

Part 5: Stormwater and Land Drainage

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5.1 Referenced Documents

Planning and Policy

- > The *Christchurch City District Plan*
www.ccc.govt.nz/the-council/plans-strategies-policies-and-bylaws/plans/christchurch-district-plan
- > Resource Management Act (RMA) (1991)
- > Building Act (2004)
- > New Zealand Building Code (1992)
- > Canterbury Regional Council *Canterbury Land and Water Regional Plan*
www.ecan.govt.nz/your-region/plans-strategies-and-bylaws/canterbury-land-and-water-regional-plan
- > Christchurch City Council *Water Supply, Wastewater and Stormwater Bylaw* (2014)
www.ccc.govt.nz/the-council/plans-strategies-policies-and-bylaws/bylaws/water-supply-wastewater-and-stormwater-bylaw-2014/
- > Christchurch City Council *Waterways and Wetlands Natural Asset Management Strategy 1999*
www.ccc.govt.nz/the-council/plans-strategies-policies-and-bylaws/strategies
- > Christchurch City Council *Integrated Water Strategy* www.ccc.govt.nz/assets/Documents/The-Council/Plans-Strategies-Policies-Bylaws/Strategies/Integrated-water-strategy.pdf

Design

- > Christchurch City Council *Waterways, Wetlands and Drainage Guide, Ko Te Anga Whakaora mō Ngā Arawai Rēpo (WWDG)* (2003) Part A and B www.ccc.govt.nz/environment/water/policy-and-strategy/waterways-wetlands-and-drainage-guide
- > Christchurch City Council *Streamside Planting Guide*
www.ccc.govt.nz/environment/water/waterways/waterway-restoration/
- > Christchurch City Council leaflet *Stormwater Tanks on Private Property*
www.ccc.govt.nz/services/water-and-drainage/stormwater-and-drainage/stormwater-and-your-property/
- > Christchurch City Council *Small Site Stormwater Attenuation*
www.ccc.govt.nz/services/water-and-drainage/stormwater-and-drainage/stormwater-and-your-property/
- > Christchurch City Council *Rain Garden Design, Construction and Maintenance Manual*
www.ccc.govt.nz/consents-and-licences/construction-requirements/infrastructure-design-standards/waterways-wetlands-and-drainage-design/
- > Canterbury Regional Council *Erosion and sediment control guidelines* 2007
www.esccanterbury.co.nz/
- > NZS 4404:2010 *Land development and subdivision infrastructure*
- > *New Zealand Fish Passage Guidelines* www.niwa.co.nz/freshwater-and-estuaries/research-projects/new-zealand-fish-passage-guidelines
- > New Zealand Transport Agency *Bridge Manual* (2013)
- > McKerchar and Pearson, *Flood Frequency In New Zealand*, 1989

Construction

- > Christchurch City Council Civil Engineering *Construction Standard Specifications Parts 1-7 (CSS)*
www.ccc.govt.nz/consents-and-licences/construction-requirements/construction-standard-specifications/download-the-css

Where a conflict exists between any Standard and the specific requirements outlined in the Infrastructure Design Standard (IDS), the IDS takes preference (at the discretion of the Council).

5.1.1 Source documents

This Part of the IDS is based on Part 4 of NZS 4404:2010, by agreement, and with the consent of Standards New Zealand.

5.2 Introduction

This Part of the IDS covers the design and construction requirements of stormwater and land drainage works for land development and subdivision, including capital works projects.

5.2.1 Philosophy

The Christchurch City Council is taking a values-based approach to management of the natural and physical resources that make up Christchurch's system of waterways, wetlands and drainage. This includes not only the natural waterway system but also the built network. By understanding the natural processes operating in land and water we are much more able to bring to life values that are important to the community while addressing drainage issues associated with individual developments. Values that have been specifically identified are ecology, landscape, recreation, heritage, culture and drainage.

The emphasis on each value at a particular site will be dependent on the objectives of the project. The process toward understanding these values, how they can be reflected and enhanced in new developments, and an appreciation of ongoing management requirements, is outlined in the *Waterways, Wetlands and Drainage Guide (WWDG) Part A*. Design and management for the six values is a requirement of the *Waterways and Wetlands Natural Asset Management Strategy*.

5.2.2 Objectives

Stormwater run-off is the chief driver of water quality in urban catchments, and stormwater management is crucial to reducing flood events. The *Integrated Water Strategy* establishes that the objectives of a stormwater drainage system include: to regulate the storm surface run-off rate of flow and volume (quantity); to control groundwater levels; and to protect the quality of both, to the extent that agreed levels of service are maintained and any adverse effects on the environment are not more than minor. To satisfy the latter, remedial or mitigation works will often need to be incorporated within the stormwater drainage system (see *WWDG Part B* clause 2.2). Potential adverse effects include flood damage, surface and channel erosion and sedimentation, water pollution, loss of bio-diversity and damage to aquatic ecosystems.

Well designed and maintained alternative systems that replicate the pre-development hydrological regime can not only mitigate adverse environmental effects but also enhance amenity and ecological values

5.2.3 Four purposes

The stormwater drainage system serves four purposes: the conveyance of storm surface run-off with minimal flood damage; control of water quality; protection of bio-diversity and ecological function; groundwater control and protection. Consider all four aspects in the engineering design and endeavour to achieve them with minimal adverse effects on the environment.

Opportunities exist for the stormwater drainage design to integrate with the natural drainage system. On and off-site treatment and attenuation, grassed swales, natural or artificial waterways, ponds and wetlands, for example, may in certain circumstances be not only part of the stormwater drainage system, but a required solution (depending on urban priorities) especially if a low impact on receiving waters downstream is critical. Low Impact Urban Design & Development (LIUDD) is one means of achieving these four purposes along with other sustainability objectives.

