Infrastructure Design Standard

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PART 1: INTRODUCTION

CONTENTS

1.1 REFERENCED DOCUMENTS:

Planning and Policy:

- Timaru District Plan
- Resource Management Act (1991)
- Building Act (2004)
- Local Government Act (2002) and Local Government Act 2002 Amendment Act 2014
- New Zealand Building Code (Schedule 1, Building Regulations 1992)
- Timaru District Council *Long Term Council Plan (2021-2031)*
- Environment Canterbury *Land and Water Regional Plan (2019)*
- Waka Kotahi NZTA *Landscape Guidelines (2014)*
- All New Zealand Transport Agency (NZTA) guidelines (including RTS series) and manuals (including TNZ standards and the *Bridge Manual*)
- NZS 3910 *Conditions of contract for building and civil engineering construction*
- NZS 4404:2010 *Land development and subdivision infrastructure*
- NZS 4431:1989 *Code of practice for earth fill for residential development*
- AS/NZS 1158 Set *Lighting for roads and public spaces set*

Design:

- Austroads Guide Suite
- Christchurch City Council Design Guide *Crime Prevention Through Environmental Design*

Construction:

- Timaru District Council Construction Standard Drawings and Specifications

Note: Where a conflict exists between any Standard and the specific requirements outlined in the Infrastructure Design Standard (IDS), the IDS takes precedence (unless deemed otherwise at the discretion of the Timaru District Council).

1.2 INTRODUCTION

This document is based on the Christchurch City Council (CCC) Infrastructure Design Standard (IDS). Timaru District Council (TDC) is grateful to the Christchurch City Council for approval to use the IDS and benefit from both the knowledge and learnings it represents.

The Timaru District Council Infrastructure Design Standard (TDC IDS) will be revised on a regular basis much as CCC does.

In 2019, TDC decided to develop a separate Code of Practice based on the IDS for use within the wider Timaru district. The TDC IDS will act as a blueprint for Council and Developers to undertake Land Development and Infrastructure projects across the district. The TDC IDS in combination with TDC Infrastructure Construction Specifications and Standard Drawings form the TDC Engineering Code of Practice.

1.3 DOCUMENT PURPOSE

The purpose of the Infrastructure Design Standard is to provide the design standard for both TDC funded assets and assets that will be vested with Council, through processes such as subdivision, as well as provide a publicly available guide for developments to reference for private asset design.

Previously, requirements were detailed within the District Plan or through references to other standards. This first edition aims to bring these details together into one consolidated document.

There may be examples within the Wider Timaru District where infrastructure does not comply with the requirements of the IDS. It is not the intention that compliance with the IDS be used as a vehicle to justify retrofitting or inclusion in or reprioritisation of the Council's programme of work as determined by the *Long Term Plan*.

Note: Where the *District Plan* is referred to, this means those objectives and provisions in the operative Timaru District Plan, unless specifically stated otherwise.

The parts of the TDC IDS are summarised below:

- **Part 1**: **Introduction** highlights the major changes and includes those definitions specific to the IDS.
- **Part 2: General Requirements** covers a number of regulatory details and sets out the process from design to acceptance of land developments by the Council
- **Part 3: Quality Assurance** sets out the requirements for the application of quality assurance practice’s to the construction of all assets. Each project will require the implementation of a project quality system, with documentation and certification presented to the Council at both the design and

construction stages; the traditional Council role of Clerk of Work type inspections will be replaced with a structured audit-based system.

- **Part 4: Geotechnical Requirements** sets out the requirement for geotechnical input in land development and what must be considered by the geotechnical engineer. It emphasises the Council's desire to work with the landforms and preserve natural features. It also details issues to be considered on Hazardous Activity and Industries List (HAIL) sites and erosion, sediment and dust control.
- **Part 5: Stormwater and Land Drainage** provides more prescriptive design and compliance criteria and reinforces the change of emphasis to include water quality and ecological protection. Fish passage design guidance is referenced.
- **Part 6: Wastewater Drainage** incorporates both an explanation of Timaru's reticulation system and how the Council's philosophy has changed. It provides the design and compliance criteria for wastewater systems including those pertaining to modern materials. The requirements for private drains have been tied to the New Zealand Building Code.
- **Part 7: Water Supply** covers the design and compliance criteria of water reticulation. It references the Drainage and Water Construction Specifications for larger infrastructure including those pertaining to modern materials.
- **Part 8: Roading** sets out both the design and compliance criteria for the road layouts e.g. road classification and the roads themselves e.g. footpaths construction depths. It includes specifications for the design and construction of roads, former National Roads Board requirements have been replaced with Austroads specifications.
- **Part 9: Utilities** covers the Council's compliance requirements for telecommunication, electricity and gas. It excludes the utility design itself, as these are beholden to the network operator's requirements.
- **Part 10: Lighting** sets the Council's requirements for street lighting design and construction. It builds on *AS/NZS 1158*. It includes LED requirements.
- **Part 11: As-Builts** set the Council's requirements for as-built information on completion of development construction works.

1.4 DEFINITIONS

This is the non-exhaustive list of definitions relevant to the Timaru District Council IDS. These definitions complement those included in the Ministry for the Environment National Policy Statement 21 Definitions Standard.

Definitions are provided where another source is cited.

Definitions specific to this document include:

Drain[1]
Drain means any artificial watercourse, open or piped, that is designed, and constructed, or used, for the purpose of the drainage of surface or subsurface water, but excludes artificial watercourse used for the conveyance of water for electricity generation, irrigation, or water supply purposes,

Drainage
DRAINAGE means wastewater drainage or stormwater drainage, and "drain" has a corresponding meaning.

Earthworks[2]
Any alteration to the contours, including the excavation and backfilling or recompaction of existing natural ground and the stripping of vegetation and topsoil

Network Utility Operator[3]
s. 166 of the Resource Management Act 1991
Network utility operator means a person who—
(a) undertakes or proposes to undertake the distribution or transmission by pipeline of natural or manufactured gas, petroleum, biofuel, or geothermal energy; or
(b) operates or proposes to operate a network for the purpose of—
> *(i) telecommunication as defined in section 5 of the Telecommunications Act 2001; or*
> *(ii) radiocommunication as defined in section 2(1) of the Radiocommunications Act 1989; or*

(c) is an electricity operator or electricity distributor as defined in section 2 of the Electricity Act 1992 for the purpose of line function services as defined in that section; or
(d) undertakes or proposes to undertake the distribution of water for supply (including irrigation); or
(e) undertakes or proposes to undertake a drainage or sewerage system; or
(f) constructs, operates, or proposes to construct or operate, a road or railway line; or
(g) is an airport authority as defined by the Airport Authorities Act 1966 for the purposes of operating an airport as defined by that Act; or

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[1] National Policy Statement 21 Definitions Standard
[2] NZS 4404: 2010
[3] Section 166 of the Resource Management Act 1991

(h) is a provider of any approach control service within the meaning of the Civil Aviation Act 1990; or
(i) undertakes or proposes to undertake a project or work prescribed as a network utility operation for the purposes of this definition by regulations made under this Act, —
and the words network utility operation have a corresponding meaning.
requiring authority means—
(a) a Minister of the Crown; or
(b) a local authority; or
(c) a network utility operator approved as a requiring authority under section 167.

Wastewater[4]
Water that has been used and contains unwanted dissolved or suspended substances from communities, including homes, businesses, and industries

[4] NZS 4404: 2010

1.5 ABBREVIATIONS

The following is a non-exhaustive list of the abbreviations that apply in the Infrastructure Design Standard. These abbreviations are additional to those abbreviations included within NZS 4404.

AADT – Average annual daily traffic
AEP - annual exceedance probability
ASF (l/s) – average wastewater flow is the daily average flow from domestic, industrial and commercial sources, excluding infiltration and surface entry, as determined in clause 6.4 – Sanitary Sewer Design Flows (Wastewater Drainage)
CAR – Corridor Access Request
CPTED – Christchurch City Council Design Guide *Crime Prevention Through Environmental Design*
CSS – Christchurch City Council *Construction Standard Specifications*
GPS – global positioning system
HAIL – Hazardous Activity and Industries List
IDS – *Infrastructure Design Standards*
ISO – International Standards Organisation
LTCCP –*Long-Term Council Community Plan - Our Community Plan*
MF (l/s) – maximum flow is the instantaneous design total peak
NUO – Network Utility Operator
OD – outside diameter
P/A ratio – peak to average ratio PSF/ASF
PE 80B – Polyethylene type 80B
PE 100 – Polyethylene type 100
PN – Pressure nominal
PSF (l/s) – peak wastewater flow
PVC-o – Oriented Poly-Vinyl Chloride
PVC-u – Unplasticised Poly-Vinyl Chloride
PWAP – Parks and Waterways Access Policy
RAMM – Road Asset and Maintenance Management
RMA – Resource Management Act
RON – road opening notification
SCADA – Supervisory, Control And Data Acquisition
SCIRT – Stronger Christchurch Infrastructure Rebuild Team
SN – Stiffness number
SPF – Storm peak factor
STMS – Site Traffic Management Supervisor
WAP – Works Access Permit
WK – Waka Kotahi NZ Transport Agency

PART 2: GENERAL REQUIREMENTS

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2.1 REFERENCED DOCUMENTS

The reference documents outlined in Part 1: Introduction were utilized in the development of this Part, along with the following documents for additional input.

Planning and Policy

- Heritage New Zealand Pouhere Taonga Act 2014
- Health and Safety at Work Act (2015)
- Wildlife Act 1953

Where a conflict exists between any Standard and the specific requirements outlined in the Infrastructure Design Standard (IDS), the IDS takes precedence (unless deemed otherwise at the discretion of the Timaru District Council).

2.1.1 Source documents

This part of the Timaru District Infrastructure Design Standard (IDS) is based on Part 2 of the CCC Infrastructure Design Standard (CCCIDS), by agreement and with the consent of Christchurch City Council.

2.2 INTRODUCTION

The IDS serves as a basis of compliance for projects carried out by the Council as part of its capital works programme, as well as the subdivision and development of land.

This Part of the IDS includes both those components of the design process common to all developments or not restricted to one asset type and those components particular to the subdivision of land.

The provisions of the IDS must be read subject to the provisions of the *Timaru District Plan* (*TDP*) and to any applicable statutes, regulations, and bylaws.

2.3 RELATIONSHIP WITH ACTS OF PARLIAMENT

2.3.1 Resource Management Act

The *Resource Management Act 1991* (*RMA*) is the principal statute under which the use and subdivision of land is controlled.

The *TDP* is a resource management instrument tasked with the purpose of achieving the promotion of sustainable management of natural and physical resources, which is the overarching purpose of the *RMA*.

The IDS serves as a technical compliance manual and, although outside the *TDP*, its provisions are referred to and given effect through conditions of resource consent and through capital works' project briefs.

2.3.2 Building Act

The *Building Act* provides a national focus for building control to ensure that buildings are safe and sanitary and have suitable means of escape from fire. The *Building Regulations* made under the Act provide the mandatory requirements for building control in the form of the *New Zealand Building Code*[1]. The *Building Code* contains the objective, functional requirements and performance criteria that building works must achieve.

Where infrastructural development associated with capital works and the subdivision or development of land involves the creation of structures with associated site works, you must observe the requirements of the *Building Act*. Nothing in the IDS shall detract from the requirements of the *Building Act* or the *Building Code*.

[1] New Zealand Building Code

2.3.3 Local Government Act

The mechanism for requiring contributions under the Local Government Act, through land or cash, is set out in the Timaru District *Long Term Plan 2021-2031*[2].

2.4 DETERMINING REQUIREMENTS FOR CONSENTS

The design and construction of utilities carried out as part of a land development or subdivision is controlled by the subdivision and the building consent processes.

The *Building Act* Part 1 Section 8 includes within its definition of a building, "*a mechanical, electrical or other system*" but only if the system is attached to a temporary or permanent movable or immovable structure and "*the system is required by the building code… or if installed, is required to comply with the building code*." The provision of water, stormwater and sewer reticulation within private land, e.g. an access lot or new access, therefore requires consent under the Building Act. Evidence of compliance is provided by obtaining a building consent, carrying out the works in accordance with that consent and the issue of a code compliance certificate by the Council.

https://www.timaru.govt.nz/services/building/overview/additional-consent-info/forms-and-checklists

https://www.timaru.govt.nz/__data/assets/pdf_file/0010/334576/Building-IS-122-Guidance-Notes-Essential-Features-of-a-Producer-Statement.pdf

The Council will accept the IDS as an alternative design solution under a Building Consent but only for reticulation which is not covered by an acceptable solution in the *Building Code*. This enables the IDS to be used to design both private and public systems, removing inconsistencies in standards between these ownership types.

Systems owned or operated by a network operator (e.g. the Council) that are external to a building and are connected to, or intended to be connected to, the building to provide for the successful functioning of the network utility operator's (NUO) system in accordance with the system's intended design and purpose are not included in the definition of a building and therefore are exempt from the provisions of the *Building Act*. Authorisation to carry out this work is provided through the conditions of a subdivision consent. Evidence of this compliance is provided through certification in accordance with Part 3: Quality Assurance.

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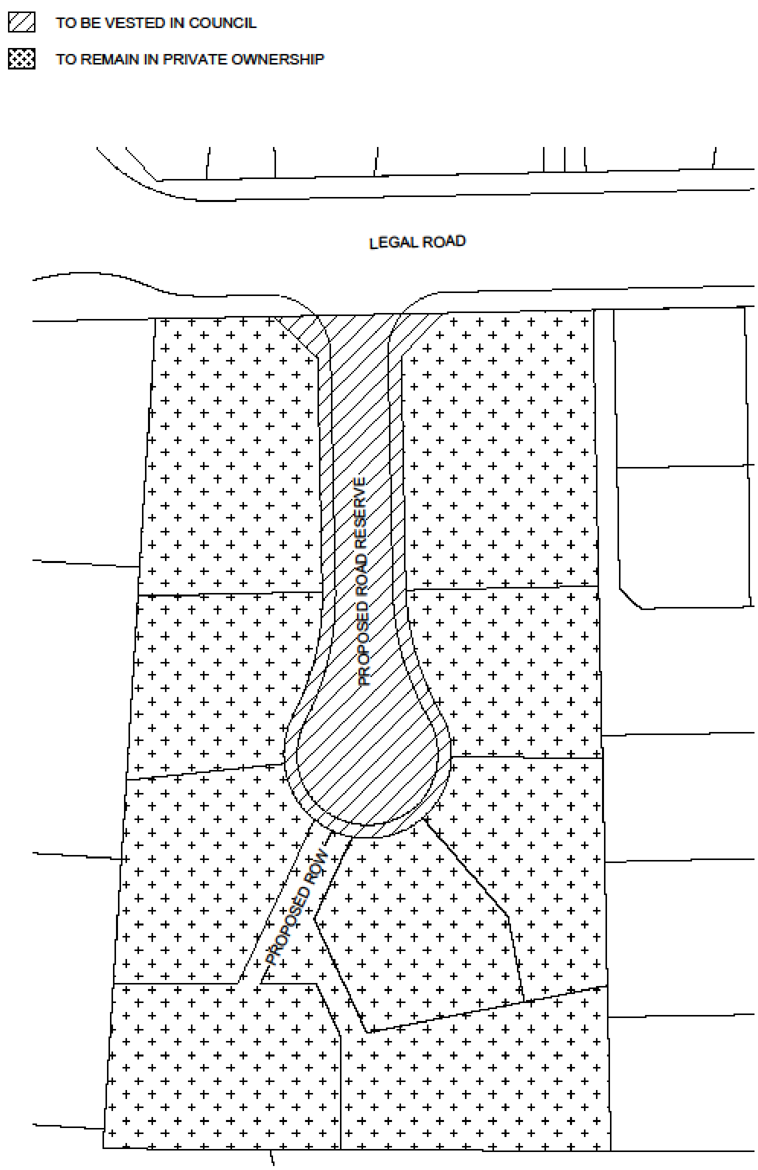
[2] Timaru Long Term Plan 2021-2031

Figure 1 indicates those parts of a subdivision that remain in private ownership and therefore would be covered by a building consent, and those covered by the subdivision consent and therefore the requirements of the IDS. This diagram applies equally to infill, unit title, greenfield and brownfield development.

Figure 1 Relationship between public and private ownership



As shown, reticulation of any size installed in private land will remain private, with the exception to that covered by an easement in gross in favour of the Council. The only exception to the requirement for private reticulation to be installed under a building consent is for a lateral laid from a main a minimum of 600mm into a lot. The portion which is private i.e. the length installed over the legal boundary and within the lot under a service consent, does not require installation under a building consent.

2.5 EXPANDING ON DISTRICT PLAN REQUIREMENTS

2.5.1 Fees

The Council Fees and Charges[3] includes an application fee for Subdivision Consent applications. This fee is a deposit with the true and actual cost calculated of processing time spent by Council staff, then invoiced upon issuance of the consent decision. The balance of the cost of processing the application is payable by the applicant.

2.5.2 Pre-application meeting

Developers and designers of “greenfield” subdivisions that will result in substantial infrastructural assets being vested to the Council, or smaller complex subdivisions on the hills, are strongly advised to request a pre-application meeting at which issues and options can be discussed with the Council.

You should submit a concept plan before this pre-application meeting.

Council staff including District Planning Consents Team Leader, Infrastructure Planner, and representatives from the Drainage and Water and Land Transport Unit should be present at any pre-application meeting.

2.5.3 Future development

Where further development upstream of, or adjacent to the area under consideration is provided for in the *TDP*, the Council may require infrastructure or additional capacity to be constructed to the upper limits of the development.

You must make allowance for these requirements where specified by the Council in the consent conditions or project brief.

2.5.4 Balancing landform choices

Working with and balancing of natural landforms is key creation of a good design and helps prevent the introduction of adverse effects on the surrounding land.

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[3] TDC Fees and Charges

The final choice of landform for a development is dependent on factors specific to the site, such as:

- relationship with surrounding landscapes.
- natural drainage patterns.
- size of the development.
- proposed and existing roading patterns.
- preservation of natural features.
- enhancement of natural features where compromised by fragmentation or reduction due to the proposed development.
- stability of the land.
- function and purpose of the development.
- potential for flooding, erosion, and other natural events.

The order of importance of these factors will vary from project to project.

The final choice of landform must represent the most desirable compromise between the development requirements, the preservation of natural features including the existing soil profile, and the natural quality of the landscape. Also refer to clause 4.6.1 – Suitability of landform (Geotechnical Requirements).

2.5.5 Environmental considerations

Planning advice and scoping of potential environmental impacts should be completed during the investigative stage of projects. This ensures that the site and its surroundings are fully understood prior to the commencement of design.

The Council has environmental policies designed to protect and enhance the district's natural environment. It also encourages parties to retain and enhance the natural environment in tandem with development works. When carrying out a design, you should evaluate its overall impact on the environment for both the construction and operational phases, in a manner consistent with legislation*, National Policy Statements, Regional Plans* and the *TDP*.

An archaeological site is any place in New Zealand that was associated with human activity occurring before 1900 and which may provide evidence relating to the history of New Zealand. Any work on any part of these sites will require an archaeological authority from Pouhere Taonga - Heritage New Zealand and possibly a resource consent to alter an historic item.

Wherever possible, one should avoid environmentally significant areas. Some examples of these areas include:

- stands of native vegetation, bushland (Significant Natural Areas, QE2 Land, etc.),
- habitats of threatened native species including lizard and bat habitats,

- waterways and floodways.
- wetlands, swamps, estuaries, sand dunes, foreshore areas.
- community drinking water supply zones
- archaeological sites, heritage item precincts and cultural sites.
- Department of Conservation scenic reserves and protected species.
- ecologically significant sites or habitats including protected trees.
- Maori relics and significant indigenous sites.
- *Hazardous Activity and Industries List* (HAIL) sites including parks, cemeteries, landfill sites and contaminated land.
- areas of aggressive ground conditions, e.g. acid sulphate soils and aggressive ground waters.

The Wildlife Act 1953 protects most native species. The Department of Conservation can issue permits to translocate or destroy species protected under the Wildlife Act, e.g. native bat populations in the Geraldine Downs, however mitigation and compensatory conditions may apply. It is preferable to avoid impacts on protected species.

The *National Environmental Standard (NES) for Assessing and Managing Contaminants in Soil to Protect Human Health* ensures land that is potentially affected by contaminated soil is identified and assessed before work commences. Small scale works on confirmed sites may be permitted, but others require a resource consent administered by Timaru District Council.

When it is not possible to avoid environmentally sensitive areas, address the following environmental issues in the design strategy and construction methodology and through an Environmental Management Plan (EMP) which complies with clause 3.8.2. Environmental management issues:

- The environmental impact of the construction;
- Protection of trees and ecologically significant vegetation;
- Protection of waterways and site restoration;
- The use of low impact methods and design solutions such as trenchless technology, rain gardens, eco-sourced native plants, wetlands and other mitigation methods;
- The impact of construction equipment on the site and surrounding area;
- Mitigation of key environmental risks including erosion, sediment and dust control, spills, wastewater overflows, dewatering and excavation and disposal of material from contaminated sites.

Ensure that the appropriate authorisations are obtained from The Timaru District Council, Canterbury Regional Council – Environment Canterbury, Pouhere Taonga Heritage New Zealand, and the Department of Conservation and that the work is carried out in accordance with the Council's requirements.

2.5.6 Road name signs

When the development contains new roads, private ways or access lots that require signage, the developer will pay a fee to Council for the manufacture and erection of any new nameplates and posts. Any roundabout chevron signage is additional to this signage and must be organised and paid for by the developer. The developer is responsible for moving existing signage, where the new work affects its placement.

2.5.7 Coastal hazards

Council's flood modelling incorporates the 100-year projection of 1.2m sea level rise in the mapping of Coastal High Hazard (Erosion and Inundation) Areas. Information on design floor levels is available at https://timaru.isoplan.co.nz/eplan/.

Consider the impact of climate change on coastal areas and the upstream effect on groundwater levels and flooding when developing land or infrastructure.

Supporting information on coastal hazards, including the *Timaru District Coastal Hazard Assessment*[4] is available on the Council's webpage. Further explanation and clarification of the interpretation of this information is available from Council.

2.6 URBAN DESIGN AND THE INFRASTRUCTURE DESIGN STANDARD

A useful definition of urban design is:

*'The art of **making places for people**. Urban design is concerned with the **way places work** as well as how they **look**. It concerns the **connections** between people and places, **movement** and **urban form**, **open space** and **buildings**, and the **process** of creating successful neighbourhoods, towns, and cities.*

*Urban design is important in creating **sustainable** developments that support **economic** life and **social** integration.'*

This definition highlights the importance urban design has in creating successful places where people want to live, work and play. Urban design skills and principles are commonly used to coordinate various parts of a development to ensure each design decision is complementary to the next, over a range of scales.

Many of the standards in the IDS could simply be 'ticked off' in a piecemeal way but developers are encouraged to think more holistically and to understand how their development fits into the 'big picture'.

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[4] Timaru District Coastal Hazard Assessment

New developments should reinforce the broader strategic objectives for the Timaru District. These strategies and plans aim to incrementally shape the future growth of the Timaru District in a sustainable way (including environmentally, socially and economically). The success of these strategies is largely dependent on how well individual developments contribute to the bigger picture. The strategies include:

- Timaru Growth Management Strategy,
- City Hub Strategy,
- Active Transport Strategy,
- 2018-2048 Stormwater Strategy

The Council also recognises that some places have their own character, which may require a different approach to infrastructure design. For some of these special areas the Council will or has prepared place-based plans and may require new developments in these areas to conform to these plans. Check whether the development falls within one of these areas.

Development Area Plans will be produced soon for new growth areas within the district. Currently we have Outline development plans for Gleniti Residential 6 Zone, Washdyke Industrial Expansion Zone, and Broughs Gully Development Area. The existing development areas and associated rules are available on the Proposed District Plan ePlan[5].

The Council has a few non-regulatory guidelines on urban design best practice. These are targeted particularly at public space, such as streets and parks that will be vested to the Council. However, the configuration of public space has a direct influence on what can be achieved within private areas, including the mix of land uses, different residential densities, lot layout and built form. Non-regulatory guidelines include:

- Roading also has policies on:
  - Sealed Road Surfacing Policy
  - Street and Amenity Lighting Policy
  - Urban Street Trees Policy
  - Vehicle Crossings Policy

The Council encourages designers and developers to seek further guidance, particularly when considering the relationship between the public and private areas. The Council recommends that developers commission professional consultants to carry out the site design or to peer review respective proposals.

[5] Timaru District Proposed District Plan ePlan

2.7 REQUIREMENTS FOR DESIGN AND CONSTRUCTION

2.7.1 Investigation and design

All investigation, calculations, design, supervision, and certification of the works, as outlined in the IDS, must be carried out by or under the control of persons who:

- are experienced in the respective fields;
- hold appropriate membership in the respective professional bodies;
- have appropriate professional indemnity insurance.

The provisions of the IDS do not reduce the responsibility of those professionals to exercise their judgement and devise appropriate solutions for the circumstances of each development or project.

For projects that will affect strategic transportation routes, consult with Council's Land Transport Unit regarding the construction methodology and temporary traffic management needs.

2.7.2 Construction

All works carried out in any development must be done by persons who:

- have the appropriate experience in the relevant areas;
- have the appropriate equipment;
- are approved for that type of work e.g. authorised drain layers, authorised water supply installers, Site Traffic Management Supervisors. Refer to Timaru District Council's Infrastructure Approved Contractor List[6] for details.

2.7.3 Quality assurance

All quality aspects of the investigation, design and construction must comply with Part 3: Quality Assurance. If any or all the certificates or other documents referred to in Part 3: Quality Assurance are not supplied, the Council may refuse to accept the work and refuse to issue a certification for the work pursuant to Section 224(c) of the RMA.

[6] TDC Infrastructure Approved Contractor List

2.8 SURVEY REQUIREMENTS

2.8.1 Level datum

Design and as-built information must be supplied in New Zealand Transverse Mercator 2000 (NZTM2000) projection and Lyttelton (1937) vertical datum.

All plans are required to state the datum used. All levels are to be stated in height above Mean Sea Level (in metres).

For Drainage requirements refer to Stormwater (Part 5) Section 5.4.2.

2.8.2 Benchmarks

Timaru District Council Construction Standard Specifications[7]

These standard specifications set out the technical requirements for the construction of Infrastructure (Roading and Drainage and Water) Assets undertaken both on behalf of Timaru District Council or that are intended to be taken over or maintained by Timaru District Council.

Construction of assets which are outside the scope of the current specifications (including legacy specifications) will require specific approval from the Timaru District Council. If the relevant specification is not listed, please contact Timaru District Council.

2.9 DRAWINGS

Engineering drawings must be legible, clear, readable, and complete. They must clearly illustrate the proposal and enable both assessment of compliance with the IDS and accurate construction. Produce drawings on A3 series format. Follow the draughting requirements attached in Appendix I - Standard Draughting Layout and Format Requirements.

Engineering drawings generally include the following:

- A locality diagram giving the overall layout and location of the works;
- Detailed drawings, longitudinal sections, cross sections and diagrams of the proposed developments and/or works;
- Special details where the standard drawings are not sufficient;
- Benchmarks at a maximum spacing of 650m;

[7] TDC Construction Standard Specifications

- A north point, preferably pointing above the horizontal (i.e. in the top 180 degrees);
- Standard sheet notes;
- Set out information;
- A service legend, where services are shown on the drawing;
- A planting key or clearly labelled planting, where it is shown on the drawing.

If the project is large, provide a separate landscape drawing. On smaller projects, landscaping details may be shown on the engineering drawings. In both cases, show landscape planting areas on the roading construction drawings, by shading or hatching.

2.9.1 Content of drawings

Show the following information on the drawings:

- The extent of the works showing existing and proposed roads, and the relationship of the works with adjacent works, services and/or property, including adjacent property levels;
- Proposed and existing property boundaries and street numbers;
- Significant existing vegetation to be removed and any special or protected trees, and any areas of heritage significance that may be affected by the works;
- The extent of earthworks, including earthworks on proposed reserves, existing and proposed contours, areas of cut and fill, batter slopes, proposed stockpiles, subsoil drainage, erosion and sediment control measures both temporary and permanent;
- Details and location of existing and proposed stormwater primary and secondary flowpaths;
- The design of proposed roads (and their connections with existing roads), including plans, longitudinal and cross sections, horizontal and vertical geometry and levels, typical cross sections, details of proposed pavement and surfacings, kerbing, berms, footpaths, cycleways, tree planting, road marking and signage and all other proposed street furniture;
- Details and location of existing water, wastewater and stormwater mains and service connections, valves, hydrants, manholes, sumps, bends, tees, thrust blocks, meters and backflow devices;
- The horizontal and vertical alignment and location, including invert levels, physical grades, lengths, sizes, materials, types, minimum cover, cut to invert, position relative to other services of all proposed water, wastewater and stormwater mains and service connections, valves, hydrants, manholes, sumps, bends, tees, thrust blocks, meters and backflow devices, and services that may be reconnected or plugged;
- Details and location of mechanically restrained portions of pipelines, pipeline bridges, pumping stations, reservoirs, intake and outlet structures, headwalls,

swales, basins, ponds and the location of surface obstructions, hazards, or other features that may be affected by the works;
- In respect of water mains - chlorination points, pressure reducing valves with upstream and downstream design pressures;
- The street lighting layout showing the location and type of each light, proposed and existing significant road features (e.g. kerbs, property boundaries, planting and traffic management features) and property addresses;
- Details and location of existing and proposed telecommunications, electricity and gas supply, including proposed underground and above-ground junction boxes, transformers and similar equipment;
- The bedding and backfill depths, design compactions and trench restoration details for all underground services;
- Details of proposed landscaping of roads and allotments, and details of proposed reserve development including earthworks, landscaping features, landscaping structures, tree planting, irrigation, hard and soft surface treatment, park furniture and playground equipment. Include details of ongoing maintenance requirements, where appropriate.

This information may be expanded in the upcoming relevant chapters.

2.9.2 Form of drawings

Provide all drawings in electronic form and as a .pdf - details are included in Section 12.4 As-Built Records. Prepare electronic drawings in Arc GIS shapefiles (.shp), Digital Exchange Files (.dxf), Microstation (.dgn), 12Da or AutoCAD format.

All drawings must be legible at A3 size. Street lighting drawings can be either 1:500 or 1:1000 scale.

2.10 ACCEPTANCE OF DESIGN

This clause applies to works carried out under subdivision consent.

Include stage boundaries on all plans that are submitted for engineering acceptance where the project is being constructed incrementally.

2.10.1 Documents to be submitted for engineering acceptance

The Council will require a design report to be submitted. Clause 3.3.2 – Design report (Quality Assurance) sets out in detail what is required in a design report.

Submit the design records, incorporating drawings, calculations, specifications, material specifications where not detailed elsewhere, graphical representations and calculations of infrastructure where requested, with the design report. This information should enable the process to be followed easily and should allow for replication of the results.

Include the geotechnical engineer's report on the suitability of the land for subdivision and/or development, including any site investigations.

Each separate Part of the IDS sets out those aspects particular to that Part which must be covered by the design or design report, where relevant.

2.10.2 Cost benefit or life cycle costing

Where required by the Council, one must carry out a cost benefit or life cycle costing of a proposal. This will typically be for larger, unique projects where new network or a significant shift from standard practice is proposed.

Life cycle costing may be used to consider options within a proposal or for a proposal as a whole. In undertaking life cycle costing, consider the initial costs borne by the developer or the Council and the maintenance and replacement costs borne by the future owners and/or the Council. Maintain a reasonable balance between these short-term and long-term costs, which can be assessed by suitably qualified asset management professionals.

2.10.3 Engineering acceptance

When the Council is satisfied that both the design and design report meet the requirements of the IDS, the Council shall notify the designer that the design and Design Report has been accepted and stamp the plans as accepted. For this acceptance, the Council may require amendments to any quality plans, engineering drawings, specifications and/or other documentation and further reports submitted.

2.11 ACCEPTANCE FOR CONSTRUCTION

Work must not commence on the proposed site unless and until:

- A resource consent for the work has been issued, except when no such consent is required;
- The Council has given engineering acceptance for works carried out under a subdivision consent;
- The Contractor has received stamped accepted plans:
- Where required, the Council has accepted the Contract Quality Plan and Engineer's Review Certificate as detailed in clause 3.3.3 - Contract Quality Plan (Quality Assurance);
- Any other consent required has been granted e.g. NZ Railways Corporation, Department of Conservation, landowner.

2.11.1 Notification of hold or witness points

Hold or witness points form part of the Contract Quality Plan required for each development. The developer or contractor must notify the Council at all 'hold' or 'witness' points and such other times as the Council may determine, for Council's information and to enable audits or witnessing to be carried out. Hold points may include but are not limited to:

- Pre-Earthworks, Erosion and Sediment Control Inspection
- Compaction Testing of each pavement layer
- Deflection Testing of basecourse
- Concrete Testing of kerb and corbel concrete
- Pressure Testing of installed water supply reticulation
- Sterilization Certification of installed water supply reticulation
- Microbiological Test Results for water supply reticulation
- Hydrostatic Testing for sewer and stormwater mains and manholes

You must give the Council at least one working days' notice and adequate access for audits or tests. Audits will be carried out within one working day of notification if possible. The Council will inform the developer and/or engineer to the contract of any problems encountered with these audits so they can be addressed at an early stage.

2.11.2 Testing

Any work required to be tested by the contractor or developer in the presence of the Council must be pre-tested and proved satisfactory before test witnessing by the Council is requested.

2.12 COMPLETION OF LAND DEVELOPMENT WORKS

2.12.1 Defects liability

The defects liability period for all works must be 12 months from the issue of Council's Practical Completion Certificate or Provisional Acceptance of Assets to Vest at the section 224(c) Certification stage of a subdivision. You must maintain the works until they are formally taken over by the Council or to a date specified in a bond for completion of uncompleted works. The developer must also remedy defective works, as defined in NZS 3910, over this period.

You must establish and maintain landscaping, over this period or until the landscape establishment bond is released. Establishment includes achieving vegetation coverage to stabilize disturbed surfaces.

2.12.2 Completion documentation

You must upon completion of all developments, provide completion documentation in accordance with Part 3: Quality Assurance. Additionally, you must provide evidence that reticulation and plant to be taken over by network utility operators has been installed to their standards and will be taken over, operated, and maintained by the network utility operator concerned.

Required completion documentation includes, as a minimum:

- completion certificates as per Part 3: Quality Assurance appendices;
- the geotechnical reports, certificates and as-built records required by Part 4: Geotechnical Requirements;
- an up-to-date Environment Canterbury compliance monitoring report which indicates no significant or major non-compliance;
- Evidence of a complying post construction safety audit for works on or becoming legal road.
- completion documentation required by Part 10: Lighting;
- as-built records of all infrastructure, where required by the subdivision consent or contract, showing the information required by each Part;
- as-built data, where required by the subdivision consent or contract, for all infrastructure taken over by the Council, in RAMM format;
- project and contract records , e.g. inspection and test plans, non-conformance reports;
- other documentation required by the Council including, but not limited to, operation and maintenance manuals and warranties for stormwater treatment facilities and new facilities involving electrical or mechanical plant; asset valuations for all infrastructure to be taken over by the Council;

When all the conditions of approval that are imposed on a resource consent for subdivision have been met, the Council will issue a Section 224(c) Compliance Certificate to that effect.

2.12.3 Approval of uncompleted work

Where in the opinion of the Council it is appropriate, the Council may approve uncompleted work, subject to satisfactory bonds being arranged. This arrangement must be made and agreed on prior to an application for Engineering Clearance or section 224(c) certification under the *RMA*.

2.13 BONDS

A bond template is available in Appendix IV – Bond Form or from Engineering Forms[8] on the TDC Website.

2.13.1 Uncompleted works bonds

Bonds to cover minor uncompleted works, especially where a subdivision or development has been substantially completed, are recognised as an acceptable procedure, and will be permitted at the discretion of the Council. Council may consider bonding the establishment of planting, lawns and associated works as uncompleted works.

Bonds must be secured by an appropriate guarantee or otherwise must be in cash and lodged with the Council. Where necessary bonds must be executed and registered on the associated record of title.

The amount of the bond shall be the estimated value of the uncompleted work plus a minimum of a 50% margin to cover additional costs estimated to be incurred by the Council in the event of default.

A bond can be in relation to a specific condition of resource consent which shall be organized and agreed to with the District Planning Unit. If in relation to a specific engineering design component, an agreement can be entered into with the Council's Infrastructure Group.

[8] TDC Engineering Forms

Appendix I. STANDARD DRAUGHTING LAYOUT AND FORMAT REQUIREMENTS

Provide electronic drawings to a minimum standard that complies with the AS/NZS 1100.501:2002[9] – Technical Drawing: Structural engineering drawing, including completing the follow:

1 Drawing base data (existing topography)

Draw existing features in a lighter line thickness e.g. 0.18mm or 0.25mm. Draw standard draughting symbols un-shaded for existing features e.g. □.

2 Drawing proposed work

Draw proposed work in a heavier line thickness e.g. 0.35mm and thicker. Use the same line type, to enable clear differentiation between existing features and proposed work. Draw standard draughting symbols filled in for proposed features e.g. ■.

3 Labelling

Draw text at the suggested minimum heights in Table 1.

Table 1 Minimum text heights

Titles and drawing numbers	5mm
Subtitles, headings, view and section designations	3.5mm
General notes, material lists, dimensions	2.5mm
Road name	7mm
Side road	5mm
Existing property levels	1.8mm
Buildings	3.5mm

Notes: This table is derived from AS/NZS 1100.101: 1992 Table 4.1.

Differentiate between existing features and proposed features by using different formatting:

- lower case or upper case;
- normal format or bold format;
- 0.25mm pen weight or 0.5mm pen weight.

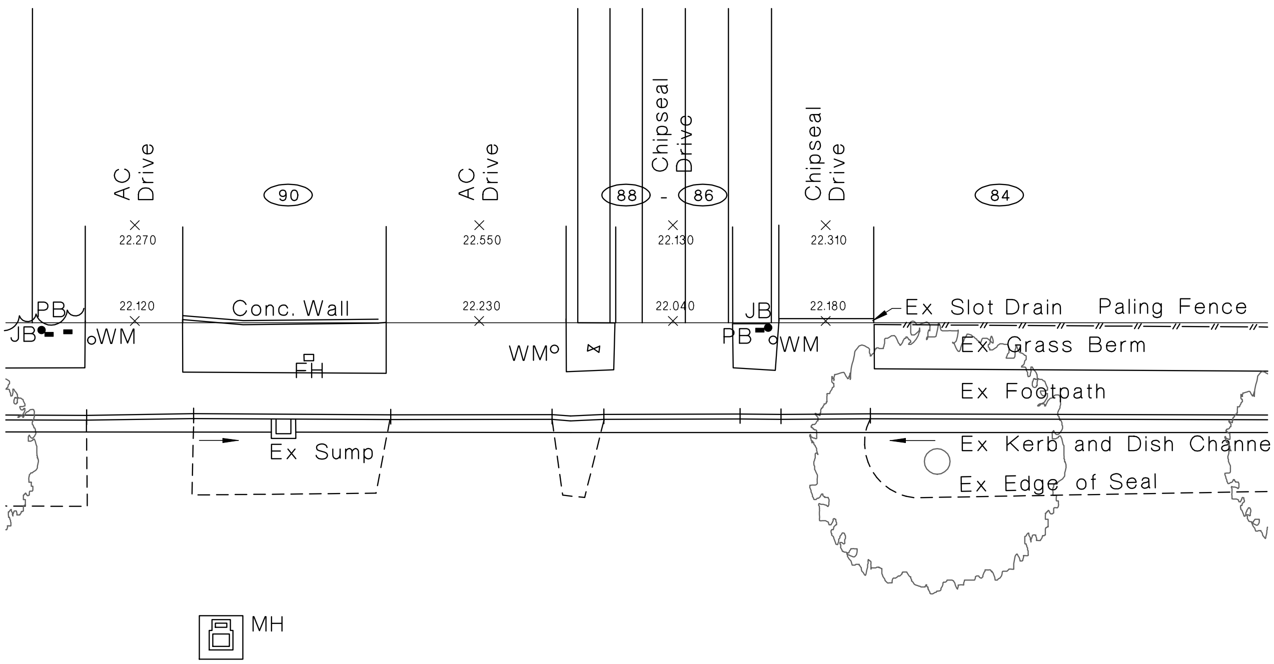
[9] AS/NZS 1100.501:2002

Use the abbreviations in Table 2.

Table 2 Feature abbreviations

Asphaltic concrete	AC
Edge of seal	EOS
Tangent point	TP
Curve Tangent point	CTP

Figure 2 Labelling existing street features (1:200 scale)



Ensure notes do not go through other notes and that leaders do not cross.

Place road names above the north road boundary but not through section boundary lines. Show spot levels on the legal boundary and at least 3.0m inside the abutting private property.

Use standard symbols for trees, lights, service covers and boxes. Typical symbols are shown in the example drawings in section 14 of this appendix. Draw symbols to true scale. Typical abbreviations are shown in Tables 2, 3, 4 and 7.

4 Underground services

Use the line types, colours and RGB values set out in Figure 5. Label all high voltage cables and all fibre optic cables or indicate with a slightly heavier line weight.

Figure 3 Service legend

SERVICES LEGEND	COLOUR	RGB
SEWER (Gravity)	Red	255,0,0
SEWER (Pressure)	Red	255,0,0
WATER	Green	0,176,80
STORMWATER	Blue	50,150,255
POWER	Orange	255,128,0
TELECOM	Purple	128,0,255
GAS	Yellow	194,194,0

Label all utility structures or boxes. Label water meters (these include the backflow preventers installed as part of the connection on each side).

Table 3 Service abbreviations

Water meter	WM
Fire hydrant	FH
Power box (above-ground)	PB
Power pole	PP
Sluice valve	SV
Gate valve	GV
Pressure reducing valve	PRV
Backflow preventer	BFP

Note: Label telecommunications boxes, manholes and pillars to suit the development.

5 Drainage

Label all stormwater and sewer pipes with pipe size and flow direction, using similar terminology to that used by the manufacturer to code or classify the pipe e.g. label a 225 diameter stormwater pipe as Ø225 RCRR Class X stormwater or DN225 PVC-U stormwater. Show all laterals.

For major pipes 750mm and above, show the outside width of the pipe and manholes, as the manhole lid may not be on the pipe centreline. Show the actual shape of special manholes.

Label all sumps and manholes with the structure identifier e.g. MH with a unique letter and sump abbreviation with a unique number. Structures that are not affected by the work do not require a unique letter or number. Start at one end of the project and number or letter continuously through. Where an existing sump is being modified, draw the proposed sump over it. Label any structures that are being altered in height.

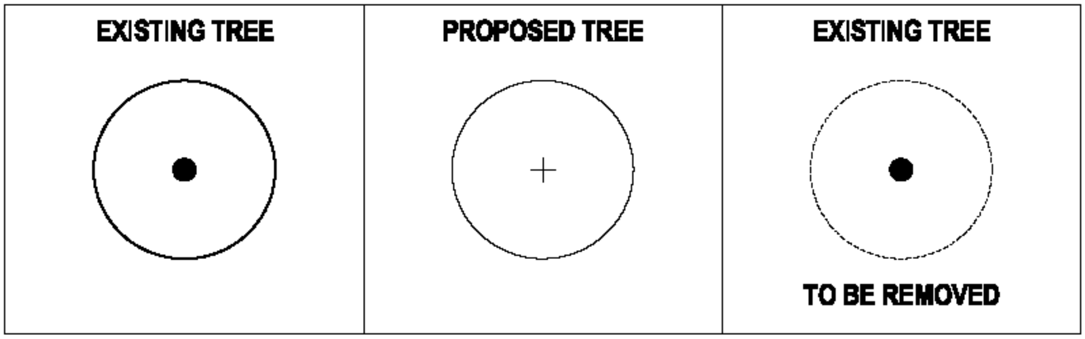
Table 4 Drainage structure abbreviations

Single Sump	SS
Double Sump	DS
Splay Pit	SP
House Drain Sump	HDS
Hillside Sump	HS
Corner Sump	CS
Manhole	MH
Inspection Chamber	IC
Rodding Eye	RE
Flush Tank	FT
Flush Manhole	FM
Air Gap Separator	AGS
Sewer Pole Vent	PV

6 Landscape

Show existing trees, including those to be removed and retained, as well as proposed trees, using the symbols in Figure 5. Label any heritage or protected tree(s). Distinguish existing vegetation from proposed vegetation. Show the full canopy of existing trees that will be retained.

Figure 4 Landscape draughting symbols



Cross reference all other related drawings, including irrigation or lighting. Show underground services and street light locations on planting drawings.

All planting drawings must have a plant list. The plant list must include the botanical name, common name, container size and/or height of plant at time of planting and the quantity. The plant list can also include any abbreviations used, planting centres (plant spacing) as detailed in Figure 6 and any special maintenance requirements to retain the initial concept i.e. hedge heights, park furniture treatments. Where there is a separate plant list for trees only, cross reference any other plant lists/drawings.

Figure 5 Typical plant list

ABBREV.	BOTANICAL NAME	COMMON NAME	SIZE	CTRS	QTY.
Aca mic	Acaena microphylla	scarlet bidi bidi	Pb5	600mm	14
Ane les	Anemanthele lessoniana	wind grass	Pb5	600mm	63
Car tes	Carex testacea	sedge	Pb5	600mm	266
Cor aus	Cordyline australis	cabbage tree	Pb18	n/a	8
Iso nod	Isolepis nodosa	knobby clubrush	Rx90	600mm	22
Jun pal	Juncus pallidus	rush	Rx90	600mm	5
Rho spp	Rhododendron spp	rhododendron cv	Pb40	n/a	1
Rho C	Rhododendron 'Cockatoo'	rhododendron cv	Pb5	n/a	55
Ros FCA	Rosa 'Flower Carpet Appleblossom'	groundcover rose	Pb5	800mm	53

Note: 1) The abbreviation column is optional.

7 Road lighting

Draw road lighting as specified in Waka Kotahi NZTA *Specification and Guidelines for Road Lighting Design.*

8 Title blocks

The title block must include the following information:

- A project title, including street address;
- A unique number or identifier, preferably the consent or project number;
- The designer's name, signature and contact details;

- The draughtsperson’s name;
- The drawing checker’s name;
- The design reviewer’s name and signature;
- The stage of work e.g. for acceptance, accepted engineering drawings, construction, as-built;
- The date of preparation and of acceptance;
- The scale or scales used;
- A graphic scale;
- The datum and origin;
- The original sheet size;
- A drawing title e.g. Long-section;
- Sheet numbers, including the number in the set;
- An amendment box, including brief description of amendment and sign off by designer.

The scale for drawings is generally 1:200 but other accepted engineering scales may be used to suit the level of details on the drawings. Scales progress in multiples of 10 e.g. 1:1, 1:2, 1:5.

9 Long-sections

Draw horizontal scales generally to match the plan. Vertical scales may be 1:20 or 1:50, to improve clarity.

Show concrete surround on the pipe long-section. Label structures and vertical curves. Use thicker line weights for proposed work.

10 Cross-sections

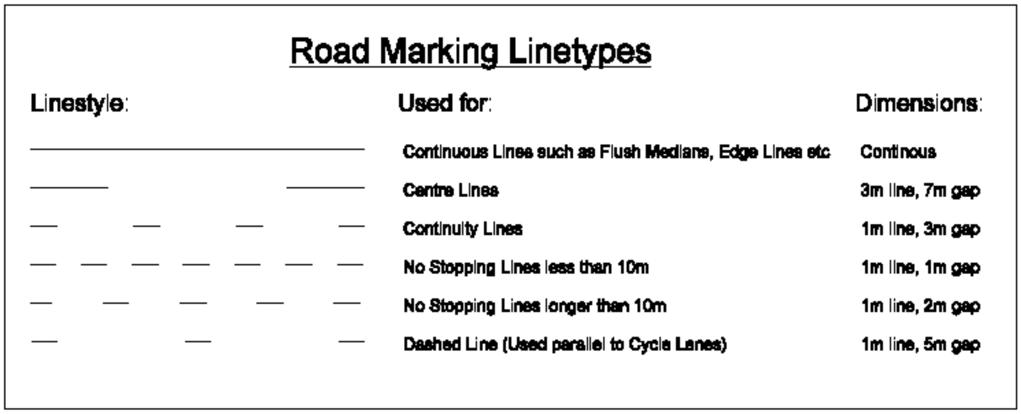
Label levels with identifiers e.g. K12.400. Use thicker line weights for proposed work. Provide a minimum of one fully detailed typical cross-section per sheet.

Show construction depth outlines for roads, paths, grass berms and landscape planting. Label legal boundaries vertically.

11 Road marking drawing

Use the following line types when detailing roadmarking.

Figure 6 Roadmarking line types



The road marking drawing must show:

- The existing markings to be removed (i.e. sandblasted);
- The new road markings to be installed;
- How the proposed markings mate into the existing markings at the project's extents.

Show roadmarking on a drawing base that is essentially 'as-built' in terms of features such as kerbs and paths. Indicate the type of marker, generally by using the standard symbols and descriptions in Tables 6 and 7.

Table 5 Marker symbols and descriptions

Text Description for drawings		Symbol
RPM	Reflective Pavement Markers	
	WHITE MONO RPM	○
	RED MONO RPM	□
	WHITE BI DIRECTION RPM	⦶
	WHITE/YELLOW BI DIRECTION RPM	⬗
	YELLOW BI DIRECTION RPM	◆
KTM	Kerb Top Markers	
	KTM	•

Note: Specify numbers, spacing's and colours for reflective pavement markers and kerb top markers.

Table 6 Sign types and descriptions

Sign	Text Description for drawings
BRIDGE END MARKERS (always used in pairs)	BEM
HAZARD MARKER	HM

12 Locality diagram

Show the road boundaries and street names. Show the limit of the development. Draw the locality diagram true to the map orientation or at the same orientation as the engineering drawing.

Figure 7 Locality diagram

13 Examples and drawings

Examples of standard drawings follow.

Figure 9 Plan View

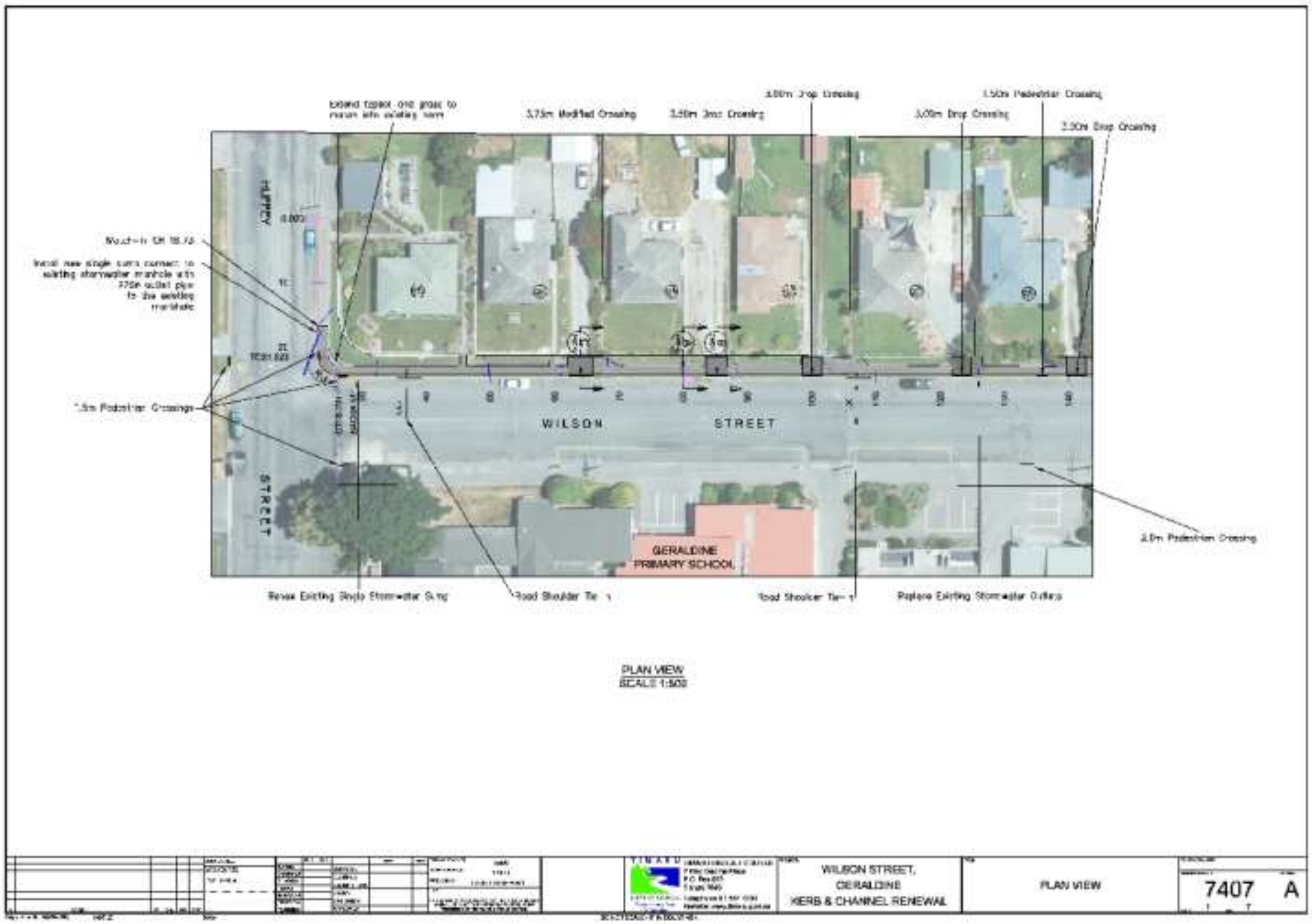


Figure 10 Long-section

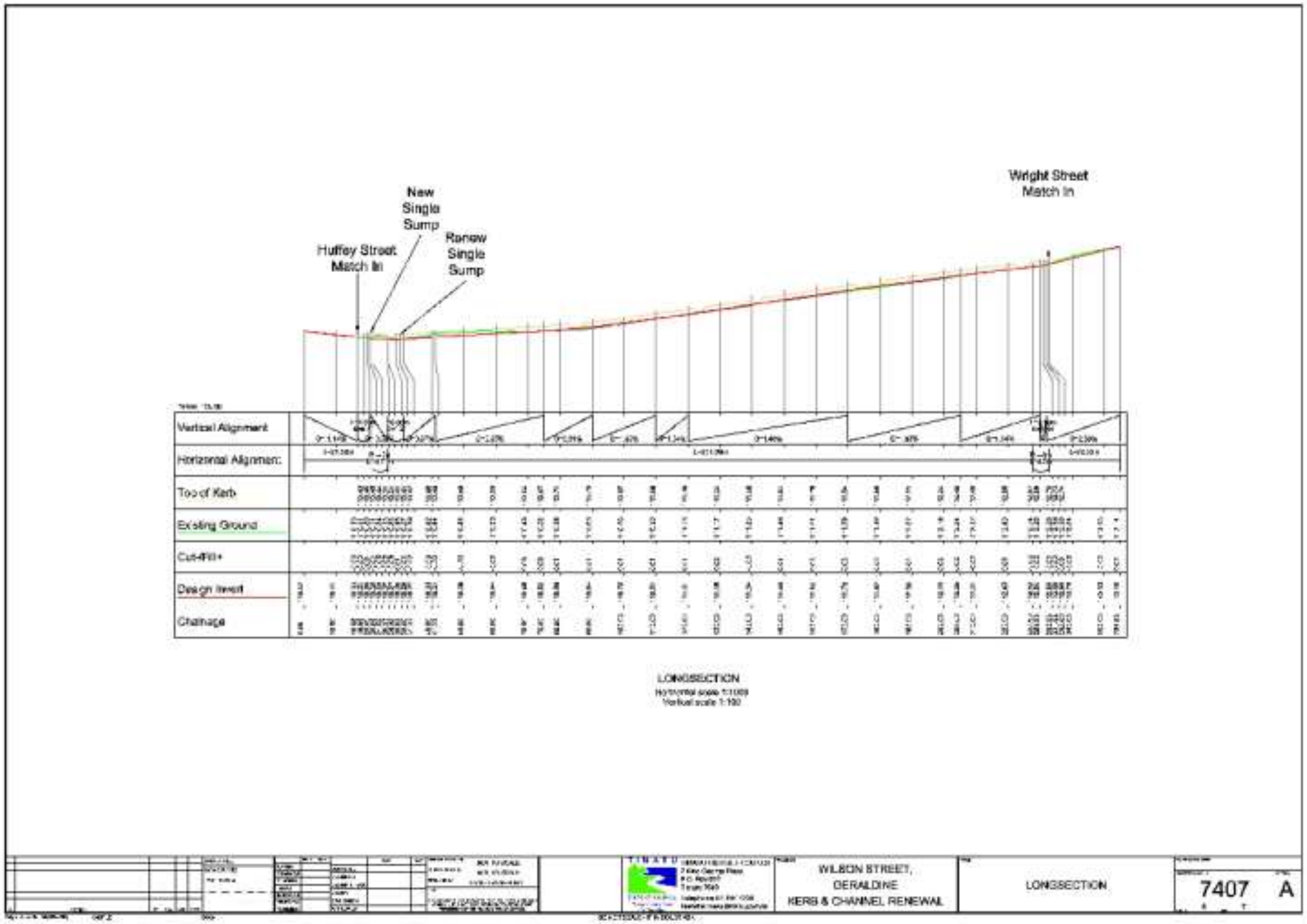


Figure 11 Services Plan

Figure 12 Vehicle Crossing Detail

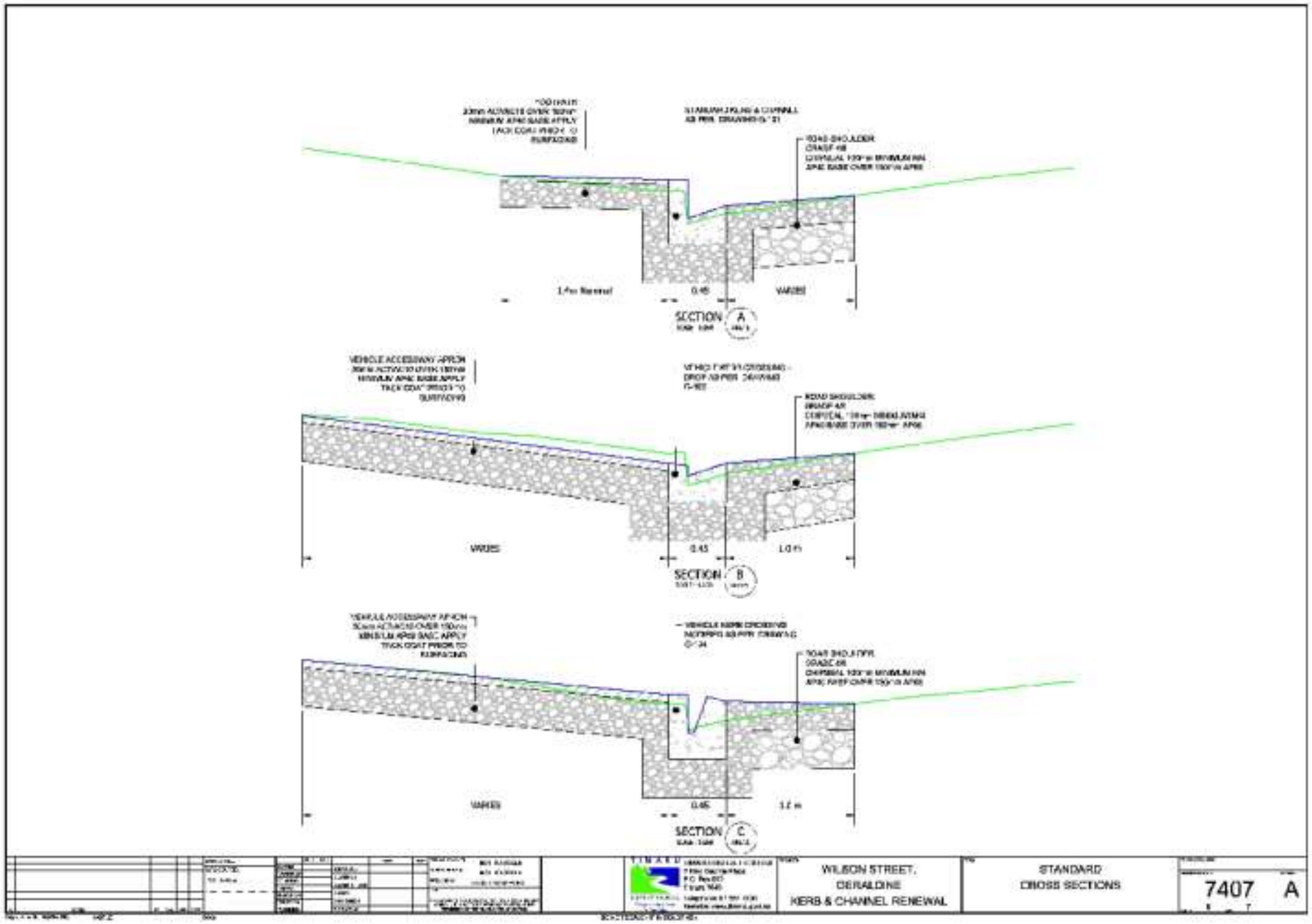


Figure 13 Example Symbol Key

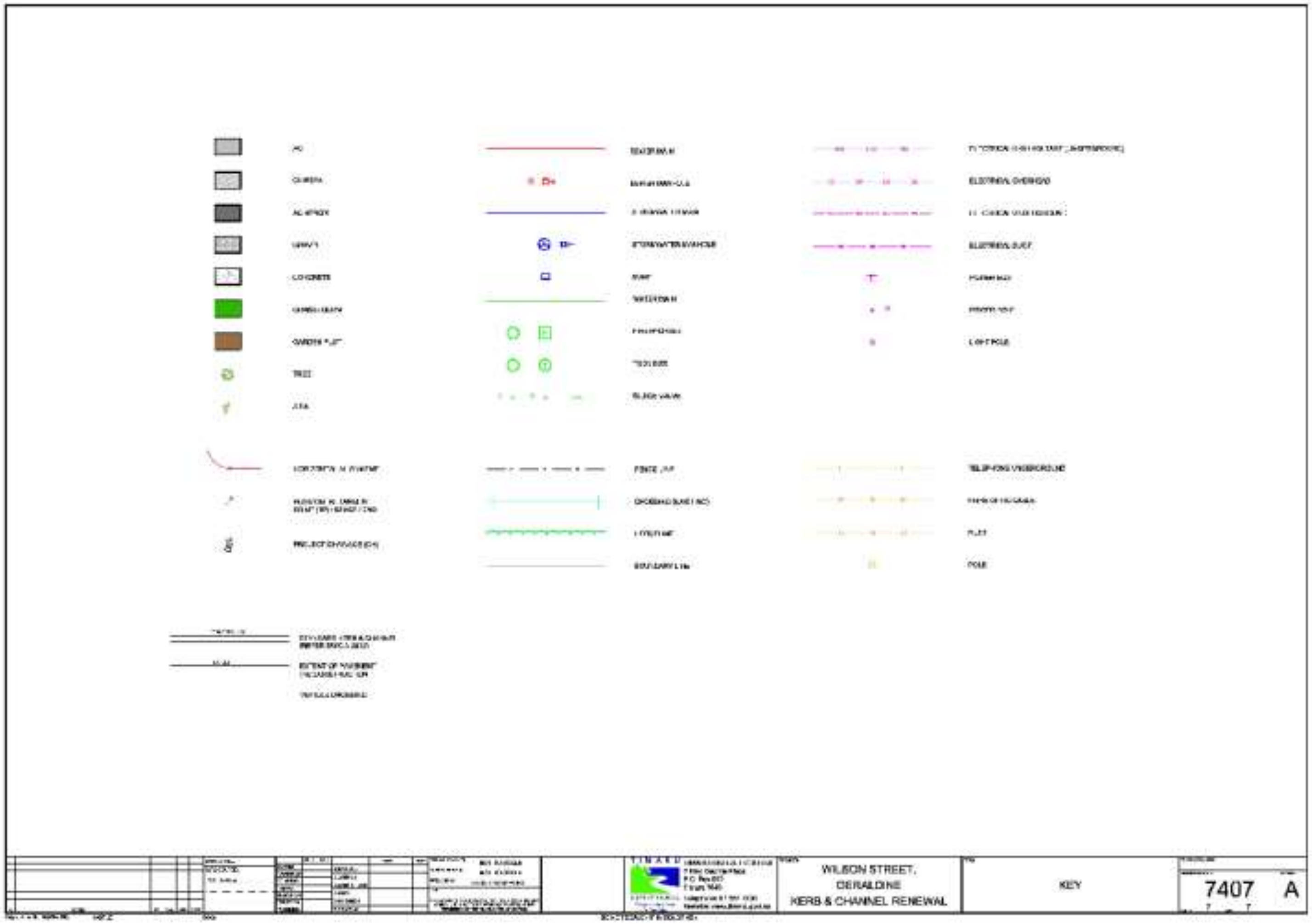


Figure 14 Earthworks Plan

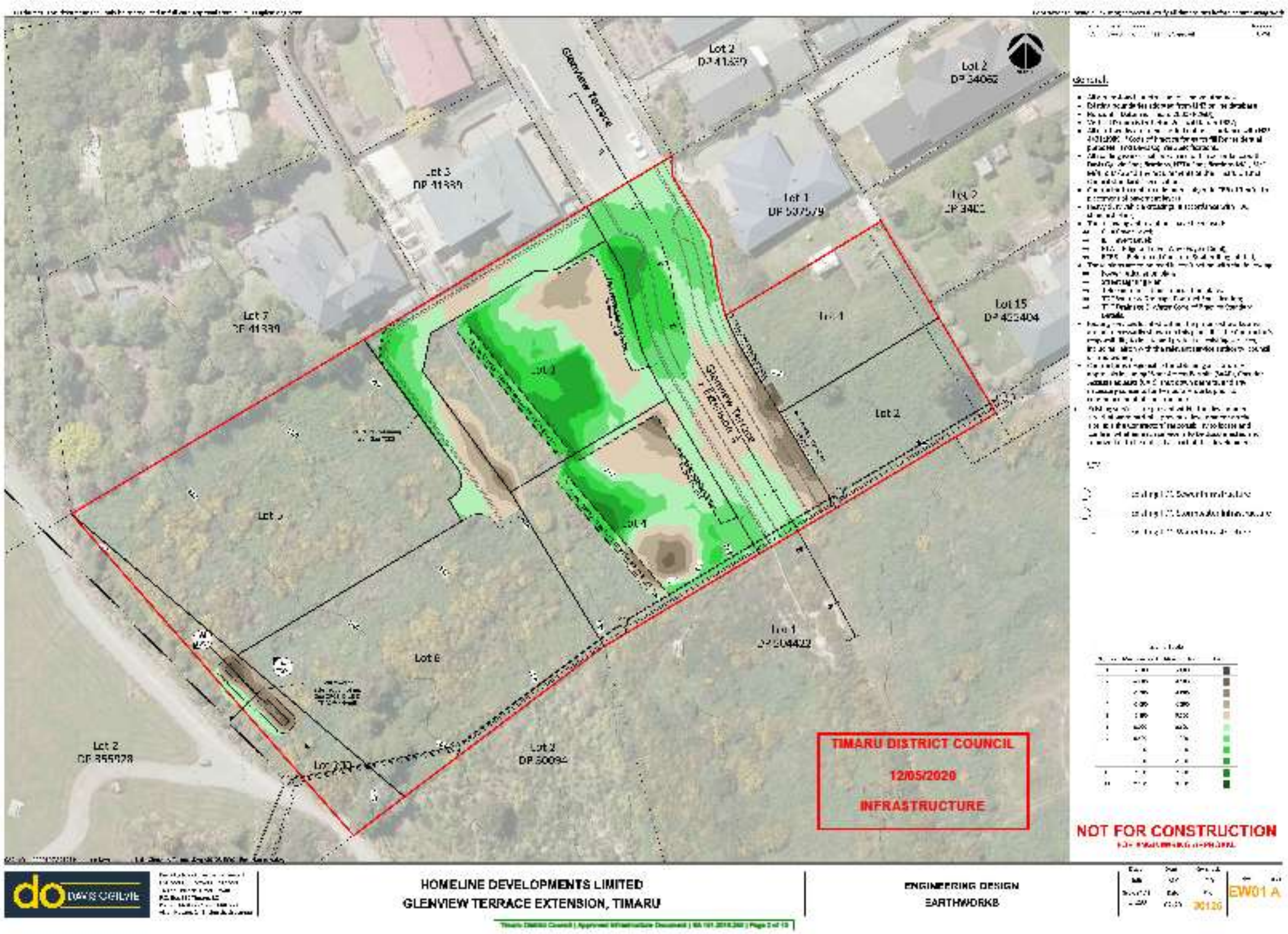


Figure 15 Cross-sections

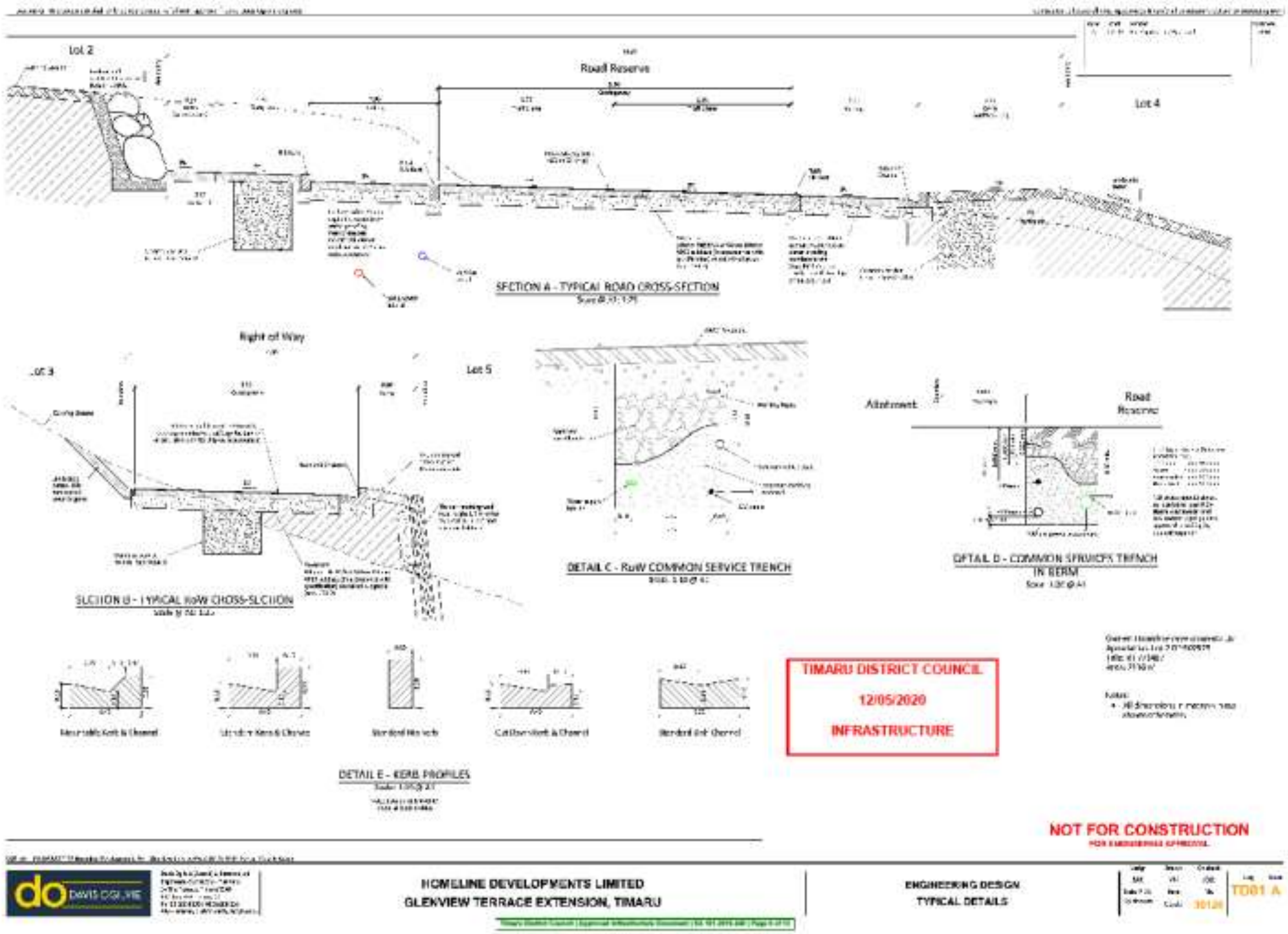


Figure 86 **Drainage Layout Drawing**

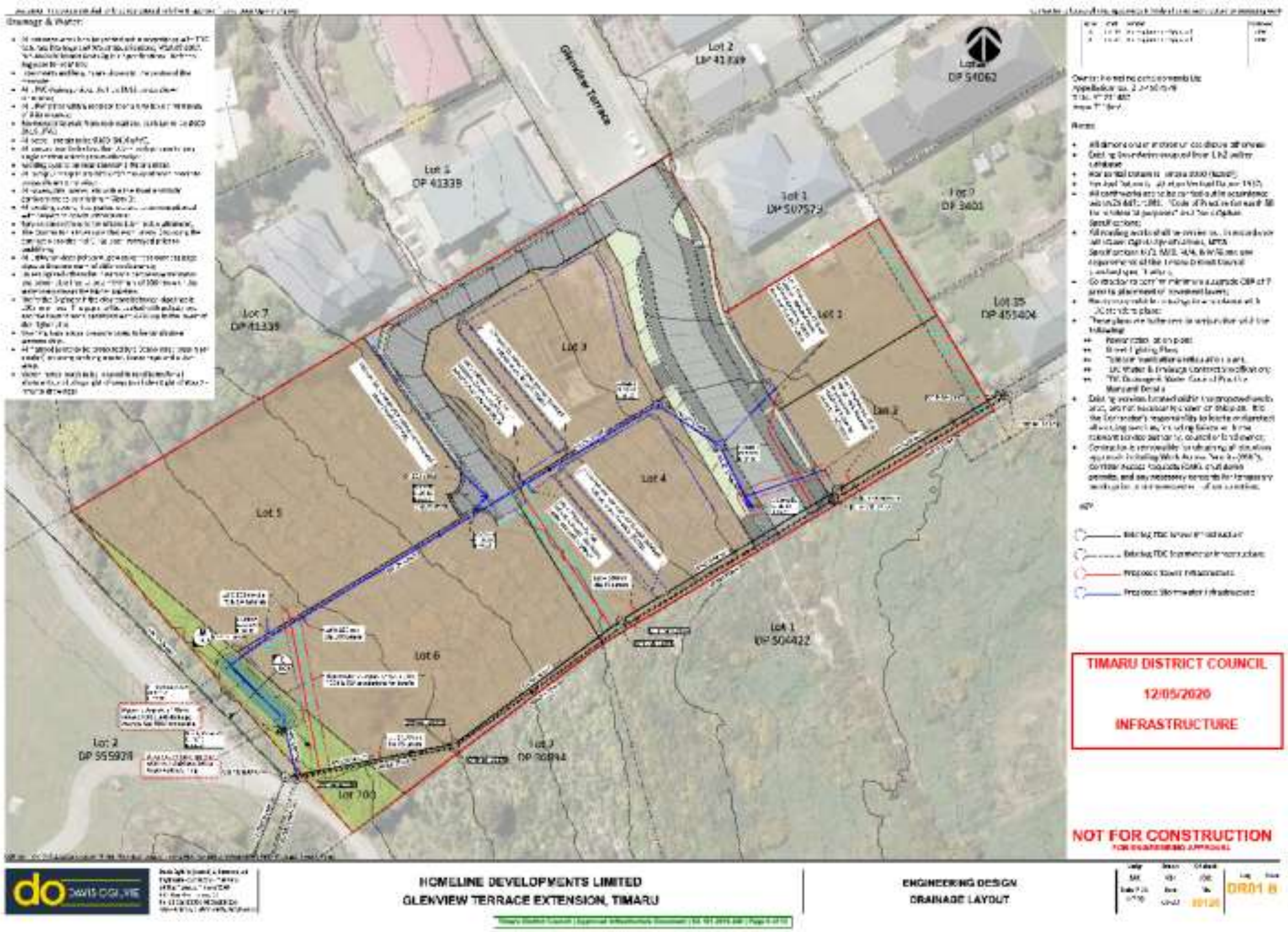
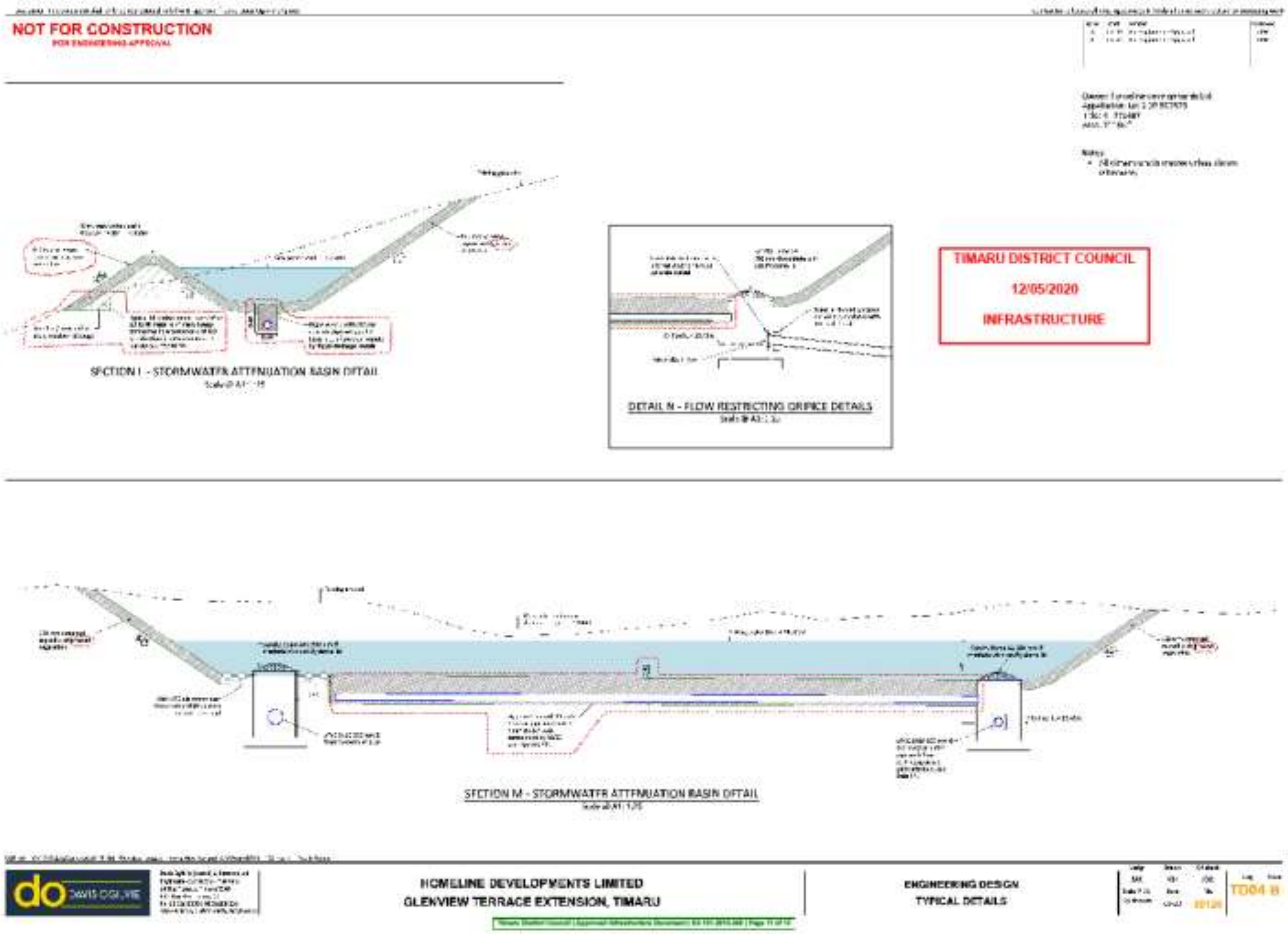


Figure 96 **Special drainage details**



Appendix II. DRAUGHTING CHECKLIST

DRAWING – (LAYOUT)	
Street names and waterways correctly spelt and orientated with correct text size.	☐
Running distances are shown at top of drawing - at right angles to drawing.	☐
Join lines (if any) are shown and labelled.	☐
North point (should be correctly orientated i.e. not pointing down), service legend and standard notes (bottom right hand corner of sheet) shown. Drawing to be labelled with scale.	☐
Leader arrows from notes should not cross one another.	☐
Existing notes and proposed notes do not overlap one another, or the boundary and section lines.	☐
Title block filled out correctly, including sheet numbers.	☐
Any amendment to drawing to be indexed in amendments box as a letter (not number) with small description and date.	☐
Any details or sections to be labelled correctly.	☐
Related drawings cross referenced.	☐
Locality diagram labelled and orientated correctly.	☐
Proposed notes are standard in wording. Benchmark referenced.	☐
DRAWING – (EXISTING FEATURES)	
Existing kerb and channel correctly labelled.	☐
All existing manholes, sumps, fences, grass berms, footpaths, driveways and landscape features are labelled.	☐
Boundaries shown – existing and proposed, including easements.	☐
Property levels or contours are shown over development, at boundary and 3m outside development.	☐
All buildings to be hatched and labelled (e.g. DAIRY).	☐

House numbers shown at correct orientation.	☐
All existing drainage pipes are correctly labelled with flow direction shown.	☐
All existing utilities are correctly labelled.	☐
Existing vegetation, including that to be removed, is clearly shown, in both canopy size and position.	☐
DRAWING – (PROPOSED FEATURES)	
Proposed kerb and channel correctly labelled.	☐
Proposed kerb and flat channel has fender line shown.	☐
All radii on proposed kerb and channel shown.	☐
TP’s, CTP’s on proposed kerb face have ‘tick’ shown.	☐
Proposed cutdowns are shown and labelled (particularly at intersections and adjacent to pedestrian islands). Does not apply to standard driveways.	☐
Proposed property/spot levels and contours	☐
All proposed paths/paving/other hard surfaces are shaded and labelled correctly.	☐
Correct Peg box attached.	☐
Manholes being altered or installed have an allocated letter.	☐
Extent of filling, finished levels shown.	☐
If landscape planting is shown on drawing there must be a landscape planting key.	☐
If there is a separate landscape planting drawing, planting to be patterned and labelled on roading drawing; cross referenced to the landscape planting drawing.	☐
LANDSCAPE DRAWING (additional to layout)	
Proposed features/structures labelled, including furniture/bins/signs/fountains/fencing.	☐
Proposed playground equipment/softfall areas/sports fields/recreational hard surfaces labelled.	☐

Proposed vegetation/plant symbols clearly labelled and/or listed in plant list.	☐
Plant list has correctly spelled botanical names, common names, sizes and quantities.	☐
LONG SECTION (additional to layout)	
Proposed kerbs, crowns, edge of seals to be labelled. No existing kerbs, edges of seal, are shown (when required, small sections may be shown for clarity).	☐
Pipe size, class, protection shown, vented manholes labelled.	☐
Longitudinal section to have title below section.	☐
Sump numbers/MH letters correspond to the drawing.	☐
Running distances from easily located point on engineering drawing.	☐
All required grades shown and labelled.	☐
Existing and proposed levels shown, including cuts and fills.	☐
Property boundaries, road intersections, crossing services shown.	☐
Datum shown to 3 decimal places.	☐
ROAD MARKING DRAWING (additional to layout)	
RPM'S and KTM's use the symbols and are correctly labelled.	☐
Correct line types are used for 100 mm WHITE, NO STOPPING, CONTINUITY etc.	☐
Correct line weights used for 'ex lines to be removed'; 'ex lines to remain' and 'proposed markings'.	☐
CROSS SECTIONS (additional to layout)	
Every cross section sheet to have at least one typical cross section showing construction in full and labelled correctly with standard notes.	☐
The word chainage should not appear. Cross sections labelled with chainage value only (ie 20.00 m) to be centred under cross section.	☐
Proposed kerb and fender, quarter points, crown, interpath channel, and invert of swales to have levels shown.	☐

Sump numbers/MH letters correspond to the drawing.	☐
Proposed stormwater pipes, sumps and any services which could be disturbed to be shown.	☐
North, south or west and east boundaries to be labelled as such.	☐
Proposed trees and other plantings are shown in relation to underground services, paths and carriageways.	☐
Datum text to be positioned at left hand side of cross section on datum line.	☐

DESIGN CHECK BY: ……………………………. **DATE:** ………………

Appendix III.BENCHMARK CERTIFICATE

ISSUED BY: ……………………………………………………………………………
(Surveying firm or suitably qualified surveyor)

TO: ………………………………………………………………………………………..
(Owner/Developer)

TO BE SUPPLIED TO: ……………………………………………………………….
(Territorial authority)

IN RESPECT OF: ………………………………………………………………….
(Description of benchmark)

AT: ……………………………………………………………………………………

………………………………………………………………………………………….
(Address)

On behalf of ……………………………………… I ……………………………………
(Surveying firm)) *(Surveyor)*
A Licensed Cadastral / Registered Professional surveyor (delete one) hereby certify that

the benchmark shown on finder diagram ……………………….... has been installed in accordance with the requirements of the Infrastructure Design Standard and current

good survey practice, using ……………………...………………….... methodology.
The surveying firm issuing this statement holds a current policy of professional

indemnity insurance of no less than $…………………………….............
(Minimum amount of insurance shall be commensurate with the current amounts recommended by IPENZ, ACENZ, TNZ, INGENIUM.)

