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LANDPRO

Draft Environmental Management Plan for Parkburn Subdivision

Prepared for Fulton Hogan Land Development Ltd

Project Name:	**Parkburn Subdivision bulk earthworks EMP**
Client:	Fulton Hogan Land Development Limited
Document Name	Draft Environmental Management Plan
Date:	17 July 2026
Application Prepared By:	Landpro Limited [redacted] Will Nicolson, BAppSc, CEnvP, Assoc.NZPI Principal Environmental Consultant [redacted]
Reviewed By:	Nathan Archer Survey Manager [redacted]
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1. Introduction

Fulton Hogan Land Development Ltd (the applicant; FHLD) is seeking to undertake subdivision and use of land for urban development as part of rehabilitation of the existing Parkburn Quarry. Key components of the project include:

- A staged subdivision to provide for approximately 1,000 residential lots/units, together with a local commercial centre, a potential primary school site, and reserve areas.
- Associated bulk earthworks, landscaping and infrastructure development, including the construction of new roads and two intersections with State Highway 6 (SH6).
- The formation of two coves extending into Lake Dunstan/Te Wairere/Te Wairere.
- Restoration works along the margins of the Park Burn and Lake Dunstan/Te Wairere.

FHLD has engaged Landpro Ltd to prepare this Environmental Management Plan (EMP) to mitigate potential adverse effects on the environment from the proposed bulk earthworks and associated disturbance.

This EMP has been prepared generally in accordance with the following guidelines:

- Otago Regional Council's 'Residential Earthworks in Otago' 2023 (ORC Guidelines), and
- Auckland Council's 'Erosion and Sediment Control Guide for Land Disturbing Activities in the Auckland Region' 2023 (GD05)

This document recognises and has regard to Lake Dunstan/Te Wairere as a Statutory Acknowledgment Area under the Nagi Tahu Claims Act 1998 and seeks to ensure the water quality of Lake Dunstan/Te Wairere and areas of interest are protected and not degraded.

This document has been prepared in support of a fast track substantive application for subdivision and development at the site, and is to be treated as a live document that must be implemented and updated for the duration of the earthworks activities.

1.1 Author experience

This EMP has been authored by Will Nicolson, a Principal Environmental Consultant and Planner at Landpro Ltd. Will holds a BAppSc in Environmental Management, is a certified Environmental Practitioner (CEnvP), an Associate member of the New Zealand Planning Institute, and a Practitioner of the Institute of Sustainability and Environmental Professionals.

Over the past 15 years, Will has undertaken a wide range of environmental management-related work for a variety of clients, with a particular focus on erosion and sediment control (ESC) and EMPs. Will has developed, implemented and audited EMPs on large, complex projects in New Zealand, Canada and the UK.

Will meets the prerequisites for constituting a Suitably Qualified and Experienced Professional/Person/Practitioner (SQEP) in relation to the creation and implementation of this EMP. In Will's role as author of this report, he confirms that he has read and complies with the Environment Court of New Zealand's Code of Conduct for Expert Witnesses Practice Note 2023.

2. Project details

Project location: Parkburn Quarry, 922 Luggate-Cromwell Road. Approximately 8 km northwest of Cromwell township. The site location in relation to Cromwell is shown in Figure 1, below.

The property encompasses a total of approximately 118 ha, with the proposed ground disturbance area encompassing virtually all of this area, plus a small area of Crown Land.