5.3 Consent and Compliance Issues

Christchurch City Council holds a number of network discharge consents throughout its territory which it may use to authorise the discharge of stormwater from third party developments into its network. Compliance with relevant consent conditions may require on-site stormwater mitigation (treatment and/or attenuation/disposal). If Council does not authorise the stormwater discharge under one of its global consents, separate authorisation from Canterbury Regional Council (Ecan) may be required unless the activity meets the permitted activity threshold of Rules 5.95 or 5.96 in the *Canterbury Land and Water Regional Plan*. Both a land use consent (Council) and a discharge consent (Ecan) are generally required for subdivisions and capital works projects and when significant water quantity and quality issues need to be addressed.

Consult with Council prior to consent application. If separate Ecan consent is required, it is good practice for Council and Ecan to process subdivision and water-related resource consents simultaneously and deal with land and water issues at a joint hearing pursuant to section 102 of the RMA.

Typical conditions will reflect the Council's network stormwater consent and stormwater management plans including:

- > An erosion and sediment control plan is required for all activities involving land disturbance.
- > Sediment generated by the activity must be contained within the work site.
- > Sumps collecting runoff from new hardstand areas must be fitted with submerged or trapped outlets
- > Site management and spill procedures are required for sites where the occupier engages in hazardous activities.

Additional conditions may include:

- > An assessment of water quantity effects, and provision of on-site stormwater storage or network upgrade may be required.
- > No discharge onto or into land where the average site slope exceeds 5 degrees.
- > First flush treatment is required for stormwater runoff from new hardstand areas in excess of 150 m² where usage could generate contaminants exceeding normal residential levels.
- > Treatment may be required for stormwater runoff from buildings with uncoated metal roofs.

Requirements in the *Water Supply, Wastewater and Stormwater Bylaw* must be met (see also *WWDG Part B* chapter 17).

5.3.1 Legislation

The Resource Management Act (RMA) is the principal statute that controls land development, including stormwater drainage aspects.

5.3.2 Consent from the Canterbury Regional Council

Other activities often associated with stormwater drainage works which must be authorised by Ecan include: the diversion of natural water during construction work; the permanent diversion of natural water as a consequence of the development; activities in the bed or on the banks of a natural waterway; damming waterways; permanent or construction related dewatering.

5.3.3 Exercising consents

Discharge and temporary water consents and land use consents required during construction must be applied for by, and exercised in the name of, the developer.

Other discharge and water permits required for works that are to be transferred to the Council upon completion, must be applied for by, and exercised in the name of the developer. Discuss with the Council any application involving consents intended to transfer to the Council. The Council must approve these prior to application as it will not accept the transfer of a consent unless it has previously approved the conditions of that consent.

5.4 Quality Assurance Requirements and Records

Provide quality assurance records that comply with the requirements in Part 3: Quality Assurance, during design and throughout construction.

5.4.1 The designer

The designer of all stormwater reticulation systems that are to be taken over by Christchurch City Council and the person undertaking the catchment analysis must be suitably experienced. Their experience must be to a level to permit membership in the relevant professional body. Refer to clause 2.7.1 – Investigation and design (General Requirements) for further information.

The design peer reviewer must have at least equivalent experience to the designer.

5.4.2 Information to be provided

The level datum used must be the Christchurch Drainage Datum.

This is the reference plane used for drainage purposes in Christchurch. Levels above this plane are stated in metres as ‘reduced level’ or R.L. The Christchurch Drainage Board established this datum in 1878 at 50 feet below the floor of the Cathedral. Refer to *WWDG Part B* Appendix 1 and clause 2.8.1 – Level datum (General Requirements) for further information.

Specific information to be provided with any concept drawings or Resource Consent plans must include:

- > the location of any natural waterways, springs, bores, wells or wetlands within the site or in close proximity to a boundary. The location in plan and level of the water’s edge and shoulder of the banks must be indicated;
- > the location of existing drainage pathways;
- > representative pre-existing and post development cross-sections through any natural waterways or wetlands, including the areas immediately adjacent to the proposed development;
- > catchment boundaries defined by surface levels (where the location of the catchment boundary is uncertain, the developer must define the boundary by survey);
- > summaries of hydrological and hydraulic modelling as required by the *WWDG* (see *WWDG Part B* chapters 21 and 22), including design parameters and assumptions;
- > estimates of catchment imperviousness and the basis for its derivation;
- > the proposed proximity of buildings to the water’s edge and/or shoulder of the banks;
- > clear identification of the extent of any existing and post-development river or coastal floodplains on or in close proximity to the site and overland flow paths within the site;

- > secondary flow paths;
- > identification of any natural or artificially created basins;
- > the impact of any proposed filling or excavation on existing surface drainage pathways;
- > existing services and easements;
- > details of any contaminated ground or historical filling;
- > trees, other significant vegetation and other features to be protected and retained (e.g. natural landforms, ecological protection areas);
- > details of any investigations such as ground water levels, profiles, infiltration testing and effects on the environment and geological or water quality assessments.

5.4.3 Design records

Provide the following information to support the Design Report:

- > details and calculations that demonstrate that levels of service required by the *WWDG Part B* chapter 20 will be maintained;
- > detailed calculations and drawings where applying to build within a flood plain, which determine the floodplain boundaries and levels relative to building floor levels (see *WWDG Part B* chapter 20 and the Building Act);
- > details and calculations that clearly indicate any impact on adjacent areas or catchments that the proposed works may have;
- > draft versions of operations and maintenance manuals for any water quantity or quality control structures (refer also to clause 5.7.4 - Operations and maintenance manual);
- > landscape and planting drawings complying to Part 2: General Requirements – Appendix I Standard Draughting Layout and Format Requirements.

Design checklists, to aid this process, are available in *WWDG Part B* clauses 6.10 and 19.2.

Provide the following additional information for detention basins and swales:

- > the design return period;
- > the design rate of discharge at each discharge point;
- > the design water level;
- > the design volume, where there is a storage function.

5.4.4 Construction records

Provide the information detailed in Part 3: Quality Assurance and the *Construction Standard Specifications (CSS)*, including:

- > Environment Canterbury compliance monitoring reports;
- > all performance test results;
- > CCTV records;
- > material specification compliance test results;
- > compaction test results;
- > subgrade test results;
- > infiltration test results.