………………………………………… Date: ……………………………
(Signature of Surveyor)

…………………………………………
(Surveying firm)

…………………………………………
(Address)

Appendix IV.BOND FORM

TIMARU DISTRICT COUNCIL
Te Kaunihera ā Rohe o Te Tihi o Maru

Application to establish an Engineering Bond

Resource Consent No.

....

Sections 108(2)(b), 108a, 109 and 222(1) of the Resource Management Act 1991

Applicant's details:

....
(first name) *(middle name)* *(surname)*

....
(company name / trust name)

....
(street address)

....
(postal address if different from above)

....
(phone number) *(fax number)*

....
(e-mail address)

Note : *A trust will not be accepted as an applicant; if the trust wishes to apply for consent, it must be an application by the trustees and the application should state that they are applying as trustees. In the case of an unregistered company, please provide the name of a natural person. In the case of a registered company, the director's name and signature are required.*

Agent's details: *(will receive correspondence on behalf of the applicant)*

....
(name of applicant's professional advisor / firm name)

....
(contact person)

....
(postal address , must be within New Zealand)

....
(phone number) *(fax number)*

....
(e-mail address)

Site details:

....
(street address)

....
(legal description)

Payment method:

Direct debit YES / NO Bank bond YES / NO

Conditions to be bonded:

....
(condition numbers)

....
(brief description of conditions to be bonded)

....

....

....

Reason for bonding:

....
(reason)

....

....

....

....
(expected date of completion, max 24 months from granting of the bond agreement)

Note: *Timaru District Council reserves the right to not allow for the establishment of a bond.*

Fees:

An administration fee of $350.00 to process this bond must be paid to the Timaru District Council at lodgement of this application. Please note that additional costs may be incurred where appropriate.

Amount of bond:

A minimum of 50% contingency over and above the value of the uncompleted work to cover additional costs that may be incurred by the Timaru District Council in the event of default is required.

Note: *The applicant is not required to pay the total amount of the bond at this stage but will be required to do so prior to Timaru District Council endorsement of the bond agreement.*

Required information:

I/we (the applicant/s) understand that this application must include the following items: (please tick)

- ☐ Two quotes from independent Timaru District Council approved contractors on their company letterhead.
- ☐ A copy of the Timaru District Council accepted Private Way Design / Engineering Plans. (if required as a condition of resource consent)
- ☐ A copy of the Timaru District Council Service Approval for the works. (should approval be required)

Acceptance of responsibility:

I/we (the applicant/s) understand that when entering into a bond agreement with the Timaru District Council I/we agree to all the following: (please tick)

- ☐ Incomplete application forms will not be processed.
- ☐ The applicant agrees to carry out the bonded works to the satisfaction of the Timaru District Council within the stipulated time frame, regardless of ownership of the affected property, and agrees to inform future or prospective owners of the nature of any bonded works.
- ☐ The applicant agrees to supply the Timaru District Council with right of entry to complete the works from all future owners of the property, until such a time as the terms of this agreement have been met.
- ☐ The applicant may be liable for all costs incurred by Timaru District Council and its agents as a result of processing and administering this bond. This sum may be deducted from the bonded amount if deemed necessary by the Timaru District Council.
- ☐ The bond agreement (if approved) is not transferable.

Declaration:

I/we (the applicant/s) request the Timaru District Council accept a bond pursuant to Section 348(2)(b) of the Local Government Act 1974.

Applicant/s: ………………………………………………………………………………..
(signature/s)

………………………………………………………………………………..
(date)

See overleaf for further information on the Completion Certificate / Bond Agreement process.

General information on Engineering Bond Agreements:

The typical process for establishing a Bond is as follows:

- The applicant/s applies for a Bond Agreement using this form.
- Providing all required information is provided, the Timaru District Council will prepare the Bond Agreement and determine the value of the bond.
- Two copies of the Bond Agreement will be sent to the applicant for signing.
- Once signed, both copies are to be returned to the Timaru District Council for signing, payment of the bond is usually made at this time and is required prior to the Timaru District Council signing the Bond Agreement.
- Once signed by the Timaru District Council and provided payment of the bond is made, one of the copies of the Bond Agreement will be returned to the applicant/s and one will be kept on the resource consent file.

Typical Terms and Conditions of a Bond Agreement are as follows:

1. Interest will not be paid on the bond deposited with the Timaru District Council.
2. If the applicant completes all the work set on in the First Schedule *(this schedule details the works to be bonded)* to the satisfaction of the Timaru District Council within twenty four months of the date of the establishment of the Bond, the Bond shall be refunded to the consent holder in full upon request.
3. If the consent holder fails to carry out the works set on in the First Schedule to the satisfaction of the Timaru District Council within twenty four months of the date of the completion certificate, the Timaru District Council may apply the bond towards the completion of the works, or such portion of those works that require completion. Any surplus after completion by the Timaru District Council shall be refunded by the Timaru District Council to the applicant upon request.
4. The Timaru District Council's rights under this Bond Agreement will not be affected or prejudiced by any delay, neglect or forbearance on the Timaru District Council's part, in exercising any of those rights.
5. Where the bond is not sufficient to fully pay all the Timaru District Council's actual costs under this agreement, then the difference between the actual costs and the bond shall be a debt owing by the applicant, and the applicant is hereby bound to pay those additional costs.

Note: *These terms and conditions are subject to change.*

The typical process for obtaining a refund of the bond is as follows:

- The applicant/s applies for the refund of the Bond using the enclosed form *(additional copies of this form are available from the Timaru District Council)*.
- Providing all outstanding works have been completed, the Timaru District Council will prepare the refund and a credit for the bonded amount will be sent the applicant/s.

PART 3: QUALITY ASSURANCE

CONTENTS

FIGURES

3.1 REFERENCED DOCUMENTS

Planning and Policy

- Health and Safety at Work Act (2015) and subsequent amendments

Design

- AS/NZS ISO 9000:2016 *Quality management systems - Fundamentals and vocabulary*
- Engineering New Zealand – Te Ao Rangahau *Practice Note 1: Guidelines on Producer Statements (2014)*
- Engineering New Zealand – Te Ao Rangahau *Practice Note 2: Peer Review Version 2 (2018)*
- Engineering New Zealand – Te Ao Rangahau *Practice Note 4: Health and Safety by Design (Draft)*
- NZS 3910:2013 *Conditions of contract for building and civil engineering construction*
- Transit New Zealand *Quality Standard TQS2*: Second Edition (June 2005)
- Waka Kotahi New Zealand Transport Agency *Health and Safety in Design Minimum Standard:* Version 2 (October 2016)

Construction

- Worksafe New Zealand – Mahi Haumaru Aotearoa *Underground services – Guide for safety with underground services*
- Worksafe New Zealand – Mahi Haumaru Aotearoa *Management and removal of asbestos*
- Worksafe New Zealand – Mahi Haumaru Aotearoa *Planning entry and working safely in a confined space*
- Worksafe New Zealand – Mahi Haumaru Aotearoa *Working at height*
- NZ Utilities Advisory Group (Inc) *National Code of Practice for Utility Operators' Access to Transport Corridors*

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).

The terms, and their definitions, used in this standard are consistent with those of AS/NZS ISO 9000:2016 and NZS 3910:2013.

3.1.1 Source document

TQS2 was used as a guide in the development of this section of the IDS. That standard was developed by Transit New Zealand (now Waka Kotahi NZ Transport Agency) as a framework for an acceptable quality management system for the suppliers of physical works on state highways and came into effect as a mandatory requirement from July 1996.

The use of that standard as a basis for this Part has been with the kind permission of Waka Kotahi NZTA.

3.1.2 Guidelines

Notes have been included in Appendix I – Guidelines and further explanation. These are intended to aid in the understanding of this section, expand on the requirements and explain the application of a project quality system in more detail. Read them in tandem with the clauses in this section.

3.2 INTRODUCTION

Timaru District Council aims to achieve well-designed and constructed assets for its ratepayers. Building and maintaining assets, regardless of whether they are created through the subdivision and development of land or the capital works process, is a partnership of developers, designers, and contractors. Where quality principles are applied to both design and construction, real benefits result.

Timaru District Council therefore requires the application of quality assurance for all physical works that result in assets being transferred to the Council. Any designer, contractor or supplier wishing to tender for capital works or any developer exercising a resource consent must implement this part.

Where the assets will be vested through subdivision, designing, and constructing assets in accordance with a Project Quality System will be a condition of subdivision consent. The developer must demonstrate compliance by providing and applying the project quality system, to substantiate the release of the subdivision compliance certificate, known as the 224(c) certificate. Similarly, a contractor engaging in capital works is required to provide and apply a Contract Quality Plan during the contract period, which provides the supporting structure for the quality system.

This Part provides a framework for a quality management system. It has been developed by a Council internal working party and has been benchmarked against best national practice. The quality management system must ensure that all quality assurance issues relevant to a subdivisional land development, or a capital works project are effectively defined, managed and communicated to ensure that all quality requirements are achieved.

3.3 PROJECT QUALITY SYSTEM

The project quality system must include documented procedures relating to all management, design and construction activities. This includes the following components:

- Project management, as described in clause 3.4;
- Management of purchasing, as described in clause 3.5;
- Control and inspection of the work, as described in clause 3.6;
- Non-conformance and quality improvement, as described in clause 3.7;
- Health and safety, as described in clause 3.8.1;
- Environmental management, as described in clause 3.8.2.

The Project Quality System consists of a document trail comprising:

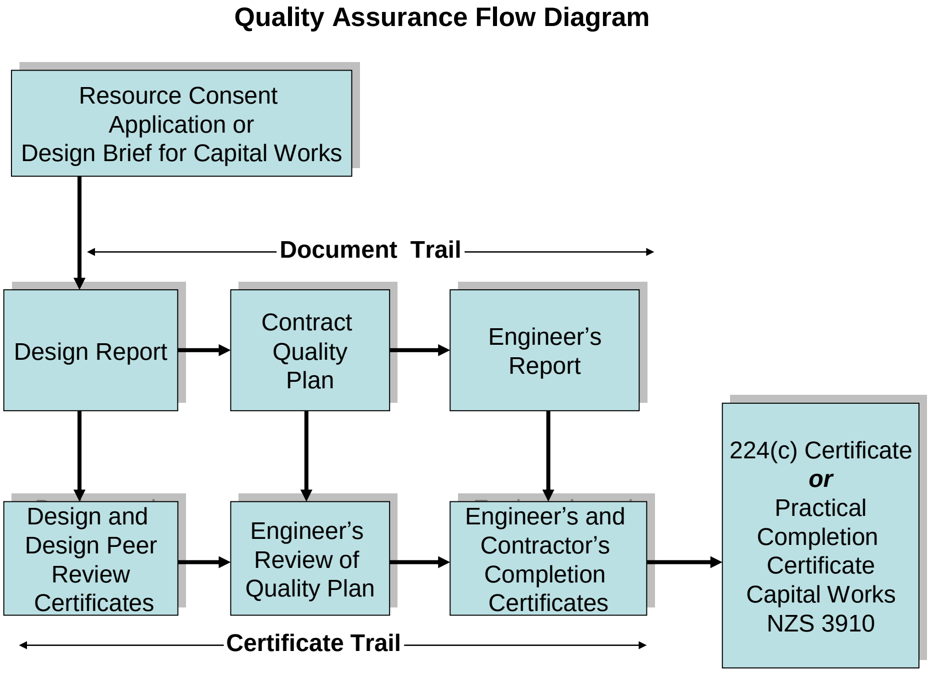
- the Design Report, as described in clause 3.3.2 and illustrated in the example in Appendix II;
- the Contract Quality Plan, as described in clause 3.3.3 and illustrated in the example in Appendix III;
- the Engineer's Report, as described in clause 3.3.4.

These three documents support the certificate trail, which establishes compliance with the Project Quality System. The certificate trail includes:

- the Design Certificate (see Appendix IV) and Design Peer Review Certificate (see Appendix V), which complete the Design Report documentation;
- the Engineer's Review Certificate (see Appendix VI), which completes the Contract Quality Plan;
- the Engineer's Completion Certificate (see Appendix VII) and the Contractor's Completion Certificate (see Appendix VIII), which complete the Engineer's Report;
- the 224(c) Certificate or Practical Completion Certificate.

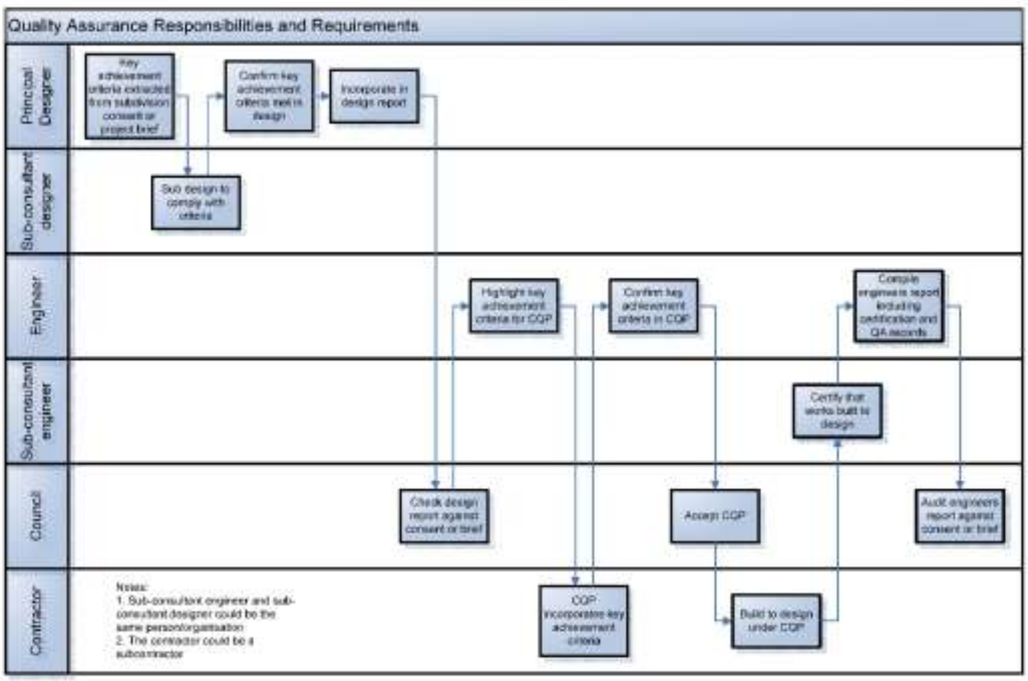
The issue of the 224(c) Certificate or Practical Completion Certificate is therefore dependent on the application of the Project Quality System and the provision of its related documentation. This interrelationship is set out in figure 1.

Figure 1 Quality Assurance Flow Diagram



Quality assurance responsibilities and requirements are a combination of relationships across the investigation, design and construction phases. Figure 2 explains those relationships and the point at which they are applicable.

Figure 2 Responsibilities and Requirements Diagram



Simplified Project Quality System procedures are acceptable where no infrastructure is to be vested in Council. Lateral connections and standard vehicle access construction will follow a simplified Project Quality System through Council's Service Consent process. Any request for simplified procedures with an Engineer Design shall accompany the Application.

3.3.1 Key achievement criteria

Key achievement criteria are defined as elements of design or construction that are critical to the quality of the asset. These are typically found in the resource consent or project brief. They may also come out of particular aspects of the design e.g. the designer may require proof of levels on a weir at a particular place in the system to support compliance with a higher level key achievement criteria.

3.3.2 Design Report

Submit a Design Report, where required as a condition of consent in respect to a subdivision land development or where specified in the project brief. Submit a Design Certificate to the Council along with the Design Report. The Design Report and subsequent Design Certificate should be completed by a suitably qualified Engineer or Licensed Surveyor holding Chartered Professional Engineer or Registered Professional and/or Licensed Cadastral Surveyor qualifications. Engineering acceptance is subject to presentation of this report.

The designer describes how they have:

- Identified and addressed the design, management, administrative and legislative requirements specific to the design;
- Included Safety in Design and Hazard and Operability (HAZOP) principles specific to the design;
- Planned the work to satisfy those requirements;
- Provide confirmation that capacity of supply for utilities is available;
- Managed communication with stakeholders and other parties to the design;
- Reviewed/tested the design to ensure compliance with the quality requirements;
- Recorded design activities and maintained records and evidence of compliance.

If required as a condition of consent, peer review the design in accordance with *Practice Note 2: Peer Review*. Submit a Design Peer Review Certificate to the Council along with the Design Report. Consultation on the suitability of the peer reviewer is to be undertaken with Council prior to organizing the review.

Where aspects of the design require expertise outside of the field of knowledge of the designer, provide a Design Certificate from a suitably qualified sub-consultant designer to support the submission of the Design Report. Ensure additional information obtained from the sub-consultant designer regarding key achievement criteria or other matters is also incorporated in the Design Report.

3.3.3 Contract Quality Plan

Submit a Contract Quality Plan within the time frame and to the extent specified in the resource consent or contract. Submit an Engineer's Review Certificate to the Council along with the Contract Quality Plan. Where specified as a deliverable in the contract or as a requirement of resource consent, the Contract Quality Plan and Review Certificate must be subject to review and acceptance by the Council, along with any major amendments. Present the Contract Quality Plan and Review Certificate 10 working days before physical works commence.

The contractor describes how they will:

- Employ measures to eliminate or minimise hazards on and in the vicinity of the site;
- Identify and address the contract management (including health and safety, traffic management, technical and environmental issues), administration and legislative requirements specific to the contract as detailed in clause 3.4 – Project Management;
- Plan the work to satisfy those requirements;
- Control (manage) the work, including that undertaken by subcontractors, to comply with requirements – identify which PCBU is responsible for what activities and work areas;
- Manage communications with stakeholders and other parties to the contract;
- Inspect/test the materials and work to ensure compliance with the quality requirements;
- Address communication and reporting requirements;
- Manage, review and update management plans to ensure they remain relevant to the requirements of the contract and work being undertaken;
- Record contract activities and maintain records as evidence of compliance.

Provide certification upon Practical Completion through submitting a Contractor's Completion Certificate.

Where aspects of the construction require expertise outside of the field of knowledge of the contractor, the contractor must provide a Completion Certificate from a suitably qualified subcontractor to support the submission of the Contractor's Completion Certificate. Ensure additional information obtained from the subcontractor regarding key achievement criteria or other matters is also incorporated in the Contract Quality Plan.

3.3.4 Engineer's Report

Submit the Engineer's Report upon completion of physical works, where required as a condition of consent in respect to a subdivisional land development or where specified in the project brief.

The engineer describes how they have:

- Identified and addressed the quality management requirements specific to the project;
- Inspected, audited and tested the materials and work to ensure compliance with the quality requirements;
- Recorded project activities and maintained auditable records as evidence of compliance, including any non-conformance reports.

Provide certification upon Practical Completion through submitting an Engineer’s Completion Certificate. Present the completed audit records with the application for 224(c) certification.

Where aspects of the construction require expertise outside of the field of knowledge of the engineer, provide a Completion Certificate from a suitably qualified sub- consultant engineer to support the submission of the Engineer’s Report.

3.4 PROJECT MANAGEMENT

Clearly state the responsibility, authority, necessary qualifications and relationships of the key personnel involved in achieving quality outputs. Include these in the Design Report or Contract Quality Plan.

In the case of capital works contracts for the Council include the responsibilities for safety and environmental management programmes, in accordance with relevant legislative requirements (as set out in clause 3.8 – Safety and Environmental Management).

3.5 MANAGEMENT OF PURCHASING

3.5.1 Purchasing instructions

Purchase orders that are significant in terms of achieving the project quality requirements must be in writing. They must contain a clear specification of the requirements.

3.5.2 Material supply

Check materials purchased for the project that are significant in terms of achieving the contract quality requirements. Confirm compliance with the specified requirements prior to incorporation in the project. Note the verification of compliance either on the relevant checksheet or some other appropriate record.

3.5.3 Subcontractor quality control

The contractor is responsible for the quality of materials supplied and work performed by its subcontractors. Include appropriate quality assurance procedures in the Contract Quality Plan, to control and monitor subcontractor compliance with the contract and/or Contract Quality Plan. Conduct planned periodic audits of subcontractor activity.

These procedures do not relinquish the responsibility of the main contractor. Ensure that the subcontractor is aware of specific technical and management requirements in the contract, and that these are incorporated in the Contract Quality Plan. Ensure that the subcontractor has appropriate controls in place for the management of any specific construction risks.

3.6 CONTROL AND INSPECTION OF THE WORK

Undertake the work in a planned and controlled manner to ensure that the quality requirements are realised. Demonstrate that the following has been undertaken on all projects:

- Identify the key achievement criteria;
- Plan how these will be realised;
- Control the work in conformance with the project quality system;
- Check, inspect or test the work and verify that it conforms to the specified requirements;
- Record the results as documentary evidence of compliance.

This clause relates to both design and construction works and requires that all the processes involved are properly managed.

3.6.1 Identifying and planning

Systematically identify from the consent the key achievement criteria of the project for each discipline. Identify the key achievement criteria at each stage to satisfy all the requirements of clause 3.6.2 – Checking, inspection, testing and recording. Use these as a basis for developing the Design Report, Contract Quality Plan or Engineer's Report. Include documentation of constraints, assumptions and base data, e.g. site investigations, in these documents.

Apply documented procedures to the extent necessary to ensure that those performing the work fully understand what is required, or where their absence could create a risk to the quality or safety of the work being undertaken.

3.6.2 Checking, inspection, testing and recording

Check, inspect or test against all the identified key achievement criteria to verify compliance during design and construction and on final completion. Specify the methods, specification references, frequency, timing, responsibilities and necessary qualifications for checking, inspection and testing in the Design Report, Contract Quality Plan and Engineer's Report. Measure compliance against quantified acceptance criteria based on the IDS and/or specification requirements. Document the results and retain as part of the quality records.

Clearly indicate any "hold' or "witness points" in the Design Report, Contract Quality Plan or Engineer's Report, where the project requires checking, an inspection and/or approval to proceed (i.e. internally and/or from the Council). Establish systems to record the findings, any remedial action initiated and the final approval to proceed. Treat non-conforming work in accordance with clause 3.7 – Non-Conformance and Quality Improvement.

Where there is a requirement to use third party accredited agencies, include the details of compliance methods in the Design Report, Contract Quality Plan or

Engineer's Report.

3.7 NON-CONFORMANCE & QUALITY IMPROVEMENT

3.7.1 Control of non-conforming work

The designer must have a procedure to ensure that design work that does not conform to the specified requirements is either:

- redesigned to meet the specified requirements; or
- accepted by concession from the Council.

Record all non-conforming work on the relevant design record and/or the relevant design checksheet.

The contractor/engineer must have a procedure to ensure that construction work that does not conform to the specified requirements is either:

- reworked to meet the specified requirements;
- accepted with or without repair by concession from the Council;
- rejected and replaced.

Record all non-conforming work on the relevant construction checksheet.

If the construction non-conformance is significant in that it either:

- results in the need for written concession;
- results in delay or interference to the work or to other parties;
- indicates that the fault has occurred due to the use of incorrect work practices and/or failure of materials and could have been prevented;
- occurs sufficiently frequently as to indicate a problem in training or procedures,

produce a Non-Conformance Report (NCR) and send to the Council.

The report and supporting documentation must clearly indicate the action to be taken to rectify the non-conformance, the timeframe and responsibilities. It must be authorised by the designer or engineer. An example of a report is enclosed in Appendix IX – Non-Conformance Report.

In cases involving concessions, the designer or engineer and the Council must approve the proposed rectification (the corrective action) of the non-conforming work in writing and prior to implementation.

3.7.2 Quality improvement

Investigate the cause (as opposed to the symptom) of reported non-conforming work. Record proposals for improving the company's quality system on the Non-Conformance Report, to prevent the recurrence of a specific non-conformance. Send all corrective action proposals to the Council.

Ensure that the proposed corrective action is properly and effectively implemented.

3.8 SAFETY AND ENVIRONMENTAL MANAGEMENT

3.8.1 Health and safety

Consider "Safety in Design" and carry out a risk assessment appropriate to the scale of the project. Use these outputs to inform requirements for the project's health and safety system. Refer to *Health and Safety in Design Minimum Standard* and ensure the contractor applies the *Guide for Safety with Underground Services*. Reference shall be given to any pertinent Worksafe NZ guides, Codes of Practice and Practice Notes.

A health and safety programme is mandatory for all contract quality plans submitted as part of a capital works project. It is not a Council requirement of subdivision consents, however it is considered best practice that Engineers include this for subdivisions.

Operate a formal health and safety programme, which complies with the statutory requirements of the Health and Safety at Work Act and any subsequent revisions and associated regulations. To the extent practical and permissible by law, health and safety policies and procedures should be integrated into the engineer’s and contractor's quality system.

Ensure the system addresses the following as a minimum:

- Hazard identification and assessment of control measures imposed;
- Hazard monitoring and auditing, including frequency;
- Emergency management;
- Hazard monitoring and auditing, including frequency;
- Procedures for training and supervising staff in relation to safety issues; and
- Contact details of key personnel.

3.8.2 Environmental management

Consider environmental management in the design and carry out a risk assessment appropriate to the scale of the project. Use these outputs to inform requirements for the project's environmental management system.

Operate a formal environmental management programme that complies with the statutory requirements of the Resource Management Act, any associated Regulations and any other specific requirements set out in any applicable resource consent. To the extent practical and permissible by law, integrate the programme into the quality system.

Ensure the Environmental Management Plan (EMP) within the environmental management system addresses as a minimum:

- The identification of environmental risks in clause 2.5.5 – Environmental considerations and an assessment of mitigation measures imposed;

- Emergency response and contingency management;
- Procedures for compliance with resource consents and permitted activities;
- Environmental monitoring and auditing, including frequency;
- Corrective action, reporting on solutions and update of the EMP;
- Procedures for training and supervising staff in relation to environmental issues;
- Contact details of key personnel responsible for environmental management and compliance.

The Contract Quality Plan must identify all compliance issues relating to the Resource Management Act, including any conditions contained within the project related resource consents.

Appendix I. GUIDELINES AND FURTHER EXPLANATION

PROJECT QUALITY SYSTEM (clause 3.3)

The project quality system identifies how the requirements of the project were or will be addressed. These may include quality, safety, environmental, technical and general management requirements. This may be achieved by:
- adopting industry best practices;
- adopting or adapting documents developed for the same or similar activity on previous jobs;
- preparing new documents for those activities which are new or substantially different from anything undertaken previously.

Provide details of how all the identified requirements were or will be planned, controlled (managed), checked or inspected for compliance and the results recorded. Include provision for document control, including review and approval of the quality systems. The identified requirements will include the key achievement criteria but also those routine items which, through being achieved, will provide a quality asset.

For example, if a consent had a condition like "*The surface water management system shall rely on stormwater disposal to ground in accordance with the consent conditions of CRCXXXX.1*", the key requirement (achievement criteria) to ensure this condition was met would be to demonstrate that the design soakage rates for any infiltration system can be achieved on-site.

Each part of the IDS contains examples, for guidance, of records that can be provided to support the project quality system e.g. thrust block design calculations in clause 7.3.2 – Design records (Water Supply).

Design Report (clause 3.3.2)
A Design Report is a document specific to a design, which describes how the design was managed and administered in compliance with the requirements of the IDS and the resource consent or project brief.

Include a list of project personnel, their qualifications and their contact details. List the procedures and design checksheets that were used to effectively manage the design. These procedures should include the necessary qualifications of key personnel as they relate to particular tasks. Highlight exceptional aspects of the project that must be covered by the Contract Quality Plan.

For the example given above, information provided through the project quality system to support the assertion of compliance (which is more substantial as the condition is a key achievement criteria) might include, in the Design Report:
- Methodology to determine the design soakage rate.
- Design checksheet (see guidelines to clause 3.6.2) including the assumptions upon which the design is based (see clause 5.4.3 – Design records (Stormwater) bullets) and their source.

- Calculations leading to the design infiltration.
- Record of key achievement criteria for inclusion in the CQP.
- Design Certificate.
- Designers qualifications relevant to infiltration design.
- Design Peer Review Certificate if required.
- Specific requirements for OMM to preserve ongoing compliance.

Supporting information retained in the project quality system might include:
- Alternatives explored.
- Contractual requirements around the key achievement criteria into the CQP.
- Quick check of the design infiltration, by an alternative method if possible.

An example of a simple proforma Design Report setting out the minimum requirements of the IDS is provided in Appendix II. It is an example only and designers may develop their own format to suit their specific needs.

Contract Quality Plan (clause 3.3.3)
A Contract Quality Plan is a document specific to the project, which describes how the contract works will be managed and administered in compliance with its requirements.

Include, or otherwise reference, the procedures and the checksheets necessary to effectively manage the contract works. These procedures should include the qualifications of key personnel as they relate to key tasks particularly the key achievement criteria e.g. the connection to the Council water reticulation must be undertaken by a Timaru District Council Infrastructure Approved Contractor for water main connections. The following is a guideline of the information that should be included in the Contract Quality Plan:
- A statement of policy with respect to the timing and frequency of internal reviews and/or audits of the quality plan during the project.
- A schedule of the contractual quality records to be kept.
- A list of subcontractors.
- Procedures for auditing subcontractor compliance to the quality plan.
- A schedule of inspection and/or testing of materials and/or completed works, clearly indicating ‘hold’ or ‘witness’ points.
- Documented procedures included, or referenced, for all activities.
- Non-conformance & quality improvement procedures included, or referenced.
- Provisions for traffic management and environmental management plans included or referenced.

For the example given above, information provided through the project quality system to support the assertion of compliance (which is more substantial as the condition is a key achievement criteria) might include, in the Contract Quality Plan:
(Pre-construction)
- Engineers Review certificate.
- Inspection and test schedule highlighting the infiltration test requirement.

(Post-construction)
- Contractor's Completion Certificate.
- Inspection and test schedule proving compliance is achieved.

Supporting information retained in the project quality system might include:
- Infiltration test record sheets;
- CLEGG inspection results;
- NDM inspection results;
- Benkelmen Beam deflection test results;
- Pipeline air pressure and hydrostatic test results.

An example of a simple proforma Contract Quality Plan is provided in Appendix III. This sets out the minimum requirements the Contract Quality Plan must achieve for this standard. It is an example only and contractors may develop their own format to suit their specific needs.

Prepare site-specific Erosion and Sediment Control Plans (ESCP) in accordance with clause 4.8 – Erosion, Sediment and Dust Control (Geotechnical Requirements).

As noted above, processes and procedures for the management of subcontractors must be stipulated in the Contract Quality Plan. This is especially important where subcontractors perform a large component of the works (e.g. earthworks).

Engineers Report (clause 3.3.4)
An Engineer's Report is a document specific to a project, which describes how the project was managed and administered in compliance with the IDS, the Contract Quality Plan and the resource consent or project brief. It provides background information to the release of the 224(c) certificate.

The Engineer's Report shall be supplied to Council's Primary Engineering Contact (PEC) for an Engineering Design Acceptance or Council Project Contract. The QA Documentation shall be provided to the PEC via a cloud based sharefile system or USB, to be uploaded to Council's document management system and update Council's asset management system.

The following is a guideline of the information that should be included in the Engineer's Report:
- A schedule of the project and contractual quality records that have been kept. A summary of the quality records proving compliance is to be submitted to the Council.
  Note: The summary shall come in the form of a letter report showing how conditions of consent are met. All QA documentation and reports shall be labelled to relate to each condition of consent or contract.
- What procedures were employed for auditing contractor and subcontractor compliance with the quality plans.

For the example given above, information provided through the project quality system to support the assertion of compliance (which is more substantial as the condition is a key achievement criteria) might include, in the Engineers Report:

- Engineers Completion Certificate.
- Non-conformance Reports if generated.
- O&M Manual as it relates to the ongoing achievement of this condition.
- Audit and test schedule proving compliance has been achieved.

PROJECT MANAGEMENT (clause 3.4)

The project management structure need only show the key positions or functions. In many companies an individual can hold more than one position or be responsible for more than one function. The designer and the engineer can be the same person or organisation.

Relate job descriptions to positions and named individuals. They can be quite simple and should only state the principal responsibilities of the position, any necessary qualifications and the reporting lines. Examples of a management structure and job descriptions for a typical subdivision and a small/medium contractor are enclosed in Appendix II – Design Report section 1 and Appendix III – Contract Quality Plan section 3.

Purchasing instructions (clause 3.5.1)
Ensure that purchasing instructions are precise; otherwise there is a significant risk of not getting what is needed. Include, as appropriate:

- the product type, class, and size etc;
- the quality standards;
- the quantities;
- the scope of the work;
- the delivery details;
- the completion dates.

It may not be necessary to fully describe the requirements in every case e.g. when there is a record that the supplier has previously supplied full details or a copy of the specification and that the detail is current. In this instance, it would be sufficient to order by reference to those previously supplied details.

Material supply (clause 3.5.2)
Checking for compliance should preferably be done on receipt of the materials. The "verification" referred to can be recorded when completing the relevant checksheet (refer to the examples given in Appendices XIII - XVII). Attach any supporting documentation to the checksheet, such as delivery dockets or supplier certificates of compliance, which provide evidence of the type, grade, and class etc of material used.

Keep records of material tests that are traceable to defined sections of the work e.g. seven and 28 day concrete crushing strength test results, basecourse sand equivalent tests ex-supplier.

Identifying and planning (clause 3.6.1)
Each project is unique in that it:
- has technical requirements which may vary in part or full from other projects;
- will have a different scope of work from other projects, which is also likely to alter during the course of the project;
- will be in a different location and therefore will have different external influences from other projects;
- will utilise different resources;
- will have its own programme etc.

The identification of the project requirements is therefore important and must be undertaken in some systematic and documented manner. The project must be planned and managed to suit its unique set of characteristics, either by "highlighting" the key achievement requirements in the relevant sections of the consent, project brief or contract specification, or in a more formalised manner, by listing the requirements on a form. These key requirements must also be communicated between the various parties to the project.

The procedures should follow a standard format and be "user friendly". They will describe how individual work activities are planned, controlled and inspected for compliance with the specification requirements. They will:
- describe how the activity or task will be performed;
- define key task responsibilities and required qualifications;
- describe how key design parameters which directly impact on the effectiveness of the design are communicated;
- indicate the sequence;
- specify the resources to be used;
- be written in precise and easily understandable language.

They should contain as a minimum the information outlined in the example in Appendix XII – Quality System Work Procedure.

Examples of work activities that would be covered by procedures include: surface and groundwater modelling; survey and setout; placement of unbound granular basecourse; stormwater pipework; traffic control. For work activities that are more or less standard, procedures from previous projects may be adopted or adapted.

Checking, inspection, testing and recording (clause 3.6.2)
The documentation requirements associated with checking, inspection, testing and recording need not be complex. The checksheets are useful in that they provide a breakdown of the checks that should be performed and, when completed, serve as a record. They should be developed for each key design and work activity and should contain the quality requirements as reminders.

The design checksheet should:

- include the constraints, assumptions and base data;
- identify the personnel responsible for the design;
- record that the design has been checked and the method used;
- provide for "signing-off" at the bottom of the sheet after a fully complying "design check".

The engineer’s checksheet should:

- identify the personnel responsible;
- provide for "signing-off" at the bottom of the sheet.

Examples of engineer’s checksheets are included in Appendices XIII – XVI and XIX.

The construction checksheet should:

- provide a checklist of the items to be inspected;
- include the acceptance criteria;
- identify the personnel responsible for doing the inspection;
- contain space for recording that compliance of the individual items has been attained;
- contain reference to further records generated by non-conformances;
- provide for "signing-off" at the bottom of the sheet after a fully complying "final inspection".

Examples of construction checksheets are included in Appendix XVII and XVIII.

An audit or inspection and test schedule should provide a full listing of all audits, inspections and tests of materials and completed works. It should clearly indicate ‘hold’ or ‘witness’ points and include signing off by the contractor, the engineer and the Council where required. A sample engineer’s audit and test schedule is contained in Appendix X and a sample inspection and test schedule is contained in Appendix XI.

Control of non-conforming work (clause 3.7.1)
It is inevitable that, even with excellent practices and controls, some degree of defective workmanship or material will occur. When it does, it is important that it is properly handled to ensure that the defects are rectified in the appropriate way.

A non-conformance should be considered an opportunity for improvement, rather than to apportion blame. By adopting this philosophy, identifying a non-conformance provides an opportunity to learn from the mistake and (more importantly) prevent it happening again.

Note that there is a clear differentiation between what should be considered a “routine construction issue” or a “routine design step” and a non-conformance. Ensure this is understood by and communicated to all staff. A construction issue, such as soft subsoils, is often identified (and reasonably expected) during a project and does not therefore necessitate the raising of a Non-Conformance Report, unless procedures have not been followed. The inability to achieve the minimum grade on a sewer design is a non-conformance and must be reported, as is the inability to achieve a passing Benkelman Beam test or infiltration test, as examples.

A non-conformance exists, and therefore a report should be raised, in all instances where a defect in the work or design occurs that indicates that the required standard or key achievement criteria prescribed in the Design Report, Contract Quality Plan or Engineer’s Report has not been met, e.g. failure to achieve compaction results, pre-seal inspection etc. For this process to be successful it must be handled in a positive and constructive manner, without unnecessary recrimination.

Any non-conforming work that is subject to follow-on work by other parties must be clearly denoted as such to alert the other parties to its non-conforming status.

Quality improvement (clause 3.7.2)
The objective is to reduce, if not eliminate, the root causes of the recurring inefficiencies and errors which have caused or can cause non-conforming work, i.e. to find a permanent cure for the problem, not just a "quick-fix". This provides a formal and disciplined procedure for identifying, investigating and correcting inefficiencies and shortcomings in a company's work practices.

There can be significant benefits to the company from the positive application of quality improvement, through reducing the incidence of non-conforming work and improving efficiency, to reducing costs including those of rework. Common causes of non-conforming work that can be addressed are:

- lack of training.
- lack of resources.
- poor communication / incomplete instructions.
- inadequately defined work practices.
- inadequate supervision.

Environmental management (clause 3.8.2)
Environmental management is an integral part of project management and therefore will be most efficiently operated within the framework of the project’s quality system.
Design the environmental management programme in full compliance with the Resource Management Act. Specific activities that may require resource management consents or authorisations include:

- management of stockpile material.
- selection and management of disposal areas.
- the use of chemical sprays and fertiliser.
- noise and dust nuisance.
- prevention of fuel and oil spills including the actions taken if an oil spill occurs.
- control of silt, contaminants and stormwater runoff.
- the diversion of, or taking water from, waterways.
- work around protected trees.
- redirection of groundwater.

- excavation of Hazardous Activity and Industries List (HAIL) sites and accidental discovery of contaminated material.
- discharges of dewatering water, sewage, or contaminants.
- archaeologically and culturally sensitive sites.
- disturbance of wildlife species or habitat.
- excavation over aquifers.

It is a legal requirement to maintain fish passage under the Freshwater Fisheries Regulations.

This is by no means an exhaustive list. There may also be Department of Conservation permits and Heritage New Zealand Pouhere Taonga authorities. Consider (if not contractually required to) developing a formal Environmental Effects Register. Also identify these matters in an assessment of environmental effects, for applications for subdivision consent.

Appendix II. DESIGN REPORT

____
(contract name/subdivision name)

____
(contract /subdivision consent number)

Copy No: …… of ……….

Version: ………………………….

Date of Issue: …………………….

CONTENTS:

APPENDICES: *(attach these – as applicable)*

1 - Design Certificate <see example in Appendix IV>
2 - Design Peer Review Certificate <see example in Appendix V>
3 - Non-Conformance Report <see example in Appendix IX>

DESIGN REPORT APPROVALS:

This Design Report has been:

Prepared by: ______________________________
(Designer) *(Name/Sign/Date)*

Approved by: ______________________________
(Principal designer) *(Name/Sign/Date)*

Reviewed by: ____________________________________
(Peer Reviewer) *(Name/Sign/Date)*

1 Project Personnel and Design Management

Principal designer:

Name: ______________________________

Address: ______________________________

____

____

Contact Ph (Mobile): ____________ Contact Ph (A/H): ____________

Telephone: ____________ Fax: ____________

Developer:

Name: ______________________________

Address: ______________________________

____

____

Contact Ph (Mobile): ____________ Contact Ph (A/H): ____________

Telephone: ____________ Fax: ____________

Sub-consultant designer:

Name: ______________________________

Address: ______________________________

____

____

Contact Ph (Mobile): ____________ Contact Ph (A/H): ____________

Telephone: ____________ Fax: ____________

Design Peer Review (if undertaken):

Name: ______________________________

Address: ______________________________

____

____

Contact Ph (Mobile): ____________ Contact Ph (A/H): ____________

Telephone: ____________ Fax: ____________

The following key personnel have been involved in this design:

Name	Position Title	Responsibility

This list should include details of different design specialists, internal reviewers and auditors.

2 Sub-consultant designers

Sub-consultant designers undertook the following design activities:

Activity	Name of Sub-consultant designer

Sub-consultant designers were selected in accordance with company policies and procedures, and were provided with copies of the relevant project briefs and/or resource consents requirements and/or drawings prior to commencement of the work.

Sub-consultant designers were subject to monitoring and their work was subject to periodic internal audit.

3 Full Description of Work

This section contains a full description of the work included in the Design Report. It should include a description of:

- *the existing pre-development site;*
- *the proposed development;*
- *the extent of the assets to be constructed;*
- *all key design and quality requirements, from the Council and the developer e.g. key achievement criteria;*
- *evidence of consultation, if applicable;*
- *the constraints, parameters, assumptions and raw data on which the design is based;*
- *data manipulation methods e.g. computer software, methodology.*

4 Quality Control and Inspection

Procedures and design checksheets were used to control the design and verify compliance with the quality requirements. The following documents were used for this design:

Identifier	Title

....

....

The documents can be made available for the Council's review, if requested.

Exceptional aspects of this project to be covered by the Contract Quality Plan include:

…………………………………………………………………………………
…………………………………………………………………………………

5 Environmental Management

The following Resource Consents, relevant to the design, have been obtained:

…………………………………………………………………………………
…………………………………………………………………………………

In accordance with the resource consent/s, environmental controls relating to this particular design will be outlined in the Contract Quality Plan.

6 Concessions

If, during the process of design, work is identified which does not conform to the specified requirements and will require a concession from the Council, submit a Non-conformance Report as part of the Design Report. The concession proposed will be discussed and must be approved by the Council prior to execution.

7 Design Check and Review

Undertake internal design reviews, to verify the design outlined and/or referenced in this Design Report, in accordance with "Reviewing the work of another engineer". Include written documentation of this review, by checksheet, calculations carried out by hand or another method to check design calculations, or document here.

Undertake a peer review, to verify the compliance and effectiveness of the design, in accordance with "Reviewing the work of another engineer". Document the review here or include as an Appendix.

This review shall be specific only to those aspects of the works in which the reviewer is competent i.e. more than one reviewer may be required where the development incorporates specialised disciplines.

Record, report and action the review findings.

8 Design Records

The following design records were produced for this design and are appended where noted:
(e.g. engineering drawings, specifications, calculations, material specifications where not detailed elsewhere, photos etc.)

……………………………………………………………………………………
……………………………………………………………………………………

The following completed checksheets are appended *(e.g. safety in design, risk register)*.

Checksheet No.	**Title**

Appendix III. **CONTRACT QUALITY PLAN**

____

(contract name/subdivision name)

____

(contract /subdivision consent number)

Copy No: …… of ……….

Version: ………………………….

Date of Issue: …………………….

CONTENTS:

APPENDICES: *(attach these – as applicable)*

1 – Construction Programme
2 – Inspection & Test Schedule <see example in Appendix XI>
3 – Site Safety Plan
4 – Traffic Management Plan(s)
5 – Erosion and Sediment Control Plan
6 – Non-Conformance Report – <see example in Appendix IX>
7 – Contractor’s Completion Certificate <see example in Appendix VIII>

CONTRACT QUALITY PLAN APPROVALS:

This Contract Quality Plan has been:

Prepared by: __________________________________
(Name/Sign/Date)

Approved by: __________________________________

(Engineer)	*(Name/Sign/Date)*
Approved by: *(Contractor)*	*(Name/Sign/Date)*

1 Contract Personnel

Contractor:
Name: ______________________________
Address: ____
____
Contact Ph (Mobile): ____________ Contact Ph (A/H): ____________
Telephone: ____________________ Fax: ____________

Developer:
Name: ______________________________
Address: ____
____
Contact Ph (Mobile): ____________ Contact Ph (A/H): ____________
Telephone: ____________________ Fax: ____________

Project Manager:
Name: ______________________________
Address: ____
____
Contact Ph (Mobile): ____________ Contact Ph (A/H): ____________
Telephone: ____________________ Fax: ____________

Engineer:
Name: ______________________________
Address: ____
____
Contact Ph (Mobile): ____________ Contact Ph (A/H): ____________
Telephone: ____________________ Fax: ____________

2 Document Control

This Contract Quality Plan (CQP) has a controlled distribution as follows:

Copy No	Issued To	Date	Version No
1	<Contract Manager>		
2	<Site Supervisor>		
3	<All Subcontractors>		
4	<Other>		
5	<Engineer *(for review and acceptance)*>		
6	Council *(for review and acceptance*)		

This CQP will be subject to periodic review during the course of the contract. All holders of controlled copies listed above will be issued with updates to this document as and when they occur.

3 Contract Management

The following key personnel have been assigned to this contract:

Name	Title

<or insert your organisation chart here>

Key responsibilities and authorities are as follows:

a) Overall responsibility for the management of the contract and principal contact with the developer and the engineer:

____
(Title)

b) Authorised to address and resolve issues of dispute relating to compliance with the quality requirements of the contract and this quality plan and rectification of non-conforming work:

____
(Title)

c) Responsible for and qualified to the required level for the day to day on-site supervision, control and inspection of the works and communicate on such matters with the developer or engineer. Authorised to receive, on behalf of the contractor, any instructions from the developer or engineer (refer NZS 3910 Clause 5.2.1):

____
(Title)

d) Responsible for on-site Traffic Control activities, qualified to STMS level:

____
(Title)

e) Responsible for compliance with the requirements of the Resource Management Act (Environmental Management):

____
(Title)

f) Preparation and amendment of this quality plan:

____
(Title)

g) Approval of this quality plan:

____
(Title)

4 Subcontractors

Subcontractors will undertake the following work activities:

Activity	Name of Subcontractor

All Subcontractors are required to operate in accordance with this Contract Quality Plan.

5 Quality Control and Inspection

Procedures, construction checksheets and inspection and test schedules will be used to control the work and verify compliance with the quality requirements. The following procedures will be adopted for this contract or will be prepared in advance and be made available on site:

Identifier	Title

These can be made available for the Council’s review, if requested.

Compliance checksheets are appended to the various parts of the CSS, which may provide initial guidance on what to consider when compiling construction checksheets.

An example of an inspection and test schedule is contained in Appendix XI. The schedule should indicate the frequency, timing, type of both inspection and/or tests required to be performed on the materials and at certain stages of construction. This schedule would be signed off as the specified activities are completed, and once completed would then serve as a Contract Record (refer clause 3.5.2 – Material supply).

In addition to the inspection and test schedule, the following key ‘Hold’ and ‘Witness’ points have been identified by the engineer as requiring inspection and approval by the engineer and/or the Council prior to further construction. They will be documented on the relevant construction checksheet.

Key achievement criteria may suggest some of these points. ‘Hold’ or ‘witness’ points could include:

- *Site establishment, including Traffic Management and Erosion and Sediment Controls;*
- *Commencement of works;*
- *Formwork or foundations prior to pouring concrete;*
- *Prepared earthworks and subsoil drainage prior to filling;*
- *Completed earthworks and prepared subgrade prior to topsoil or metal courses;*
- *Confirmation of thrust block ground conditions and design;*
- *Complying polyethylene pipe weld preconstruction joint tests;*
- *Drainage and water reticulation bends, junctions and inspection points prior to backfilling, to allow as-builting;*
- *Utility reticulation prior to backfilling;*
- *Water and drainage reticulation during testing;*
- *Sterilisation of watermain;*
- *Finished subbase before the placement of basecourse;*
- *Finished basecourse before the commencement of surfacing or paving;*
- *Finished surface prior to roadmarking;*
- *Landscape areas formed and plants on site prior to planting;*
- *Construction safety audit;*
- *Practical Completion inspection;*
- *Defects Liability inspection for planting;*
- *Defects Liability inspection for roading etc.*

6 Environmental Control

The following Resource Consents, relevant to the works undertaken and/or materials used in this contract, have been received:

………………………………………………………………………………
………………………………………………………………………………
These have been reviewed and appropriate controls have been put in place to manage and/or mitigate the risk.

In accordance with contract requirements, *<if applicable>* environmental controls relating to this particular contract and/or the work being undertaken are outlined *<delete as applicable>* further in the attached documentation/in the site-specific Erosion and Sediment Control Plan appended. The compliance and effectiveness of management controls will be subject to periodic review.

7 Non-Conformance

If, during the process of inspection, work is identified which does not conform to the specified site requirements, a Non-Conformance Report will be prepared by the person at 3 b). The rectification proposed will be discussed and agreed with the engineer and will be stated on the NCR.

A proforma Non-Conformance Report is attached.

8 Contract Records

The following records will be produced for this contract:
(e.g. site meeting minutes, construction checksheets, photos, inspection and test schedules, test results, construction programmes, completion documentation, as-built records)

………………………………………………………………………………
………………………………………………………………………………

Appendix IV. DESIGN CERTIFICATE INFRASTRUCTURE/ LAND DEVELOPMENT

ISSUED BY: ………………………………………………………………………… *(Design firm or suitably qualified design professional)*

TO: ……………………………………………………………………………………..
(Owner/Developer)

TO BE SUPPLIED TO: ……………………………………………………………….
(Territorial authority)

IN RESPECT OF: ………………………………………………………………….
(Description of infrastructure/land development)

AT: ……………………………………………………………………………………

…………………………………………………………………………………………….
(Address)

……………………………has been engaged by……………………………………
(Design firm or suitably qualified design professional) *(Owner/Developer)*

to provide ………………………………… services in respect of the infrastructure/land development described above. I have the qualifications and experience relevant to this project as set out herein and have designed the subject works.

I ……………………………............. on behalf of ……………………………….
(Designer) *(Design firm)*
confirm that the design is to current good engineering practice, and that it satisfies all relevant resource consent conditions.

The design firm issuing this statement holds a current policy of professional indemnity insurance of no less than $…………………………….............
(Minimum amount of insurance shall be commensurate with the current amounts recommended by IPENZ, ACENZ, NZTA, IPWEA.)

Qualifications and experience (including professional affiliations):

……………………………………………………………………................................

…………………………………………………………………………………………

…………………………………………………… Date: ………………………
(Signature of designer)

Appendix V. DESIGN PEER REVIEW CERTIFICATE INFRASTRUCTURE/ LAND DEVELOPMENT

ISSUED BY: ………………………………………………………………………
(Design peer review firm or suitably qualified design peer review professional)

TO: ……………………………………………………………………………..
(Owner/Developer)

TO BE SUPPLIED TO: ……………………………………………………………
(Territorial authority)

IN RESPECT OF: ………………………………………………………………….
(Description of infrastructure/land development)

DESIGNED BY: ……………………………………………………………….. *(Design firm/Designer)*

……………………........ has been engaged by ……………….............
(Design peer review firm or suitably qualified design peer review professional) *(Owner/Developer)*

to provide design review services in respect of …………………………………….
aspects of the above work, which is described in the specification and shown on the

drawings numbered ……………………. to be approved by………………………
(Territorial authority)
under consent number……………………………on …………………………….
(Date)
As an independent professional, I have reviewed the design assumptions, methods, accuracy and conclusions. I have sighted the conditions of consent to the works and the specifications and drawings for approval. In my professional opinion and based upon reasonable enquiry, this review, information supplied by the designer and the designer's certification (copy attached),

I ……………………………confirm on behalf of ………………………………
(Design peer reviewer) *(Design Firm)*
the acceptability of the design and that the design complies with the above consent and current good engineering practice, subject to the findings below if any.

………………………………………………Date……………………………........... *(Signature of Design peer reviewer)*

…………………………………… Member NZIS ACENZ IPENZ
(Professional qualifications and Number)

…………………………………………………….
(Address)

Findings ………………………………………………………………………

………………………………………………………………………

Appendix VI. ENGINEER'S REVIEW CERTIFICATE
REVIEW OF CONTRACT QUALITY PLAN

ISSUED BY: …………………………………………………………………………
(Engineering consultancy firm or suitably qualified engineer)

TO: ………………………………………………………………………………..
(Owner/Developer)

TO BE SUPPLIED TO: ……………………………………………………………
(Territorial authority)

IN RESPECT OF: ……………………………………………………………….
(Description of infrastructure/land development)

DESIGNED BY: ……………………………………………………………….
(Design Firm/Designer)

AT: ………………………………………………………………………………..
(Address)

I, ……………………….............. on behalf of ……………………………….
(Engineer) *(Engineering consultancy firm)*
have reviewed the Contract Quality Plan (a copy of which is attached).

I confirm the following have been provided in accordance with IDS Part 3: Quality Assurance:

- Contract personnel and contact details listed
- Quality policy statement enclosed
- Contract management and responsibilities set out
- Subcontractors listed
- Procedures are documented and hold or witness points listed
- Site Safety and Environmental controls detailed
- Non-conformance process detailed
- Contract records listed

……………………………………………………… Date: ………………………
(Signature of engineer)

…………………………………………… Member ACENZ IPENZ
(Professional qualifications)

………………………………………………………
(Address)

Appendix VII. ENGINEER'S COMPLETION CERTIFICATE INFRASTRUCTURE/ LAND DEVELOPMENT

Issued by: ....
(approved certifier firm)

To: ....
(developer / owner)

To be supplied to the **Timaru District Council**

In respect of: ....
(description of land development / subdivision)

At:...
(address)

....

I... on behalf of .... has
(engineer / licensed surveyor) *(design firm)*

been engaged by the abovementioned developer / owner to provide observation, review and certification services for the abovementioned land development / subdivision.

I have sighted the Timaru District Council resource consent conditions that relate to the abovementioned land development / subdivision and the accepted Private Way / Engineering Design.

As an independent professional, I or personnel under my control, have carried out periodic reviews of the land development work appropriate to the nature of the work and in my professional opinion, based upon reasonable enquiry, these reviews, information supplied by the contractor during the course of the works and the contractor's certification upon completion of the works, the works, other that those outstanding works listed below, have been completed in accordance with the abovementioned consent and sound engineering practice.

My qualifications are:
……………………………………………………….........
(professional qualifications and affiliations and experience)

....

I / my design firm holds professional indemnity insurance in excess of no less than

$.. and includes runoff cover.
(minimum amount of insurance as recommended by IPENZ, ACENZ or IPWEA)

I understand that my professional opinion may be used and relied upon by Timaru District Council in determining the outcome of any approval for the abovementioned land development / subdivision.

This certificate is furnished to the Timaru District Council and the abovementioned developer / owner for their purposes alone.

Outstanding works (if any):...
(details of any outstanding works)

....

Construction approved by: ……………………………………………
(signature of engineer / licensed surveyor)

……………………………………………
(date)

Appendix VIII. CONTRACTOR'S COMPLETION CERTIFICATE INFRASTRUCTURE/ LAND DEVELOPMENT

Issued by: ....
(contracting firm)

To: ....
(principal)

To be supplied to the **Timaru District Council**

In respect of: ....
(description of land development / subdivision)

At:...
(address)

....

.... was contracted to the abovementioned principal to
(contracting firm)

carry out and complete certain land development / subdivision construction in accordance with contract

number.......................... for ....
(contract number) *(description of land development / subdivision)*

I ....being a duly authorised
(duly authorised representative)

representative of the abovementioned contracting firm hereby confirm that the abovementioned contracting firm has carried out and completed the construction, other than those outstanding works as listed below, in accordance with the abovementioned contract, the requirements of the accepted Engineering Design and the Timaru District Council.

I understand that my opinion may be used and relied upon by Timaru District Council in determining the outcome of any approval for the abovementioned land development / subdivision.

This certificate is furnished to the Timaru District Council and the abovementioned principal for their purposes alone.

Outstanding works (if any):...
(details of any outstanding works)

....

Construction approved by: ....
(signature of duly authorised representative)

....
(date)

Appendix IX. NON-CONFORMANCE REPORT

Contract Name/No: .... NCR Ref No: ....

1. NON-CONFORMING WORK DETAILS:

(provide precise location, detailed description and sketches as appropriate)

Company responsible for NC ....

Contractor (sign/date) ....

2. PROPOSED CORRECTIVE ACTION or CONSESSION REQUESTED

(provide details with sketches, calculations, etc.)

3. APPROVALS:

3.1 The corrective / concession action is accepted / not accepted / accepted subject to attached conditions.

Engineer (sign/date) ....

Council (sign/date) ....

3.2 The corrective action has been completed.

Certified: (sign/date) ....

Reviewed: (sign/date) ....

Approved: (sign/date) ....

Appendix X. ENGINEER'S AUDIT & TEST SCHEDULE

Testing			Inspection		Verification		
Phase	Test / Material Certificate Audit Frequency	Specification Reference	Contractor Y/N	Engineer Y/N	Hold Point Y/N	Acceptance Criteria	Signed / Accepted / Date
Note that the below information is an example for selected phases only. Prepare audit and test plans unique to the project, incorporating that project's quality criteria for infrastructure and materials installed on that project.							
Materials							
TNZ M/4:AP20 TNZ M/4:AP40	All Suppliers Certificates All Contractors test results	TNZ M/4	Y	Y	N	See acceptance criteria tables below	

Acceptance criteria (TNZ M/4:AP20 / AP40):

Sieve Size	*Percent Passing*	
	AP20	*AP40*
37.5mm		*100*
19.0 mm	*100*	*66 - 81*
9.5 mm	*55 – 75*	*43 - 57*
4.75 mm	*33 – 55*	*28 - 43*
2.36 mm	*22 - 42*	*19 - 33*
1.18 mm	*14 – 31*	*12 - 25*
0.600 mm	*8 – 23*	*7 – 19*
0.300 mm	*5 – 16*	*3 – 14*
0.150 mm	*0 – 12*	*0 – 10*
0.075 mm	*0 - 8*	*0 - 7*

Fraction	*Percent within*	
	AP20	*AP40*
19mm – 4.75mm		*28 – 48*
9.5mm – 2.36mm	*20 – 46*	*14 – 34*
4.75mm – 1.18mm	*9 – 34*	*7 – 27*
2.36mm – 0.600mm	*6 – 26*	*6 – 22*
1.18mm – 0.30 mm	*3 – 21*	*5 – 19*
0.600mm – 0.150mm	*2 - 17*	*2 - 14*

- *CBR under Vibrating hammer test over 80%*
- *Less than 10% fines shall pass a 2.36mm sieve after a crushing resistance test with a 130kN load*

<table>
<tr><th colspan="3">Testing</th><th colspan="2">Inspection</th><th colspan="3">Verification</th></tr>
<tr><th>Phase</th><th>Test / Material Certificate Audit Frequency</th><th>Specification Reference</th><th>Contractor Y/N</th><th>Engineer Y/N</th><th>Hold Point Y/N</th><th>Acceptance Criteria</th><th>Signed / Accepted / Date</th></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td>Shall have a quality index above CA from weathering quality index test
Shall either have a sand equivalent greater than 40 or the fraction of the aggregate passing a 0.075mm sieve shall have a clay index less than 3 or the fraction of the aggregate passing a 0.425mm sieve shall have a plasticity index less than 5
70% of the aggregate by weight shall have 2 or more broken faces</td><td></td></tr>
<tr><td>AP65</td><td>All Suppliers Certificates
All Contractors test results</td><td>TDC Contract Drainage and Water Specifications (DWCS) – 5.4</td><td>Y</td><td>Y</td><td>N</td><td><table><tr><th>Sieve Size</th><th>Percent Passing</th></tr><tr><td>65.0 mm</td><td>100</td></tr><tr><td>37.5 mm</td><td>60 - 90</td></tr><tr><td>19.0 mm</td><td>45 - 65</td></tr><tr><td>9.5 mm</td><td>30 - 50</td></tr><tr><td>4.75 mm</td><td>20 - 40</td></tr><tr><td>2.36 mm</td><td>10 - 28</td></tr><tr><td>1.18 mm</td><td>7 - 22</td></tr><tr><td>0.600 mm</td><td>5 - 16</td></tr><tr><td>0.300 mm</td><td>4 - 12</td></tr><tr><td>0.150 mm</td><td>3 - 8</td></tr><tr><td>0.075 mm</td><td>3 - 6</td></tr></table>
AP65 shall be free of organic matter
Less than 10% fines shall pass a 2.36mm sieve after a crushing resistance test with a 130kN load
AP65 shall either have a sand equivalent greater than 25 or the fraction of the aggregate passing a 0.075mm sieve shall have a clay index less than 3 or the fraction of the aggregate passing a 0.425mm sieve shall have a plasticity index less than 5</td><td></td></tr>
<tr><td>Premix concrete for kerb and channel</td><td>All Suppliers certificates</td><td>NZS 3104:2021</td><td>Y</td><td>Y</td><td>N</td><td>Concrete (Normal) strength 20 MPa at 28 days, slump 75mm, nominal maximum aggregate 19mm, water content under 170 kg/m3,</td><td></td></tr>
</table>

Testing			Inspection		Verification		
Phase	Test / Material Certificate Audit Frequency	Specification Reference	Contractor Y/N	Engineer Y/N	Hold Point Y/N	Acceptance Criteria	Signed / Accepted / Date
100 dia uPVC Kerb entry	All Suppliers certificates	AS/NZS 1260: 2017	Y	Y	N	SN10, factory moulded	
100 dia uPVC SN10 pipe	All Suppliers certificates	AS/NZS 1260: 2017	Y	Y	N	SN10, 100mm uPVC	
First class topsoil	All Suppliers Certificates All Contractors test results	TDC DWCS – 5.4.3	Y	Y	N	• *Under 5% solid detritus, under 10% stone, both under 30mm diameter* • *Under 25% clay, organic matter 7-20%* • *Loose friable, well aerated, lightly processed* • *pH 5.5-7.5*	
Medium grade bark mulch	All Suppliers Certificates All Contractors test results	CCC CSS Part 1: 39.2	Y	Y	N	• *Under 25% wood chips, under 1% inorganic component, 100% between 11-40mm*	
Construction							
Subgrade strength	Penetrometer test at 50 metre intervals, all Contractors test results	Land Transport Unit Backfill and Reinstatement Requirements Guide (BRRG) – Section 4	Y	Y	Y	CBR greater than 7	
Kerb and channel stringline	Check height and location of string line at every peg on day poured	CCC CSS Part 6: 4	Y	Y	Y	String 100mm behind kerb location and at design level	
Subbasecourse density	Nuclear Densometer test every 25 metres All Contractors test results	BRRG – Section 3	Y	Y	Y	Minimum 2100 kg/m3 , 95% of readings exceeding 2150 kg/m3	
Subbasecourse level	Measure depth from string line every 50 metres and at all grade changes and TPs	BRRG – Section 3	Y	Y	N	Finished levels within -25mm & +5mm of design	

Testing			Inspection		Verification		
Phase	Test / Material Certificate Audit Frequency	Specification Reference	Contractor Y/N	Engineer Y/N	Hold Point Y/N	Acceptance Criteria	Signed / Accepted / Date
Concrete placement	All Contractors test results	CCC CSS Part 6: 4.3	Y	Y	N	Slump 75mm	
Kerb level	Check level of kerb every 50 metres and at all grade changes and TPs	CCC CSS Part 6: 4.5	Y	Y	N	Finished level +/- 5mm of design	
Kerb alignment and location	Check alignment and location every 50 metres and at all TPs	CCC CSS Part 6: 4.5	Y	Y	N	Location +/-10mm of design, max 5mm deviation, cumulative visible gaps 10mm over 3m straightedge	
Tree pit excavation	Check dimensions, subgrade condition in 1/5th tree pits	CCC CSS Part 2: 8.4, Part 7: 6.6	Y	Y	Y	Minimum 1000mm deep, 750mm wide, subgrade loosened for 150mm all around	
Tree pit construction	Check finished level of filling, mulch area in 1/5th tree pits	TDC SD 7424	Y	Y	N	Finished surface +0mm, -0mm design Mulch extends 150mm outside tree stakes	
Trench excavation	Check dimensions of each fifth trench	TDC SD 5301	Y	Y	N	Minimum 850mm to invert in drives, 750mm to invert in untrafficked areas without protection	
Pipe laying	Check fall to outlet of each fifth pipe	TDC SD 5301	Y	Y	N	Invert level of pipe below property gully level	
Pipe haunching	Check depth of haunching of each fifth pipe	TDC SD 5301	Y	Y	Y	150mm above and below pipe	
Trench backfill compaction	Clegg test each 1/5th trench. All Contractors test results	BRRG – Section 2 & 3	Y	Y	N	Backfill exceeds Clegg Impact value of 35 in the commercial crossing, 25 in other areas	

Appendix XI. INSPECTION & TEST SCHEDULE

Testing			Inspection		Verification		
Material / Construction Phase	Test(s) / Material Certificate(s) Required Frequency	Specification Reference	Contractor Y/N	Engineer Y/N	Hold Point Y/N	Contract Records	Signed / Completed / Date
Note that the below information is an example for selected phases only. Prepare inspection and test plans unique to the project, incorporating that project's quality criteria for infrastructure and materials installed on that project.							
Materials – Kerb and channel							
AP65	One sieve analysis/500m3	TDC DWCS – 5.4	Y	Y	N	Suppliers certificate Gradings	
Premix concrete for kerb and channel	Suppliers certificate/truck	NZS 3104:2021	Y	Y	N	Suppliers certificate	
100 dia uPVC SN10 kerb entry	Suppliers certificate/delivery	AS/NZS 1260: 2017	Y	Y	N	Suppliers Certificate	
Construction – Kerb and channel							
Subgrade strength	Penetrometer test at 50 metre intervals under kerb and channel	BRRG – Section 4	Y	Y	Y	Metalcourse design checksheet	
Kerb and channel stringline	Check height and location of string line at every peg on each day string line used	CCC CSS Part 6: 4.4	Y	N	N	Kerb and channel construction checksheet	
Subbasecourse density	Nuclear Densometer test every 10 metres	BRRG – Section 3	Y	Y	Y	Kerb and channel construction checksheet	
Subbasecourse level	Measure depth from string line every 20 metres and at all grade changes and TPs	BRRG – Section 3	Y	Y	N	Kerb and channel construction checksheet	
Concrete placement	Slump test where mix appears dry	CCC CSS Part 6: 4.3	Y	Y	N	Kerb and channel construction checksheet	
Kerb level	Check level of kerb every 20 metres and at all grade changes and TPs	CCC CSS Part 6: 4.4	Y	N	N	Kerb and channel construction checksheet	
Kerb profile	Check profile at all hand boxed sections immediately after pour	CCC CSS Part 6: 4.4	Y	N	N	Kerb and channel construction checksheet	

Testing			Inspection		Verification		
Material / Construction Phase	Test(s) / Material Certificate(s) Required Frequency	Specification Reference	Contractor Y/N	Engineer Y/N	Hold Point Y/N	Contract Records	Signed / Completed / Date
Kerb alignment and location	Check alignment and location every 20 metres and at all TPs	CCC CSS Part 6: 4.4	Y	N	N	Kerb and channel construction checksheet	
Stormwater outlets	Check outlets at invert after placement	CCC CSS Part 6: 4.5	Y	N	N	Kerb and channel construction checksheet	
Materials – Tree pit							
First class topsoil	One sieve analysis, nutrient content and soil pH test/50m3	CCC CSS Part 1: 34.1	Y	Y	N	Test results Suppliers certificate	
Bark mulch	One sieve analysis/50m3	CCC CSS Part 1: 35.2	Y	Y	N	Gradings Suppliers certificate	
Construction – Tree pit							
Tree pit excavation	Check dimensions, subgrade condition of each pit	CCC CSS Part 2: 8.4, CCC CSS Part 7: 6.6	Y	Y	Y	Landscape construction checksheet	
Tree pit construction	Check finished level of filling, mulch area of each pit	CCC CSS Part 2: 9.5.4 CCC CSS Part 7: 6.6	Y	N	N	Landscape construction checksheet	
Materials – Property stormwater pipes							
100 dia uPVC SN10 pipe	Suppliers certificate/delivery	DWCS	Y	Y	N	Suppliers Certificate	
TNZ M/4: AP20	One sieve analysis/50m3	TNZ M/4	Y	Y	N	Suppliers certificate Gradings	
Construction – Property stormwater pipes							
Trench excavation	Check dimensions once for each property	AS/NZS 2032:2006 and AS/NZS 2566.2:2002	Y	N	N	Property stormwater checksheet	
Pipe laying	Check fall to outlet for each line	AS/NZS 2032:2006 and AS/NZS 2566.2:2002	Y	N	N	Property stormwater checksheet	
Pipe jointing	Check each line doesn't leak	AS/NZS 2032:2006 and AS/NZS 2566.2:2002	Y	N	N	Property stormwater checksheet	
Pipe haunching	Check depth once for each property	TDC SD 5301	Y	Y	Y	Property stormwater checksheet	
Trench backfill compaction	Clegg test every 10 metres of trench, on all layers	BRRG – Section 3	Y	N	N	Property stormwater checksheet	

Testing			Inspection		Verification		
Material / Construction Phase	Test(s) / Material Certificate(s) Required Frequency	Specification Reference	Contractor Y/N	Engineer Y/N	Hold Point Y/N	Contract Records	Signed / Completed / Date
Property stormwaters	Check all properties connected	AS/NZS 2032:2006 and AS/NZS 2566.2:2002	Y	N	N	Property stormwater checksheet	

Appendix XII. QUALITY SYSTEM WORK PROCEDURE CONTROL & INSPECTION OF PIPE SUBSOIL DRAIN CONSTRUCTION

1. Scope of this procedure

Subsoil drain construction other than perforated corrugated plastic pipe.

2. Responsibility & Actions

The site supervisor shall be an authorised drainlayer, where the pipe is laid in the legal road or shall be vested. Where the pipe is to be laid under a building consent, the site supervisor shall be a registered drainlayer.

The site supervisor shall be responsible for progressively inspecting the work to ensure it complies with the requirements.

The results of the inspection shall be recorded on the Pipe Subsoil Drain Construction Checksheet for defined sections of drain.

Inspection shall record the following:

a) Pipe type and diameter.

b) Trench width and depth.

c) Bedding and filter material and depth.

d) Measured grade.

e) Joint details.

f) Backfilling.

g) Connections.

Appendix XIII. ENGINEER'S H&S EXAMPLE CHECKSHEET
HEALTH AND SAFETY MANAGEMENT PLAN

CONTRACTOR: ______________________ DATE: __________
PROJECT DESCRIPTION: ______________________________

The following should be documented:

	Requirement Met? Yes	No
1. Project Description:		
• Brief description of the scope of the work or services	☐	☐
• Summary of major activities and types of work	☐	☐
• Specialist tasks or procedures are documented and reference to safe work procedures and training documented	☐	☐
• Areas of project requiring special consideration are documented and procedural requirements are referenced: e.g. presence of public, traffic management, notifiable work, restricted work	☐	☐
2. Contractor's Health and Safety Structure and System:		
• Names and positions of personnel with specific health and safety responsibilities are documented	☐	☐
• Position and name of the senior person who will liaise with the Engineer on health and safety issues is documented	☐	☐
• Name and position of the on-site supervisor is documented	☐	☐
3. Contractor's Induction and Safety Training:		
• Outline of the contractor's induction procedures for employees and subcontractors	☐	☐
• Register of personnel completing the induction programme	☐	☐
• Details of employee health and safety training relevant to the project.	☐	☐
• Copies of relevant certificates attached e.g. Code of Practice for Temporary Traffic Control, Cable Location, Confined Spaces	☐	☐

- Register of persons holding authorisations, permits, competency certificates, licenses etc required for the project ☐ ☐

4. Safe Work Practices and Procedures

- List of company safe work procedures relevant to the project ☐ ☐
- Copies of safe work procedures, permits or notifiable work notices ☐ ☐
- Details of project operations subject to work permits ☐ ☐
- Work permit procedure documented ☐ ☐
- Distribution list of people (including subcontractors) issued with safe work procedures ☐ ☐

5. Noise

- Control measures and standards are documented with clear procedures on how to achieve the control ☐ ☐

6. Hazard Management

- All hazards (existing and potential) associated with the project are documented on the hazard register form ☐ ☐
- Residual risk shall be transferred to the project contractor ☐ ☐
- Safety in Design principals shall be incorporated into the Hazard Management system ☐ ☐
- The hierarchy of controls has been considered (i.e. eliminate, isolate or minimise) ☐ ☐
- Control measures are documented with clear procedures on how to achieve the control ☐ ☐
- Evidence of employee and subcontractor training on control measures is included ☐ ☐

7. Workplace Health and Safety Inspections

- Inspection team documented ☐ ☐
- Frequency and type of inspection defined ☐ ☐

- Checklists to be used are included ☐ ☐
- Procedure for actioning inspection findings included ☐ ☐
- Hazard reporting procedures documented and form included ☐ ☐
- Specific areas targeted for inspections documented ☐ ☐

8. Emergency Procedures

- Overall emergency plan and structure for the project ☐ ☐
- Register of emergency equipment and locations ☐ ☐
- Register of current qualified first-aiders ☐ ☐
- Arrangements/coordination with other worksite occupants in event of emergency ☐ ☐

9. Accident Reporting, Recording and Investigation

- Details of accident recording, reporting and investigation system and procedures ☐ ☐
- Details of how accidents will be notified to WorkSafe NZ and Engineer ☐ ☐
- Details of how accident statistics are to be compiled (major projects) ☐ ☐

10. Health and Safety Performance Monitoring (Major Projects)

- Details of how health and safety performance statistics associated with the project are reviewed ☐ ☐
- Details of how monthly health and safety performance reports will be compiled for review by Engineer ☐ ☐
- Nature of health and safety performance information presented to employees on a regular basis ☐ ☐
- Outline of auditing programme to evaluate the effectiveness of the Health and Safety Management Plan ☐ ☐

11. Health and Safety Management Plan Review

This Health and Safety Management Plan has been:

Reviewed by:	_______________ *(Name/Position/Sign)*
Approved by:	_______________ *(Sign/Date)*
Contractor notified:	_______________ *(Date)*
Reviewed by: *(Council)*	_______________ *(Name/Position/Sign)*

Appendix XIV. ENGINEER'S GRAVITY PIPE TEST CHECKSHEET

CONTRACTOR ___________________________ ASSET (sewer/sw) ______
PROJECT TITLE ___________________________

SITE AND PIPELINE INFORMATION
Overall length (m) _______________________ Location ______________
Pipe material and class _____________________ _____________________
Nominal diameter (mm) _____________________ _____________________

PRESSURE TEST STANDARDS (to Drainage and Water Contract Specification)
Contract document reference ____________

Type of test	Visual inspection	*Select test method (delete inapplicable)*	
		Air test	**Hydrostatic test**
Reference	clause 3.14	clause 8.4	clause 8.4
Performance measure	No leaks or defects visible	Pressure drop less than 2kPa (0.2m) over test period	Water level does not drop over test period[1]

TEST CRITERIA *(provide before testing)* TEST RESULTS

Section tested	**Length (m)**	**Test pressure (kPa or m)**	**Test period(min)**	**Test Date**	**Pressure achieved (m) or loss (ml)**	**Pass / fail**

Note: 1) Hydrostatic and air testing shall be undertaken in accordance with Clause 8.4 of the Drainage and Water Contract Specification. Reference 1 and 2 below for Test Periods.

2) For Hydrostatic test of Concrete pipe and structures, the lines shall be filled with water 24 hour prior to the inspection.

3) For low pressure air tests, air should be bled through the line, forcing water out to achieve an airtight system. Maximum air pressure of 10kPa to be applied.

Engineer ____________________ Signature ______________
Contractor Rep ____________________ Signature ______________
Council Rep ____________________ Signature ______________
Date plan accepted ______
Date and time pipe test witnessed ______ Retest required yes/no
NCR reference ____________________ Pipeline accepted yes/no

1. Hydrostatic Testing

Allowable losses (ml) over a 5 minute test period

Conditions: Concrete pipe, where 30kPa hydrostatic test is required.

	Length of test section (m)							
Pipe diameter (mm)	5	10	15	20	30	40	50	100
225	28	56	84	113	169	225	281	563
300	38	75	113	150	225	300	375	750
375	47	94	141	188	281	375	469	938
450	56	113	169	225	338	450	563	1125
525	66	131	197	263	394	525	656	1313
600	75	150	225	300	450	600	750	1500

2. Air Testing

Length of air test required (min:sec)

Conditions: Maximum air pressure of 10 kPA with permissible loss in a concrete or plastic pipe of 2kPa or 0.3 PSI.

	Length of test section (m)									
Pipe diameter (mm)	10	20	30	40	50	60	70	80	90	100
150	2:00	2:00	2:00	2:00	2:00	2:00	2:00	2:00	2:00	2:00
200	2:00	2:00	2:00	2:00	2:00	2:00	2:00	2:00	2:00	2:00
225	2:00	2:00	2:00	2:00	2:00	2:00	2:10	2:10	2:10	2:10
250	2:00	2:00	2:00	2:00	2:20	2:30	2:40	2:40	2:40	2:40
300	2:00	2:00	2:00	2:20	3:00	3:00	3:00	3:00	3:00	3:00
375	2:00	2:00	2:40	3:40	3:40	3:40	3:40	3:40	3:40	3:40
450	2:00	2:30	3:50	4:20	4:20	4:20	4:20	4:20	4:20	4:20
600	2:30	4:30	5:50	5:50	5:50	5:50	5:50	5:50	5:50	5:50

Appendix XV. ENGINEER'S CONCRETE PRESSURE PIPE TEST CHECKSHEET

CONTRACTOR ________________ ASSET (sewer/water) __________
PROJECT TITLE _________________________

SITE AND PIPELINE INFORMATION
Overall length (m) ____________ Location __________
Test water disposed of to ____________
Pipe material and class ____________ Nominal diameter (mm) __________

PRESSURE TEST STANDARDS (to CSS: Part 3)
Contract document reference ___________

	Select test method (delete inapplicable)	
Type of test	**Working pressure water test**	**Max operating pressure water test**
Reference	clause 14.3.1	clause 14.3.1
Performance measure	No pressure loss	Measured loss mm/hr not to exceed 0.3 x length m x dia mm
Test period	3 hrs	5 mins

THRUST BLOCKS

Block identifier	**Bearing capacity (kPa)**		**Redesign required**	**New design details**
	Assumed	**Site verified**		
Add rows as necessary				

TEST CRITERIA *(provide before testing)* TEST RESULTS

Section tested	**Length (m)**	**Specified test pressure or allowable loss**	**Test Date**	**Pressure achieved (m) or measured loss (mm/hr)**	**Pass / fail**
Add rows as necessary					

Engineer ____________________ **Contractor Rep** ______________
Signature ____________________ Signature ______________
Date plan accepted ______ ________________ **Council Rep** _
Signature _
Date and time pipe test witnessed ______ Retest required yes/no
NCR reference ____________________ Pipeline accepted yes/no

Appendix XVI. ENGINEER'S PRESSURE PIPE TEST CHECKSHEET

CONTRACTOR ________________ ASSET (sewer/water) __________
PROJECT TITLE _________________________

SITE AND PIPELINE INFORMATION
Overall length (m) ____________ Location __________
Test water disposed of to ____________
Pipe material and class ____________ Nominal diameter (mm) __________

PRESSURE TEST STANDARDS
Contract document reference ____________

Type of test	*Select test method (delete inapplicable)*	
	Pressure rebound method	**Constant pressure method**
Material	PE ≤ DN315	DI, GRP, PVC, steel
Reference	clause 6.3.4.4	clause 6.3.4.1
Performance measure	Pressure rises or remains static	Make up water Q ≤ 0.14^{LDH1}
Test pressure (m)	Minimum of pipe rating but no more than 1.25 x pipe rating	

THRUST BLOCKS

Block identifier	Bearing capacity (kPa)		Redesign required	New design details
	Assumed	Site verified		
Add rows as necessary				

CONSTANT PRESSURE METHOD *Remove redundant test method*
TEST CRITERIA *(provide before testing)* TEST RESULTS

Section tested	Q (l/hr)[1]	Specified test pressure (m)	Test Date	Makeup water used (l/hr)	Pass / fail

PRESSURE REBOUND METHOD *Remove redundant test method*
TEST CRITERIA *(provide before testing)* TEST RESULTS

Section tested	Specified test pressure (m)	Test Date	P_{60}[2]	ΔV[2]	Pressure plot[2]	Pass / fail

Note 1) Provide details of this calculation.
2) Provide time/pressure readings and graphed results to confirm test details, as detailed in NZS 2566.2:2022.
3) M5 Reference Test to be completed for pressure pipelines >DN315 or where specified in Contract documents.

Engineer ____________________ **Contractor Rep** ______________
Signature ____________________ Signature ______________

Date plan accepted ______ **Council Rep** _

________________ Signature _

Date and time pipe test witnessed _______ Retest required yes/no

NCR reference ____________________ Pipeline accepted yes/no

Appendix XVII. CONSTRUCTION CHECKSHEET ACTIVITY PIPE SUBSOIL DRAIN CONSTRUCTION

CONTRACT/JOB: ____________ DATE: ____________
DRAIN LOCATION: ____________

Task	Acceptance Criteria/Test Frequency	Task/Completion Signature/Comment
1. Drawings and specifications checked for requirements		
2. Pipe material • type class • diameter		
3. Filter material • specification • grading		
4. Trench • alignment check • grade (normal min 1:100) • width • depth		
5. Bedding • min depth 75mm • sockets not bearing	Yes/No	
6. Pipe laying • sockets uphill • joints clean, invert flush • joints as detailed • rings required • isolated from surface water		
7. Backfill material • specification • grading		
7. Backfill placement • layer depth • compaction		
8. Connections • as per design • location		

Arising NCR: ________________________

All tasks defined above have been satisfactorily completed to the standards required:

Contractor: ________________________
(Sign/Date)

Appendix XVIII. CONSTRUCTION CHECKSHEET
ACTIVITY – BASECOURSE STRINGING

CONTRACT/JOB: ______________ DATE: ______________
ROAD LOCATION: ______________

Refer to diagram on back of this sheet for measuring diagram

Ch.	L	C	R

Ch.	**L**	**C**	**R**

Appendix XIX. PUMP STATION OUTSTANDING WORK/DEFECT LIST

TIMARU DISTRICT COUNCIL Te Kaunihera ā-Rohe o Te Tihi o Maru	CITY ENVIRONMENT GROUP CONSTRUCTION / COMMISSIONING WORK PACK OUTSTANDING WORK/DEFECT LIST	**Workpack Ref:**

The listed Defect List items **must** be completed as dictated by the stated Category before the commissioning of the asset covered by this Construction Work Pack proceeds to the next phase. Phases and Categories are detailed in the Pump Station Pre-Commissioning, Commissioning and Testing Procedure.