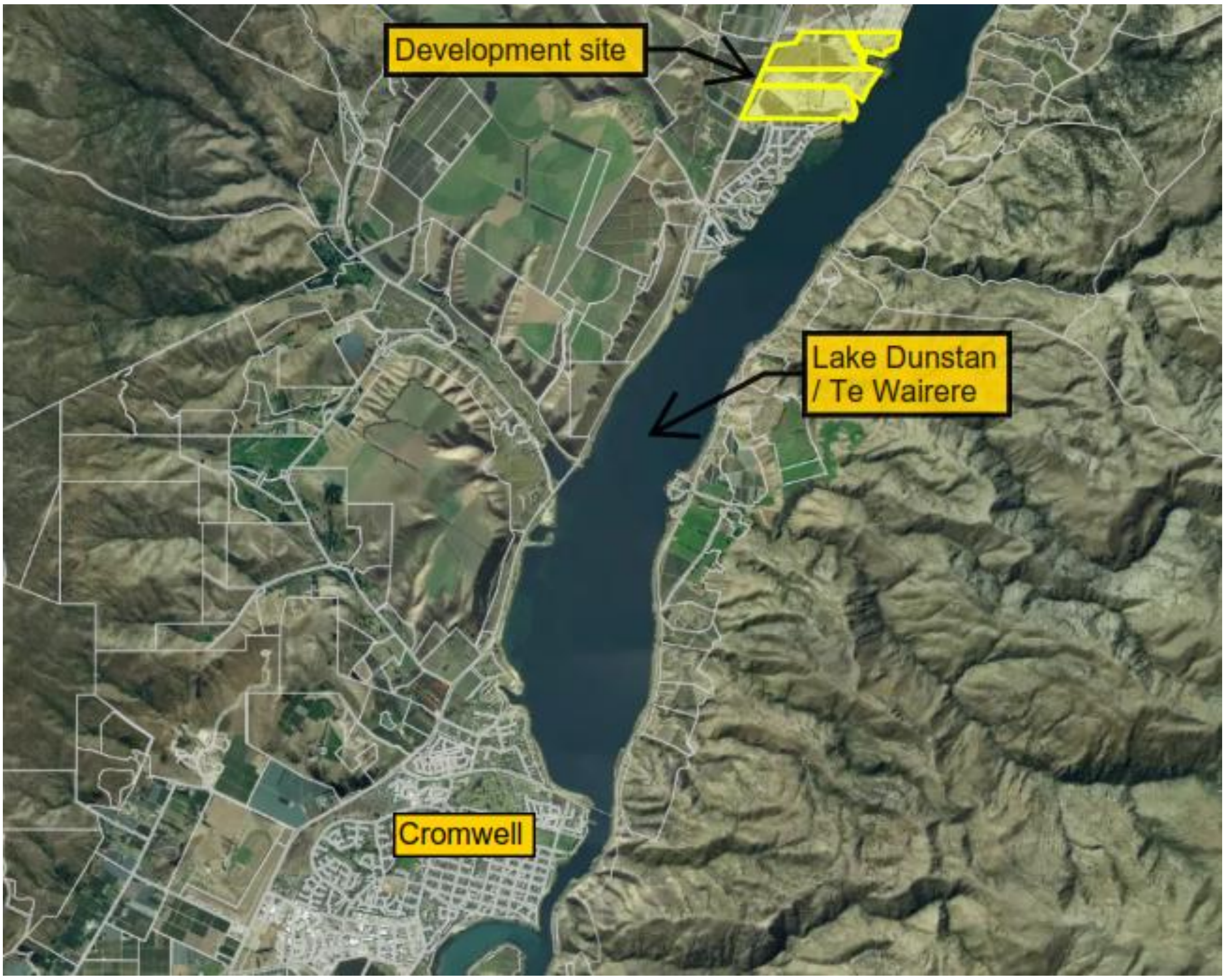


Figure 1: General site location (Source: GRIP)

Project duration: As the project is pending necessary approvals required prior to tendering and programming the works, the duration is unknown at this stage. However, given the size of the development, earthworks will be ongoing for several years as the developer iteratively releases the various subdivision stages.

The existing general site layout is shown in Figure 2.

Figure 2: General site layout, at time of writing (source: Insight Engineering)

2.1 Project description

The proposed development consists of the following construction elements:

- Formation of allotments, totalling 989 lots divided over 15 stages that will progress from south to north (Figure 3);
- Roading network, including pedestrian/cycle paths;
- Drainage and utility reticulation throughout the development, including construction of a wastewater pump station;
- Associated earthworks; and
- Associated landscaping and restoration works, including weed removal and revegetation works along the margins of Lake Dunstan/Te Wairere and the Park Burn (Figure 4).