Provide the Council with a certificate for each pipeline tested including the date, time and pressure of the test. Provide details of the pipes in a form complying with the requirements of Part 12: As-Builts, including manufacturer, diameter, type, class, jointing and contractor who laid the pipe.

5.5 Catchment Management Planning

Carry out stormwater planning on a coordinated and comprehensive catchment-wide basis. Although this is primarily the responsibility of the Council, consider catchment-wide issues at the concept design stage and comply with the catchment management plan, if one exists.

The implications of future upstream development on the site, and the cumulative effects of land development on water quality and flooding downstream, are important considerations. The larger the scale of the development the more significant the catchment management planning issues are likely to be.

Discuss any catchment management planning issues with the Council at an early stage (see also *WWDG Part B* chapters 2, 5, 7 to 12 and 20).

5.5.1 Effects of land use on receiving waters

Impervious surfaces and piped stormwater drainage systems associated with urban development have a major effect on catchment hydrology. Faster run-off of polluted storm flows, reduction in base flows and accelerated channel erosion and depositions alter the hydrology and adversely affect the quality of receiving waters. This in turn reduces the diversity of the aquatic biological community.

The effects of rural development on receiving waters are generally less significant where riparian margins are protected. The modification to stream hydrology is generally minor. However, any reduction in riparian vegetation increases sediment loads and nutrient concentrations are likely to reduce aquatic biodiversity.

Consult with Ecan at an early stage to identify likely adverse effects of land use on receiving waters (see also *WWDG Part B* chapter 2).

5.5.2 Catchments and off-site effects

All drainage systems, including waterways, must provide for the collection and controlled disposal of surface and ground water from within the land being developed, together with run-off from upstream catchments. In designing downstream facilities, consider the upstream catchment to be fully developed and comply with any Catchment Management Plan. Consult the Council about mechanisms for assigning costs associated with off-site effects.

Ground water is a precious resource. Carry out development in a way that avoids adverse effects on ground water quality and levels. Refer to clause 4.5 - Ground Investigations (Geotechnical Requirements) and *WWDG Part B* clause 5.3.1.

For all land development works (including projects involving changes in land use or coverage), include an evaluation of stormwater run-off changes on upstream and downstream properties. This evaluation will generally be required at the resource consent stage.

Development must not increase upstream flood levels, unless any increase is negligible and can be shown to have no detrimental effects.

Investigate downstream impacts including changes in flow peaks and patterns, flood water levels, contamination levels, erosion or silting effects, and effects on the existing stormwater drainage system. Where such impacts are considered detrimental, mitigation measures (e.g. peak flow attenuation, velocity control, contamination reduction facilities) on or around the development site, or the upgrading of downstream stormwater disposal systems at the developer's expense, will be required.

Consider the impact of climate change on coastal areas and the upstream effect on groundwater levels and flooding when designing stormwater basins and infrastructure. Refer to clause 2.5.7 - Coastal Hazards for further information.

5.6 Drainage System Design

Stormwater drainage is the total system protecting people, land, infrastructure and improvements against flooding. It consists of a primary drainage system of pipes and waterways and detention areas and a secondary system consisting of open channels, controlled flood plains, natural ponding areas and flow paths. These are utilised in conjunction with the setting of building levels to ensure that buildings remain free of inundation up to the minimum protection standard. Protection standards are set by the RMA, the *District Plan* and the *Building Act* and are discussed in *WWDG Part B* chapter 20.

The primary system must cater for the more frequent rainfall events including the 20% AEP storm. The secondary system must convey over-design events without inundation hazard to house floors and building platforms at least to the 2% AEP storm, including occasions when there are blockages in the primary drainage system.

Consider the following aspects and include in the design, where appropriate:

- > The Six Values (refer to clause 5.6.1 – Integrated stormwater systems to achieve the six values);
- > size (or sizes) of the surface water drainage pipework throughout the proposed reticulation system;
- > details relating to the protection of trees, other significant vegetation, natural habitats and other features to be protected and retained;
- > selection of appropriate pipeline material type(s) and class;
- > mains layout and alignment including: route selection, topographical and environmental aspects, easements, foundation aspects, clearances and shared trenching requirements, provision for future system expansion;
- > hydraulic adequacy including acceptable flow velocities and other requirements where applicable to satisfy *WWDG Part B* chapter 22;
- > property service connection locations and sizes;
- > seismic design - all structures must be designed with adequate flexibility and special provisions to minimise risk of damage during earthquake. Provide specially designed flexible joints at all junctions between rigid structures (e.g. reservoirs, pump stations, bridges, buildings, manholes) and natural or made ground;
- > geotechnical investigations - take into account any geotechnical requirements determined under Part 4: Geotechnical Requirements;
- > major reticulation and its potential for significant traffic disruption. Discuss at an early stage with Council.

5.6.1 Integrated stormwater systems to achieve the Six Values

Integrated stormwater systems are both the optimum and preferred method of stormwater treatment. When these systems are being considered, discuss their use with the Council at an early stage. Refer to *WWDG Part B* chapters 5 to 12 for more information on this topic.

Well-designed and well-maintained integrated systems, which replicate the pre-development hydrological regime, can not only mitigate adverse environmental effects, but also enhance local amenity, water quality and ecological values. These systems are designed in accordance with the waterway's six values (refer *WWDG Part A* Table 1.1):

- > Ecology - Includes ecological processes and inter-relationships between plants, birds, fish and insects.
- > Landscape - The special character of sites, aesthetic quality, and sense of place to people and communities.
- > Recreation - Active and passive recreation, play and facilities associated with recreational activities.
- > Heritage - Sites and activities of both human (e.g. structures) and natural (e.g. landforms) significance.

- > Culture - The values of Maori and European, as well as wider community aspirations and involvement.
- > Drainage - Groundwater and surface water inter-relationships, flows, flooding and stormwater.

5.6.2 Secondary flow paths

Shape lots generally so that they fall towards roadways, which may be used as secondary flow paths. Secondary flow velocities must be sub-critical except where it is unavoidable on hillsides. On hillsides, convey secondary flows safely and as directly as possible into permanent open waterways.