- **Category A** – Complete prior to handover to CEG for Control System Commissioning
- **Category B** – Complete prior to Clean Water Commissioning
- **Category C –** Minor items that do not prevent commissioning
- **Category D –** Items not part of project scope required to incorporate

Type refers to the following:

- **Snag (S) -** any defects/faults/problems/issues/actions identified prior plant handover
- **Defect (D) -** any defects/faults/problems/issues/actions identified at plant handover and during Defect Liability Period

Station Name:

Page No.: of

ITEM NO.	ITEM REPORTED BY, CATEGORY, AND DISCIPLINE:					DETAILS	PERSON TO ACTION	PROGRESS REPORT			ITEM COMPLETED		ACCEPTED BY CEG	
	Initial	Date	Category	Discipline	Type			Initial	Date	Report	Initial	Date	Initial	Date

Discipline Codes:

General – **Gen**; Civil – **Civ**; Mechanical – **Mech**; Electrical / Control / SCADA - **EICA**

PART 4: GEOTECHNICAL REQUIREMENTS

CONTENTS

FIGURES

4.1 REFERENCED DOCUMENTS

Planning and Policy

- Resource Management Act (1991) Section 106
- Building Act (2004) Section 36
- Chartered Professional Engineers Act of New Zealand (2002)

Design

- NZS 1170 *Structural Design Actions Set*
- NZS 4431:2022 *Engineered fill for construction of lightweight structures*
- NZS 3604:2011 *Timber-framed buildings*
- New Zealand Transport Agency *Bridge Manual*
- Canterbury Regional Council *Erosion and sediment control toolbox*
- Auckland Regional Council Guideline Document 1, *Stormwater Management Devices in the Auckland Region* (2017)
- Ministry for the Environment *Hazardous Activities and Industries List (HAIL)*
- Ministry for the Environment *Contaminated Land Management Guidelines No. 1 – Reporting on Contaminated Sites in New Zealand* (2011)
- Ministry of Business, Innovation and Employment *Rockfall: Design considerations for passive protection structures.*
- Ministry of Business, Innovation and Employment and New Zealand Geotechnical Society *Earthquake Geotechnical Engineering Practice Series Modules 1 to 6*
- New Zealand Geotechnical Society *Geotechnical Issues in Land Development*, Proceedings of NZ Geotechnical Society Symposium, Hamilton (1996)
- New Zealand Geotechnical Society *NZ Ground Investigation Specification*
- New Zealand Geotechnical Society *Field Description of Soil and Rock (*December 2005)
- New Zealand Geotechnical Society *Application of the New South Wales RMS "A Guide to Slope Risk Analysis" for NZTA Projects*.
- Australian Geomechanics Society Practice Note 2007 (and commentary) *Landslide Risk Management*, Australian Geomechanics Volume 42 No 1 (March 2007) www.australiangeomechanics.org/
- Engineering NZ Practice Notes & Guidelines
- Transport Research Board. *Landslides: Investigation and Mitigation,* Special Report No. 247 National Academy of Sciences. 1996
- Ministry of Business, Innovation and Employment. *Rockfall: Design considerations for passive protection structures.* Oct 2016
- Understanding the potential for Liquefaction in Timaru District
- Timaru District Growth Management Strategy 2017
- Liquefaction Hazard in Timaru District

Construction

- Engineering NZ Construction Monitoring Services

- Ministry of Business, Innovation and Employment *Part D* – *Guidelines for the geotechnical investigation and assessment of subdivisions in the Canterbury Region* Dec 2012

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).

4.1.1 Source documents

This Part of the IDS is based on Part 2 of NZS 4404:2010, by agreement, and with the consent of Standards New Zealand.

4.2 INTRODUCTION

This part of the IDS draws attention to the need for the assessment of land suitability and includes:

- site and ground investigations;
- surface and subsurface drainage and erosion control;
- liquefaction (including lateral spreading);
- contaminated sites;
- unsuitable historic fill;
- foundation stability;
- slope stability (including the design of rockfall protection structures); and
- control of earthworks.

The *District Plan* sets out planning rules, which may include the provision of geotechnical and natural hazards requirements.

Such assessment assures a suitable platform for the construction of buildings, roads and other structures, as well as the minimisation or mitigation of any adverse environmental effects arising from such works. It should also include an early assessment of the site's soils and their potential to provide for on-site stormwater systems (e.g. detention basins, infiltration basins).

This part is not a geotechnical standard but sets out some, though not necessarily all, of the matters to be considered in planning and constructing a land development or geotechnical hazard management project.

As Timaru District does have liquefaction prone areas and is susceptible to tectonic activity, consideration of earthquake effects must be taken into account, particularly in the higher risk areas.

4.2.1 Relevant standards

NZS 4431:2022 applies to the construction of earthfills for residential development, including residential roading. It does not, however, deal with historic fill that has not been placed in accordance with any Standard. It does not cover natural slopes, banks, batters or reinforced earth rockfall protection barriers.

There is no Standard for earthfill for other than residential developments. Clause 4.7.3 - Compaction standards for fill material sets out the requirements in these situations.

4.2.2 Statute and District Plan requirements

Where there is a requirement for an assessment of land stability to meet the provisions of the Resource Management Act and the Building Act, this is the responsibility of the applicant's Geoprofessional. The Council relies on that assessment when granting the resource consent. The Geoprofessional determines the methods used and investigations undertaken.

Special requirements apply when the land is subject to erosion, avulsion, alluvium, falling debris, subsidence, inundation or slippage. In such situations, refer to section 106 of the Resource Management Act or section 74 of the Building Act.

Specific Council requirements include:

- On a subdivision that has been granted resource consent no earthworks can begin prior to final engineering acceptance, unless written permission from the Council is given, detailing conditions that must be adhered to.

4.3 QUALITY ASSURANCE REQUIREMENTS AND RECORDS

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

4.3.1 The Geoprofessional

The Geoprofessional must be suitably experienced. Their experience must be to a level to permit an appropriate grade of membership in the relevant professional body. The Geoprofessional may be a suitably experienced civil or geotechnical engineer, engineering or environmental geologist or a hydrologist. Refer to clause 2.7.1 – Investigation and design (General Requirements) for further information.

The Geoprofessional must possess both suitable insurance policies with a minimum of $1,000,000 of public liability/indemnity coverage and relevant experience.

4.3.2 Requirement for a Geoprofessional

Engage a Geoprofessional or other Suitably Qualified Experienced Practitioner to provide geotechnical, soil contaminant and geohydrological expertise where the following issues exist:

- the construction of earthworks associated with any development requires initial planning and design, to ensure that fill, embankments and slopes remain stable and that fill material is placed in such a way that it can support the future loads imposed on it.
- the assessment of ground for building foundations, roads, etc. requires specialist expertise e.g. weak ground may require special design.
- the wide range of soil and rock types, physical conditions and environmental factors existing in different areas make it impossible to lay down precise requirements for land stability assessment or earthworks.
- the preliminary evaluation in clause 4.4 – Preliminary site evaluation raises doubt about the stability, or suitability, of the land for the proposed development.

- other geotechnical hazards are identified.
- the Council requires Geoprofessional expertise to assess the project.

4.3.3 Responsibilities of the Geoprofessional

The Geoprofessional will carry out the following functions:

- Undertake a site assessment and any preliminary site evaluation required, including investigations of sub-surface conditions and identifying geotechnical, natural and environmental hazards affecting the land, before the detailed planning of any development. Consider hazards located outside but which may pose a risk to the site. These matters must be included with the Geotechnical Assessment Report in any assessment of environmental effects (AEE) associated with any consent application;
- Before work commences, be involved in the design or review of the drawings and specifications defining any earthworks, rockfall hazard mitigation or other construction work, and submit a written report to the Council on the foundation recommendations, natural hazard risk and slope stability aspects of the project with the application for engineering acceptance, including any required Producer Statements;
- Determine the earthwork requirements, where no standard for earthworks is applicable to the project, to conform to the IDS and to the subdivision or resource consent conditions (if any) that apply to the proposed development;
- Before work commences, and during construction, determine the extent of further services required (including investigation and geological work);
- Before and during construction, determine the methods and frequency of construction control tests to be carried out, determine the reliability of the testing, and evaluate the significance of the test results and field inspection reports in assessing the quality of the finished work;
- During construction, undertake inspections at intervals consistent with the extent and complexity of the geotechnical issues associated with the project;
- On completion, submit a written report to the Council attesting to the compliance of the earthworks and/or the rockfall hazard mitigation with the specifications and to the suitability of the development for its proposed use. If NZS 4431 is applicable, the reporting requirements of that Standard must be used as a minimum requirement. Otherwise, provide the required Producer Statements.

4.3.4 Geotechnical Assessment Report

The Geotechnical Assessment Report is presented with the resource or building consent application. The report shall include, as applicable:

- Details of and the results of site inspections, evaluations and field investigations.
- Documentation of rock and soil types, distribution and properties.
- A liquefaction and lateral spread assessment.
- An assessment of rockfall, cliff collapse and landslide (mass movement) hazards, including those resulting from seismic activity.

- An assessment of the slope stability confirming the location and appropriateness of building sites.
- An assessment on drainage of the subject site and disposal of surface water.
- An assessment of ground bearing capacity.
- Recommendations for measures to avoid, remedy or mitigate any geotechnical hazards on the land subject to the application. These shall be in accordance with the provisions of Section 106 of the Resource Management Act 1991 where they are supporting a resource consent application.
- A statement of professional opinion as set out in Appendix I – Statement of Professional Opinion on the Suitability of Land for Subdivision.

The Ministry of Business, Innovation and Employment's *Part D - Guidelines for the geotechnical investigation and assessment of subdivisions in the Canterbury region* provide guidance on the extent of the assessment required in areas prone to liquefaction.

4.3.5 Design Report

Detail the key achievement criteria and assumptions in the Design Report, such as the chosen factors of safety, for the geotechnical aspects of the engineering design.

Wherever building sites on natural ground have soil strengths less than 100 kPa or exhibit other specific characteristics that may require specific foundation design, note them in the report, along with any recommendations for strengthening or piling foundations for residential buildings or other works.

Provide the following design records, as appropriate, to support the Design Report:

- the site inspection and evaluation
- the foundation aspects of the project including proposed mitigation measures
- the consideration of slope stability including displacements, rockfall and/or cliff collapse hazards
- the extent of further Geoprofessional inputs required (including investigation and geological work)
- the methods and frequency of construction control tests to be carried out
- the extent of further construction monitoring by the Geoprofessional to confirm design assumptions

4.3.6 Geotechnical Completion Report

For all developments where a Geoprofessional is engaged, the Geoprofessional must submit a Geotechnical Completion Report, accompanied by a statement of professional opinion as set out in Appendix II – Statement of Professional Opinion on the Suitability of Land for Building Construction. The report must, as applicable:

- Identify any specific design requirements that necessitate the design of the development to deviate from the relevant New Zealand standard.
- Describe the extent of inspection, the results of testing and include all geotechnical reports prepared for the development.

- Indicate the degree of compliance of the development with the design or standards set by the Geoprofessional.
- Include documentation on both the testing of the soils for compaction and for soil strength and type, clearly showing the areas to which the tests relate.
- Include areas where compaction complied with the required Standards, any areas requiring re-testing and areas which did not comply with the Standards.
- Include documentation of rock types, distribution and properties (if rock is present on the site).
- Detail the rockfall protection works undertaken and any ongoing maintenance requirements necessary to protect the site in perpetuity.

For simple developments where there are no earthworks, the Geotechnical Completion Report will consist of the Geotechnical Assessment Report. For large or more complex developments where there may have been several stages of geotechnical reporting, include all relevant geotechnical information in the Geotechnical Completion Report.

4.3.7 As-Built records

Prepare as-built records and maintenance manuals, which comply with Part 11: As-Builts. Present the as-built records in conjunction with the Geotechnical Completion Report and tabulated results.

4.4 PRELIMINARY SITE EVALUATION

Consider the total surroundings of the site, without being influenced by details of land tenure, territorial or other boundary considerations.

Locate and review any historic geotechnical investigations or reports (including subsurface investigations) that may help to identify the key geotechnical issues for the site.

In simple cases, a visual appraisal may be sufficient. In other cases, depending on the nature of the project, its locality, the scale of development proposed and individual site characteristics, consider the following matters before preparing a proposal for development.

4.4.1 Existing landforms

Study the general nature and shape of the ground and take particular note of:

- the geological nature and distribution of soils and rock
- existing and proposed surface and subsurface drainage conditions and the likely effects on groundwater and on surface runoff
- the previous history of rockfalls in the area
- the previous history of ground movements in similar soils in the area

- where earthworks are involved, the performance of comparable cuts and fills (if any) in adjacent areas
- aerial photography and other sources of information that should be reviewed and incorporated into any slope stability assessment

4.4.2 Surface and subsurface drainage

Identify the existing natural surface and subsurface drainage pattern of any area, and locate any natural springs or seepage. Wherever any natural surface or subsurface drainage paths may be interfered with or altered by earthworks, assess the wider implications e.g. the impact on springs in nearby waterways. Sealing areas to preserve these drainage paths may be preferable to providing alternative drainage paths. Consider also the stormwater needs of the site and erosion and sedimentation control during development.

4.4.3 Slope stability

When assessing the stability of slopes and earthfills, refer to criteria applicable to land development in New Zealand that is published or recommended by the New Zealand Geotechnical Society, including *Geotechnical Issues in Land Development*.

Some natural slopes exist in a state of marginal stability and natural triggers like an earthquake or rainfall event may trigger failure. In addition, relatively minor works such as trenching, excavation for streets or building platforms, removal of scrub and vegetation, or the erection of buildings, can lead to failure. Look for signs of instability, such as cracked or hummocky surfaces, crescent-shaped depressions, crooked fences, trees or power poles leaning uphill or downhill, uneven surfaces, swamps or wet ground in elevated positions, plants such as rushes growing down a slope and water seeping from the ground.

4.4.4 Foundation stability

Study the general topography of the site and its surroundings for indications of areas that have previously been built up; either as a result of natural ground movement or by the deliberate placing of fill material. Unless such fill has been placed and compacted under proper control, long-term differential settlement could occur, causing damage to superimposed structures, roads, services or other structures.

Test those areas of natural ground on planned subdivisions or developments that are not proposed to be filled or excavated, for soil strength and type.

4.4.5 Unsuitable historic fill

Council records may (or may not) indicate that a site has been filled with unsuitable, uncontrolled or contaminated material. Discuss any remediation proposals for such fillings with the Council at an early stage of the investigation.

4.4.6 Contaminated sites

Sites known to be, or subsequently found to be, contaminated as a result of previous activities may require the services of a specialist environmental scientist or Suitably Qualified and Experience Practitioner for a site evaluation. *Hazardous Activities and Industries List (HAIL)* provides further detail.

Ascertain, at an early stage, the extent of any contamination and gain a reasonably accurate picture of any constraints on earthworks, including excavated material disposal. Refer to *Contaminated Land Management Guidelines* for information on reporting requirements.

4.4.7 Local conditions

Consider the range of soil types which exist within e.g. expansive soils, volcanic soils, dispersive soils, soft alluvial sediments and compressible soils. Note the presence of loess and loess colluvium as these soils have specific slope instability characteristics. The Council and Canterbury Regional Council (Environment Canterbury) may have information on the soil types of particular areas.

4.4.8 Liquefaction

Liquefaction is the loss of strength of a liquefied soil and can result in any of the following types of damage: ground surface disruption including surface cracking, dislocation, ground distortion and slumping; permanent deformations such as large settlements and lateral spreads; and sand boils. Refer to Figures 1 and 2 below for identifying areas of potential risk to liquefaction.

Use the Building Code Geotechnical *Guidelines Module 3: Identification, assessment and mitigation of liquefaction hazards* when determining areas at risk of liquefaction.

Use the *Part D - Guidelines for the geotechnical investigation and assessment of subdivisions in the Canterbury region* when reporting on developments on land prone to liquefaction.

Figure 1: Liquefaction potential in Timaru District

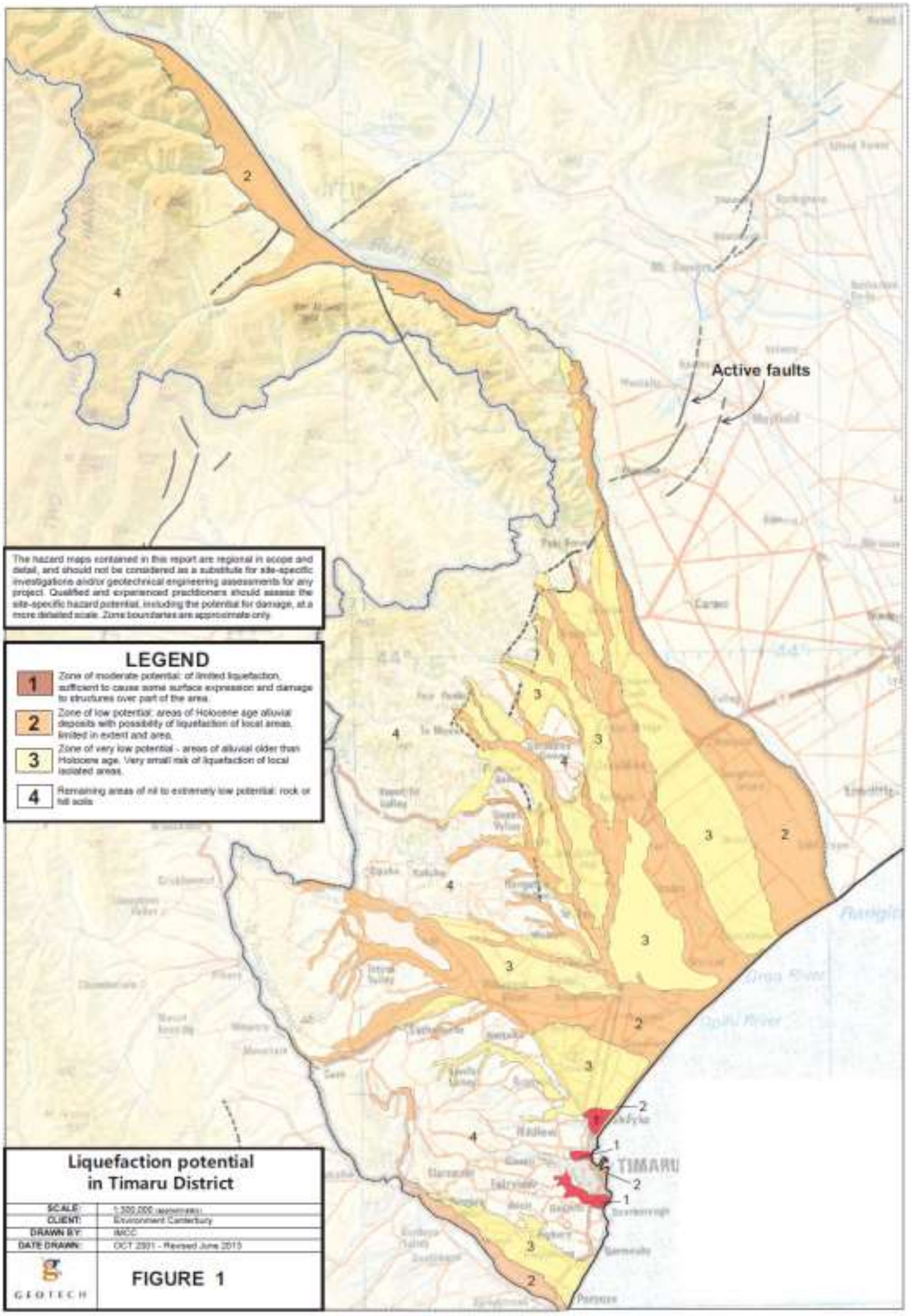
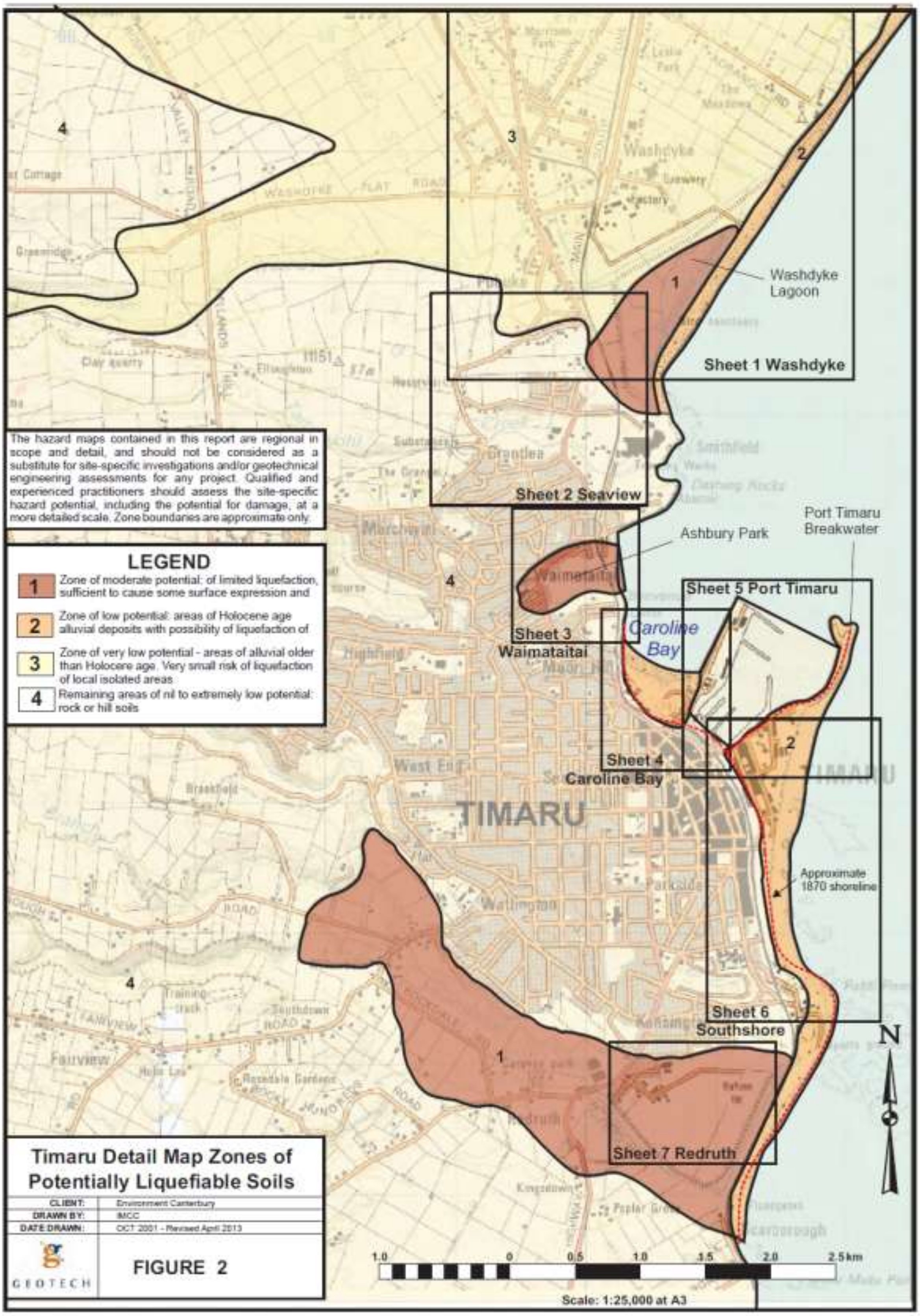


Figure 2: Timaru Detail Map Zones of Potentially Liquefiable Soils



4.4.9 Peer review

If the risk to the land is assessed as being medium to very high, obtain a peer review of the geotechnical assessment for the proposed development before an application for Engineering Design Acceptance. An independent Geoprofessional must carry this out. *Peer Review: Reviewing the work of another Engineer* provides guidance on this process. Refer to clause 3.3.2 – Design report (Quality Assurance) for further information.

4.5 GROUND INVESTIGATIONS

Make sufficient borings, probings or open cuts to:

- classify the soil strata by field and visual methods.
- evaluate the likely extent and variation in depths of the principal soil types.
- establish the natural long-term seasonal groundwater levels.
- characterise the natural ground water environment.

Obtain an indication of the seasonal variation in groundwater levels from a review of historical data held by the Council or Canterbury Regional Council, or by an extended period of monitoring. At least one year's readings may be required wherever groundwater levels are critical, or could have a long-term effect on the development.

4.5.1 Geotechnical data

In addition to the general assessment of the suitability of the site for its intended use (buildings, roads), obtain sufficient geotechnical (rock or soil) test data to characterise the ground data for areas that are intended to:

- form in-situ bases for fills
- yield material for construction of fills
- be exposed as permanent batters
- remain as permanent slopes or cut areas
- be used for stormwater disposal to ground

For consistency in the reporting of soils to the Council, use the *Field Description of Soil and Rock*. Appendix III provides templates and the necessary details to be supplied in Soil Logs (Figure 3) as well as the details for the Soil Description (Figure 4).

4.5.2 Further investigation

The geotechnical information thus obtained forms the basis for:

- further sampling and testing which may be required on representative soil or rock types
- relating subsequent soil or rock test properties to relevant strata over the site
- assessment of, or calculations for, slope stability
- assessment of, or calculations for, foundations suitable for the finished site

- assessment of, or calculations for, road pavements

Determine the test data that is appropriate for different areas.

4.5.3 Special soil types

Wherever special soil types are known to exist in a locality or are identified, advise on appropriate measures for incorporation of these soils into a development through the advice of a Suitably Qualified and Experienced Practitioner. Where the presence of coal tar contamination has been identified, detail the proposed on-site treatment.

Special soil types include, but are not limited to:

- soils with high shrinkage and expansion
- compressible soils
- volcanic soils
- soils subject to liquefaction
- soils prone to dispersion (e.g. loess)
- marine or estuarine soils

Contact the Council for information on hazard rating and on special soil types in the locality additional to those referenced above, if unfamiliar with the area.

4.6 PLANNING AND DESIGN

4.6.1 Suitability of landform

The choice of a suitable landform is dependent on many factors that may be specific to a particular site. Refer to clause 2.5.4 – Balancing landform choices (General Requirements) for these factors.

Avoid unnecessary earthworks, aim to protect original soils and drainage patterns and to minimise disturbance, compaction, earthworks and the importation of topsoil, although earthworks may be justified in the following circumstances:

- to minimise the risk of property damage through ground movement in the form of rockfall, debris slides, slips, subsidence, creep, erosion or settlement.
- to minimise the risk of property damage through flooding, surface water run-off or groundwater modification.
- to develop a more desirable roading pattern with improved accessibility to and within the site, and to create a better sense of orientation and identity for the area as a whole.
- to increase the efficiency of overall land use, including the quality of individual sites and amenity areas around buildings, the economics of providing engineering services and the standard of roading and on-site vehicular access.
- to create, where needed, suitably graded areas for playing fields and other community facilities.

- to enhance the general environmental character of the area by softening the landscape or by artificially creating or emphasizing landforms of visual significance, particularly on flat sites or on areas devoid of landscape features.

4.6.2 Seismic considerations

Consider the seismic effects on earthfills, foundations, major or critical infrastructure, slopes, rockfall sources and liquefiable ground, and take these into account in the design and construction of any development. These effects could include liquefaction, lateral spread, rockfall, cliff collapse and slippage.

4.6.3 Peat

Ensure the geotechnical design in peat or organic compressible material areas will achieve the infrastructure design life required by all other parts of the IDS. Preserve the flow of groundwater through the peat at pre-development levels.

Special care is required in any development over peat areas to:

- maintain uninterrupted groundwater flow;
- preserve existing natural groundwater levels to avoid area wide settlement;
- avoid settlement of any surface works or structures;
- ensure the continued operation of infrastructural services and service connections to buildings throughout their design life.

4.6.4 Debris slides

Confirm that any proposed building platform is unlikely to be affected by debris slides. Refer to Timaru District Council *“Stormwater Management Guidelines”* for further information.

4.6.5 Reducing waste

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

- Design to reduce waste during construction e.g. minimise earthworks, reuse excavated material elsewhere.
- Use materials with a high recycled content e.g. recycled concrete subbase. Proposed recycled materials will need approval from the Council to ensure that environmental contamination does not occur.

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

4.7 CONSTRUCTION

4.7.1 Underrunners and springs

In hill catchments, underrunners are often encountered. Where practicable and considered necessary, intercept these and bring them to the surface, with a free outfall into the stormwater system wherever possible. If possible, locate the source and redirect or eliminate the underrunner, following consent received from Council.

4.7.2 Control testing

A testing laboratory, or a competent person under the control of the Geoprofessional, must carry out the construction control testing. The testing laboratory must have recognised registration or quality assurance qualifications.

4.7.3 Compaction standards for fill material

The standard of compaction and method of determination is as set out in NZS 4431, except where NZS 4431 is not applicable. For example, reinforced earth embankment barriers, industrial and commercial developments often have specialised requirements for fill materials and compaction. Specify the fill and compaction standards, procedures and methods of determination for the development in these cases. Use NZS 4431 as a basis where appropriate.

4.8 EROSION, SEDIMENT AND DUST CONTROL

4.8.1 Minimisation of effects

Design and construct earthworks to minimise soil erosion and sediment discharge. Where necessary, make permanent provision to control erosion and sediment discharge from the area of the earthworks.

At the planning and design phase, consider the generation of dust during and after the earthworks operation. If necessary, incorporate specific measures to control dust.

Requirements for erosion, sediment and dust control will be set in the resource consent conditions from Timaru District Council and/or Canterbury Regional Council for the project. Refer to these conditions and take into account in the early stages of planning a project.

4.8.2 Site-specific erosion and sediment control plan requirements

For all developments where erosion could result in contaminants and sediments entering the groundwater, surface waters or the Council’s stormwater system, provide a site-specific Erosion and Sediment Control Plan (ESCP) to the Council at least four weeks before any works start on site. Note that, even where the Council has accepted an ESCP, the developer remains entirely responsible for all adverse effects associated with the site development. Also refer to the SMG for guidelines as appropriate.

Develop the ESCP to eliminate or reduce the following issues:

- ecological damage to waterways;
- channel infilling;
- disturbed or uncompacted surfaces and potential sediment yield;
- contaminated runoff;
- sediment discharges from dewatering;
- potential contamination from bituminous materials.

The ESCP must include the following assessment factors:

- a description of the pre-development surface water runoff regime;
- the development area (hectares);
- the catchment area passing through the site (hectares) marked on drawing;
- a plan of the development area, identifying discharge points to drains or pipelines;
- calculated flow rates, and velocities through from the site (dry weather, two-year flood and typical water levels);
- a site plan showing the proposed earthwork strategy;
- the earthworks engineering drawings;
- a statement on how the exposed soil surface will be minimised;
- a statement (with sketches as appropriate) on how sediment runoff will be trapped and disposed of;
- a statement on potential tracking of soils on and off site by machinery;
- a statement on other contaminants and how they will be controlled;
- a statement on specific design requirements triggered where dewatering is required;
- a statement on how ground water will be treated and discharged (if required).

The ESCP must comply with the standards:

- as specified by Canterbury Regional Council e.g. *Erosion and sediment control guidelines, Sediment Control Toolbox for Canterbury;*
- Timaru District Consolidated Bylaw 2018 Chapter 15: Water Services Bylaw

4.8.3 Protection measures

Take the following protection measures, unless incompatible with Canterbury Regional Council resource consent conditions:

- Construct stabilised construction entrances and detail proposed remedial works to mitigate contaminants moving off site e.g. mud on streets or silt in existing sumps in streets.

- Construct sediment traps and retention ponds where necessary. These should be cleaned out, as required, to ensure that adequate sediment storage is maintained.
- Use temporary barriers, or silt fences using silt control geotextiles, to reduce flow velocities and to trap sediment.
- Leave sections of natural ground unstripped to act as grass (or other vegetation) filters for run-off from adjacent areas.
- Construct temporary drains at the top and toe of steep slopes to intercept surface run-off and to lead drainage away to a stable watercourse or piped stormwater system.
- Slope benches in batter faces back and grade (both longitudinally and transversely), to reduce spillage of stormwater over the batter wherever surface water could cause erosion of batters, or internal instability through infiltration into the soil.
- Prevent overland flow paths from discharging water over batter faces by constructing open interceptor drains in permanent materials formed to intercept surface run-off and discharge via stable channels or pipes, preferably into stable watercourses or piped stormwater systems.
- Grade the surfaces of fills and cuts to prevent ponding.
- Shape and compact the upper surface of intermediate fills with rubber-tyred or smooth-wheeled plant when rain is impending or when the site is to be left unattended, to minimise water infiltration.
- Topsoil and grass the completed battered surfaces of fills to reduce run-off velocities.
- Re-topsoil and grass (or hydroseed) all earthwork areas as soon as possible after completion of the earthworks and drainage works.
- Use planting, environmental matting, hydroseeding, drainage channels or similar measures at an early stage in the earthworks construction phase as a permanent control of erosion and sediment discharge.
- To control dust or encourage early vegetation growth, water the site frequently during construction.
- Establish the permanent surface at an early stage of the construction phase.

Possible treatment methods are provided in the TDC SMG and Environment Canterbury *ESC Toolbox*.

Ensure a satisfactory grass strike is obtained on all completed earthworks surfaces as soon as practicable. The intention is to provide early vegetative cover, particularly before the onset of winter, to minimise erosion and sedimentation. Suitable irrigation methods may be required to assist grass growth in the summer months.

Prevent water from stormwater systems flowing into a fill or into natural ground near the toe or sides of a fill. Do not construct stormwater or wastewater soakage systems in a fill, which could impair the fill's stability. Take into account the effect of utility services laid within the fill.

Appendix I. STATEMENT OF PROFESSIONAL OPINION ON THE SUITABILITY OF LAND FOR SUBDIVISION

ISSUED BY: ……………………………………………………………..…………
(Geotechnical engineering firm or suitably qualified Geoprofessional)

TO: ……………………………..………………………… *(Territorial authority)*

TO BE SUPPLIED TO: ……………………………………………*(Owner/Developer)*

IN RESPECT OF: …………………………………………………………………….
(Description of proposed infrastructure/land development)

AT: …………………………………………………………………

……………………………………………………………………………………*(Address)*

I …………………………….............. on behalf of ……………………………….
(Geoprofessional/SQEP) *(Geotechnical engineering firm)*
hereby confirm:

1. I am a suitably qualified and experienced Geoprofessional employed by ……………………………………………………………………………………and the geotechnical firm named above was retained by the owner/developer as the Geoprofessional on the above proposed development.

2. The geotechnical assessment report, dated …………….….... has been carried out in accordance with the Ministry of Business, Innovation and Employment *Part D - Guidelines for the geotechnical investigation and assessment of subdivisions in the Canterbury region* and the Timaru District Council *Infrastructure Design Standard – Part 4: Geotechnical Requirements* and includes:

(i) Details of and the results of my/the site investigations.
(ii) A liquefaction and lateral spread assessment.
(iii) An assessment of rockfall and slippage, including hazards resulting from seismic activity.
(iv) An assessment of the slope stability and ground bearing capacity confirming the location and appropriateness of building sites.
(v) Recommendations proposing measures to avoid, remedy or mitigate any potential hazards on the land subject to the application, in accordance with the provisions of Section 106 of the Resource Management Act 1991.

3. In my professional opinion, not to be construed as a guarantee, I consider that Council is justified in granting consent incorporating the following conditions:

(i)……………………………………………………………………………………..

(ii)…………………………………………………………………………………….

4. This professional opinion is furnished to the territorial authority and the owner/developer for their purposes alone, on the express condition that it will not be relied upon by any other person and does not remove the necessity for the normal inspection of foundation conditions at the time of erection of any building. It is limited to those items referred to in clause 2 only.

5. This statement shall be read in conjunction with the geotechnical report referred to in clause 2 above, and shall not be copied or reproduced except in conjunction with the full geotechnical completion report.

6. Liability under this statement accrues to the geotechnical firm only and no liability shall accrue to the individual completing this statement.

7. The geotechnical engineering firm issuing this statement holds a current policy of

professional indemnity insurance of no less than $…………………………….........
(Minimum amount of insurance shall be commensurate with the current amounts recommended by ENGINEERING NEW ZEALAND, ACENZ, NZTA, IPWEA.)

……………………………………………………… Date: ………………………

(Signature of engineer, for and on behalf of ……………………………………………………………)

Qualifications and experience

……………………………………………………

……………………………………………………

This form is to accompany Form 9 – Resource Management Act 1991 (Application for a Resource Consent (Subdivision))

Appendix II. STATEMENT OF PROFESSIONAL OPINION ON THE SUITABILITY OF LAND FOR BUILDING CONSTRUCTION

ISSUED BY: …………………………………………………………………………
(Geotechnical engineering firm or suitably qualified engineer)

TO: ……………………………………………………………………………………..
(Owner/Developer)

TO BE SUPPLIED TO: ……………………………………………………………….
(Territorial authority)

IN RESPECT OF: …………………………………………………………………….
(Description of infrastructure/land development)

AT: ……………………………………………………………………………………

…………………………………………………………………………………………….
(Address)

I …………………………................ on behalf of ……………………………….
(Geoprofessional) *(Geotechnical engineering firm)*
hereby confirm:

1. I am a suitably qualified and experienced Geoprofessional and was retained by the owner/developer as the Geoprofessional on the above development.

2. The extent of my inspections during construction, and the results of all tests carried

out are as described in my/the geotechnical completion report, dated ………………......

3. In my professional opinion, not to be construed as a guarantee, I consider that *(delete as appropriate)*:

(a) the earthfills shown on the attached Plan No ………………………….. have been

placed in compliance with the requirements of the…………………….......Council and my/the specification.
(b) the completed works give due regard to land slope and foundation stability considerations.
(c) the original ground not affected by filling is suitable for the erection thereon of buildings designed according to NZS 3604 provided that:

(i) ……………………………………………………………………………………..

(ii) …………………………………………………………………………………….

(d) the filled ground is suitable for the erection thereon of buildings designed according to NZS 3604 provided that:

(i) ………………………………………………………………………………..

(ii) ……………………………………………………………………………….
(e)The original ground not affected by filling and the filled ground are suitable for the construction of a development/subdivision and are not subject to erosion, subsidence or slippage provided that:

(i) ……………………………………………………………………………..

(ii) ……………………………………………………………………………….

NOTE: The sub-clauses in Clause 3 may be deleted or added to as appropriate.

4. This professional opinion is furnished to the territorial authority and the owner/developer for their purposes alone, on the express condition that it will not be relied upon by any other person and does not remove the necessity for the normal inspection of foundation conditions at the time of erection of any building.

5. This statement shall be read in conjunction with my/the geotechnical report referred to in Clause 2 above, and shall not be copied or reproduced except in conjunction with the full geotechnical completion report.

6. Liability under this statement accrues to the geotechnical firm only and no liability shall accrue to the individual completing this statement.

7. The geotechnical engineering firm issuing this statement holds a current policy of

professional indemnity insurance of no less than $……………………………..........
(Minimum amount of insurance shall be commensurate with the current amounts recommended by ENGINEERING NEW ZEALAND , ACENZ, NZTA, IPWEA.)

……………………………………………………… Date: ………………………
(Signature of engineer)

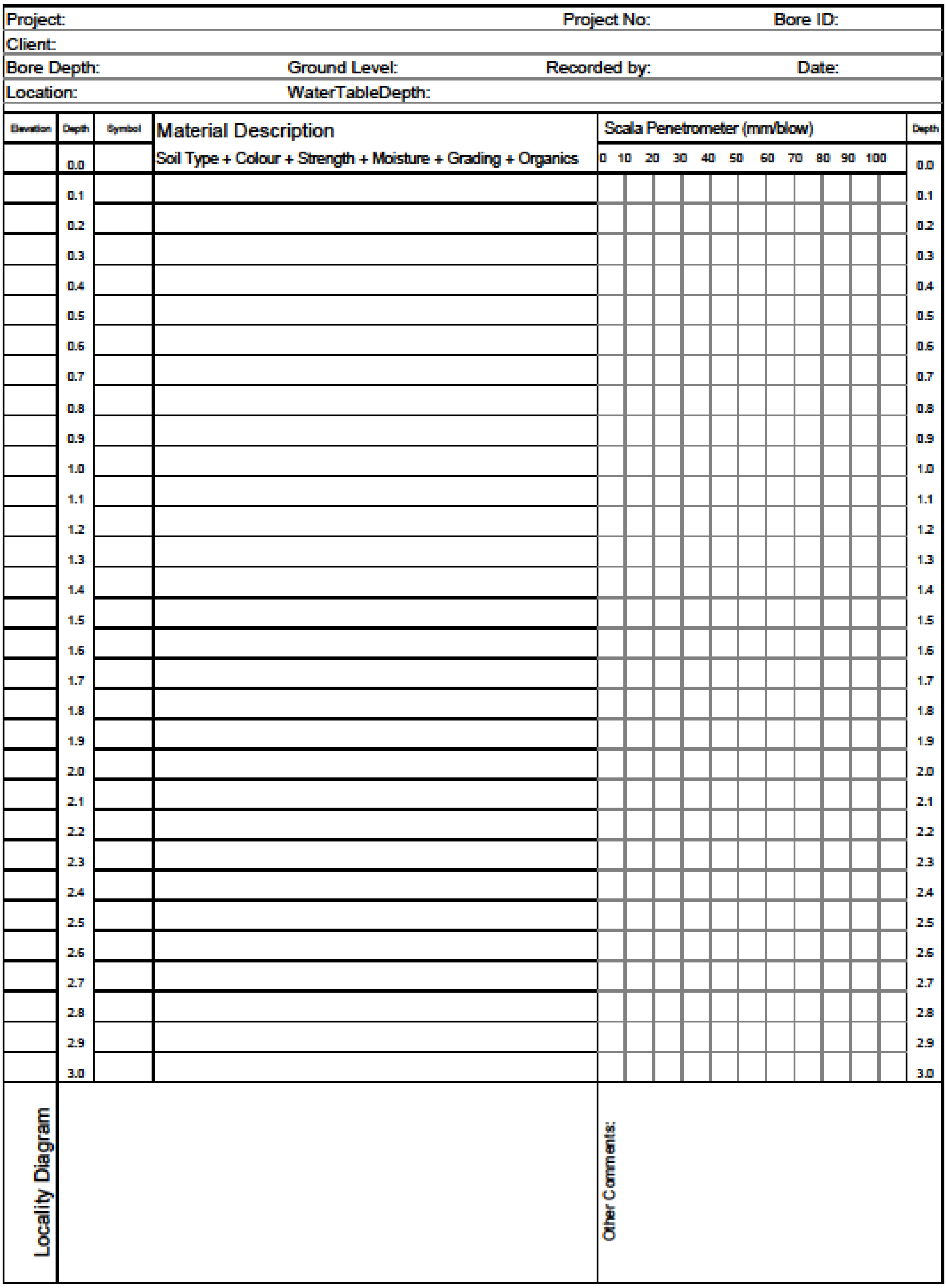
Qualifications and experience

……………………………………………………

……………………………………………………

Appendix III. SOIL LOG AND DESCRIPTIONS

Figure 3: Soil Log



Project: Project No: Bore ID:
Client:
Bore Depth: Ground Level: Recorded by: Date:
Location: WaterTableDepth:

Elevation	Depth	Symbol	Material Description Soil Type + Colour + Strength + Moisture + Grading + Organics	Scala Penetrometer (mm/blow) 0 10 20 30 40 50 60 70 80 90 100	Depth
	0.0				0.0
	0.1				0.1
	0.2				0.2
	0.3				0.3
	0.4				0.4
	0.5				0.5
	0.6				0.6
	0.7				0.7
	0.8				0.8
	0.9				0.9
	1.0				1.0
	1.1				1.1
	1.2				1.2
	1.3				1.3
	1.4				1.4
	1.5				1.5
	1.6				1.6
	1.7				1.7
	1.8				1.8
	1.9				1.9
	2.0				2.0
	2.1				2.1
	2.2				2.2
	2.3				2.3
	2.4				2.4
	2.5				2.5
	2.6				2.6
	2.7				2.7
	2.8				2.8
	2.9				2.9
	3.0				3.0

Locality Diagram

Other Comments:

Figure 4: Soil Descriptions

Soil Descriptions

Examples: Sandy GRAVEL, with some clay
Clayey SILT, with trace of peat, light grey, firm, moist

SOIL TYPE

Lesser Fraction	
20-50% volume	
Soil Type Term	
Coarse	gravelly
Medium	gravelly
Fine	gravelly
Coarse	sandy
Medium	sandy
Fine	sandy
Silty	
Clayey	
Peaty	

Dominant Fraction			
> 50% volume			
Soil Type term		**Particle size (mm)**	**Graphic Symbol**
BOULDERS		> 200	
COBBLES		60 - 200	
COARSE	GRAVEL	20 - 60	
MEDIUM	GRAVEL	6 - 20	
FINE	GRAVEL	2 - 6	
COARSE	SAND	0.6 - 2.0	
MEDIUM	SAND	0.2 - 0.6	
FINE	SAND	0.06 - 0.2	
SILT		0.002 - 0.06	
CLAY		< 0.002	
PEAT		N/A	

Minor Fraction		
12 - 20%	5 - 12%	< 5%
with some	**with minor**	**with trace**
boulders		
cobbles		
coarse	gravel	
medium	gravel	
fine	gravel	
coarse	sand	
medium	sand	
fine	sand	
silt		
clay		
peat		

COLOUR

Adjective1	*Adjective2*	*Main Colour*
light	pinkish	pink
dark	reddish	red
	yellowish	yellow
	brownish	brown
	olive	olive
	greenish	green
	bluish	blue
	greyish	white
		grey
		black

STRENGTH

Cohesive Soil Consistency

Consistency	*Undrained Shear Strength (kPa)*	*Characteristic*
very soft	< 12	Easily exudes between fingers
soft	12 - 25	Easily moulded by fingers
firm	25 - 50	Can be moulded with fingers with some effort
stiff	50 - 100	Impossible to mould with fingers, but will change shape with heel pressure
very stiff	100 - 200	As for stiff, but considerable heel pressure is required
hard	200 - 500	Brittle, very tough

Non Cohesive Soil Density

Density	*Characteristic*
very loose	Very easy to excavate by hand
loose	Easy to excavate by hand
medium dense	Between loose and dense
dense	Very difficult to excavate by hand
very dense	Particles bound together

MOISTURE

Moisture	*Description*
dry	Cohesive soils usually hard or powdery Granular soils run freely through hands
moist	Some moisture present – usually darkens the colour
wet	Strong squeezing in the hand will drive some water out
saturated	Squeezing will drive water out

SAND/GRAVEL GRADING

well graded
poorly graded

ORGANIC CONTENT

Adjective	*Organic Type*
trace	fibrous
little	wood pieces
some	root fibres
and	vegetation

For full descriptions see: *Field Description of Soil and Rock*, NZ Geotechnical Society, Dec 2005

PART 5: STORMWATER AND LAND DRAINAGE

CONTENTS

FIGURES

TABLES

EQUATIONS

5.1 REFERENCED DOCUMENTS

Planning and Policy

- Timaru District Revenue & Financing Policy
- Timaru District Consolidated Bylaw 2018
- Timaru District Council Stormwater Services Activity Management Plan 2021-2031

Design

- Christchurch City Council Streamside Planting Guide
- New Zealand Fish Passage Guidelines
- Timaru District Council Acceptable Solutions No. 1
- Christchurch City Council Waterways, Wetlands and Drainage Guide: Part B
- Ministry of Business, Innovation and Employment Acceptable Solutions and Verification Methods for the New Zealand Building Code Clause E1 Surface Water
- Auckland Council Stormwater management devices in the Auckland region. Auckland Council guideline document, GD2017/001
- Waikato Regional Council Waikato Stormwater Management Guideline, Technical Report TR2020/07
- Construction Industry Research and Information Association Infiltration Drainage – manual of good practise (R156)
- New Zealand Water Environment Research Foundation On-site Stormwater Management Guideline

Construction

- Timaru District Council – Land Transport Unit Backfill & Reinstatement Requirements Guide
- Timaru District Council Construction Standard Specifications

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.

5.1.2 Definitions and Abbreviations

Annual Recurrence Interval (ARI)	The average number of years that it is predicted will pass before an event of a given magnitude occurs. For example, a 1 in 20 year ARI event would on average happen once every 20 years.
Catchment area	An area of land where surface water from rain and melting snow or ice converges to a single point at a lower elevation, usually where the water joins another waterbody e.g. a river, lake, reservoir, estuary, wetland, sea, or ocean.

Certification	Applied in the context of Stormwater Discharge Certification, this refers to the process by which a stormwater discharge may be approved by TDC for entry to the reticulated stormwater network
Council	The local authority Timaru District Council.
Critical duration	The duration of a specific storm event which either results in the highest stormwater runoff rate or the duration of a storm event that results in the greatest downstream flooding.
Design storm	The theoretical rainfall event that the analysis is based on for a particular AEP. It is based on certain assumptions about rainfall depth, intensity, and or critical duration.
Development area	Any individual area within a site or sites that is undergoing development and construction activities.
Environment Canterbury / ECan	Canterbury Regional Council.
Erosion and Sediment Control (ESC) Plan	A plan to manage soil carefully when the land is disturbed (during development construction activities) in order to protect slopes from erosion, protect against loss of soil from a site and protect waterways.
Flood Risk Certificate	A certificate issued by Timaru District Council which specifies: a. the flood event risk level for specific land (being either land not subject to flooding in a 0.5% AEP flood event, or land subject to flooding in a 0.5% AEP flood event, or land within a High Hazard area); and b. where a. above identifies that the specific land is subject to flooding in a 0.5% AEP flood event, the minimum finished floor level for any new building or structure (or part thereof) on the specific land to provide at least 300mm freeboard above the flood level in a 0.5% AEP flood event; and c. if the specific land is within 150m of a stopbank, the minimum finished floor level for any new building or structure (or part thereof) on the specific land to avoid risk from a stopbank failure; and d. whether the specific land is located within an overland flow path.
Hazardous Activities and Industries List (HAIL)	A compilation of activities and industries that are considered likely to cause land contamination resulting from hazardous substance use, storage or disposal. The HAIL is intended to identify most situations in New Zealand where hazardous substances could cause, and in many cases have caused, land contamination.
High Hazard Area	A flood hazard areas subject to inundation events where the water depth (metres) x velocity (metres per second) is greater than or equal to 1 or where depths are greater than 1 metre, in a 0.2% annual exceedance probability flood event.
HIRDS	The High Intensity Rainfall Design System is a web-based programme that can estimate rainfall frequency at any point in New Zealand (maintained by NIWA). It can be used to estimate rainfall depths for hydrological design purposes, and to assess the rarity of observed storm events. (NIWA HIRDS is superseded by Appendix L –High Intensity Rainfall Design for Timaru District)

Impervious surface	an area with a surface which prevents or significantly reduces the soakage or filtration of water into the ground. It includes: • Roofs; • Paved areas including driveways and sealed or compacted metal parking areas and patios; • sealed outdoor sports surfaces • Sealed and compacted-metal roads; • Engineered layers such as compacted clay. It excludes: • Grass or bush areas; • Gardens and other landscaped areas; • Permeable paving and green roofs; • Permeable artificial surfaces, fields or lawns; • Slatted decks; • Swimming pools, ponds and dammed water; and • Rain tanks
Listed Land Use Register (LLUR)	The Listed Land Use Register is a publicly available database that identifies sites where hazardous activities and industries have been located throughout Canterbury.
Reticulated Stormwater Network	A network of pipes, swales, drains, kerbs and channels owned or operated by a network utility operator that collects stormwater within areas used or proposed to be used for rural lifestyle and urban-residential, commercial or industrial purposes and conveys that stormwater to any device, wetland, retention or detention pond or infiltration basin for the treatment of stormwater, prior to a discharge to land, groundwater or surface water. It excludes any drainage system that has been constructed for the primary purpose of collection, conveyance or discharge of drainage water, or any natural waterbody
Stormwater	Run-off that has been intercepted, channelled, diverted, intensified or accelerated by human modification of a land surface, or run-off from the surface of any structure, as a result of precipitation and includes any contaminants contained within
Stormwater Management Area	The urban catchment extent within which Council manages a reticulated stormwater system. May include areas identified for future development.
Stormwater Management Plan (SMP)	A plan prepared to address the management of stormwater within a Stormwater Management Area, prepared and lodged as part of a stormwater discharge consent application.
Stormwater neutrality	Management of stormwater runoff from the site during one or more specific rainfall events to restrict post-development peak flows and/or volumes to pre-development flows and/or volumes. post development stormwater runoff volumes generated on the site do not exceed the pre-development stormwater volumes off the site
Stormwater Neutrality Device	A device or natural system which retains (re-use) or detains the stormwater discharge from the site, and slows the release of the stormwater at a rate that is no more than the site's original discharge
TDC	Timaru District Council.
Time of concentration	A hydrological term that describes the response time of a catchment to rainfall. It represents the time period required for runoff from the furthest point of the catchment to reach a given point.
WSUD	Water Sensitive Urban Design is an engineering design approach which integrates the water cycle into urban design to minimise environmental degradation and improve aesthetic and recreational appeal

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 management of stormwater is critical in the urban environment for the safety of the community and the protection of public and private property. If not effectively collected and drained, stormwater can become a significant hazard and can cause damage to structures and properties. However, the discharge of stormwater also has the potential to cause adverse effects on the environment and subsequently the well-being of communities. The natural attributes of rivers, lakes and other freshwater bodies can be degraded by excessive sediment and contaminant inputs or by the flow rates and volumes of stormwater discharges. Timaru District Council (TDC) has a responsibility to ensure that urban stormwater is managed in a manner that sustainably supports the environmental, social, cultural and economic well-being of the communities it serves.

Timaru District faces significant challenges in Planning and Regulation, Asset Management, Managing the receiving environment and stakeholder engagement and education. In order to overcome these broad issues and their individual challenges TDC has set out a stormwater management framework through this Design Standard and the TDC Construction Standard Specifications (CSS).

The National Policy Statement for Freshwater Management 2020 Policies will guide Timaru DC Stormwater practices. These policies are outlined below:

Policy 1: Freshwater is managed in a way that gives effect to Te Mana o te Wai
Policy 2: Tangata whenua are actively involved in freshwater management (including decision-making processes), and Māori freshwater values are identified and provided for.
Policy 3: Freshwater is managed in an integrated way that considers the effects of the use and development of land on a whole-of-catchment basis, including the effects on receiving environments.
Policy 4: Freshwater is managed as part of New Zealand’s integrated response to climate change.
Policy 5: Freshwater is managed through a National Objectives Framework to ensure that the health and well-being of degraded water bodies and freshwater ecosystems is improved, and the health and well-being of all other water bodies and freshwater ecosystems is maintained and (if communities choose) improved.
Policy 6: There is no further loss of extent of natural inland wetlands, their values are protected, and their restoration is promoted.
Policy 7: The loss of river extent and values is avoided to the extent practicable.
Policy 8: The significant values of outstanding water bodies are protected.
Policy 9: The habitats of indigenous freshwater species are protected.
Policy 10: The habitat of trout and salmon is protected, insofar as this is consistent with Policy 9.

Policy 11: Freshwater is allocated and used efficiently, all existing over-allocation is phased out, and future over-allocation is avoided.
Policy 12: The national target (as set out in NPS-FW 2020: Appendix 3) for water quality improvement is achieved.
Policy 13: The condition of water bodies and freshwater ecosystems is systematically monitored over time, and action is taken where freshwater is degraded, and to reverse deteriorating trends.
Policy 14: Information (including monitoring data) about the state of water bodies and freshwater ecosystems, and the challenges to their health and well-being, is regularly reported on and published.
Policy 15: Communities are enabled to provide for their social, economic, and cultural well- being in a way that is consistent with this National Policy Statement.

5.2.2 Objectives

The design of Timaru District's stormwater management reticulation endeavours to provide a network with sufficient capacity to contain the stormwater up to the design rain events without overflows. The *2018-2048 Timaru District Stormwater Strategy* establishes objectives for the stormwater network. These objectives include but are not limited to the need to minimise the adverse effects of stormwater on communities and freshwater systems, increase resilience and maintain affordability of stormwater services, and ensure the agreed level of service is maintained to the satisfaction of the Council and community. To satisfy the latter, remedial or mitigation works will often need to be incorporated within the stormwater drainage system.

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. 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.

The Timaru District Plan seeks to manage land uses to avoid or mitigate potential effects, and to support integrated management of the freshwater resource within the Canterbury region. For stormwater, this can be achieved through water sensitive urban design (WSUD); using natural processes to protect water quality and the aquatic habitat and enhance liveability through cultural significance, connectivity and recreation.

The purpose of the Stormwater Management Chapter is to:

- Assist Council in meeting their obligations under the Resource Management Act through the appropriate implementation of their Stormwater Management Plans and associated stormwater consents.
- Provide guidance on what a new development, or re-development, must achieve in order to be granted Certification from Council to discharge stormwater to the Council stormwater network.

- Outline and demonstrate the preferred approach for stormwater management in commercial, industrial and residential development in the district.
- Provide a selection of methods and tools to mitigate the effects of stormwater runoff from developments.

5.2.3 Stormwater Strategy 2018-2048

Stormwater management is a complex activity that involves the participation of a wide range of stakeholders including national and local government, private business sector, property owners and Takata Whenua.

In the Timaru District, TDC has the lead role in providing and managing urban stormwater services. Timaru District Council has developed the Stormwater Strategy 2018-2048 to provide direction to TDC's decision-makers on stormwater using an integrated management approach. The Strategy establishes:
1) TDC's stormwater management goals for the next 30 years and beyond; and
2) What TDC will do to achieve those goals.

5.2.4 The Regional and District Context

The Timaru District Stormwater Strategy 2018-2048[1] is the overarching framework for stormwater management in the district. The stormwater strategy is based on the vision set out in the Long Term Plan[2], and provides direction for the stormwater management provisions of the District Plan. The goals of the Stormwater Strategy sit across four themes: receiving environment, planning and regulation, asset management, and stakeholder engagement and education

These goals are incorporated into the Stormwater Management Plans. Stormwater Management Plans (SMPs) provide a holistic view of stormwater management within a catchment. This planning framework enables the potential cumulative effects of stormwater discharges on receiving environments to be considered and managed. SMPs will soon be in place for urban catchments across the Timaru District. These include:

- Geraldine Stormwater Management Plan
- Pleasant Point Stormwater Management Plan
- Temuka Stormwater Management Plan
- Timaru Stormwater Management Plan
- Washdyke Stormwater Management Plan
- Washdyke Industrial Expansion Zone (WIEZ) Stormwater Management Plan

The SMP provides 'best practice' strategies for stormwater management and enables a single resource consent for stormwater discharge to replace existing consents (where present) within a catchment. The consent provides a framework for the

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[1] TDC, 2017. Timaru District Stormwater Strategy 2018 – 2048. Timaru District Council, June 2017.
2 TDC, 2021. Together we can thrive – Long Term Plan 2021 – 2031. Timaru District Council, August 2021.

approval of appropriate discharges without requiring further resource consents to be sought from the Regional Council, as the impacts of the development of the catchment have already been considered as a whole. Catchment wide consents are referred to as 'Global' consents. These enable TDC to authorise, and exercise control, over stormwater discharges into its reticulated network to manage effects on the environment in accordance with the SMPs.

The Timaru District Plan has been developed to support the principles and purpose of the Resource Management Act 1991, Local Government Act 2002 and subsequent hierarchy of regulations including the National Policy Statement for Freshwater Management 2020[3] (NPSFM), National Environmental Standards (NES) and the New Zealand Coastal Policy Statement 2010[4] (NZCPS). The National Policy Statement for Freshwater Management 2020 Policies will guide stormwater practices in the Timaru district. Te Mana o te Wai 6 principles relating to the roles of tangata whenua and other New Zealanders in the management of freshwater are to be considered and integrated into the design of all stormwater systems. These policies and principles are summarised in further detail in the TDC IDS.

5.2.5 Te Mana o te Wai

The information below is sourced from the National Policy Statement for Freshwater Management 2020. See the link below to the factsheet from the Ministry for the Environment for further details.

https://environment.govt.nz/assets/Publications/Files/essential-freshwater-te-mana-o-te-wai-factsheet.pdf

Fundamental concept – Te Mana o te Wai

Concept

(1) Te Mana o te Wai is a concept that refers to the fundamental importance of water and recognises that protecting the health of freshwater protects the health and well-being of the wider environment. It protects the mauri of the wai. Te Mana o te Wai is about restoring and preserving the balance between the water, the wider environment, and the community.

(2) Te Mana o te Wai is relevant to all freshwater management and not just to the specific aspects of freshwater management referred to in this National Policy Statement.

Framework

(3) Te Mana o te Wai encompasses 6 principles relating to the roles of tangata whenua and other New Zealanders in the management of freshwater, and these principles inform this National Policy Statement and its implementation.

(4) The 6 principles are:

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[3] MfE, 2020. National Policy Statement for Freshwater Management 2020. New Zealand Government, Ministry for the Environment, August 2020.

[4] DoC, 2010. New Zealand Coastal Policy Statement 2010. New Zealand Government, Department of Conservation, December 2010.

(a) *Mana whakahaere*: the power, authority, and obligations of tangata whenua to make decisions that maintain, protect, and sustain the health and well-being of, and their relationship with, freshwater
(b) *Kaitiakitanga*: the obligation of tangata whenua to preserve, restore, enhance, and sustainably use freshwater for the benefit of present and future generations
(c) *Manaakitanga*: the process by which tangata whenua show respect, generosity, and care for freshwater and for others
(d) *Governance*: the responsibility of those with authority for making decisions about freshwater to do so in a way that prioritises the health and well-being of freshwater now and into the future
(e) *Stewardship*: the obligation of all New Zealanders to manage freshwater in a way that ensures it sustains present and future generations
(f) *Care and respect*: the responsibility of all New Zealanders to care for freshwater in providing for the health of the nation.

(5) There is a hierarchy of obligations in Te Mana o te Wai that prioritises:
(a) first, the health and well-being of water bodies and freshwater ecosystems
(b) second, the health needs of people (such as drinking water)
(c) third, the ability of people and communities to provide for their social, economic, and cultural well-being, now and in the future.

5.3 CONSENT AND COMPLIANCE ISSUES

Timaru District 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 thresholds 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 (*Appendix F – Construction Stormwater Management*).
- Sediment generated by the activity must be contained within the work site.
- Sumps collecting runoff from new hardstand areas must be fitted with

suitable treatment devices.

- 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 30 m^2 for all activities except for residential
- Treatment will be required for stormwater runoff from buildings with uncoated metal roofs. No new discharge from zinc or copper materials will be accepted.

Requirements in the *Timaru District Consolidated Bylaw 2018: Chapter 15 Water Services* must be met.

5.3.1 Legislation

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

The Building Act 2004, specifically Section 71 to 74, identifies the requirement for Building Control Authorities (Council) to give specific consideration to the impact that construction of new buildings and major alterations on land that is “subject or is likely subject to” a natural hazard will have on the building, land and/or other properties.

The specific consideration given by Council leads to a determination whether the proposed building work is suitable on the site. The considerations are in relation to Coastal Erosion and Inundation Hazards that the work may be susceptible to.

Based on Case Law and various MBIE Determinations, Timaru District Council has adopted the standards in Table 1 in relation to inundation and coastal erosion hazards to be mitigated against as required by the Building Act and Building Code.

Table 1 Building Act Hazard Mitigation

Hazard Criteria		Coastal Erosion	Inundation
Natural Hazard provisions (ss71-74, Building Act 2004)	Probability	50% / P_{50}[5]	1% AEP Rain Event
	Sea Level Rise Emission Scenario	0.8m	0.8m
	Inundation Triggers	0.3m or greater in depth, or	
		Overland flow velocity of 1 m/s or greater with a depth of 100mm	
Code Compliance	Building Code Clause	B1 Structure 'Low Probability' test	E1 Surface Water
	Probability	5%, P_5	2% AEP Rain Event
	Sea Level Rise Emission Scenario	1.2m	0.6m

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 to water and water take 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.

5.3.4 Flood Risk Certification

Flood Risk Certificates issued by Timaru District Council outline site specific hazards and risks in relation to stormwater flood risks. Flood Risk Certificates are the urban equivalent of a *Flood Hazard Assessment* supplied by Environment Canterbury identifying river flooding risks.

Flood Risk Certificates outline flood risks in the urban environment to be mitigated against as required under various legislations and District and Regional Plans.

Environment Canterbury Regional Policy Statement defines High Hazard Area and sets Territorial Authorities (District Councils) responsibility to set requirements to avoid or mitigate these hazards.

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[5] P50 means that there is a 50% probability that erosion will occur to a specific line within the property boundary by 2100. Similarly, P5 means there is a 5% probability of it occurring.

The Timaru District Plan is the mechanism to give effect to the Regional Policy Statement. The Timaru District Plan triggers the requirement that minimum floor heights of habitable buildings shall be located above a 0.5% AEP flood event with a minimum freeboard. The District Plan also sets out the controls on development within 0.2% AEP High Hazard Areas.

5.4 STORMWATER DISCHARGE IN TIMARU DISTRICT

This chapter provides specific detail on how to meet the TDC requirements for stormwater certification when undertaking new development within a catchment area subject to a global consent.

Figure 1 below describes the overall process by which a development application will be considered and accepted by TDC.

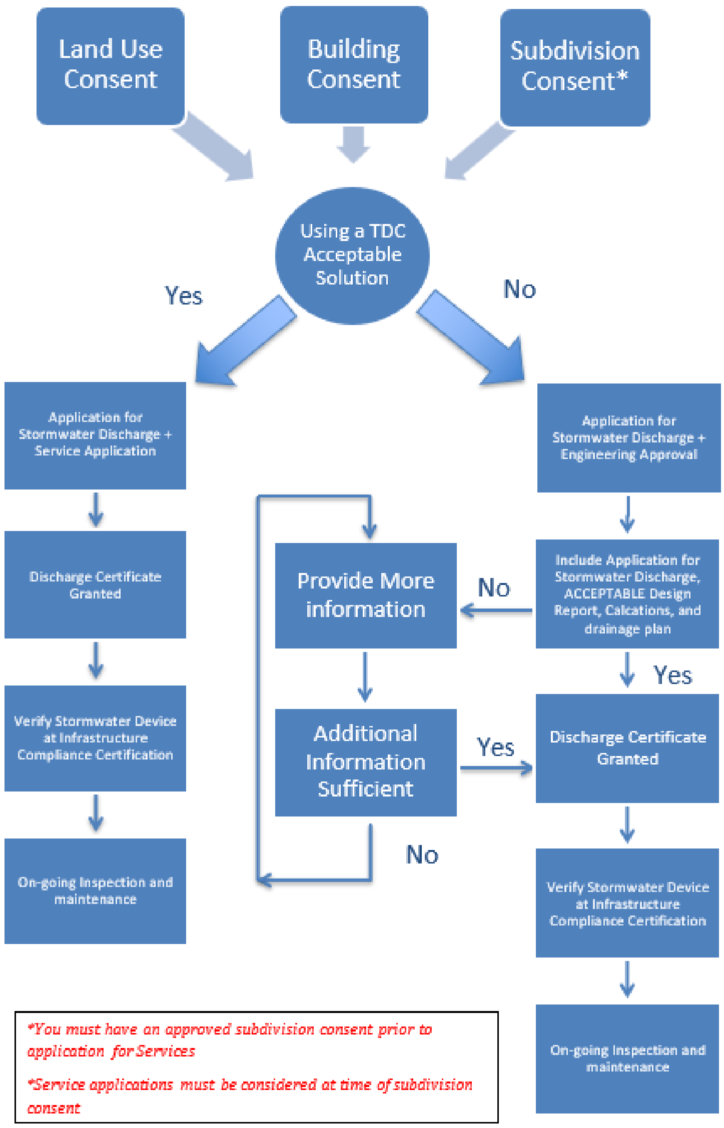

Figure 1 Stormwater Discharge Application process for development

5.4.1 Stormwater Discharge Certification

Stormwater certification applies to all discharges to the reticulated network, or to stormwater assets which will be vested with Council. Under the Timaru District Plan - Stormwater Chapter, written permission is required from the owner of the reticulated stormwater network to allow entry of stormwater to the network. This approval (termed Certification) from TDC is largely based on two factors;

- Treatment of stormwater to remove contaminants, and,
- Restriction of the quantity of stormwater discharged, by limiting the post-development discharge to the pre-development rate/volume (termed stormwater neutrality).

Figure 2 provides a visual overview of the key considerations for certification. A Certification Application Form can be found on TDC’s website.

Following submission of the certification documentation, TDC will review the application. The application may also go through a peer review process, prior to issuing certification. Certification may be withheld by TDC if certification requirements are not adequately addressed.

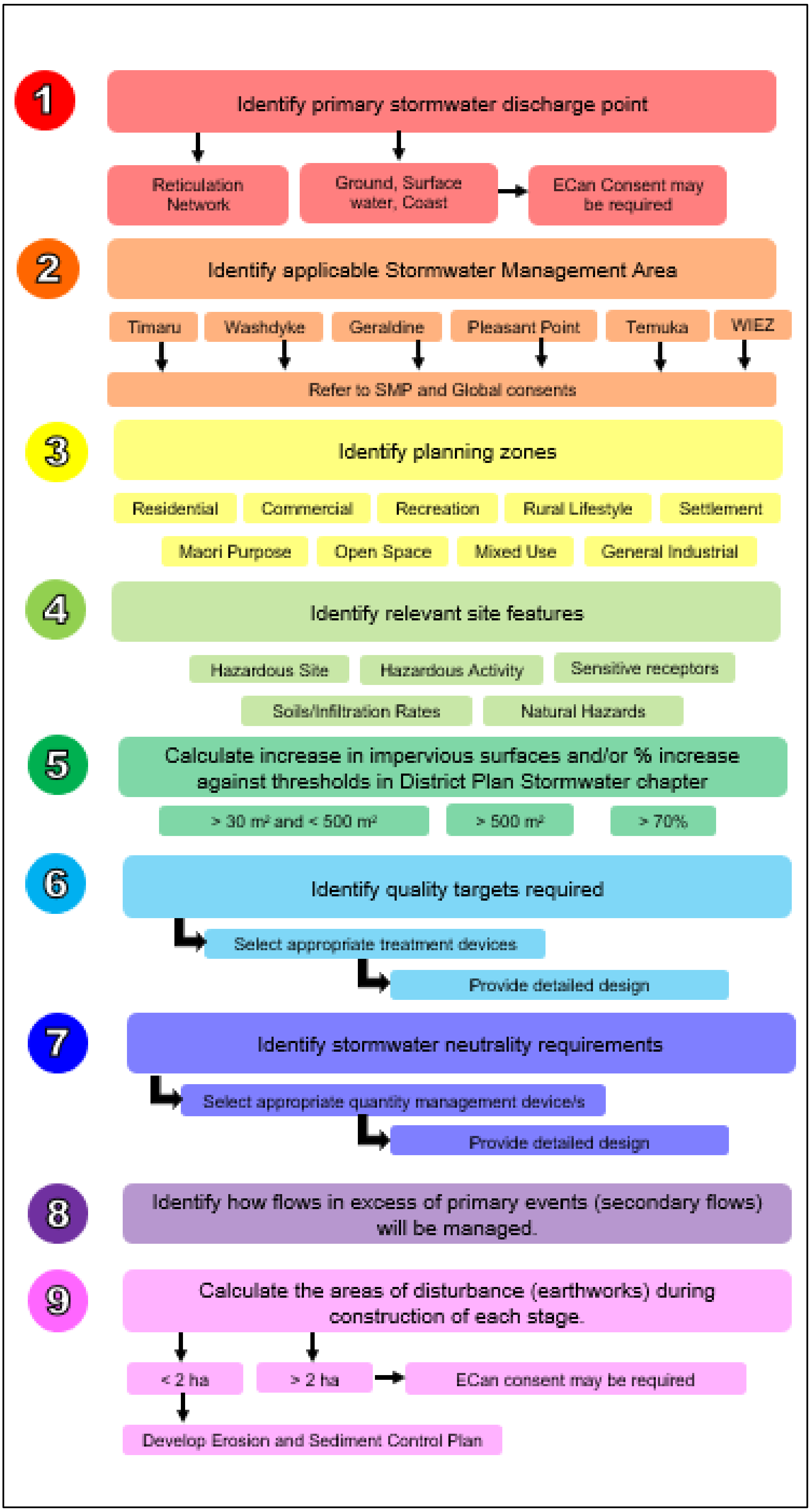

Figure 2 Overview of TDC Stormwater Certification Requirements

5.4.2 Acceptable Solutions vs. Engineered Design

Where discharges are managed through an Acceptable Solution[6], the Application for Stormwater Discharge is processed by TDC to achieve Discharge Certification. Where discharges are not proposed to be managed through an Acceptable Solution, a design report, calculations and drainage plan will be processed through the TDC Engineering Approval process.

Where applications do not fit the requirements for stormwater discharge certification, the developer will need to apply for their own Discharge Consent from ECan. Additionally, the developer is likely to have to construct, operate and maintain their own infrastructure. In the event that the discharge is into the TDC network, approval from TDC will still need to be obtained.

Additionally, this Guideline also provides broader guidance applicable to all stormwater management in the district, regardless of its ultimate discharge location. This document and Timaru District Council Construction Standard Specifications (CSS) form the primary references. Additional guidance can be sought from the following publications:

- Christchurch City Council Waterways, Wetlands and Drainage Guide (WWDG)
- Ministry of Business, Innovation and Employment, Acceptable Solutions and Verification Methods for New Zealand Building Code Clause E1 Surface Water
- Auckland Council Guidance Document 01 (GD01), Stormwater Management Devices in the Auckland Region
- Waikato Regional Council Technical Report 2020/07, Waikato Stormwater Management Guideline.
- Construction Industry Research and Information Association (CIRIA) Infiltration Drainage - Manual of Good Practise
- New Zealand Water Environment Research Foundation (NZWERF), On-site Stormwater Management Guideline.

5.5 QUALITY ASSURANCE REQUIREMENTS AND RECORDS

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

5.5.1 The designer

The designer of all stormwater reticulation systems that are to be taken over by Timaru District 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.

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[6] TDC, 2021. Stormwater Management: Acceptable Solution No. 1. https://www.timaru.govt.nz/__data/assets/pdf_file/0010/580789/Acceptable-Solutions-No.1-wTank-Details.pdf

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

5.5.2 Information to be provided

Design and as-built information must be supplied in New Zealand Transverse Mercator 2000 (NZTM2000) projection and Lyttelton (1937) vertical datum.

All plans are required to state the datum used. All levels are to be stated in height above Mean Sea Level (in metres).

Refer to the *CSS* 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 (see *Appendix C – Stormwater Quantity*), including design parameters and assumptions;
- estimates of catchment imperviousness and the basis for its derivation (*see Appendix C – Table 4.4: Runoff Coefficients)*;
- 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;
- notable 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.

The Timaru District Plan maps should be referenced for details on flood assessment areas, including overland flow paths, and notable trees.

5.5.3 Design records

Provide the following information to support the Design Report (*see 3.3.2*):

- details and calculations that demonstrate that levels of service required by the *TDP* will be achieved;
- detailed calculations and drawings where applying to build within a flood assessment areas, which determine the floodplain boundaries and levels relative to building floor levels (see *SMPs* and the Building Act);
- details and calculations that clearly indicate any impact on adjacent areas or catchments that the proposed works may have;
- details of a Safety in Design (SiD) assessment completed for the stormwater infrastructure designed;
- draft versions of operations and maintenance manuals for any water quantity or quality control structures;
- landscape and planting drawings complying to the approved landscape management plan.

Design checklists, to aid this process, are available in *Appendix C: Design Checklists*.

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.

5.5.4 Construction records

Provide the information detailed for Completion Documentation (*see 2.12.2*) and for required by the *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;
- completed Stormwater Discharge Certificate.

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 the *CSS*, including manufacturer, diameter, type, class, jointing and contractor who laid the pipe.

5.6 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.

5.6.1 Stormwater Management Principles

The preferred approach to managing stormwater in the Timaru District is through the use of natural soil and plant processes and topography, with the overall aim to enhance urban liveability. Water Sensitive Urban Design (WSUD) is an engineering design approach which integrates natural processes into urban design to minimise environmental degradation. The terms low impact design, sustainable urban drainage or green infrastructure all refer to similar approaches which aim to:

- Minimise impervious areas
- Manage stormwater as close to source as practical
- Preserve and utilise natural site features
- Account for biodiversity, cultural values, amenity and water quality
- Hydraulic neutrality - limit the post-development flows to the pre-development rate

In practise, the following should be applied:

- Use on-site disposal (soakage/infiltration) where practicable
- Restore any degraded or piped streams
- Maintain sufficient water flows to protect aquatic life
- Apply bio-engineering practises, which integrate plant, soil and ecological features into traditional engineering approaches
- Protect and enhance riparian vegetation
- Incorporate practises to remove contaminants from stormwater
- Store runoff and release it slowly (attenuation)

Stormwater management in the Timaru District is governed by a number of documents, including Stormwater Management Plans, Infrastructure Design Standards, National Standards such as NSZ4404, the New Zealand Building Code, with guidance also given in the District Plan.

The key measurable outcomes for stormwater management in the Timaru District refer to;

1. Stormwater Quality – achieving a specific removal rate for particular

contaminants
2. Stormwater Quantity – achieving stormwater neutrality for appropriate design events
3. Secondary Flow paths – providing safe conveyance of flows in excess of the primary system

Notwithstanding the functionality of a stormwater system, it must also consider additional values such as cultural, recreational, ecological and landscape aesthetics. The above have to be achieved in an economically sustainable manner to ensure the system is financially viable to construct and maintain through its full lifecycle.

Discharging stormwater to ground is the preferred option for quantity management. This has the advantages of reducing the overall volume of water discharged off site, managing the runoff close to the source, thereby reducing costs and resources for conveyance (pipes, swales etc). Discharging to ground can also assist in quality management though the filtering effect of soils. However, discharge to ground is not appropriate for all sites.

The following sections step through factors which influence the selection of stormwater management tools; such as size, geography, geology and land use. Furthermore, this forms the basis of the information to be provided for Certification from TDC to discharge to the reticulated network or vest a stormwater system. The completion of the Stormwater Discharge Certification Application Form is required to accompany discussions with TDC.

5.6.2 Location and size

The site location determines which Stormwater Management Area (SMA) it falls under. Maps for SMAs are provided in Appendix C. Each SMA has different characteristics which may influence how stormwater is managed in that area. These requirements are set out in the SMPs and Global Consents that accompany the SMPs.

Hazards or features onsite which may affect how stormwater is managed must also be considered. These will generally be identified within District Planning Maps. Consideration should also be given to activities, hazards and ecological receptors in the surrounding area which may affect stormwater management, such as historic or active landfills, drinking water bores, mātaitai reserves or areas of cultural significance.

The size of the site and the extent of site disturbance will also have implications. Limitations are set on the size of development from which stormwater construction-phase discharges can be accepted within global consents. The global consent relevant to the SMA will detail area limitations.

Thresholds are set in the Proposed District Plan - Stormwater Chapter[7] for areas of increased impervious surface. This refers to 'minor' developments – those where the additional impervious area is between 30 m^2 and 500 m^2 in size, and with a resultant impervious area covering less than 70 % of the site. Where the increase in impervious area is equal to or greater than 500 m^2, this is termed a 'major' development. Tables 2 and 3 below summarise the neutrality requirements for these two development types for different activity zones.

Table 2 Summary of Minor Development requirements for Stormwater Neutrality

Zone	Residential (GRIZ, MDEZ, SZ, MPZ, RLZ)	Commercial (all)	Industrial (GIZ)	Other (NOZ, OSZ, SPRZ)
Activity	>30 m^2 and <500 m^2 <70% impervious	>50 m^2 and <500 m^2	>30 m^2 and <500 m^2	
Stormwater Neutrality	1 in 10 year	1 in 50 year	1 in 50 year	1 in 50 year
Event Duration	1 hour	1 hour	1 hour	1 hour

Table 3 Summary of Major Development requirements for Stormwater Neutrality

Zone	Residential (GRIZ, MDEZ, SZ, MPZ, RLZ)	Commercial (all)	Industrial (GIZ)	Other (NOZ, OSZ, SPRZ)
Activity	>500 m^2			
Stormwater Neutrality	1 in 10 year	1 in 50 year	1 in 50 year	1 in 50 year
Event Duration	24 hours	24 hours	24 hours	24 hours

Thresholds are also set in the District Plan - Stormwater Management Chapter for minimum stormwater treatment requirements. Different activity zones trigger different expectations on contaminant removal (Table 4).

Table 4 Minimum Target Contaminant Removal Rates

Zone	Residential (GRIZ, MDEZ, SZ, MPZ, RLZ)	Commercial (all)	Industrial (GIZ)	Other (NOZ, OSZ, SPRZ)
Activity	Non-residential Activity (including roads) >30 m^2	>50 m^2	>30 m^2	>30 m^2

[7] Proposed Timaru District Plan – He Po. He Ao. Ka Awatea

First Flush	10 mm/hr 21 mm depth	10 mm/hr 21 mm depth	10 mm/hr 21 mm depth	10 mm/hr 21 mm depth
Suspended Solids	> 80 %	> 80 %	> 80 %	> 80 %
Total zinc	> 70 %	> 70 %	> 80 %	> 70 %
Total copper	> 70 %	> 70 %	> 80 %	> 70 %
Total Petroleum Hydrocarbons	> 70 %	> 70 %	> 70 %	> 70 %
Nutrients (Nitrogen, Phosphorus)	> 50 %	> 50 %	> 50 %	> 50 %

5.6.3 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, unless the effects of development are managed and mitigated.

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.

5.6.4 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).

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 catchment 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 will be required, at the developer's expense.

Consider the impact of climate change on coastal areas, rainfall intensity, 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. Consideration should also be given to the impact any infrastructure may have on local flora and fauna.

5.7 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 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.

The primary system that is required must cater for the more frequent rainfall events including the 10% AEP storm (new designs). The secondary system (secondary flow path) 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:

- Te Mana o te Wai 6 principles relating to the roles of tangata whenua and other New Zealanders in the management of freshwater;
- Adherence to safety in design principles for all assets;
- size (or sizes) of the surface water drainage pipework throughout the proposed reticulation system;
- 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;
- 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;
- provide confirmation that ECAN Regional Policy Statement compliant habitable floor heights are achievable in a 0.5% AEP event.

5.7.1 Integrated stormwater systems to achieve the Te Mana o te Wai 6 principles

Integrated stormwater systems are both the optimum and preferred method of stormwater treatment. When these systems need to be considered, discuss their use with the Council at an early stage..

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 Te Mana o te Wai 6 principles (see 5.2.4 – Te Mana o te Wai).

5.7.2 Secondary flow paths

Overland flow paths should be provided to convey secondary flows, in excess of the capacity of primary drainage system. 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 (armouring, reinforced turf, dissipation structures, etc.) 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.

5.7.3 Location and design of basins and swales

Ponding basins are being used throughout the district 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 and access to structures 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 consultation must be undertaken with Council’s Parks and Reserves Unit at the planning and design stages.

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 *Appendix B* for specific design criteria regarding the design of basins and stormwater treatment systems. Note that underdrain systems 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.