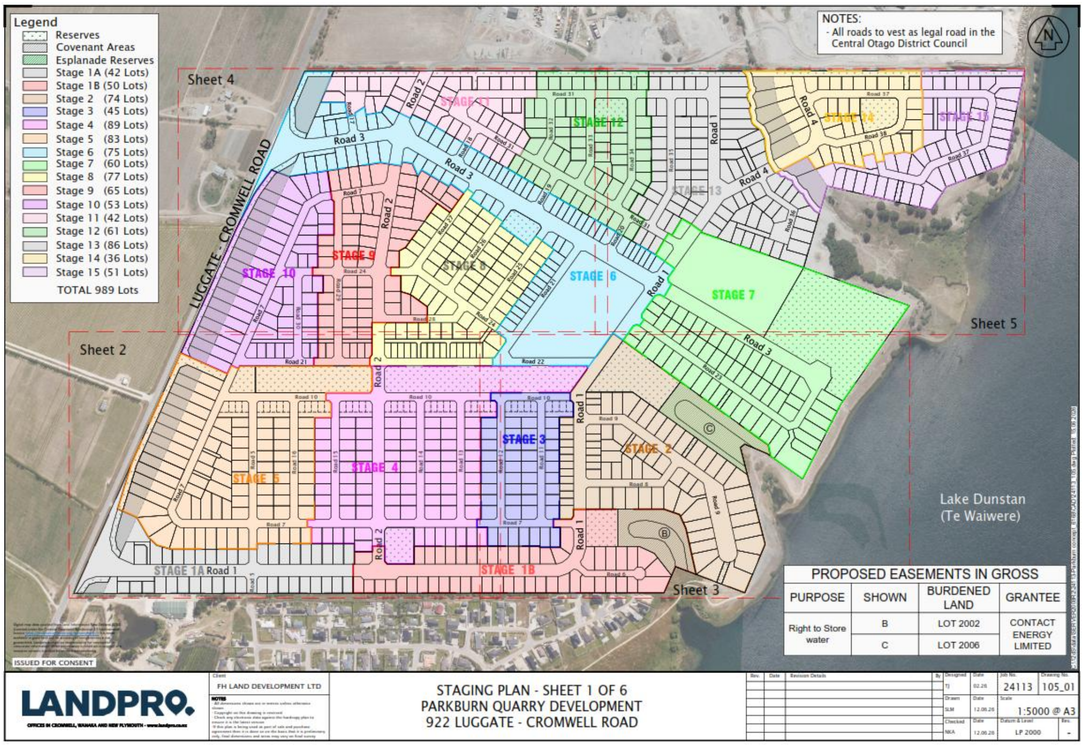


Figure 3: Development staging plan

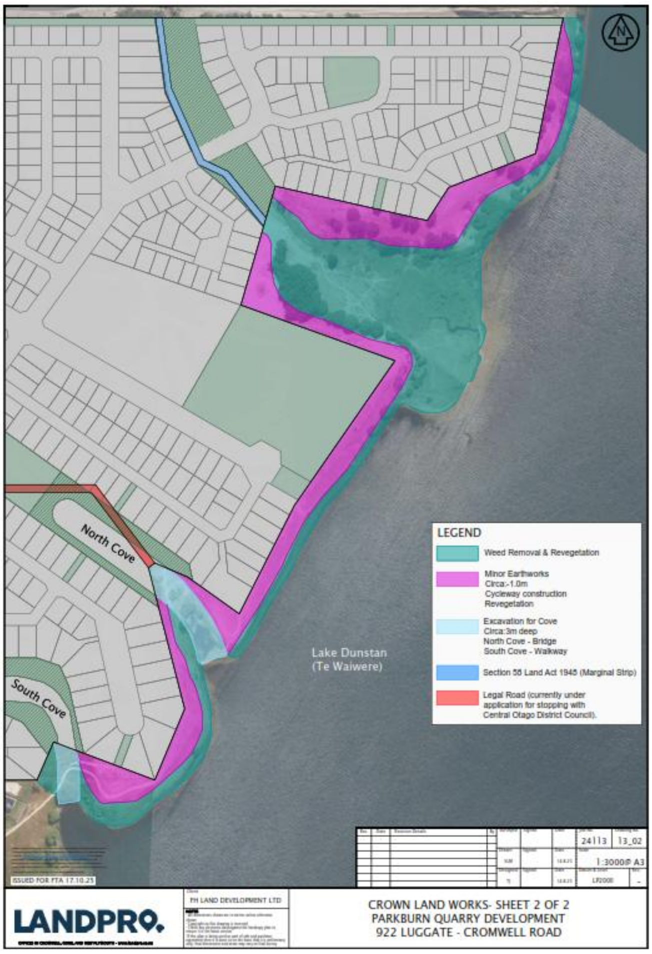


Figure 4: Proposed instream / water margin works.

2.1 Earthworks

Table 1, below, provides a summary of proposed earthworks details associated with the development. As the design develops, these areas and volumes may be subject to change.

Table 1: Cut and fill values associated with bulk earthworks within the site. Note: existing onsite pea gravel cut and fill volumes are excluded; all volumes are solid measure

Area	1	2	3	4	5	6	7	8	9	R1	R2	**Total**
Cut (m^3)	39,400	287,300	187,700	971,400	49,400	25,200	60,500	134,100	48,200	7,600	448,700	**2,259,500**
Fill (m^3)	1,186,900	454,900	644,800	-	600	-	-	-	48,200	532,500	448,700	**1,029,400**
Area of disturbed ground (ha)	17.6	15.4	20.1	20.8	9.7	2.4	5.7	5.3	3.6	9.0	8.2	**117.8**

In addition to the above, the applicant is proposing approximately 2.2 ha of earthworks within Crown Land, within and adjacent to Lake Dunstan/Te Wairere, along with works within and adjacent to the Park Burn.

The maximum cut depth is 12.3 m, within Area 4, while the maximum fill height is 14.6 m, towards the southwest corner of the site in Area 1. Refer to the Bulk Earthworks Staging Plans, provided in Appendix A, for further details.

Topography varies across the site, with some of the site composed of active quarry or former quarrying, some of the site composed of flat to gently-sloping undisturbed grassland, along with smaller areas of sloped river and lake margins.

As the site is directly adjacent to the lake, the general natural slope is in an easterly to southeasterly direction from the state highway to the lake margin. As the design contour plan below shows, post-development design grades will continue this gentle east to southeast grade towards the lake, with the addition of a large drainage swale towards the middle of the development, and minor recontouring works in the Park Burn stream corridor.

To achieve the design contours shown in Figure 5, significant quantities of fill are to be relocated from the higher, currently unquarried sections of the site (roughly the northwestern quarter of the site) to the lower, quarried sections of the site (the southern and eastern portions)(Figure 6).