Where secondary flow paths cannot, with good design, be kept on roads, they should be kept on public land such as accessways, parks, and reserves. Secondary flow paths over private land are the least desirable option and will require protection by legal easements.

Design secondary flow paths so that erosion or land instability caused by the secondary flows will not occur. Where necessary, incorporate special measures to protect the land against such events.

In most circumstances, limit ponding or secondary flow on roads in height and velocity such that the carriageway is passable.

The secondary flow path sizing and location must be supported by adequate analysis, taking into account extreme events, to show:

- > that it is of adequate capacity to cope with the anticipated flow;
- > that it discharges to a location that does not detrimentally affect others and can safely dissipate via a controlled disposal system as the storm peak passes.

Consider the secondary flow path under conditions of total inlet blockage at critical culverts and other critical structures.

Avoid shaping roads to create basins with piped outlets. Where basins are created a higher level of service for the primary system may be required. The desirable standard for ponding or secondary flow on roads is that they are passable to light vehicles in the 2% AEP (annual exceedance probability) event and to 4WD vehicles in a more extreme event.

5.6.3 Location and design of basins and swales

Ponding basins are being used throughout the city as stormwater treatment and detention devices to improve water quality and to mitigate increased stormwater flows. These structures are important landscape features in public open space. Carefully consider their location, design, construction, and ongoing maintenance requirements during the early stages of planning.

From a landscape perspective, these types of basins are often very specifically designed and managed in order to optimise their primary functions (e.g. stormwater storage capacity, soil

infiltration). Design solutions should build on the features of the local landscape, features associated with the proposed development and the wider planning context. As the Council will generally take on the responsibility for these structures, it needs to have input into the design of these structures from the outset.

Co-locate basins with public open space having a similar appearance and maintenance approach (i.e. road reserves and recreation reserves with a garden approach to maintenance). Basins should not be located in areas that are being managed primarily for their ecological values (such as esplanade reserves). The management approach for ecological areas aims to support natural processes through encouraging natural regeneration with limited maintenance that focuses predominantly on managing for weed species.

Where there is co-location of stormwater features with reserves, open space or streetscapes the requirements of clause 10.5.4 – Local purpose (utility) reserves (Reserves, Streetscape and Open Spaces) must also be met.

Design and construct swales and basins so that they replicate natural landforms. Avoid regular shapes, ‘bathtubs’ and even slopes: instead create organic, undulating landforms with sinuous inverts and mid-slope terraces. Avoid slopes that have a gradient steeper than one-in-four. Round off all tops and toes of slopes to blend imperceptibly with adjoining landforms. For safety reasons, ensure open sightlines from surrounding public and private land. Provide sufficient areas of land to achieve this land shaping and to enable public access, as well as to provide for stormwater capacity.

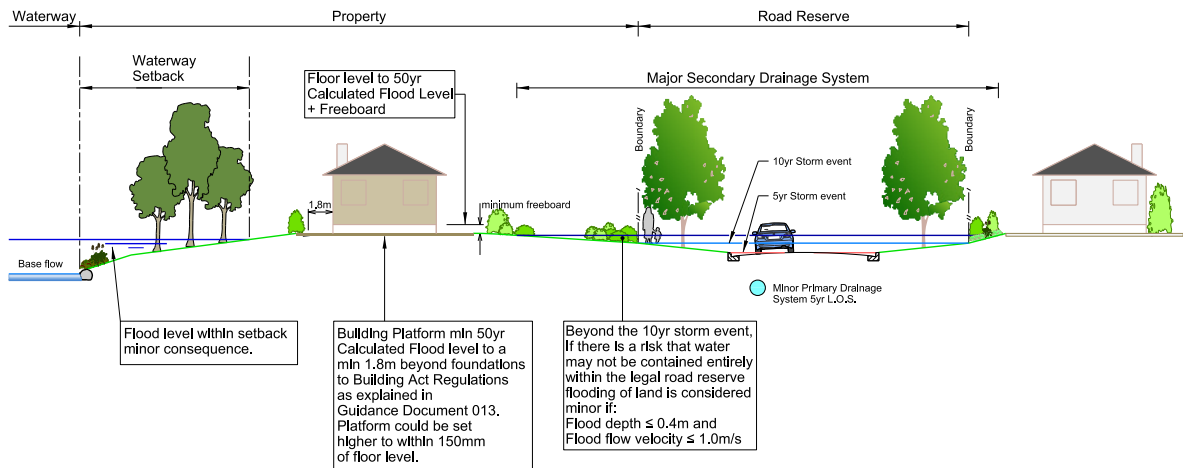
Refer to *WWDG Part B* chapter 6 for specific design criteria regarding the design of basins and stormwater treatment systems. Note that underdrain systems (*WWDG Part B* figure 6-14) should not have topsoil detailed over the soakage media as this impedes filtration.

Council encourages preserving and adding life-containing materials such as humus in the soils of soakage basins. Soil structure and permeability can be maintained and improved by soil biological communities.

5.6.4 Design standards for new developments

Design all new surface water and land drainage systems to design storms in accordance with *WWDG Part B* chapters 20 and 21.

For the protection of buildings, design and build the stormwater system of water pathways and ponding areas so that every new building platform is at less than 2% annual exceedance probability (AEP) risk of flooding. Include a minimum freeboard height above computed flood levels as shown in Figure 1, complying with Table 1. Any relevant building floor protection specified in the City Plan or Banks Peninsula District Plan must also apply. Both the building platform and the floor level can be individually placed higher than these minimum levels, so long as their heights comply with the requirements of the Building Code.



dg10380d

Figure 1 Minimum floor levels

Table 1 Minimum freeboard

Building type	Minimum freeboard height (m)
Habitable building floors	0.4
Commercial and industrial buildings	0.3
Habitable building platforms	0.25

Note:

- Freeboard is the 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.
- Discuss commercial and industrial developments with special circumstances with the Council.
- In circumstances where ponded water on roads will exceed 100mm a greater freeboard may be required.