5.7.4 Design standards for new developments

Design all new stormwater and land drainage systems to design storms in accordance with *Appendix L – Rainfall Intensity*.

For the protection of buildings, design and build the stormwater system of secondary flow pathways and ponding areas so that every new building platform is above the 0.5% annual exceedance probability (AEP) risk of flooding. Include a minimum freeboard height above computed flood levels as shown in Figure 3, complying with Table 5. Any relevant building floor protection specified in the *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.

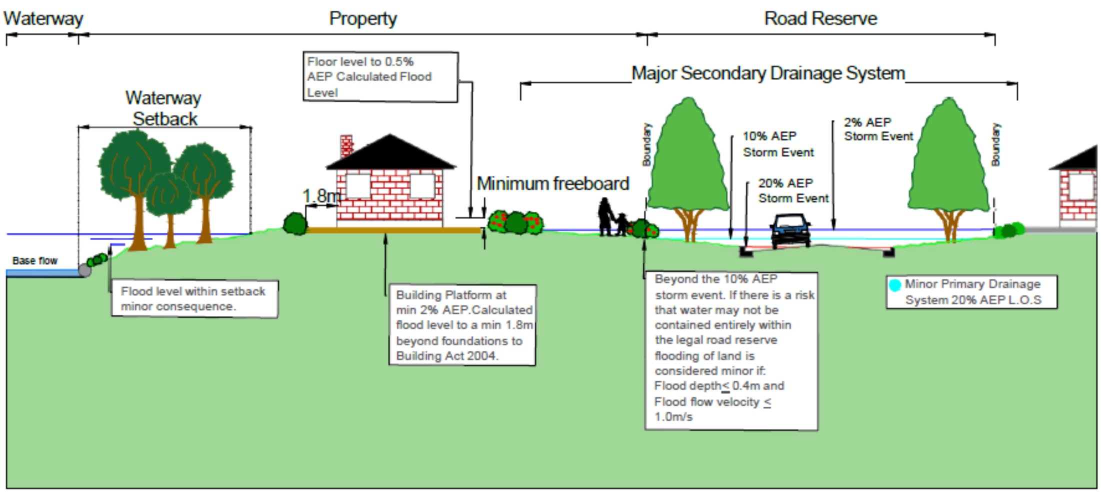

Figure 3 Minimum floor levels

Table 5 Minimum freeboard

Building type	Minimum freeboard height (m)
Habitable building floors	0.3
Commercial and industrial buildings	To Be Determined by developer
Habitable building platforms	0.15

Note:
1) 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.
2) Discuss commercial and industrial developments with special circumstances with the Council.
3) In circumstances where ponded water on the crown of roads will exceed 100mm, a greater freeboard may be required.

Discuss protection standards in tidal areas with ECAN and 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 required.

5.7.5 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 *Appendix B* for waterway design at bridges and culverts.

5.7.6 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 at the lowest point of 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.

5.7.7 Outfall water levels
The Council may 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.

5.7.8 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.

Consult with Council on proposed technologies to be included in a design prior to lodging an application for Engineering Design Acceptance.

5.7.9 Stormwater pumping
Permanent stormwater pumping will only be permitted under exceptional circumstances.

5.7.10 Liquefaction
Reference Section 4: Earthworks for geotechnical design requirements.

5.8 LAND DRAIN DESIGN

Design land drains in accordance with the guidance set out in *Appendix B*.

Maintain fish and invertebrate passage, unless otherwise authorised by Council or by ECAN.

Provide access along at least one side of any land drain for maintenance, taking into account the "reach" of cleaning machinery. Maintenance access should be designed two ended or at a minimum with a turning area to reduce the likelihood of reverse manoeuvring out of any land drains.

Vegetate berms and banks and lay at slopes that are stable, not prone to scour in flood flows and maintainable.

5.8.1 Constructed land drains

Design constructed waterways to meet the aesthetic and amenity criteria of the Council (see *Appendix B*). 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.

5.8.2 Natural land drains

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 Council, ECAN and the National Environmental Standard for Freshwater will be required for this activity.

Provide for drainage, landscape, ecology, heritage, recreation and cultural values when enhancing these waterways. Consultation with local iwi may contribute to an understanding of the principles underpinning these values and for information about specific criteria. A landscape management plan will be required to be reviewed and accepted by Council prior to onsite work.

Create Local Purpose (Esplanade) Reserves around significant natural land drains.

5.8.3 Hill watercourses

Hill watercourses are not suitable on longitudinal slopes greater than 8%. 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.

Traditional approaches to bed and bank stabilisation entail structural approaches, however, design emphasis has changed to consider a wider range of values. Approaches for stream bed stabilisation include: altering the stream bed substrate, forming riffles, runs and pools, or structural stabilisation in hillside applications.

Approaches for bank protection include: bank regrading to 1 in 3 or flatter, vegetating banks with low-maintenance planting, or structural lining such as bank terracing, gabion and retaining walls.

This requirement may be waived where the development consists of a small number of residential properties whose hard surface runoff is attenuated though 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.

5.8.4 Operations and maintenance manual

Provide an Operations and Maintenance Manual in accordance with *Appendix F* and *H* 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 set out in Appendix E 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.

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

5.8.5 Fencing

Council approval is required for the erection of a fence across a land drain. Fences must not significantly impede flood flows up to the minimum protection standards.

5.9 STORMWATER DISPOSAL

5.9.1 Approved outfall

The discharge for a development must be authorised by ECAN. This can be achieved by conforming to the Environment Canterbury Land Water Regional Plan (LWRP), a Stormwater Management Plan obtained by the developer 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 that will impede the natural flow may be placed in the channel.

When designing outfalls, 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 contains acceptable outfall details.

5.9.2 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 *Appendix B*). 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 *CSS* for guidance.

5.9.3 Stormwater tanks

Stormwater tanks on private properties can regulate stormwater discharge from connected impervious areas such as roofs, hardstand areas and driveways to achieve pre-development discharge rates to Council's system. The Council may require a stormwater tank when:

- New subdivision creates additional impervious cover and a global attenuation system (retention pond, shared tank, etc.) is not provided;
- 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 *District Plan* and *Acceptable Solution 1* for guidelines on sizing and configuration.

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

5.10 RETICULATION LAYOUT

5.10.1 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 consideration must be given to the capacity of the downstream primary system. Greater attenuation levels for longer periods of time may be required.

5.10.2 Location and alignment of stormwater pipelines

Locate stormwater pipeline mains within the legal road (outside of live traffic lanes) or within other public land. Allow for access for construction or future maintenance.

Position pipes as follows:

- within berms and footpaths of the road reserve, under parking bays as a last option,
- within public land with the approval the Council,
- within drainage reserves,
- within private property (if unavoidable) adjacent to, and if possible parallel to boundaries.

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.

5.10.3 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.

5.10.4 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 CSS and be used only where approved by the Council.

5.10.5 Building over pipelines

The Timaru District Consolidated Bylaw 2018 – section 1515.1. Building over or adjacent to network infrastructure services defines the Council’s requirements and protection for the drainage works.

5.10.6 Easements

Easements are required for constructed drains 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:

- 2 x (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.

5.11 RETICULATION DETAILING

5.11.1 Pipeline connections

Make pipeline connections in accordance with *CSS*.

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

5.11.2 Minimum pipe sizes

The minimum diameter Council stormwater pipe to be designed is an internal diameter 225mm.

5.11.3 Minimum cover

Minimum cover is to be designed in accordance with Part 9 – Utilities and Council's Standard Drawings. The stormwater cover depths from Table 3 in Part 9 are a minimum of 0.8m.

Where the minimum cover to Council's specifications is not achieved, pipelines must be adequately protected from external loadings. Council approval of the pipeline protection must be obtained.

5.11.4 Gradients and acceptable flow velocities

Minimum gradients in flat terrain should be as steep as possible to insure silt deposition does not occur. The minimum velocity should be at least 0.6 m/s at the flow of half the 50% AEP design flow. For flow velocities greater than 3.0 m/s, best management practices are to be designed into the system.

5.11.5 Structures
Design inlets and outlets in accordance with *Appendix A*. Install debris grills where blockage is a potential problem. Provide for operational requirements.

Consider the effects of inlet and tailwater controls when designing culverts.

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

Where pipes discharge onto land or into a drain outlet, 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 *Appendix A*.

5.11.6 Manholes
Construct manholes in accordance with the *CSS*.

Manholes are chambers located at regular intervals along a pipeline to facilitate access and changes in direction. The preference is for manholes to be located in roads to enable access for maintenance.

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.

*Note: **Smoothly** refers to flow that is unimpeded or generating turbulence within the structure.*

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. Secure manholes against uplift in accordance with *CSS*.

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.

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

- meet the *CSS* 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 5302, whichever is relevant.

5.11.7 Sumps
Council seeks the use of slam lock sump grates as detailed in *CSS* Standard Detail 5302 where they meet the requirements of that site. All sumps within the kerb and channel shall have a back entry as detailed in the *CSS* and the use of splay pits in high intake scenarios is a reasonable approach to mitigate ponding.

Do not locate sumps in kerb crossings. Where sumps are located in this position consider the relocation of either the sump or crossing.

Where sumps are the primary collection system, they should be spaced such that the flow draining to a single inline sump does not exceed 10 L/s, typically spaced no more than 90 metres apart. This capacity allows for partial blockage of the sump grating.

In hillside sumps, high flow velocities can cause difficulties in flow interception and erosive damage. The maximum capacity of the hillside sump is 80 L/s.

Where a manhole or sump is likely to experience differing movement from the pipeline under seismic loading, replace the yield joints with flexible joints (see *CSS* for detail). These may mitigate the potential for damage by allowing some longitudinal movement at the structure.

In applications where catchments may generate hydrocarbons or floatables, submerged outlets on sumps are preferred. Sumps on kerb and channel should be located to avoid access crossings.

5.11.8 Subsoil drains
Design subsoil drains, which are installed to control groundwater levels, in accordance with engineering best practice.

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

5.11.9 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.

5.11.10 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 of 1:5 and steeper. Where lime stabilised fill or similar 'firm mix' fill is used for haunching, water stops are not required. *Appendix B* and the *CSS* 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*.

5.12 CONNECTION TO THE PUBLIC SYSTEM

5.12.1 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 if kerb and channel outlets;
- Each connection must be capable of serving the entire building/impervious surface 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 ECAN or approved by Council under a Global Discharge Consent 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.

5.12.2 Connection of lateral pipelines to mains

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

5.13 MEANS OF COMPLIANCE

5.13.1 Surface water

Surface water hydrology must be in accordance with *Appendix C*.

5.13.2 Estimation of surface water run-off – peak flow rate
Estimation of the peak flow rate must be in accordance with *Appendix C*.

5.13.3 Estimation of surface water run-off – volume
Estimation of volumes must be in accordance with *Appendix C*.

5.13.4 Sizing of the stormwater drainage system
Drainage system hydraulics must be in accordance with *WWDG Chapter 22*.

5.13.5 Soakage systems
Design of the soakage systems must be in accordance with the associated SMA requirements and the requirements of the Canterbury Land and Water Regional Plan.

5.13.6 Pipe flow
Determine pipe diameters, flows and gradients as prescribed in *NZS 4404:2010*.

For pipes not flowing full use Manning's equation adopting 'n' values from *NZS 4404:2010*.

5.13.7 Energy loss through structures
Refer to *NZS 4404:2010* for guidance on energy loss through structures.

5.13.8 Determination of water surface profiles
Design stormwater drainage systems in accordance with *WWDG Chapter 22* and *NZS4404:2010*, 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*[8].

Stormwater pipelines generally operate in a surcharged condition at full design flow. Pipe diameters chosen on the basis of pipe flow graphs, such as *NZS4404:2010* (which uses pipeline gradient rather than hydraulic gradient), are likely to be conservative in parts affected by free outfall conditions.

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[8] CCC, 2020. WWDG Part B: Appendix 5, https://ccc.govt.nz/assets/Documents/Environment/Water/waterways-guide/WWDG-Appendices-June-2020.pdf

5.13.9 Stormwater quality

Design stormwater management systems to achieve quality standards in accordance with or exceeding the requirements of the Stormwater Management Plan for the catchment. Stormwater treatment must be designed to reduce the level of all contaminants with potential to be generated by the development to a level that will no longer have negative impacts on the receiving waterbody.

An effective method of removing contaminants from stormwater is to utilize a series of treatment devices to provide management of various contaminants. This combination of treatment devices established in a specified sequence is referred to as a "Treatment Train". Refer to the *Appendix D – Stormwater Quality* and the *CSS* for further detail on devices and construction requirements.

Many treatment options involving discharges of stormwater to ground require a consent to discharge to land and/or water from ECAN. Refer to clause 5.3 - Consent and compliance issues for further information.

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.

5.13.10 Fish Passage

Land drains and stormwater systems to be designed in accordance with New Zealand Fish Passage Guidelines.

5.14 CONSTRUCTION

Construction must be carried out in accordance with *CSS*.

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* for this type of work.

5.14.1 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/.

5.14.2 Materials

All materials must comply with those listed in the *CSS* which provides a guide when specifying materials.

Proposed pipes and concrete structures that are likely to lie in aggressive groundwater will need specific design and additional protection such as an external plastic wrapping membrane.

5.14.3 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* and *BRRG* 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 through the layers of reinstatement. The material used must be capable of achieving the backfill compaction requirements set out in *CSS* and *BRRG*. Any deviation from the standards set in the Council *CSS* and *BRRG* will require acceptance from Council.

5.15 AS-BUILT INFORMATION

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

APPENDIX A: STORMWATER MANAGEMENT AREA MAPS

Figure 1 Map of the Timaru Stormwater Management Area

Figure 2 Map of the Temuka Stormwater Management Area

Figure 3 Map of the Pleasant Point Stormwater Management Area

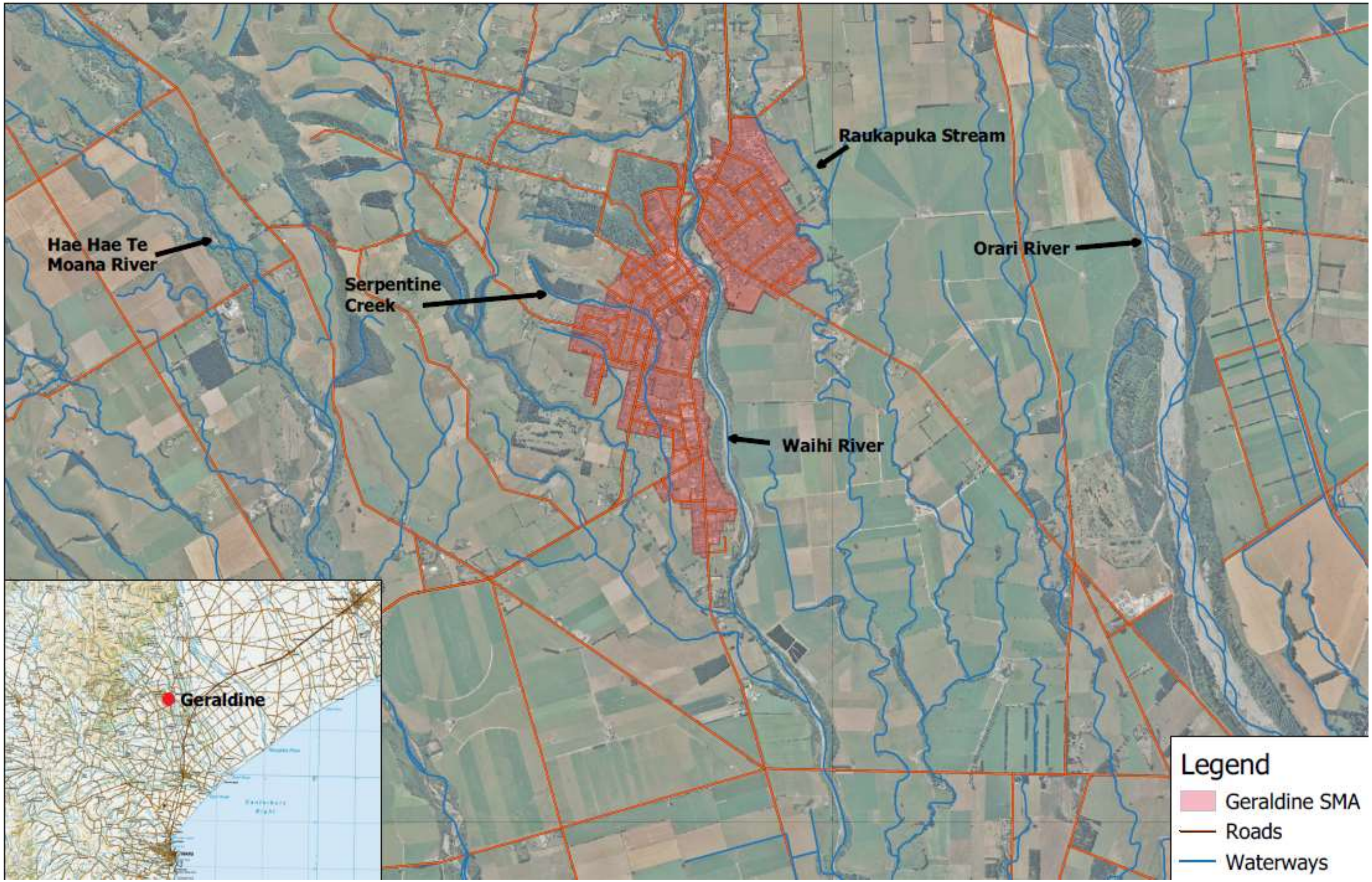


Figure 4 Map of the Geraldine Stormwater Management Area

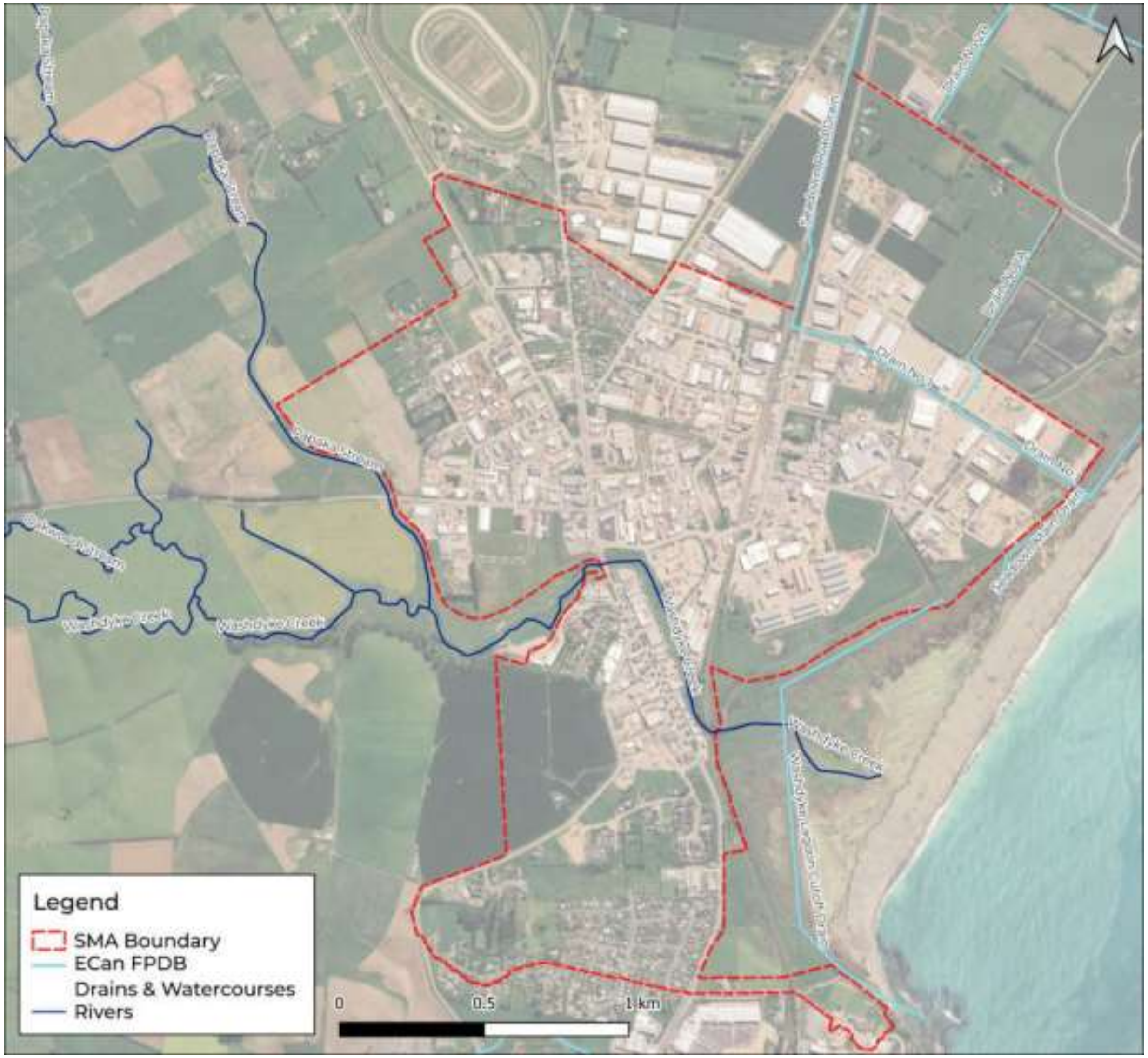


Figure 5 Map of Waitarakao/Washdyke Stormwater Management Area

APPENDIX B: STORMWATER MANAGEMENT DEVICES

Introduction
A number of devices can be used to achieve stormwater quality, neutrality, or a combination of both. Detailed design guidance is provided for common stormwater devices, including:

- Swales – vegetated or grassed
- Bioretention – raingardens, tree pits or planters
- Infiltration – basins, permeable pavements and soakage pits
- Wetlands
- Ponds – wet and dry basins

Design considerations are also provided for proprietary treatment devices.

Acceptable Solutions
An Acceptable Solution for stormwater attenuation has been prepared by TDC and is available on the website. These provide a means of achieving discharge certification. The use of the Acceptable Solutions are limited to application on 'Minor' developments only – refer to Table 4-1 of Appendix D.

Stormwater Devices
Stormwater management options are tabulated in Table 1 below, with commentary on the function, common limitations and comparative advantages of each device. Physical constraints of the site, such as contributing catchment size and soil conditions should also be considered when choosing a treatment or attenuation system.

Many devices can perform both quantity management and treatment functions. The ability to provide this function is identified with a ✓. However this is subject to site conditions and suitable design.

Table 1: Stormwater Device Options						
Device	**Function**	**Comparative Advantages**	**Design Limitations**	**Additional Values**	**Quantity**	**Treatment**
Swale	Trap sediment Some filtration Conveyance	Narrow design Cost-effective, simple construction	Suitable for longitudinal slopes < 4%. On steeper slopes check dams required to reduce velocities Requires minimum 30 m length Shallow design levels	Streetscape	✓	✓
Bioretention	Filtration Removal of dissolved contaminants and fine particles	Enhanced treatment capability More natural functioning system	Under drain required where limited by soil infiltration Depth limited by high groundwater	Groundwater recharge Landscape	✓	✓
Infiltration	Discharge to ground, achieving hydraulic neutrality Filtration	Can be located below ground (small footprint) Can remove need for separate detention system	Unsuitable in poorly drained soils Requires pre-treatment for removal of sediment to prevent clogging Depth limited by high groundwater	Groundwater recharge Landscape	✓	✓
Dry Basin	Stormwater detention Removal of coarse to medium particles	Large detention capacity	Large space requirement Depth limited by high groundwater	Recreation Landscape	✓	✓
Wet Pond	Stormwater detention Removal of coarse to fine particles	More natural functioning system	Large space requirement Free draining soils may require lining of basin	Bird and aquatic habitat Landscape	✓	✓

Table 1: Stormwater Device Options						
Device	**Function**	**Comparative Advantages**	**Design Limitations**	**Additional Values**	**Quantity**	**Treatment**
			Consider safety, access and planting through slopes and planting			
Wetland	Enhanced treatment capability Removal of dissolved contaminants and fine particles	Enhanced treatment capability More natural functioning system	Requires permanent standing water Not suitable on steep slopes Large space requirement Shallow operation levels Requires diversion of flood flows	Bird and aquatic habitat Landscape	✓	✓
Water Tanks	Stormwater detention	Cost-effective, simple installation	No treatment capability	-	✓	-
Permeable Paving	Discharge to ground, achieving hydraulic neutrality	No additional area requirement – reduction of impervious surfaces Can remove need for separate detention system	Requires flat slopes less than 1V:10H Expensive solution Unsuitable in high traffic areas May clog in high sediment generating catchments and are prone to clogging in long term. Unsuitable in poorly drained soils Difficult to maintain	Groundwater recharge	✓	-
Gross Pollutant Trap	Trap coarse sediments and macro pollutants	Prevents blockage of system Cost-effective	Limited treatment capability No detention capability	-	-	✓

Table 1: Stormwater Device Options						
Device	**Function**	**Comparative Advantages**	**Design Limitations**	**Additional Values**	**Quantity**	**Treatment**
Proprietary Systems	Filtration and/or physical separation	Small footprint Good treatment capability 'Plug and Go' systems	Little ecosystem value No detention capacity	-	-	✓

Swales
Swales are broad grassed channels used to treat and convey stormwater runoff. Swales help to filter sediments, nutrients, and other contaminants from stormwater before discharge to receiving environments. Swales treat stormwater runoff by the following:

- Filtration
- Infiltration
- Adsorption, and
- Biological uptake.

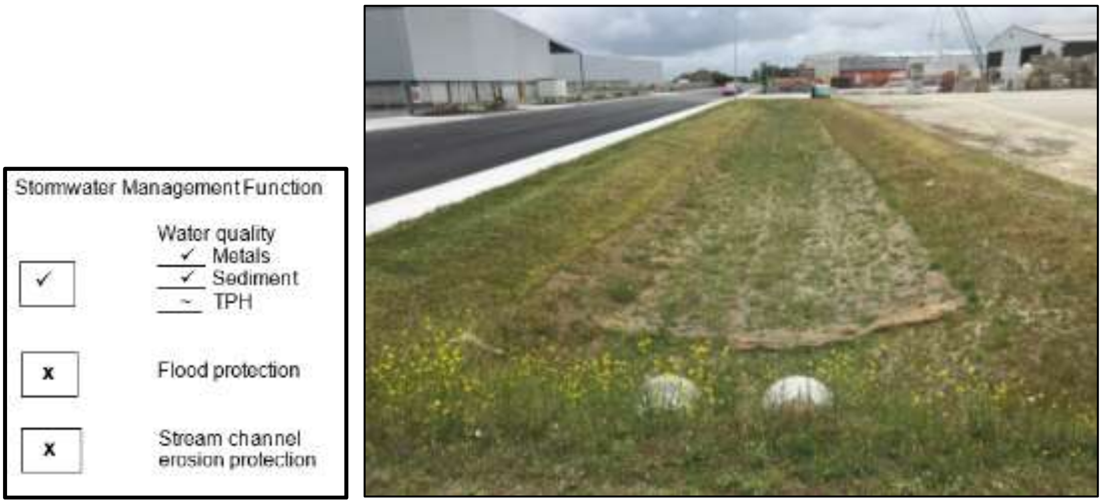


Figure 1: Typical grass-lined swale

In addition to providing water quality treatment, swales can also be used to convey stormwater runoff in place of a conventional piped reticulation system. Swales are generally constructed using in situ topsoils, rather than engineered media. Hence whilst they may provide limited infiltration of runoff, they are not primarily designed for this purpose.

Swales are appropriate to use adjacent to roadways as they can occupy a linear corridor. Although swales may vary in their purpose in different areas, their overall objective is to convey and treat stormwater, slow stormwater flows and provide limited infiltration of stormwater runoff depending on the condition of the subsoil and whether or not the swale is lined.

Water quality treatment is provided by passing stormwater flows through vegetation. Passage through vegetation and providing contact with organic matter allows physical, chemical and biological processes to occur that reduce contaminant delivery downstream.

Design Parameters
Site suitability should be based upon the parameters provided in Table 6-2.

Table 2: Site Suitability Parameters	
Parameter	**Limitation**
Swale catchment area	Swales are most effective for lower flows and volumes. Therefore, are suitable for small / medium sized catchments, generally 3 hectares or less in size.
High sediment loadings	High sediment loadings will clog up the swale invert and promote concentrated flows, which degrade water quality

	function. Swales should be protected from high sediment loads with pre-treatment. Dense planting and level spreaders at inlet can reduce sediment loads.
Swale slope	Swales should have a longitudinal slope less than 5%. In areas with steeper slopes, check dams can be used to reduce the overall swale slope.
Soils	Swales can be implemented in any soil although karst geology may require an impermeable liner on the swale invert to avoid instability issues.
Groundwater	The invert of the swale should not intersect with seasonal high groundwater. The swale base should be at least 1m above the seasonal high groundwater level.
Setback	Swales >1m from a property boundary should have a lined vertical surface if within 5 m of structures. Swales should not be within 3m of a structure.

The following Table 3 should be used for swale design elements.

Table 3: Swale Design Elements	
Design parameter	**Criteria**
Water quality event	Maximum velocity: 0.8 m/s Flow depth: less than vegetation height, maximum 150mm for grassed swales and 300mm for vegetated swales
Primary event	Maximum velocity: 1.5 m/s unless erosion protection is provided. Flow depth: 150 mm below top of swale (unless swale is part of overland flow path)
Longitudinal slope	Swales are not suitable on slopes greater than 8% Slopes of 5-8% require check dams Swales on slopes less than 2% require an underdrain
Check dams	Required when longitudinal slope is >5% to reduce velocities. Maximum height of check dam to equal the depth of flow for the water quality event
Inflow points	Usually a slotted kerb. Care should be taken to ensure sheet flow from the catchment is directed to the swale through inflow points. Where concentrated flows enter the swale (from pipes) level spreaders shall be placed at the head of the swale to disperse flows.
Vegetation	Grass or vegetated. If vegetated plants should be selected that are tolerant of both drought and inundation and that don’t shed leaves.
Maximum water depth above vegetation	The water depth for the water quality event should not exceed design height of the grass. This is a key criterion for ensuring Manning roughness coefficient is provided.
Design grass length	100 - 150 mm
Manning coefficient	0.25 for WQ storm 0.03 for a grassed swale (10-yr. Storm)

Table 3: Swale Design Elements	
Design parameter	**Criteria**
	0.25 for a vegetated swale (10-yr. Storm)
Minimum hydraulic residence time (HRT)	9 minutes
Minimum bottom width	0.6 m
Maximum bottom width	2 m
Minimum length	30 m
Maximum catchment area served	3 hectares
Maximum side slope	< 5H:1V for mown grass < 3H:1V for vegetated or unmown grass
Underdrain (not always present)	Required when longitudinal slope of a grassed swale is <2%, optional in other instances. Recommended where local soils have poor infiltration, to prevent stagnation and saturation of swale base. Underdrains are buried under the swale channel to capture filtered stormwater (usually a perforated pipe) and connect directly to the catch pit or stormwater manhole. Access must be provided for backwashing slotted drain.
Outlet	Outlets are usually a catch-pit with a flat grate or a scruffy dome

There are several points that need further discussion. They include:

- Residence time
- Manning's coefficient of roughness
- Lateral inflow

Hydraulic Residence Time

The Hydraulic Residence Time (HRT) is the time that the water takes to travel through the swale. This is a key factor for water quality performance in a vegetated swale. The residence time depends on the following items:

The longitudinal slope of the swale:

- cross-sectional area of the swale
- Velocity of the flow

The velocity of flow is a function of the flow area, slope and frictional resistance of the vegetation and a common equation for calculating velocity is Manning's Equation.

$$v = \frac{R^{\frac{2}{3}}\sqrt{S}}{n} \quad \textbf{Eqn (6-1)}$$

Where:

v = average velocity (m/s)

R = the hydraulic radius of the swale (m)

s = slope of the swale (m/m)
n = Manning's coefficient of roughness

Residence time can then be determined by the following equation:

$$t = \frac{L}{60v} \quad \textbf{Eqn (6-2)}$$

Where:
t = residence time (minutes)
v = average velocity (m/s)
L = average flow length in swale (m)

A minimum average HRT of 9 minutes is recommended to design treatment swales in the Timaru District. Depending on how the swale is configured, there may be areas in the upper part of the swale that exceed the required HRT, and areas in the lower portions of the swale where HRT may not be met. As such, it is required that an average HRT of 9 minutes is achieved.

Manning's Coefficient of Roughness

There are many variables used to determine the Manning's roughness coefficients. A standardised Manning's roughness coefficient of 0.25 shall be applied for water quality flow calculations.

For the 10% or 20% AEP event analyses, it is assumed that the vegetation is submerged so the coefficient of roughness shall be reduced accordingly. A Manning's roughness coefficient of 0.03 for grassed swales, and 0.25 for vegetated swales is applied in these calculations.

Swale Inflow

There are two common ways that flow enters swales: via concentrated flow or dispersed lateral inflow. In addition to lateral flow diversion, Figure 2 also illustrates the use of check dams along a swale.

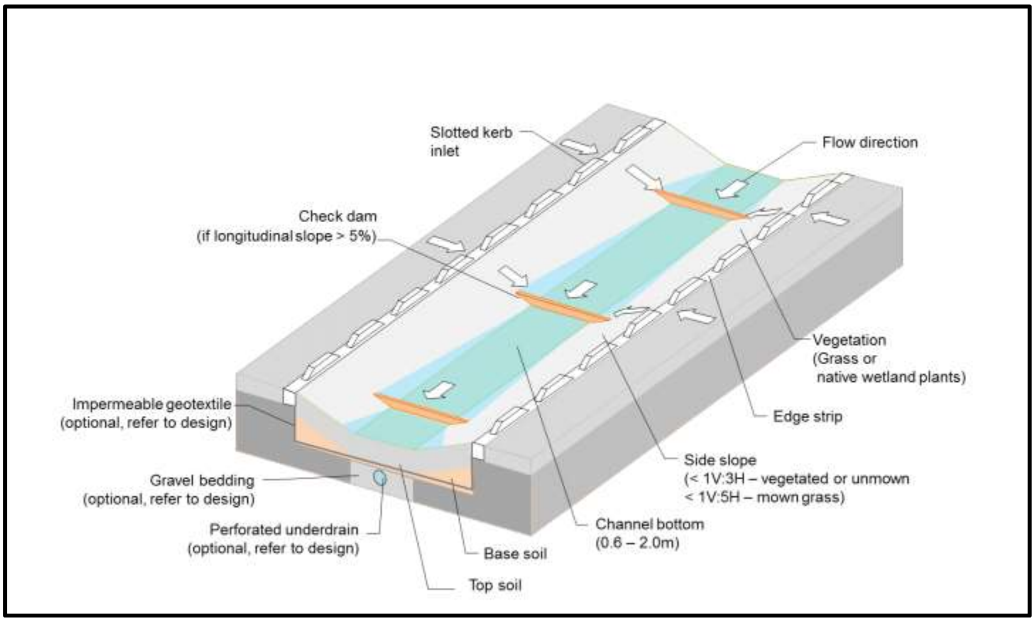


Figure 2: Schematic of a typical swale cross section

Detailed Design Procedure

The design approach takes the designer through a series of steps that consider swale performance for water quality treatment and consideration of larger flows to ensure that scour or resuspension of deposited sediments does not occur.

1. Calculate Water Quality Flow for runoff from impervious areas only using a design intensity of 10 mm/hr.
2. Calculate conveyance flow from all contributing areas for the primary rainfall event (as per Table 4-2), using a 10 minute rainfall design event.
3. Establish the longitudinal slope of the swale.
4. Select a vegetation cover and corresponding a value for Manning's coefficient of roughness
5. Select preliminary swale geometry including shape, side slope, base width and water quality flow depth (based on vegetation length)
6. Calculate cross sectional area (A), and hydraulic radius (R). The following equations can be used to calculate A and R based on a trapezoidal cross section.

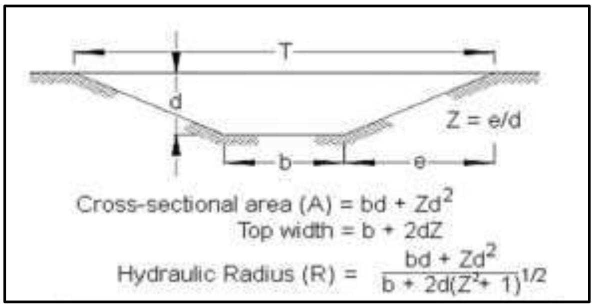


Figure 3: Swale channel geometry

$$A = bd + Zd^2 \quad \textbf{Eqn (6-3)}$$

$$R = \frac{bd + Zd^2}{b + 2d\sqrt{Z^2 + 1}} \quad \textbf{Eqn (6-4)}$$

Where:
A = Cross-sectional area (m^2)
R = Hydraulic radius (m)
T = Top width of trapezoid/parabolic shape (m)ex
d = Depth of flow (m)
b = Bottom width of trapezoid (m)
Z = Swale side slope (Z H : 1 V)

7. Use Manning's equation to check the flow in the swale. If Q calculated is less than water quality flow increase swale dimensions to accommodate flow (repeat steps 4- 7).

$$Q = \frac{AR^{\frac{2}{3}}\sqrt{s}}{n} \textbf{Eqn (6-5)}$$

Where:
Q = Flow rate (m^3/s)
n = Manning's n (dimensionless)
s = Longitudinal slope (m/m)

8. Check the swale velocity from the following equation:

$$v = Q/A \textbf{Eqn (6-6)}$$

If v > 0.8 m/s, repeat steps 4 – 8 until the velocity is less than 0.8 m/s.

9. Check the length of flow in the swale is sufficient to meet minimum HRT requirements as per equation 6-2.

Flows in Excess of the Water Quality Storm
It is expected that runoff from events larger than the water quality design storm will be conveyed via the swale. In that situation, a stability check should be performed to ensure that the 10-year, 10 minute ARI event does not cause erosion. For the 10-year storm, flow velocities should not exceed 1.5 m/s, although higher velocities may be designed for with appropriate erosion protection.

Shallow or steeper slope situations
Where slopes are less than 2%, an underdrain must be used to prevent soils from becoming saturated during wet times of the year. Figure 4 provides a typical cross-section of the underdrain system ensuring that water passes through the invert of the swale, through a

loam soil, then geotextile fabric and gravel prior to discharge through a 100 mm perforated pipe.

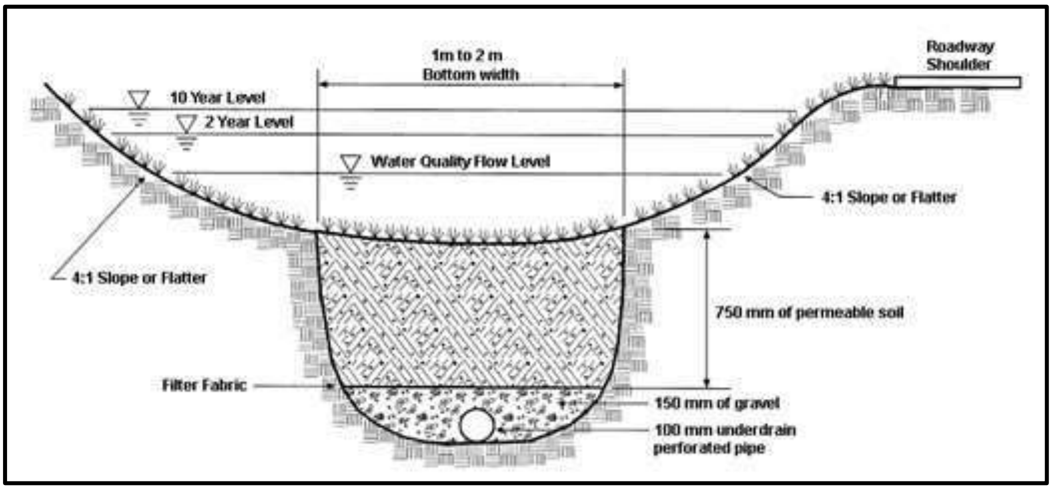


Figure 4: Swale schematic showing soils and underdrain

Where slopes exceed 5%, swales can only be used if check dams are included so that the ultimate post-construction slope between check dams is less than 5%. A key design element is that, as shown in Figure 4, the crest of the downstream check dam extends backwater to the toe of the upstream check dam.

To determine the spacing between check dams the following equation is to be used:

$$L_{cd} = \frac{h_{cd}}{s} \quad \textbf{Eqn (6-7)}$$

Where:
L_{cd} = length between check dams (m)
h_{cd} = height of the check dams (m)
s = longitudinal slope (%)

Determining the number of check dams required for the swale is determined by the following equation:

$$N = \frac{L}{L_{cd}} \quad \textbf{Eqn (6-8)}$$

Where:
N = number of check dams
L = total length of the swale (m)
L_{cd} = length between check dams (m)

When using check dams it is important to ensure that scour does not occur at the toe of the check dams. If in doubt, erosion control measures such as stone should be placed at the toes of the check dams to ensure stabilisation.

Larger storms should be calculated assuming the storage behind the check dams is full and the overall slope of the flow would be the slope from the upstream top of the swale to the bottom.

Case Study – Swale

Project Description:
A small rural lifestyle development is proposed with an overall impervious area of 40%. The area of the development is 1.5 hectare with each lot uniformly sloping at 1% towards the road. A swale will be used to treat runoff from impervious surfaces and convey it to an existing water drain downstream of the development. Runoff from the road is dealt with separately. The soil has medium soakage and pre development land use was pasture.

Design Procedure:
As the development is rural residential the swale must be designed to a 1 in 5 year event (as per Table 4-2, Appendix D). Using the High Intensity Rainfall Design charts in Appendix L (Table 2) the design intensity for a 10 minute storm is 48 mm/hr. The design intensity for the water quality event is given as 10 mm/hr.

Using Tables 4-4 and 4-5 the following runoff coefficients are chosen.

Table 1. Chosen runoff coefficients.

	Description	**Runoff coefficient**	**Slope adjustment**	**Intensity adjustment**	**Final value**
Impervious	Roofs, sealed roads and paved surfaces	0.9	-0.05	+0.15	1
Pervious	Medium soakage soil types: pasture and grass cover	0.3	-0.05	+0.15	0.4

composite coefficient is then calculated using equation 4-3.

$$C = \frac{((1.5\times0.4)\times1)+((1.5\times0.6)\times0.4)}{1.5} = 0.64$$

1. Water Quality Event:

Using the rational method for the impervious area of the site only, the flow is calculated using equation 4-1.

$$Q = 2.78\ \times\ 1\ \times\ 10 \times\ (0.4 \times 1.5) = 16.68\, L/s = 0.0167\, m^3/s$$

2. Conveyance Flow for a 20% AEP storm and a 10 minute rainfall design event for the whole site:

$$Q = 2.78 \times 0.64\ \times\ 48 \times 1.5 = 128.1\, L/s = 0.128\, m^3/s$$

3. Establish a longitudinal slope for the swale:

A slope of 2.5% is chosen, as a result no check dams or an underdrain are required.

4. Vegetation is chosen. Because the swale is vegetated, Manning's coefficient for roughness will be 0.25 for the water quality storm and the 1 in 5 year storm.
5. A trapezoidal swale shape is applied to the swale. A side slope of 1V: 5H is chosen and initial values for b and d respectively, b = 1.05m and d = 0.1m.
6. Combining Manning's equation and first approximations for the hydraulic radius an iterative process is used to determine the dimensions of the swale. Whilst meeting the minimum and maximum requirements outlined in Table

6 - 3. The following process is used:

$$A = bd + Zd^2$$

$$A = 1.05 \times 0.1 + (5\, x\, 0.1^2) = 0.155\, m^2$$

$$R = \frac{bd + Zd^2}{b + 2d(Z^2 + 1)^{\frac{1}{2}}}$$

$$R = \frac{0.155}{1.05 + 2 \times 0.1(5^2 + 1)^{\frac{1}{2}}} = 0.0749\, m$$

7. Manning's equation is used to find the flow in the swale and hence the velocity in the swale.

$$Q = \frac{AR^{\frac{2}{3}}\sqrt{s}}{n}$$

$$Q = \frac{0.155 \times 0.0749^{\frac{2}{3}}\sqrt{0.025}}{0.25} = 0.0174\, m^3/s$$

$$v = Q/A$$

$$v = \frac{0.0174}{0.155} = 0.112\, m/s$$

At this stage the values are checked against the required values.
Is the base width between 0.6m and 2m? Yes.
Is the swale velocity less than 0.8 m/s? Yes.
Is the swale flow greater than the design water quality flow? Yes.
If these requirements are not met the values of b, d and s must be adjusted until these are achieved.

8. The final requirements are a minimum HRT of 9 minutes and minimum swale length of 30m.

Using a HRT of 9 minutes (t = 9)

$$L = v \times t(\frac{60s}{1minute})$$

$$L = 0.111 \times 9\left(\frac{60s}{1minute}\right) = 60.2m$$

9. The conveyance in the swale for a 20% AEP 10 min event is also checked using the same iterative process. The only variable that should be changed when determining the swale flow and velocity is the depth of flow.

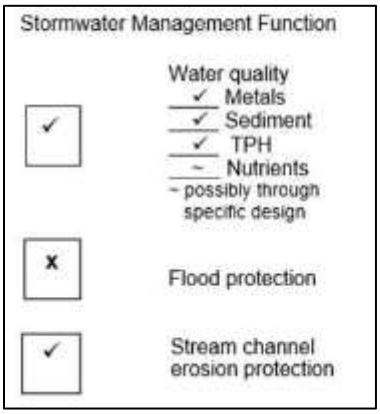
Using the same equations as above and adjusting d the following values are determined respectively, d = 0.273m whilst keeping b = 1.05m, v = 0.194m/s and Q=0.128m^3/s.

Is the swale velocity less than 1.5 m/s? Yes.
Is the swale flow greater than the primary event flow? Yes.

10. The primary event must have a flow depth no greater than 150mm from the top of the swale.

Therefore, the final dimensions of the swale are d = 0.423m, b = 1.05m, T = 5.28 and L = 60.2m.

Bioretention
Bioretention is a process whereby stormwater runoff is treated by passing the water through a filtration media. The water then evapotranspires, infiltrates into the ground or provides a slow release to surface waters when infiltration to ground cannot be achieved.



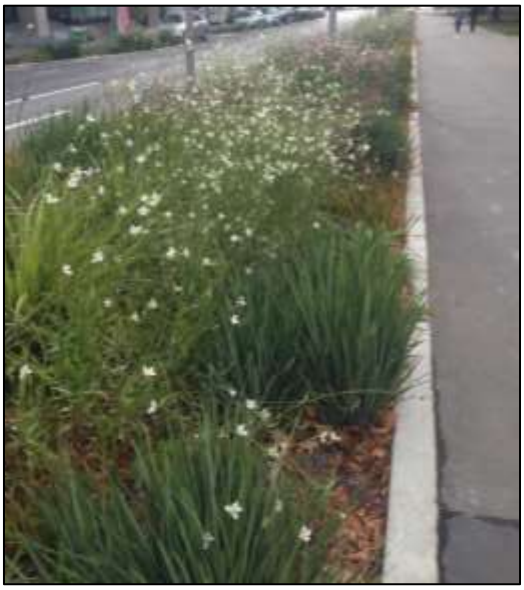


Figure 5: Bioretention

The major pollutant removal pathways within bioretention devices are:

- Sedimentation in the extended detention storage, sediments and metals
- Filtration by the filter media, fine sediments and colloidal particles; and
- Nutrient adsorption and pollutant decomposition by soil bacteria; adsorption of metals and nutrients by filter particles; and bio-accumulation by plants.

To retain the filter media within the bioretention device and aid drainage, one or more layers are used under the filter as a transition from the fine sands and soils of the filter media to the drainage layer at the bottom of the device. The surfaces of most bioretention devices are planted with a range of vegetation.

Bioretention devices are also known by other names such as raingardens or bio filters and can range in size from tree pits to very large systems of 1,000 m^2 filter area or greater.

Rain gardens
Rain gardens are planted gardens made up of layers of specified soil media which promote the filtration and retention of stormwater. Rain gardens function by promoting the ponding of stormwater in the planted area, which slowly filters through the soil media. The combination of this filtration process, and biological uptake by the plants help absorb and filter contaminants before stormwater soaks into the underlying soil, or conveyance networks.

The key components of a rain garden are shown in Figure 6. Including each component in the design is critical to ensure effective operation, and to reduce the long term maintenance requirements.

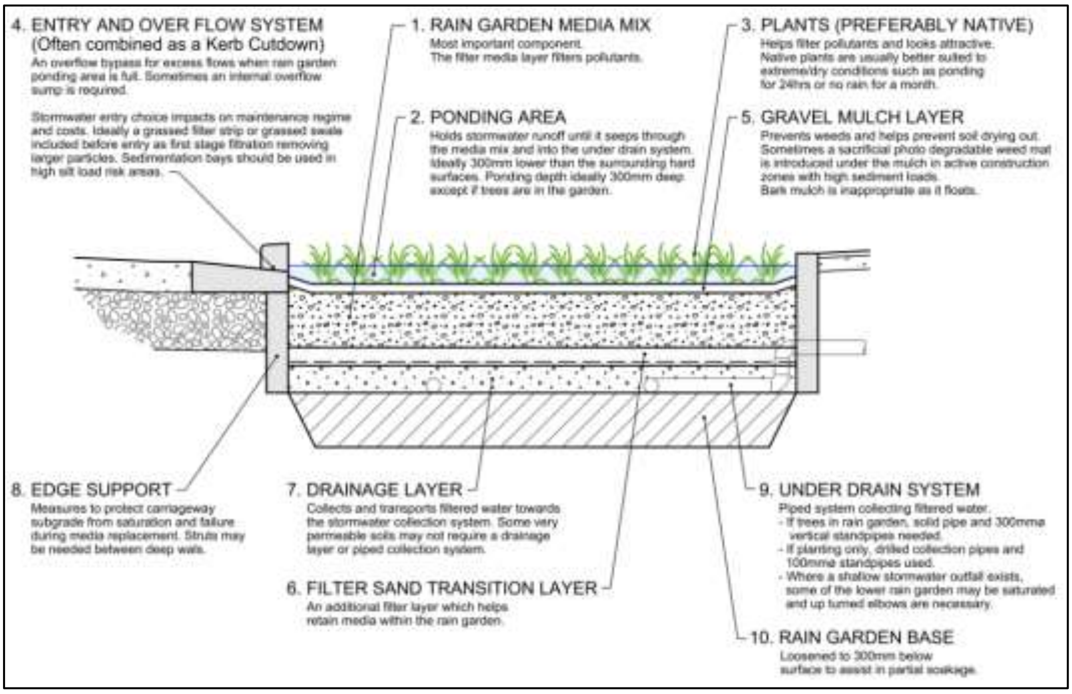


Figure 6: Typical Rain garden (source CCC, 2016

Rain gardens are best suited for retrofit into existing developed areas, or in development areas with minimal available space. For large developments, ponds, swales and wetlands remain TDC's preferred stormwater treatment device due to the lower maintenance costs and higher amenity value. Rain gardens are preferred over proprietary filtration units as they provide additional benefits including improved street amenity.

Rain gardens are excellent solutions for retrofit in existing roadways, where they can be installed in existing on-street parking space, or in the existing carriageway when road narrowing is taking place. It is important to install sediment removal pre-treatment upstream of rain gardens as they primarily fail due to blinding of the surface with the sediment.

For urban intensification, rain gardens can help reduce the effect of increased impermeability, help improve stormwater quality and attenuate flows from frequent minor rainfall events. The added street amenity is another positive factor to consider when eventuating stormwater management options.

A regular maintenance regime is critical to ensure adequate long term performance of a rain garden. The cost of such regime is likely to be higher than what is expected for a basin or wetland. Maintenance and irrigation over the first 2 to 3 years are critical to ensure plant establishment and the long term performance of the systems.

Rain Garden Design Parameters

Site suitability should be based upon the parameters provided in Table 4.

Table 4: Site Suitability Parameters	
Parameter	**Limitation**
Catchment area	The allowable catchment area of a rain garden is dictated by

	the maximum allowable foot print area of a rain garden being 1200 m^2. As a general rule of thumb, the rain garden filter area should have a minimum foot print of 1.5% of the impervious catchment area. This means that for a 1200 m^2 rain garden, the maximum impervious catchment area should be roughly 4 ha.
Sediment loadings	High sediment loadings will clog up the soil media and ultimately affect the performance of the rain garden. Pre-treatment is required in such scenarios to reduce the impact of sediment loads and improve long term performance. The maintenance regime must also reflect this.
Soils	The infiltration capacity of the underlying soil must be determined to design the rain garden. In areas of poor infiltration rates, a sub soil drain to a suitable outfall must be included in the design.
Groundwater	The base of the rain garden must be at least 1000mm higher than the seasonally high ground water table.

The following Table 5 should be used for rain garden design elements.

Table 5: Rain garden Design Elements	
Design parameter	**Criteria**
First flush depth	21 mm (to achieve 80% annual volume capture)
Media depth	600 mm preferred if nitrogen is not the primary pollutant (300 mm minimum). 900 mm if nitrogen is the primary pollutant
Media infiltration rate	Initially 50 – 150 mm/hr Use 30 mm/hr for design purposes
Extended detention ponding volume	Minimum 40% of first flush volume
Extended detention ponding depth (EDD)	Maximum 300mm. Consider reducing this depth in high pedestrian areas.
Depth to seasonally high groundwater	800mm minimum from base of rain garden
Outlet configuration	Downed outlet with soffit of outlet at top of transition layer.

Rain Garden Detailed Design Procedure

The methodology below outlines the rain garden design procedure.

1. Calculate the water quality volume for the draining catchment area
2. Calculate the minimum extended detention ponding volume (40% of first flush volume).
3. Calculate the filter area of the rain garden:

$$A_{rg} = 41.67 \times \frac{V_{ff} d_{rg}}{k(h + d_{rg}) t_{rg}} \quad \textbf{Eqn (6-9)}$$

Where:

A_{rg} = Filtration area of rain garden (m^2)

V_{ff} = First flush volume (m^3)
d_{rg} = Filter depth (m) – 0.6m recommended
k = coefficient of permeability (mm/hr) – 30 mm/hr recommended
h = average height of water (m) – Half of extended detention depth recommended
t_{rg} = time to pass first flush volume through soil (day) – 1 day recommended

4. Calculate the minimum live storage area of the rain garden:

$$A_{EDD} = \frac{V_d}{2h} \quad \textbf{Eqn (6-10)}$$

Where:
A_{EDD} = Ponding area of rain garden (m^2)
V_d = Extended detention ponding volume (m^3)

Rain Garden – Case Study

Project Description:
An existing area of land in Timaru town centre is being turned into a carpark. A rain garden is proposed between the carpark and existing road to add to the amenity of the street and help reduce the added area of permeability the carpark brings. The carpark is 3000 m^2 with a slope of 2%.

Design Procedure:
The water quality depth for Timaru is 21mm.
Using Tables 4-4 and 4-5 the following runoff coefficients are chosen.

Table 1. Chosen runoff coefficients

	Description	Runoff coefficient	Slope adjustment	Intensity adjustment	Final value
Impervious	Roofs, sealed roads and paved surfaces	0.9	-0.05	+0.05	0.9

1. Water quality volume;

$$WQV = \frac{0.9 \times 3000m^2 \times 21mm}{1000} = 56.7m^3$$

2. Minimum extended detention volume (live storage needed):

$$V_d = 0.4 \times 56.7 = 22.68m^3$$

3. Filter Area of the Rain Garden

$$A_{rg} = 41.67 \times \frac{V_{ff}(m_3) \times d_{rg}(m)}{k\left(\frac{mm}{hr}\right)(h(m) + d_{rg}(m))t_{rg}(days)}$$

$$A_{rg} = 41.67 \times \frac{56.7 \times 0.6}{30 \times ((0.3 \times 0.5) + 0.6) \times 1} = 63m^2$$

4. Calculate the minimum live storage area of the rain garden

$$A_{EDD} = \frac{22.68}{2 \times 0.15} = 75.6m^2$$

5. Check to see if the calculated filter area meets the required live storage area

$$A_{rg}(63m^2) < A_{EDD}(75.6m^2)$$

Because A_{rg} < A_{EDD} the filter area of the rain garden must be increased to meet the minimum required live storage area,

$$New\ A_{rg} = \frac{22.68}{2 \times 0.15} = 75.6m^2$$

Generally, the live storage requirement will govern the size of the rain garden. However, if live storage can be provided upstream of the raingarden the rain garden can be sized based on treatment area only.

Stormwater Tree pit

A stormwater tree pit is a tree pit which is designed to treat stormwater runoff. The design of such tree pit is the same as a rain garden however is found to provide better retention than a rain garden due to the higher evapotranspiration rate associated with the tree compared to typical rain garden vegetation. Figure 7 below shows a typical stormwater tree pit configuration.

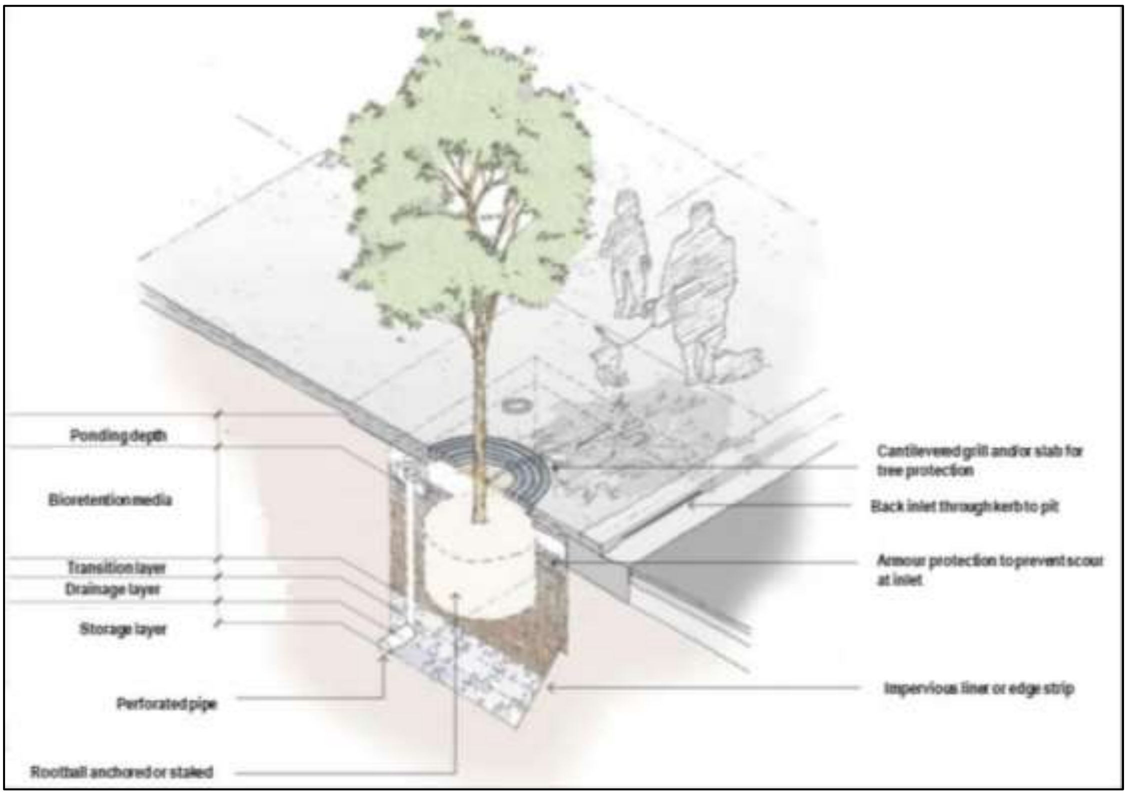


Figure 7: Typical Stormwater Tree pit

The maximum size of the tree and the tree's root ball must be considered in sizing the tree pit to ensure the tree’s future needs can be accommodated. The need for future soil replacement and irrigation during establishment must also be considered. Due to these constraints, stormwater tree pits are usually unsuitable for when services are in close proximity to the location.

Infiltration
Infiltration devices are designed and constructed to capture and treat stormwater runoff through:

- Filtration
- Infiltration,
- Adsorption, and
- Biological uptake

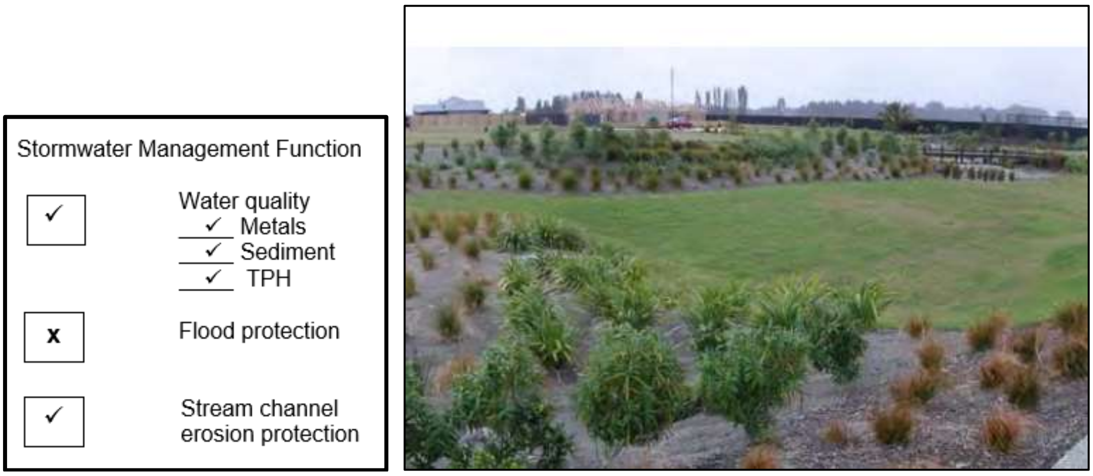


Figure 8: Typical infiltration device

An infiltration device can be used to direct urban stormwater away from surface runoff paths and into the underlying soil. In contrast to surface detention methods, which are treatment or delay mechanisms that ultimately discharge all runoff to streams, infiltration diverts runoff into groundwater. Of all the traditional stormwater management practices, infiltration is one of the few that can achieve volumetric hydraulic neutrality by reducing the overall volume of stormwater being discharged to surface water receiving environments. This practice most closely matches the hydrological cycle of a greenfield site, allowing groundwater recharge and baseflows in groundwater-linked waterways.

It is critical to provide pre-treatment prior to infiltration devices to remove sediment which can clog the filter media.

There are a wide variety of infiltration devices, including but not limited to:

- Infiltration basins
- Soakage pits
- Permeable pavements

Infiltration Basin
An infiltration basin is essentially a pond that has no surface outlet other than for extreme events. The only way for the water to leave the ponded area is through infiltration to ground. Figure 9 shows a schematic of an infiltration basin with an overflow outlet.

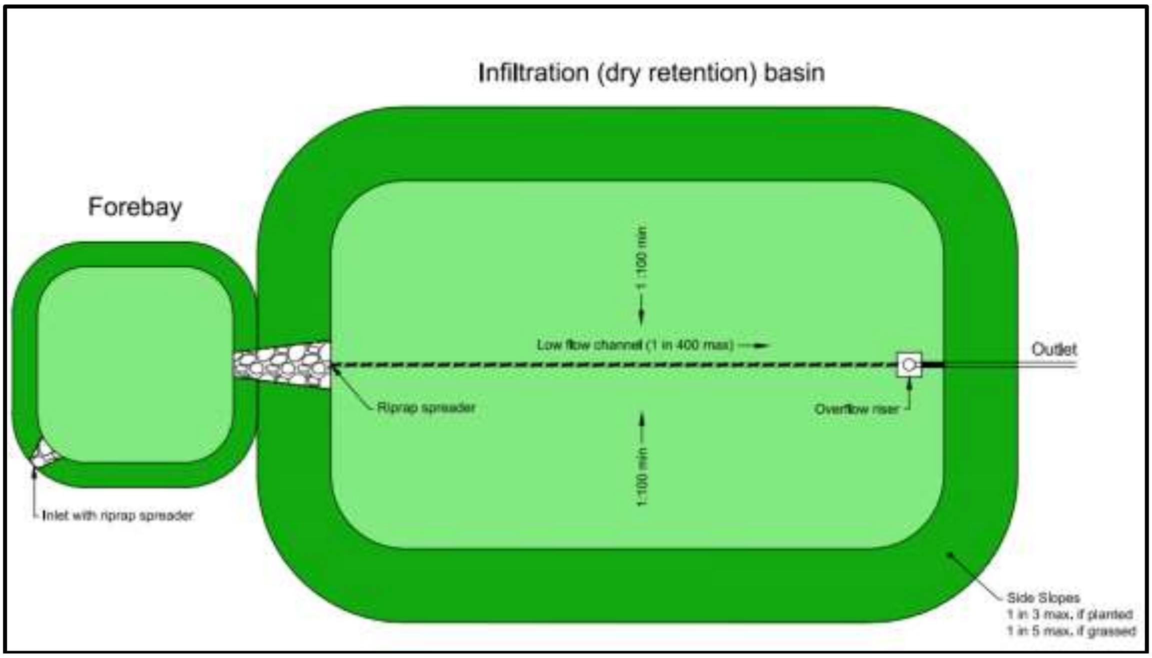


Figure 9: Schematic of an infiltration basin

Infiltration basins are detention facilities which temporarily store stormwater runoff and infiltrate stormwater to ground. Due to the interaction of stormwater with soils and vegetation as it infiltrates, they can achieve a high level of stormwater treatment.

Infiltration basins can also be designed to provide flow attenuation. This is accomplished by providing “dry” storage above the designated infiltration volume. This attenuated volume is then released through an outlet system.

Soakage Pit
Soakage pits provide a stormwater discharge function in a similar fashion to infiltration basins. However, the excavated subgrade is filled with rocks and the void spaces provide for stormwater storage until the runoff infiltrates as shown in Figure 10. Due to the lack of interaction between soils and vegetation prior to discharge, soakage pits are not considered to provide stormwater treatment. Pre-treatment may also be required, depending on the source of stormwater directed to them.

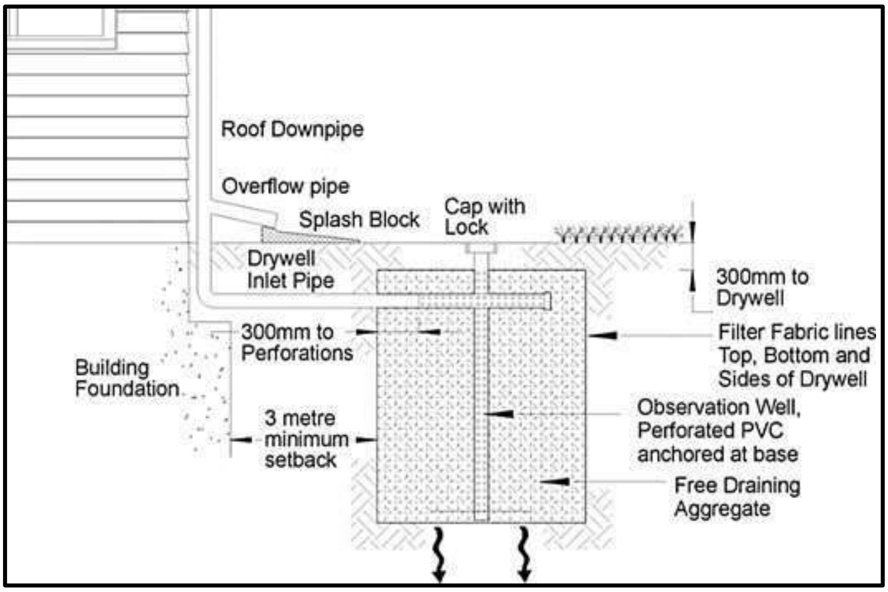


Figure 10: Schematic of a soakage pit

Permeable Pavements
Modular block permeable pavement permits precipitation to drain between paving blocks with a pervious opening as show in Figure 11. Paving blocks are appropriate only for areas with very light or no traffic, or for parking areas with minimal turning movements. They are laid on a gravel subgrade and filled with sand or sandy loam but can also be used with grass in the voids which may require irrigation and lawn care during the summer months.

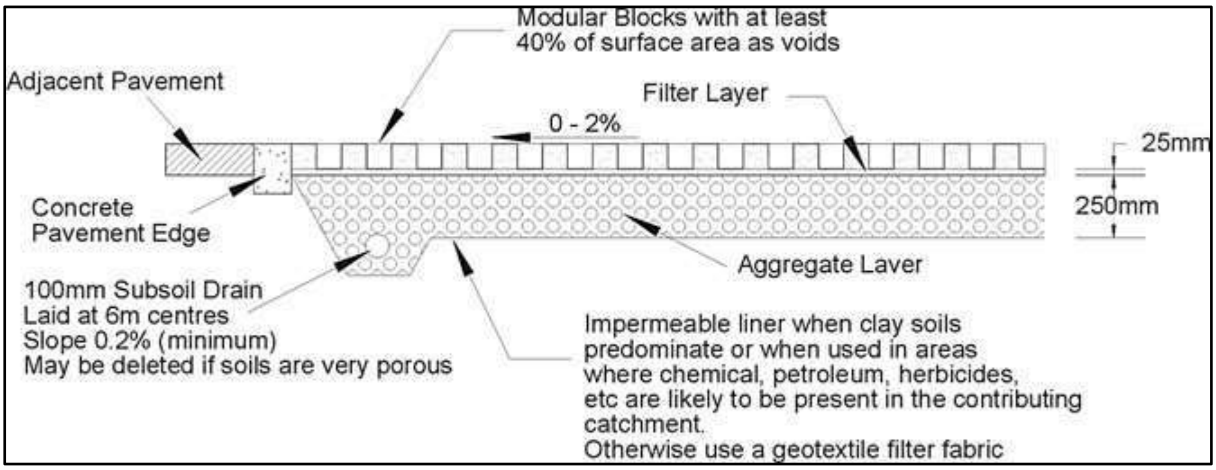


Figure 11: Schematic of permeable pavement

Evolving materials such as permeable concrete, enable stormwater to pass through the hardened material with inter-connected pore spaces. This enables discharge of rain falling directly on the surface. However, the surface can become clogged with fine particles. Reference and specifications should be sourced from suppliers for the design, installation and ongoing maintenance of these products.

Infiltration Device Components
Details for the standard components for infiltration devices are provided in Table 6 below:

<table>
<tr><th colspan="3">Table 6: Infiltration Device Components</th></tr>
<tr><th>Parameter</th><th>Device</th><th>Description</th></tr>
<tr><td rowspan="3">Pre-treatment</td><td>Basin</td><td>Pre-treatment is provided via a forebay which limits sediment entering the infiltration basin. The only situation where pre-treatment is not required is when runoff has low sediment load, such as roof water from residential areas.</td></tr>
<tr><td>Soakage pit</td><td rowspan="2">Pre-treatment limits sediment entering the infiltration device and extends the life of the device. The only situation where pre-treatment is not required is when runoff has very low sediment load, such as roof water from residential areas.</td></tr>
<tr><td>Permeable pavement</td></tr>
<tr><td rowspan="3">Storage (optional)</td><td>Basin</td><td>Storage is provided within the infiltration basin and is to be sized accordingly.</td></tr>
<tr><td>Soakage pit</td><td rowspan="2">Storage may be provided within, above or below the aggregate. Storage chambers such as crates, arches and pipes can also be incorporated.</td></tr>
<tr><td>Permeable pavement</td></tr>
<tr><td rowspan="2">Aggregate</td><td>Soakage pit</td><td rowspan="2">Aggregate in the form of gravel, is used to create storage space within the device. Clean drainage aggregate to provide retention and detention storage comprising washed gravel 20 – 40 mm diameter with defined void ratio of at least 0.3.</td></tr>
<tr><td>Permeable pavement</td></tr>
<tr><td rowspan="2">Geotextile</td><td>Soakage pit</td><td rowspan="2">The sides (and top for a soakage pit) of the infiltration device are lined with geotextile to prevent the migration of aggregate and sediments. Geotextile must be secured at edges and base and all joins overlapped to prevent the movement of fine sediment between the device layer and base soils. Geotextile is not to be placed between aggregate layers within the device.</td></tr>
<tr><td>Permeable pavement</td></tr>
<tr><td rowspan="3">Overflow</td><td>Basin</td><td rowspan="3">Infiltration systems should be fitted with an overflow system for the management of rainfall events which exceed the infiltration and storage capacity of the device. This overflow is to be directed towards an approved outfall.</td></tr>
<tr><td>Soakage pit</td></tr>
<tr><td>Permeable pavement</td></tr>
</table>

Observation well	Soakage pit Permeable pavement	An observation well should be installed so that inspections can be made. It should consist of a perforated PVC pipe, 100-200 mm in diameter and have footplate and an impermeable lockable cap.

Infiltration Device Design Parameters

Site suitability should be based upon the parameters provided in Table 7.

Table 7: Infiltration Device Site Suitability Parameters	
Parameter	**Limitation**
Catchment	Soakage pits and permeable pavements are suitable for small – medium catchments. Infiltration basins are suitable for medium – large catchments. Devices needs to be located at the lower end of the catchment.
Groundwater	The invert of an infiltration device should be at least 1 m from the seasonally high groundwater level, or any impermeable soil layer.
Infiltration rate	Geotechnical assessment is required to confirm infiltration capacity of subsoils. Soils must have a minimum infiltration rate of 10 mm/hr after including a factor of safety of 3. Therefore, the lowest measured infiltration rate must be equal to or greater than 30 mm/hr.
Underlying soil	Soils need to be evaluated to ensure suitable rates of ground soakage. It must also be ensured that the device is not positioned in an area with instability issues, expansive or saline soils.
Aquifers	The potential impact of infiltration devices on aquifers and downgradient users must be assessed and any risks must be mitigated.
Contaminated Land	Not suitable in an area with contamination nor an area with a high risk of future contamination.
Slope	Implementation on slopes greater than 15% shall only be allowed with design input from a geotechnical expert.
Setback	Infiltration devices must be located at least 3 m from structures, slopes, on-site wastewater systems and roads.
Traffic	Infiltration basins and soakage pits must be located at least 3 m away from trafficked areas. Permeable pavements are suitable for parking or areas with light traffic.

Soil type / infiltration rate
Soil infiltration or permeability is the most critical consideration for the suitability of infiltration devices. Infiltration devices should be constructed in medium textured soils with high permeability. They are unsuitable for use in soils with poor drainage or high ground water. The underlying soils must be tested at the proposed site, refer to Appendix I for an infiltration testing methodology, minimum infiltration rates, and other site considerations.

Pre-treatment
Pre-treatment is required prior to infiltration devices to reduce the potential for clogging, improve long term performance of the device and minimise operation and maintenance requirements. The exception is infiltration devices accepting only residential roof runoff.

Inlet stability
In addition to pre-treatment, long term function depends on having flows enter the infiltration device through a stable system that does not scour and increase sediment load to the device. If entry is via a reticulated system then velocities entering the device have the potential to cause scour, hence the inlet to the device would need to be stabilized appropriately.

Protection during construction / building phases
Infiltration devices must be protected during site development to ensure construction-phase stormwater runoff does not enter the device. If possible, infiltration devices should not be constructed until the surrounding areas have been stabilised and erosion is no longer a concern. Where this isn't possible, incoming flows must be diverted around infiltration devices until the contributing catchment area is stabilised.

Detailed Design Procedure

In terms of the design approach:

1. Calculate the volume to be managed by the infiltration device V_{runoff}
    a. Water Quality Volume OR
    b. Primary rainfall event runoff volume OR
    c. Volume required to achieve stormwater neutrality

2. Assume an initial depth and surface area of the soak pit.
3. Calculate the volume of soakage for the design storm duration:

$$V_{soak} = A_{sp} S_r D_s$$ **Eqn (6-11)**

Where:
A_{sp} = Surface area of the infiltration device (m^2)
S_r = Design soakage rate (m/hr)
D_s = Duration of storm (hrs)

4. Calculate the volume of storage required.

$$V_{storage\ req} = V_{runoff} - V_{soak} + pA_{sp-surface}$$ **Eqn (6-12)**

Where:

$A_{sp-surface}$ = Surface area of infiltration device exposed to rainfall (m^2) (zero for buried soak pits)
p = Design event rainfall depth (m)

5. Calculate the volume of storage available within the infiltration device.

$$V_{storage\ avail} = A_{sp} d_s V_r \quad \textbf{Eqn (6-13)}$$

Where:
V_r = Void ratio (typically 0.38 for below ground storage in aggregate and 1 for above ground ponding in infiltration basins)
d_s = depth of infiltration device (m) (this is depth of media below ground for a soakage pit or permeable pavement and ponding height for infiltration basin)

6. Check $V_{storage\ avail} \geq V_{storage\ reg}$
7. Check draw down time is less than 48 hours

$$D = \frac{V_{storage\ req}}{S_r A_{sp}} \quad \textbf{Eqn (6-14)}$$

8. If $V_{storage\ req}$ is significantly less than $V_{storage\ avail}$ or the draw down time is less than 48 hours the infiltration device may be oversized. Steps 2 – 7 can be repeated with varying values for the surface area of the soak pit until the optimum size is accomplished.

Steps 1-8 of the Detail Design Procedure should be completed for all durations up to and including a 24 hour rain events.

Case Study – Soakage pit

Project Description:
Runoff from a 1000m^2 area of road reserve is to be captured and discharged to ground through a soak pit. 70% of the catchment is made up of impervious surfaces (footpaths and roads) and the remaining 30% consists of berms and landscaping. Soakage testing on the proposed site suggests a field soakage rate of 1200 mm/hr. A factor of safety of 3 should be applied for the design soakage rate. The groundwater at the site is 3m below existing ground level. As per Table 4-2 the soak pit needs to be sized to cope with a 1 in 10 year event. The slope of the kerb and channel conveying runoff to the soak pit has a grade of 1:200.

Design Procedure:
Due to the lack of interaction between soils and vegetation prior to discharge, soakage pits are not considered to provide stormwater treatment. Therefore, the water quality volume is not considered. Instead, the runoff volume from for the 1 in 10 year event 1 hr storm is calculated. All storm durations up to and including a 24 hour storm are subsequently run to confirm the peak storm design.

Using Table 2 in the High Intensity Rainfall Design Chart, using a duration of 60 minutes and a 1 in 10 year storm event the intensity is found to be 25 mm/hr.

Using Tables 4-4 and 4-5 the following runoff coefficients are chosen.

Table 1. Chosen runoff coefficients

	Description	Area (ha)	Runoff coefficient	Slope adjustment	Intensity adjustment	Final value
Impervious	Roofs, sealed roads and paved surfaces	0.07	0.9	-0.05	+0.15	1
Pervious	Medium Soakage – pasture and grass cover	0.03	0.3	-0.05	+0.15	0.4

The composite coefficient is then calculated using equation 4-3.

$$C = \frac{(0.07\times 1)+(0.03\times 0.4)}{0.1} = 0.82$$

1. Rational method to calculate runoff volume:

$$Q = \frac{2.78\ \times\ 0.82\ \times\ 25\ \times\ 0.1}{1000} = 0.0057\,m^3/s$$

$$V_{runoff} = 0.0057\ \times\ 60min\ \times\ 60sec = 20.52m^3$$

2. Assume an initial surface area of the soak pit and a depth.

The depth is chosen as d = 2m, to meet the requirement of a minimum of 1m vertical clearance from seasonal groundwater. An initial surface area of 15 m^2 is chosen.

3. Calculate the volume of soakage for the design storm duration:

$$V_{soak} = A_{sp}S_rD_s$$

$$V_{soak} = 15\ \times\ 0.4\ \times \frac{60min}{60hrs} = 6\,m^3$$

4. Calculate the volume of storage required.

$$V_{storage\ req} = V_{runoff} - V_{soak} + pA_{sp}p$$

$$V_{storage\ req} = 20.52 - 6 + 0 \times \frac{25}{1000} = 14.52\,m^3$$

5. Calculate the volume of storage available.

$$V_{storage\ avail} = A_{sp}\ d_sV_r$$
$$V_{storage\ avail} = 15\ \times\ 2\ \times\ 0.38 = 11.4\,m^3$$

6. Check $V_{storage\ avail} \geq V_{storage\ reg}$

$V_{storage\ avail}(11.4\,m^3) \leq V_{storage\ req}(14.52\,m^3)$

Criteria not met

7. Increase the surface area to meet $V_{storage\ req}$:

The surface area of the soak pit is increased until the $V_{storage\ avail}$ is equal to or greater than $V_{storage\ req}$. Steps 3 to 6 should be repeated using a new value for the surface area of the soak pit. If it results in zero ponding the design is complete. Otherwise, another iteration should be completed until zero ponding occurs.

In this case an A_{sp} = 18 m^2 is adequate.

8. Check draw down time is less than 48 hours

$$D = \frac{V_{storage\ req}}{S_r A_{sp}} = \frac{14.52}{0.4 \times 18} = 1.85\ hrs$$

Case Study – Infiltration Basin

Project Description:

Runoff from a 10000m^2 residential subdivision is to be conveyed to an infiltration basin and discharged to ground. 80% of the catchment is made up of impervious surfaces (footpaths and roads) and the remaining 20% consists of berms and landscaping. Soakage testing on the proposed site suggests a field soakage rate of 900 mm/hr. A factor of safety of 3 should be applied for the design soakage rate. The groundwater at the site is 2m below existing ground level. There is no surrounding secondary flow paths or infrastructure to attenuate to so there is no outlet structure. The infiltration must be designed to detain a 1 in 100-year storm event with a 1 hour duration. All storm durations up to and including a 24 hour storm are subsequently run to confirm the peak storm design.

Design Procedure:

Using Table 2 in the High Intensity Rainfall Design Chart, using a duration of 60 minutes and a 1 in 100-year storm event the intensity is found to be 50 mm/hr.

Using Tables 4-4 and 4-5 the following runoff coefficients are chosen.

Table 1. Chosen runoff coefficients

	Description	Area (ha)	Runoff coefficient	Slope adjustment	Intensity adjustment	Final value
Impervious	Roofs, sealed roads and paved surfaces	0.8	0.9	-0.05	+0.15	1
Pervious	Medium Soakage – pasture and grass cover	0.2	0.3	-0.05	+0.15	0.4

The composite coefficient is then calculated using equation 4-3.

$$C = \frac{(0.8\times 1)+(0.2\times 0.4)}{1} = 0.88$$

1. Rational method to calculate runoff volume:

$$Q = \frac{2.78\ \times\ 0.88\ \times\ 50\ x\ 1}{1000} = 0.12232\frac{m^3}{s}$$

$$V_{runoff} = 0.122\ \times\ 60min\ \times\ 60sec = 440.4m^3$$

2. Assume an initial surface area of the soak pit and a depth.

The depth is chosen as d = 1m, to meet the requirement of a minimum of 1m clearance from seasonal groundwater. An initial surface area of 355 m^2 is chosen.

3. Calculate the volume of soakage for the design storm duration:

$$V_{soak} = A_{sp}\, S_r D_s$$

$$V_{soak} = 342 \times 0.3 \times \frac{60min}{60hrs} = 102.6\, m^3$$

4. Calculate the volume of storage required.

$V_{storage\ req} = V_{runoff} - V_{soak} + pA_{sp}$

$$V_{storage\ req} = 20.52 - 6 + \frac{50}{1000} \times 355 = 351.6\, m^3$$

5. Calculate the volume of storage available.

$V_{storage\ avail} = A_{sp} d_s V_r$

$V_{storage\ avail} = 355 \times 1 \times 1 = 355\, m^3$

6. Check $V_{storage\ avail} \geq V_{storage\ reg}$

$V_{storage\ avail}(355\, m^3) \leq V_{storage\ req}(351.6\, m^3)$

Criteria is met

7. Check draw down time is less than 48 hours

$D = \frac{V_{storage\ req}}{S_r A_{sp}} = \frac{351.6}{0.3 \times 355} = 3.3\, hrs$

Wetland
The creation of wetlands in urban areas to manage stormwater helps to reintroduce natural areas into the urban landform. Wetlands provide many important benefits including the attenuation of flood flows, maintenance of water quality and support aquatic and terrestrial ecological values. From a contaminant removal perspective, wetlands provide a number of different removal processes that are not available in deeper wet ponds.