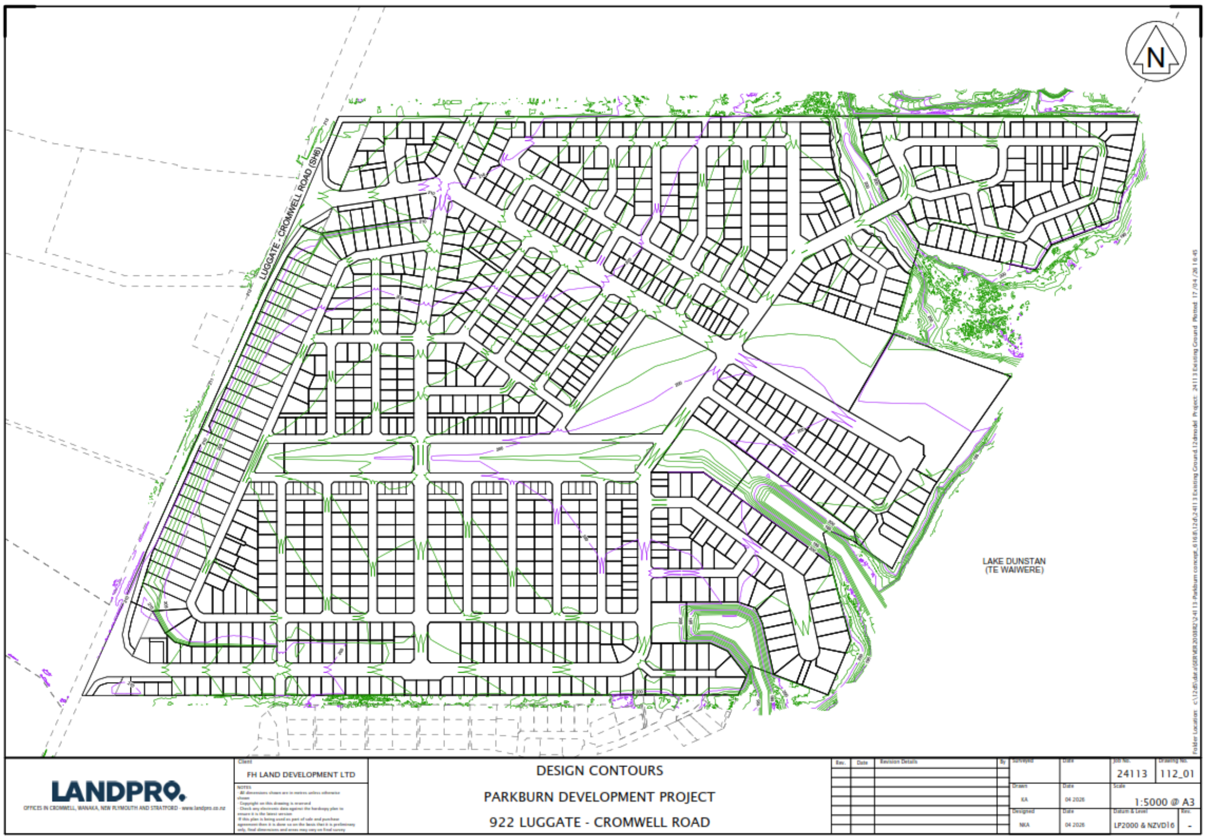


Figure 5: Project design contours

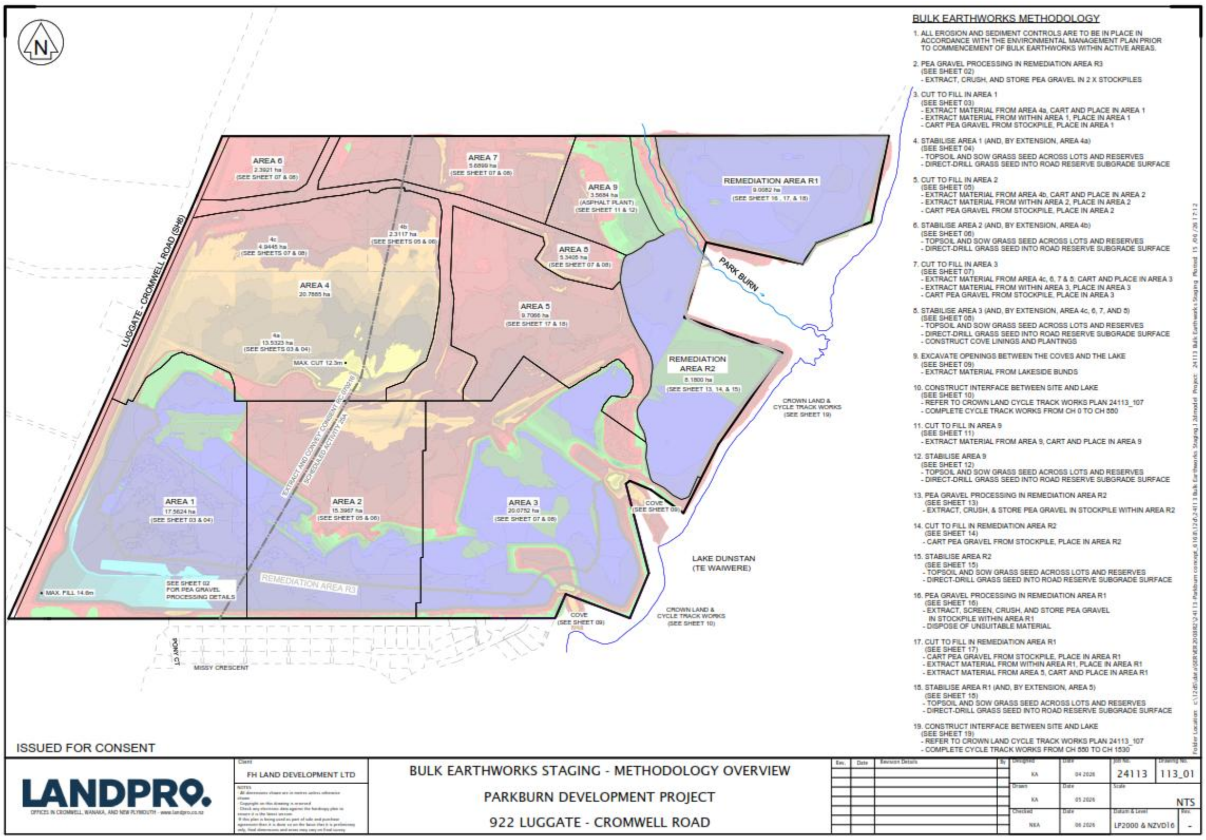


Figure 6: Bulk earthworks staging plan - overview

Much of the available fill from within the property consists of pea gravels, which will be crushed and compacted onsite to provide certified fill for the development. This will occur as part of the ongoing, existing consented quarry works.

Topsoil will also be stockpiled and reused following achievement of design grades, however as much of the site has already been quarried, additional topsoil may need to be imported from offsite to ensure adequate stabilisation of earthworked areas.

Note that larger copies of all project plans, including detailed area-specific cut and fill plans, are provided in Appendix A.