Discuss protection standards in tidal areas with the Ecan and the Council at an early stage. Storm surge and tsunami hazards, climate change and sea level rise must be considered, and a precautionary design approach is recommended.

5.6.5 Bridges and culverts

Design all bridges and culverts to enhance the visual qualities of the site. Bridges must have an attractive appearance. Refer to the *Bridge Manual* and *WWDG Part B* chapter 13 for waterway design at bridges and culverts.

5.6.6 Protection of road subgrade

The potential risk of carriageway damage from a saturated sub-base is a design issue. Early discussion with the Council is needed when the maximum level of detained water in any ponding area is higher than 200mm below any carriageway or right of way within a horizontal distance of 80 metres. Provide evidence that the road subgrade will not be compromised. Special pavement or pond design may be necessary.

5.6.7 Outfall water levels

The Council will provide the start water level at the point of connection to the public stormwater system or at some point downstream where design water levels are known, as a subdivision consent parameter.

When a tributary drain or a waterway flows into a much larger drain or a much larger waterway, the peak flows generally do not coincide. Check both the situation where the tributary has reached peak flow but the receiving waterway has not and where the receiving waterway is at peak flow but the tributary has passed it. Take the worst case as the design case (refer to *WWDG Part B* clause 22.5.2).

5.6.8 Alternative technologies

Alternative technologies will be considered on a case by case basis. These may include bio-retention devices (rain gardens and stormwater tree pits) or proprietary in-line filtration devices.

5.6.9 Stormwater pumping

Permanent stormwater pumping will only be permitted under exceptional circumstances. Refer to *WWDG Part B* clause 13.6 pages 13-15.

5.6.10 Liquefaction

Part 4: Geotechnical Requirements – Appendix IV Liquefaction Vulnerability Overview Map indicates likely seismically generated settlements and displacements affecting underground reticulation. Clauses 4.4.9 – Liquefaction and 4.6.2 – Seismic considerations (Geotechnical Requirements) provide further detail on the application of these maps when designing piped infrastructure.

5.7 Waterway Design

Design waterways in accordance with *WWDG Part B* chapters 7 to 13 inclusive. Maintain fish and invertebrate passage, unless otherwise authorised by the Council or by the ECan. Refer to *WWDG Part B* clauses 2.2 and 13.2.3.

Provide access along at least one side of any waterway for maintenance, taking into account the “reach” of cleaning machinery. Vegetate berms and banks and lay at slopes that are stable, not prone to scour in flood flows and maintainable.

5.7.1 Constructed waterways

Design constructed waterways to meet the aesthetic and amenity criteria of the Council (see *WWDG Part B* chapters 7 to 9, 11 and 12). These waterways must form part of a surface water management system.

Protect constructed waterways, which will be maintained by the Council, by easement where they will not be placed in public ownership.

5.7.2 Natural waterways

Restore the natural character and enhance amenity values of highly modified natural waterways wherever possible.

Where it is possible, avoid the piping or filling in of natural waterways. Where the activity is unavoidable, a resource consent from the Council and the Ecan will be required for this activity.

Provide for drainage, landscape, ecology, heritage, recreation and cultural values when enhancing these waterways. Refer to *WWDG Part A* for an understanding of the principles underpinning these values and *WWDG Part B* Chapters 7 to 9, 11 and 12 for information about specific criteria. For information about riparian planting refer also to the *Streamside Planting Guide*.

Create Local Purpose (Esplanade) Reserves around significant natural waterways.

5.7.3 Hill watercourses

All hill watercourses that will receive stormwater discharges from development must be stabilised with permanent materials. Permanent materials include suitably bedded and stabilised rock lined channels and pipes. Vegetation is not a permanent material.

This requirement may be waived where the development consists of a small number of residential properties whose hard surface runoff is attenuated through a suitably sized rain tank and distribution system and that discharges at least 5 metres inside the boundary of each property, such that overland flow will not be increased over the natural rate of runoff.

5.7.4 Operations and maintenance manual

Provide an Operations and Maintenance Manual in accordance with *WWDG Part B* clause 19.2 for any water quantity and/or quality control structures or formed features such as ponds. The manual must describe the design objectives of the structure, describe all the major features, identify all the relevant references to the *WWDG* and identify key design criteria (including any conditions attached to the relevant resource or other consents).

A separate section must explain operations such as the recommended means of sediment removal and disposal, and identify on-going management and maintenance requirements such as landscape establishment, vegetation control and nuisance control. Amend Appendix II - Generic Guides for Riparian Maintenance (Reserves, Streetscape and Open Spaces), to show the required maintenance regime for all plantings. Clause 10.11 – Establishment (Reserves, Streetscape and Open Spaces) expands on these requirements.

Submit the manual for engineering acceptance as part of the Design Report.

5.7.5 Fencing

The *Water Supply, Wastewater and Stormwater Bylaw* requires consent for the erection of a fence across a waterway. Fences must not significantly impede flood flows up to the minimum protection standards (Refer *WWDG Part B* clause 13.9).

5.8 Stormwater Disposal

5.8.1 Approved outfall

The discharge for a development must be authorised by Ecan. This can be achieved by conforming to the Stormwater Management Plan or complying with the conditions of the discharge consent held by council.

The outfall for a development must be either the public stormwater drainage system or an approved alternative stormwater disposal system.

A suitable outfall and if required a dissipating structure must be constructed at the outlet to ensure no erosion occurs in the immediate vicinity of the waterway. No obstruction which will impede the natural flow may be placed in the channel.

When designing outfalls, in addition to *WWDG Part B* clause 14.7 - Pipe outfall structures, consider:

- > the surrounding land use now and in the future;
- > maintenance of the outfall including its potential for siltation;
- > geotechnical constraints including the site's bearing capacity, potential groundwater movement and seismic effects;
- > fish passage;
- > backflow prevention;
- > structural design where vertical heights are over 1.5m.

CSS: Part 3 contains acceptable outfall details.

5.8.2 Discharge to ground

Surface water infiltration systems may be used for developments in rural areas or for developments in urban areas, if connection to the public system is not feasible and ground conditions are suitable for soakage (Refer to *WWDG Part B* 6.5). Carry out a geotechnical assessment when considering the large-scale use of infiltration systems.

