated Swales

- a) In some cases, swales can be used to provide an alternative to a piped system. The following criteria shall be used in the design of these systems:

- 1) Longitudinal Slope 1 – 5%
- 2) 100mm maximum water depth above vegetation
- 3) 2m maximum bottom width
- 4) 30m minimum length
- 5) 3:1 maximum side slope
- 6) in conjunction with reticulated drainage

- b) Further design information can be found in Auckland Regional Council's Technical Publication 10.

5.16.6 Rain Gardens

- a) The minimum requirements for a rain garden are:

- 1) An under drain must be used
- 2) Minimum 50mm gravel cover over the under drain
- 3) Must include a ponding area
- 4) Filter Fabric must be used on at least the side walls (open weave in stable soils and impervious in unstable soils)

- b) Further design information can be found in Auckland Regional Council's Technical Publication 10.

5.16.7 Operation, Monitoring and Maintenance

- a) The long-term effective operation of on-site and off-site LID devices depends not only on sound design and construction, but also on applying routine and sound operation and maintenance practices. The design and construction of any stormwater management practice shall take into consideration the future ownership, access and maintenance requirements and shall ensure that maintenance can be carried out with little or no disturbance to the surroundings or neighbouring properties.

- b) An Operation and Maintenance Manual for stormwater management devices, public or private, shall be provided to Council for approval at the time of application for resource consent. The manual shall include information about what, when and how a proposed system will be maintained to ensure its ongoing effectiveness in achieving stormwater management functions and how the device will be protected from any ongoing development or building works in the area. As a guide, Table 5-13 below sets out the minimum monitoring and maintenance requirements and frequencies for LID systems.

Table 5-13 Maintenance and Monitoring Requirements for LID systems

Device	Item	Frequency
All	Inspection by a Certified professional	5 years
Swale/Filter Strip	Clear debris, litter from entry and contributing areas	As required, at least quarterly
	Mow grass to keep height between 50mm and 150mm	As required, at least quarterly
	Check that there is a thick growth of grass or other approved thin stemmed vegetation. Reinststate vegetation as necessary, remove undesirable vegetation	As required, at least quarterly
	Check that flow is evenly dispersed, remedy concentrated flow or erosion damage by revegetation, earthworks or installation of level spreaders or additional check dams	As required, at least quarterly
	Removal of accumulated sediments, restore vegetation as required	As required, at least annually
Infiltration Trench	Clear debris, litter from entry and contributing areas	As required, at least quarterly
	Evaluate performance during a rainfall event	6 monthly
	Remove accumulated sediments, clear excessive vegetation and repair damaged areas	Annually
	Remove small section of upper trench and inspect upper layer of filter material for sediment deposits. If clogged, restore to original condition	2 yearly
Rain Garden	Clear debris, litter from rain garden and contributing areas	As required
	Remove noxious or invasive weeds and plants	As required but inspect at least quarterly
	Check plant height and density, prune excessive vegetation, replace plants if necessary	As required, but at least 6 monthly

Device	Item	Frequency			
	Check that the surface dewaters between storms: 220mm of ponded water depth should empty within 1 or 1.5 days depending on design (residential, commercial/industrial). If longer, check for surface clogging, remove sediment. Replace planting soil medium if required	6 monthly			
	Outlet/overflow spillway: check condition, scour erosion, blockage	6 monthly			
	Sediment accumulation: remove if more than 30mm depth, re-establish plants after sediment removal	Annually			
	Rain garden integrity: check device has not been blocked or filled in	Annually			
	Replace mulch	Every 2 to 3 years			
Porous Pavement	Evaluate performance during a rainfall event	6 monthly			
	Remove sediments and debris that can potentially clog pores	Annually			
	Repair damaged areas in paving surface	Annually			
Proprietary Devices	Design specific	Design specific			
Rain Tank		After storm	Quarterly	Annually	2 yearly
	Spouting and downpipes: check for problems such as debris/blockages and leaks and rectify	✓	✓	✓	✓
	First-flush diverter device: check for blockages; empty debris/sediment	✓	✓	✓	✓
	Tank water quality: check for clarity and odour		✓	✓	✓
	Tank structure: check for leaks and rectify			✓	✓
	Tank cleaning: empty the tank and clean out any sediment accumulations and growths				✓

c) The manual must include estimated costs of ongoing maintenance and address the following matters where they are applicable:

- 1) A comprehensive description of ongoing maintenance procedures required to ensure that the system/s operates effectively and efficiently;
- 2) Clearly defined ownership and management responsibilities for every part of the given system, including the resource consent holder(s);