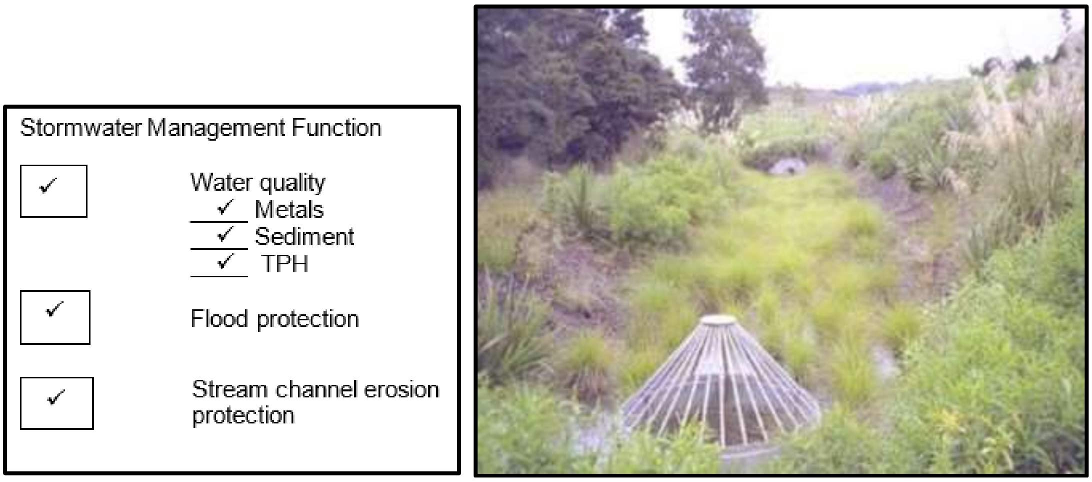


Figure 12: Typical Wetland

The design of wetlands is complex and impacted by site and outcome considerations. The Christchurch City Council simplistic method for wetland sizing using Reed's method (Reed *et al*., 2005) is applied here.

Design Parameters
Hydrology is the single most important criterion for determining the success of a constructed wetland as it dictates the health of the wetland vegetation. They should therefore only be used in areas that have a base flow from rain, upstream runoff or groundwater to ensure the long-term viability of wetland processes.

Site considerations for the design of wetlands include the following:

Table 8: Site considerations for wetland	
Catchment	Wetlands should be sized based on the entire contributing catchment and must be located in the catchment's lower portion.
Location	Wetlands should be placed away from slopes or locations where there are potential slope stability issues. Wetlands should be designed with appropriate setbacks from dwellings, property lines, retaining walls, structures and traffic areas. Wetlands should not be located on or near contaminated land or fill materials. Wetlands should be positioned offline from any water course.

Groundwater	A geotechnical investigation is needed to inform all wetland designs. Some permeability may be desired for in instances where groundwater recharge is desired.
Soils	Wetland functionality is not impacted by poor drainage.
Base flow	Wetlands need to receive adequate base flow / water inputs to maintain the health of wetland vegetation. Some permeability can be designed for where groundwater recharge / retention is required as long as it does not impact vegetation health.
Pre-treatment	Pre-treatment is recommended to reduce the long term maintenance costs of wetlands. Ongoing maintenance is also required for the removal of litter, and sediment build up.
Maintenance	Adequate space is required for access for operation and maintenance functions to be performed around the wetland – to all pre-treatment areas and the main body of the wetland and the inlet and outlet structures. Regular maintenance is required to remove gross pollutants and to remove sediment build up from wetland forebays.

Wetland design considerations and parameters include the following (Table 9):

Table 9: Design Considerations for Wetlands	
Wetland shape	Should be designed to promote flows that use the full width of the wetland and that avoid short circuiting. Length to width ratio of the flow path should approximate 10L:1W
Inlets	Inlets need to be located within a forebay bund to capture gross sediments in the forebay and to enable flows to be dispersed into the main body, avoiding short circuiting. Debris screens should be used for safety and to remove rubbish and prevent clogging. Erosion protection should be provided at the discharge point for inlets (rock rip rap on a geotextile layer). The invert of the inlet should be no lower than the designed permanent water level of the wetland. A high flow bypass should form part of the inlet structure, diverting non-design flows upstream of the forebay with erosion protection.

Table 9: Design Considerations for Wetlands	
Hydraulic residence time (HRT)	Provide a minimum hydraulic residence time of 2 days to achieve water quality treatment.
Outlets	The service outlet incorporates specific outlets at different levels sized to achieve the required design criteria for the site. The outlet riser should incorporate the specific outlets, a top debris screen and a valve/screw cap located close to the wetland base level to allow for dewatering of the wetland for maintenance. The outlet pipe which discharges downstream must be correctly sized. If discharging to a coastal area, stream, lake or wetland, erosion protection must be provided. A removable weir plate should be included in the outlet arrangement (within an accessible manhole) that allows the permanent water level to be adjusted for maintenance. Anti-seepage solutions must be provided along outlet pipes.
Forebay	To hold a minimum of 15% of the water quality volume, depth is 1.0 m. The base of the forebay should be lower than the main body of the wetland. The base should be hardened for easier maintenance. A vertical depth marker should be included to assess sediment build up. Flow velocities from the forebay to be less than 0.25m/s during a 10 year ARI event. Forebay bund is to be accessible for maintenance. A submerged impermeable bund is recommended (crest level 100- 150mm below the permanent water level) to delineate the forebay from the main body of the wetland but to provide a constant depth. The forebay bund ends should be keyed into the side slopes.
Slopes	All slopes must be approved by a geotechnical engineer based on site specific constraints. Wetland bank slopes should generally not exceed 4H:1V and be planted

Table 9: Design Considerations for Wetlands	
Water depth	Banded bathymetry; intermittent deeper water and shallow planted areas, as discussed below For design purposes assume an operating depth of 0.25 m to determine overall wetted area.
Wetland safety bench	Is to be provided at least 3m wide around the entire wetland (no more than 300mm below the permanent water level), densely planted to form a natural barrier.
Emergency spillway	Should be armoured and ideally located in natural ground. The spillway embankment should be carefully compacted during construction to prevent settlement. Where possible locate near the inlet to the wetland to minimise resuspension of sediments in large storm events. Invert should be 100mm above the maximum water level in the wetland. Freeboard should be at least 300mm above the maximum peak flow of the design storm event.
Maintenance access	An access track is to be provided that is a minimum of 3.5m width and adequate slope to provide ease of access. A sediment drying area is required near the forebay (sized to accommodate 10% of the permanent water volume at 1m depth), located away from the wetland banks, flat with vehicle access.
High flow bypass	It is recommended that a high flow bypass and maintenance bypass is included in the design. High flow bypasses should be designed to: • Withstand high flows without erosion and scour. • Preferably to be above ground, e.g. a vegetated trapezoidal channel. • Take into account downstream conveyance capacity constraints.
Planting	At least 80% of the wetland zone is to be densely planted (excluding the forebay area) at a minimum density of 4 plants / m^2. Assume a wetland vegetation porosity of 0.75. Suitable plant selection is critical for wetland success. Plant

Table 9: Design Considerations for Wetlands	
	species should be tolerant to the required ranges of depth, frequency and duration of inundation. Taller marsh species should be selected within deep marsh zones. Initial planting densities in deep marsh zones should be higher than in shallow marsh zones, so hydraulic resistance is similar between shallow and deep areas. Vegetation that provides a high level of shading (trees, shrubs and reeds/tall sedges) should be planted around, and within, the wetted margin of the wetland.
Flow velocities	Flow velocities in the wetland must not exceed 0.1 m/s for up to the 2 year ARI event and 0.5 m/s for larger storms.
Fish passage	Should be included in the design where appropriate.

Constructed wetlands must be designed in accordance with:

- New Zealand Society of Large Dams (NZSOLD), Dam Safety Guidelines, 2018
- NZSOLD, Guideline on Inspecting Small Dams, 1997
- New Zealand Building Act, 2004.

Bathymetry

Constructed wetlands are shallow vegetated water bodies that do not contain large volumes of water per surface area when compared to wet ponds.

Wetlands are to be designed to have banded bathymetry, as illustrated in Figure 8-27 below. Banded bathymetry, in long section, has variable depths with alternating deep and shallow marsh sections interspersed with occasional open water areas. Design for 60% of the surface area to have a depth range of 0 – 0.5 m, and the remaining 40% a depth range of 0.5 – 1.0 m. It is assumed that water spreads evenly across the full width of the wetland as a uniform flow.

No areas of a wetland other than the sediment forebay should be deeper than 1 metre.

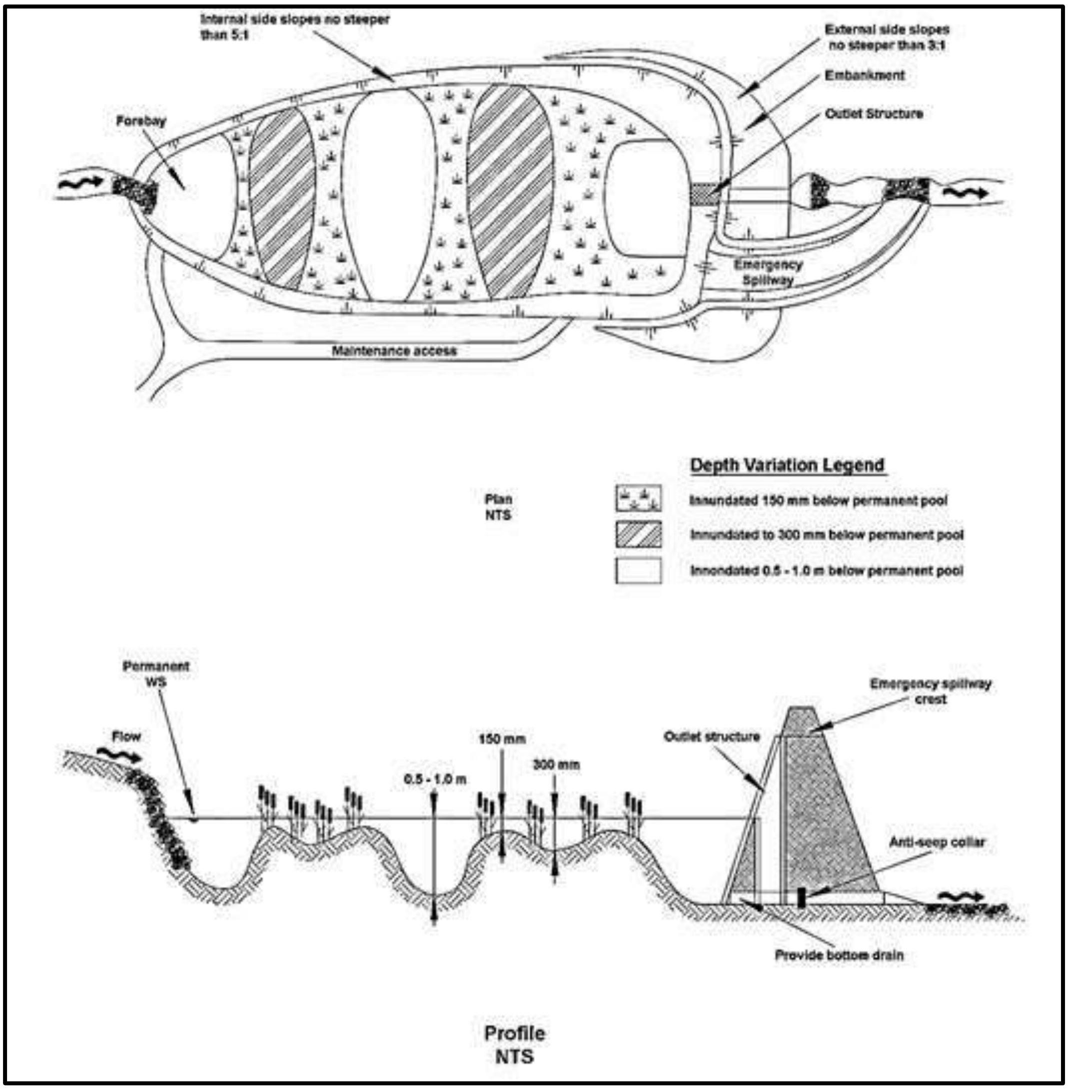


Figure 13: Banded bathymetric wetland schematic

Soils

An important element of wetland function is the need to maintain suitable conditions for wetland plants. As such, a soils analysis of the invert of the wetland shall be undertaken to ensure that the wetland area will retain water.

Where a liner is used in a wetland, a minimum depth of 300 mm of soil (or greater depending on what is suitable for the selected wetland vegetation) is required above the liner to ensure vegetation has enough soil to grow in.

Groundwater Levels

If a wetland is proposed in an area with known high groundwater levels, the groundwater level and water quality must be taken into account when considering the need for a liner/impermeable layer in the base of the wetland.

If the wetland isn't to have an impermeable layer then ideally the full range of groundwater levels needs to be understood in terms of both the impacts of groundwater on storage/detention volumes during winter high groundwater levels, and drawdown and associated effects on vegetation during summer low groundwater levels.

High Flow Bypass

Wetlands can be designed to provide flow attenuation. However, flow velocities must be managed to reduce the risk of resuspension of captured sediments and associated pollutants, prevent scour of biofilms and to protect plants.

Wetlands should be designed with a high flow bypass where possible to protect wetland vegetation from damage during large rainfall events. The bypass should divert high flows upstream of the forebay.

Design Procedure

The design steps are the following:

1. Calculate Water Quality Volume
2. Provide detention prior to entering the wetland, through a combination of wet/dry ponds or size the forebay to detain the full WQV for slow release to the wetland over 4 days.
3. Determine the average flow rate (m^3/day) through the wetland:

$$Q = \frac{WQV}{4\ days} \quad \textbf{Eqn (6-15)}$$

4. Determine the wetland treatment area (m^2) required (A_s):

$$A_s = \frac{Q\ t}{y\ n} \quad \textbf{Eqn (6-16)}$$

Where

t = hydraulic residence time (days)

y = average water depth (m)

n = vegetation porosity (assume 0.75)

5. The shape of the wetland should be designed to promote flows that utilise the full width of the wetland. The length of the wetland flowpath should approximate 10 times its width.
6. Ensure that the percentage of wetland depths meet the above criteria with a banded bathymetric design.
7. Determine the need for extended detention. Wetlands can provide up to 0.5 m detention storage over the WQV.
8. Size outlets using orifice and weir equations provided in Section 6.8 Stormwater Ponds.

Plants for a given project should be considered for suitability by an appropriately skilled practitioner. It is essential that selected plants are very tolerant of wet and dry conditions.

Case Study – Wetland

Project Description:

Runoff from a 2.5ha area commercial site with warehousing and hardstand is to be captured and treated via a wetland before being discharged to the TDC reticulated network. The catchment is 100% impervious surface (including the stormwater management surface area). As per Table 4-3 the stormwater system needs to meet neutrality requirements for the 1 in 10 year (10%), 24 hour rainfall event.

Design Procedure:
The first flush depth for Timaru is 21mm.

Using Tables 4-4 and 4-5 the following runoff coefficients are chosen.

Table 1. Chosen runoff coefficients

	Description	Area (ha)	Runoff coefficient	Slope adjustment	Intensity adjustment	Final value
Impervious	Roofs, sealed roads and paved surfaces	2.5	0.9	-0.05	+0.15	1

1. Calculate water quality volume:

$$WQV = \frac{0.9 \times 25000 \times 21}{1000} = 472.5m^3$$

2. An extended detention dry pond will act to detain water prior to release into wetland over 4 days

$$Q = \frac{472.5}{4\ days} = 118.13\, m^3/day$$

3. Determine the wetland treatment area. Assume HRT 2 days, average water depth in wetland 0.25 m and vegetation porosity of 0.75.

$$A_s = \frac{Q\ t}{y\ n}$$

$$A_s = \frac{118.13 \times 2}{0.25 \times 0.75} = 1260m^2$$

4. Preliminary wetland sizing is 120m long, approximately 10.5 m wide, 60% shallow @ 0.15 m deep, 40% deep @ 0.40 m deep (average depth 0.25 m)

Wet and Dry Ponds
A stormwater pond is a constructed stormwater management device that collects and detains stormwater runoff from an upstream contributing catchment. A pond can be designed to provide attenuation of flows to help mitigate downstream flood risk and to protect streams from erosion and scour effects. Stormwater ponds can provide some water quality treatment.

Stormwater Management Function

✓*	Water quality ~ Metals ✓ Sediment ~ TPH ~ possibly through specific design
✓	Flood protection
✓	Stream channel erosion protection

* Up-catchment treatment required

Figure 14: Typical Wet Pond

This section provides details about ponds that are either normally dry or normally wet. The following summarises the key differences:

Dry pond - A constructed pond that temporarily detains stormwater runoff to control the peak rate of discharge to mitigate potential flood effects and can provide extended detention to help mitigate downstream erosion and scour effects. These ponds are designed to be dry between storm events.

Wet pond - A constructed pond that has a permanent pool of standing water with live storage provided above this to attenuate peak flows during rainfall events. These ponds can provide some water quality treatment. They can also provide extended detention to help mitigate downstream erosion and scour effects. Increased water temperature associated with the standing water can have a significant adverse effect on receiving environments.

A typical wet pond is shown in Figures 15 and 16.

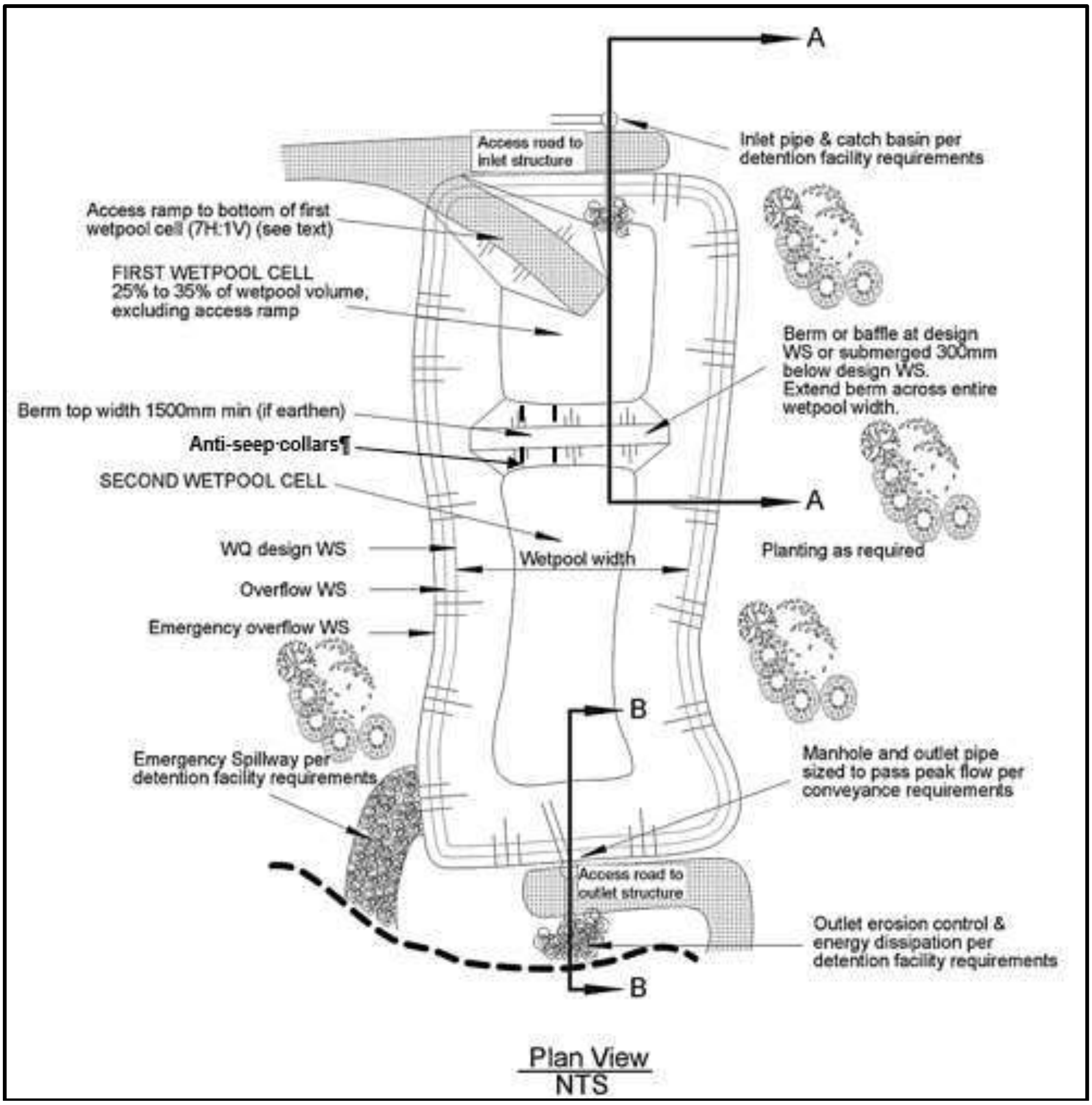


Figure 15: Schematic of a stormwater management pond

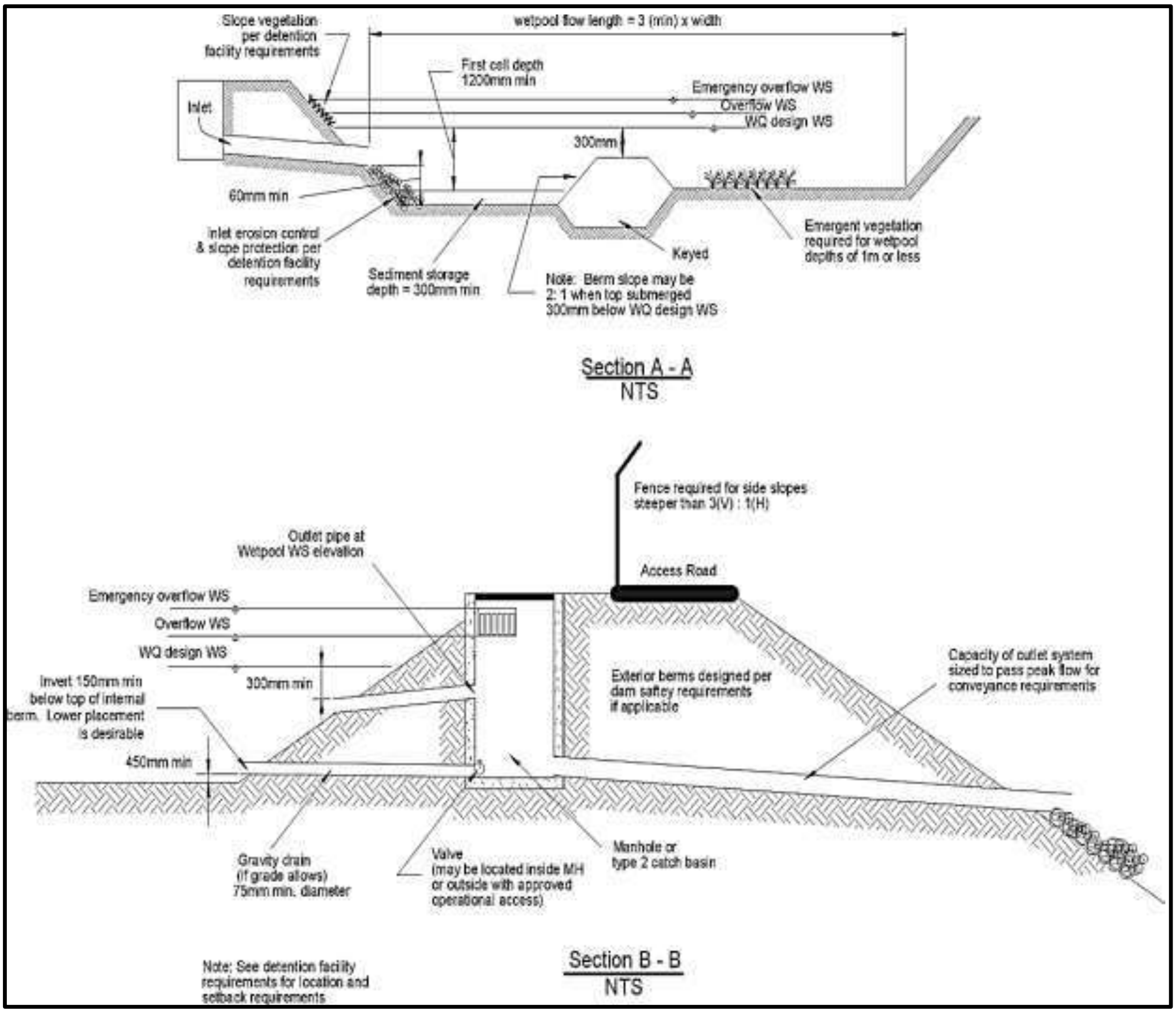


Figure 16: Pond cross-sections

Constraints on the use of ponds

Dry ponds

- Require porous soils or subsurface drainage to ensure that the bottom stays dry between storm events
- Not suitable in areas with high water tables or shallow depth to bedrock
- Not suitable on fill sites or steep slopes unless geotechnically checked
- May not be suitable if receiving water is temperature sensitive

Wet ponds

- Not suitable on fill sites or near steep slopes unless geotechnically checked
- May need supplemental water supply or liner system to maintain permanent pool if not intercepting groundwater
- Minimum contributing drainage area of 6 hectares is needed to maintain the permanent pool
- Not feasible in very dense urban areas or areas with high land costs due to large surface area needs
- May not be suitable if receiving water is temperature sensitive due to warming of pond surface area.

- Safety issues around pool depth need to be addressed

Technical safety criteria for pond design and construction that are beyond the scope of this document include:

- Minimum dam top width
- Embankment side slopes for stability
- Seepage control
- Foundation standards
- Outlet protection
- Access and set aside area for sediment drying

Design Parameters

Site considerations for the design of ponds include the following:

Table 10: Site considerations for Ponds	
Catchment	Ponds should be sized based on the entire contributing catchment and must be located in the catchment's lower portion. Wet ponds should have a minimum contributing drainage area of 6 hectares is needed to maintain the permanent pool
Location	Ponds should be placed away from slopes or locations where there are potential slope stability issues. Ponds should be designed with appropriate setbacks from dwellings, property lines, retaining walls, structures and traffic areas. Ponds should not be located on or near contaminated land or fill materials. Ponds should be positioned offline from any water course.
Groundwater	A geotechnical investigation is needed to inform all pond designs. Dry ponds are not suitable in areas with high water tables or shallow depth to bedrock. Wet ponds may need supplemental water supply or liner system to maintain permanent pool if not intercepting groundwater
Soils	Dry ponds require porous soils or subsurface drainage to ensure that the bottom stays dry between storm events Wet pond functionality is not impacted by poor drainage.
Base flow	Wet ponds need to receive adequate base flow / water inputs to maintain the permanent water level.

Maintenance	Adequate space is required for access for operation and maintenance functions to be performed around a pond. Regular maintenance is required to remove gross pollutants and to remove sediment build up from wet pond forebays.

Pond design considerations and parameters include the following (Table 11):

Table 11: Design Considerations for Ponds	
Pond shape	For wet ponds a minimum length to width ratio of 3L:1W is preferred to facilitate sedimentation
Inlets	Inlets to wet ponds need to be located within a forebay bund to capture gross sediments in the forebay and to enable flows to be dispersed into the main body, avoiding short circuiting. Debris screens should be used for safety and to remove rubbish and prevent clogging. Erosion protection should be provided at the discharge point for inlets (rock rip rap on a geotextile layer). The invert of the inlet should be no lower than the designed permanent water level of the pond. A high flow bypass should form part of the inlet structure, diverting non-design flows upstream of the forebay with erosion protection.
Outlets	The service outlet incorporates specific outlets at different levels sized to achieve the required design criteria for the site. The outlet riser should incorporate the specific outlets, a top debris screen and a valve/screw cap located close to the pond base level to allow for dewatering of wet ponds for maintenance. The outlet pipe which discharges downstream must be correctly sized. If discharging to a coastal area, stream, lake or wetland, erosion protection must be provided. A removable weir plate should be included in the outlet arrangement (within an accessible manhole) that allows the

Table 11: Design Considerations for Ponds	
	permanent water level to be adjusted for maintenance. Anti-seepage solutions must be provided along outlet pipes.
Forebay (Wet Ponds Only)	To hold a minimum of 15% of the water quality volume, minimum depth is 1.0 m. The base of the forebay should be lower than the main body of the pond. The base should be hardened for easier maintenance. A vertical depth marker should be included to assess sediment build up. Flow velocities from the forebay to be less than 0.25m/s during a 10 year ARI event. Forebay bund is to be accessible for maintenance. The crest of the forebay weir should be set to the permanent water level, or 300 mm below the water quality level, whichever is highest The forebay bund ends should be keyed into the side slopes.
Permanent Water Volume (Wet Ponds Only)	Permanent water volume shall provide a minimum permanent water volume of 50% of the water quality volume when extended detention is required, or 100% of the water quality volume when extended detention is not required.
Slopes	All slopes must be approved by a geotechnical engineer based on site specific constraints. Pond bank slopes should generally not exceed 4H:1V if planted or 5H:1V where mowing is required
Water depth	Minimum forebay depth 1m Maximum depth of pond 2m
Safety Features	A reverse slope bench or slope break should be provided 300 mm above the normal standing water pool (where there is a normal pool) for safety purposes. A submerged safety bench is to be provided at least 3m wide around the entire pond (no more than 300mm below the permanent water level)

Table 11: Design Considerations for Ponds	
	Maximum pond side slopes should be 4 H to 1 V. Steeper slopes will make it very difficult for someone who is in the pond to get out of it. TDC does not require fencing of ponds, as it is considered that use of natural features such as reverse benching, dense bank planting, and wetlands buffers (which consist of a dense stand of vegetation) will provide a similar level of protection. The fencing requirement may be reconsidered on a case-by-case basis.
Emergency spillway	Should be armoured and ideally located in natural ground. The spillway embankment should be carefully compacted during construction to prevent settlement. Where possible locate near the inlet to the wet pond to minimise resuspension of sediments in large storm events. Invert should be 100mm above the maximum water level in the pond. Freeboard should be at least 300mm above the maximum peak flow of the design storm event.
Maintenance access	An access track is to be provided that is a minimum of 3.5m width and adequate slope to provide ease of access. A sediment drying area is required near the forebay for wet ponds (sized to accommodate 10% of the permanent water volume at 1m depth), located away from the pond banks, flat with vehicle access.
High flow bypass	It is recommended that a high flow bypass and maintenance bypass is included in the design. Where the pond has an attenuation requirement, then the bypass can be directed to the second cell High flow bypasses should be designed to: • Withstand high flows without erosion and scour. • Preferably to be above ground, e.g. a vegetated trapezoidal channel. • Take into account downstream conveyance capacity constraints.

A schematic of pond safety features is shown in Figure 17.

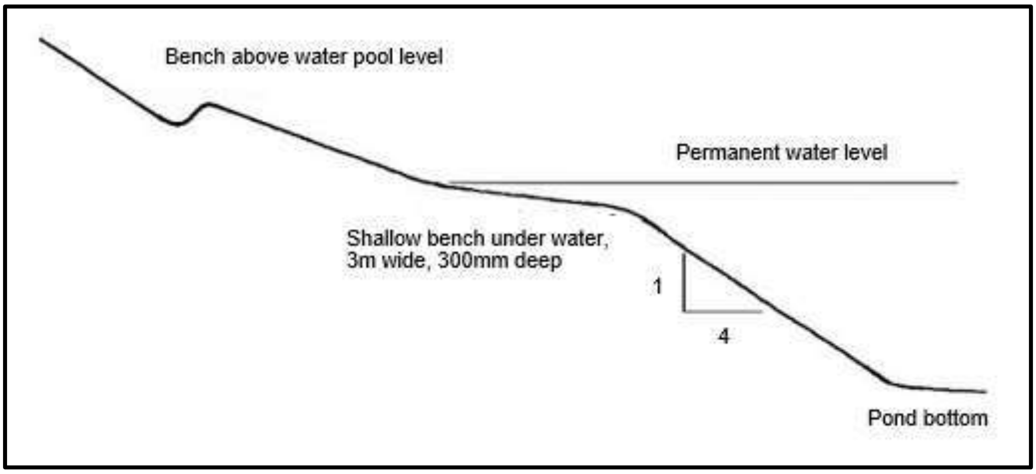


Figure 17: Schematic of safety benches and slopes

Aesthetics must be considered as an essential pond design component. Ponds can be a site amenity if properly designed and landscaped.

Design Procedure
Pond design tasks include the following:

1. Determine the need for stormwater quantity management. Calculate the extended detention requirement which detains the 2 year ARI event and releases it over 48 hours.
2. Determine the need for water quality management. Calculate the water quality volume.

Forebay (Wet Pond Only)
A forebay must be provided for all wet ponds to capture sediment and ensure that flows into the main pond are non-erosive. The sediment forebay is intended to capture only coarse sediments and is the location where most frequent sediment cleanout will be needed.

The forebay bund separating the forebay from the main body of the pond should be formed from impermeable material so that the water level in the forebay can be lowered for maintenance purposes. The crest of the forebay weir should be set to the permanent water level, or 300 mm below the water quality level, whichever is highest.

The forebay should meet the following criteria:

1. The volume of the forebay should be at least 15 % of the calculated water quality volume.
2. Flow velocities from the forebay during the 10-year ARI rainfall event must be less than 0.25 m/s, in order to avoid resuspension of sediment. In some cases this may necessitate increasing the size of the forebay above the minimum criteria provided above.
3. The recommended depth of the forebay is 1 metre or more, to reduce velocities.
4. The forebay should be cleaned out when filled with sediment to 50% of its design volume.

Permanent Water Volume (Wet Pond Only)
The permanent water volume is the volume of water permanently held within a wet pond, between the permanent water level and the base of the pond. It includes the forebay volume and the volume stored in the second wet pool cell. This permanent water pool provides some settling of sediments and amenity value.

The permanent water volume should meet the following criteria:

1. Provide a minimum permanent water volume of 50% of the water quality volume when extended detention is required, or 100% of the water quality volume when extended detention is not required.
2. The volume of permanent water in the forebay is included in the permanent water volume.
3. All ponds should have a shallow bench within the permanent water volume which is 300 mm deep and extends at least three metres from the shoreline, before sloping down to the pond floor.

Hydraulic flow characteristics
The extended detention volume is equal to the 2 year ARI event and includes 50% of the water quality volume. The extended detention volume is located above the permanent water level in a wet pond, or above the base of a dry pond. The extended detention volume should be stored and released over a 48 hour period.

Spillways and Outlet Capacity
There are two primary outlets from a pond: the service outlet and the emergency outlet. They will be discussed in the context of their sizing. Figure 18 illustrates the various outlet elements and components.

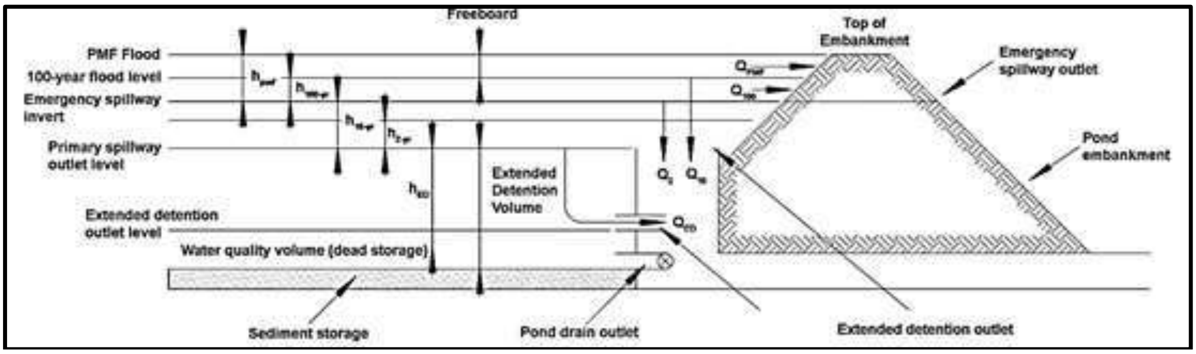


Figure 18: Schematic of pond outlet components

The service outlet should be designed to at least accommodate the flows from the primary drainage system entering the pond. It is important to consider blockage on all outlet devices as smaller orifices will be highly susceptible to blockage unless specifically designed for.

The emergency spillway will convey flows beyond the service spillway's capacity. It should be designed to convey at least the 100-year ARI storm with a freeboard of at least 300 mm.

The emergency spillway should be constructed in natural ground and not placed on fill material unless it is armoured to prevent scour of the embankment. Operating velocities must be calculated for spillways, and particularly at the toe of the spillway, in natural ground to determine the need for additional armouring.

In situations where embankment failure may lead to loss of life or extreme property damage, seek specialist design advice. The New Zealand Society on Large Dams (NZSOLD) can provide guidance on assessing risk and embankment design.

The service outlet may consist of an orifice or pipe outlet, a drop inlet structure, a broad crested weir, a cascade weir or a weir leading to an open channel. As peak control requirements call for both 2 and 10- year ARI storms to be controlled, the discharge is clearly defined in terms of the following equations.

Low Flow Outlet

Required orifice size can be determined by trialling various orifice sizes.

$$Q_i = 0.62A\sqrt{2gh_i}$$

h_i = height of water above centroid of orifice

= the elevation at extended detention - the elevation at normal pool + d/2.

Other devices may be suitable for extended detention design, and all are based on a similar approach to the orifice opening approach. Those designs can include:

- Multiple orifices at the same elevation (n orifices, A area each)

$$Q_i = n0.62A\sqrt{2gh_i}$$

h_i = height of water above centroid of orifice

= the elevation at extended detention - the elevation at normal pool + d/2.

- Vertical slot extending to water surface (width w)

$$Q_i = 1.8wh_i^{\frac{3}{2}}$$

h_i = height of water above invert of slot

- Vertically spaced orifices (situated h_1, h_a, h_b from surface of pond filled to the WQ volume. Each orifice area A)

$$Q = 0.62A\sqrt{2gh_1} + 0.62A\sqrt{2gh_a} + 0.62A\sqrt{2gh_b}$$

- Pipe (area A)

$$h = \left(\frac{1.5{Q_i}^2}{2gA^2}\right) + h_f$$

where h_f is pipe friction loss.

Drop inlet

For moderate flows, the top of the drop shaft acts as a circular sharp weir. For a circular drop inlet, the energy head above the weir lip, (h_{ii}) can be used to calculate the flow according to:

$$Q_{ii} = 3.6pRh_{ii}^{\frac{3}{2}}$$

Where R is the radius of the inlet.

For a box weir:

$$Q_{ii} = 7.0wRh_{ii}^{\frac{3}{2}}$$

Where w is the length of the four sides of the square box, on the inside.

These equations apply only for h_{ii}/R ≤ 0.45 (or, for a box inlet, h_{ii}/w ≤ 0.45). For h_{ii}/R > 0.45, the weir becomes partly submerged, and for h_{ii}/R > 1 the inlet is fully submerged and the flow resistance is equal to the inlet resistance of a pipe, typically:

$$h_{ii} = k\left(\frac{v^2}{2g}\right)$$

Where v is the velocity at flow Q_{ii} and k is typically 0.5 to 1.0, depending on the details of the inlet

For a circular inlet:

$$v = \left(\frac{Q_{ii}}{pR^2}\right)$$

Starting with the design flow and the chosen pipe radius, the head (h_{ii}) can be found by using the appropriate formula for the h_{ii}/R value. If this head is higher than desired, a large outlet can be used.

Aeration of the flow over the weir should be considered if the flows are so high that inadequate ventilation may cause damage to the drop structure. In general, adequate ventilation will be provided by appropriate sizing of the outlet pipes. It is recommended that the outlet pipe be sized so that when the emergency spillway is operating at maximum flow (Qv), the outlet discharges at 75% full. Standard pipe friction and pipe outlet loss calculations can be performed to determine the required outlet size.

The entry to the outlet should be protected by a screen or grid cage to collect debris.

Broad crested weir

In this case, a weir narrower than the emergency weir is used. The weir could be situated away from the emergency weir, or if sufficient erosion protection is provided, in a lowered section of the emergency spillway.

The flow may pass down a single chute into a small plunge pool or appropriately lined area. Alternatively, a series of small cascades or a stepped spillway may be used. To size the weir, the change in pond elevation (h_{ii}) at the service design flow is found by solution of the following equation:

$$Q_{ii} = 0.57\sqrt{2g}\left(\frac{2}{3}Lh^{3/2} + \frac{8}{15}zh^{5/2}\right)$$

As an approximation, the following formula may be used for a broad-crested weir:

$$Q_{ii} = 1.7Lh_{ii}^{3/2}$$

Where *L* is the weir length.

Weir with channel

This design will be useful for shallower ponds, where the channel can be easily constructed by making a cut in the embankment.

The outflow is controlled by the weir. The following may be used as an approximation for a sharp-crested weir:

$$Q_{ii} = 1.8L{h_{ii}}^{3/2}$$

Where Q_{ii} is the service design flow, h_{ii} is the head over the weir when the emergency spillway starts operation and L is the length of the weir. The outlet channel should be sufficiently large that the water level is below the water level (h_{ii}) at the service design flow (to avoid backwater effects).

Emergency spillway design

The emergency spillway section is normally designed as a trapezoidal channel whose sizing is based on trial and error to the following equation:

$$Q_{ii} = 0.57\sqrt{2g}\left(\frac{2}{3}Lh^{3/2} + \frac{8}{15}zh^{5/2}\right)$$

Where:

Q = discharge through the spillway

L = horizontal bottom width of the spillway

h = depth of flow at design flow

z = horizontal/vertical side slope (recommended to be 3)

Pond and Site Design

Pond shape

The design of pond shape should consider engineering constraints, design parameters to achieve treatment, and the existing topography. For a given catchment the design parameters include water volume, surface area, depth, flow velocity and detention period. A minimum length to width ratio of 3L: 1W is preferred to facilitate sedimentation. The designer should minimise dead zones and short-circuiting to improve the treatment performance of the pond.

An average 5 m buffer width around stormwater ponds is required for access and landscaping. Where possible, ponds should be located alongside reserve areas to maximise green space.

Pond contours

Pond contour profiles are critical to the design of a pond: they determine available storage, the range of plants that can be grown and the movement of water through the pond. The safety features of shallow slopes and reverse slopes will help provide areas suitable for a variety of plants.

Edge form
Edge form influences the appearance of a pond, increases the range of plant and wildlife habitats and has implications for pond maintenance. Edges can include sloping margins where water level fluctuations cause greater areas of wet soils. Such gradually sloping areas can appear a more natural part of the landscape than steep banks, and they provide opportunities for a greater range of plants and habitat. Maximum side slopes of 3H:1V are recommended, with flatter slopes of 5H:1V where mowing is required.

Oil separation
Stormwater will, in most situations, contain oils and greases. Having an extended detention outlet similar to the reverse sloping pipe shown in Figure 8-26 will allow water to be discharged from below the surface and encourage volatilisation of the hydrocarbons on the surface.

Debris screens
Screens are used to trap rubbish and organic debris, which is unsightly, especially if trapped in vegetation. Screens should be used to protect extended detention outlets from clogging. Screens may be installed either at the inlet to the pond or at the outlet from the pond.

Access
Access to the pond for maintenance must be provided for in the design. Access slopes for maintenance vehicles should not exceed 12H:1V for trucks and 5H:1V for excavator access.

Proprietary Treatment
Technology and innovation are bringing continuous improvement to the stormwater treatment industry in New Zealand. A number of suppliers have both off-the-shelf products and custom-designed proprietary stormwater treatment systems. These devices typically have a small footprint and have been shown to provide high levels of contaminant removal.

Proprietary devices range from sumps inserts, gross pollutant traps (GPT) and oil-water separators to enhanced systems which use membrane and media filtration. The broadly termed 'enhanced proprietary' systems have significant advantages in performance over other proprietary primary separators and gross pollutant traps. Innovative treatment methods include: hydrodynamic separation, engineered media filtration, membrane filtration and combined media-bio-filtration.

Figure 19: Examples of enhanced proprietary stormwater devices

Design Basis
Design of proprietary devices considers three key parameters; flowrate, contaminant loading and hydraulics. Flow-based treatment devices are designed to treat the water quality flow rate of 10 mm/hr. They require a driving head to operate and typically rely on filtration as their treatment mechanism. Attenuation is incorporated in some treatment devices (such as proprietary raingardens and sand filters). These devices are designed with a ponding depth above the media and a media infiltration rate. Suppliers and manufacturers play a key role in the design process, providing support for the following:

- Selection of the appropriate devices for the contaminant type and loading
- Sizing of devices
- Detailed design to meet hydraulic requirements
- Maintenance requirements and contacts

Calculation sheets, design plans and product specifications are required to be submitted as part of the approval process for the use of any proprietary system. Documentation of water quality analyses should also be supplied to support contaminant removal efficiencies.

Council's preference is to avoid the use of proprietary devices to achieve stormwater treatment objectives in greenfield residential developments. However, proprietary systems may be an appropriate solution for brownfield and industrial / commercial developments where there may be a constraint on available space for implementing stormwater management systems. TDC will typically not approve the use of a proprietary product that has not already been shown to function successfully in New Zealand.

APPENDIX C: PLANNING, DESIGN AND OPERATION CHECKLIST

Treatment system design and operation should follow the checklist below.

Catchment Hydrology

☐ Determine runoff flows

- ☐ Base flow, summer and winter
- ☐ Frequent events, say 5 times per year
- ☐ Rare flood events
- ☐ First flush volume

Selection of Catchment Management Measures

☐ Determine flood detention objectives

☐ Determine water quality objectives

☐ Estimate the pollutant discharges (dissolved, suspended, and floating)

☐ Identify critical pollutants and receiving water reduction targets

Pre design monitoring:

☐ Design a monitoring/sampling program

- ☐ Select sites for monitoring
- ☐ Assess instrumentation needs

Treatment train selection:

☐ Review types of stormwater treatment systems

☐ Make the treatment train selection based on objectives

☐ Adopt at least first flush offline treatment

Siting the facilities:

☐ Look at physical constraints

☐ Consider landscape and other values

Design Principles

☐ Look at litter trapping measures

☐ Set preliminary basin/pond/wetland depth and shape

☐ Carry out flow routing for:

- ☐ Base flow
- ☐ Frequent events
- ☐ Rare flood events
- ☐ First flush diversion

☐ Look at water treatment of:

- ☐ Base flow
- ☐ Frequent events
- ☐ Rare flood events
- ☐ First flush volume

☐ Determine likely sediment removal effectiveness

- ☐ Assess particle sedimentation efficiency
- ☐ Look at ability to retain settled particles

☐ Consider recreation and aesthetic functions

☐ Refine basin/pond/wetland depths and shape

☐ Resolve inlet and outlet configurations

☐ Select aquatic and riparian plants and design the planting

☐ Look at likely impacts of water quality on ecology

☐ Design structural elements

- ☐ Look at soil substrates, groundwater, and percolation
- ☐ Carry out embankment design
- ☐ Design the shoreline of the structure for wave, water current, aesthetic, and ecological needs
- ☐ Design outlet control structures, allowing for water level control and full drawdown
- ☐ Carry out spillway design
- ☐ Review all components for maintenance requirements including access

☐ Assess and resolve Health and Safety issues

Operation and Maintenance

☐ Produce an Operation and Maintenance manual (Refer to Appendix B.2)

☐ Pond and/or wetland performance assessment

☐ Design a monitoring/sampling program

- ☐ Select sites for monitoring
- ☐ Assess instrumentation needs

APPENDIX D: STORMWATER QUANTITY

Introduction

Adverse environmental impacts can occur when high stormwater flows are discharged into the receiving environment. These flows alter the natural flow patterns and can have negative impacts such as erosion, scour, siltation and flooding. Development typically increases in the area of impervious surfaces such as roads and roof areas. These cause both an increase in volume of stormwater runoff (due to decreased infiltration or interception by vegetation), and a reduction in time it takes to enter the receiving environment, when compared to the pre-development flow patterns.

The aim of stormwater quantity management, or stormwater neutrality, is the reduction of post-development flows into the receiving environment, back to pre-development levels. This can typically be achieved by:

- attenuation – holding the water back and allowing a slow discharge
- on-site discharge – infiltrating the water to ground, or
- alternative methods such as onsite retention or re-use (these are not discussed further in this document)

Design Guidance

To assess the impact of changes to a catchment, analysis of the flows before and after development need to be made. The determination of stormwater inputs such as design rainfall intensity and runoff rates are applied to the Rational Method or a detailed hydraulic analysis. Some guidance on approaches is provided:

- Surface water runoff from non-hill catchments up to 15 hectares, and hill catchments up to 5 hectares, may be calculated using the Rational Method'
- For catchments larger than the areas above, the Rational Method tends to give a conservative result. Therefore for larger areas a dynamic analysis by computer modelling should be used.

It is common practise for stormwater quantity analysis to be undertaken using hydraulic and/or hydrologic modelling software. This document does not provide specific guidance on inputs or methods, however, reference can be made to WWDG[1] Chapter 21.4 Advanced Analysis, NZWERF[2] or use of hydraulic modelling software such as HEC-HMS or Mike Urban.

Certification Requirements

Certification requirements apply to stormwater discharges into the TDC reticulated network and/or assets to be vested and where discharges to ground are within Global Consented Stormwater Management Areas. The process to achieve certification from TDC for discharges to the reticulated network is summarised, with the application form available, on the TDC website[3].

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[1] CCC, 2020. Waterways, Wetlands and Drainage Guide: Part B. Christchurch City Council. Updated June 2020.

[2] NZWERF, 2004. On-site Stormwater Management Guideline. New Zealand Water Environment Research Foundation, October 2004.

[3] TDC Stormwater Discharge Certification, https://www.timaru.govt.nz/services/environment/storm-water/stormwater-discharge-certification

With respect to stormwater quantity, the Timaru District Plan sets out the requirements in the Stormwater Management Chapter. All development (including re-development) which creates 30 m² or more of additional impervious surfaces is required to achieve stormwater neutrality.

The events for up to which stormwater neutrality must be achieved is defined by both zone and activity as described in the District Plan. It is expected that an assessment of stormwater neutrality would include rainfall events up to and including the duration specified in Tables 4-1 and 4-2.

Table 4-1: Summary of Minor Development requirements for Stormwater Neutrality				
Zone	**Residential (GRIZ, MDEZ, SZ, MPZ, RLZ)**	**Commercial (all)**	**Industrial (GIZ)**	**Other (NOZ, OSZ, SPRZ)**
Activity	>30 m² and <500 m² <70% impervious			
Stormwater Neutrality	1 in 10 year	1 in 10 year	1 in 50 year	1 in 50 year
Event Duration	1 hour	1 hour	1 hour	1 hour

Table 4-2: Summary of Major Development requirements for Stormwater Neutrality				
Zone	**Residential (GRIZ, MDEZ, SZ, MPZ, RLZ)**	**Commercial (all)**	**Industrial (GIZ)**	**Other (NOZ, OSZ, SPRZ)**
Activity	>500 m²			
Stormwater Neutrality	1 in 10 year	1 in 10 year	1 in 50 year	1 in 50 year
Event Duration	24 hours	24 hours	24 hours	24 hours

Rational Method

The Rational Method is used to estimate runoff from small catchments (non-hill catchments up to 15 ha and hill catchments up to 5 ha). It should be used with caution as the result is highly sensitive to correct selection of the runoff coefficient. For larger catchments, a dynamic analysis by computer modelling is recommended.

The Rational Formula has the form:

$$Q = 2.78\, C\, i\, A \qquad \text{Eqn (4-1)}$$

Where

Q = runoff in litres per second (L/s)

C = runoff coefficient (Table 4-4)

i	= rainfall intensity (mm/hr) during the design storm duration (D) for the selected return period (Appendix L)
A	= area catchment above the point being considered (ha)

See below for procedures for determining A, C, i and D.

Catchment Areas

The catchment area (A) is the catchment upstream of the point under consideration, measured in hectares. The District Plan – Stormwater Chapter refers to impervious surfaces, as per the Definitions. Typical impervious surfaces include:

- Roofs
- Paved areas including driveways and sealed or compacted metal parking areas and patios
- sealed outdoor sports surfaces
- Sealed and compacted-metal roads
- Engineered layers such as compacted clay

TDC Design Rainfall

Design rainfalls specific to the main centres of Timaru District have been developed to account for localised rainfall characteristics. Design rainfall intensities, inclusive of climate change corrections, are provided in Appendix L for the townships of Timaru, Pleasant Point, Geraldine and Temuka.

For sites located away from these towns, source rainfall data from the National Institute of Water and Atmospheric Research (NIWA's) High Intensity Design Rainfall System[4] (HIRDS). The design scenario to be applied is RCP8.5 for the period 2081 – 2100, to account for the potential impact of climate change.

The Design Storm Duration (D) for stormwater devices is specified within the standards of the TDC District Plan – Stormwater Chapter. However, in applications where the duration must be determined, refer to the methodology provided in Appendix J.

Runoff Coefficient

The runoff coefficient is the proportion of rainfall that becomes runoff. Its value depends on the characteristics of the catchment, which mainly depend on the amount of pervious area. For example in sealed urban areas a higher proportion of rainfall will become runoff than would occur on rural catchment areas.

Table 4-4 lists runoff coefficients appropriate to a variety of land uses and soil characteristics. For catchments having a mixture of different types, the runoff coefficient shall be determined by averaging the value for individual parts of the catchment by using the formula:

[4] NIWA, 2017. High Intensity Rainfall Design System V4. https://hirds.niwa.co.nz/. National institute of Water and Atmospheric Research.

$$C = \frac{\sum C_i A_i}{A_c} \qquad \textbf{Eqn (4-3)}$$

Where C = the runoff coefficient for the catchment

C_i = the runoff coefficient for a particular land use or surface type

A_i = the area of land to which C_i applies

A_c = the catchment area

Table 4-4: Runoff Coefficients for Soil Types and Land Use	
Surface	***C***
Natural Surface Types	
Bare impermeable clay with no interception channels or run-off control	0.70
Bare uncultivated soil of medium soakage	0.60
Heavy clay soil types: – pasture and grass cover – bush and scrub cover – cultivated	 0.40 0.35 0.30
Medium soakage soil types: – pasture and grass cover – bush and scrub cover – cultivated	 0.30 0.25 0.20
High soakage gravel, sandy and volcanic soil types: – pasture and grass cover – bush and scrub cover – cultivated	0.20 0.15 0.10
Greenspace – Parks, playgrounds and reserves – Gardens, lawns, etc.	Choose appropriate soil and cover type from above
Developed Surface Types	
Roofs, sealed roads and paved surfaces	0.90
Paving stones – with sealed joints – with open joints	 0.80 0.60
Unsealed roads and unsealed yards (e.g. gravel hardstand)	0.50
Note: Table modified from NZBC E1[5].	

The values of run-off coefficient given in Table 4-4 shall be adjusted for slope and rainfall intensity in accordance with Table 4-8, with a maximum C of 1.0 (i.e. if the adjustment to C from Table 4-5 results in a C>1, a value of 1.0 should be used.

[5] MBIE, 2020. Acceptable Solutions and Verification Methods for the New Zealand Building Code Clause E1 Surface Water. Ministry of Business, Innovation and Employment. Amended November 2020.

Table 4-5: Runoff coefficient adjustments	
Catchment Characteristics	**Adjustment to C**
Slope	
0-5%	- 0.05
5-10%	0.00
10-20%	+ 0.05
>20%	+ 0.10
Rainfall Intensity	
< 10 mm/hr	0.00
10-25 mm/hr	+ 0.05
25-50 mm/hr	+ 0.15
> 50 mm/hr	+ 0.20
Note: Table modified from NZBC E1[6].	

Devices for Quantity Management

A summary of devices which can be used for quantity management is provided in Table 4-6. A more detailed discussion of advantages and limitations of devices is provided in Appendix B.

Table 4-6: Devices for Quantity Management		
Type	**Options**	**Comments**
Tanks	Aboveground or below ground	Effective when limited area is available Provides storage volume with limited rate discharge to the network or surface water
Basins	Wet ponds, dry basins or wetlands	Provides storage volume with limited rate discharge to the network or surface water Provision of additional ecological values
Discharge to Ground	Infiltration, bioretention practises and permeable paving	Achieves stormwater neutrality without requiring a discharge point to the network or surface water

Worked Example – Neutrality

To achieve stormwater neutrality, post-development flows into the receiving environment must be reduced to less than or equal to pre-development flows. A simplified method to determine a site's stormwater neutrality requirement follows, with a worked example below:

1. Using the Rational Method or alternative analysis, calculate the flow from the existing site, for the applicable storm event and duration (Table 4-1 above).

[6] MBIE, 2020. Acceptable Solutions and Verification Methods for the New Zealand Building Code Clause E1 Surface Water. Ministry of Business, Innovation and Employment. Amended November 2020.

Convert to a volume of stormwater generated over the duration of the rain event.

2. Repeat Step 1 for the proposed site development
3. The increase in volume/flow between the existing site (pre-development) and the proposed (post-development) represents the volume/flow required to be attenuated or discharged to ground to achieve stormwater neutrality.

- Pre-development Area = 550 m^2, medium soakage soil with pasture average grass cover, 5-10% slope
- Post-development Area = 180 m^2 roof, 230 m^2 driveway, 140 m^2 grass
- Total Impervious Surface added is 410 m^2. This is 75% of the site (410/550 x 100).
- The development site is located in a Mixed Use zone. According to Table 4-3, for sites with >70% impervious area, stormwater neutrality is to be achieved for a 1 in 10 year, 24 hour event.

Table 4-6: Worked Example Parameters

	Catchment Area (ha)	Runoff Coefficient	Rainfall Intensity (mm/hr)	Peak Discharge (L/s)
Pre-development				
Grass	0.055	0.3	4.375	0.20
			Permissible site Discharge	0.20
Post-Development				
Grass	0.014	0.3	4.375	0.05
Roof	0.018	0.9	4.375	0.20
Driveway	0.023	0.9	4.375	0.25
			Post-development Discharge	0.50

- The post-development discharge exceeds the discharge from the site prior to development by 0.3 L/s.
- Acceptable Solution 1 (Rainwater Tanks) cannot be applied as the design requires a 24 hour event.

Options include:

- Roof water tank and Infiltration device – Conversion of the driveway to permeable pavement would allow the runoff to infiltrate to ground and meet stormwater neutrality while roof water is detained in a tank
- Storage – A raingarden or dry basin could provide attenuation at the surface, or tanks located underground

APPENDIX E: STORMWATER QUALITY

Introduction

Water quality refers to the chemical, physical and biological characteristics of water. In the context of stormwater, contaminants may be entrained in water, dissolved or a chemical constituent which can affect the ecological, aesthetic, cultural, recreational or economic value of a receiving environment. Stormwater treatment is the reduction of these contaminants to a level at which they no longer have negative impacts, prior to their discharge to the environment. Table 5-1 summarises common stormwater contaminants and their impacts.

Table 5-1: Common stormwater contaminants

Type	Contaminant	Impacts
Suspended Solids	TSS	Increased sediment bed load. Smothering of fish and invertebrate gills, decreased light availability for aquatic plants and reduced visibility for fish.
Nutrients	Nitrogen, Phosphorus	Nuisance plant growth
Hydrocarbons	TPH, PAH	Oxygen depletion of waters
Metals	Copper, Lead, Zinc	Impact on the physiology of plants, chronic and acute effects on animals
Microbes	E. *coli*	Potential impacts on human health

The most effective method for removing contaminants in stormwater is to use a number of devices to provide multiple water quality benefits. It is important to select a range of treatment devices which provide complimentary contaminant removal. The combination of treatment devices in sequence is referred to as a "Treatment Train".

Design Guidance

Stormwater treatment design uses two methods for calculation: flow-based and volumetric. The flow-based approach is applied to devices which have a constant flow and little storage volume, such as swales and proprietary devices. A volumetric approach is applied to devices which can store stormwater, such as ponds and raingardens, and this attenuation forms a key part of the treatment mechanism.

Minimum target removal rates for contaminants in stormwater are tabulated in the TDC District Plan Stormwater Chapter (Table 5-2). This may require that devices be combined to achieve the specified removal rates for contaminants of concern.

An alternative approach to treatment calculations is to use contaminant concentrations and percentage removals, to achieve a specified target concentration. This approach is applied by ECan through the Canterbury Land and Water Regional Plan[1] and the Receiving Water Standards identified in Schedule 5 and Water Quality Limits in Schedule 8. A methodology and references are provided in Appendix K. However, this approach does not presently meet the certification requirements for TDC.

Practises such as riparian planting and re-vegetation are encouraged in the district. The ecological goal is to create a sustainable and naturally functioning ecosystem, which requires a minimum of ongoing intervention and maintenance. Planting and habitat creation will also help attract invertebrates, fish, and birds back to urban areas. While the impacts on improved water quality are not quantified, these practises support a holistic approach to stormwater management. Refer to WWDG Section 11 for further detail.

Certification Requirements

Certification requirements only apply to stormwater discharges into the TDC reticulated network or assets to be vested. The process to achieve certification from TDC for discharges to the reticulated network is summarised, with the application form available, on the TDC website[2].

With respect to stormwater treatment, the Timaru District Plan sets out the requirements in the Stormwater Management Chapter. The minimum contaminant removal rates for stormwater treatment are defined by both zone and activity and are tabulated below (Table 5-2).

Table 5-2: Minimum Target Contaminant Removal Rates

Zone	Residential (GRIZ, MDEZ, SZ, MPZ, RLZ)	Commercial (all)	Industrial (GIZ)	Other (NOZ, OSZ, SPRZ)
Activity	Non-residential Activity (including roads) >30 m²	>50 m²	>30 m²	>30 m²
First Flush	10 mm/hr 21 mm depth	10 mm/hr 21 mm depth	10 mm/hr 21 mm depth	10 mm/hr 21 mm depth
Suspended Solids	> 80 %	> 80 %	> 80 %	> 80 %
Total zinc	> 70 %	> 70 %	> 80 %	> 70 %
Total copper	> 70 %	> 70 %	> 80 %	> 70 %
Total Petroleum Hydrocarbons	> 70 %	> 70 %	> 70 %	> 70 %
Nutrients (Nitrogen, Phosphorus)	> 50 %	> 50 %	> 50 %	> 50 %

[1] ECan, 2019. Canterbury Land and Water Regional Plan. Canterbury Regional Council, February 2019.

[2] https://www.timaru.govt.nz/services/environment/storm-water/stormwater-discharge-certification

Water Quality Volume

The Water Quality Volume (WQV) or First Flush Volume (Vff) refers to the stormwater runoff volume that occurs at the start of a rain event. This runoff typically contains higher concentrations of contaminants which have accumulated on surfaces between rain events. Effective treatment of the first flush volume forms the design basis for many treatment devices.

The Water Quality Volume is calculated according to Eqn 5-1 below.

$$WQV = \frac{\boldsymbol{CAd}}{\mathbf{1000}} \qquad \textbf{Eqn (5-1)}$$

Where

WQV	= water quality volume (m^3)
C	= runoff coefficient (Section 4.4.3)
A	= contributing catchment area (m^2)
d	= first flush rainfall depth

A first flush rainfall depth of 21 mm is applied throughout the Timaru district.

Water Quality Flow

The Water Quality Flow (WQF) refers to the stormwater runoff flow that occurs at the start of a rain event. This runoff typically contains higher concentrations of contaminants which have accumulated on surfaces between rain events. While many stormwater treatment devices utilise the Water Quality Volume detailed in Section 0 above, some flow based devices are sized based on the Water Quality Flow.

The Water Quality Flow is calculated using the rational method according to Eqn 4-1, with runoff coefficients determined based on Table 4-4. For treatment devices that are designed on a flow-based approach, a design intensity of 10 mm/hr is applied.

Removal Rates

The minimum contaminant removal rates for stormwater treatment are defined in Table 5-2. The removal rates achieved for specific contaminants by different treatment devices are summarised (Table 5-3).

Minimum contaminant removal rates are not applicable where there are particularly sensitive or significant receiving environments. In which case, investigation of the receiving environment must be carried out and specific target concentrations achieved for the protection of the receiving environment.

Table 5-3: Removal rates (%) for various treatment devices						
	TSS	**Zinc**	**Copper**	**TPH**	**Nitrogen**	**Phosphorus**
Swale	75	50	60	50	20	30
Filter strip	70	50	60	>70	20	20
Sand filter	80	90	90	>70	35	45
Bioretention devices	80	70	75	>70	40	60
Bioretention devices (anaerobic zone)	80	70	75	>70	50	80
Infiltration devices	80	80	70	>70	30	60
Dry ponds	40	10	20	20	10	20
Dry ponds (extended detention)	60	20	30	30	20	30
Wet ponds	75	30	40	30	25	40
Wetlands	80	60	70	70	40	50
Green roofs	Design for quantity management only[1]					
Water tanks	Design for quantity management only[1]					
Permeable paving	Design for quantity management only[1]					
Notes: [1] These are evolving technologies and their ability to treat stormwater will be considered at TDC's discretion on the supply of literature to support contaminant removal rates.						

Removal rates for proprietary devices have not been provided. These devices will be considered at TDC's discretion on the supply of testing data and literature to support their contaminant removal rates.

Treatment by Devices

Multiple devices may be required to achieve the minimum removal rates at the point of discharge, referred to as a Treatment Train. An equation to estimate the percentage total removal of a given contaminant for two or more stormwater management devices in series is the following:

$$\boldsymbol{R = A + B - \frac{(A\ x\ B)}{100}} \qquad \textbf{Eqn (5-2)}$$

Where:

R = total removal rate %

A = Removal rate of the first or upstream practice %

B = Removal rate of the second or downstream practice %

Modelling software is available that can be used to develop stormwater treatment trains and give percentage removals and specific concentrations expected for the treatment train given typical contaminant runoff from various catchment types. An example is MUSIC by EWater[3].

[3] https://ewater.org.au/products/music/

Many water quality treatment devices can have limited quantity control capability and may be required to be used in conjunction with another device to achieve the stormwater quality requirements for the site. Other factors including topography, land use characteristics, receiving environment and overall design intent must also be considered to determine the appropriate system to manage water quality.

Devices for Quality Management

A summary of devices which can be used for quality management is provided in Table 5-4. A more detailed discussion of advantages and limitations of devices is provided in Appendix B.

Table 5-4: Devices for Quality Management

Type	Options	Comments
Swales	Vegetated or planted swales, filter strips	Less effective for removal of nutrients and dissolved contaminants
Basins	Wet ponds or dry basins	Removal of coarse to fine particles
Wetlands	-	Good removal of fine particles and dissolved contaminants
Infiltration	Discharge to ground or underdrainage	Requires pre-treatment for sediment removal to prevent clogging
Bioretention	Anaerobic zones Discharge to ground or underdrainage	Good removal of fine particles and dissolved contaminants
Proprietary	Various manufacturers and operational criteria	Removal efficiencies vary significantly. Requires testing data to validate the removal efficiencies

Worked Example - Quality

Options for devices to achieve the minimum contaminant removal for stormwater quality for a residential subdivision of greater than 6 lots are provided below. This activity creates a road and is therefore a non-residential activity within the residential zone. This requires contaminant removal rates of:

- TSS >80%
- Nutrients (Nitrogen, Phosphorus) >50%
- Metals (Zinc, Copper) >70%
- Hydrocarbons >70%

Example devices and treatment trains to meet the minimum treatment for a greater than 6 lot subdivision may include:

1. A single Bioretention device with an anaerobic zone, such as a rain garden - this can meet quality requirements at removal rates of:
   TSS 80%, Nitrogen 50%, Phosphorus 80%, Zinc 70%, Copper 75%, TPH 70%

2. Multiple Devices in Treatment Train

A swale and a wetland can be sized to meet quality requirements at removal rates of:

$R = A + B - ((A \times B)/ 100)$ where A is swale and B is wetland

For TSS,	$R = 75 + 80 - [(75x80)/100] = 155 - 60 = 95\%$ removal
For nitrogen,	$R = 20 + 40 - [20x40)/100] = 60 - 8 = 52\%$ removal
For phosphorus,	$R = 30 + 50 - [(30x50)/100] = 80 - 15 = 65\%$ removal
For copper,	$R = 60 + 70 - [(60x70)/100] = 130 - 42 = 88\%$ removal
For zinc,	$R = 50 + 60 - [(50x60)/100] = 110 - 30 = 80\%$ removal
For TPH,	$R = 50 + 70 - [(50x70)/100] = 120 - 35 = 85\%$ removal

APPENDIX F: OPERATION AND MAINTENANCE

Operation and Maintenance

Routine maintenance and monitoring involves scheduled tasks to ensure the stormwater device/asset is functioning as intended.

Private devices' inspection and maintenance obligations fall to the owners. Inspection reports may be required to be submitted to TDC. Non-compliance may lead to an inspection by TDC and maintenance at the owner's cost. Public assets will be inspected, maintained and monitored by TDC according to the relevant consents and Operation and Maintenance Manual.

Consideration of maintenance requirements i.e. access points, HSE and the ability to replace parts, must be considered during the design of stormwater devices and structures. A list of typical inspections, maintenance requirements and frequencies for a range of stormwater management devices is provided in Appendix H. Responsive maintenance may also be required if conditions in the catchment change or if unusual damage or a high degree of wear and tear occurs to the extent that the device is not operating as intended.

Annual maintenance/inspection records should be kept, including but not limited to:

- Date and details of inspections of the stormwater system; and
- Date and details of any maintenance work, repairs and upgrades to the stormwater system, including removal of material and its disposal.

Preparation of an Operation and Maintenance Manual is required for stormwater infrastructure. Reference the Checklist below when setting up the operation and maintenance requirements for a new asset.

Appendix F.2: OPERATION AND MAINTENANCE CHECKLIST

For Designers and System Managers

☐ Photocopy and use this checklist for all projects.

☐ For all questions, consider impacts on adjacent owners/ community.

Responsibilities

☐ Is it clear who is responsible for the various aspects of maintenance?

☐ What is expected of the adjoining owner? What is expected of the Council?

☐ Have all the necessary consents been obtained?

☐ What is the process for transferring project responsibility between different entities (e.g. between construction, plant establishment, and long-term maintenance phases)?

☐ Who should hold the discharge permit and any other consents? Should they be transferred to the Council, and if so, when?

☐ If the system component is on private land, have the landowner's needs been taken into account?

☐ Have all the written agreements of roles and responsibilities been completed?

Operation and Maintenance Methods and Procedures

☐ Have clear O&M strategies, procedures, or guidelines been issued? Are the documents readily accessible to all personnel involved?

NB: Operation manuals are always required for wetlands, basins, and ponds.

☐ Have the most appropriate maintenance techniques been specified? Are they authorised?

☐ Have alternative techniques been considered? Is the preferred technique the most cost-effective?

☐ Has satisfactory access for maintenance been provided? What type of machinery, if any, will need to gain access?

☐ Do any pools/ponds need to be completely drained for lining repair, sediment removal, etc?

Does pond water level need to be managed or completely drained? How can this be achieved?

☐ Is access width, space, slope, and surface still suitable during storm emergency conditions?

☐ Will the maintenance regime need to change through the life of the project?

☐ Has site security and adjoining owners' security been considered? Is there a need for fencing and locked gates?

Public Safety and Security

☐ Have requirements of the Health and Safety at Work Act 2015 been met (i.e. have all the hazards been identified and avoided, remedied, or mitigated against)?

☐ Does the system meet the Council's health and safety requirements?

☐ Does the proposal conform to the principles of reducing crime through environmental planning and design (refer to Crime Prevention Through Environmental Design – ISO 22341:2021)

☐ Is open-style fencing needed to improve safety and/ or security?

☐ Is the system component safe in terms of the Building Act (2004)?

☐ Is it safe for adjoining public activities? For example, is ready egress available?

☐ Will the facility be available for safe entry and exit for recreation?

Flooding and Other Hazards

☐ Does the design storm capacity meet agreed planning criteria?

☐ Where is the secondary flow path likely to be? Should it be protected by an easement?

☐ Is storm inspection and debris removal needed? If this is so, have all necessary arrangements been made?

☐ Is the level-of-service that has been designed for, adequate in view of the importance and susceptibility of the system component(s) during extreme storms?

☐ Is uncontrolled growth likely to cause a fire hazard during hot, dry summer seasons?

☐ How will the system component perform under each of the Engineering Lifelines hazard scenarios?

For example, seismic activity, River flooding, local flooding, tsunami, wind, snow, and slope hazards?

Design

☐ Have "life cycle" design principles, including project life cycle cost, been considered?

☐ Is the design a relatively low maintenance solution in the short-tern,? In the long-term?

Thus is the solution a sustainable one?

☐ Have potential flow obstructions, erosion, and sedimentation problems during the early development and establishment phases been identified and provided for in the design?

Vegetation

☐ Has the initial planting contract maintenance been defined?

☐ Has the establishment transitional maintenance been defined (i.e. while the planting becomes established; usually year 2-4 after planting)?

☐ Has the ongoing maintenance from year 5 and beyond been defined?

☐ Is there any specific maintenance criteria for the riparian vegetation in the area?

☐ How will the terrestrial vegetation growth be controlled - by sickle, weed eater, mechanical mower, or herbicide? Are the contours and space available compatible with the preferred method? What is the likely frequency of growth control measures?

☐ Will aquatic vegetation need to be controlled by handwork, excavator, harvester, or herbicide? How will algal growth be managed?

☐ Is there any specific maintenance criteria for the aquatic vegetation (including both marginal and submerged plants) in the area?

☐ Is erosion control needed if watering is necessary during plant establishment?

☐ What is the acceptable maximum height and density of vegetation that will not compromise hydraulic requirements?

☐ Could the selected plant species cause other maintenance problems located downstream?

For example, flax and cabbage tree leaves can wrap around the impellers of storm water pumps.

☐ What undesirable terrestrial or aquatic plant species could potentially become established? How will they be controlled?

Debris, Litter, and Sediment

☐ Where will debris, litter, and sediment accumulate? What measures will be needed to interrupt and remove it? How often?

☐ Are debris grills or trash racks needed?

☐ If the system component blocks during a storm, where is the secondary flow path that will divert overflows safely?

☐ Should a pond, debris trap, gross pollution trap, vegetative filter, or other interception device be installed upstream?

☐ Will sediment need to be removed? Is adequate access provided for this?

Nuisances

☐ How will the incidence of pests and nuisances be minimised:

- ☐ problem insects (blackflies, biting midges, and mosquitoes)?
- ☐ stagnant water conditions?
- ☐ smells?
- ☐ algal blooms?
- ☐ rats?

☐ How will complaints be managed?

☐ Will vegetation have adverse effects on adjoining properties?

☐ How many dwellings are close enough to be affected by nuisance

APPENDIX G: CONSTRUCTION STORMWATER MANAGEMENT

Erosion and Sediment

Erosion and sedimentation are natural processes where soil is worn away, transported and deposited by wind or water. However, these processes can be accelerated by manmade factors such as urban development and earthworks. During construction activities bare soil is exposed, which leads to an increased risk of erosion.

Effects of erosion and sedimentation include:

- ecological impacts on downstream waterways due to siltation, smothering of aquatic habitats, abrasion and low light levels
- physical blockages in channels or pipes causing increased flood risk and damage to assets
- effects on Te Mana o te Wai
- impacts on recreational use and visual amenity of waterbodies
- unsuitability of downstream water to be used for irrigation, stock and domestic water supplies

The management of erosion and sediment during construction activities is of high importance. ECan's Erosion and Sediment Control Toolbox[1] (ESCT) identifies the key principles of Erosion and Sediment Control (ESC). These principles are applied through a variety of tools which, when combined in an effective management strategy, form an Erosion and Sediment Control Plan (ESCP).

Erosion and Sediment Control Plans

All construction works where bare soil will be exposed to rainfall require an ESCP in general accordance with ECan's ESCT.

Resource consent from ECan is generally required when undertaking earthworks and discharging water generated during construction. The intention of the Global Discharge Consents are to allow construction discharges to the TDC network for small sites, without requiring a separate ECan consent (Figure 8-1). However, approval must be sought and gained from TDC prior to discharges commencing.

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[1] ECan 2021. Erosion and Sediment Control Toolbox for Canterbury. https://esccanterbury.co.nz/. Canterbury Regional Council.

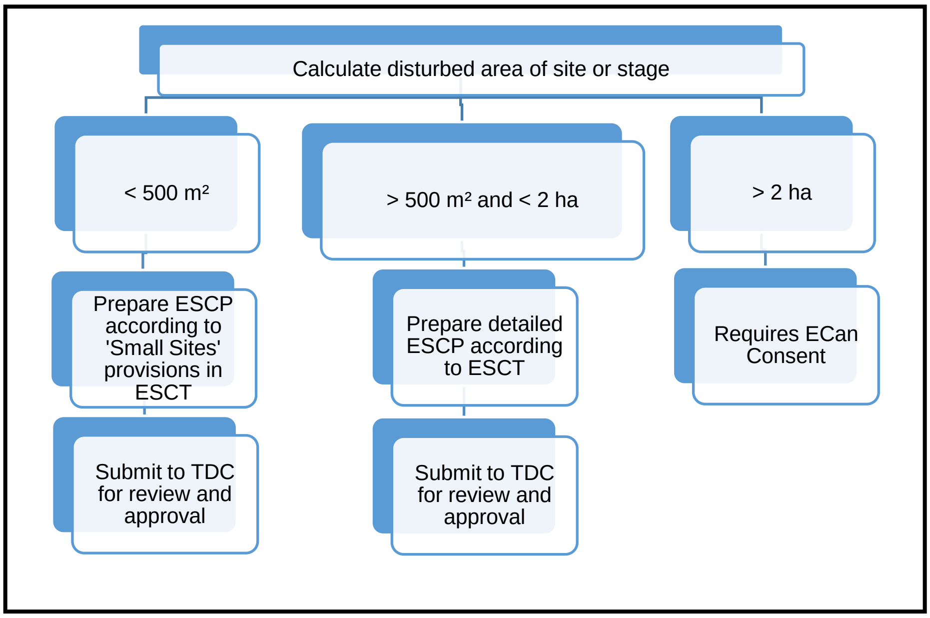


Figure 8-1: Flow chart of ESCP requirements

For minor developments (sites< 500 m²) an ESCP, as outlined in ECan's ECST Checklist 25, shall be submitted to TDC for approval showing where and how the following site management measures, at a minimum, are to be achieved:

- stabilised all-weather access
- control of water at the top of the site
- control of sediment at the foot of the site
- stockpiles and construction materials located within the sediment control zone
- connection of downpipes as soon as possible

For major development (sites greater than 500 m^2 and < 2 ha), the ESCP shall be submitted to TDC for approval including the following detail, at a minimum:

- Location of the works, and cut and fill areas
- Contour information at suitable intervals
- Erosion and sediment controls; including supporting sizing calculations
- Catchment boundaries for the sediment controls
- Details of construction method, timing and duration
- Monitoring and maintenance schedules

Staging of construction is important. Discharge of stormwater runoff during construction from an area of disturbed land exceeding 2 ha will not be authorised by Council's global consent.

Construction should not commence without evidence of an ESCP that has been approved by Council. Council may inspect the development during construction at any time to check for compliance with the approved ESCP and ECan's ESCT.

Care should be taken if sediment-laden runoff is discharged into any infiltration-based stormwater systems during construction. Council maintain the right not to authorise any system under their global consent that they suspect has been compromised through poor construction practices (heavy sediment loads or over compaction of infiltration surfaces) and may require confirmation of performance prior to acceptance.

Appendix H: Typical Inspection/Maintenance requirements for Stormwater Systems		
Activity	**Maintenance Method**	**Frequency**
General		
Inspect sumps	Visual inspection, ensure grates securely fitted and remove accumulated sediment	6-monthly
Sweeping of kerb and channel	Street sweeper to remove accumulated debris	3-monthly
Inspect structures for erosion, scour or damage.	Remove sediment, debris and litter. Reinstate as required	6-monthly
Check for hydrocarbon accumulation or spills	Remove hydrocarbons that are visible in a layer > 5 mm thick within sumps	Annually
Basins		
Inspect inlet and outlet structures for erosion, scour or damage.	Reinstate levels and vegetation as required.	After significant rainfall events
Clean screens or grates and orifice	Remove sediment, debris and litter.	3-monthly and after significant rainfall events
Repair any structural damage	As required depending on damage	As required
Inspect for sediment deposition or scour within basin and on embankments	Reinstate levels and vegetation as required.	6-monthly
Check for ponding	Ensure basins adequately drain and are dry 48 - 72 hr after rainfall event.	After significant rainfall events
Check vegetation cover	Assess plants for disease or die-off and re-plant if necessary, to maintain healthy coverage of vegetation. Remove weeds as required.	3-monthly
Maintain grass cover	Mow grass to maintain healthy grass cover at a length of between 50mm and 100mm. Remove clippings. Remove weeds as required and re-seed grass in bare areas.	As required
Check for hydrocarbon accumulation or spills	Remove hydrocarbons that are visible over an area >0.5 m^2	6-monthly
Wetlands		
Inspect inlet and outlet structures for erosion, scour or damage.	Remove sediment, debris and litter. Reinstate levels and vegetation as required.	After significant rainfall events

Clean any screens or grates and orifice	Remove sediment, debris and litter.	3-monthly and after significant rainfall events
Repair any structural damage	As required depending on damage	As required
Check for sediment deposition	Remove sediment build up which affects the operation of the wetland	6-monthly
Check vegetation cover	Assess plants for disease or die-off and re-plant if necessary, to maintain healthy coverage of vegetation. Remove weeds as required	3-monthly
Check wetland embankment and baffles	Assess for structural integrity and reinstate slumping and vegetation as required.	3-monthly
Check for hydrocarbon accumulation or spills	Remove hydrocarbons that are visible over an area >0.5 m²	6-monthly
Inspect for pest species	Check for signs of pest species and control as required	6-monthly
Swales		
Inspect inlet and outlet structures for erosion, scour or damage.	Remove sediment, debris and litter. Reinstate levels and vegetation as required.	After significant rainfall events
Inspect for sediment deposition, scour and ponding along swale length	Reinstate levels and vegetation as required.	6-monthly
Check vegetation cover	Assess plants for disease or die-off and re-plant if necessary, to maintain healthy coverage of vegetation. Remove weeds as required.	3-monthly
Maintain grass cover	Mow grass to maintain healthy grass cover at a length of between 50mm and 100mm. Remove clippings. Remove weeds as required and re-seed grass in bare areas.	As required
Check for hydrocarbon accumulation or spills	Remove hydrocarbons that are visible over an area >0.5 m²	6-monthly
Bioretention		
Inspect inlet and outlet structures for erosion, scour or damage.	Remove sediment, debris and litter. Reinstate levels and vegetation as required.	After significant rainfall events
Clean grates	Remove sediment, debris and litter.	3-monthly and after significant rainfall events

Repair any structural damage	As required depending on damage	As required
Check for sediment deposition	Remove sediment build up which can block the filter media	6-monthly
Check vegetation cover	Assess plants for disease or die-off and re-plant if necessary, to maintain healthy coverage of vegetation. Remove weeds as required. Do not apply fertilizer.	3-monthly
Check underdrainage is free from blockage	Clear underdrainage with a water jet. CCTV inspection could be utilized if required.	Annually
Check for hydrocarbon accumulation or spills	Remove hydrocarbons that are visible over an area >0.5 m^2	6-monthly
Inspect for pest species	Check for signs of pest species and control as required	6-monthly
Infiltration		
Inspect inlet and outlet structures for erosion, scour or damage.	Remove sediment, debris and litter. Reinstate levels and vegetation as required.	After significant rainfall events
Clean any screens or grates and orifice	Remove sediment, debris and litter.	3-monthly and after significant rainfall events
Check for sediment deposition	Remove sediment build up which can block the infiltration media	6-monthly
Check for hydrocarbon accumulation or spills	Remove hydrocarbons that are visible over an area >0.5 m^2	6-monthly
Check for ponding	Ensure systems adequately drain and are dry 48 - 72 hr after rainfall event.	After significant rainfall events
Proprietary Systems		
Inspect inlet and outlet structures for erosion, scour or damage.	Remove sediment, debris and litter. Reinstate levels as required.	After significant rainfall events
Clean any screens or grates and orifice	Remove sediment, debris and litter.	3-monthly and after significant rainfall events
Repair any structural damage	As required depending on damage	As required
Check for hydrocarbon or solids accumulation	Remove via vacuum truck or other method as specified by supplier	As specified
Replace media or cartridges	As specified by supplier	As specified

APPENDIX I: DISCHARGES TO GROUND AND INFILTRATION TESTING

Discharges to Ground

A discharge to ground refers to the retention of stormwater onsite, which is then discharged into soils and ultimately groundwater. Various methods of discharge can be applied such as rapid soakage; via underground rock-filled chambers, or infiltration; allowing water to filter through sand, soil or engineered media.