A discharge consent may be required from Ecan for discharge to soakage.

Design and locate infiltration systems to allow easy access for maintenance. Refer to the Council's webpage *Small Site Stormwater Attenuation* for further information.

5.8.3 Stormwater tanks

Stormwater tanks on private properties can regulate stormwater discharge from connected impervious areas such as roofs, hardstand areas and driveways. The Council may recommend or require a stormwater tank when:

- > the public stormwater system downstream has no capacity for a new connection and it is uneconomic to upgrade it;
- > direct discharge to a hill gully or slope is likely to cause erosion.

Refer to the Council's webpage *Small Site Stormwater Attenuation* for further information.

The Council may approve a request from a private property owner to install a stormwater tank for water conservation or other reasons.

Refer to the Council's leaflet *Stormwater Tanks on Private Properties* for further guidance, including installation guidelines.

5.9 Reticulation Layout

5.9.1 Topographical considerations

In steep terrain, the location of pipes is governed by topography. Gravity pipelines operating against natural fall create a need for deep installations, which can be very expensive. They can also create basins with piped outlets.

The pipe layout must conform to natural fall as far as possible. Where basins are created, provide a fail-safe outlet. At basins a higher level of service for the downstream primary system may be required.

5.9.2 Location and alignment of stormwater pipelines

Locate stormwater pipeline mains within the legal road (but not under the crown of the carriageway unless the wastewater sewer is located elsewhere) or within other public land. Allow for access for construction or future maintenance.

Position pipes as follows:

- > within the road formation (refer *WWDG Part B* clause 14.2.1).
- > within public land with the approval the Council.
- > within drainage reserves.
- > within private property (if unavoidable) adjacent to, and if possible parallel to, boundaries, with a minimum offset to the pipe centreline of one metre.

Make crossings of roads, railway lines, creeks, drains and underground services at right angles, as far as practicable.

Allow for possible future building plans when locating proposed pipes and avoid maintenance structures within the property. This may include specifying physical protection of the pipe within or adjacent to the normal building areas or any engineering features (existing or likely) on the site e.g. retaining walls.

5.9.3 Clearances from other services or structures

Clause 9.5.3 – Typical services layout and clearances (Utilities) summarises clearances for utility services. Confirm these clearances with the network utility operators, before deciding on any utility layout or trench detail.

Locate pipes that are adjacent to existing buildings and structures clear of the “zone of influence” of the building foundations. If this is not possible, undertake a specific design covering the following:

- > protection of the pipeline;
- > long term maintenance access for the pipeline;
- > protection of the existing structure or building.

Specify the protection on the engineering drawings.

5.9.4 Curved pipelines

The straight-line pipe is usually preferred as it is easier and cheaper to set out, construct, locate and maintain in the future.

Curved pipes must be to the manufacturer’s design and construction standards and be used only where approved by the Council.

5.9.5 Building over pipelines

The *Water Supply, Wastewater and Stormwater Bylaw* defines the Council’s requirements and protection for the drainage works.

5.9.6 Easements

Easements are required for constructed waterways and in those instances when there are secondary flow paths through private property. Provide easements for public pipelines and public subsoil drains through private property or where private pipelines serving one property cross another.

Equation 1 Easement width

The easement width is the greater of:

- > $2x$ (depth to invert) + OD
- > 3.0m

where OD = outside diameter of pipe laid in easement

The easement registration must provide the Council with rights of occupation and access and ensure suitable conditions for operation and maintenance.

5.10 Reticulation Detailing

5.10.1 Pipeline connections

Make pipeline connections in accordance with *CSS: Part 3*.

Design the stormwater drainage system as a separate system (i.e. with no inter-connections whatsoever with the wastewater system).

5.10.2 Minimum pipe sizes

The minimum diameter Council stormwater pipe within the carriageway is 225mm.

5.10.3 Minimum cover

Where the minimum cover complying with the manufacturer's specifications is not achieved, pipelines must be adequately protected from external loadings.

5.10.4 Gradients and acceptable flow velocities

Refer to *WWDG Part B* clause 14.2.4.

5.10.5 Structures

Design inlets and outlets in accordance with *WWDG Part B* clauses 14.6 and 14.7. Install debris grills where blockage is a potential problem. Provide for operational requirements.

Consider the effects of inlet and tailwater controls when designing culverts, as set out in *WWDG Part B* clause 22.9.

Take backflow effects into account in design. Consider outlet design and water level conditions in the design of discharges to existing stormwater systems and waterways and incorporate backflow prevention if necessary.

Where pipes discharge onto land or into a waterway outlet, if required design structures to dissipate energy and minimise erosion or land instability. Ensure velocities are non-scouring at the point of discharge. Acceptable outlet velocities will depend on soil conditions, but should not exceed:

- > 0.5m/s where the substrate is cohesive; or
- > velocities given in *WWDG Part B* Clause 22.7 Table 22-5.

5.10.6 Manholes and sumps

Provide manholes and sumps in accordance with *WWDG Part B* clause 14.4 and 14.5 and *CSS: Part 3*.

Council prefers the use of wavy sump grates as detailed in *CSS: Part 3* SD 301/5 where they meet the requirements of that site. In addition to the single sumps in *WWDG Part B* clause 22.10.2 - Sump capacity, the capacity per standard or cycle safe wavy grating unit, allowing for partial blockage of the sump grating, is:

Table 2 Grate capacity (l/s)

	Inline	Valley
Cycle safe sump unit	15	40
Wavy sump unit	20	40

Do not locate sumps in kerb crossings. Where sumps are located in this position; consider the relocation of either the sump or crossing; detail the installation of a cycle safe wavy sump top or; detail a corner sump top and provide additional drainage capacity elsewhere if necessary. Balance the means of providing sufficient inlet capacity against cyclist safety perceptions when selecting and locating sump grates, to ensure all uses of the roadway are optimized.