- 3) For devices located on private property (individual lots or right of ways) a consent notice or other suitable encumbrance shall be registered on the property/ies stipulating the specific requirements and obligations of the landowner regarding ongoing operation and maintenance works and costs;
- 4) For lots adjacent devices within roads or other public areas, a condition shall be included with the building site certification for the lot (prior to 224 certification) requiring sediment control devices (such as construction entrances and silt fences) to be shown on the building plans submitted for building consent and requiring that these devices be erected and maintained by the applicant prior to commencement of building works or earthworks on the lot to prevent runoff of sediment. A detail of the sediment control devices shall be provided by the Developer with the building site certification.
- 5) Raise public awareness by erecting and maintaining signs within the subdivision informing builders, contractors and tradespersons about the onsite stormwater systems and the importance of ensuring vehicles and sediment are kept away from the devices;
- 6) The developer shall produce brochures for prospective landowners informing them of the onsite stormwater devices and their obligations as landowner. These brochures shall be made available through sale and agreement transactions and at the time of building consent approval;
- 7) Specification of accessibility to all points of the stormwater system;
- 8) An assessment of the durability of each device/system and/or materials used;
- 9) Specification of any resource consent conditions, and description of how they will be achieved;
- 10) Sufficient information to describe how the proposed device integrates into the existing infrastructure;
- 11) The replacement value of any system devices, including the method of replacement; and
- 12) Lifecycle costing of the given system.

5.17 PIPE SYSTEM CONSTRUCTION AND INSTALLATION

5.17.1 Excavation Works

The following standards and conditions apply to the excavation in preparation for pipework laying:

5.17.1.1 Trench width

- a) The Minimum trench width shall be 300mm wider than the external diameter of the collar of the pipe being laid.
- b) The trench shall be of sufficient width to permit with freedom the installation of all trench support and to allow the laying and jointing of pipes and placing of bedding and pipe surround materials. See SD 617 and 523.

5.17.1.2 Base of excavation

- a) No construction or work upon the excavation bottom shall commence until the natural bottom of the excavation has been inspected and accepted by the DPA.
- b) The foundation of the trench is to be checked for stability of the soil by the DPA. Generally a plate compactor is to be run over the trench floor to bind the surface and identify any obvious weak spots. Where the bottom of an excavation is unable to provide a firm foundation with minimum bearing capacity of 50kPa (e.g., clay soils that can easily be penetrated 40mm with a thumb or in sand or gravel that makes a footprint more than 10mm deep) at the required level without abrupt irregularities, engineering advice should be sought on how to provide a satisfactory foundation (see AS/NZS 2032:2006, clause 5.3.6). The DPA shall order the use of additional granular bedding material as specified in AS/NZS 3725:2007 for concrete pipes, or AS/NZS 2566.2:2002 for PVC and other flexible pipe systems.

5.17.1.3 Trench support

- a) The Contractor shall provide trench support to comply with the requirements of the Occupational Safety and Health service of the Department of Labour. The Contractor shall ensure that the sides of the trench are sufficiently supported so that cracking of the surrounding ground does not occur.
- b) Where trench support extends below the invert of the pipeline or structure special precautions may be required, including leaving part of the support in place, to ensure the foundation of the pipe or structure is not weakened.

5.17.1.4 Trench in an existing watercourse

- a) Where the trench is in an existing watercourse, drain, or gully, etc, the Contractor shall strip all vegetation and organic material from the sides and bottom before placing foundations or backfill.

5.17.1.5 Dewatering

- a) Excavations shall be kept free of water during construction.

- b) In no circumstances shall stormwater or ground water be allowed to drain into any existing wastewater drain, and pipe ends shall be plugged to prevent such ingress.
- c) Discharge of stormwater or groundwater to existing stormwater drains or the pipes already laid will be permitted providing adequate silt traps prevent debris and suspended matter from entering drains. Should deposits in existing stormwater drains or the pipes already laid occur as a result of the operations of the Developer or the Contractor such deposits shall be cleared forthwith at the Developer's or the Contractor's cost as the case may be.
- d) Ground water lowering may be permitted except where this practice may present a risk of subsidence.
- e) The Contractor or Developer shall cause as little damage or interference to property or persons as possible in disposing of water from the works, and shall be responsible for any damage or interference, which may be caused. This shall include any damage to the structure of any road.

5.17.2 Bedding of Pipes and Pipe Protection

5.17.2.1 Metal bedding

Note: Includes bedding, haunch support and side support material as defined by NZS 2566.2:2002 and AS/NZS 3725: 2007.