In many urban applications, a discharge to ground may form the primary discharge system, with an overflow to the TDC reticulated network when the capacity of the soakage system is exceeded.

Suitability for Discharge to Ground

Natural hazards, site activities and ecological receptors in the surrounding area may influence stormwater management on-site. The identification of potentially hazardous land (i.e. landfill), or sensitive groundwater (i.e. drinking water bores) downgradient will require additional information and assessments.

If a site has previously had a hazardous activity occurring (as defined by the HAIL, see Section 3.4), and/or is identified on ECan's Listed Land Use Register[1] (LLUR) there are stormwater management implications:

- The discharge may not be accepted under the Global Consent, and therefore would require a separate ECan consent
- Consideration will be made to whether the site has been remediated and investigations undertaken by a suitably qualified and experienced person (SQEP) in contaminated land
- If not already undertaken, there are likely to be additional requirements for Detailed Site Investigation (DSI) under the National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health (NES). This may include the requirement for a NES consent and remediation works.

Groundwater quality may be compromised by stormwater discharges to ground where sensitive receptors are present. The location and details of wells used as the source of a community drinking-water supply can be found on the Community Supply Wells and Community Water Supply Protection Zone map layers on ECan's online GIS mapping website Canterbury Maps[2]. Discharges to ground are not permitted within the protection zone of a community drinking-water supply bore. The dimensions of the protection zones for community drinking-water protection are specified in Schedule 1 of the Canterbury Land and Water Regional Plan[3].

Groundwater levels may be altered by the discharge of significant quantities of stormwater to ground. Groundwater mounding, a localised increase in groundwater level, can occur which may lead to groundwater flooding of adjacent low lying areas.

[1] ECan, 2021. Listed Land Use Register. https://llur.ecan.govt.nz/ Canterbury Regional Council, 2021.
[2] ECan, 2021. Canterbury Maps. https://canterburymaps.govt.nz/ Canterbury Regional Council, 2021.
[3]ECan, 2019. Canterbury Land and Water Regional Plan. Canterbury Regional Council, February 2019.

In order to evaluate the feasibility of discharging stormwater to ground, an understanding of soils, groundwater and soakage potential is required. Indicative information can be found through desktop investigations as described in Table 9-1.

Table 9-1: Investigations for Discharge to Ground	
Desktop Investigations	
Indicative soil type/ subsoil properties[4]	Indicative soil maps can be found in Landcare Research's S-Maps Online database (Landcare Research New Zealand Limited, 2016).
Indicative depth to groundwater[2]	Depth to groundwater can be estimated using ECan's online GIS (Canterbury Maps), inspection of Bore Logs and Well Cards of surrounding bores.
Groundwater flow direction	Flow direction can be estimated using ECan's online GIS (Canterbury Maps)
Soakage Potential	Confirm the Soakage Potential (refer Section 3.10) using highest known groundwater depth and soil infiltration rate If the site is not located in a moderate or good soakage zone, soakage may not be feasible or limited. Soakage testing will be required as part of the application if discharge to ground is proposed.
Historic / current activities	List the historic and current activities on the site, particularly the presence of any past or present activities on the HAIL[5]. A copy of any information held on ECan's Listed Land Use Register and Preliminary Site Investigation (PSI) should be included, where appropriate.

Design Infiltration Rate

Infiltration potential can be estimated using Table 9-2, based on information derived during the desktop investigations. This provides an initial indication of whether the site may be suitable for on-site discharge.

Table 9-2: Indicative Infiltration Suitability				
Subsoil type	**Limiting Subsoil Permeability**	**Depth to groundwater**		
		< 3 m	3 – 6 m	> 6 m
Poorly drained (silty loam over clay)	< 10 mm / hr	**poor**	**poor**	**poor**
Imperfectly drained (silty loam, clay bound gravel)	10 – 25 mm / hr	**poor**	**moderate**	**moderate**
Moderate to well drained (silty / sandy loam)	25 – 100 mm / hr	**poor**	**moderate**	**good**
Well drained (sandy loam, gravel)	> 100 mm / hr	**moderate**	**good**	**good**

Site specific investigations of soil and groundwater are required to confirm infiltration rates for design. Infiltration tests should be carried out in test pits/bore holes, after recording the soil properties, to determine the Measured Infiltration Rate. An infiltration testing methodology is provided in Appendix D.

[4] This information is indicative and suitable for concept level design only.
[5] ECan, 2019. Canterbury Land and Water Regional Plan. Canterbury Regional Council, February 2019.

The Design Infiltration Rate is required for design of infiltration-based stormwater treatment facilities and discharges to ground. The lowest infiltration value from all test locations should be used, and a Factor of Safety (FoS) of 3 should then be applied to the lowest Measured Infiltration Rate for design use.

Infiltration Testing

TEST SELECTION

Accepted testing methodologies and their application are summarised below. Refer to Section 3.7.3 for conversion of test results into a design infiltration rate.

- **Flooded Pit Test** – Designed to mimic a soak-pit's actual operation.
- **Auger Test** – A variation on the flooded pit test.
- **Topsoil Soakage Test** – A shallow depth test carried out at the topsoil level. This test is required to assess infiltration rates through the topsoil that is proposed to be used to line soakage systems.

FLOODED PIT TEST

The flooded pit test is to be in accordance with the BRE Digest 365 Soakaway Design (Building Research Establishment (BRE), 2016) methodology and is designed to mimic the operation of an actual soak-pit in a design event situation. This testing methodology can account for the effects of groundwater mounding when correctly carried out.

Designers should note that the results of tests may be affected by seasonal factors. In the winter and spring the soil moisture and groundwater level will be higher than in the summer (except where up-gradient irrigation has a significant effect). Testing under a worst case basis should be undertaken.

The test procedure is as follows:

1. Excavate a test pit to the anticipated design depth, or a minimum of 1.5 m. Ideally plan dimensions will also be similar to that expected / proposed. Alternatively, the minimum pit dimensions may be 0.3-1.0 m wide, by 1-3 m long, which is easily achieved with an excavator. The pit should have vertical sides trimmed square.

   Note: **Do not enter the pit,** and take care working near the sides of the pit, particularly where they may be unstable. Where there is a risk of people or livestock falling into the pit do not leave it unattended or provide means to prevent entry.

2. Measure the pit dimensions carefully (depth, length / width at top and length / width at base). For safety reasons, do not enter the pit, estimate the base dimensions if necessary.
3. If necessary for stability, the pit should be filled with granular material. When granular fill is used, a full-height, perforated, vertical observation tube should be positioned in the soakage trial pit so that water levels can be monitored with a dip tape.
4. Place a fixed object at the top of the pit to provide a consistent point for measuring the depth to the water surface.

5. Fill the pit with clean uncontaminated water to the maximum design water depth. In the absence of any design information, use a maximum water depth to 300 mm below ground level. Rapid inflow is needed so that the pit can be filled in a short time (this is likely to require a minimum 100 mm hose for filling the pit).

   Note that the test will require a large water tanker (ideally 8-10 m^3) and the means to refill locally in a reasonable time. Council can advise the location of the nearest filling point where tankers can be filled and refilled for the purpose of undertaking this test.

6. If the water drains too fast to fill the pit with a full flowing 100 mm hose, no further testing is required. In this case, the maximum design value of 1,000 mm/hr can be used.

7. Record the depth to the water surface and time from filling, at intervals sufficiently close to clearly define water level versus time, until empty or the water level has at least dropped below 25% of the maximum design water depth.

8. Calculate the soil infiltration rate from the time taken for the water level to fall from 75% to 25% effective storage depth in the soakage trial pit:

   $$f = 1000 \frac{V_{p75\text{-}25}}{a_{s5o}\, t_{p75\text{-}25}} \qquad \text{Eqn (3-1)}$$

   where f = soil infiltration rate (mm/hr)

   $V_{75\text{-}25}$ = effective storage volume between 75% and 25% maximum design depth (m^3)

   a_{s50} = internal surface area of the soakage trial pit up to 50% effective storage depth and including the base area (m^2)

   $t_{p75\text{-}25}$ = the time for the water level to fall from 75% to 25 % maximum design depth (hrs).

9. If it is impossible to carry out a full-depth soakage test, the soil infiltration rate calculation should be based on the time for the fall of the water level from 75% to 25% of the actual maximum water depth achieved in the test. The effective area of loss from the soakage trial pit is then calculated as the internal surface area of the pit to 50% maximum depth achieved, plus the base area of the soakage trial pit.

10. Repeat the test a minimum of three times on the same or consecutive days.

AUGER TEST

The flooded test pit method is suitable for use with auger holes with modifications to items 4 and 8 as follows:

4. Fill the pit with clean uncontaminated water to the maximum design water depth and maintain full for at least four hours. In the absence of any design information, use a maximum water depth to 300 mm below ground level.

8. Continue to repeat the test until the calculated infiltration rates for two consecutive tests are within 5%.

TOPSOIL SOAKAGE TEST

This methodology is designed to ascertain topsoil infiltration rates where that topsoil is proposed to be used to line an infiltration swale or basin. The test methodology is designed to be simple and easy to carry out.

The measured topsoil infiltration rate can also be used to verify Horton's Infiltration Values for use in hydraulic models.

The test procedure is as follows:

1. Using a sharp spade cut out a piece of turf approximately 250 x 250 mm and 50 – 100 mm deep. Make sure to score the sides after the hole is dug because a spade can smear and compact the sides, which can affect the infiltration rate.
2. Place a fixed object at the top of the pit to provide a consistent point for measuring the depth to the water surface (or ruler fixed in the hole).
3. Carefully measure the dimensions of the excavation.
4. Fill the excavation to the top with water and time the time taken to fully drain.
5. Where there is minimal separation from ground water (i.e. <1 m) this test should be done in conjunction with the Flooded Pit Test to ascertain the capacity of the underlying soils.
6. Calculating the Infiltration Rate

$$f = \frac{d}{t} \frac{A_{base}}{A_{50}} \qquad \text{Eqn (3-2)}$$

Where: f = soil infiltration rate (mm/hr)

d = total excavation depth (mm)

A_{50} = internal surface area of the trial pit up to 50% the total depth and including the base area (m^2)

A_{base} = base area (m^2)

t = the time for the pit to empty (hrs).

7. Repeat the process until the excavation consistently drains within a set period of time – this represents the ultimate infiltration rate.

ALTERNATIVE INFILTRATION TESTING METHODS

The following alternative infiltration test methods will also be accepted:

- Soil Permeability Measurement - Constant Head Test (in accordance with Appendix G of AS/NZS 1547:2012) (Standards New Zealand, 2012)
- ASTM D3385-09, Standard Method for Infiltration Rate of Soils using Double Ring Infiltrometer (ASTM International, 2009).

APPENDIX J: TIME OF CONCENTRATION METHODOLOGY

Design Storm Duration

The maximum peak flow is assumed to occur under an average rainfall of duration just equal to the time necessary for all of the catchment to begin contributing, the so-called Time of Concentration or Tc, which is the time taken for runoff from the furthest point of the catchment to reach the design point. For longer durations the rainfall intensity will be less and for shorter durations not all the catchment will be contributing. In both cases the resulting calculated flow will normally be smaller.

The Time of Concentration to the point of interest is taken as an initial time of entry (Te) (overland flow) plus travel time (Tt) in open channels, road channels and pipes. The minimum Tc shall not be less than 10 minutes in residential or commercial areas, and not less than 25 minutes in parks and rural areas. For hillside flow, ensure that the travel time is evaluated from the very top of the catchment.

Time of Entry (Te)

Time of Entry is the time taken for runoff to travel overland from properties and roofs to the point of entry at the road channels. Overland flow can occur on either grassed or sealed surfaces. In urban areas, overland flowpaths will typically be less than 50 m, due to interception by fences or structures. Standard times of entry are applied to urban areas:

Industrial/Business/Commercial areas	Te = 5 minutes
Residential areas	Te = 10 minutes
For hillside, parks and rural catchments,	Te = the time for overland flow, as estimated by Figure 10-1 or the following equation

$$Te\ (Overland) = \frac{100nL^{0.33}}{S^{0.2}} \qquad \textbf{Eqn (10-1)}$$

Where *Te(overland)* = flow time (mins)

n = roughness coefficient for overland flow (Table 10-1)

L = length of overland flow path (m)

S = slope of catchment (%)

If the actual slope of sections of the catchment varies significantly from the average, determine the average slope using the Equal Areas Method[1].

[1] MBIE, 2020. Acceptable Solutions and Verification Methods for the New Zealand Building Code Clause E1 Surface Water. Ministry of Business, Innovation and Employment. Amended November 2020.

Table 10-1: Horton's n roughness values for overland flow	
Surface Type	**Horton's n roughness coefficient**
Asphalt/concrete	0.010 – 0.012
Bare sand	0.010 – 0.060
Bare clay/loam	0.012 – 0.033
Gravelled surface	0.012 – 0.030
Short grass	0.100 – 0.200
Lawns	0.200 – 0.300
Pasture	0.300 – 0.400
Dense Shrubbery	0.400

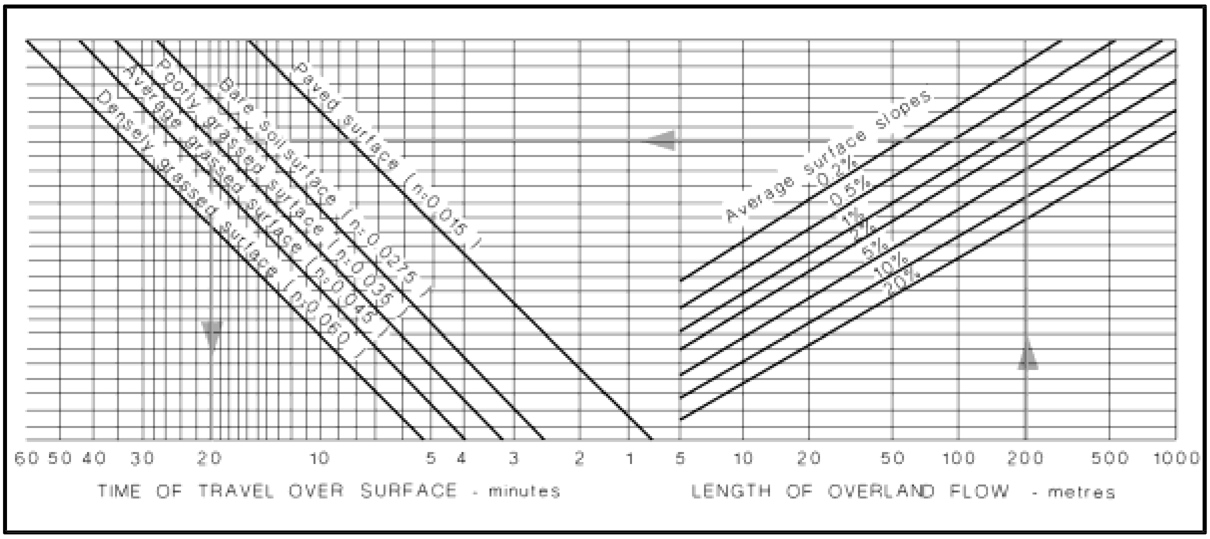


Figure 10-1: Nomograph for estimating overland sheet flow times (CCC, 2020)

Time of Network Flow (Tt)

The time of network flow, or travel time (Tt), is comprised of the time of road channel flow, pipe network flow, and open channel flow.

The *Time of Road Channel Flow*, is the time taken for water to flow from the point of entry at the road channel, to the point of discharge to a sump, drain, or other outlet. Figure 10-2 gives side channel velocities and flow times with flow depth to top of kerb for flat channels based on a Manning 'n' of 0.016.

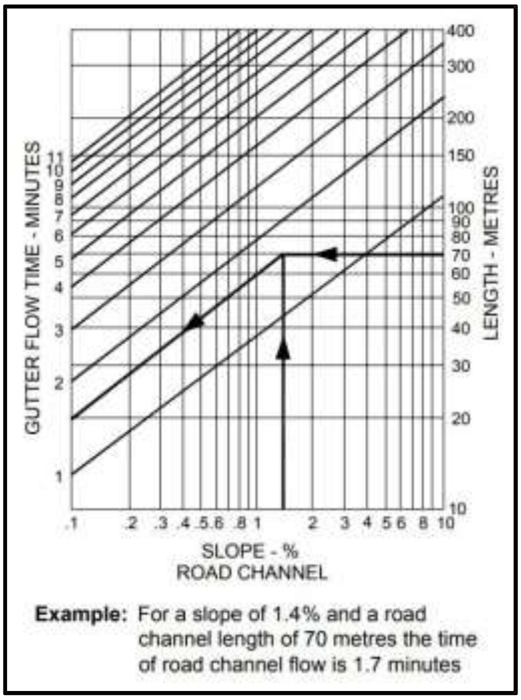


Figure 10-2: Side channel flow time from channel length and slope (CCC, 2020)

The *Time of Pipe Flow* can be derived from flow velocity obtained from the Pipe Flow Nomograph[2]. To follow this procedure, longitudinal sections are required of the piped systems, giving internal pipe diameters, lengths, and gradients. For preliminary calculations, if there is little detail of the final pipe systems, then the typical velocities in Table 10-2[3] may be used.

Table 10-2: Typical pipe flow velocities for various gradients (CCC, 2020)

Gradient	Grade	Typical velocities (m/s) for various diameters (mm)					
		225	300	375	450	600	750
Flat	1 in 500	0.5	0.6	0.7	0.8	1.0	1.1
	1 in 200	0.8	1.0	1.1	1.3	1.5	1.8
Moderate	1 in 100	1.1	1.4	1.6	1.8	2.2	2.5
	1 in 50	1.6	1.9	2.2	2.5	3.1	3.6
Steep	1 in 20	2.5	3.1	3.5	4.0	4.9	5.6
	1 in 10	3.6	4.3	5.0	5.7	6.9	8.0

The *Time of Open Channel Flow* is calculated by means of the Manning equation (refer to WWDG Chapter 22: Hydraulics). If there is insufficient data available to calculate the time of open channel flow, the approximate natural stream velocities given in Table 10-3[4] can be used.

[2] MBIE, 2020. Acceptable Solutions and Verification Methods for the New Zealand Building Code Clause E1 Surface Water. Ministry of Business, Innovation and Employment. Amended November 2020.
[3] CCC, 2020. Waterways, Wetlands and Drainage Guide: Part B. Christchurch City Council. Updated June 2020.
[4] CCC, 2020. Waterways, Wetlands and Drainage Guide: Part B. Christchurch City Council. Updated June 2020.

Table 10-3: Approximate natural stream velocities (CCC, 2020)		
Catchment Description	**Grade**	**Velocity**
Flat	Flat to 1 in 100	0.3 – 1.0 m/s
Moderate	1 in 100 to 1 in 20	0.6 – 2.0 m/s
Hillside	1 in 20 or steeper	1.5 – 3.0 m/s

Where open channel or stream flow forms a significant part of the catchment (particularly for rural channelised catchments), computer modelling must be considered. However, there are a number of methods that can be used to estimate the travel time for open channel flow e.g. Bransbury Williams, Mannings, Ramser-Kirpich and US Soil Conservation Service procedures. The estimates from these methods will vary because different interpretations of the time of concentration are involved and not all of the formulae are suited to the same conditions.

Appendix K: Alternative Water Quality Target Contaminant Concentration Method		
	Methodology	**Reference/Comment**
1.	Identify contaminants of concern to receiving environment, and standards required to be met	Refer to LWRP[1] Schedules 5 and 8 for specific Water Quality Classes. Water Quality Classes can be determined from ECan Canterbury Maps[2].
2.	Identify contaminants of concern for the proposed activity/land use	Typically urban stormwater contaminants of concern include: • Total Suspended Solids (TSS) • Metals (Zinc, Copper, Lead) • Hydrocarbons/Oil and Grease Additionally, consider microbiological contaminants (E. *coli*) and nutrients (nitrogen and phosphorus), or as defined by specific land use.
3.	Identify concentrations of untreated contaminants discharged	Preferably, on-site sampling of stormwater would be undertaken to identify concentrations. Where this data is unavailable, consult resources including: • NIWA Urban Runoff Quality Information System (URQIS)[3] • WWDG[4] Table 6-2 • Brough et al, 2012[5] or other published data
4.	Determine Treatment Train of devices using % removal rates	Typical % removal rates of contaminants by devices can be found from resources including: • Table 5-3 in Section 5.5 • WRF International Stormwater BMP Database[6] • WWDG[7] Table 6-6
5.	Apply Mixing Zone calculation to identify concentrations of contaminants in discharge, beyond the mixing zone	Refer to LWRP[8] Schedule 5 for mixing zone calculation for waterways and lakes.

[1] ECan, 2019. Canterbury Land and Water Regional Plan. Canterbury Regional Council, February 2019.
[2] ECan, 2021. Canterbury Maps. https://canterburymaps.govt.nz/ Canterbury Regional Council, 2021.
[3] NIWA, 2020. Urban Runoff Quality Information System (URQIS). https://niwa.co.nz/information-services/urban-runoff-quality-information-system-urqis. National Institute of Water and Atmospheric Research.
[4] CCC, 2020. Waterways, Wetlands and Drainage Guide: Part B. Christchurch City Council. Updated June 2020.
[5] Brough A, Brunton R, England M, Eastman, R. 2012. Stormwater Quality – An analysis of runoff from modern subdivisions and the implications for stormwater treatment. Water New Zealand Stormwater Conference 2012.
[6] WRF, 2020. https://www.bmpdatabase.org/ International Stormwater BMP Database.
[7] CCC, 2020. Waterways, Wetlands and Drainage Guide: Part B. Christchurch City Council. Updated June 2020.
[8] ECan, 2019. Canterbury Land and Water Regional Plan. Canterbury Regional Council, February 2019.

High Intensity Rainfall Design for Timaru District

TIMARU DISTRICT COUNCIL
Te Kaunihera ā-Rohe o Te Tihi o Maru

The following figures are to be used when calculatiing the required design for stormwater attenuation system within Timaru Distrrict.
The design rainfalls has allow for the effect of climate change to 2090.
The effect of climate change is based on the estimates in the *"Climate Change Effect and Impacts Assessment - A guidance manual for Local Government in New Zealand"* by the Ministry for the Environment (MfE, 2008).

Table 1 - TIMARU: Rainfall Depth Duration Frequency Estimates (mm)

ARI	10-min	20-min	30-min	1-hr	2-hr	6-hr	12-hr	24-hr	48-hr	72-hr
Dist	*PE3*	*PE3*	*PE3*	*PE3*	*PE3*	*PE3*	*PE3*	*PE3*	*PE3*	*PE3*
2.33	5	7	8	11	16	29	38	56	74	80
5	8	12	14	18	24	40	56	82	105	112
10	12	17	20	25	31	51	71	105	130	139
20	15	24	27	32	39	63	88	127	154	163
50	21	34	36	42	51	79	110	157	184	194
100	26	41	43	50	59	90	125	176	204	215

Table 2 - TIMARU: Rainfall Depth Intensity (mm/hr)

ARI	10-min	20-min	30-min	1-hr	2-hr	6-hr	12-hr	24-hr	48-hr	72-hr
Dist	*PE3*	*PE3*	*PE3*	*PE3*	*PE3*	*PE3*	*PE3*	*PE3*	*PE3*	*PE3*
2.33	30	21	16	11	8	5	4	3	2	2
5	48	36	28	18	12	7	5	3	3	2
10	72	51	40	25	16	9	6	4	3	2
20	90	72	54	32	20	11	7	5	4	3
50	126	102	72	42	26	13	9	7	4	3
100	156	123	86	50	30	15	10	7	5	3

Table 3 - TEMUKA: Rainfall Depth Duration Frequency Estimates (mm)

ARI	10-min	20-min	30-min	1-hr	2-hr	6-hr	12-hr	24-hr	48-hr	72-hr
Dist	*PE3*	*PE3*	*PE3*	*PE3*	*PE3*	*PE3*	*PE3*	*PE3*	*PE3*	*PE3*
2.33	5	6	7	10	16	29	39	53	66	71
5	6	8	10	16	22	39	54	72	91	99
10	8	10	14	21	29	49	66	90	114	123
20	9	13	17	25	35	59	78	106	137	147
50	10	16	21	32	43	73	95	129	165	177
100	13	16	24	37	49	82	107	145	184	198

Table 4 - TEMUKA: Rainfall Depth Intensity (mm/hr)

ARI	10-min	20-min	30-min	1-hr	2-hr	6-hr	12-hr	24-hr	48-hr	72-hr
Dist	*PE3*	*PE3*	*PE3*	*PE3*	*PE3*	*PE3*	*PE3*	*PE3*	*PE3*	*PE3*
2.33	30	18	14	10	8	5	4	3	2	1
5	36	24	20	16	11	7	5	3	2	2
10	48	30	28	21	15	8	6	4	3	2
20	54	39	34	25	18	10	7	4	3	3
50	60	48	42	32	22	12	8	5	4	3
100	78	48	48	37	25	14	9	6	4	3

Table 5 - GERALDINE: Rainfall Depth Duration Frequency Estimates (mm)

ARI	10-min	20-min	30-min	1-hr	2-hr	6-hr	12-hr	24-hr	48-hr	72-hr
Dist	*PE3*	*PE3*	*PE3*	*PE3*	*PE3*	*PE3*	*PE3*	*PE3*	*PE3*	*PE3*
2.33	6	7	9	14	20	36	50	68	84	90
5	7	10	14	21	27	50	68	92	117	126
10	10	14	17	26	37	62	84	115	147	158
20	12	16	22	32	44	75	100	136	176	188
50	14	21	27	42	55	94	122	165	211	227
100	16	23	31	48	63	106	137	186	237	254

Table 6 - GERALDINE: Rainfall Depth Intensity (mm/hr)

ARI	10-min	20-min	30-min	1-hr	2-hr	6-hr	12-hr	24-hr	48-hr	72-hr
Dist	*PE3*	*PE3*	*PE3*	*PE3*	*PE3*	*PE3*	*PE3*	*PE3*	*PE3*	*PE3*
2.33	36	21	18	14	10	6	5	3	2	2
5	42	30	28	21	14	8	6	4	3	2
10	60	42	34	26	19	10	7	5	4	3
20	72	48	44	32	22	13	8	6	4	3
50	84	63	54	42	28	16	10	7	5	4
100	96	69	62	48	32	18	11	8	5	4

Table 7 - PLEASANT POINT: Rainfall Depth Duration Frequency Estimates (mm)

ARI	10-min	20-min	30-min	1-hr	2-hr	6-hr	12-hr	24-hr	48-hr	72-hr
Dist	*PE3*	*PE3*	*PE3*	*PE3*	*PE3*	*PE3*	*PE3*	*PE3*	*PE3*	*PE3*
2.33	5	6	7	10	16	29	39	53	66	71
5	6	8	10	16	22	39	54	752	91	99
10	8	10	14	21	29	49	66	90	114	123
20	9	13	17	25	35	59	78	106	137	147
50	10	16	21	32	43	73	95	129	165	177
100	13	19	24	37	49	82	107	145	184	198

Table 8 - PLEASANT POINT: Rainfall Depth Intensity (mm/hr)

ARI	10-min	20-min	30-min	1-hr	2-hr	6-hr	12-hr	24-hr	48-hr	72-hr
Dist	*PE3*	*PE3*	*PE3*	*PE3*	*PE3*	*PE3*	*PE3*	*PE3*	*PE3*	*PE3*
2.33	30	18	14	10	8	5	4	3	2	1
5	36	24	20	16	11	7	5	31	2	2
10	48	30	28	21	15	8	6	4	3	2
20	54	39	34	25	18	10	7	4	3	3
50	60	48	42	32	22	12	8	5	4	3
100	78	57	48	37	25	14	9	6	4	3

PART 6: WASTEWATER DRAINAGE

CONTENTS

FIGURES

TABLES

EQUATIONS

6.1 REFERENCED DOCUMENTS

Planning and Policy

- Timaru District Council Sewer Services Activity Management Plan 2018-2028

Design

- New Zealand Building Code *Compliance Document G13 Foul Water*
- Water New Zealand *Pressure Sewer National Guidelines* (February 2020)
- Water Services Association of Australia *Vacuum Sewerage Code of Australia* WSA 06-2008
- AS/NZS 2566.1:1998 *Buried flexible pipelines - Structural design*
- AS/NZS 3725:2007 *Design for installation of buried concrete pipes*
- AS/NZS 5065:2005 *Polyethylene and polypropylene pipes and fittings for drainage and sewerage applications*
- AS/NZS 4131:2010 *Polyethylene (PE) compounds for pressure pipes and fittings*
- AS 3996:2019 *Access covers and grates*
- PIPA POP010A *Polyethylene Pressure Pipes Design for Dynamic Stresses* (May 2010)
- PIPA POP101 *PVC Pressure Pipes Design for Dynamic Stresses* (Aug 2018)
- Australasian Society for Trenchless Technology *Guidelines for Horizontal Directional Drilling, Pipe Bursting, Microtunnelling and Pipe Jacking*
- Lauchlan, C., Forty, J. and May, R., *Flow resistance of wastewater pumping mains,* Proceedings of the Institution of Civil Engineers 158 (WM2), (2005)
- Water Industry Specification 4-34-04 *Specification for renovation of gravity sewers by lining with cured-in-place pipe* March 1995

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

6.2 INTRODUCTION

Council's Wastewater Services involves the collection, treatment, and disposal of domestic and industrial wastewater.

Sewer systems are provided in the urban areas of Timaru, Temuka, Geraldine and Pleasant Point. These systems are linked via pipeline to the main Wastewater Treatment Plant (WWTP) and ocean outfall in Timaru. A small collection scheme also serves the Arowhenua community which feeds into the Temuka pond for treatment. Additional sewer is not currently available for any rural zoned areas. Rural houses manage their own effluent.

6.2.1 Wastewater Bylaw

The Timaru District Council Consolidated Bylaw 2018 defines the Council's requirements and protection for the drainage works.

This includes reference to Chapter 15 (Water Services Chapter) Part 5 and 6 (Wastewater and Trade Waste sections) of the Timaru District Council Consolidated Bylaw 2018.

6.2.2 Service Delivery

TDC owns all the public sewer infrastructure assets. Core service functions of asset operation and management, inspection, project supervision and customer services are carried out in-house by staff of TDC's Drainage and Water Unit.

To augment in-house capacity, TDC uses private contractors on a needs basis to carry out identified tasks such as:

i. maintenance and repair of the reticulation network;
ii. physical works to build or renew assets;
iii. some pre-engineering/engineering designs; and
iv. special studies in support of planning/policy development.

In general, contracting of works/services to the private sector is permissible and justified for reasons of cost effectiveness and when a specialist skill is required.

6.2.3 New developments

Gravity reticulation, with conventional pumped systems where necessary, remains the preferred method of reticulation for most developments but alternative technologies for new developments on the perimeter of the older system are considered. Council will also consider pressure sewer systems (PSS) where there are downstream capacity constraints or the site has significant construction issues, natural hazards or poor ground conditions.

In areas where gravity reticulation systems are not achievable due to grades or long distances, common pressure main or PSS, including small privately operated and municipal systems, are an option subject to the Council's approval. If approved by Council, common pressure mains where each lot must have an individual wastewater pump connected to a common pressure main system, the individual pumps shall be privately owned and maintained by the property owner.

Biofilter design is included in this Part of the IDS. Biofilters are required at the terminal of all rising mains likely to generate hydrogen sulphide (H_2S). Provide calculations on the Maximum Hydraulic Residence time before wastewater within any pressure main goes anaerobic for domestic waste streams.

6.2.4 Design lifetime

All wastewater reticulation systems are expected to last for an asset life of at least 100 years with appropriate maintenance. Design the systems accordingly, to minimise life cycle costs for the whole period. Unlined concrete manholes and pipes should only be used where the average airflow concentration of H_2S is less than <1ppm.

6.2.5 Alternative technology

Areas where alternative technologies are appropriate include outlying residential and rural residential areas that intend to vest assets as part of the Council reticulated network. Proposals for the vesting of alternative technologies should be discussed with Council pre-application for engineering design acceptance.

6.3 QUALITY ASSURANCE REQUIREMENTS AND RECORDS

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

6.3.1 The designer

The design verifier of all wastewater systems that are to be taken over by Timaru District Council 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.

6.3.2 Design records

Provide the following information to support the Design Report:

- all options considered and the reason for choosing the submitted design;
- hydraulic calculations, preferably presented in an electronic form;
- all assumptions used as a basis for calculations, including pipe friction factors;
- a valid wastewater capacity certificate;
- design checklists or process records;
- design flow rates;
- system review documentation as detailed in clause 6.4.9 – System review;
- thrust block design calculations, including soil bearing capacity;
- trenchless technology details, where appropriate;
- calculations carried out for the surge analysis of pressure pipes where appropriate.

6.3.3 Construction records

Provide the information detailed in Part 3: Quality Assurance and the *Development Engineering Construction Standard Specifications (TDC CSS)* through the Contract Quality Plan (CQP), including:

- Test method;
- performance test results;
- material specification compliance test results;
- compaction test results;
- subgrade test results;
- confirmation of thrust block ground conditions and design;
- CCTV records;

- site photographs.

Provide the Council with a certificate for each pipeline tested including the date, time, test method 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.

6.3.4 Approved materials

All materials must comply with those listed in the *TDC CSS* which provides a guide when specifying materials.

Proposed pipes and concrete structures that are likely to lie in aggressive groundwater will need specific design and additional protection such as an external plastic wrapping membrane.

6.3.5 Acceptance criteria

All pipelines must be tested before acceptance by Council. Provide confirmation in accordance with the Contract Quality Plan that they have been tested, inspected and signed off by the engineer. Perform testing in accordance with *TDC CSS*.

All pump stations must be commissioned before acceptance by Council. Provide the following pre-commissioning documentation before requesting Council witness commissioning:

- confirmation that HAZOP items are closed out
- completed Health and Safety audit of constructed works
- construction and safety audit defect record using Appendix XIX – Pump Station Outstanding Work/Defect List (Quality Assurance)
- draft Operations and Maintenance Manuals
- draft of Final Management Plan (if required)

Further information is available in the *Sewage Pumping Station Design Specification.*

6.4 SANITARY SEWER DESIGN FLOWS

Standard design flows shall be determined on the basis of:

Table 1 Design Flows by Zone

Zone	Design Flows
(i) Residential	35m3/hectare/day peak WWF* (37 persons/hectare) (0.0245m3/hectare/minute)
(ii) Commercial and Mixed Use	118m3/hectare/day peak WWF (0.082m3/hectare/minute)
(iii) Industrial	53m3/hectare/day peak WWF (0.037m3/hectare/minute)
* (Wet Weather Flow)	

6.4.1 Site Specific Design Flows

For developments with more site specific limitations, and because sanitary sewer flows vary with the time of day, the climate and the extent and type of development within the catchment must be considered to calculate design flows. Design systems to carry maximum flows without surcharging.

The maximum wastewater flow is given by:

Equation 1 Maximum flow

$$MF = P/A \times SPF \times ASF$$

where MF = Maximum flow occurring during wet weather (l/s)
P/A = Dry weather diurnal peak to average ratio (clause 6.4.2)
SPF = Storm Peak Factor including infiltration (clause 6.4.3)
ASF = Average Sewage Flow (clause 6.4.4 or 6.4.6)

Design pipelines with sufficient capacity to cater for all existing and predicted development within the area to be served. Make allowance for all areas of subdivided or unsubdivided land that are capable of future development.

When calculating the unit ASF, the net area used includes roads but excludes reserves.

All diameters are nominal bore, unless otherwise noted. Polyethylene (PE) only is specified by a nominal outside diameter (OD).

6.4.2 Peak to average ratios

Use a peak/average ratio (P/A) of **2.0** for wastewater reticulation design.

6.4.3 Dilution from infiltration and inflow

Infiltration is the entry of subsurface water into the pipeline through cracks and leaks in the pipeline. Inflow is the direct entry of surface water to the pipeline from low gully traps, downpipe discharges and illegal stormwater connections.

For new developments, apply a storm peak factor (SPF) of **2.5** to the peak wastewater flow to allow for infiltration and storm inflow. When determining the minimum (self-cleansing) flow for the tractive force calculation, use a SPF of **1.0**.

Infiltration and Inflow (I & I) can be reduced when designing greenfield pressure sewer systems. Nominate a SPF for pressure sewer system design (for both greenfield and developed areas) and explain the supporting rationale in the design report.

6.4.4 Average residential wastewater flows

Residential flows are derived from a water use of **220 litres per person per day**. The unit average wastewater flow is given by:

Equation 2 Unit ASF

Unit ASF = persons/hectare x litres/person/day

And

Equation 3 ASF

ASF = unit ASF x area

Further examples of unit ASF values for different residential zones, and corresponding maximum flows per hectare, are shown in Table 2.

Table 2 Unit ASF values

Zoning	Net density (households/ha)	Unit ASF (l/s/ha)	Unit MF (l/s/ha)
General Residential (GRZ)	15	0.10	0.51
Medium Density Residential (MRZ)	30	0.21	1.03
Settlement Zone (SETZ)	8	0.055	0.28
Rural Lifestyle Zone (RLZ)	2	0.01375	0.07

Note: For mixed density developments or zonings not covered by Table 2, detail in the Design Report how the design flows, based on Table 2 and 3 values, where determined.

6.4.5 Maximum flows for new developments

Calculate the maximum flow for new developments using Equation 1.

For example, at an assumed residential population density (GRZ) of 15 households per hectare, with a corresponding unit ASF of 0.10 l/s/ha (from Table 2) and a development area of 1 hectare, calculate the maximum flow as follows:

Equation 4 Maximum flow calculation example based on area

$$\begin{aligned} MF &= P\,/\,A\ ratio \times SPF \times ASF \\ &= 2 \times 2.5 \times (0.10\ l/s\ ha \times 1\ ha) \\ &= 0.5\ l/s \end{aligned}$$

Where the actual number of lots is known, ASF can be calculated use Equation 5, where a water usage of 220 litres/person/day and an occupancy rate of 2.7 persons/lot are utilised. If there is any scope for further infill development, increase the number of lots to allow for this.

E.g. For a residential subdivision of 200 lots:

Equation 5 Maximum flow calculation example based on number of lots

ASF = number of lots x 220 *l*/person/day x 2.7 persons/lot
= 200 lots x 220 *l* person/day x 2.7 persons/lot
= 118,800 *l*/day
= 1.38 *l/s*

MF= 2 x 2.5 x (1.38 *l/s*)
= 6.9 *l/s*

6.4.6 Average commercial and industrial wastewater flows

Wastewater flow from commercial developments is derived from a water use of 1 litre per second per 1,000 of population (where this is known). Unless other figures are available, use the values in Table 3.

Table 3 Commercial and industrial unit ASF values

Zoning	Unit ASF (l/s/ha)	Unit MF (l/s/ha)
Local Centre (LCZ)	0.09	0.45
Large format retail (LFRZ)	0.15	0.75
Town Centre (TCZ)	2.00	10.0
City Centre (CCZ)	2.00	10.0
General Industrial (GIZ)	0.38	1.90
Neighbourhood Centre (NCZ)	0.09	0.45

Note:
1) Where the type of commercial or industrial zoning is not known, assume GIZ.
2) For zonings not covered by Table 3, detail in the Design Report how the design flows, based on the Table 3 values, were determined.
3) The gross area of malls was used in calculating ASF values.

For known industries, base design flows on available water supply and known peak flows. Ensure that the design flow allows for potential wet industries, using Table 3.

Use Equation 1 for industrial areas greater than 15 hectares.

When assessing whether a wet industry can be reasonably accommodated in an area that is reticulated but not fully developed, leave sufficient flow capacity in the pipeline to serve remaining developing areas at a unit ASF of 0.15 l/s/ha (provided that no other wet industries are being planned).

6.4.7 Total design flows for existing developments

Base the design of major renewal and relief sewers (greater than 375mm Internal Diameter [ID]) serving older catchments on actual catchment performance. As the performance, which is derived from flow monitoring, is not always available, discuss larger reticulation requirements with Council.

6.4.8 Size of private sewer drains

The minimum size of private gravity sewer drains must be 100mm diameter or minimum set in G13 of the New Zealand Building Code.

For major industrial users, determine the size of the lateral using the maximum flow requirements and the available grade.

6.4.9 System review

When the pipe selection and layout have been completed, perform a system review, to ensure that the design complies with both the parameters specified by the Council and detailed in the IDS. The documentation of this review must include a full hydraulic system analysis. Compliance records must cover at least the following requirements:

- pipe and fittings materials are suitable for the particular application and environment;
- pipe and fittings materials are approved materials;
- pipe class is suitable for the pipeline application (including operating temperature, surge and fatigue where applicable);
- seismic design - all infrastructure is designed with adequate flexibility and special provisions to minimise the risk of damage during an earthquake, and with consideration for the cost and time to repair any potential damage. Provide specially designed flexible joints at all junctions between rigid structures (e.g. pump stations, bridges, buildings, manholes) and natural or made ground;
- layout and alignment meets the Council's requirements;
- maximum operating pressure will not be exceeded anywhere in the pressure pipe system;
- capacity is provided for future adjacent development.

6.5 GRAVITY PIPELINES

Design pipes to withstand all loads, including hydrostatic and earth pressure and traffic, in accordance with *Buried flexible pipelines - Structural design* and *Design for installation of buried concrete pipes*. Design pipes exposed to traffic to HN-HO-72 axle loading only, as described in clause 3.2.2 of the *Bridge Manual*.

6.5.1 Alignment

Lay gravity pipelines in straight lines and at a constant gradient between access points such as manholes and inspection chambers. Discuss major reticulation and its potential for significant traffic disruption at an early stage with Council.

Where possible, particularly within greenfield developments, wastewater infrastructure is to be laid outside of the traffic carriageway within berms or footpaths. Refer to clause 6.14 – Embedment and Backfill for further information regarding depths of pipes.

The preferred solution for wastewater reticulation is to avoid easements over private property. However, if an easement is required for new infrastructure determine its width using Equation 6.

Equation 6 Easement width

The easement width is the greater of:

- 2 x (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.

6.5.2 Temporary ends

Subject to resource consent conditions, extend wastewater sewers to the upstream boundary of new developments, to allow for connection of any future upstream catchments. Terminate the main at an access point.

6.5.3 Minimum gradients

Design minimum gradients to maintain self-cleansing flows, using the ‘simplified sewerage design’ method, which is based on ‘tractive force’ theory and uses the following parameters:

Minimum tractive force, τ	1 N/m^2
Minimum proportional depth of flow, d/D	0.2
Maximum proportional depth of flow, d/D	0.7 (84% pipe–full capacity)
Manning’s roughness (n)	0.013

Calculate the minimum (self-cleansing) flow using Equation 7 but the minimum flow value should not be less than 1.5 ℓ/s. It is important not to overestimate this value as the smaller the flow, the steeper the necessary gradient. If the flow is overestimated, the gradient chosen could be too flat to self-cleanse. 1.5 ℓ/s has been chosen to represent the discharge from a single water closet or similar fitting.

Equation 7 Minimum self-cleansing flow

$$SCF = P/A \times ASF$$

where SCF = minimum self-cleansing flow (l/s)
P/A = Dry weather diurnal peak to average ratio (clause 6.4.2)
ASF = Average Sewage Flow (6.4.4 – Residential and 6.4.6 – Commercial and Industrial)

Determine the minimum pipe gradient that meets the tractive force and proportional depth requirements for the minimum self-cleansing flow from either Equation 8 or by using Appendix I – Tractive Force Design Charts. Use hydraulic models for pipes over 300mm diameter as the charts are not applicable at these larger diameters.

Equation 8 Minimum pipe gradient

$$i_{\min} = 5.64 \times 10^{-3} \times SCF^{-0.461}$$

where i_{min} = minimum gradient in m/m
and q = the daily peak flow in l/s
and SCF = minimum self-cleansing flow in l/s

An example calculation is illustrated in Appendix II – Determination of Minimum Gradient and Hydraulic Design Example.

Consider detailing flush tanks where their use may reduce the need for a pump station. Present a non-conformance report in this instance.

6.5.4 Hydraulic design

Gravity pipelines maintained by the Council must have a minimum diameter of 150mm.

Determine the minimum pipe diameter that meets the tractive force and proportional depth requirements for the maximum flow using either Equation 9 or Appendix I – Tractive Force Design Charts. An example calculation is illustrated in Appendix II – Determination of Minimum Gradient and Hydraulic Design Example.

Equation 9 Minimum pipe diameter

$$D_{\min} = 24.35 \times \left(\frac{MF}{i_{\min}^{\frac{1}{2}}} \right)^{\frac{3}{8}}$$

where D_{min} = minimum pipe diameter in mm
and i_{min} = minimum gradient in m/m
and MF = Maximum flow occurring during wet weather in l/s

Size pipelines to cater for future flows from the upstream catchment, when fully developed.

6.5.5 Inverted siphons on sanitary sewers

Inverted siphons are sometimes necessary when passing major obstacles such as rivers and large drains. Problems associated with inverted siphons derive primarily from an accumulation of solids when velocities are reduced during low flow. Accumulated solids can give rise to odour problems, make the wastewater more septic, and restrict peak flows. Remember that the water seal blocks airflows and can affect the ventilation pattern.

Size the pipes to give peak daily velocities of at least 0.6m/s. If flows are expected to increase significantly with time, install two different sized pipes, giving three possible modes of operation. These modes of operation may be used progressively in steps, as flows build up over time, by the removal of plugs. Design the plugs to be easily removable and provide details in the Design Report.

To improve the transmission of solids, the maximum pipeline slopes, between slope structures, must be 45° and 22.5° on the downward and upward legs respectively, with manholes placed to make cleaning. Because bedding conditions are often difficult, concrete-lined steel pipes and bends of cast iron are commonly used. Differential settlements are likely to occur between the manhole and the siphon piping so give special attention to the joints in these areas.

It may be necessary to surround piping with concrete under waterways that are dredged from time to time. It may also be necessary to provide isolation valves to help flush siphons.

Do not install siphons on any lateral.

6.6 MANHOLES

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.

Consider plastic manholes, or lining of manholes, where concrete manhole corrosion due to the presence of H_2S is likely e.g. immediately downstream from pressure sewer outfalls. Design manholes to clause 6.6.4 - Structural Design including mitigation of flotation or liquefaction related movement.

Design the manhole cover's support structure to disperse traffic loads as required by the manhole's load bearing capacity and provide a producer statement confirming this design. Detail robust flexible connections that provide the equivalent design life to the adjacent infrastructure. Similarly, consider plastic inspection chambers where corrosion is an issue and provide equivalent details to those discussed above.

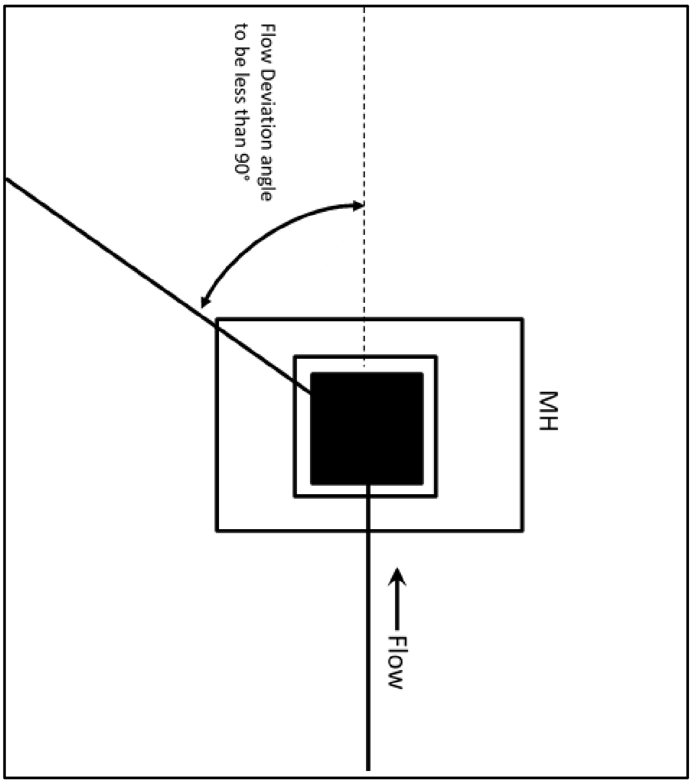
Constraints on depth within the *TDC CSS* will also apply.

6.6.1 Location and spacing

Manholes should be positioned within berms or parking bays to keep the live traffic lanes clear of piped infrastructure.

The flow deviation angle between the inlet and outlet pipes must not be greater than 90 degrees, as shown in Figure 1. Ensure the distance between incoming pipes in the manhole complies with *TDC CSS*.

Figure 1 Flow deviation



Maximum spacing between manholes shall be 120m on all diameters. However in larger diameter pipes, equal to or greater than 450mm, can be subject to specific design and approval.

6.6.2 Pole Vents

Pole vents are designed to allow the intake of fresh air and act as pressure releases for gases that accumulate within a reticulated system. Pole vents are to be designed into the system at high points within the gravity network and in proximity to pressure system discharge points into the gravity system.

Any design for a pressure system should include an assessment of whether a pole vent is necessary based on the location of the discharge point to the gravity system.

See more details on Pressure Pipelines and Pressure Sewer Systems in clauses 6.8 and 6.9 respectively.

Vents shall be designed and installed in accordance with Council's Standard Drawing within the TDC CSS. The vent design allows for the escape of gas at a height well above pedestrian or average residential dwelling heights.

6.6.3 Vented manholes

Vented manholes are designed to serve as intakes for fresh air, which passes through the sewers and laterals to the main vents on individual houses, disposing of corrosive and foul air in a way that causes minimal offence. However, occasional temperature inversions cause the air to flow in reverse and inlet vents should also be located so that any foul air coming from them causes minimal offence.

To avoid surface water entry and the associated gorging of pipelines, site vented manholes away from areas where ponding of stormwater is likely to occur. If this is not possible, install vent stacks on the road boundary. Show on the wastewater engineering drawings the extent of flooding at which secondary flow paths are activated, to verify that vented manholes will not be affected. Likewise, avoid road intersections because gravel and grit entry are greater at these locations.

Vented manholes shall have grit catch trays under lid in situations where secondary flow intrusion is not avoidable.

Venting of manholes is subject to specific design and should be considered only in situations where a pole vent is not feasible for installation.

6.6.4 Structural design

Design structures to withstand all loads, including hydrostatic and earth pressure and traffic, in accordance with the *Bridge Manual*. Design structures exposed to traffic to HN-HO-72 loading.

Manholes must comply with *TDC CSS*, or with other Council approved designs. Provide yield joints between manholes and pipes in accordance with *TDC CSS*. Where the structure is likely to experience differing movement from the pipeline under seismic loading, replace the yield joints with flexible joints. These may mitigate against the potential for damage by allowing some longitudinal movement at the structure.

A specific design is required for larger pipes, especially where changes of direction are involved. The design must incorporate a standard manhole opening and be able to withstand a heavy traffic loading HN-HO-72.

Check all chambers for flotation, including under seismic conditions. The factor of safety against floating should be at least 1.2 excluding skin friction in the completed condition, with an empty chamber and saturated ground. Counter increased forces resulting from greater depths and spans by thicker walls, counterweighting or reinforcing.

Consider the foundation conditions as part of the design. If there is a possibility of soft ground, carry out ground investigations and a full foundation design.

6.6.5 Drop structures in manholes

Drop manholes are a potential source of blockages. Lay pipelines as steeply as possible to avoid any need for a drop.

When a wastewater pipe must enter a manhole with its invert level more than 200mm higher than the soffit of the outlet pipe, provide a drop manhole as detailed in *TDC CSS*.

6.6.6 Fall through manholes

The minimum fall in the invert of angled wastewater manholes is set out in Table 4.

Table 4 Minimum fall in manhole

Angle of deviation	Minimum fall (mm)
30° - 90°	50
0° - 30°	30

When there is an increase in the pipe size at a wastewater manhole, the soffit of an inlet pipe must not be lower than the soffit of the outlet pipe.

6.7 WASTEWATER PUMPING STATIONS

All pump stations to be vested shall be designed to current industry best practices and approved through Council's Engineering Design Acceptance process. Hydraulic function of any pump station to vest shall be included in the Design Report. All Council pump stations or pump stations to be vested to Council require odour treatment to remove odours and corrosive gases.

Consider the seismic effects on foundations, connections and liquefiable ground, and take these into account in the design and construction of any pumping station.

Include supervisory control and data acquisition (SCADA) functional descriptions and code with required operations and maintenance manuals.

6.8 PRESSURE PIPELINES

Rising main design is affected by the performance of the downstream pumping station. Carry out the design of these components together to provide an integrated and efficient system.

Try to minimise the time fluids spend in a rising main, and maintain velocities high enough to transport solids. Both these objectives can be achieved by minimising the length and diameter of the pipe. A maximum rising main diameter of 150mm is preferred.

Rising mains will also need to withstand static and friction heads of long duration, together with short duration water hammer pressures. Once pipe diameters are selected, match pipe class selection to pump, flow and surge characteristics. Allow for fatigue (cyclic dynamic stresses) from a large number of stress cycles over a 100-year lifecycle when selecting the pipe pressure class.

Water hammer and surges can arise from a number of different operations, e.g. the sudden starting or stopping of a pump or closure of a non-return valve. Water hammer can be critical in pumping systems, especially in large diameter rising mains and high static head systems. For details on designing for surge and fatigue see the *Polyethylene Pressure Pipes Design for Dynamic Stresses* and *PVC Pressure Pipes Design for Dynamic Stresses*.

Consider soft closing, non-return valves for installations in high head situations.

Submit the design for rising mains, including levels and layout, with the Design Report. Submit a detailed hydraulic surge and fatigue analysis report, including all assumptions and all calculations. Where the rising main is over 100m long or greater than 150mm diameter, model the main's performance.

Consider seismic effects, temperature differentials and the Poisson's effect in flexible pipes. Design end restraints to compensate for this where necessary. Design for lateral spread in high liquefaction areas e.g. by drilling pipelines under rivers or designing flexibility at connections to bridges. Design for traffic loads, where the minimum covers in clause 9.6.3 – Pipe Depths are not achieved.

Allow for issues such as operation and maintenance and consider failure of any mechanical surge protection measures and protection from damage during these situations.

Rising mains are normally constructed from polyethylene pipe.

6.8.1 Maximum operating pressure

Design the components of a pressure pipeline to withstand a maximum operating pressure that is no less than any of the following:

Equation 10 Maximum operating pressure

Maximum operating pressure is greater of: ➢ 400 kPa ➢ $1.5(H_s + H_f)$ ➢ pump shut off head ➢ positive surge pressure where H_s = static head H_f = friction head

Ensure that external loads on the pipeline are included in all load cases, especially when pressure testing large diameter pipes. Provide a factor of safety of at least 2.0 against buckling under negative or external pressures.

For flexible pipes, such as PVC or polyethylene, the fatigue effects may define the pressure rating, which must be the greater of the maximum operating pressure calculated above, the minimum pressure rating in Table 5 or the equivalent operating pressure. To calculate the equivalent operating pressure (P_{eo}) for polyethylene use the methodology described in *Polyethylene Pressure Pipes Design for Dynamic Stresses*. For PVC, use the methodology described in *PVC Pressure Pipes Design for Dynamic Stresses* to confirm the pipe class.

Table 5 Minimum pressure ratings for flexible pipes

Material type	Pressure rating (kPa)
PVC-U	900
PE 80	800
PE 100	800

6.8.2 Velocity

The rising main velocity should be no less than 0.6m/s. Where lower velocities are unavoidable or where sediment or slime build-up may be an issue, introduce a daily scouring cycle. Maintain this cycle at a velocity that achieves the below target tractive shear stress for a duration sufficient to clear the line:

- For scouring of sediment the minimum tractive shear stress shall be 3 Pa.
- For the stripping of slime growth the minimum tractive shear stress shall be greater than 4 Pa.

Calculate the tractive shear stress using Equation 11.

Equation 11 Tractive shear stress

$$Tractive\ Shear\ Stress\,(Pa)\ \tau = \frac{f\ \gamma V^2}{8g}$$

where *f* = friction factor
γ = fluid density (N/m^3)
V = flow velocity (m/s)

The friction factor '*f*' should be determined from the Colebrook-White Equation 12.

Equation 12 Colebrook-White equation

$$\frac{1}{\sqrt{f}} = -2\log_{10}\left\{\frac{k_s}{3.71D} + \frac{2.51}{\text{Re}\sqrt{f}}\right\}$$

where k_s = hydraulic roughness (m)
D = pipe diameter (m)
Re = Reynolds number (VD/v)
v = kinematic viscosity 1.11 x 10^{-6}m^2/s at 15ºC

The hydraulic roughness 'k_s' may be calculated directly from Equation 13, as detailed in *Flow resistance of wastewater pumping mains*.

Equation 13 Hydraulic roughness

$$k_s\,(mm) = \alpha\,V^{-2.34}$$

where α = scaling coefficient
V = flow velocity (m/s)

Table 6 α values correspond to typical pipe sliming states which cover the range in Wallingford (2006) but with sliming state descriptions adapted to suit Christchurch design conditions. The use of these values is suitable for Timaru District. If a rising main is well managed with regular flushing, during normal operation the value α will typically fall into the range between good and poor and the hydraulic roughness k_s will vary accordingly.

Table 6 Values of the coefficient *α* for various sliming states

New	Good	Average	Poor	Neglected
0.06	0.15	0.6	1.5	6.0

Alternatively, the roughness value k_s is available in Table 7.

Table 7 Hydraulic Roughness (k_s) for various sliming states

Mean velocity	Sliming state versus k_s (mm)				
	New	Good	Average	Poor	Neglected
0.5m/s	0.30	0.60	3.0	6.0	30.0
0.75m/s	0.15	0.30	1.5	3.0	15.0
1.0m/s	0.06	0.15	0.6	1.5	6.0
1.5m/s	0.03	0.06	0.3	0.6	3.0
2.0m/s	0.015	0.03	0.15	0.3	1.5

Note: These k_s values are 'standardised' and so vary slightly from values calculated using Equation 13.

6.8.3 Gradients
Consider air movement through the system. Ideally rising mains should rise from the pumping station to termination. Surcharge all lengths sufficiently to keep the pipe full and prevent sudden discharges of foul air at pump start. Avoid creating summits since they trap air, reducing capacity, and allow the build up of sulphides, which convert to droplets of sulphuric acid and may cause pipe corrosion.

If a summit is unavoidable, provide automatic air release valves with drains to a sanitary sewer. Design the air valves specifically for wastewater operation. Mount air valves vertically above the pipeline to which the air valve is connected. (Fat or solids will block the connecting pipe if the valves are mounted to one side of the vented pipeline.) Fit an isolating gate valve between the air valve and the vented pipeline and mount the valves in a concrete valve chamber. The chamber must be large enough to allow easy access for maintenance staff to operate the isolating valves or remove all valves from the chamber. Specify that air valves on mains of 300mm diameter and less be installed on branches with the same diameter as the main.

Gradients are less important for temporary rising mains but consider creating vertical sections to provide pump starting head and pipeline charging. Wherever there are undulations in the line, consider installing air release valves.

6.8.4 Manholes
Manholes receiving discharge from a pressure pipeline shall be constructed from non-corrosive material. This is due to the corrosive nature of effluent within the pressure system that may become septic.

PE or other non-corrosive material linings may be used on concrete manholes structures with the prior consent of Council at the design phase of the process.

6.8.5 Valves
Consider detailing sluice and scour valves, particularly at troughs in the gradient. Consider isolation valves on long lengths of pressure pipe, particularly where there is insufficient capacity to store flows.

Sluice valves are defined in clause 7.8.1 – Sluice valves.

Label air valves with 10mm Helvetica text using a 200 x 70mm label on W/B/W traffolyte.

6.8.6 Thrust blocks
Specify thrust blocks sized for the pressure class of the pipe as a minimum and to withstand the maximum operating pressure and the test pressure. Confirm the bearing capacity of the in-situ soil and the thrust block design and record as detailed in the Contract Quality Plan prior to installation.

Design and detail thrust blocks individually for any of the following situations, as the thrust block detailed in *TDC CSS* is not appropriate:

- The test pressure or maximum operating pressure is greater than 390 kPa.
- The allowable ground bearing capacity is less than 50 kPa.

6.9 PRESSURE SEWER SYSTEMS

The Council will only consider pressure sewer systems on a case-by-case basis where other methods are inappropriate. Generally use the Water New Zealand *Pressure Sewer National Guidelines* for the detailed design of pressure sewerage systems except as amended as follows.

Subject to resource consent conditions, design the pressure sewer system (PSS) with sufficient capacity to cater for all existing and predicted development within the area to be served. Make allowance for all areas of subdivided or unsubdivided land that are capable of future development. In brownfield areas, the capacity of the existing downstream pressure sewer main may constrain the ability to add extra connections. Discuss reticulation requirements with Council.

Design PSS to allow for individual pumps and storage chambers located within each property and to these criteria:

- Total dynamic head of 45 - 55 metres
- Maximum in-network retention time of 4 hours (based on the weighted average of the accumulated retention time in each zone against the total number of connections)
- Provide emergency storage equivalent to 72 hours of average sewage flow (ASF) in the pump unit and storage chamber
- The minimal pipe length and diameter appropriate, to reduce retention times.

Construct PSS pipelines from polyethylene pipe.

6.10 VACUUM SEWERS

The Council will only consider vacuum technologies on a case-by-case basis where other methods are inappropriate. Design vacuum sewerage systems using the *Vacuum Sewerage Code (WSA 06)*, amended as follows.

Use the following guidelines for the detailed design of vacuum systems:

- Water Environment Federation *Alternative Sewer Systems*, MOP FD-12 (2008)
- BS EN 1091:1997 *Vacuum sewerage systems outside buildings*
- *Airvac Design Manual 2012.*

Contact Council to determine whether existing vacuum sewer systems have the capacity to service additional connections. Specify hardware and fittings consistent with adjacent vacuum system infrastructure, to minimise operational requirements.

6.11 BIOFILTERS

A biofilter is a device used to treat odours arising from the wastewater system. Prevent odours by:

- avoiding the use of rising mains;
- reducing turbulence generally;
- minimising retention times.

The usual form of biofilter used in sewerage systems is a media bed, through which the odorous gas is passed. The principal odour component of wastewater is H_2S (hydrogen sulphide) and the biofilter operation makes use of the ability of naturally occurring bacteria to convert the H_2S to acid and elemental sulphur.

The use of passive carbon odour treatment devices should be avoided. The use of these devices are only to be considered when all other options have been exhausted.

Typically, the situations where odours cause nuisance are where the wastewater is more than eight hours old, held in anaerobic conditions in rising mains and where there is high turbulence that encourages H_2S to come out of solution.

6.12 LATERALS

All lateral connections shall be connected directly to the main or manholes and comply with *TDC CSS*.

6.12.1 Sanitary junctions and laterals

Gradients are subject to Ministry of Business, Innovation, and Employment (MBIE) Regulations but the minimum gradient for a 100mm diameter pipe in roads is 1 in 80. Do not install siphons on any lateral without Council approval.

Lay laterals at least 0.6m clear from property side boundaries, to terminate 0.6m inside the net site area of the lot with a Maintenance Access Point (MAP) as per *TDC CSS*. Haunch laterals, laid as part of a development, in accordance with this Part of the IDS. All materials used must be Council-approved.

Wherever possible, position each junction opposite the centre of each lot frontage, unless the position of the sanitary fittings is known and indicated otherwise.

Form all junctions with a Y or riser junction so that the side flow enters the main at 45^{o}, to reduce deposition of solids.

Avoid lateral connections to manholes at the top of a line where minimum gradients are involved.

6.12.2 Cover

Design the lateral grade and invert level to serve the lot adequately. If there could be conflict with other services, it may be necessary to lower the lateral.

The minimum level for a gully trap is calculated by starting from the soffit level of the main at the connection point. Add the minimum cover to the lateral and the elevation increase of the lateral to this soffit level. The minimum cover is set in the MBIE Regulations. The elevation increase over the lateral length is calculated assuming the lateral is laid at a gradient of 1 in 80 from the main to the gully trap.

Gully traps must be at least 1.0m above the soffit level of the sewer main. If the gully is lower than the crown of the road, ensure that the gully does not become an overflow for the sewer main in the event of a system blockage. Consider installing backflow prevention devices in places where this cannot be achieved.

On sewer renewal work, when a lateral is identified for renewal and runs close to trees as defined in *TDC CSS*, either reroute the lateral around the tree by repositioning the junction on the main, or use pipe bursting or similar techniques to relay the lateral in its present position. Specify jointing in accordance with *TDC CSS*.

6.12.3 Common drains

Read the following notes in addition to the MBIE Regulations.

New sewer mains installed in private property as part of a development and that serve only that development will be private common drains, unless Council specifies through a consent condition that they must be vested. If the developer considers a sewer main in private property should be vested, request this at the time of applying for subdivision consent.

Size the private common main using discharge units as specified in *Compliance Document G13 Foul Water*.

In developments serviced by sewer mains located at the rear of the lots (typically hill developments) extend the sewer main to the boundary of the last lot.

Haunch and backfill laterals laid at the time of development, including those in rights of way, in accordance with *TDC CSS*.

Provide Y junctions and laterals extending clear of the right of way for all lots. All laterals must finish 0.6m inside the net site area of the lot.

6.13 MATERIAL SELECTION

Use *TDC CSS* as a guide when specifying materials. Specify polyethylene materials for wastewater mains installed adjacent to or that cross waterways and which may experience lateral spread under seismic loading.

6.13.1 Approved materials

All materials must comply with those listed in the *TDC CSS* which provides a guide when specifying materials.

6.13.2 Reducing waste

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

- Plan to reduce waste during demolition 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/.

6.13.3 Corrosion prevention

Corrosion can be caused by hydrogen sulphide, aggressive groundwater, saltwater attack, carbon dioxide or oxygen rich environments.

Design to minimise corrosion through:

- selecting materials which will resist corrosion;
- designing in an allowance for corrosion over the 100-year life-cycle of the asset;
- providing protective coatings.

Bolts and fittings must be hot dip galvanised and incorporate zinc anodic protection. All metal components must be protected from corrosion with a petrolatum impregnated tape system, applied in strict accordance with the manufacturer’s specifications. Do not use stainless steel where it may fail as a result of crevice corrosion caused by cyclic stress in the presence of sulphides and chlorides.

6.13.4 Gravity sewers immediately downstream of pressure pipelines

PVC and PE are suitable for use in gravity sewer pipelines.

Where a new rising main or PSS will discharge to an existing gravity system, use measures that will mitigate against H_2S corrosion or reduce the level of dissolved sulphides and remove hydrogen sulphides. These measures could include any one, or a combination, of:

- detailing corrosion protection treatment or replacement with plastic structures for all manholes within 400m of and including the receiving manhole.
- designing for velocities below 1.5 m/s at the discharge point.
- reducing turbulence through detailing a minimum four metres length of gravity flow between the discharge chamber and the existing gravity sewer system and ensuring the flow enters the existing system at its invert.

Provide odour control at the receiving manhole where the fully developed system's maximum retention time exceeds 4 hours.

6.13.5 Steep gradients

Where gradients are steeper than 1 in 3 over lengths greater than 3.0m or where velocities are higher than 4.0m/s, and when flows are continuous or frequent, specify wear-resistant pipes such as cast iron, ABS or PE100. This requirement may extend past the termination of the steep grade. Sacrificial layers can be used in special concrete pipes, or in in-situ structures.

Avoid lateral junctions on these sections of pipeline. Take care to provide adequate anchorage for the pipes, through designing thrust or anchor blocks or by utilising restrained pipe systems.

6.14 EMBEDMENT AND BACKFILL

Consider the whole trench, including the pipe, the in-situ material, the embedment and the backfill as a structural element. Design it to withstand all internal and external loads.

Specify wrapping of the embedment 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.

Use the manufacturer's material specifications, design charts or computer models to design bedding and embedment, unless these provide a lesser standard than would be achieved through applying the requirements of *TDC CSS* and *TDC Land Transport Unit Backfill & Reinstatement Requirements Guide (BRRG)*. Provide details in the Design Report.

Specify backfill materials individually. The material used must be capable of achieving the backfill compaction requirements set out in *TDC CSS* and *BRRG*.

Earth loads on deep pipelines can significantly increase when pipes are not laid in narrow trenches e.g. embankments. However, where there is a danger of the surrounding soils or backfill migrating into the embedment or foundation metal, protect the embedment and foundation metals with an approved geotextile.

6.14.1 Pressure pipes
Embed pressure pipelines as detailed in *TDC CSS* and design thrust blocks as detailed in clause 6.8.5 - Thrust blocks. In the case of upward thrust, reliance must be placed on the dead weight of the thrust block. Special design may be warranted where there are high heads, large pipes or unusual ground conditions.

6.14.2 Difficult ground conditions
Consider the ground conditions as part of the design. If there is a possibility of soft ground, carry out ground investigations.

Replacing highly compressible soils (such as peat) with imported granular fill material can cause settlement of both the pipeline and trench surface, because of the substantial increase in weight of the imported material. Refer to clause 4.6.3 – Peat (Geotechnical Requirements) for further information.

Embedment and backfill in these areas may need to be wrapped in filter cloth to stop the sides of the trench pushing out into the softer ground. Wherever the allowable ground bearing strength is less than 50 kPa, design structural support of the pipe and any structures.

Consider using a soft beam under the pipe embedment for support or using a flexible foundation raft. Retain joint flexibility. Difficult bedding conditions may warrant the use of piling, in which case smaller pipes may require some form of reinforced concrete strengthening to take bending between piles.

6.14.3 Scour
'Hillsides' are defined as any location where either the pipe gradient or surface slope directly upstream or downstream is steeper than 1 in 20. 'Hillsides' may have large variations in groundwater levels. These variations can cause sufficient water movement within the trench for bedding scour to develop.

Fill any under-runner voids encountered during the work with either 'foam concrete' or 'stiff flowable mix' as defined in *TDC CSS*. This treatment must be carried out under the direction of the engineer.

Embedment and backfill materials for hillside areas include lime stabilised AP20 and AP40 respectively (40kg/m^3) and 'lime stabilised backfill' as defined in *TDC CSS*.

Use lime stabilised AP40 for backfilling all carriageways, and lime stabilised AP20 in all areas outside carriageways.

Specify water stops at 5m spacing on all pipelines with gradients steeper than 1 in 3. Where impermeable backfill, i.e. lime stabilized backfill, is utilized for embedment and backfill, water stops are not required. Construction must comply with *TDC CSS*.

6.14.4 Redundant infrastructure

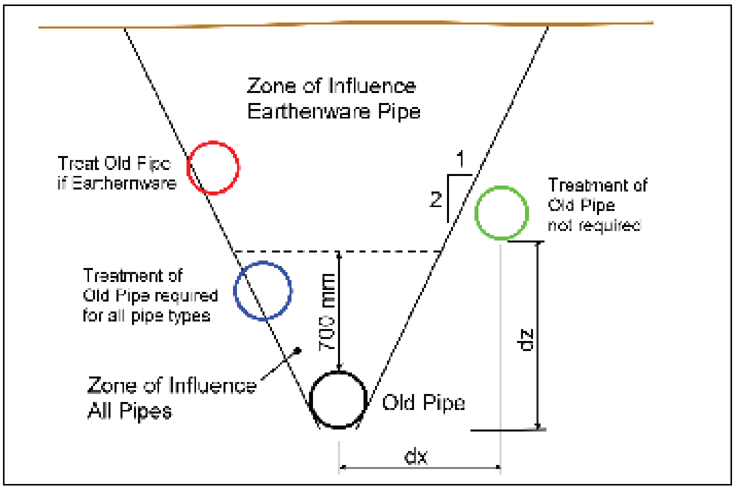
Where works will produce redundant in-ground piping, treat the potential void by either removing or by filling the pipe as detailed below.

- Treat obsolete pipes below new pipes where the new pipe is within the zone of influence of the obsolete pipe, as illustrated in Figure 2.
- Treat all pipes on the hillside.
- Where treating obsolete AC pipes, fill them and leave them in the ground to avoid contamination issues.
- For all other pipes that are outside the zone of influence illustrated in Figure 2, only detail sealing of the ends of the abandoned pipes with concrete or grout, including the lateral junctions.

These treatments should prevent voids forming that could undermine the foundations of pavements and adjacent services or could disrupt groundwater flows.

Flowable fill with a minimum strength of 1.5 MPa is the suggested material for filling old pipes. Require confirmation through the Contract Quality Plan that the void has been filled. This may be through the provision of a methodology or other means.

Figure 2 Pipe zone of influence



The zone of influence extends to the ground surface for obsolete earthenware pipes but is limited to 700mm above the soffit of the obsolete pipe otherwise.

A pipe is within the zone of influence if the centreline separation distance (d_x) is less than the minimum given by:

Equation 14 Separation distance

$$d_{xmin} = 0.5d_z + 0.3\ dia_{old} + 0.8\ dia_{new}$$

where d_z is the difference in invert level between the new and obsolete pipes.

TDC CSS – Redundant and Abandoned Infrastructure specifies treatment methods for redundant manholes.

Where the design manhole invert is being adjusted to a higher pipe level, detail that the manhole invert be filled and re-benched to the requirements of *TDC CSS* – New pipe invert in existing manhole.

6.15 CLEARANCES

Part 9: Utilities summarises clearances for utility services. Confirm these clearances with the network utility operators before deciding on any utility layout or trench detail. Maintain the clearances unless the utility operator grants approval otherwise.

6.16 TRENCHLESS TECHNOLOGY

When working in high volume roads, public areas, adjacent to trees or through private property, consider using trenchless technologies.

Thorough surveys and site investigations, which minimise the risk of encountering unforeseen problems during the work, are essential for the success of trenchless construction. Ensure that the method used complies with the pipe manufacturer's specifications.

Options available include the following:

- Pipe bursting;
- Pipe or manhole relining;
- Horizontal directional drilling (HDD);
- Auger boring/Guided boring;
- Pipe ramming;
- Slip lining;
- Microtunnelling;
- On-line replacement (pipe reaming or pipe eating).

The Council may approve other technologies on a case-by-case basis as they are considered or developed. When proposing a new trenchless technology, submit a full specification to the Council that covers the design and installation process.

Submit the following, with the Design Report:

- plans and long sections showing the design vertical and horizontal alignment, how the required clearances from other services and obstructions will be achieved and the expected construction tolerances (including annulus dimensions);
- the location and site space requirements of launch and exit pits and their impacts on traffic and existing services;

- how the alignment and depth will be tracked and as-built records provided over the whole length, including joint locations;
- reticulation details including structural pipe design, jointing details, jointing methods, connections, inline structures and excavation treatments to prevent groundwater movement;
- geotechnical investigation results and how these have affected the choice of trenchless installation method;
- dilapidation survey when planned work is near buildings or structures;
- the method of spoil removal;
- a risk management and assessment study including environmental management, to mitigate potential constructed, installed and operational issues.

Refer to *Guidelines for Horizontal Directional Drilling, Pipe Bursting, Microtunnelling and Pipe Jacking.*

Specify hold points for acceptance and for inclusion in the Contract Quality Plan, and required material or performance tests to be included in the Contractors Inspection and Test Plan, including:

- Presentation of trenchless contractor's details, including experience with method, pipe diameter and expected ground conditions, to Council for acceptance.
- Presentation of installation methodology to Council for acceptance, including depth and location tracking.
- Determination of design tensile forces/stresses on the pipe and auditing against these values during pipe pull and compression stresses on pipe ram casings.
- Determination of design slurry pressure rates, methods to prevent fracking and auditing against these during directional drilling.
- Calculations and methodology to ensure installed allowable pipe buckling stress is not exceeded during grouting.
- Relaxation period for polyethylene pipe post installation.

6.16.1 Pipe bursting

Pipe bursting is suitable only for replacing sewers that are constructed of brittle pipe material, such as unreinforced concrete and vitrified clay. Generally, this method is not suitable for replacing reinforced concrete pipes.

Pipe bursting should not be used unless the sewer being replaced has sufficient grade to comply with clause 6.5.3 – Minimum gradients, with an allowance for grade variation as the burst line will maintain the existing grade. Provide CCTV records of both the existing pipeline before bursting and the new pipeline after bursting, to confirm the adequacy of the final grades.

Obtain accurate information about the original construction material and the condition of the existing pipeline, including whether there have been any localised repairs, and whether sections of the pipeline have been surrounded or embedded in concrete. Take special care when the existing pipe has been concrete embedded, as this will tend to raise the invert level of the new pipeline and cause operational problems. Shallow pipes or firm foundations can also disturb the ground above the burst pipe.

Replace the entire pipe from manhole to manhole. The number and frequency of lateral connections may influence the economic viability of this technique.

Grouting of the annulus, especially on the hills, is an essential part of this technique. Where special techniques are required, ensure these are approved **before** the work commences.

6.16.2 Cured in Place Pipe Lining (CIPP)

Cured in place pipe (CIPP) lining systems are preferable for renovating gravity sewers. Before undertaking CIPP, check the structural integrity of the host pipe and ensure that the hydraulic capacity is sufficient for projected future peak flows. Council will not accept lining of 100mm diameter wastewater mains.

The CIPP liner must produce a durable, close fit with a smooth internal surface. The liners must have a design life of 50 years, and be resistant to all chemicals normally found in sewers in the catchment area. The manufacturer must submit guarantees to this effect to the Council.

The design of the CIPP liner, including the required wall thickness under different loading conditions, must comply with the manufacturer's recommendations and specifications. Submit a liner specification to the Council that addresses the design procedure and installation methodology. Follow the layout of the *Specification for renovation of gravity sewers by lining with cured-in-place pipe*.

As the host pipe is blocked during the insertion and curing operations, adequate flow diversion is essential for this method. Repair any structural problems at the junctions by open dig prior to CIPP installation.

The opening of connections must be carried out remotely from within the lined sewer. For this purpose, prepare accurate location records by detailed surveys prior to CIPP installation. Additional grouting of junctions may be required after opening.

6.16.3 Horizontal directional drilling and auger or guided boring

Restrict sewer installation using boring or directional drilling to instances where their construction tolerances are acceptable. Installing gravity reticulation using directional drilling is not generally appropriate. Consider possible ground heave over shallow pipes.

Take into account the space requirements for the following:

- drill pits, including working space;
- drill rigs, including access paths for drill rigs;

- drill angle (the drill rig may need to be placed some distance away from the sewer starting point, depending on the angle);
- placement of an appropriate length of the joined sewer on the ground for pulling through the preformed hole;
- erosion and sediment control;
- existing services.

Surface-launched drilling machines require larger construction and manoeuvring spaces compared to pit-launched drilling machines. Consult specialist contractors before selecting this technique.

6.16.4 Slip lining

It is essential to carefully consider the effect that the work will have on the system operation **before** using a slip-lining technique, especially in relation to finished invert levels and capacity.

Carefully inspect and prepare the host pipe prior to the installation of the new pipe. Use a sizing pig at the investigation stage, to confirm clearances.

Replace the entire pipe from manhole to manhole. Reconnect lateral connections to the new sewer as set out in *TDC CSS*– Thermoplastic Jointing of Polyethylene Pipe by Electrofusion Welding. The number and frequency of lateral connections may influence the economic viability of this technique.

Carry out grouting of any annulus after installing the new pipeline and gain approval for the technique to be used **before** the pipe is installed. Ensure that grouting doesn't cause buckling or flotation of the internal pipe.

Slip lining of 150mm diameter, or smaller, sewers is not permitted.

6.17 INFRASTRUCTURE APPROVED CONTRACTORS

Only Timaru District Council Infrastructure Approved Contractors are permitted to install pipework that will be vested into the Council, install connections to Council mains within legal roads or private property. A full list of authorised drainlayers and conditions of approval may be found on the Council webpage for Infrastructure Approved Contractors[1].

Construction of the wastewater system must not start until acceptance in writing has been given by the Council.

Wherever works are installed within existing legal roads, obtain a Works Access Permit (WAP) for that work. Apply for a Corridor Access Request (CAR) at

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[1] https://www.timaru.govt.nz/services/consents-licences-and-registrations/infrastructure-approved-contractors

www.beforeudig.co.nz. The work must comply with requirements as set out in *TDC CSS* for this type of work.