Where the manhole is likely to experience differing movement from the pipeline under seismic loading, replace the yield joints with flexible joints e.g. *CSS: Part 3* SD 341/4. These may mitigate the potential for damage by allowing some longitudinal movement at the structure.

Consult the Council before embarking on any part of the system design where the velocity is such that the flow will not progress smoothly through the manhole into the discharge pipe.

Check the effects of turbulence or hydraulic grade on pressure within manholes. Where pressures may expel manhole covers, assess options to maintain public safety e.g. by installing safety grates or fixing down the manhole cover. No feature should impede flow through a manhole. The flow deviation angle between the inlet and outlet pipes must not be greater than 90 degrees, as shown in Figure 1 in clause 6.6.1 – Location and spacing (Wastewater). If circumstances necessitate such a feature, widen the cross section of the manhole to counteract any potential head loss. The design must be accepted by the Council.

Secure manholes against uplift in accordance with *WWDG Part B* clause 14.4.

Where a special manhole cannot be constructed with a standard riser the lid must:

- > meet the *WWDG Part B* clause 14.4 requirements for structural design, as confirmed by a Design Certificate;
- > have minimum concrete strength and cover of 40 MPa and 50mm respectively;
- > conform to the geometric requirements of SD 302 or SD 303, whichever is relevant.

5.10.7 Subsoil drains

Design subsoil drains, which are installed to control groundwater levels, in accordance with *WWDG Part B* clause 5.3.1.

Refer to manufacturer's literature for information on pipe materials, filter fabrics, bedding and filter design.

5.10.8 Pipelines in permeable ground

Where a buried pipeline is likely to encounter an underground source of water, ensure that the groundwater in the water bearing layers will not be diverted to a new exit point through the backfill. Specify backfill material with the same permeability as the surrounding ground and detail water migration barriers at any change of ground permeability.

5.10.9 Steep gradients

Provide adequate anchorage for the pipes, through designing thrust or anchor blocks or by utilising restrained pipe systems.

Specify water stops on all pipelines with gradients steeper than 1:3. Where 'firm mix' is used for haunching water stops are not required. *WWDG Part B* clause 14.2.3 details the design criteria to consider before installing concrete water stops, additional to those relating to permeable ground. Specify water stops constructed to comply with *CSS: Part 3 SD 347*.

5.10.10 Pipe ducts

Pipe ducts shall be considered when a pipeline crosses an NZTA designated road, railway crossing, stream crossings or other instances where above-ground features obstruct or impede the ability to access a pipe for maintenance or renewal. Pipe ducts shall be required for any pipes crossing the alignment of a newly constructed NZTA expressway or motorway. Installation of additional pipe ducts shall be required for future proofing purposes for any pipeline anticipated to be required with 50 years.

Pipe ducts crossing a railway shall comply with Kiwi Rail ducting requirements. In all other instances, pipe ducts shall be constructed out of PE100, RCRR or steel. Pipe class strengths shall be designed to meet maximum anticipated loading and asset life of the greater of 100

years or the pipeline to be placed within the duct. Minimum class strengths allowed shall be SDR 11 for PE100, Class 4 (Z) for RCRR and PN35 for steel. Corrosion protection design is required for steel ducting.

Duct size shall allow for minimum annulus spacing of 50 mm between the duct and appropriate flange connector or coupler fitting for the pipeline or 20% greater than the diameter of the appropriate flange connector or coupler fitting, whichever is greater. This also applies to ducts installed under railways. For design purposes, assume the duct size meets minimum compliant ID standards and flanges or couplers meet maximum OD dimensional standards. When gravity pipelines are to be inserted into the duct, duct sizing may need to be increased to allow for pipeline design grades to be achieved. Centraliser and casing spacing systems are required and shall be specified in the design drawings. Detail how the duct, in the case of a future proof duct, or duct annulus will be sealed to prevent ground or surface water ingress. Grouting or installation of any flowable fill within the annulus is strictly prohibited since the ducts shall be designed and constructed to allow easy installation and extraction of the pipe.

The grade the duct needs to be designed and laid to take into consideration grade requirements of the pipe installed in the duct and whether the pipeline is gravity or pressurised. Design such that no high points are created. If high points are unavoidable, an air valve is required for pressurised pipelines.

Duct positioning shall allow for adequate space and staging area for the removal of the entirety of the pipeline length from flange to flange or coupler to coupler or combination thereof from the duct.

SDR11 PE100 pipe material shall be installed within the duct for all pressure pipe applications to allow for pipe de-rating due to risk of scratching or gauging the pipe during installation. Alternative material/wall thickness options for gravity pipe installations will be considered/ approved by CCC on a case by case basis. Detail flange connection and fitting details at each end.

5.11 Connection to the Public System

5.11.1 Individual lots and developments

The connection of individual lots and developments to the public system must meet the following requirements:

- > Connection must be by gravity flow via laterals to mains or waterways, or to a roadside kerb or swale or rain tanks, or (in certain situations) on-site detention tanks;
- > Provide all new urban lots with individual service laterals located at least one metre from the top of the vehicle crossing cutdown;
- > Each connection must be capable of serving the entire building area of the lot (unless approval is obtained from the Council to do otherwise);

- > Provide stormwater connections at such depth at the boundary of urban lots that a drain is able to be extended from the connection, at grades and cover complying with the Building Act, to the farthest point on the lot;
- > The minimum diameter of connections must be:
 - 100mm for residential lots.
 - 150mm for commercial/industrial lots.
 - 150mm for connections serving three or more dwellings or premises (unless otherwise approved by the Council);
- > Where the public system is outside the lot to be served, extend a connection pipeline a minimum of 0.6m into the net site area of the lot;
- > Connection to features such as vegetated swales, soakpits, or soakage basins is acceptable provided the system is authorised by the Ecan and adverse effects and potential nuisances are addressed;
- > Seal all connections to pipelines or manholes by removable caps at the upstream end, until such time as they are required.

5.11.2 Connection of lateral pipelines to mains

Connections of laterals to mains must be in accordance with *CSS: Part 3*.