- a) Metal Bedding shall be in accordance with SD 617 and 523. (For concrete pipes, "Type H2" bedding in accordance with AS/NZS 3725:2007 shall be used.)
- b) The bedding material shall be:
 - 1) In a sand environment - Sand
 - 2) For PVC and flexible pipes - AP20 as per SD 401, or as per AS/NZS 2566.2:2002, Appendix G
 - 3) For concrete pipes - AP20 as per SD 401, or as per AS/NZS 3725:2007, Table 6
- c) Bedding shall be placed and raked-in so as to provide support for the pipe uniformly along the whole length of the barrel with chases provided for sockets, couplings and other appurtenances. For PVC and flexible pipes the bedding shall not be compacted and the centre of the bedding shall not be walked on either during or after placement. For concrete pipes only the centre strip of the bedding shall not be compacted (see SD 523).
- d) The pipes shall be laid and brought to true alignment and level before installing the metal haunching, side support and covering the pipes.

5.17.2.2 Pipe embedment

- a) The metal haunching and side support shall be placed uniformly along and around the whole length of the pipe barrel, couplings and other appurtenances in a manner to ensure uniform density of side support (including haunch support) and overlay with no distortion, dislodgement or damage to the pipeline.
- b) Following placement, the embedment material shall be compacted in layers to uniformly support the pipe. When choosing compaction equipment, the number of passes and the thickness of layer to be compacted, account shall be taken of the material to be compacted and the pipe to be installed.
- c) Compaction equipment or methods that produce horizontal or vertical earth pressures that may cause damage to, or excessive distortion of, the pipe shall not be employed.
- d) Metal haunching and side support shall be compacted to the manufacturer's requirements and as a guide, a minimum Clegg Impact Value of 35 under vehicle loaded areas or 25 under non traffic loaded areas shall be achieved at any point on any haunching constructed of AP20.

5.17.2.3 Installation of geotextiles

- a) Where there is a possibility of migration of fines between the native soil and the pipe surround soil, the DPA shall require the metals to be protected by an approved geotextile filter fabric that overlaps by at least 300mm.

5.17.2.4 Concrete surround for concrete pipes

- a) For concrete pipes the DPA may order concrete surround in accordance with SD 618 under the following conditions:
 - 1) In areas subject to vehicle traffic where the cover of the pipe barrel is, or will be, less than that required for the class of pipe as specified by the pipe manufacturer.
 - 2) In areas other than those covered above, where the cover over the barrel of the pipe is or will be less than 300mm, irrespective of the type or class of pipe.

Note: Flotation of the pipe during placement of concrete surround shall be prevented. PVC pipes shall not be concrete surrounded.

5.17.2.5 Concrete protection slab for PVC pipes

- a) Where cover over PVC pipes is less than the minimum stated in Table 5-10 including temporarily under construction traffic, a concrete protection slab shall be constructed in accordance with SD 618.

5.17.2.6 Water-stops and trench groundwater

- a) Where permeable bedding such as 'bedding chip' 'drainage metal' or 'sand' is used, water-stops and trench drainage shall be constructed to prevent unwanted movement of groundwater along the trench and pipe bedding. Also see section 5.17.2.3.
- b) Water-stops shall be constructed to the requirements of SD 615. Trench Drainage shall be constructed to the requirements of SD 614.
- c) Manholes can be considered to be water-stops provided they are constructed appropriately.
- d) Where water stops are required, they should be provided at the following intervals:

Pipe Grade	Maximum Spacing
1 in 15 or steeper	12m
1 in 25	15m
1 in 50	30m
1 in 100	60m

Note: Intermediate grades (and spacing) are determined by interpolation

5.17.3 Pipe Installation

- a) To help with future identification the end caps and inside of the end of all new stormwater laterals must be painted with green acrylic paint and marked with a 75mm x 25mm ground treated marker stake suitably identified and partly painted green. (Note: wastewater laterals are to be marked red.)
- b) A laser shall be used by the Contractor for fixing line and grade, for setting the pipes to line and level, and for jointing on all major pipelaying work where possible.
- c) The maximum deviation in level of pipe invert when laid shall be 5mm from design level.
- d) The maximum horizontal deviation from a straight line shall be 10mm.
- e) Pipes shall not be laid on bricks, blocks and wedges or other temporary or permanent supports except when concrete surround is to be placed.
- f) Joints shall be flexible and watertight.
- g) Pipes shall be kept clear of dirt or debris, and any pipes that contain such matter shall be required to be cleaned out. Internal pipe walls shall be kept clean and free of all dirt, rubbish and water. Spigots, sockets, rubber rings, etc, shall be thoroughly cleaned before jointing.