6.18 AS-BUILT INFORMATION

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

APPENDIX I. TRACTIVE FORCE DESIGN CHARTS

Chart 1 Tractive force design chart (grade as %)

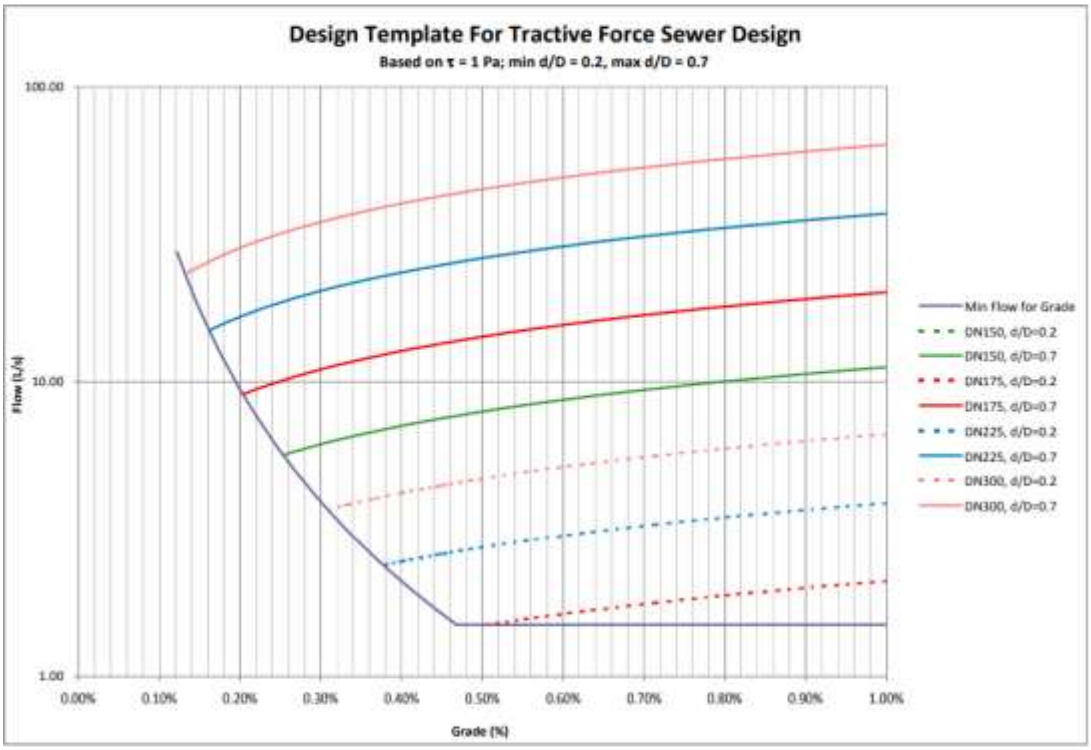
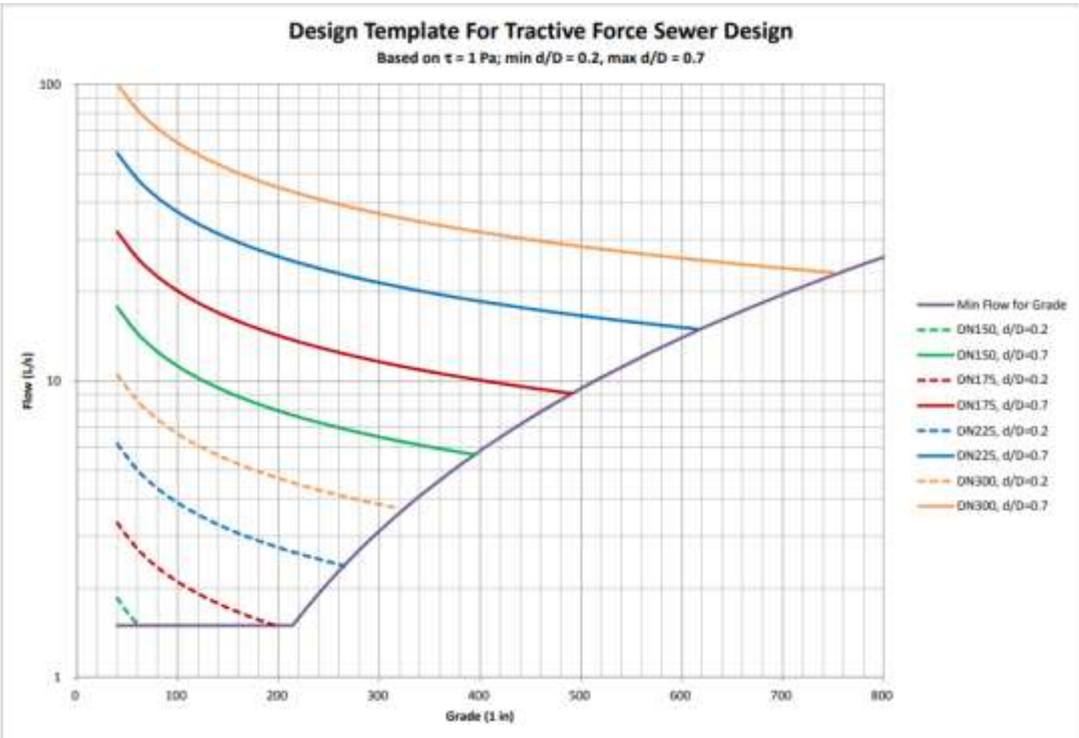


Chart 2 Tractive force design chart (grade as ratio)



APPENDIX II. DETERMINATION OF MINIMUM GRADIENT AND HYDRAULIC DESIGN EXAMPLE

An area of 12.0 hectare is zoned GRZ, with a corresponding unit ASF of 0.10 l/s/ha. The minimum SCF from Equation 7:

$$SCF = P/A\ x\ ASF$$

P/A – Dry Weather Diurnal Peak to Average Ratio = 2.0

ASF – Average Sewage Flow = 0.1 l/s/ha

SCF = 2.0 x (0.1 l/s/ha x 12 ha)

SCF = 2.4 l/s

Drawing the minimum SCF on the Tractive Force Design Chart (Chart 1 Above), the horizontal line intersects the minimum grade line at an approximate grade of 0.38% or 1 in 263.16.

Calculate the maximum flow:

Equation 15 Maximum flow calculation example based on area

MF = P / A ratio x *SPF* x *ASF*
= 2 x 2.5 x (0.10 *l/s ha* x 12 *ha*)
= 6 *l/s*

Drawing a horizontal line at 6 l/s on Chart 2 from Appendix 1, the vertical line representing 0.38% or 1 in 263.16 at a point just below the line representing the maximum capacity of a DN150 pipe.

The corresponding pipe size will be 150mm.

APPENDIX III. WASTEWATER MATERIAL SELECTION TABLE

Table 2 Wastewater materials

Property	CLS	DI	PE	PVC-U
approved for gravity wastewater	As special only	As special only	yes	yes
approved for wastewater pressure	As special only	As special only	yes	yes
suitable for trenchless methods			yes except gravity	yes
provide a restrained system	yes	yes	yes	with restrained joints
suitable for anaerobic conditions	requires cathodic protection	no	yes	yes
suitable for tidal zones	requires cathodic protection	no	yes	yes
suitable for above-ground applications	yes	yes	no	no
Fatigue resistant	yes	yes	requires design	requires design
Approved in internal diameters > 600	yes	no	yes	no
Wear resistant (flow regular, velocity > 4m/s)	yes	yes		
Suitable for industrial zoning			yes	yes
H_2S resistant	Lining requires design	Lining requires design		

PART 7: WATER SUPPLY

CONTENTS

FIGURES

TABLES

EQUATIONS

REFERENCED DOCUMENTS

Planning and Policy

- Timaru District Council Water Supply Activity Management Plan 2018-2028
- Ministry for the Environment *National Environmental Standard for Sources of Human Drinking Water*
- Water Services Act 2021
- Water Services Regulation (Drinking Water Standards for New Zealand) 2022

Design

- SNZ/PAS 4509:2008 *New Zealand Fire Service Fire Fighting Water Supplies Code of Practice* (*Fire Service Code of Practice)*
- AS/NZS ISO 9001:2016 *Quality Management Systems – Requirements*
- AS/NZS 4020:2005 *Testing of products for use in contact with drinking water*
- AS/NZS 2566.1:1998 *Buried flexible pipelines structural design, supplement 1*
- AS/NZS 2845.1:2010 *Water supply – Backflow prevention devices*
- UKWIR 10/WM/03/21 *Guidance for the Selection of Water Supply Pipes to be used in Brownfield Sites*

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).

7.1 INTRODUCTION

This Part includes:
- the assessment of required infrastructure;
- technical design requirements;
- material requirements.

The Timaru District Consolidated Bylaw 2018 defines the Council's requirements for protecting the water supply.

7.1.1 Description of the water supply system

The statements in this section have been adapted from the Timaru DC Water Asset Management Plan 2018-28

TDC delivers water supply services for residential, commercial, industrial and stockwater purposes. There are 12 water supplies being managed by TDC consisting of:
- Six (6) urban drinking schemes for Geraldine, Peel Forest, Pleasant Point, Temuka, Timaru and Winchester;
- Four (4) rural drinking and stockwater schemes for Downlands, Orari, Seadown and Te Moana; and
- Two (2) stockwater only schemes for Beautiful Valley and Rangitata-Orari

Urban Water Supply Schemes

The urban water supply schemes consist of the Geraldine, Peel Forest, Pleasant Point, Temuka, Timaru and Winchester water supplies. They are operated as individual water supplies but funded as a single scheme.

Geraldine Water Supply

The Geraldine Water Supply is predominantly an urban on-demand scheme. Water is supplied for domestic, commercial, industrial and stock drinking water purposes. The Geraldine Scheme also supplies water to parts of the Te Moana Water Supply.

Peel Forest Water Supply

Peel Forest Water Supply is a small scheme supplying drinking water in the residential area of the township. The scheme does not supply the picnic area, campground or all of the properties at Peel Forest.

The Peel Forest water supply is classified as an urban on-site storage scheme. The treatment process in the scheme was upgraded in 2016 to improve water quality and meet the criteria of Drinking Water Standards NZ.

Pleasant Point Water Supply

The Pleasant Point Water Supply is an urban scheme with on-demand and on-site storage supply. The supply is for domestic drinking water purposes only.

Upgrading of the scheme is being undertaken to increase security of supply. A new reservoir became operational November 2020. Pump station upgrades, remediation of the raw water reservoir, and network renewals are also planned. The scheme upgrade will result in a greater ability to allow on-demand connections within the scheme and the removal of on-site storage tanks as an option to property owners.

Temuka Water Supply
Temuka Water Supply Scheme is an urban on-demand scheme that supplies domestic drinking water only. The Scheme supplies treated water to three distinct networks, namely: the Temuka Water Supply, the Orari Water Supply, and the Winchester Water Supply.

Security of supply is a major issue being addressed in the implementation of the 30-year Temuka Water Supply Strategy. Part of the Strategy was the renewal of the Temuka trunk main in 2016 which addressed a leakage issue. Other works identified in the Strategy which are being considered include investigation of a new source and construction of a new storage.

Timaru Water Supply
Timaru Water Supply Scheme is an urban on-demand scheme that supplies domestic drinking water only. Customers in the Timaru water scheme are domestic and industrial users, with each accounting for approximately half of the total volume of water consumption.

The Timaru Scheme also supplies treated water to the Hadlow Subzone of the Downlands Water Scheme.

Security of supply is a major issue within the scheme. A long-term strategy is being developed to address water use efficiency issues and enable the scheme to sustainably meet current and future demand. Options investigated relate to water take provisions within resource consents, developing a new source, improving existing sources, and reducing demand.

Winchester Water Supply
The Winchester water supply is a small on-demand scheme supplying the Winchester township. Customers of the Winchester Scheme are predominantly domestic or related to a domestic and farming population.
The scheme's source and treatment plant were decommissioned in September 2016. Winchester is now supplied treated water from the Temuka Water Supply.

<u>Rural Water Supply Schemes</u>

Downlands Water Supply
The Downlands Water Supply Scheme is jointly owned by the District Councils of Timaru, Waimate and Mackenzie. The proportions within each territorial jurisdiction are Timaru District (82%), Waimate District (14%) and Mackenzie District (4%). There is a Downlands Joint Standing Committee, with representation from the three

Councils, who acts as the policy governing body for the scheme. The Committee has appointed TDC as Downlands Scheme Manager responsible for the management and operation of the scheme.

The Downlands Water Supply Scheme is primarily a stock water scheme which also supplies domestic drinking water to rural properties within the scheme boundaries. It is a restricted supply which requires on-site storage. Increasing supply to meet increased demand, security of supply and meeting drinking water standards are the priority focus for the Downlands Scheme in the next 10 years. Major programmed capital works include upgrading of the Te Ngawai trunk main and intake, upgrading of the treatment plant, and increasing storage capacity (raw and treated water).

Orari Water Supply
The Orari water supply is restricted for domestic and stock water use. The scheme does not produce its own water; it is entirely supplied from the Temuka Water Supply with water that is already treated. Customers of the Orari Scheme are predominantly domestic or lifestyle property owners. The scheme has minimal stock water demand.

Seadown Water Supply
The Seadown scheme supplies both stock and drinking water. Connections to troughs are on demand while domestic connections are generally restricted. Seadown has issues with supply to farm properties with connections directly to troughs instead of reticulated tanks. Water wastage from troughs is very high and could reduce the LOS during high demand. This gives issues with water conservation and quantity.

TDC is carrying out sustainable water management strategy to this scheme. Seadown Rural Water Supply Model Review and Analysis is being undertaken to identify feasible options to be assessed and approved by the Council. TDC will be assessing whether to keep the current set-up of the scheme or to convert to a restricted supply.

Te Moana Water Supply
The Te Moana supply is a restricted water supply based on units of supply of 1,000 L/day. Customers of the Te Moana Scheme are predominantly domestic or farming. The Te Moana scheme has reached its original capacity so additional water is being purchased from Geraldine to supplement the main intake.

The security of water supply in the scheme is being addressed through the programmed works which include the establishment of a new source, a new treatment plant, pump station upgrade and watermain upgrade.

<u>Stock Water Only Schemes</u>

Beautiful Valley Stockwater Scheme
The Beautiful Valley Stockwater Scheme is a piped stockwater supply. It also caters for garden and shed use but not for domestic use. Therefore there is no treatment provided.

The scheme is very small (41 rating units and 1800 hectares design area) and no additional water is available at the source. The scheme has no expansion capacity and there are no plans to cater for additional demand.

Rangitata-Orari Stockwater Races
The Rangitata-Orari (RO) water race is a stock water supply. The water flows from the Orari River and is fed into a network of open water races some 170 km long. Some significant modifications to the water race network have occurred as a result of the establishment of the Rangitata South Irrigation (RSI) Scheme in the area which is upgrading then utilizing parts of the races for conveying irrigation water. A large number of RO ratepayers are also shareholders in the RSI. There are also a number of RO ratepayers who are not irrigation shareholders and who wish to remain on the RO stockwater scheme, and a number of ratepayers who wish to permanently withdraw from the scheme. The final scope of the Scheme is still to be established through the on-going discussions between Council and RSI. This will determine the future demand in the scheme.

7.2 QUALITY ASSURANCE REQUIREMENTS AND RECORDS

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

7.2.1 The designer
The designer of all water supply systems that are to be taken over by Timaru District Council must be suitably experienced. This 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.

7.2.2 Design records
Provide the following information, to support the Design Report:

- hydraulic calculations, preferably presented in electronic form;
- all assumptions used as a basis for calculations, including pipe friction factors;
- calculations carried out for the surge analysis of pressure pipes, where appropriate;
- design checklists or process records;
- design flow rates;
- system review documentation as detailed in clause 7.5.5 – System review;

- thrust block design calculations, including soil bearing capacity;
- trenchless technology details.

7.2.3 Construction records

Provide the information detailed in Part 3: Quality Assurance and the Timaru DC '*Timaru District Council Construction Standard Specifications" TDC CSS* including:

- pressure test results;
- chlorination test results;
- bacteriological test results;
- material specification compliance test results;
- compaction test results;
- subgrade test results;
- confirmation of thrust block ground conditions and design;
- site photographs.

The developer must provide the Council with a certificate for each pipeline pressure 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, date of manufacture, serial number, jointing and contractor who laid the pipe.

7.2.4 Acceptance criteria

All pipelines must be tested before acceptance by Council. Provide confirmation in accordance with the Contract Quality Plan that they have been tested, inspected and signed off by the engineer.

All pump stations must be commissioned before acceptance by Council. Provide the following pre-commissioning documentation before requesting Council witness commissioning:

- confirmation that Hazard and Operability (HAZOP) items are closed out
- completed Health and Safety audit of constructed works
- construction and safety audit defect record using Appendix XIX – Pump Station Outstanding Work/Defect List (Part 3 – Quality Assurance)
- draft Operations and Maintenance Manuals
- draft of Final Management Plan (if required)

7.3 WATER SUPPLY DESIGN

All pipe diameters are internal unless otherwise noted.

7.3.1 Design considerations

Consider the:

- hydraulic adequacy of the system;
- ability of the water system to maintain acceptable water quality, including consideration of materials and their disinfection demand, and prevention of back siphonage and stagnation;
- structural strength of water system components to resist applied loads, including ground bearing capacity;
- seismic design - all structures must be designed with adequate flexibility and special provisions to minimise risk of damage during earthquake. Provide flexible joints and isolation valves at all junctions between rigid structures (e.g. reservoirs, pump stations, bridges, buildings, manholes) and natural or made ground;
- pipeline's ability to withstand both internal and external forces, taking into account any transient temperature changes;
- Poisson's effect and end restraint designs to compensate where necessary;
- requirements of the Fire Service Code of Practice;
- impact of the works on the environment and community;
- "fit-for-purpose" service life of the system;
- best way to minimise the "whole-of-life" cost;
- resistance of each component to internal and external corrosion or degradation. Refer to clause 6.13.3 – Corrosion prevention (Wastewater Drainage) for further information;
- installation requirements expressed in *TDC CSS;*
- capacity and ability to service future extensions and development;
- location of major reticulation and its potential for significant traffic disruption. Discuss at an early stage with Council.
- networking, redundancy and security of supply.

Design all parts of the water supply system that are in contact with drinking water using components and materials that comply with AS/NZS 4020. Select the pipe material to ensure a minimal impact on water quality within the system.

7.3.2 Design life

All water supply distribution systems are expected to last for an asset life of at least 100 years with appropriate maintenance, and must be designed accordingly to minimise life cycle costs for the whole period.

7.3.3 Future system expansion

Design watermains with sufficient capacity to cater for all existing and predicted development within the area to be served. Make allowance for areas of subdivided or un-subdivided land capable of future development, as specified by the Council in the design parameters.

7.3.4 Contaminated sites

Avoid contaminated sites wherever possible. If a contaminated site cannot be avoided, provide details about the following issues with the Design Report:

- compliance with statutory requirements;
- options for decontaminating the area;
- selection of ductile iron or galvanised submains, wrapped in accordance with *TDC CSS*- Fittings, and jointing techniques that will maintain the water quality (in accordance with the approved materials set out in the *TDC CSS* and *Appendix A – Acceptable Pipe and Fitting Materials – NZS4404:2010*);
- safety of construction and maintenance personnel;
- any special pipeline maintenance considerations.

Consult with Council Drainage and Water staff if any further information is required.

7.3.5 Specific structural design

Design pipelines being installed at depths greater than detailed in *TDC CSS* to resist static and dynamic loads. The design must comply with AS/NZS 2566.1 including Supplement 1. Provide details of the final design requirements in the Design Report.

Any ground that has an allowable bearing capacity less than 50 kPa is unsatisfactory for watermain construction. In such environments, engage a geotechnical specialist to investigate the site and to design and supervise the construction of an appropriate support or foundation remediation system for the watermain. Refer to clause 4.6.3 – Peat (Geotechnical Requirements) for further information.

Wherever it is necessary to fill an area before laying a watermain across it, or to build an embankment in which to lay the watermain, seek advice from a geotechnical specialist, to ensure that the weight of the fill will not cause failure or leakage of the pipe joints, after the main is laid.

7.3.6 Reducing waste

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

- Plan to reduce waste during demolition 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 installation waste.
- 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/.

7.4 DESIGN PARAMETERS

In developments where adequate system pressure and coverage from hydrants already exists, the Council will advise the point of supply and the minimum pipe size for the supply pipe. The developer is responsible for the full cost of the supply pipe from the point of supply to the individual connection points.

When the developer is providing water reticulation for vesting in the Council, the Council will provide the following parameters, after receipt of the application plan:

- point of supply;
- mains size at the point of supply;
- supply type (e.g. on-demand or restricted);
- design number of connections, as provided by the developer;
- additional development to be allowed for in the design;
- static pressure;
- residual pressure at peak system demand in the network;
- residual fire pressure during fire demand at point of supply;
- fire water classification at point of supply;
- the minimum residual pressure at house site at peak system demand;
- networking requirements;
- other requirements (e.g. minimum mains size).

7.4.1 Flow and pressure for urban on-demand water supply areas

Develop residential zones to comply with the definitions in the *District Plan*. The minimum residual pressure at the point of supply shall be 200 kPa. Provide the design flow rates, for developments other than standard residential zones (e.g. multi-unit developments or older persons' housing), with the Design Report.

7.4.2 Design for restricted water supply areas

Restricted water supply areas apply to:

- Downlands,
- Te Moana,
- Seadown,
- Beautiful Valley,
- Orari Township

Design any rural restricted supply to meet requirements of the scheme for each property.

The minimum storage capacity per connection must be 3 days allocation or 10,000L whichever is greater. The supply must be installed as per Council's standard drawings. Any other sources of water on any property must not be connected to the Scheme reticulation.

Individual sites may provide their own water bores for domestic purposes. These bores must be established in accordance with the consent requirements of Environment Canterbury. The water must be tested to show that the water quality is potable in accordance with the *Drinking Water Standards*.

Rural restricted supplies are not designed for firefighting purposes.

7.4.3 Fire service requirements

Design the water supply reticulation to comply with the *Fire Service Code of Practice*. In particular, the reticulation must meet the requirements for firefighting flows, residual fire pressure and the spacing of hydrants.

Where a development is not able to be connected to water supply reticulation in the first instance, the water supply is to comply with an alternative firefighting water source outlined in the Fire Service Code of Practice. In particular, it is best practice that the non-reticulated supply meet the requirements for firefighting flows, pressure, access and couplings.

7.4.4 Fire services

Many industrial and commercial sites require the installation of fire services. The site owner is responsible for providing these fire services, which must be designed to meet the requirements of the New Zealand Building Code.

All fire service connections to the Council reticulation will have a meter fitted to detect any unlawful water use and shall be backflow protected in accordance with their level of risk.

Do not assume that current pressure and flow will be available in the future when designing private fire services. As the Pressure and flow available is likely to reduce in the future, due to demand growth and pressure management, owners should ensure there is an adequate water supply and pressure in accordance with the *Fire Services Code of Practice* prior to development.

7.5 RETICULATION DESIGN

7.5.1 Standard main sizes

Acceptable standard nominal bore (DN) main diameters are 100, 150, 200, 300, 375, 450 and 600mm. Acceptable standard nominal outside (OD) submain diameters are 50 and 63mm. Polyethylene pressure pipe only is specified by a nominal outside diameter (OD).

Rural reticulation may be designed to a nominal OD at a minimum of 20mm. Sizing rural reticulation will be dependent on network modelling to determine the required size to supply the required level of service.

7.5.2 Minimum pipe and fitting class

The minimum pipe class for reticulation mains is PN 12 in urban and PN 16 in rural. The minimum class for fittings is PN 15. Utilize the *TDC CSS* or *Appendix A – Acceptable Pipe and Fitting Materials – NZS4404:2010* before specifying the required pipe class. Some parts of Downlands Rural Scheme operate up to 2200 kPa.

7.5.3 Pipe hydraulic losses

Take differences in elevation across the subdivision or development into account.

Calculate pipe friction losses from the pipe supplier's technical information or from representations of the Darcy-Weisbach/Colebrook-White formula. Use friction factors from Table 1 that take into account the effects of pipe aging.

Table 1 Friction factors

Pipe material	K_s (mm)
PVC-U, PE	0.015
Ductile Iron	0.06

Note: 1) These friction factors are extracted from NZS 4404, Table 6.1.
2) Manufacturers' design charts may be based on smoother pipe assumptions than these (e.g. K_s = 0.003) but such charts usually assume 'as new' laboratory conditions and ignore effects such as fittings and pipe ageing.

7.5.4 Surge and fatigue re-rating of plastic pipes

Although plastic pipes may be permitted in zones affected by dynamic pressure variations (e.g. pump zones), in locations downstream of pressure reducing valves, and in high surge areas, it is essential that the pipe class be reclassified (rerated) for both surge and fatigue (cyclic dynamic pressure variations) in accordance with the criteria set out in *Polyethylene Pressure Pipes Design for Dynamic Stresses* or *PVC Pressure Pipes Design for Dynamic Stresses*.

7.5.5 System review

When the pipe selection and layout have been completed, perform a system review, to ensure that the design complies with both the parameters specified by the Council and detailed in the IDS. The documentation of this review must include a full hydraulic system analysis. Compliance records must cover at least the following requirements:

- minimum residual pressure can be maintained at all property connections;
- maximum operating pressure will not be exceeded anywhere in the system;
- pipe class is suitable for the pipeline application (including operating temperature, surge and fatigue);
- pipe and fittings materials are suitable for the particular application and environment;
- pipe and fittings materials are approved materials;
- minimal likelihood of water quality problems or water stagnation;

- valve spacing and positioning allows isolation of required areas;
- mains layout and alignment meets the Council's requirements;
- meets minimum firefighting demands;
- control valves, where required, are positioned to provide the required control of system;
- watermains are extended to boundaries;
- connections, to existing or future subdivisions, form a cohesive network and provide security of supply;
- capacity provided for future adjacent development.

7.6 RETICULATION LAYOUT

Lay watermains in public roadways unless there is no practicable alternative. Remove any existing reticulation between new lots.

7.6.1 Mains layout

Consider the following factors when deciding on the general layout of the mains:

- the need for mains to be replaced due to their physical condition and/or inadequate capacity or whether new mains are required to provide additional capacity;
- providing easy access to the main for repairs and maintenance;
- whether system security, disinfectant residual maintenance and mains cleaning meet operational requirements;
- the location of valves for shut off areas and zone boundaries. Note the '50 property' constraint in clause 7.8.1 – Sluice valves, for shutting off sections of the network;
- provision for scour and air valves;
- required clearances to other utilities. Refer to clause 9.5.3 – Typical services layout and clearances (Utilities);
- topographical and environmental considerations;
- avoidance of dead ends;
- providing dual or alternate feeds to minimise customer disruptions.

Generally, the connection of reticulation to trunk mains is not permitted, as these mains may be shut down for servicing over extended periods, disrupting supply to reticulation where alternate feeds have not been provided.

Identify obstructions along the pipeline route and specify clearances. Specify clearances from other utility services, such as electricity, telecommunication cables, gas mains, stormwater drains and sewers. Where bending pipes, comply with the requirements of clause 7.7.7 – Working around structures.

7.6.2 Duplicate mains

Provide duplicate mains to provide adequate fire protection in the situations set out in Table 2:

Table 2 Duplicate mains

Situation	Duplicate main
Parallel to large distribution/trunk mains that are not available for service connections	Required
Industrial/commercial areas	May be required
Arterial and dual carriageway streets	May be required

7.6.3 Reticulation in legal road

Evaluate and incorporate the following design considerations when locating reticulation in legal roads:

- Situate the pipeline in the least costly location, such as on the side of the legal road that serves the most properties;
- Wherever roads are cut into the hillside, situate pipes on the cut or high side, to make best use of road drainage and limit the risk of consequential damage;
- Excavate for the pipeline in undisturbed ground;
- Consider the balance between initial capital cost versus ongoing operational and maintenance costs, for factors such as access and soil type;
- Consider special cover requirements when renewing or laying new pipes in streets with a high crown and dish channels (refer to clause 7.7.5 – Cover over pipes);
- Allow for known future utility services and road widening.

Lay principal mains on one side of all residential streets to within 65m of the end of the cul-de-sac. In commercial and industrial streets, lay principal mains to within 20m of the end of the cul-de-sac. Measure the distance to the terminal hydrant from the road boundary at the end of the cul-de-sac. If the cul-de-sac is short enough to provide adequate fire protection from the intersecting road, locate the fire hydrant at the intersection.

The preferred location for principal mains is within berm and footpath outside of the carriageway, set a minimum of 0.7m from the back of the kerb. Lay principal mains in new subdivisions only after the kerb and channel has been laid, unless the Council has given prior approval. Principal mains must not be less than 100mm diameter and must be fitted with fire hydrants in accordance with the *Fire Service Code of Practice*.

The preferred position of surface boxes, e.g. sluice valves and fire hydrants, is in line with either side of property entranceways. Locate surface boxes clear of feature paving such as cobblestones, and within roundabout islands where possible.

7.6.4 Watermains in easements

The preferred solution for water reticulation is to avoid easements over private property. This is generally only used as a temporary solution to landlocked developments, pending the future provision of a permanent supply within a legal road.

Typical situations where the Council may approve mains in easements include those where there is the need for a link main to provide continuity of supply or to maximise water quality, or where fire protection is required for multiple properties within a private right-of-way. Easements may be located over private property, public reserves, crown reserves, other government-owned land, private roads or accessways in both conventional and community title subdivisions.

Equation 1 below is to be utilized to calculate easement width when mains are required to be located through private properties.

Equation 1 Easement width

The easement width is the greater of:

- $\rhd$ $2 \times (\text{depth to invert}) + \text{OD}$
- $\rhd$ 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 watermain operation and maintenance.

Construct principal mains, which are in any easements excluding over private rights of way, of steel, ductile iron, PE 80 or PE 100. Install valves in order to isolate that section of pipe.

7.6.5 Submains

In industrial areas and/or commercial zones all submains must be 100ID PVC or PE. In residential zones, submains shall be 63OD PE 100 PN12.5 pipe.

Lay the submain at least one metre along the allotment’s street frontage, including corner properties. Serve corner properties from one side only unless future subdivision is expected.

Install submains approximately 150mm from boundaries to serve all allotments. In category V roads (as defined in Appendix I – Lighting categories – Chapter 11: Lighting), amend the submain’s design location to allow for the location of the lighting poles on the road boundary.

Locate 50ID diameter valves next to the submain on the crossover. Wherever a crossover serves both directions and more than ten properties each way, locate valves on the submain on either side of the crossover.

Submains on straight roads shall loop back to the main with cross overs at a minimum spacing of every two hydrants

7.6.6 Termination points and hydrants at the end of mains

Avoid termination points or dead ends, in order to prevent poor water quality. Consider alternative configurations such as a continuous network, link mains and use of submains to serve properties off the end of mains.

A hydrant must be placed within 1.5m of the end of all permanent and temporary sections of dead end mains greater than or equal to 100mm diameter. Apart from the firefighting function, this also allows the section of dead end main to be flushed regularly to ensure acceptable ongoing water quality. This is particularly important in new subdivisions, where only a small number of properties may be connected initially.

7.6.7 Temporary ends of watermains

Lay watermains to within 1.0m of a subdivision boundary, where it is intended that the road will extend into other land at some future time.

In new development areas, construct mains to terminate approximately 2.0m beyond finished road works, with a hydrant within 1.5m of the temporary end, as detailed in clause 7.6.6 - Termination points and hydrants at the end of mains. The hydrant must be suitably anchored, to ensure that future works do not cause disruption to finished installations.

7.6.8 Connecting new mains to existing mains

When specifying the connection details, consider the:

- pipe materials, especially capacity for galvanic and other corrosion;
- relative depth of mains;
- standard fittings;
- pipe restraint and anchorage;
- limitations on shutting down major mains to enable connections;
- existing cathodic protection systems.

Anchor valves unless they are secured by restrained joint pipes.

Where connecting to mains that are deeper than the standard cover, obtain the correct cover on the proposed reticulation main by utilising joint deflection of the reticulation pipes downstream of the valve that is attached to the branch connection.

Design connections from the end of an existing main to address any differing requirements for the pipes being connected, particularly restraint, spigot/socket joint limitations and corrosion protection. Use standard fittings and pipework to connect to non-metallic mains. Confirm all sluice valves near the connection are restrained.

Any alterations or connections to the existing reticulation system must be done at the developer's expense.

7.6.9 Temporary works

The Council may, at its discretion, approve a delay in providing the total infrastructure requirements for large developments that will be developed over a period of several years. Such approval is conditional on the provision of a temporary infrastructure of sufficient capacity for the immediate development and a bond to ensure construction of the remaining infrastructure when necessary.

7.7 RETICULATION DETAILING

7.7.1 Proposed method of installation

There are a number of methods of installing underground services. These include open trenching, directional drilling, pipe bursting or slip lining. Factors that may influence the selection of installation method include the ground conditions, disruption to traffic, need to work around trees, topographical and environmental aspects, site safety and the availability of ducts or redundant services, e.g. old gas mains or their offsets.

Wherever the intention is to lay a number of utilities with a submain in a common trench, pay particular attention to obtaining the required minimum cover and clearances for each utility in the trench cross-section. Mains must always be laid in a separate trench. These clearances are summarised in clause 9.5.3 – Typical services layout and clearances (Utilities).

Where a polyethylene watermain is installed within a duct, detail flanges at each end.

7.7.2 Hillsides

Give special consideration to the design and installation of pipelines on hillsides, as defined in clause 6.14.3 – Scour (Wastewater Drainage). Refer to clause 6.14.3 - Scour (Wastewater Drainage) for lime stabilisation specifications.

7.7.3 Backfill and bedding

Specify backfill materials for the specific installation location. The material used must be capable of achieving the backfill compaction requirements set out in *TDC CSS* and *BRRG*.

Bedding materials should comply with *TDC CSS* and the pipe manufacturer's specifications. Highlight in the Design Report wherever there is a conflict in bedding specifications between the requirements of the *TDC CSS* and the pipe manufacturer and state what was specified for the design.

7.7.4 Trenchless technology

Trenchless technology can be used for alignments passing through:

- environmentally sensitive areas.
- built-up or congested areas.
- areas not suitable for trenching (e.g. railway and main road crossings).
- difficult hill crossings.
- private land.

Installation by methods such as directional-boring, thrust-boring, micro-tunnelling and pipe-jacking may be used in order to lessen the impact of the works on pavements and trees. Pipe bursting is not permitted for water supply infrastructure.

Submit the following, with the Design Report:

- Plans and long sections showing the design vertical and horizontal alignment, how the required clearances from other services and obstructions will be achieved and the expected construction tolerances (including annulus dimensions);
- The location and site space requirements of launch and exit pits and their impacts on traffic and existing services;
- How the alignment will be tracked and as-built records provided over the whole length, including joint locations;
- Reticulation details, including structural pipe design, jointing methods, connections, inline structures and excavation treatments to prevent groundwater movement;
- Geotechnical investigation results and how these have affected the choice of trenchless installation method;
- The method of spoil removal;
- A risk management and assessment study including environmental management, to mitigate potential constructed, installed and operational issues.

Refer to *Guidelines for Horizontal Directional Drilling, Pipe Bursting, Microtunnelling and Pipe Jacking*.

Specify hold points for, for acceptance and for inclusion in the Contract Quality Plan and required material or performance tests to be included in the Contractors Inspection and Test Plan including:

- Presentation of drilling contractor details, including experience with method, pipe diameter and expected ground conditions, to Council for acceptance of trenchless installation.
- Presentation of installation methodology to Council for acceptance, including location tracking.
- Determination of design tensile forces/stresses on the pipe and auditing against these values during pipe pull.
- Determination of design slurry pressure rates and auditing against these values during directional drilling.
- Relaxation period for polyethylene pipe post installation.

7.7.5 Cover over pipes

All Pressure Watermains must have not less than 0.8m cover at all times. Large fittings may require increased cover to allow the correct installation. The maximum cover must not exceed 1.5m. Where the design cover exceeds this, present a non-conformance report for Council consideration. See Timaru District Council Standard Drawings 5301-2 for specific cover depths and details for various situations. If the proposed situation is not covered by the standard drawing, PS1 Design Certification must be provided with the proposal.

7.7.6 Clearances to other services or obstructions

Become familiar with the required clearances from existing and proposed overhead and underground utilities. Identify all underground and surface obstructions, or utility assets that may be hazardous, on the engineering drawings. Refer to clause 9.5.3 – Typical services layout and clearances (Utilities) for clearances for utility services.

When using a trenchless technology installation method, apply the clearances required for watermains laid in an open trench.

New parallel water reticulation services must cross as close as practicable to 45°.

7.7.7 Working around structures

Watermains that are located close to structures, such as foundations for walls and buildings, must be clear of the "zone of influence" of the structure's foundations, to ensure that the stability of the structure is maintained and that excessive loads are not imposed on the watermain. Refer to Table 3 below for guidance on minimum clearances from structures.

Table 3 Minimum clearance from structures

Pipe Diameter (mm)	Clearance to Wall or Building (mm)
<100	300
100-150	1000
200-300	1500
375	2000

Watermains that are constructed from metallic materials must not be located within 30m, measured horizontally, of overhead electricity transmission towers having a voltage 66kV or higher, especially if cathodic protection will be provided. Galvanic anodes for cathodic protection should be located away from the transmission lines or approximately midway between the transmission towers.

Deviate a mains pipeline around an obstruction by deflection at the pipe joints and with bends. If plastic pipes are used, restrict radii to greater than 100 x the pipe OD for tapped bends and to 75 x OD otherwise. The deflection angle permitted at a flexible joint must comply with the manufacturer's recommendation. Provide a detailed design, showing the route of the watermain around the obstructions.

7.7.8 Crossings

Wherever watermains cross under roads, railway lines, waterways, drainage reserves or underground services, make the crossing, as far as practicable, at right angles. Design and locate the main to minimise maintenance and crossing restoration work. Make all crossings of natural waterways below the invert level of the waterway.

Wherever pipelines are located under major infrastructure assets, carriageways, intersections or waterways, determine whether the pipeline may require mechanical protection, or if different pipeline materials are needed for the crossing. Consider seismic loading and its potential to cause abutment movement or bridge approach slumping when detailing pipes traversing bridges.

7.7.9 Above-ground watermains

Include the design of pipeline supports and loading protection with the design of above-ground watermains. Address any exposure conditions such as corrosion protection, UV protection and temperature re-rating. Provide details of mechanical protection to prevent vandalism and rockfall.

7.7.10 Redundant infrastructure

Redundant watermains are generally left in the ground. Specify removal of hydrants, valves and surface boxes and detail that the ends of redundant pipework, including at these fittings, are capped.

7.7.11 Tracer wire

Specify the installation of tracer wire or tape directly above watermains in rural areas or within easements, including where the watermain is installed by trenchless methods. Detail connections to fittings, overlaps and jointing that comply with the manufacturer’s instructions. Confirm the effectiveness of the tracer wire and record in the Contract Quality Plan.

7.8 RETICULATION FITTINGS

Detail jointing of PE pipes and fittings with diameters greater than 125mm OD using only electrofusion couplers or butt welds.

7.8.1 Sluice valves

Sluice valves specified in Timaru are defined as clockwise opening valves with diameters greater than or equal to 100mm and gate valves are defined as clockwise opening valves with diameters below 100mm.

Sluice valves are required next to the branch of any tee. Other valves must also be provided to ensure that turning off a maximum of five valves can isolate the network in any area. The maximum five-valve shut off must not isolate more than 50 properties.

Locate sluice valves at street intersections and also along the line of the main as required. Consider the following when deciding on the location of sluice valves:

- the operational needs of the system so that continuity of supply is maximised;
- operation and maintenance requirements;
- the safety of maintenance personnel.

Keep the number of valves to a minimum, without compromising the ability to easily identify and isolate a section of the network.

Attach sluice valves to flanged fittings at junctions rather than plain-ended fittings.

The force required to open or shut a manually operated valve, using a standard valve key, with pressure on one side of the valve only, must not exceed 15kg on the extremity of the key. Specify geared operation, motorised valves or a valve bypass arrangement, to reduce pressure across the valve, if the allowable force cannot be met.

7.8.2 Backflow

Design and equip drinking water supply systems to prevent back siphonage. Locate air valves and scours to avoid water entering the system during operation. Backflow prevention devices must meet the requirements of AS/NZS 2845.1.

7.8.3 Scour valves

Scours are required on mains of 300mm diameter and larger. Generally, valves must be 150mm diameter in size. Scours are required on mains less than 300mm diameter where there are no fire hydrants. Install scour valves at the lowest point between isolating valves, and discharge to an approved outfall.

7.8.4 Air valves

Air can accumulate at high points when it is drawn into the system at reservoirs and pumps. Mains should be laid evenly to grade between peaks to ensure all possible locations of potential air pockets are known. Investigate the need for air valves at all high points, particularly those more than 2.0m higher than the lower end of the section of watermain, or if the main has a steep downward slope on the downstream side.

Air may also come out of solution in the water due to a reduction in pressure, such as when water in a main flows uphill or at pressure reducing valves. Air valves may be required to allow continuous air removal at these locations.

The number and location of air valves required is governed by the configuration of the distribution network, in terms of both the change in elevation and the slope of the watermains. Install air valves in a secure enclosure above the ground, with an isolating valve to permit servicing or replacement without needing to shut down the main.

Air valves are not normally required on reticulation mains in residential areas, as the service connections usually eliminate air during operation. Where the need is primarily for admission and exhaust of air during dewatering and filling operations, a high-point hydrant usually adequately serves reticulation networks.

On hillsides, locate a fire hydrant adjacent to and downhill from any sluice valve where the main descends from that location to release air.

300mm and 375mm diameter reticulation mains, with only a few service connections, may require dual-acting air valves, to automatically remove accumulated air that may otherwise cause operational problems in the water system.

Dual-acting air valves, incorporating an air valve (large orifice) and an air release valve (small orifice) in a single unit, are generally preferred for distribution and trunk mains, and where required on reticulation mains. The nominal diameter of the large orifice of air valves must be 50mm, for installation on mains less than or equal to 300mm diameter.

7.8.5 Additional hydrants and scour valves for maintenance activities

Hydrants, additional to those required by the *Fire Service Code of Practice*, may be needed to facilitate maintenance activities, such as flushing the watermains. Ensure that these are approved and there are adequate drainage facilities to cope with the contents of the watermain from dewatering and flushing operations.

Where automatic dual-acting air valves are not installed at high points on the watermains, install a hydrant to release air during charging, to allow air to enter the main when dewatering and for manual release of any build-up of air as required. Install a fire hydrant at the top section of a hillside main, to act as an air intake and prevent the creation of a vacuum.

Provide hydrants at low points on watermains, to drain the pipeline when scours are not installed. As a general rule, place a hydrant or scour at the lowest point of elevation where the volume of water unable to be drained exceeds $15m^3$. This normally applies to mains greater than or equal to 200mm diameter.

7.8.6 Pressure reducing valves and check valves

Pressure reducing valves are preferred over break pressure tanks, and must be sized for minimum and maximum demand. The pressure reducing valves must have V-porting and relief valves, capable of taking full flow to an approved outfall, which is visible to the public.

Consider and allow for increased pressures as a result of pressure reducing valve failure.

Pressure reducing valves and check valves that are 100mm diameter and larger must have bypass pipe work and shutoff valve arrangements. This allows the valve to be isolated for maintenance or to reverse the flow if necessary.

7.8.7 Thrust and anchor blocks on mains

Design thrust blocks for all fittings and valves, to withstand the greater of:

- maximum operating pressure and test pressure, including transient and pump shut off head;
- adjacent pipeline class rating;
- a minimum pressure of 1200kPa.

The precast thrust block detailed in *TDC CSS* may be used if all of the following criteria are met:

- the fitting or valve is up to and including 200mm diameter;

- the maximum operating pressure is up to and including 700 kPa;
- the trench ground conditions can sustain an allowable bearing capacity greater than 150 kPa, as established by testing;
- the thrust block will not experience up-thrust.

The thrust block must have a minimum surface area of $0.18m^2$ in contact with an undisturbed trench wall.

If the above criteria are not all complied with, design and detail thrust blocks individually for the site bearing capacity. Consider the buoyancy effect of any alteration in the watertable.

Confirm the bearing capacity of the in-situ soil and the installed thrust or anchor block design and record in the Contract Quality Plan prior to installation.

Consider the Poisson's effect in flexible pipes and design end restraints to compensate for this, where necessary. Also detail anchorage for in-line valves on pipelines that are not capable of resisting end bearing loads.

7.8.8 Restrained joint watermains

Restrained joint watermain systems can be used in place of thrust and anchor blocks to prevent the separation of elastomeric seal-jointed pipelines.

Restrained joint systems include welded steel joints, flanged pipes and fittings and factory made mechanical restrained joint systems. Polyethylene pipe fabricated joints are not acceptable. Specify details of factory made mechanical restrained joint systems in the Design Report, including the:

- length of restrained pipeline and adjacent fittings required to ensure the transfer of thrust forces to the ground strata;
- requirement for placing suitably worded marking tape in the trench over the pipeline to define the limits of the restrained joint system;
- requirement for details of the commercial restrained jointing systems to be shown on the as-built records, including the location of restrained portions of pipelines.

7.8.9 Provision for sterilisation

The fittings and reticulation layout must provide for chlorination. At the point of connection, provide a 20mm diameter tapping band for chlorination. The connection to the existing main must be capable of 500 litres/minute capacity from the reticulation. Provide an outlet (normally 50mm diameter, or a fire hydrant) to flush the chlorinated water out of the reticulation, at the end of each section of main and specify the outfall in the Design Report.

7.8.10 Connections

For design purposes, assume a minimum 20mm diameter connection, unless Council consent has been granted for other sizes.

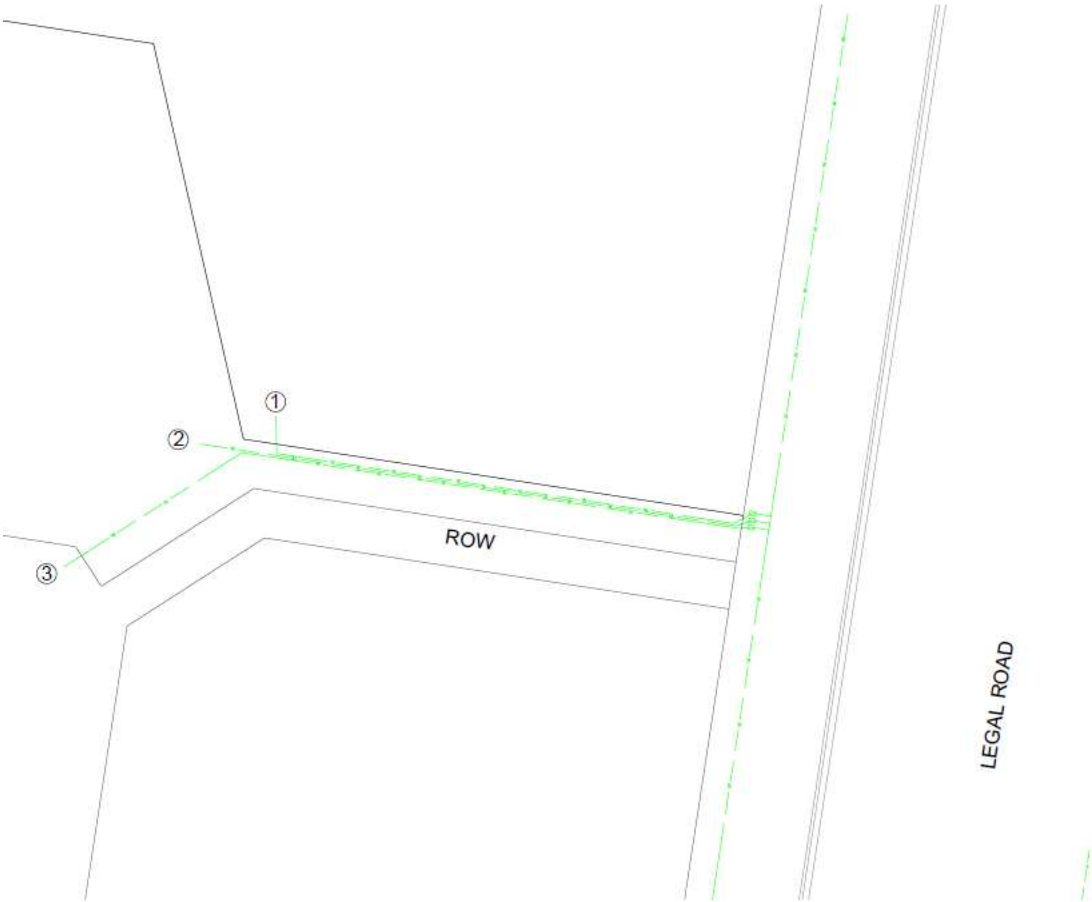
Individual connections may be installed at the time of Engineering Acceptance by the developer. Lateral connections (including isolation valve and meters) will become the property of, and be maintained by, the Council, up to the point of supply to the individual property.

7.8.11 Multiple Configurations for PRIVATE PROPERTY

Supply pipes in private property and mutually owned right-of-ways are considered to be privately owned and must be protected by easements in favour of the dominant tenants.

One service connection per property title, with manifolds located within the Road Reserve. Figure 1 provides an outline for multiple supplies servicing units down a right of way.

Figure 1 Multiple supplies at boundary



For up to two dwellings, a single connection can be made to the main via a DN25 lateral, and then be split into individual isolation valves. For more than two dwellings, lateral must be sized sufficiently to provide 200 kPa capacity to the point of supply.

7.9 MATERIALS

All materials must comply with those listed in the *TDC CSS* which provides a guide when specifying materials.

7.9.1 Material selection

Water reticulation materials have specific design and installation issues, as identified in the manufacturers' design manuals, specifications and other literature. Consider these issues, as tabulated below, when specifying materials.

Table 4 Material design issues

Mains Pipeline Material	**Issues to be Considered**
Ductile iron and steel	• Internal lining and external coatings must be undamaged or fully restored after repairs or fabrication work. • Potential problems with stray electric currents and bimetallic corrosion.
PVC-U	• Tests pressure not to exceed 1.25 times the rated pressure of the lowest rated component but to be at least 1.25 times the maximum operating pressure. • UV degradation. • Scratching, gouging and impact damage. • Proper bedding and installation required. • Permeation by contaminants possible.
PE 80, PE 100	• Susceptible to permeation by some hydrocarbon contaminants. • Sophisticated equipment and highly skilled workers required. • UV degradation (Blue pipe). • Bedding support to prevent excessive deformation. • Pulling forces for PE are not to exceed the manufacturer's recommendations. • Minimum radii. • Poisson's effect and end restraint.

All plastic pipes used in the Timaru public supply must have a nominal pressure rating (PN) of not less than 12 bar or PN 12 (1200 kPa). PVC-M and PVC-O pipe will not be accepted.

Submains must be made from polyethylene pipe of resin type PE 100 or PE 80, with a minimum pressure rating of PN 12.5. Contaminated sites will require careful material selection. Refer to clause 7.4.4 – Contaminated sites.

7.9.2 Material specifications

All materials must comply with those listed in the *TDC CSS* which provides a guide when specifying materials.

The specific requirements for reticulation materials that are to be incorporated within the supply network are listed in the *TDC CSS*. Bedding and backfill materials must comply with the requirements of the *TDC CSS*.

The Council has an asset service life requirement of 100 years. Pipes and fittings must have a minimum required design life of 100 years and a minimum warranty period of 50 years. All products must be fit for their respective purpose and comply in all respects with the Council's current specification for the supply of that material and the standards referenced.

Manufacturers of any pipes and fittings intended for use in the Timaru District distribution system must have a certified quality management system in place that complies with AS/NZS ISO 9001. This system must apply to all aspects of the manufacturing processes, including product handling, administration and stock control.

The Council requires the right to verify that any and all contracted and subcontracted products conform to the specified requirements (clause 7.5.2 of AS/NZS ISO 9001). Full product identification and traceability is required (clause 7.5.3 of AS/NZS ISO 9001). Protection of the quality of the pipe and fittings includes transportation and off-loading at the delivery point (clause 7.5.5 of AS/NZS ISO 9001). Full quality records (as per the manufacturer's Quality Assurance manual) must be available on request for evaluation by the Council and be kept for a minimum period of 10 years.

Both the developer and the contractor are responsible for ensuring the appropriate handling, storage, transportation and installation of pipes and fittings to avoid damage and to preserve their dimensions and physical properties. The total exposed storage period from the date of manufacture to the date of installation for all PVC pipe must not exceed 12 months. Store fittings under cover at all times.

The Council reserves the right to require full details of the manufacturer's means for demonstrating compliance. Irrespective of the means of demonstrating compliance and the supplier's and manufacturer's quality assurance systems, responsibility remains with the developer to ensure the installation of products that conform with the requirements of the IDS and the appropriate standards. The Council may arrange for independent testing to be carried out on randomly selected samples or assembled joints.

Positive verification inspections or testing results obtained by the Council shall not limit the supplier's responsibility to provide an acceptable product, nor shall it preclude subsequent claims made under warranty due to manufacturing defects, faulty design, formulation or processing.

7.10 INFRASTRUCTURE APPROVED CONTRACTORS

Only Timaru District Council Infrastructure Approved Contractors are permitted to install pipework that will be vested into the Council and any pipework that is located within legal roads. A full list of authorised drainlayers and conditions of approval may be found on the Council webpage.

7.11 CONNECTION AND STERILISATION

Design a sterilisation point in the new reticulation.

Construction of the water supply system must not start until approval in writing has been given by the Council.

Wherever works are installed within existing legal roads, 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 the *TDC CSS* for this type of work.

7.11.1 Connecting into existing system

New pipe work must not be connected to the Council reticulation until after the mains have been sterilised and passed a pressure test. The pressure test must be carried out as specified in *TDC CSS* – Performance Testing, in the presence of the Council.

7.11.2 Sterilisation

The approved contractor will organise sterilisation of the new reticulation or infrastructure, which may include bacteriological testing of the water to confirm compliance with the *Drinking Water Standards*, prior to commissioning. Bacteriological testing takes 24 hours. Further details are set out in *TDC CSS.* Sterilisation report shall be provided as part of final engineering clearance documentation.

7.12 AS-BUILT INFORMATION

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

PART 8: ROADING

CONTENTS

FIGURES

TABLES

8.1 REFERENCED DOCUMENTS

Planning and Policy

- Timaru District Council Policies – Roading and Transport Related
- Land Transport Act (1998)
- Traffic Regulations (1976)
- Canterbury Regional Council *Metro Strategy* (2010)
- Canterbury Regional Council *Canterbury Regional Public Transport Plan* (2014)
- Land Transport NZ *Traffic Control Devices 2004 Rule*
- Land Transport NZ *Setting of Speed Limits 2017 Rule*
- New Zealand Transport Agency *Planning Policy Manual – for integrated planning and development of state highways* (2007)
- New Zealand Asset Management Support *New Zealand Infrastructure Asset Valuation and Depreciation Guidelines* (2006)

Design

- AS 2890.5:1993 *Parking facilities - On-street parking*
- Austroads *Guide to Traffic Management Set* (including *Part 6: Intersections, Interchanges and Crossings, Part 8: Local Area Traffic Management*
- Austroads *Guide to Pavement Technology Set* and the New Zealand Supplements
- Austroads *Guide to Road Safety Set* (including *Part 6: Road Safety Audit, Part 8: Treatment of Crash Locations, Part 9: Roadside Hazard Management*)
- Austroads *Guides to Road Design Set* (including *Part 3: Geometric Design, Part 4: Intersections and Crossings, Part 4B: Roundabouts, Part 6: Roadside Design, Part 6A: Pedestrian and Cyclist Paths*
- Christchurch Transport Operations Centre *CTOC Regional Special Conditions*
- Ministry for the Environment *National Guidelines for Crime Prevention through Environmental Design (CPTED) in New Zealand*
- New Zealand Heavy Haulage Association Design *Road Design Specifications for Oversize Loads*
- NZS 4121:2001 *Design for Access and Mobility: Buildings and Associated Facilities*
- NZS 4404:2010 *Land development and subdivision infrastructure*
- NZTA RTS series
    - *Guidelines for the Implementation of Traffic Controls at Cross Roads RTS 1*
    - *Guidelines for Street Name Signs RTS 2*
    - *Guidelines for Flush Medians RTS 4*
    - *Guidelines for Rural Road Marking and Delineation RTS 5*
    - *Guidelines for Safe Kerbline Protection RTS 8*
    - *Road Signs and Markings for Railway Level Crossings RTS 10,*
    - *Guidelines for Facilities for Blind and Vision-Impaired Pedestrians RTS 14*
    - *Guidelines for Urban-Rural Thresholds RTS 15*)
- New Zealand Utilities Advisory Group *The National Code of Practice for Utilities' Access to the Transport Corridors*
- Timaru District Council *Road Bridge Policy*
- Waka Kotahi NZTA *New Zealand Supplement to the Austroads Guide to Traffic Engineering Practice Part 14: Bicycles*

- Waka Kotahi NZTA *Overdimension vehicle route maps (OVRM)*
- Waka Kotahi NZTA *P43 Specification for Traffic Signals*
- All Waka Kotahi NZTA guidelines
  - *Pedestrian Network Guide (PNG)*
  - *Cycling Network Guidance (CNG)*
  - *Public Transport Design Guidelines (PTDG)*
  - *Road Safety Audit Procedures for Projects*
  - *Speed Management Guide*
  - *Speed Management Guide – Toolbox*
  - *Policy and Planning Manual (PPM)*
  - *Traffic Control Devices Manual*
- All Waka Kotahi NZTA manuals and TNZ standards (including T/10 *Skid Resistance Investigation and Treatment Selection* and the *Bridge Manual*)
- Worksafe NZ *New Zealand Code of Practice for Electrical Safe Distances* NZECP 34:2001

Construction

- All Waka Kotahi NZTA manuals and specifications
- Road Safety Manufacturers Association *Compliance Standard for Traffic Signs* 2010
- NZS 8603:2005 *Design and application of outdoor recreation symbols*

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).

8.2 INTRODUCTION

This Part sets out Council's requirements for designing streets, and other access linkages, that not only function well but are also appropriate and safe environments.

This Part is **not** intended to be a detailed design guide or to replace the need for traffic and pavement engineering expertise in some areas of the design process.

8.2.1 Legal requirements

All traffic control devices, as defined in the Land Transport Act, on roads and rights of way, must comply with current versions of the:

- Land Transport Act;
- Traffic Regulations;
- *Traffic Control Devices 2004 Rule;*
- *Traffic and Parking Bylaw*.

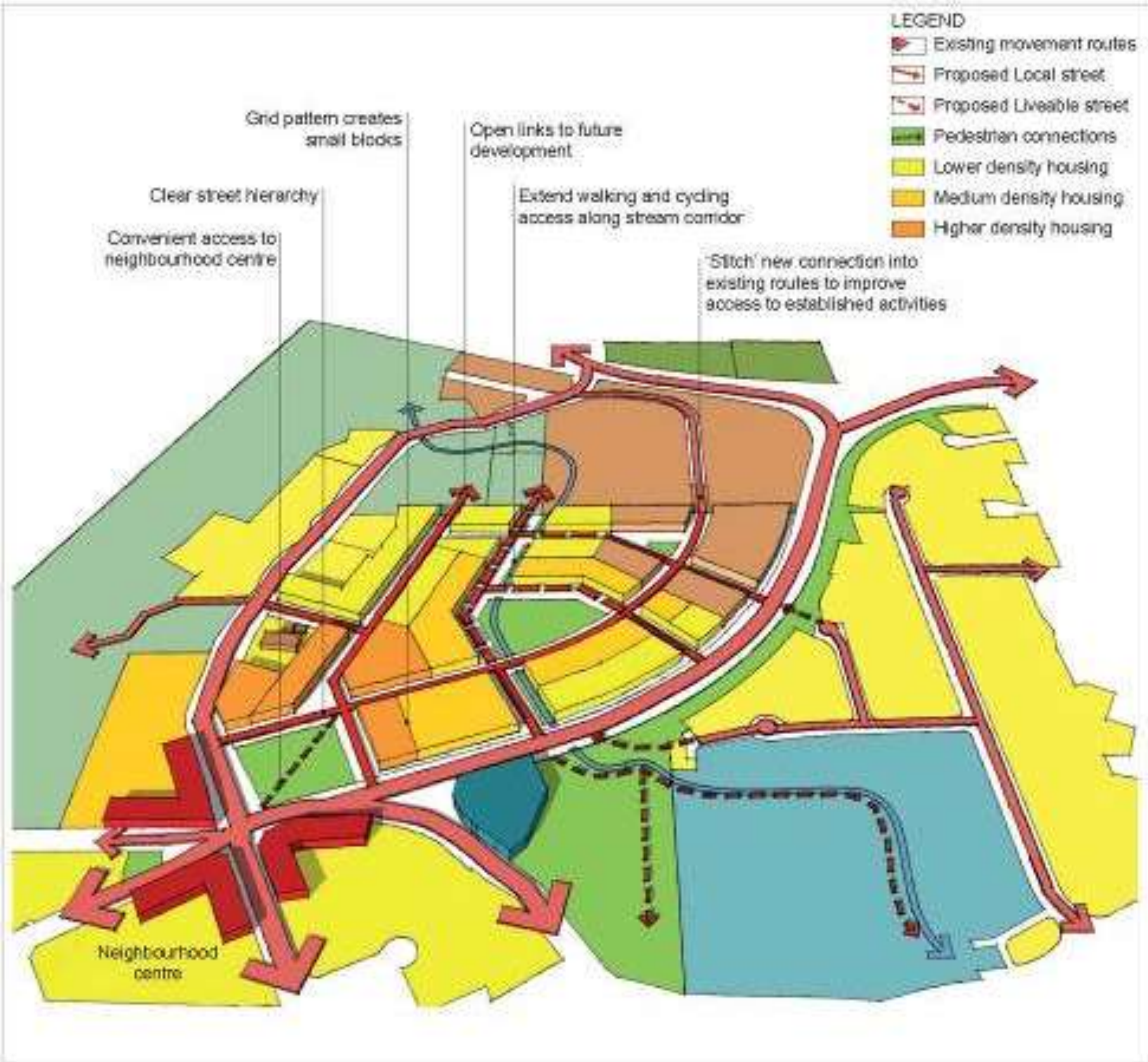
8.3 CREATING GOOD URBAN INFRASTRUCTURE

To create good urban structure, acquire a good understanding of the urban design principles which underlie the layout of blocks, streets and open spaces in new developments and the inter-relationship between them. While the focus is on new public spaces, also consider the three dimensional character of the spaces which are formed by buildings on private areas within the blocks. The relationship between public and private areas is an essential part of creating places for people.

Access to, and within, areas to be developed includes more than the road network that provides formal access to properties. It also includes public transport routes and green linkages that provide access for pedestrians and cyclists to use areas such as reserves and waterways.

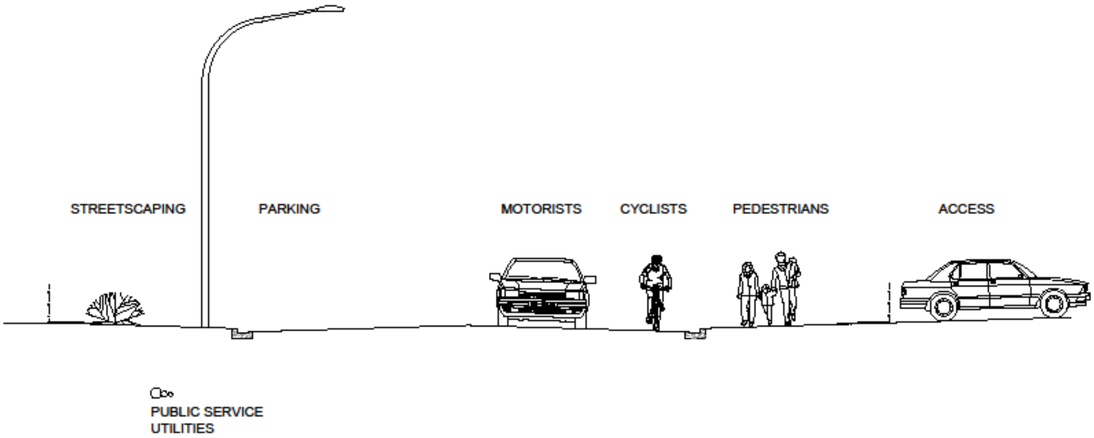
The road network and associated linkages need to be highly connected, to reflect the desired lines and destinations within the area and also in surrounding neighbourhoods. This encourages people to walk or cycle where practicable, rather than using their car, particularly for shorter local trips. Figure 1 illustrates this interconnectedness. When this can be achieved, it results in energy savings and creates a safer and more pleasant neighbourhood.

Figure 1 Streets and linkages arranged in an informal grid



Streets can serve a wide range of functions, whilst providing valuable and unique areas of community space (see Figure 2). Use the design process to challenge the assumption that motor vehicles have "automatic" priority (particularly on local roads) and consider all the demands and functions of the street space, in order to achieve a better balance for all those who use it.

Figure 2 Street functions



The Council encourages innovative design, for access and roading, which satisfies the following objectives:

- safe – the layout must be safe for all users, including pedestrians, cyclists, public transport users and motorists;
- secure – the design of the roads and other linkages must not compromise the personal security of the users;
- energy efficient – the layout should minimise the number and length of vehicle trips and promote alternatives to motor vehicle use;
- linked – the layout of a development should be extended on a hierarchical network basis for all modes. It should promote walking and cycling, particularly for short trips to local facilities, and should provide direct access to public transport routes. Linkages to existing areas of development must also be provided;
- suitable traffic speeds – the road design must encourage traffic speeds that are appropriate for the road classification and context;
- comprehensible – the road layout must be easy to read and follow, for both residents and visitors;
- accessible - the road design should incorporate footpaths, kerb cutdowns, raised thresholds, refuge islands, etc that provide easy access for all;
- enhances environment – the road design should incorporate carriageway and residential stormwater quality improvements or design features as part of the grass berm design e.g. encouraging sheet flow over grass berms, swales protected from traffic use;
- attractive – the design of the street landscaping and other features can add significantly to the amenity, environment and character of the area.

Where the above objectives may be achieved through other mechanisms, the Council may reconsider applying the requirements of this Part of the IDS to a development.

8.4 QUALITY ASSURANCE REQUIREMENTS AND RECORDS

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

8.4.1 Design records

Provide the following information, to support the Design Report:

- a clear description of the purpose of the work;
- the scope of the work e.g. legal requirements for road elements such as the provision of appropriate transport facilities, suitable access to the existing transport network;
- transport infrastructure and services issues (e.g. vehicle, cycle, public transport, pedestrian);
- traffic-loading, traffic modelling and volume data and projections used and calculations to determine Equivalent Standard Axles (ESAs);
- geometric data;
- geotechnical data, including site assessments, subgrade information and CBR's;
- pavement design methodologies used and corresponding metalcourse calculations;
- surface treatment information;
- road drainage control and edge treatment;
- hydraulic data (e.g. road level, flood level);
- slope stability (during construction and permanent) and retention details;
- utility service conflicts and programmed work issues;
- traffic safety audits;
- streetscape and amenity features.

8.4.2 Safety audit

Safety auditing is an important component in the design of all facilities on legal road. Safety audits provide a check that the proposed design is safe for all users. Safety audits should be integrated throughout the design of new transport facilities.

Provide an independent safety audit at the concept or subdivision consent stage, and for any Variations, which also considers the development's potential to generate high trip volumes requiring specific changes to the road infrastructure. If an audit is not submitted with a resource consent application, a condition of consent shall be issued requiring a safety audit at the Application for Engineering Acceptance.

An independent safety audit of the constructed asset must also be undertaken and submitted as part of the as-built record. The 224 Certificate will not be issued until safety audit requirements have been addressed.

Carry out safety audits in accordance with *Road Safety Audit Procedures for Projects* and *Guide to Road Safety Part 6: Road Safety Audit*. Use the *Guide to Road Safety, Part 8: Treatment of Crash Locations,* for safe design practices.

8.4.3 Construction records

Provide the information detailed in Part 3: Quality Assurance, including:

- material specification compliance test results;
- subgrade test results and corresponding recalculations of metalcourse depths;
- compaction test results;
- Benkelman Beam test results;
- as-built levels of the top of kerb, manhole covers, sump grates and the road centreline;
- surface profile test results for roads and rights of way greater than 100m in length i.e. NAASRA/International Roughness Index;
- surface texture test results;
- concrete or asphalt core test results. Copies of concrete test results are not required for retaining walls;
- construction records and test results for retaining wall components;
- post-construction safety audit.

Provide details in a form complying with the requirements of Part 11: As-Builts.

8.5 ACTIVE MODE NETWORK

8.5.1 Pedestrian Facilities

a) Footpaths

The number of footpaths required for each road classification must comply with the requirements in the *District Plan* and follow guidance provided in the footpath policy.

Footpath widths are measured from the footpath edge of the kerb or service strip. The service strip may be sealed with the path. The minimum widths set out in Table 1 must **be clear of all obstructions** such as vegetation when fully mature, light standards, traffic signs, utility furniture and bollards. The building or fence line is the preferred path of travel for the majority of pedestrians who have a vision impairment and should always be prioritised as the continuous accessible path of travel (CAPT). Extra widening will be required wherever such obstructions cannot be avoided or relocated.

Table 1 Minimum footpath widths

Adjacent land use	Minimum width (m)	Preferred location
Residential	1.8	Between Berm and Service Strip
Retail/town centre	2.5	Between Street furniture and Frontage Zones
Industrial	1.8	Adjacent to kerb

Notes:
1) Residential footpaths are normally separated from the kerb by a grass berm and from the road boundary by a service strip.
2) Residential footpath widths of 1.2m are agreeable in situations of a secondary path where the other footpath in the road reserve is identified as a primary route.
3) Allow for any planting (e.g. trees) between the footpath and the kerb.
4) On slopes, it is most practicable to construct the footpath against the kerb.
5) Transitional widths may be required on the boundary between residential and retail/town centres.

Where topography or existing features preclude providing the minimum widths, discuss options with the Council.

Lateral changes of the footpath direction should normally be achieved using smooth continuous curves. This is particularly relevant where the path deviates around obstacles (e.g. utility boxes, columns/poles) or adjacent berm areas (e.g. trees, shrubs or structures) or shifts laterally to join another footpath.

Wherever the footpath deviates from pedestrian desired lines and positive guidance is required, install plant beds, fences or comparable barriers. Wherever possible, plant shrubs to soften the appearance of the guidance element. Also consider the needs of people with disabilities e.g. mitigate the possible safety risks for a person with a visual impairment by indicating the change.

Use the Timaru District Council *Footpath Policy* when designing a footpath. https://www.timaru.govt.nz/council/publications/policies/footpath-policy.

AS/NZS 2890.6:2009 Parking Facilities – Off-street parking for people with disabilities and the *National Policy Statement on Urban Development 2020 – May* 2022 should be considered in the design of pedestrian facilities.

b) Road crossings for pedestrians

Road crossings for pedestrians, both at intersections and in the mid-block, should provide for the logical and safe movement of pedestrians. Selection of the appropriate crossing type requires consideration of:

- What is the street function and surrounding land uses?
- Who is expected to use the crossing?
- What is the best location of the crossing to meet pedestrian desire lines?
- What is the relationship and spacing to other crossings (mid-block and intersections) nearby?

Advice on the appropriate crossing type can be found in the *NZTA Pedestrian Network Guidance.*

Crossing facilities may be combined with kerb build-outs and pedestrian islands, to minimise the crossing distance for users. Pedestrian islands or other facilities, to aid safe crossing of roads, may be required in areas where high numbers of pedestrians are expected to be crossing (e.g. local commercial areas, reserves, schools, retirement homes, public facilities).

Provide pedestrian crossing facilities that comply with the *Guidelines for Facilities for Blind and Vision-Impaired Pedestrians RTS 14* at all road intersections and other locations. Provide tactile warning pavers or tactile ground surface indicators (TGSI) for vision-impaired pedestrians on public footpaths at all pedestrian crossing kerb cut-downs. Specify tactile types, preferably pavers, which will achieve the 20 year operational life of the contrast between the path surface and the tactile. Plastic TGSI are not permitted in Council paths.

Provide a one metre separation between new pedestrian cutdowns and existing columns/poles or signs. Ensure cycle 'Give Way' signs and any supplementary signs are located in a position which doesn't impede pedestrians.

Use the following standards and guidelines for the selection, design and operation of pedestrian crossing facilities:

- *NZTA Pedestrian Network Guidance*
- *Guidelines for Facilities for Blind and Vision-Impaired Pedestrians RTS 14*
- *Austroads Guide to Road Design, Part 4: Intersections and Crossings -General*
- *Austroads Guide to Road Design, Part 4a - Unsignalised and Signalised Intersections*
- *Austroads Guide to Road Design Part 6A Paths for pedestrians and cyclists*
- *Austroads Guide to Traffic Management, Part 6 - Intersections, Interchanges & Crossings*

8.5.2 Cycle Facilities

Make provision for on-street and off-street cycle facilities, as required by the *Timaru District Plan,* to provide a multi-modal network. For streets on the cycle network a separated cycle facility may be more appropriate.

a) On-street facilities

Cycle lanes should be designed in accordance with NZTA Traffic Control Devices Manual Part 5 guidance as follows in Table 2.

Table 2 Cycle Lane Widths

	Posted speed limit	Desirable Minimum Width (m)
Cycle lane width – next to parking	Equal to less than 50km/h	1.8
	70km/h	2
Cycle lane width –next to kerb or between traffic lanes	Equal to less than 50km/h	1.8
	70km/h	1.9
	100km/h	2.5

For local urban roads, cycle facilities may be provided through narrow or wide kerbside lanes in accordance with *NZTA Cycle Network Guidance* as follows:

b) Separated (protected) cycle facilities

Separated cycleways are facilities exclusively for cycling. They involve some form of physical separation from motor traffic and are generally situated on or adjacent to the roadway, usually within the road reserve. The separation may involve horizontal and/or vertical components.

Separated cycleways can be either:

- one-way (uni-directional) ie cycling in the same direction as adjacent traffic usually on each side of the road; or
- contra-flow one-way (uni-directional) i.e. cycling in the opposite direction to adjacent traffic, usually on the right side of a one-way street when seen from the traffic perspective; or
- two-way (bi-directional) ie both directions for cycling accommodated within one facility on one side of the road.

There are a range of methods that can be employed to separate and protect cyclists from motor traffic, each offering different levels of actual safety (ie in terms of crash risk) and perceived safety (ie in terms of people's subjective evaluations). Refer to the *NZTA Cycle Network Guidance* for design advice.

c) Cycle parking and wayfinding

Consider installing cycle parking facilities near bus stops, to ease the transfer between transport modes. Cycle parking guidance is available on the *NZTA Cycle Network Guidance* website.

Cycle network wayfinding should be designed in accordance with *NZTA Cycle Network Guidance*.

8.5.3 Off Road Linkages for Walking and Cycling

a) Linkage corridors

Linkages for pedestrians and cyclists must create an attractive, friendly, connected, safe and accessible environment. These linkages must ensure that people can move about the community freely in areas where there are no road linkages (e.g. at the end of cul-de-sacs) and provide direct pedestrian access to bus stops. Use green linkages between cul-de-sacs, through public reserves or adjacent to waterways, or other natural features. Cul-de-sacs should be connected to other streets with walking and cycling linkages to ensure walkable blocks and overall connected networks.

The overall width of the linkage corridor needs to be adequate for the path and appropriate landscaping. Historically, minimal width linkages of 2.5 to 3.0m had been provided with little or no landscaping. These are unattractive to use and in some cases have been closed due to perceived CPTED security problems associated with them.

Therefore, providing wide, open and well-lit areas is extremely important to provide a secure and useable linkage. Figure 3 shows a well-designed linkage/accessway.

Figure 3 Good Linkage Corridor

Figure 3: Good accessway design example, low fences and overlooked by neighbours

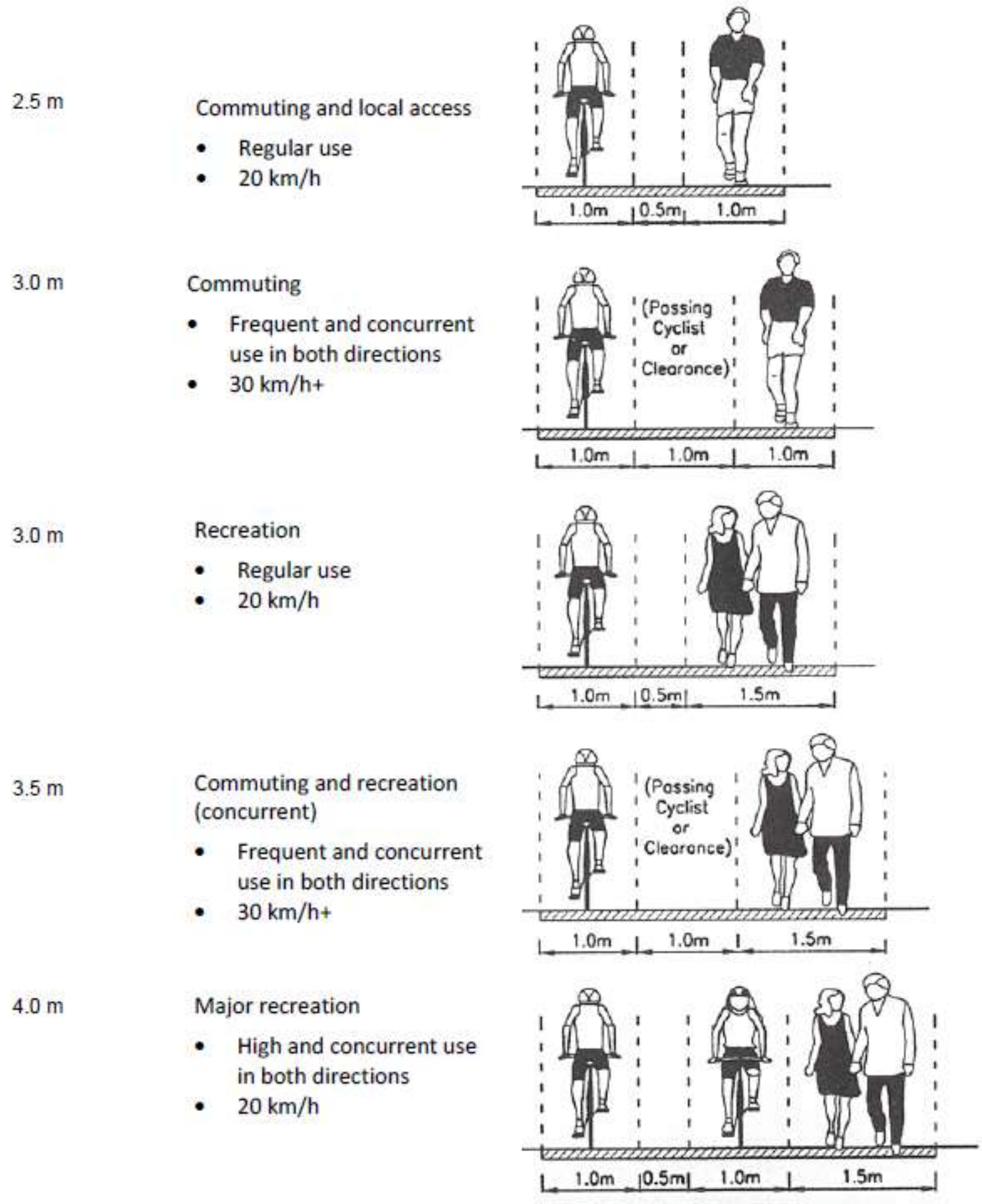
b) Paths in accessways

Design the paths so that they are suitable for pedestrians, people with disabilities, cyclists, skate-boarders, skaters, and prams. Note that motorised wheelchairs require 1.2m clear width.

The minimum clear width of formed paths in off road linkages is 1.8m for pedestrian-only paths and 2.5m for paths shared by pedestrians and cyclists. The formed width should be widened wherever a lot of people are expected to use the facility.

The Council must pass shared paths by resolution.

Figure 4 Pedestrian/shared path widths



Source: Austroads Guide to Road Design Part 6A: Paths for walking and cycling, Figure A2

Seal the path and landscape the remaining land in a manner that does not compromise the security of people using the facility.

Use the following guidelines for the detailed design of off-road paths:

- *Crime Prevention Through Environmental Design*
- *A Guide to Road Design, Part 6A: Pedestrian and Cyclist Paths*
- AS/NZS 1158 Set *Lighting for roads and public spaces - series*

8.6 PUBLIC TRANSPORT

Existing and planned or potential public transport routes and stops shall be shown on plans and designed in accordance with the NZTA Public Transport Guide.

8.6.1 Bus routes

Consider the specific needs for public transport at an early stage of the design process to ensure that:

- roads can cater for the manoeuvring requirements of public transport vehicles (including turning around or U-turns at a terminus);
- termini of routes are identified;
- routes are efficient and easily accessible by public transport vehicles;
- proposed routes form a coherent new bus route or an extension to an existing route.

The provision of bus routes in new development areas must be discussed with Canterbury Regional Council (Environment Canterbury) staff. Refer to Environment Canterbury's *Regional Public Transport Plan* for further information.

8.6.2 Bus stops

Plan and co-ordinate the bus stop locations and associated infrastructure on the street with Timaru District Council at the resource consent stage. Extra space may be required to site bus shelters or other required infrastructure, which can be incorporated in the engineering design.

Bus stops must be located in accordance with the *NZTA Public Transport Guidelines*. Bus stops should be located close to key facilities to enhance accessibility for the community, as well as general locations around the town to facilitate people movements.

If the width of the roadway does not provide for roadside parking, allow for the construction of inset bus bays or bus boarders.

8.7 ROAD CLASSIFICATION

The road network is the system of interconnected road links that provides for the movement needs of people and goods, property access and servicing needs. It is usually arranged and operated in a manner to recognise and best serve the varying demands expected of different elements (usually using a hierarchical classification system). Developments must provide road networks internally to achieve these purposes, and connect appropriately to the existing network.

The length and arrangement of these roads within the development and connections to the existing network determine the amount of traffic each element is likely to carry and the role it plays in providing for property access or longer journeys.

The place function and movement function of each link, determines its classification, and therefore its geometric characteristics and preferred speed regime.

The classifications of existing roads in the Timaru District are listed in the *District Plan.*

Be aware of any other network plans (such as the cycle network), local area traffic management schemes or neighbourhood improvement plans which may incorporate street requirements for the area.

8.7.1 Local roads

These roads provide direct access to abutting properties. They form the road network within the neighbourhood and may be subject to Local Area Traffic Management schemes to reduce speed and through traffic. The proportion of through traffic on local roads should be very low.

Local roads should not generally connect to major or minor arterials, except in exceptional circumstances and with the Council's approval.

8.7.2 Collector roads

These roads collect and distribute traffic to and from the primary road network and link with the local road network. Although a lower traffic volume is expected than for a road in the primary road network, there is a high proportion of through traffic. They may be either urban or rural.

8.7.3 Principal Roads

These roads primarily cater for traffic movement between the major areas of the District. They may be either urban or rural. Principal roads are essential to sustain overall travel within the District. Principal Roads are usually 2 lanes wide. The road reserve width is generally 19 or 20 metres and most facilities can be accommodated in this width. Intersections may require local widening where traffic demands are such that specific design is needed. If the road is a significant cycle route, a cycle lane would be marked. If not, a wider parking lane may be used by cyclists. Some parking restrictions may be required where additional facilities such as flush medians are needed

8.7.4 District Arterial Roads

District arterial roads are those which are of strategic importance to the District and are controlled by the Timaru District Council. They predominantly carry through traffic and are urban. Flush medians and right turn bays may be elements of these roads. Some degree of access and/or on-street parking control may be needed. Cycle lanes are generally marked if the cycle volumes warrant them.

These roads must be designed in conjunction with the appropriate roading authority. Discuss access to the existing road network with the Council and Waka Kotahi at the consent stage, if a State Highway will be affected. Use the NZTA *Planning Policy Manual* for the design of any works on or adjacent to a state highway.

8.7.5 Regional Arterial

These are roads of strategic importance to the region and are a significant element in the regional economy. In Timaru District, these are State Highways 79, 78 and route 72. These roads are under the control of Waka Kotahi (New Zealand Transport Agency) or the Timaru District Council and their form is consistent with the goals of the national land transport strategy.

8.7.6 National Routes

These are roads that make up routes of national strategic importance. They form part of the State Highway network (State Highways 1) and their prime function is to provide for through traffic while providing access to significant urban areas.

8.7.7 Traffic volumes

Identify the likely volumes of traffic that will be generated by a development, using the following average household trip generation rates.