5.12 Means of Compliance

5.12.1 Surface water

Surface water hydrology must be in accordance with *WWDG Part B* chapter 21.

5.12.2 Estimation of surface water run-off – peak flow rate

Estimation of the peak flow rate for localised urban catchments must be in accordance with *WWDG Part B (December 2011 update)* chapters 21, 22 and Appendix 10.

For the Banks Peninsula area, a recognised alternative flood estimation method supported by good hydrological information may be presented for consideration.

5.12.3 Estimation of surface water run-off – volume

Estimation of the peak flow rate must be in accordance with *WWDG Part B (December 2011 update)* chapters 21, 22 and Appendix 10.

5.12.4 Sizing of the stormwater drainage system

Drainage system hydraulics must be in accordance with *WWDG Part B* chapters 20 and 22.

5.12.5 Soakage systems

Design of the soakage systems must be in accordance with *WWDG Part B* chapter 6.

5.12.6 Pipe flow

Determine pipe diameters, flows and gradients from *WWDG Part B* Appendix 11.

For pipes not flowing full use Manning's equation adopting 'n' values from *WWDG Part B* Table 22-1. Determine part full pipe flow relationships from *WWDG Part B* Appendix 9.

5.12.7 Energy loss through structures

Refer to *WWDG Part B* chapter 22 for guidance on energy loss through structures.

5.12.8 Determination of water surface profiles

Design stormwater drainage systems in accordance with *WWDG Part B* clauses 14.6 and 22.10, by calculating or computer modelling backwater profiles from the specified outfall water level set by the Council as stated in clause 5.6.7 - Outfall water levels. On steep gradients, both inlet control and hydraulic grade line analysis must be used, and the more severe relevant condition adopted for design purposes. For pipe networks at manholes and other nodes, water levels computed at design flow must not exceed finished ground level while allowing existing and future connections to function satisfactorily.

An example of stormwater system analysis including a backwater calculation is provided in *WWDG Part B* Appendix 5.

Stormwater pipelines generally operate in a surcharged condition at full design flow. Pipe diameters chosen on the basis of pipe flow graphs, such as *WWDG Part B* Appendix 9 (which uses pipeline gradient rather than hydraulic gradient), are likely to be conservative in parts affected by free outfall conditions.

5.12.9 Stormwater quality

Design for surface water runoff quality in accordance with the Stormwater Management Plan for the catchment. Provide macro-pollutant traps, basins and wetlands to *WWDG Part B* chapter 6 in greenfield or large brownfield developments.

Design rain gardens to treat stormwater in small urban areas that are being redeveloped. Where the above treatment options are not practicable or where installing large trees, design stormwater tree pits. Refer to the *Rain Garden Design, Construction and Maintenance Manual*.

All these treatment options require a consent to discharge stormwater to ground.

Refer to clause 5.3 - Consent and compliance issues.

Ensure the design considers the ongoing maintenance requirements and costs. Specify verification through testing and commissioning that the constructed option achieves design infiltration rates, treatment levels and volumes specified.

The designer may propose alternative design elements with supporting evidence from recognised authorities.

5.12.10 Fish Passage

Waterways and stormwater systems to be designed in accordance with New Zealand Fish Passage Guidelines. Appendix G of guidelines has minimum standards.

5.13 Construction

Construction must be carried out in accordance with *CSS: Part 3*.

Wherever works are installed within existing legal roads, the developer must obtain a Works Access Permit (WAP) for that work. Apply for a Corridor Access Request (CAR) at www.beforeudig.co.nz. The works must comply with requirements as set out in *CSS: Part 1* for this type of work.

5.13.1 Reducing waste

When designing the development, consider ways in which waste can be reduced:

- > Plan to reduce waste during site clearance e.g. minimise earthworks, reuse excavated material elsewhere.
- > Design to reduce waste during construction e.g. prescribe waste reduction as a condition of contract.
- > Select materials and products that reduce waste by selecting materials with minimal installation wastage.
- > Use materials with a high recycled content e.g. recycled concrete subbase.

See the Resource Efficiency in the Building and Related Industries (REBRI) website for guidelines on incorporating waste reduction in your project www.rebri.org.nz.

5.13.2 Materials

All materials must comply with those listed on the Council's web page for approved materials at www.ccc.govt.nz/consents-and-licences/construction-requirements/approved-materials-list. Use Appendix III- Wastewater Material Selection Table of Part 6: Wastewater Drainage as a guide when specifying materials.

Proposed pipes and concrete structures that are likely to lie within the blue zones shown on Plan No. RGo05102 Ro1 *Aggressive Groundwater Map* (refer to Appendix IV - Aggressive Groundwater Map of Part 6: Wastewater Drainage) will need additional protection such as an external plastic wrapping membrane.

5.13.3 Bedding, haunching and backfill

Design bedding, haunching and backfill to conform to clause 6.14 – Haunching and Backfill (Wastewater Drainage) including clauses 6.14.2 – Difficult Ground Conditions and clause 6.14.3 – Scour. Bedding and haunching materials must comply with *CSS: Part 3* and the pipe manufacturer’s specifications.

Where works will produce redundant in-ground piping or manholes, specify treatment of the potential void as detailed in clause 6.14.4 – Redundant infrastructure (Wastewater Drainage).

Specify wrapping of the joints in all concrete rubber ring jointed pipes with a geotextile that complies with TNZ F/7 strength class C. Wrapping of joints is not required in ‘hillside’ trenches backfilled with lime stabilised material. Select a geotextile that will prevent the infiltration of backfill or natural material into the stormwater system where pipes break under seismic loading.

Specify wrapping of the haunching for plastic pipes and laterals in liquefaction prone areas with a geotextile that complies with TNZ F/7 strength class C. This may improve the longitudinal strength of the pipeline, reducing potential alterations in grade.

Specify backfill materials individually. The material used must be capable of achieving the backfill compaction requirements set out in *CSS: Part 1* clause 32.0 - Backfilling and clause 5.10.8 - Pipelines in permeable ground.

5.14 As-Built Information

Present as-built information which complies with Part 12: As-Built Records and this Part.