5.17.4 Installation by Trenchless Technology

- a) Gravity pipes and pressure rising main pipes may be installed by trenchless methods (subject to specific approval), including:
 - 1) Horizontal Directional Drilling (HDD);
 - 2) Pipe bursting;
 - 3) Pipe jacking/Pipe ramming;
 - 4) Auger boring/Guided boring;
 - 5) Slip lining;
 - 6) Pilot bore microtunnelling;
 - 7) In-line replacement/Pipe eating/Pipe reaming with HDD rig.
- b) Pipes may include fusion welded PE, or rubber ring joint PVC with restraint joints specifically designed for trenchless installation.
- c) Gouging or notching of the pipe shall not exceed 10% of the pipe wall thickness for pressure pipe and 20% of the pipe wall thickness for gravity pipe. Pipe shall not be bent to a radius less than 35 times the pipe OD for PE pipes or 600 times the pipe OD for PVC pipes.
- d) The trenchless installation methodology selected must be compatible with, and capable of achieving the required pipeline gradient.
- e) The specified allowable load on the pipe shall not be exceeded during pulling.
- f) Where gouging or notching exceeds the above limits or if buckling of the pipe occurs, that length of pipe shall be removed and a new section welded in at the nearest join.
- g) The Contractor shall overtop the pipe by one lineal metre for each length of pulled pipe that is the greater of one manhole length or 200m. The excess pipe length shall be supplied to the DPA for a visual inspection.

5.17.4.1 Pipe installation by pipebursting

- a) The new pipe shall be HDPE with a minimum wall thickness of 10mm, or PE100, SDR17 as a minimum wall thickness for any pipe size.
- b) Where the pipe is to replace a live pipeline, the line to be burst shall be inspected by CCTV to locate all laterals and to check for any obstructions. Live laterals shall be confirmed by the use of dye.

5.17.4.2 Pipe installation by slip lining

- a) The pipe sleeve shall be MDPE with a minimum wall thickness of 5mm, or PE80, SDR21 as a minimum wall thickness for any pipe size
- b) The host pipe shall be cleaned to provide a clear pipe diameter that passes the new polyethylene pipe without gouging or notching the pipe.
- c) The Contractor shall not detrimentally affect the host pipe when cleaning it.
- d) Prior to any attempt to pull in the new pipe a plug, no less than the outside diameter of the new pipe, shall be passed through the host pipe to ensure there is sufficient clearance.

5.17.4.3 Pipe installation by directional drilling

- a) This method shall only be used in specific circumstances where approved by the Engineering Manager. The new pipe shall be HDPE with a minimum wall thickness of 10mm, or PE100, SDR17 as a minimum wall thickness for any pipe size.
- b) The constructed pipe alignment shall not vary more than 100mm horizontally from the design alignment and the tolerance on the vertical alignment shall not exceed the specified amount except where the grade of the pipe is specified, in which case it shall be ± 5 mm from the design grade.
- c) The Contractor shall accurately monitor the position of the drilling head to achieve the above requirements.
- d) The Contractor shall be liable for damages to any underground services.

5.17.5 Manhole Installation

The following standards apply to the installation of manholes:

5.17.5.1 Concrete manholes

- a) Manholes shall be constructed in accordance with SD 602 – 609 and 507.
- b) All concrete manholes shall be made water tight by effective sealing of manhole section joints with mastic sealant and around pipe entries, where applicable, using epoxy mortar inside and out.
- c) The connection of PVC pipes to concrete structures, such as manholes and sumps, shall be with a PVC starter and finisher with a 'gritted' external surface.
- d) The connection of PE pipes to concrete structures shall be in accordance with SD 607.

- e) All PVC pipes entering or leaving a manhole shall have one flexible joint within 200mm of the manhole and a second flexible joint within 1200mm of the manhole.
- f) The channel through the manhole shall be formed from in-situ concrete properly formed to grade and radius sweeps. The channel shall be finished with a smooth, regular half circle invert with falls as specified in SD 602. Benching shall be steel float finished to give a regular smooth surface.

5.18 TESTING

5.18.1 Closed-Circuit Television (CCTV) Inspection

- a) All pipelines to be vested in Council ownership shall pass a closed circuit television (CCTV) inspection, carried out at an appropriate time agreed by Council or at the completion of the works.
- b) A professional operator with proof of experience in operating such devices shall carry out the CCTV inspection using a pan and tilt camera, in accordance with the technical specifications of the NZ Pipe Inspection Manual (published by the New Zealand Water & Wastes Association).
- c) The operator shall pan around every joint and check every lateral connection and defect.
- d) The video footage in DVD format, and the accompanying CCTV log sheets for each stormwater length (as per the template in the NZ Pipe Inspection Manual), showing the features and condition of all inspected manhole lengths, shall be provided to Council. Video footage supplied without log sheets will not be accepted.
- e) All pipelines shall be free of debris and flushed within 24-hours prior to inspection. Inspections of non-cleaned pipelines are not acceptable.
- f) A pipeline will fail its inspection if:
 - 1) The pipe is horizontally misaligned or deformed by more than 5% of the pipe diameter.
 - 2) The pipe has visible dips or ponding of water.
 - 3) The pipe has visible defects, such as open or displaced joints, defective or protruding laterals, cracked barrels or similar defects.
- g) Other testing as considered appropriate may be required by Council to ensure Council's future infrastructure will meet its projected life cycle.