Table 3 Household trip generation rates

Flat urban areas	10 trips/household/day
Hillside & rural areas	8 trips/household/day

If surveyed data is available for areas with similar characteristics, use this in preference to the values above, due to the variation in generation rates throughout the district. Some traffic count data is available at Waka Kotahi NZTA's *State Highway traffic monitoring* or Mobile Roads App.

https://maphub.nzta.govt.nz/public/?appid=31305d4c1c794c1188a87da0d3e85d04

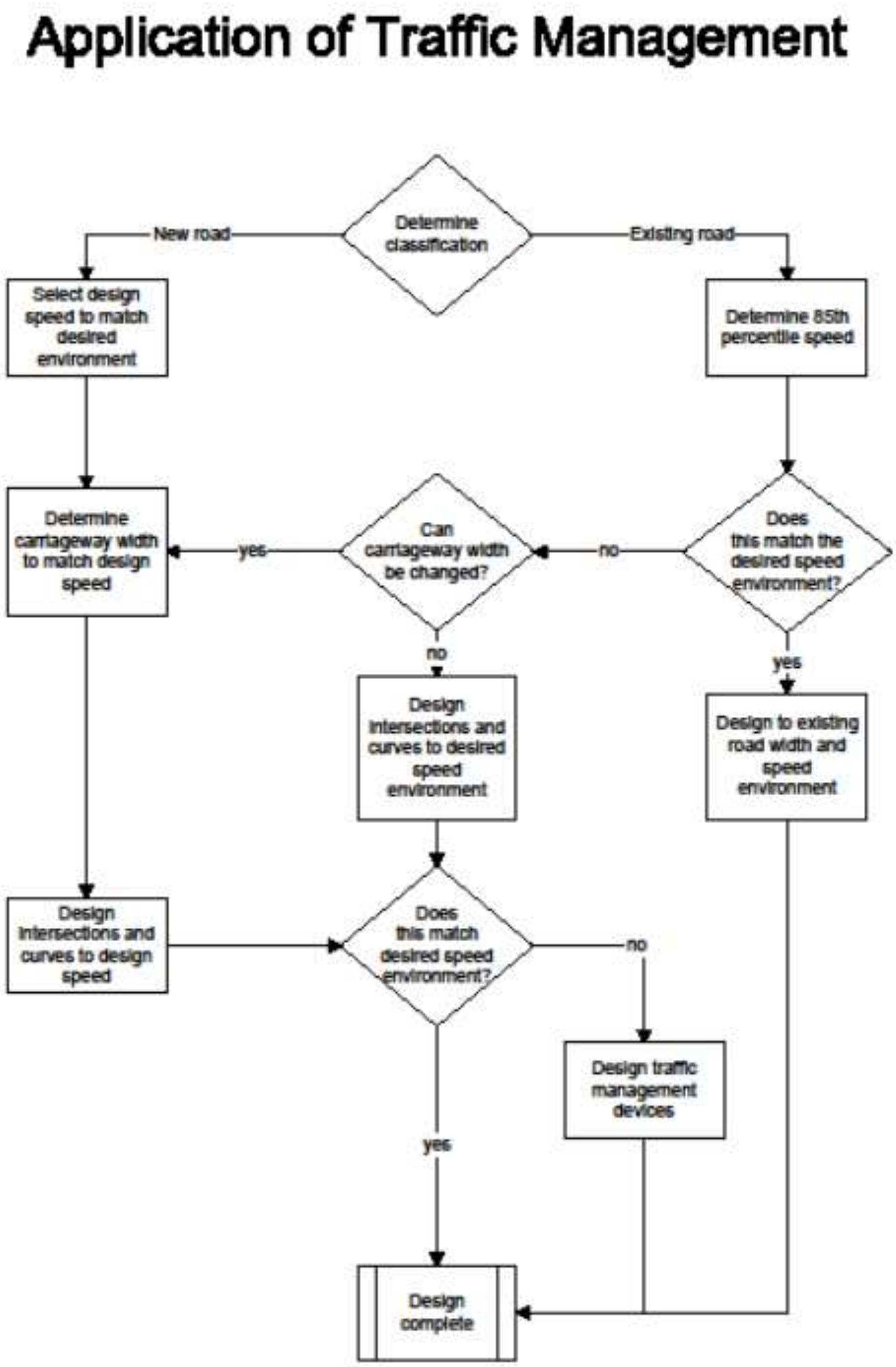
https://mobileroad.org

8.8 SPEED ENVIRONMENT

The speed environment of roads can have a huge impact on the actual and perceived safety of the facilities; therefore it is important to design for the appropriate speed of the roads involved. Determine the speed environment for the road classification first as it is the primary design control. All other factors relate to and can reinforce the design speed e.g. road alignment, width, intersection location and treatment, and landscaping. Ensure that the speed environment is consistent along the road section.

Traffic management devices should not be installed where the speed environment does not require alteration. Use the process in the flow chart in Figure 5 for determining alternative design options. If the use of traffic management devices is found to be the best management option, design considerations and device selection should be in accordance with the *NZTA Speed Management Guide.*

Figure 5 Application of traffic management



Traffic speed for lower speed environments may be controlled, so that it is conducive to a mixed use street environment and function, through a variety of means:

- roadway width – a narrow roadway may provide space for only one vehicle at a time. Parked vehicles reduce the available space for moving vehicles so that there may only be a single usable lane.
- landscaping – appropriately designed on-street landscaping can visually narrow the road. It can also be used with changes to the kerb alignment to physically narrow the roadway.
- corners – the use and spacing of tight corners to maintain short lengths of straight road makes it difficult to gain speed.
- intersection spacing – short lengths of road between intersections make it difficult to reach high speeds.
- intersection design – tight kerb radii force motorists to slow down when entering an intersection. This can be combined with an intersection treatment (e.g. change in road width or surfacing) to indicate a change in the speed environment to drivers. Roundabouts are another intersection design option for consideration.
- traffic calming – localised road narrowing, changes in road texture, changes in the road alignment (both horizontal and vertical) can all be used to reduce speeds on local roads and to create safe crossing points for pedestrians and cyclists.
- rural thresholds – localised narrowing of the road through kerbs, road markings, signage and/or roadside planting can provide a signal to drivers that they are entering a residential area with lower speed limits.

Find standards for the design of higher speed environments, such as are appropriate on various classified and rural roads, in the *Austroads* series and *NZTA Speed Management Guide.*

8.9 ROAD DESIGN

Areas that require particular attention during the road design are:

- speed environment;
- intersection design and spacing;
- connections and intersections with the existing transport network;
- future road linkages to unzoned land;
- bus movement requirements and bus stop locations and facilities;
- pedestrian and cycle facilities;
- parking requirements;
- road crossings for pedestrians;
- access requirements of mobility impaired pedestrians;
- the connection of off-road facilities to roads and property access;
- lighting;
- road surfacing;

- Waste Collection and bin collection facilities;
- Over Dimension and Overweight Vehicles

Minimise life cycle costs and benefits for all new road elements. When choosing materials in particular, consider the replacement and maintenance cost whilst ensuring levels of service are met.

Council allows over-dimension and over-weight vehicles to operate on limited sections of the road network by permit, as per NZTA Over-dimension Route Maps.
https://nzta.maps.arcgis.com/apps/webappviewer/index.html?id=e00b3ac6ab524cb19a369fc5c2b4e6fa

The maximum dimensions for which permits are normally issued are:
- *Width: up to 11.5 m*
- *Height: up to 6.5 m*
- *Length of vehicle combination: up to 35 m.*

Avoid detailing permanent objects within the streetscape that will conflict with the over-dimension envelope on these routes. Reference the Heavy Haulage Association design specification from the following link when designing for OD routes:
https://www.hha.org.nz/assets/Resources/NZHHA-Roading-Design-Spec-For-OD-Loads-Version-8.pdf.

8.9.1 Access to existing roads

Discuss access to the existing road network with the Council, and also the New Zealand Transport Agency, if a State Highway is to be affected. The NZTA Policy and Planning Manual includes guidance on access to State Highways.

The safety and efficiency of the existing roads must be maintained, when considering connections or accesses from the development.

8.9.2 Cul-de-sac/Hammerheads/No exit streets

Cul-de-sac can provide pleasant residential environments with a sense of community and little traffic but a balanced approach to their use is required. Refer to the *Timaru District Plan* for further information.

Provide walking and/or cycling linkages at the end of cul-de-sac to parks, reserves or other roads. When designing large cul-de-sac heads, consider incorporating islands or other measures to break up large expanses of seal. Surface all turning heads with asphaltic concrete.

Hammerhead designs require specific approval.

Guidance set out by the Fire and Emergency New Zealand *Designers' guide to firefighting operations*[1] *- Emergency Vehicle Access* is best practice when designing Cul-de-sac, Hammerheads and No exit streets.

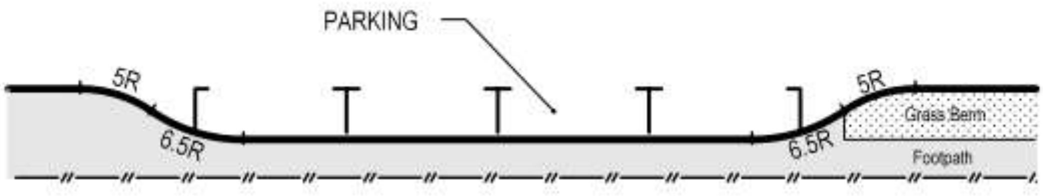
8.9.3 On-street parking

Design parking lanes widths from 2.0 - 2.5m depending on regular vehicle type using the parking lane. For example, in industrial areas a 2.5m wide lane will accommodate large trucks. Increase stall lengths to 6.5m in high turnover areas (time controlled parking of 1 hour or less).

Provide mobility car parks which meet the requirements of NZS 4121 where required by the brief or resource consent.

Street-side parking in residential areas shall be provided in bays, rather than as part of the carriageway, provided at a rate of one space per three residential units and evenly distributed along the street. Where parking is reconstructed along existing roads, parking shall be provided in bays. Construct all parking bays to the same design loading as the adjacent road pavement and with a minimum width of 2.0m for parallel parking. Radii should match those shown in Figure 6.

Figure 6 Parking bay



When parking bays are located in front of properties, consider the possible location of the property access.

Design angle parking to the *District Plan* and *NZTA Traffic Control Devices Manual – Part 7: Parking Control.*

All road markings including parking lanes or spaces shall be in accordance with the *NZTA Manual of traffic signs and markings (MOTSAM) – Part 2: Markings*. Marking is required for all angle parking and where parking restrictions are in place. Mark mobility car parks in accordance with the *NZTA MOTSAM* Part 2. There will also be other circumstances where road marking of parking is advisable e.g. outside schools and on arterial or higher roads. Marking lanes on some Collector roads may also be appropriate depending on demand. Marking individual spaces may also be appropriate if there is high demand for

[1] Fire and Emergency New Zealand, *Designers' Guide to Firefighting Operations – Emergency Vehicle Access – F5-02-GD,* https://www.fireandemergency.nz/assets/Documents/Business-and-Landlords/Building-and-designing-for-fire-safety/F5-02-GD-FFO-emergency-vehicle-access.pdf

parking as space markings help optimise the space available. There is generally no need for marking parking lanes on local roads.

The Council has delegated the approval of the installation of parking restriction signs to the Community boards. This is separate from and additional to engineering acceptance.

8.10 INTERSECTION DESIGN

The potential for crashes to occur at intersections is higher than other areas of the road network, due to the number of conflicting vehicle, cycle and pedestrian movements. Proper design of intersections can reduce the number of conflicts, while providing for a range of turning movements at the intersection.

Consider traffic safety issues due to the location of existing above-ground structures e.g. columns/poles, desire lines, landscaping and/or trees, at the time of design.

8.10.1 Comprehensibility

Comprehensibility of the network improves the ease with which people can negotiate their way through and around an area.

Generally, the geometry of any road intersection should be designed so that the major route is the through road and has traffic priority. Wherever the roads are of equal classification or one classification different, a roundabout may be used. This can also limit vehicle speeds. Wherever a local road intersects with a classified road, a perimeter threshold treatment may be appropriate to reinforce traffic priority and assist with comprehending the layout.

Improve comprehension by designing each classification of road to reflect its function, through consistency of appearance, width and geometric design of the road; e.g. the main arterial roads may have a central median. Reduce confusion by minimising the use of cul-de-sac. There should be no cul-de-sac accessing other cul-de-sac. See clause 8.10.2 - Cul-de-sac/Hammerheads/No exit streets above.

8.10.2 Intersection types and controls

To support the safety and efficiency of the road network, roads should preferably only intersect if they are classified the same or are one level different in status. If it is unavoidable that roads more than two classification levels apart must intersect, then the Council may consider applying movement controls such as left in/out only or entry only.

Within new residential areas, appropriate intersection types include:

- Priority, roundabout or signal controlled T or Y-intersections (3-way), depending on the balance of traffic flows and classification of the approach roads. All approach legs to Y junctions should be separated by 120 degrees and T junctions by 90, 90 and 180 degrees.

- Generally four-way intersections at grade must be roundabout or signal controlled due to their high crash risk. Local roads should not intersect with the main road network as cross roads and should only form cross junctions with themselves where necessary. Where unavoidable and a reasonable volume of traffic across the busier road is anticipated, offset the quieter roads as a left – right stagger, to minimise the risk of crashes.

Wherever traffic from the planned roading network for a development will access a classified road, the intersection may require roundabout or traffic signal control or have certain movements restricted. Consult with the Council before submitting the Design Report, including a Road Safety Audit, to ensure that the intersection conforms to the Council's requirements.

8.10.3 Unsignalised urban intersection spacing

Locate intersections sufficiently far apart to separate their traffic movements and provide drivers with sufficient lead-time for decision making, but also close enough to ensure a cohesive network and walkable blocks. Provide the spacing necessary to meet the requirements of the *Guide to Road Design, Part 4: Intersections and Crossings - General*. Discuss spacings for arterial – arterial intersections with the Council before the Design Report is submitted.

Use the following standards and guidelines for the design and operation of intersections and vehicle crossings:

- *Guidelines for the Implementation of Traffic Controls at Cross Roads, RTS 1*
- *Guide to Traffic Management, Part 6: Intersections, Interchanges and Crossings Management*
- *Timaru District Plan*

8.10.4 Sight distances

Adequate sight distances at an intersection must be provided as sight distance is fundamental to safe intersection design. When designing intersections and/or small radius curves, use the *Guide to Road Design, Part 3: Geometric Design*, which provides guidance on the minimum sight distance requirements.

Reference the *Timaru District Plan* for minimum sight distance requirements from new vehicle crossings and intersections.

8.10.5 Permanent signs and markings

The Council has delegated the approval of the regulatory signage and road marking on existing roads to the Community boards. This is separate from and additional to engineering acceptance.

Consider the proximity of overhead power lines: design signs and other infrastructure to provide the clearances required in the *Code of Practice for Electrical Safe Distances*.

When signs are used within the road corridor, they must comply with the following standards and guidelines:

- *Setting of Speed Limits 2007 Rule*
- *Guidelines for Street Name Signs, RTS 2*
- *Road Signs and Markings for Railway Level Crossings, RTS 10*
- NZS 8603 *Design and application of outdoor recreation symbols*
- *Compliance Standard for Traffic Signs*
- *Manual of Traffic Signs and Markings Part 1*

Locate street name signs between 450mm and 1500mm behind the new kerb or 600mm and 1500mm behind the new shoulder and within the area formed by the intersecting legal road boundaries, as specified in *RTS 2*. Ensure that reconstruction projects include the relocation of the street name sign, if the works make its old position inappropriate. Position signs at least one metre away from a vehicle entrance or kerb cutdown where possible.

8.10.6 Traffic signals

If the road controlling authority decides that traffic signals are necessary to provide safe and efficient access to the area, use the guidelines in:

- Austroads “Guide to Traffic Management, Part 6: Intersections, Interchanges and Crossings”
- NZTA “P43 Specification for Traffic Signals”
- CTOC “Regional Special Conditions”

The location and design of each installation must conform to the requirements and approvals set by the Council, to enable coordination of the traffic signals.

8.10.7 Roundabouts

Roundabouts provide control at intersections in a variety of circumstances e.g. they can control speeds or improve traffic flows. Their location must be agreed with the Council at the resource consent stage.

Consider these issues in the design:

- the classification of the intersecting roads;
- pedestrian and cyclist safety;
- the vehicle types expected to use the intersection;
- the speed environment;
- the distribution of turning traffic;
- landscaping;
- heavy vehicle access requirements.

Roundabouts at the intersection of local roads can be used to control speeds, and may be designed with semi-mountable aprons for effective traffic calming. The semi-mountable apron slows cars (it must be high enough to discourage drivers from over-running it), whilst providing for the larger turning requirements of vehicles such as rubbish trucks and emergency vehicles.

Discuss the geometric and structural design of such roundabouts with the Council. Reinforced beams and apron behind the semi-mountable kerb may be necessary to protect from damage by trucks or other heavy vehicles.

Consider the location of stormwater management systems within roundabout raised structures.

Raise platforms on the approaches can reduce speeds and provide a safer crossing for pedestrians, see Figure 7.

Figure 7 Raised platform on approach at an urban Roundabout

Use the following standards and guidelines for the design and operation of roundabouts:

- *Guide to Road Design, Part 4: Intersections and Crossings*
- *Guide to Road Design, Part 4B: Roundabouts*
- *Guide to Road Design, Part 6A: Pedestrian and Cyclist Paths*

8.11 SERVICE LANES, PRIVATE WAYS AND ACCESS LOTS

Access to a site (or sites) that will be provided by a private way must comply with the requirements of the *Timaru District Plan*.

Accessway design and construction standards, including drainage, for service lanes, private ways and access lots must comply with the requirements for an equivalent construction within legal road, including the 50-year design life. This includes the provision of a secondary flowpath for stormwater, as detailed in clause 5.6.2 - Secondary flow paths (Stormwater and Land Drainage). When designing accessways, balance the long term maintenance costs for the residents against the benefits of providing access through a vested road.

Council may approve an extension to street collection of refuse/recycling bins. If this is envisaged, the carriageway shall be designed to accommodate the truck weight and dimensions.

Consideration for emergency vehicle access as outlined in the *Designers' guide to firefighting operations – emergency vehicle access – F5-02-GD* is also recommended when designing private access. This is of particular significance where access to a building is greater than 50m in length from the carriageway within the road reserve. In this instance, a minimum traffic lane width of 4 metres is recommended to enable adequate access and operation of emergency services.

As work within private ways, service lanes and accessways will not be taken over by the Council upon completion; the Council will be placing the onus for confirming both the suitability of design and construction on the developer.

These works must comply with the requirements of Part 3: Quality Assurance.

8.12 GEOMETRIC DESIGN

8.12.1 Design speed

Safe, Functional and Appropriate speed environment is the goal in designing new and existing roads:

- Safe: operating speed under favourable conditions where vehicular control is maintained
- Functional: Classification set by Timaru District Council
- Appropriate: design for the current and anticipated environment and traffic volumes of the segment

The *Traffic Speed Limits Bylaw* and its related register of speed limits, found at https://www.timaru.govt.nz/__data/assets/pdf_file/0009/182745/Chapter-11.pdf set out the speed limits for the listed roads. Use the *Speed Limits New Zealand Schedule 1* incorporated in the *Setting of Speed Limits Land Transport Rule* to estimate the relevant speed limit for new or reclassified roads in Timaru District. The Council will determine the relevant speed limit using the *Setting of Speed Limits Land Transport Rule*.

8.12.2 Horizontal alignment

Generally, horizontal curves conform to the *Guide to Road Design, Part 3: Geometric Design*. Design the elements of the road network for the appropriate design speed.

Establish the design vehicles at the start of the design process. At intersections kerb radii should be kept as small as possible to control entry speeds and minimise pedestrian crossing distances. On local residential streets the design approach may be such as a waste collection truck is the check vehicle, i.e. can access the street and can cross the centreline when entering.

Design intersections of a collector or arterial road to meet the tracking curve requirements in *RTS 18 New Zealand on road tracking curves for heavy vehicles*.

Avoid reverse curves where possible. If they are necessary, balance and separate them by a sufficient length of straight road to allow for a satisfactory rate of superelevation reversal (where the design speed is greater than 50kph).

Curves in the same direction in close proximity must be compounded. Avoid “broken back” effects.

Where horizontal curves of less than 60m radius are necessary for topographical or other reasons, extra widening of between 0.5 and 1.5m may be required, according to the width of carriageway available to moving traffic, the radius of the curve and the classification of the street. The *Guide to Road Design, Part 3: Geometric Design* provides further information to calculate this extra widening.

Horizontal curves in 50kph areas are usually circular with a minimum centreline radius of 80m for through streets, reducing to 20m for cul-de-sac.

8.12.3 Vertical alignment

Gradient lengths must be as long as possible, with vertical curves provided in compliance with the *Guide to Road Design, Part 3: Geometric Design*.

Gradients at any point on the kerb line should not exceed 1:6 or be less than 1:400, with a minimum gradient of 1:300 on the outside kerb line of any curve. Kerb grades less than 1:500 may be acceptable in conjunction with underchannel piping or frequent stormwater outfalls.

Where the change of gradient exceeds 1%, generally join the change with appropriate vertical curves of not less than 30m for through roads and 20m in cul-de-sac.

Design the crown line at intersections to ensure a smooth ride on the main road. Normally, this means running the crown of the minor road into the nearside edge of the main road lane line or quarter point.

Design of roads should be completed so that no kerbs are overtopped by secondary flow in 2% annual exceedance probability (AEP) flood events.

No road level at a waterway crossing should be raised if this may cause unacceptable flooding. Culverts and the associated road formation shall be designed to limit secondary flow (fully blocked scenario) in a 2% AEP rain event. The design will limit the secondary flow over the road surface to a depth of 100mm above the crown line.

8.12.4 Carriageway Crossfalls

Normal carriageway crossfalls should be 3% for urban roads and unsealed crossfall should not exceed 4%.

Some variation from this requirement may be necessary in cases where a differential level between kerb lines is adopted and/or the crown is offset from the centreline.

Design turning circles to avoid an excessive differential between the crown and fender. Minimum crossfall must be 2% for asphaltic concrete and 2.5% for chipseal. Wherever an off-centre cul-de-sac head is used, offset the road crown to create symmetrical crossfall conditions.

Generally for sealed carriageways, crossfall should not exceed 6%, when measured from the carriageway edge to the crown.

8.12.5 Superelevation

Normally superelevation is not applied to urban local roads. For speed limits over 50kph, specific design of superelevation will be required. Where superelevation is required, the maximum value on local and collector roads is 5%.

8.12.6 Cross-section design

For new roads, provide carriageway and legal road widths that comply with the *District Plan*. Use Table 4 when altering existing roads. Design widths as part of an optimal road cross-section, to achieve the following objectives:

- Provide a safe layout for all users.
- Minimise the ongoing maintenance costs by designing and constructing elements to achieve their design life;
- Provide all the specified roadway elements;
- Provide bus lanes or bus priority measures where required;
- Reinforce the speed environment through appropriate lane and carriageway widths;
- Provide an attractive streetscape, adding to the amenity and character of the area;
- Facilitate a safe, efficient and effective drainage system by ensuring that the new works do not detrimentally affect the existing drainage pattern or road users;

Table 4 Carriageway elements

Zone	Road classification	Road Reserve Width (m)	Minimum lane allocation and carriageway widths						Minimum sealed carriageway width (m)	Footpath requirement	Utility/Amenity Strip Requirement
			Traffic Lane	Shoulder	Parking		Cycle Lane				
Residential	Collector	22	2 x 3.0m	n/a	Both Sides	2.0m	Both Sides	Minimum 1.8m where provided	13.6	Both sides	Both sides
	Local	20	2 x 3.0m	n/a	Both Sides		Optional		10	Both sides	Both sides
Industrial	Collector	22	2 x 4.0m	n/a	Both Sides	2.5m	Both Sides		16.6	Both sides	Both sides
	Local	20	2 x 4.0m	n/a	Both Sides		Optional		13	Both sides	Both sides
Commercial	Collector	20	2 x 3.0m	n/a	One Side	2.2m	Both Sides		11.8	Both sides	Both sides
	Local	20	2 x 3.0m	n/a	One Side		Optional		8.2	Both sides	Both sides
Rural	Collector	20	2 x 3.5m	2x1.5m (sealed)	No	n/a	No		10	No	One Side
	Local	20	2 x 3.5m	2x0.5m (sealed)	No		No		8	No	One Side
Rural Res	Collector Local	20	2 x 3.5m	2x0.5m (sealed)	No	n/a	No		8	One Side	One Side

Notes:
1) Utility strip to be located at least 300mm, ideally 1.0m, from the kerb and channel or edge of seal.
2) Design traffic lane widths to the Guide to Road Design, Part 3: Geometric Design.
3) Traffic lane widths may be set as low as 2.5m if the designed speed environment is 30km/hr or lower.
4) Design cycle facilities in accordance with clause 8.6 - Cycle Facilities.
5) On higher category roads the movement function of the route becomes more critical. Therefore, consider the removal of on-street parking where indicated by capacity/road safety/road space allocation requirements.
6) Mark parking lanes in accordance with clause 8.10.3 – On-street parking.
7) Provide swales where required by the project brief or subdivision consent.
8) Mark edgelines to prevent shoulders being incorporated in the traffic lane

When proposing narrower or wider widths or where all elements may not be provided, carefully consider the reasons and balance them against the above objectives. Submit a non-conformance report detailing the process of trading off these objectives to arrive at the non-complying design widths, as part of the Design Report and associated Road Safety Audit.

An assessment of the necessity to include particular stormwater quality and attenuation features within the road reserve could affect the proposed road reserve widths. *Part 5: Stormwater and Land Drainage* and Timaru District Council's *Stormwater Management Guide* may require referencing for the Design Report.

8.12.7 Traffic Lanes

Legally a lane for the use of vehicular traffic should be at least 2.5m wide. Traffic lanes widths need to consider the types of vehicle regularly using the road and the desired operating speed.

If the street is catering for many large vehicles, then wider lanes are needed for both travel and turning into and out of accesses. For streets with buses and coaches the minimum traffic lane width should be 3.2m. Narrower lanes help reduce speeds, 3.0m lanes are common where low speeds are desired.

Traffic lanes where cyclists are expected to mix with general traffic should be either wide enough for cyclists to ride adjacent to motor vehicles (4.2m); or so narrow that cyclists must 'take the lane' and ride behind or in front of motor vehicles (3m).

Avoid "in-between" widths of 3.2m - 4.2m where cyclists are expected to travel as this can create squeeze points for cyclists. Remove squeeze points to avoid conflicts between cyclists and motorists and limit the creation of unsafe situations for active transport modes.

8.12.8 Shoulders

The *Guide to Road Design, Part 3: Geometric Design* states that the minimum formed shoulder width for a rural road with traffic volumes over 150 vpd is 1.5m. Make an allowance for off-road parking areas on roads with 1.0m shoulders.

Sealing of the shoulder varies from 0.25 – 2.0m, depending on traffic volumes and site conditions. Table 3 provides a baseline for provision of shoulders for collector and/or local roads.

On local rural roads, the shoulder widths may be determined by the width required to provide cycle facilities. A desirable minimum sealed width for cycling is 1.5m.

When cyclists use sealed shoulders, care must be taken to ensure that the shoulder is continuous and ideally maintained alongside passing lanes and across bridges, culverts and other infrastructure to ensure cyclists are not put at risk by being moved closer to motor vehicles travelling at high speed. Any lack of continuity should be identified and suitable treatment or warning provided for all road users.

8.12.9 Footpath and Cycleway Crossfalls and gradients

The optimum crossfall for sealed footpaths is 2.0%, with a minimum of 1.25% and a maximum of 3%. Grass areas and plant beds between the footpath and the carriageway or on median islands must have crossfalls flatter than 6%.

To provide access for wheelchairs and prams, steps must not be used on footpaths within public roads, unless approved by the Council.

Grassed areas for tree planting, which are additional to the minimum berm width, must be specifically designed. In these areas, steeper slopes may be permitted provided that the area can be mown or otherwise easily maintained. Gradients up to one in two may be planted. The treatment of all gradients steeper than one in five requires Council approval.

8.12.10 Grassed berms

Install berms where specified in the *Footpath Policy.* Berms could be planted in selected areas. Where the width from the legal boundary to the kerb or road edge exceeds 3.0m in residential areas, install a berm. District Plan requires minimum 1.8m footpath and 1m utility/service trench.

The minimum width for grassed berms is 0.7m. Service strips against property boundaries shall be a minimum width of 1.0m. The smallest area of berm permitted is $2m^2$ and areas smaller than this must be formed and sealed/paved as footpath.

Where adjoining pavement surfaces meet, forming a point in the grass area with an angle of less than 60 degrees, square or round off the point of the grass berm to be no narrower than 0.7m.

8.12.11 Batters

Generally, batters should match any existing stable slope of similar material. Flatter slopes that are integrated into the natural landscape are preferred.

Where the formed batter is not required to cater for foot traffic, grassed batters are permitted, to a grade no steeper than 1:5. These must be mowable with standard mowing machinery.

The top edge of every fill, and the toe of every cut, must have a crossfall of 3% and extend at least 500mm beyond the outside edge of the footpath. If there is no footpath, measure this dimension from the back of the kerb or the outside edge of the trafficable shoulder as applicable.

Retain all new cut faces or stabilise with vegetation. Slopes steeper than one in two must be retained. Structures supporting the road must be located on legal road. Locate stabilised faces or retaining structures that support private assets or property outside of the legal road. Refer to clause 8.19 – Retaining walls for design criteria.

Some of these structures may require building consent.

8.12.12 Utilities
Show any existing utilities and services on the drawings.

Both existing and proposed underground and above-ground utility services can impact on the design through conflicts with the proposed carriageway elements. The cost of relocating existing utilities is significant and may therefore not be a viable option. Existing roads are often reconstructed at a lower finished level but restrictions on lowering carriageways, and the corresponding kerb, due to the presence of utilities can lead to property and upstream drainage problems.

To ensure there is no conflict with the road geometrics or between any utilities and proposed street features or planting, become familiar with the required clearances from both existing and proposed above-ground and underground utilities. Ensure they do not create a safety risk for people who are blind or visually impaired. Refer to clause 9.5.3 – Typical services layout and clearances (Utilities) for guidance and standards for the work. Any conflicts should be resolved during the design process.

Pothole existing underground services, to confirm both their location and depth. When utilities constraint the design, there are a range of solutions available:

- Consider moving the carriageway alignment. This can allow either underground utilities to be positioned towards the centreline or underground utilities and columns/poles to be positioned outside of the carriageway or footpath.
- Design element widths to achieve the same result as moving the carriageway alignment.
- Provide a lesser standard of elements, through restricting parking or constructing only one footpath.

8.12.13 Medians
Medians will be based on Specific designs as they are not typical throughout the district.

Determining median widths is typically dictated by the function of the road, the type of median and intersection details. The *Guide to Road Design, Part 3: Geometric Design* clause 4.7 provides guidance on median functions, types and widths.

8.12.14 Hillside construction
Where the road is or will be constructed on a slope, this can affect the ability to provide all the required elements of a streetscape and therefore impact on the achievable widths for some or all of those elements. Consider batter stability and property access, in addition to issues detailed in clause 8.12.6 - Cross-section design.

Options available for hillside construction:

- Design narrower legal road widths. Wider widths may be impracticable as it may be impossible to utilise more than a certain width due to crossfall restrictions. Property access may also be compromised if wide roads require high cuts or retaining walls.
- Use localised widening to construct passing or parking bays or to accommodate heavy vehicles.
- Provide a lesser standard of elements; through restricted parking, constructing only one footpath or combining elements e.g. shared cycle paths and footpaths.
- Construct retaining walls.
- Locate pedestrian and cycle facilities separately from the carriageway.

8.13 SPEED MANAGEMENT DEVICES

Initiatives to enhance road safety are built around the three E's – engineering, education and enforcement. Engineering the environment to 'solve' a problem may not always be the most efficient solution but is likely to be the most expensive. Consider education or enforcement as well as engineering in the design process.

Design a road at the outset for its environment and function, as it is difficult to retrospectively alter the speed environment. Analyse the existing speed environment, including the 85th percentile speeds, for assessment against the design operating speed and comparison to the constructed speed environment.

The installation of traffic management devices (TMD) is most appropriate to local residential streets where:

- the posted speed limit < 85th percentile operating speed < posted speed limit + 20km/hr;
- peak hour traffic volumes exceed 60 vehicles (equivalent to approximately 600 vehicles/day);
- the length of the road segment under consideration > 250m;
- the road has a documented crash history of the type that could be corrected by the devices considered for implementation;
- there are significant pedestrian safety issues.

Install TMD in classified or rural roads:

- at the transition from the open road to a lower speed limit;
- to enhance pedestrian safety;
- to reduce conflict points.

Use the following standards and guidelines for the design and operation of traffic management devices:

- *Guidelines for Urban-Rural Thresholds, RTS 15*
- *Guide to Traffic Management, Part 8: Local Area Traffic Street Management*
- AS/NZS 1158 Set *Lighting for roads and public spaces - series*
- *Manual Of Traffic Sign and Markings Part 2*

- *Speed Management Guide, Volume 2: Toolbox – how to implement treatments and activities;* *https://www.nzta.govt.nz/assets/Safety/docs/speed-management-resources/speed-management-toolbox-and-appendices-201611.pdf*

8.14 STREETSCAPE

The streetscape elements include paths, grassed berms, trees, shrub beds, streetlights, structures and hard landscaping. These can provide various benefits including:

- a network of safe, pleasant, comfortable, convenient and efficient paths.
- positive guidance for pedestrians and/or cyclists.
- seats, lighting, litter bins (where required) and other facilities.
- enhancement of the street environment by the inclusion of grassed areas, specimen street trees and plant beds, built structures e.g. fences, low walls, art works.
- attractive 'rain gardens' with safe overflow provision, which can provide a water quality and air quality improvement component for air and water borne vehicle pollutants.

Discourage vehicle access to berms, footpaths and swales by using landscape elements (e.g. kerbing, bollards, planting or fences).

Detail surfacing or treatment interfaces, e.g. where a path/berm intersects with a kerb, to avoid acute angles and so facilitate compaction and reduce maintenance issues.

8.14.1 On-street planting

Plant beds are generally used to soften the street environment and to provide visual guidance to pedestrians, cyclists and drivers. Landscaping is also an important component of traffic management devices and must be carefully designed to enhance the safety and effectiveness of these devices. The location of streetlights, sight line visibility and hazard criteria are critical when designing the on-street planting.

Review Council's urban street tree policy when designing on-street planting.

8.14.2 Street furniture

Landscaping structures such as planter boxes, seats, bins, sculptures, memorials and entrance structures on legal roads must be constructed in long-life materials (50-year minimum).

Some of these structures may require building consent, which the developer must obtain. The ownership of street furniture to be installed is to be confirmed with Council, when undertaken during private developments.

In low speed environments, locate continuous structures like low walls at least 450mm behind the kerb, with a maximum height of 700mm if adjoining the footpath. Locate them so that they do not obstruct the sightlines of intersections, vehicle and pedestrian crossings or signs. Ensure they do not create a safety risk for people who are blind or visually impaired.

Reference can be made to Council's *Roadside Pride Policy* for direction on how the district intends to maintain or add to the attractiveness of our district's road network.

8.14.3 Site access

Design all kerb crossings and cut-downs in accordance with Council's vehicle access standard drawings. Urban and rural site accesses should be constructed in accordance with Council's current construction standard specifications.

Wherever access to property is required across a swale, the crossing design must be specific for the affected site(s).

Use the following standards and guidelines for the design and operation of intersections and vehicle crossings:

- *Timaru District Council Proposed District Plan: Transport Chapter*
- *Guide to Road Design, Part 4: Intersections and Crossings -General*
- *Guidelines for the Implementation of Traffic Controls at Cross Roads, RTS 1*
- *NZTA Policy and Planning Manual for State Highways*

8.14.4 Roadside Treatment

Roadside treatment measures shall be included as part of any road design and safety audit reports. Risk assessments shall be undertaken as part of a safety audit and completed in accordance with the *Guide to Road Design, Part 6: Roadside Design, Safety and Barriers*.

Guide to Road Safety, Part 9: Roadside Hazard Management provide details on clear zones, hazards and safety barriers.

8.15 PAVEMENT DESIGN

8.15.1 Pavement and surface treatment design

Design roads to have an infinite life for the subbase and a 25-year life for the basecourse. Use a traffic growth rate of 2% per annum for design purposes. Heavy vehicle movement ratio important in determining design parameters.

Design roads to preferably be flexible pavements, with a 14-year life for chip seal and 24 years for asphaltic concrete, using the general principles of the current New Zealand Supplement of the *Guide to Pavement Technology.*

All roading and private access rights of way, prior to sealing, must comply with the Benkelman Beam criteria shown in Table 5.

Table 5 Benkelman Beam criteria

	Chip Seal		**Thin AC or other mix**	
Road Hierarchy	**Max Deflection (d0)**	**Min Bowl Ration (d250/d0)**	**Max Deflection (d0)**	**Min Bowl Ration (d250/d0)**
Regional/District Arterial	1.0mm	n/a	0.7mm	0.70
Principal Roads	1.0mm	n/a	0.7mm	0.70
Collector Road	1.2mm	n/a	1.0mm	0.65
Industrial Roads*	1.2mm	n/a	0.7mm	0.70
Local Roads	1.6mm	n/a	1.0mm	0.65
Service/Private Lanes	2.0mm	n/a	1.6mm	0.54

**Industrial Roads are not specified separately within Timaru District Council's Road Hierarchy, however a distinction in Benkleman Beam deflections has been included due to the heavier traffic carried by these roads*

Note: *or existing surfacing/pavement

The pavement design must detail the:

- asphaltic mix type and layer thickness. Refer to *NZTA M/10:2020* for further information;
- geotechnical requirements – test the subgrade and establish an in-situ or soaked CBR. Establish a correlation between the local soils and the test methods used;
- structural design – design pavements to meet the (modified) life-cycle requirements of the *New Zealand Infrastructure Asset Valuation and Depreciation Guidelines* as modified by the Council. The pavement designs are, however, restricted to a 50-year life for the basecourse layer.

Other considerations in the design may include, but should not be restricted to:

- type of edge restraints – in most urban environments a concrete edge restraint or kerb and channel must be provided. In other areas, provide road shoulders, as defined in clause 8.12.8 – Shoulders, to prevent edge break.
- semi-rigid and rigid pavements – semi-rigid and rigid pavements (e.g. those that require structural layers of asphaltic concrete, cement or bitumen stabilised metalcourses, concrete roads and similar) require specific design.
- coal tar - determine its presence through testing for PAHs and either specify to dispose of, encapsulate or reuse on site, whilst applying contaminated material handling methodologies.
- specifying the asphaltic mix type under the TNZ specification e.g. PA15HS for high traffic shear stress or PA20 otherwise.
- the local subgrade – many sites have subgrades where the CBR values are so low that the pavement design requires a sacrificial layer of aggregate, sand or the use of geotextiles.
- the subsurface drainage – the Council recognises that the lack of subsurface drainage outfalls often results in the inability to avoid a "bath-tub" design where the pavement materials will, at times, become saturated. However, the acceptance criteria related to life-cycle traffic loadings still apply.

- the local water table – basecourse layers must be above the water table during a 1 in 10-year flood event.
- cover to underground services – maintain adequate cover to utilities when the project proposes lowering the road level or crown.

8.15.2 Reducing waste

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

- Plan to reduce waste during demolition 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, foamed bitumen. Proposed recycled materials will need approval from the Council to ensure that environmental contamination does not occur.

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.

8.15.3 Pavement materials

The design and construction of the road must comply with the following criteria:

- materials – *DECSS* for details of approved pavement materials, gradings, etc. Any proposed variations from these materials, such as the use of cement- stabilised metalcourses or concrete roads, will require specific design;
- the extent of work – pavement materials must extend at the same thickness beyond the edge control devices, such as kerb and channel or the concrete edge restraints, as noted in *Standard Drawing G-101C Kerb and Channel Profiles.*

8.15.4 Surfacing

All surfacing must meet site-specific traffic loading requirements including skid resistance requirements as defined in TNZ T/10 *Skid Resistance Investigation and Treatment Selection*. Skid resistance should exceed either the values in Table 6 or a British Pendulum number of 50.

The selection of surfacing material is critical. Consider the benefit, performance and life-cycle costs of the material, particularly for pavers as these surfaces have higher maintenance costs i.e. select pavers for traffic management purposes, not just aesthetic reasons. Do not use pavers in narrow road medians or small islands as this location significantly increases maintenance difficulties.

Table 6 Skid resistance criteria

Site Category	Site Definition	Sideways Force Coefficient (SFC)
1	Approaches to railway level crossings, traffic lights, pedestrian crossings, roundabouts.	0.55
2	Curve < 250m radius Down gradients > 10%	0.50
3	Approaches to road intersections Down gradients 5 – 10% Motorway junction area	0.45
4	Undivided carriageway (event – free)	0.40
5	Divided carriageway (event – free)	0.35

Note: This table is sourced from TNZ M/10:1998.

All newly constructed road surfaces must comply with the NAASRA roughness counts in Table 7.

Table 7 NAASRA roughness criteria

Surfacing	Average (mm/km)	Maximum (mm/km)
All new asphaltic concrete and open graded porous asphalt surfaces	55	75
Asphaltic concrete and open graded porous asphalt overlays and shape corrections	65	90
Chipseal through streets with 10,000-20,000+ vehicles per day (Pavement Use T6 and T7).	60	80
Chipseal through streets with 2,000-9,999 vehicles per day (Pavement Use T4 and T5).	65	85
Chipseal through streets, cul-de-sac and rights of way with 0-1,999 vehicles per day (Pavement Use T1-T3).	70	90

Note: 1) See *CSS: Part 6* clause 11.7 – Testing for more detail on analysing test results.
2) Pavement use codes refer to RAMM categories.

All surfacing materials must meet the appropriate *DECSS* requirements.

The general minimum surfacing requirement is a two-coat (wet lock) chipseal – grade 4 and grade 6. At the head of a cul-de-sac, the minimum surfacing requirement is a 50mm layer of paver-laid DG14 or AC14 laid over a Grade 5 chipseal.

Newly constructed road surfaces with a two-coat chipseal, albeit from significant reinstatement or new subdivision, will require a second coat be laid a year after surfacing completion. A contribution to 50% of a second coat shall be taken by Council at the time of subdivision or engineering clearance.

Skid resistance on the new surface through all intersections must match that of the existing road, particularly back to the transition point (TP) of the road. Skid resistance can be improved through grooving in asphaltic concrete.

8.16 DRAINAGE DESIGN

8.16.1 Road drainage control

All road runoff must be contained in the legal road or within land over which drainage easements have been created in favour of Council. Take into account the road hierarchy when assessing the possible use of the legal road as a secondary flow path.

Guidance and standards for the work can be found in:

- Integrated Catchment Management Plans (ICMP) for the development area
- Part 5: Stormwater and Land Drainage
- TDC Stormwater Management Guidelines

8.16.2 Primary stormwater treatment

On-street or centralized treatment of stormwater is a required part of the design. Design for the removal of contaminants throughout the stormwater system, but particularly before the stormwater enters existing open water-bodies.

Collect surface water in kerbs and channels or within grassed swales. Provide on-street stormwater treatment depending upon the requirements of that particular water catchment area, as detailed in the resource consent or project brief. *Chapter 5 – Appendix B and E (Stormwater Devices and Stormwater Quality,* respectively) suggests macropollutant traps, swales and bio-retention devices (rain gardens and stormwater tree pits) as on-street stormwater treatment options. Council may also consider proprietary devices on a case by case basis. Refer to clause 5.6 - Drainage System Design for further information.

Do not detail sumps in kerb crossings. Where sumps are located in this position, consider the relocation of either the sump or crossing or detail the installation of a corner sump top and provide additional drainage capacity elsewhere if necessary.

All pipework downstream from sumps contained within the carriageway must have a minimum internal diameter of 225mm. Sump or access chamber spacing must not exceed 100m, for maintenance purposes.

Provide a stormwater drain/catch pit in arterial and collector roads whenever the channel flow exceeds 25 litres/sec at a grade of 1 in 500 for a 5 year event. Provide a stormwater drain/catch in local roads whenever the channel flow exceeds 50 litres/sec at a grade of 1 in 500 for a 5 year event.

8.16.3 Subsoil drainage

In areas of high groundwater, install subsoil drainage to protect the carriageway subgrade and/or metalcourse.

The subsoil drainage pipework must be punched novacoil, drilled PVC or other approved perforated pipe.

8.16.4 Swales

Design swales for temporary water storage or retention as this provides attenuation of stormwater peaks. It may also reduce the downstream flood peak. Normally this design consists of shaped grass berms, with no permeability built in to the construction materials.

Primary treatment is achieved by a detailed design that uses suitable permeable material to allow soakage to subsoil levels. Volumes undergoing primary treatment through infiltration can be increased through longer resident times in permeable swales. Provide opportunities for sediment to settle out in swales through slower velocities, longer resident times and dense grass cover, as these all slow overland flows.

Planting installed in the swale should not include bark, similar organic mulch or other loose easily transported material.

Note that repeated use of vehicles or the heavier ride-on mowers will substantially reduce the permeability of swales that have been constructed for primary treatment - take this into account. See Part 5: Stormwater and Land Drainage for guidance on design.

8.16.5 Drainage patterns

The existing drainage pattern may provide a constraint on possible design solutions. Ensure that the upstream catchment, including existing channels, can drain through the new works without ponding and that property outfalls, either at the kerb or at the boundary, are not raised above inlet levels. Thoroughly investigate the catchment around the project area, to determine accurate falls, transition levels and the most effective outfall.

8.17 STREET LIGHTING

Refer to Part 10: Lighting for street lighting requirements.

8.18 BRIDGES, CULVERTS AND OTHER STRUCTURES

Bridges, culverts and other structures within the legal road perform a key role in ensuring continuity of access for the public. Design these items to ensure their continuous function (including during extreme events) throughout their design life. For steel or concrete bridges and all culverts, this is 100 years. The use of timber for bridges is to be reserved for footbridges only. A reduced design life can be accepted depending on the specific circumstances. Refer to the *NZTA Bridge Manual* for specific design information. The TDC *Road Bridge Policy* provides some district specific considerations to incorporate.

Determine the width of bridges and culverts in conjunction with the site-specific current and future road requirements for carriageway widths. Take into account the land drainage requirements, as set out in clause 5.6.5 - Bridges and culverts (Stormwater and Land Drainage) and TDC *SMG*. The length of these structures is also site-specific and must make allowance for waterway requirements during extreme events and the requirement for footpaths. Design the wing wall and anti-scour structures to provide support and to prevent scour, as required.

Design guardrails generally in accordance with the *Bridge Manual* except that:

- side protection in low speed environments (under 50km/hr) is not always required to comply with Appendix B of the *Bridge Manual*. Where Appendix B requirements are not achieved, provide a road safety audit or assessment with the site specific design in the design report, confirming the design impact speed used in the guardrail design.
- guard rail transition distances in speed zones of 50km/hr or less may be reduced.

Design barriers for cycle or shared paths to be 1.4m high and in accordance with the *Bridge Manual*. Design the barrier to resist the loads detailed in Appendix B clause B6.4 of the *Bridge Manual*. Consider where a Pedestrian Safety Fence is still appropriate for situations where the impact from cars and cycles is not being mitigated.

Other design issues include, but are not limited to:

- legal compliance – building and resource consents are required for bridges, culverts and other structures, as appropriate. Details and conditions of a Deed of Licence shall be agreed to prior to lodgement of an Application for Engineering Design Acceptance;
- technical requirements – provide space on bridges and culverts for cyclists. The surfacing of bridge decks must meet the site-specific traffic loading requirements including skid resistance requirements. Footpaths must be separated, where they are specified;
- waterway requirements - consider the effect of the road on the secondary flow path for any waterway crossing. Refer to clause 8.13.3 – Vertical alignment;
- aesthetic contribution – use the design of the new structure to enhance the attractiveness of the built environment.
- services using a bridge for support –refer clause 3.4.3 of *The National Code of Practice for Utilities' Access to the Transport Corridors* provide guidance on the installation of services on bridges. Obtain the Council's approval for the installation of services on bridges.
- existing structures – ensure lane widths are not compromised when retrofitting existing structures to cater for future traffic needs.

8.19 RETAINING WALLS

Only retaining structures that will be vested in Timaru District Council may be located on legal road. Retaining structures that support private assets or private property e.g. driveways, must be located outside of the legal road unless approved otherwise by Council.

Design guardrails generally in accordance with the *Bridge Manual* except that:

- side protection in low speed environments (under 50km/hr) is not always required to comply with Appendix B of the *Bridge Manual*. Where Appendix B requirements are not achieved, provide a road safety audit or assessment with the site specific design in the design report, confirming the design impact speed used in the guardrail design.
- guard rail transition distances in speed zones of 50km/hr or less may be reduced.

Consider where a Pedestrian Safety Fence is still appropriate for situations where the impact from cars and cycles is not being mitigated.

Other design issues include, but are not limited to:

- safety in design - including throughout the life cycle of the constructed works.
- legal compliance – building and resource consents may be required for retaining walls. Details the requirements for the Deed of Licence shall be agreed to prior to lodgement of an Application for Engineering Design Acceptance;
- aesthetic contribution – use the design of the new structure and any fall protection to enhance the attractiveness of the built environment;
- heritage – protect and retain existing historic retaining walls and design adjacent structures in context with these features;
- existing structures – ensure lane widths are not compromised when retrofitting existing structures to cater for future traffic needs.
- maintenance – ensure access for mowing and other maintenance activities.

Design retaining walls to ensure their continuous function (including during extreme events) throughout their design life as detailed in Table 8.

Table 8 Design and durability

Wall Type	Design Life (years)
A: Uphill of road	75
B: Uphill of road directly supporting infrastructure to be vested or existing private buildings, structures and urban gardens	100
C: Directly supporting road	100*
D: Not directly supporting road	75

Note*: The design life of minor walls (less than 1.5m height that can be maintained or replaced without impeding the function of the adjacent road) may be reduced to 50 years with the approval of Council.

State the key achievement criteria and assumptions in the Design Report, as detailed in clause 3.3.2 – Design Report. Specify hold points for construction, for inclusion in the Contract Quality Plan and required material or performance tests to be included in the Contractors Inspection and Test Plan.

8.20 AS-BUILT INFORMATION

Provide as-built information as set out in Part 11: As-Builts, including a safety audit of the constructed works.

PART 9: UTILITIES

CONTENTS

TABLES

9.1 REFERENCED DOCUMENTS

Planning and Policy

- The Timaru District Plan
  https://www.timaru.govt.nz/services/planning/district-plan
- Electricity Act (1992)
- Resource Management (*National Environmental Standards for Telecommunication Facilities*) Regulations (2008)
  www.legislation.govt.nz/regulation/public/2008/0299/latest/DLM1576701.html

Design

- NZUAG *The National Code of Practice for Utilities' Access to the Transport Corridors* http://nzuag.katipo.co.nz/wp-content/uploads/2018/02/NZUAG-Code.pdf
- New Zealand *Code of Practice for Electrical Safe Distances* NZECP 34: 2001
  https://www.transpower.co.nz/resources/new-zealand-electrical-code-practice-electrical-safe-distances-nzecp-34

Construction

- Timaru District Council *Construction Standard Specifications*
  https://www.timaru.govt.nz/council/publications/construction-standard-specifications
- Timaru District Council – *Land Transport Unit – Backfill & Reinstatement Requirements Guide*
  https://www.timaru.govt.nz/__data/assets/pdf_file/0010/573598/Land-Transport-Unit-Backfill-and-Reinstatement-Requirements-Version-2.pdf

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).

9.2 INTRODUCTION

This Part discusses issues that must be considered for any developer installing utilities that will not be maintained or owned by the Council. The design requirements of the utilities themselves are not covered here but can be obtained from the individual operators. To achieve good outcomes, reference the *Backfill & Reinstatement Requirements Guide (BRRG)* and *The National Code of Practice for Utilities' Access to the Transport Corridors (CODE)* for any works within Council owned and maintained land.

9.2.1 Council requirements

The requirements for the provision and installation of utilities are set out in the *District Plan*.

Ensure that the appropriate resource consents are obtained for work in the vicinity of protected trees and that the work is carried out with these consents.

9.3 QUALITY ASSURANCE REQUIREMENTS AND RECORDS

Provide the information detailed in Part 3: Quality Assurance, during design and throughout construction.

9.4 NETWORK UTILITY OPERATOR REQUIREMENTS

Ensure that the design and construction of any network to be adopted by a utility operator complies with their standards.

Electrical design standards are written by individual electrical utility operators to comply with the requirements of the Electricity Act and its associated Regulations. There is a degree of consistency due to the continuous nature of the network.

Telecommunications design standards are also written by telecommunication utility operators. The telecommunications network is a series of separate networks with some interconnection. The design and construction standards can vary between the different operators.

9.5 UTILITY DESIGN

Design all services to enhance the visual qualities of the site. Refer to *Timaru District Council Construction Standard Specification.*

Where utilities are to be installed on bridges and culverts, design to limit the visual impact of the infrastructure.

9.5.1 Service plans

Use the latest service plans when preparing engineering drawings. Be aware that connections to properties from any service or utility may not be shown. There may also be differences between utility digital data and utility paper plans.

9.5.2 Location of utilities

Consider the following when planning the layout of a development:

- utility services are generally installed parallel to road or legal boundaries;
- utility services shall be installed outside of the carriageway;
- laterals are perpendicular to the main supply and configured to service two lots, wherever possible;
- boundary boxes and distribution pillars are installed together on a boundary junction and clear of likely vehicle access;
- allow for maintenance access.

Minimise the cross-sectional area occupied by utility services through detailing shared trenches where practicable, to allow for possible future utility reticulation. Also consider the possible location of future cabinets in service strips or footpaths.

Discuss major reticulation and its potential for significant traffic disruption at an early stage with Council.

Consider the following when planning the location and design of structures and their corresponding utility lots:

- place and design them to minimise adverse visual impact by integrating them with the design of hard and soft landscaping;
- design to minimise the potential for damage to the structure from vandalism;
- reduce their impact on traffic movement;
- structures must not reduce vehicle sight distances and should not interrupt pedestrian movement;
- ensure that they do not compromise property rights or access;
- provide access to the structure.

Refer to the *National Environmental Standards for Telecommunication Facilities* for further information regarding telecommunications cabinets.

Some structures may contribute to the environment if designed to enhance the neighbourhood character.

Consult comprehensively with the relevant network utility operators regarding the location of utilities and the spacing and final location of the structures.

9.5.3 Typical services layout and clearances

There are specific working clearances required between different utility services. Table 1 and 2 below supply vertical/crossing and horizontal/parallel service clearances.

Confirm these clearances with the network utility operators before deciding on any utility layout or trench detail. Services shall be located outside of the carriageway.

Table 1 Crossing utility clearances - outside to outside

Existing Service	*preferred location*	*vacuum sewer*	*water main*	*HV power*	*LV power*	*gravity sewer*	*storm water*	*water submain*	*telecom*
pressure >110Ø sewer ≤110Ø	path	n/a	100	50	50	50	50	100	50
vacuum sewer	berm/path		100	100	100	100	100	100	100
watermain	berm/path			150	100	100	100	n/a	100
HV power	berm/path				n/a	500 (laterals 200)	500 (laterals 200)	150	
LV power	berm/path							100	
gravity sewer	berm/path						50	100	50
stormwater	berm/path							100	50
water submain	berm/path								100
telecom	berm/path								

both services likely to be in berm/path
both services possibly to be in parking bays

Table 2 Parallel horizontal utility clearances - outside to outside

Existing Service	*preferred location*	*vacuum sewer*	*water main*	*HV power*	*LV power*	*gravity sewer*	*storm water*	*water submain*	*telecom*
pressure >110Ø sewer ≤110Ø	path	n/a	1000 600	450	450	450	450	450	450
vacuum sewer	berm/path		600	600	600	600	600	600	600
watermain	berm/path			1000	300	1000	450	n/a	450
HV power	berm/path				300	1000	1000	300	300
LV power	berm/path					500		300	300
gravity sewer	berm/path						1000	300	1000
stormwater	berm/path							300	500
water submain	berm/path								300
telecom	berm/path								

both services likely to be in berm/path
both services possibly to be in parking bays

Note:
1) Where the clearances in Table 1 or 2 cannot be achieved, provide a non-conformance Report, in accordance with clause 3.7.1 – Control of non-conforming work (Quality Assurance)
2) Ducts may be suitable where clearances are unavailable.
3) Where the crossing clearance is under 200mm, consider the use of alternative fillers to metalcourse, due to difficulties in compaction.

Consider the proximity of overhead power lines: design infrastructure to provide the clearances required in the *Code of Practice for Electrical Safe Distances*. Also, refer to the *CODE.*

Service trenches shall be laid outside of the carriageway, under berms and footpaths. Only when impractical, utilities may be installed in a Service Trench Location within the carriageway, as approved by Council.

Where possible, locate service covers outside of potential cycle lanes and preferably outside of wheel tracks. Locate vacuum collection chambers outside of the carriageway where possible or otherwise in the carriageway within 2.5m of the kerb.

New parallel reticulation services must cross as close as practicable to 45°.

9.5.4 Network reticulation

The telecommunications layout is not usually designed until the electricity layout is substantially complete - this is an economic decision as the layouts are inter-related and, in land developments, service trenches are shared wherever possible. Ensure that power is provided to telecommunication cabinets, cable television cabinets and amplifiers.

Ensure that drawings sent to the utility designer and the network utility operator show all the existing services. Ideally, these drawings should be the approved subdivision consent or engineering drawings. This reduces the likelihood of conflicts between existing and new services and increases the cost-efficiency of service provision.

9.5.5 Above-ground utilities

Locate above-ground utilities within legal road to provide clear zones as set out by *Guide to Road Safety, Part 9: Roadside Hazard Management*.

Locate street light columns in accordance with clauses 11.4.6 - Column locations (Lighting). In addition to clear zone distances within the 50km/hr speed environment, locate new utilities clear of the footpath, at least 1.0m away from kerb cutdowns and at least 0.7m behind the kerb.

9.6 CONSTRUCTION

9.6.1 Proposed installation method

There are various methods of installing underground services. These include open trenching, directional drilling, pipe bursting, slip-lining, pipe ramming and thrusting. Refer to Part 6: Wastewater Drainage for further information.

Factors that may affect the choice include the ground conditions, disruption to traffic, presence of trees, site safety, the availability of Council blue ducts and redundant services, e.g. old gas mains or their offsets.

When the intention is to lay a number of utilities in a common trench, ensure the minimum covers and separation distances for each utility in the trench cross-section are obtained.

9.6.2 Installing new reticulation within legal roads

Wherever utility services are installed along existing legal roads, obtain a Network Service Operators Works Access Permit (WAP) from the Council for that work, unless the works form part of an approved roading design. Apply for a Corridor Access Request (CAR) at www.beforeudig.co.nz. Typically, the WAP is obtained after the utility reticulation layouts are confirmed.

If granted, the WAP defines the Council's requirements for the restoration of the construction within the legal road and any constraints on the permitted hours of work within that road. To avoid possible conflicts, ensure that the requirements of the WAP are included in any contract documentation. Also refer to *Guide for Safety with Underground Services*.

9.6.3 Pipe depths

Minimum and maximum covers specified elsewhere in the IDS are summarised in Table 3 and Table 4. Where values are not provided, use the manufacturer's specifications or values from the relevant installation standard.

Table 3 Installation depths

Installation depth for material types (m)	Trafficked areas		Untrafficked areas	
	min	max	min	max
Rising, vacuum and PSS main	0.8	1.5	0.8	1.5
PSS and vacuum sewer laterals	0.8	1.5	0.8	1.5
wastewater gravity plastic (LRI ≤2)	0.8	3.5	0.8	3.5
wastewater gravity other (LRI ≤2)	0.8	3.5	0.8	3.5
wastewater gravity plastic (LRI >2)	0.8	5.0 or 3.0 below watertable	0.8	5.0 or 3.0 below watertable
wastewater gravity other (LRI >2)	0.8	5.0 or 3.0 below watertable	0.8	5.0 or 3.0 below watertable
stormwater gravity concrete	0.8		0.8	
stormwater gravity plastic	0.8		0.8	
watermain ≥100mm[1]	0.8	1.5	0.8	1.5
water submain <100mm (metal)	0.8	1.5	0.8	1.5
water submain <100mm (plastic)	0.8	1.5	.8	1.5

Note: 1) New watermains are 150mm minimum diameter.

Table 4 Installation depths in reserves

Installation depth for material types (m)	Trafficked areas		Untrafficked areas	
	min	max	min	max
Enable cables			0.5	
water submain <100mm (metal)	0.5	0.7	0.5	0.7
water submain <100mm (plastic)	0.6	0.7	0.5	0.7

9.6.4 Backfill

Bedding materials should comply with the network utility operator's requirements. Any backfill within Council owned and maintained land shall be compliant with the *BRRG.*

Specify backfill materials individually. The material used must be capable of achieving the necessary backfill compaction. The WAP specifies the final surfacing to the excavation. Refer to the *CODE* for further information.

PART 10: LIGHTING

CONTENTS

TABLES

10.1 REFERENCED DOCUMENTS

Planning and Policy

- Electricity Act (1992)
- Electricity (Safety) Regulations (2010)
- Radiocommunications Regulations (2001)

Design

- New Zealand Transport Agency M30 *Specification and Guidelines for Road Lighting Design*
- New Zealand Transport Agency M26: 2012 *Specification for Lighting Columns*
- AS/NZS 1158 *Set Lighting for roads and public spaces - series*
- AS/NZS 3000:2007 *Wiring rules and companions set*
- AS/NZS CISPR 15:2011 *Limits and methods of measurement of radio disturbance characteristics of electrical lighting and similar equipment*
- IPENZ Practice Note 02 *Peer Review – Reviewing the work of another engineer*

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).

10.2 INTRODUCTION

This Part explains the Council's lighting design requirements where the lighting is (or will be) managed by the Council and connected to the Electricity Distribution Asset Ownerstreet lighting network.

It covers lighting design requirements for both privately funded developments and Council funded new installations or upgrading of existing installations.

10.3 QUALITY ASSURANCE REQUIREMENTS AND RECORDS

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

10.3.1 Project brief

The Council must provide or agree to the lighting requirements for a project before any detailed design is undertaken. These lighting requirements will be specified in a project brief or, for developer-funded projects, in the Council's consent conditions.

10.3.2 The designer

The designer must be suitably qualified and experienced and have an excellent track record in road lighting design. Refer to NZTA M30 *Specification and Guidelines for Road Lighting Design* and clause 2.7.1 – Investigation and design (General

Requirements) for further information. The designer must ensure the lighting scheme meets the requirements of the IDS.

Where the role of the engineer for the lighting component of the project's construction is being undertaken by another party apart from the designer, provide the company and individual's name, qualifications and contact details in the Design Report.

10.3.3 Design peer reviewer

Where a peer review is required as a condition of consent, peer review the design in accordance with *Peer Review – Reviewing the work of another engineer*.

10.3.4 Design records

Provide the following information in addition to that required by NZTA M30 *Specification and Guidelines for Road Lighting Design*, to support the Design Report defined in clause 3.3.2 - Design Report (Quality Records).

- A comparative whole of life cost analysis between the options considered;
- Records of any non-compliant design elements and any departures from the design spacing that have been used in the design process in the form required in clause 3.7.1 - Control of non-conforming work ;
- A safety audit complying with clause 8.4.2 - Safety audit.

10.3.5 Engineering drawings

Provide drawings complying with clause 2.9 - Drawings and NZTA M30 *Specification and Guidelines for Road Lighting Design*.

In addition to Appendix I - Standard Draughting Layout and Format Requirements of Part 2: General Requirements, clause 8 - Title blocks, include:

a) The peer reviewer's name and signature (where a reviewer was specified)
b) An amendment box providing for a brief description of each amendment and sign off by the designer and peer reviewer.

10.3.6 Acceptance of design

Submit the Design Report for acceptance under clause 2.10.3 - Engineering acceptance, including the Lighting Design Statement (LDS1) - Design (refer NZTA M30 *Specification and Guidelines for Road Lighting Design*). Supply the lighting related documents as one package along with ALL other disciplines in the project's Design Report.

Where materials are not ordered within 12 months of the completed design's date of acceptance by Council, the acceptance is revoked.

10.3.7 Engineer's Report

Provide an Engineer's Report, including the Engineer's Completion Certificate for the lighting work. Include those documents required in clause 10.6 – Completion Procedures and Certification, and documentation to prove compliance with clause 3.3.4 – Engineers report (Quality Assurance). Provide audit and test records to confirm that the design has been implemented in its entirety, including records generated at hold or witness points. Where non-conformances have occurred, provide non-conformance reports in accordance with clause 3.7 – Non-Conformance and Quality Improvement (Quality Assurance).

The engineer must be suitably qualified and experienced and have an excellent track record in road lighting construction. The engineer may also be the designer but cannot be the contractor. The engineer must:

- ensure the lighting installation meets the requirements of the IDS;
- manage the lighting construction to its conclusion, including regular site supervision;
- resolve any complaints to the satisfaction of the Council, prior to 224(c) certification;
- sign-off the project at completion.

10.4 LIGHTING DESIGN

The lighting design must maximise safety and efficiency while minimising the life cycle cost and impact on the environment.

Design the lighting to blend in with adjacent street lighting, complement the neighbourhood character and, as far as is reasonably practicable, minimise the impact on the neighbouring properties and environment with regard to aesthetics, glare and spill light. Appendix I – Lighting Categories explains how the different categories identified in AS/NZS 1158.1.1 and 1158.3.1 apply to the Council's roads.

Reticulate all 'greenfields' developments underground. In areas where the existing overhead network is for street lighting only, or where the Electricity Distribution Asset Owner network is underground, cable the power supply for the new lighting underground. The overhead network must not be extended.

The electricity distribution asset owner usually determines whether the lighting will have an overhead or underground power supply. When lighting is being upgraded in an area where the Electricity Distribution Asset Owner network is overhead and is not part of an underground conversion project, use the Electricity Distribution Asset Owner poles to support the lights. Obtain the permission of the pole owner beforehand. This solution minimises the number of poles in that area.

This Part defines the minimum standards but it is important not to over-design and provide a standard of lighting higher than that required. Ensure that all parts of the lighting installation conform to the following:

- NZTA M30 *Specification and Guidelines for Road Lighting Design*
- AS/NZS 1158
- Electricity Distribution Asset Owner's requirements
- AS/NZS 3000.

Council requires lights to be located on columns due to issues securing electricity supply for building mounted lights. Any alternative proposal to mount lights on power supply poles or buildings shall be accompanied with approval of the owner the pole or building.

10.4.1 Category P (local road and pedestrian area) lighting

The luminaires must meet the requirements for type 4 luminaires detailed in AS 1158.3.1, Table 2.10.

Specify a minimum maintained illuminance for Category P3NZ of 0.26 lux, and a horizontal illuminance uniformity U_p (that is, the ratio of maximum horizontal illuminance to average horizontal illuminance within a defined area) less than or equal 8.

Specify mounting heights:

- between 6.0m and 7.5m in residential areas.
- between 7.0m and 9.0m in industrial areas.
- consistent along the street on each column type.

10.4.2 Category P (cycleways and pathways) lighting

The lighting category is usually Category P3NZ or P4.

Submit a non-conformance report where proposing the lighting of paths or cycleways that are not designated safe routes.

If the lights are located near trees, it may be appropriate for them to be mounted at a lower height, to illuminate underneath the tree canopy and avoid shadowing. In this case, a minimum mounting height of 4.5 metres may be accepted.

10.4.3 Pedestrian crossings

Design the lighting to comply with AS/NZS 1158.4 *Lighting for roads and public places - Lighting of Pedestrian Crossings*. The luminaires must meet the light technical parameters for New Zealand conditions detailed in AS 1158.4, Table 3.5.

10.4.4 Intersections

Wherever an existing Category V road intersects with a new Category V road or an existing Category V road being upgraded, apply the requirements of AS/NZS 1158.1 *Road lighting - Vehicular traffic (Category V) lighting* to the intersection, even if the intersecting road is not lit to the appropriate Category V Standard.

Wherever an existing minor (Category P) road intersects with a new Category V road or an existing Category V road being upgraded, apply whichever of the following options provides the higher lighting standard:

- the requirements of AS/NZS 1158 for such intersections.

- the provision of a new light positioned in the side road near the intersection. (For an underground power installation the light shall be less than 10 metres away from the kerb line of the Category V road.)

The first light from an intersection on a Category P road shall be less than 10 metres away from the through road, measured from the kerb line. Where the lighting is attached to reticulation poles, this distance can be increased to 0.4 of the designed light spacing. The design light spacing requirements for the through road continue through the intersection.

10.4.5 Traffic management devices

Design lighting of traffic management devices to support the purpose of the device:

- Where the device is intended to slow traffic, the lighting may need to be installed to a higher standard than normal road lighting. This will provide sufficient visibility to alert the drivers of the presence and speed constraint of the device.
- Where the device is intended to deter through traffic, the device may be identified by reflectors or by road lighting.

Ensure all lighting is designed to AS/NZS 1158 Set *Lighting for roads and public spaces – series.*

10.4.6 Column locations

If an adjacent property has not been developed (e.g. a new subdivision) and the column cannot be positioned in line with the common boundary, locate the column at least eight metres from the boundary to allow for a future vehicle entrance. Position columns at least one metre away from a vehicle entrance or pedestrian kerb cutdown, including in traffic islands. Refer to NZTA M30 *Specification and Guidelines for Road Lighting Design* for guidance on locating columns.

Trees in a legal road or on Council land must be at least six metres away from lighting columns and more clearance may be necessary for some tree species or if the tree is protected. Consider the necessary requirements for working near existing trees.

Where retaining walls are being constructed in the likely area of column locations, consider incorporating column foundations into the walls.

Columns shall not be installed in swales. This is because of the additional details for this installation type that are required to comply with AS/NZS 3000 and because of the use of geotextiles in swale construction.

Excluding columns located on the boundary, provide 0.5m clearance between the column face and the footpath edge. Where columns are in the footpath, ensure the path width is adjusted to compensate. Refer to clause 8.15.1- Footpaths (Roading) for footpath widths.

Specify frangible columns that comply with the requirements of NZTA M26 *Specification for Lighting Columns.* If non-frangible poles are being specified, clearly state this on the drawings.

10.4.7 Signs

Identify any signs that need to be altered, relocated onto lighting columns or onto their own posts. Locate these to comply with NZTA M30 *Specification and Guidelines for Road Lighting Design* and clause 8.11.5 - Permanent signs and markings (Roading).

10.4.8 Lighting equipment

NZTA M30 *Specification and Guidelines for Road Lighting Design* details the design life of lighting equipment. The design life for lighting columns shall be a minimum of 40 years.

Luminaires and control systems must comply with the requirements of AS/NZS CISPR15 with regard to electromagnetic compatibility. Non-compliance with this standard is an offence under the Radiocommunications Regulations 2001. All luminaires and columns shall be approved by Council.

Council is standardising its street lighting stock, the following are approved
- Betacom GLS 520 for P Category
- Schreder Teceo for V Category

Luminaires shall be LED and include a DALI 2 dimmable driver, 7 pin NEMA socket and Luminaire Controller programmed to work on the Council's Central Management System (Outdoor Lighting Network).

10.4.9 Backfill and bedding

Specify backfill materials individually. The material used must be capable of achieving the necessary backfill compaction. Bedding materials should comply with the Electricity Distribution Asset Owner requirements.

The Work Access Permit specifies the final surfacing to the excavation. Refer to the *National Code of Practice for Utilities' Access to the Transport Corridors* for further information.

10.5 INSTALLATION AND COMMISSIONING

Carry out installation and commissioning in accordance with clause 3.6 - Control and inspection of the work NZS 1158:2010 and NZS 3000:2018. Prior to accepting any newly commissioned lighting installation onto Council's network, Council will audit the installation as detailed in clause 2.12 - Completion of Land Development Works (General Requirements).

The Media Access Control Identifier (MAC ID) and location of the Luminaire Controller shall be accurately captured when installed, failure to provide this information will prevent practical completion

10.6 COMPLETION PROCEDURES AND CERTIFICATION

At the completion of the physical works, and after receiving the lighting contractor's Completion Certificate, TDC or their selected representative shall inspect the work and certify that:

- the project has met all the requirements of the project brief, consent conditions, engineering design acceptance, the standards and specifications; and
- all the documentation detailed below has been completed, is correct and has been forwarded to the Council.

Provide the following documentation:

- Test Certificates for each lighting standard;
- Compliance Certificate for the complete installation;
- As-built drawings of Council owned cables, to Electricity Distribution Asset Owner requirements;
- As-built information in RAMM format (refer to Part 11: As-Builts);
- Engineers Completion Certificate (refer to Appendix VII, Part 3: Quality Assurance);
- Lighting Design Statement (LDS4) - Construction Review and Audit (refer NZTA M30 *Specification and Guidelines for Road Lighting Design*)
- Luminaire Controller e.g. MAC ID

At the end of the defects liability period, the Engineer to Contract or Developer's Representative shall carry out an audit and certify that lighting columns are vertical and lights have been installed correctly and are at the specified mounting height.

Appendix I. LIGHTING CATEGORIES

The following table is provided as a guide, lighting installations are subject to site specific factors. Designers are encouraged to engage with Council early in the design stage to establish required lighting sub category level.

Table 1 Lighting categories

Road classification	Other criteria	Traffic volume	Lighting category
Urban			
Arterial	Major shopping area with bright surroundings	> 20,000	V1
Arterial		> 15,000	V2
Arterial		7,000 to 15,000	V3
Arterial		3,000 to 7,000	V3
Collector		> 15,000	V2
Collector		7,000 to 15,000	V3
Collector		3,000 to 7,000	V4
Collector		1,000 to 3,000	P3NZ
Local			P3NZ
Rural			
Arterial		> 15,000	V3
Arterial		7,000 to 15,000	V3
Arterial		3,000 to 7,000	V4
Collector		> 15,000	V3
Collector		7,000 to 15,000	V4
Collector		3,000 to 7,000	V4
Local	Footpath and/or on road cycle lanes		P3NZ
Local			P4

Note
1) This table is intended to be a guide only.
2) Some rural roads may not require lighting.
3) P3NZ and P4 lighting categories must comply with clause 10.4.4 – Category P (local road and pedestrian area) lighting.

PART 11: AS-BUILT RECORDS

CONTENTS

FIGURE

TABLES

11.1 REFERENCED DOCUMENTS

Design

- Timaru District Council Drainage and Water Contract Specifications
- NZS 4431:1989 *Code of practice for earthfill for residential purposes*
- NZS 5828:2015 *Playground equipment and surfacing*
- New Zealand Transport Agency *State Highway Database Operation Manual* (SM050)
- State highway database operation manual

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).

Contact Council for access to those Council reference documents available only through the internal document management system.

11.2 INTRODUCTION

Where required by a condition of contract or as a condition of subdivision consent provide as-built records, complying with this part.

Where the developer is not providing the as-built records, provide adequate notice and access to the Council to allow sufficient measurements to be obtained for an accurate record of built assets.

11.3 AS-BUILT ACCURACY

Provide as-built stormwater, wastewater and water supply pipe and pipe-related asset locations, land transport and park asset locations to the accuracies specified in the *Drainage and Water Contract Specifications (DWCS)*.

Ensure all reference states New Zealand Transverse Mercator (NZTM) and the associated New Zealand Geodetic Database (NZGD) 2000 Meridional Circuit.

Figure 1 NZGD2000 Meridional Circuits

11.4 AS-BUILT RECORDS

Provide as-built records for all infrastructure to be vested in Council ownership. Council can provide a template spreadsheet for documentation of As-built asset construction costs.

Use the *Buyer Created Tax Invoice Template* from the Inland Revenue website to provide the asset construction cost.

Asset construction costs shall include but are not limited to, cost, material, dimension and quantity for any and all assets to vest to Council.

Provide a full drawing set of as-built plans, in the same form (e.g., scale, size) as the accepted engineering or landscape plans and to at least the same level of detail. They must show all built assets to be taken over by the Council. Include details of any decommissioned assets. Provide details of the datum used, in accordance with clause 2.8.1 – Level datum (General Requirements).

Mark any changes from design in red on as-built plans and provide with the associated non-conformance reports in .pdf format. Such changes might include:

- Reduction in or additional assets installed
- Change in material type
- Additional bends in pipe
- Change in the depth of pipe, e.g. 0.8m changed to 1.5m
- Change in asset size e.g. 1050mm dia changed to 1200mm
- Any unexpected findings, e.g. redundant 1m brick barrel sewer
- Change in structure type

Clearly mark plans as “As-built” by stamping or changing the title block, including where the as-built is built 'as designed'. Date and sign the as-built records.

Submit as-built word documents digitally in either Microsoft Word .doc or Adobe .pdf format. Submit as-built spreadsheet records digitally in either .xlxs or .csv format. The drawing file format may be Arc GIS Shapefile (.shp), Digital Exchange Files (.dxf), 12Da or AutoCAD (.dwg). Format dates as day/month/year. For all supplied geospatial data, use the New Zealand Transverse Mercator (NZTM).

Each Part of the IDS may have additional requirements or documentation e.g. calculations, manuals, for that type of work, which must be supplied with the as-built records. Check with each Part for further information.

11.4.1 Part 4: Geotechnical Requirements

Provide the geotechnical completion report and tabulated results, where required.

The geotechnical completion report will be used by the Council to update the Information Register, or property files for LIM or PIM data. To aid in transferring this information into the LIM system, provide the data in a tabulated form, related to lot numbers where possible. Consent Notices under Section 221 of the Resource Management Act (1991) may be required for such sites as a condition of subdivision consent such as:

- the need for an appropriately qualified specialist to carry out further geotechnical investigations as part of a building consent application.
- the specific requirements or recommendations that need to be considered.

If NZS 4431 was applicable to the development, prepare as-built records in accordance with that standard.

If NZS 4431 was not applicable, prepare an as-built plan as follows. It must show the extent and depth of fill in the form of lines that join all points of equal depth of fill at vertical intervals, which adequately define the fill. Alternative methods of representing the fill depths may also be acceptable. It must show areas of filling of low density, any fill areas that the geotechnical engineer considers as not complying with the IDS, and areas where the standards have been varied from the original construction specification.

The as-built plan must record the position, type and size of all subsoil drains and their outlets. It must also provide information about any underrunners and springs located.

11.4.2 Part 5: Stormwater and Land Drainage

Provide as-built records for stormwater pipes and pipe-related assets conforming to the *DWCS*. Deliver asset data electronically using the Digital Format Requirements set out in the *DWCS*. Refer to IDS 5.4.4 for other Construction Records to be returned to Council.

Provide as-built records for all open waterway-related assets conforming to the asset features, materials and types listed in Appendix I – As-built data checksheet – land drainage (which generally covers open waterway-related assets). Itemise the construction cost into at least the major asset types from Table 9, Appendix II, and to separate assets (e.g. costs of each of two basins) within the asset types.

Use the checklists provided in the appendices when compiling field pickup sheets or plans. Provide the following additional as-built information for non-pipe stormwater assets (e.g. stormwater treatment device).

Provide one hard copy and an electronic copy of:

- the spare parts, workshop (overhaul) and individual installed plant and equipment product manuals;
- the master drawings;
- AutoCAD 2000 engineering drawings;
- AutoCAD .tif file (or hardcopy) for Building, Reticulation, Pumps, Reservoirs, Cables and Wells;
- Asset Owners Manuals (AOM) and Operations & Maintenance Manuals: Electrical, Mechanical including Asset (Equipment) Information and Geospatial Information;
- pickup sheets;
- diesel generator capacity details;
- power connection ICP number;
- digital photos of new assets;
- grounds maintenance plans (in pdf).

11.4.3 Part 6: Wastewater Drainage

Provide as-built information for wastewater pipes and pipe-related assets conforming to the *DWCS*. Deliver asset data electronically using the Digital Format Requirements set out in the *DWCS*. Refer to IDS 6.3.3 for other Construction Records to be returned to Council.

Provide the following additional as-built information for non-pipe wastewater assets (e.g. pump station, biofilter).

Provide one hard copy and an electronic copy of:

- the spare parts, workshop (overhaul) and individual installed plant and equipment product manuals;
- the master drawings;
- AutoCAD 2000 engineering drawings;
- AutoCAD .tif file (or hardcopy) for Building, Reticulation, Pumps, Reservoirs, Cables and Wells;
- SCADA functional descriptions and code. For standard pumping stations, level 1 process description only is required. For pumping stations or processing plants that differ from standard, submit full level 2 functional descriptions before coding, using the Level 2 functional description template.
- Asset Owners Manuals (AOM) and Operations & Maintenance Manuals: Electrical, Mechanical including Asset (Equipment) Information and Geospatial Information;
- pickup sheets;
- diesel generator capacity details;
- power connection ICP number;
- digital photos of new assets;
- grounds maintenance plans (in pdf).

11.4.4 Part 7: Water Supply

Provide as-built information for water supply pipes and pipe-related assets conforming to the *DWCS*. Deliver asset data electronically using the Digital Format Requirements set out in the *DWCS*. Refer to IDS 7.3.3 for other Construction Records to be returned to Council

Specify details of the commercial restrained joint systems on the as-built records, including the location of restrained portions of pipelines, including joints.

Provide the following additional as-built information for non-pipe water supply assets (e.g. pump station, reservoir, new well). Provide one hard copy and an electronic copy of:

- the spare parts, workshop (overhaul) and individual installed plant and equipment product manuals;
- the master drawings;
- AutoCAD 2000 engineering drawings;

- AutoCAD .tif file (or hardcopy) for Building, Reticulation, Pumps, Reservoirs, Cables and Wells;
- SCADA functional descriptions and code. For standard pumping stations, level 1 process description only is required. For pumping stations or processing plants that differ from standard, submit full level 2 functional descriptions before coding, using the *Level 2 functional description template*;
- Asset Owners Manuals (AOM) and Operations & Maintenance Manuals: Electrical, Mechanical including Asset (Equipment) Information and Geospatial Information;
- pickup sheets;
- well information: well consent details, well log, water quality results (in hard copy and electronic template, available from project manager);
- diesel generator capacity details
- power connection ICP number;
- digital photos of new assets;
- grounds maintenance plans (in pdf).

11.4.5 Part 8: Roading

When collecting asset data, load as-built records for the tabulated asset types in the Council's RAMM database using pocket RAMM or use the *RAMM Inventory for Renewal Assets template*. Base the collection of data on the *State Highway Database Operation Manual* amended by the *Requirements for RAMM Inventory Updates*.

Details of approved contractors, currently able to carry out this work, can be obtained from https://www.timaru.govt.nz/__data/assets/pdf_file/0004/305752/Infrastructure-Approved-Contractor-List-2018-19-2020-21-December-2019.pdf

Before compiling any as-built RAMM data, obtain the following information from the Council:

- Road ID;
- Road name;
- Start Displacement.

Council RAMM uses the road origin as the zero point so record all Reference Points (RPs) with reference to the origin.

Provide as-built records of any coal tar present on site, including the location, depth and method of treatment e.g. reuse or encapsulation.

Provide an Asset Owner's Manual for retaining walls, using the *Professional Services Guide Asset Owner's Manual* as a template. Include a labelled grid in the as-built drawings.

Provide as-built records conforming to the DWCS for all green assets located within, or that are going to be vested with, legal road. Deliver asset data electronically using the Digital Format Requirements set out in the *DWCS*.

11.4.6 Part 10: Lighting

When collecting asset data, load as-built records for the road lighting assets in the Council's RAMM database using pocket RAMM or use the *RAMM Inventory for Renewal Assets template*. Refer to clause 11.4.5 - Part 8: Roading for further information.

APPENDIX I. AS-BUILT DATA CHECKSHEET - LAND DRAINAGE

Table 1 Watercourse features

WATERCOURSE FEATURES - This includes all open channels, rivers, creeks, swales, ponds, etc.	
Watercourse	**Notes and Explanations**
☐ Position X,Y	
☐ Installation Date	
Watercourse Lining	
☐ Position X,Y	
☐ Installation Date	
☐ Lining Type	refer Watercourse Lining Type list
☐ Top Width	
☐ Bottom Width	
☐ Depth	
Watercourse Basin	
☐ Position X,Y and extent	include contour plan
☐ Installation Date	
☐ Basin Type	refer Watercourse Basin Type list
☐ Invert levels on inlet(s)	lip of sump or pipe invert
☐ Invert levels on outlet(s)	lip of sump or pipe invert
☐ Design volume	
☐ Design return period	
Watercourse Structure	
☐ Position X,Y	position of a point marked on the as-built plan if the structure is a point feature, or start and end points if it is a linear feature e.g. retaining wall
☐ Installation date	
☐ Reference level	level of a point marked on the as-built plan
Watercourse Valve	
☐ Position X,Y	
☐ Installation Date	
☐ Valve Type	refer Watercourse Valve Type list
ENCHANCEMENT FEATURES - This includes all plantings, stabilisation of banks, etc.	
Enhancement	
☐ Start Position X,Y	upstream
☐ Finish Position X, Y	downstream
☐ Installation Date	

Table 2 Watercourse type lists

WATERCOURSE TYPE LISTS	
Watercourse Lining Type	
CON-C	Concrete Slab with Concrete Frame
CON-I	Concrete Cast In-situ
CON-P	Concrete Precast
CON-T	Concrete with Timber Posts
INVT	Concrete Invert
INVT-R	Concrete Invert with Retaining Wall
LTIMB	Low Timber Lined
ROCK	Rock Lining
ROKMTR	Mortared Rock Lining
SPRAY	Sprayed Concrete
TIMB	Timber Lined
TIMB-T	Timber Lined with Top Struts
Watercourse Basin Type	
Detention	
Infiltration	
Lake	
Pond	
Retention	
Silt Trap	
Soak Pit	
Swale	
Watercourse Valve Type	
Gate	
Flap Gate	
Tidal Gate	