2.2 Construction sequencing

Given the size and scale of the works, the bulk earthworks have been broken up into several areas, with some areas further divided into smaller sub-areas. While detailed construction sequencing is still being finalised, it is likely that two stages will be simultaneously earthworked, with one providing the fill material required to infill the other. For example, Area 4a will be excavated to provide fill for Area 1. Once these areas have reached design grade, they will be stabilised, and the bulk earthworks will move onto the next area.

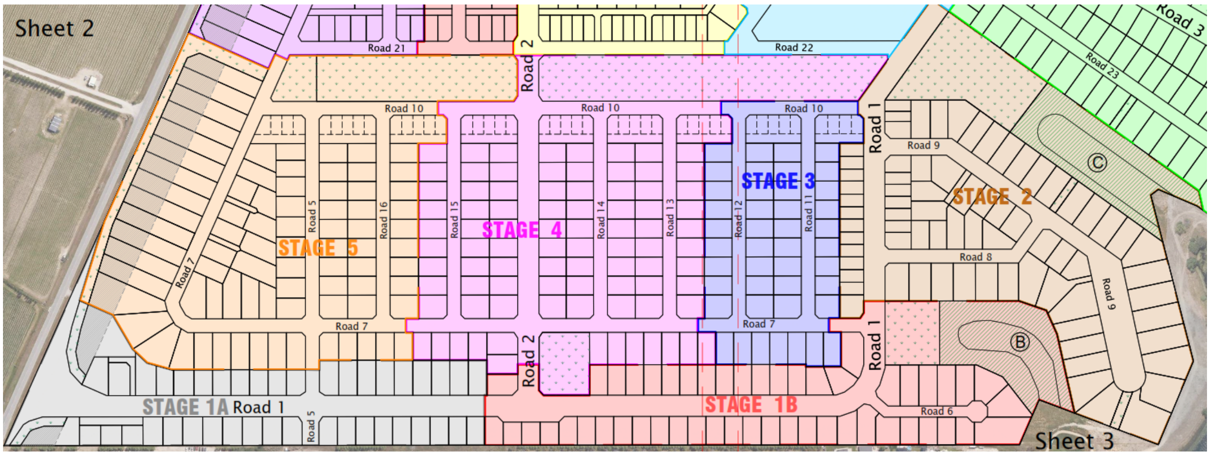
This staging has been proposed in order to minimise the environmental risk posed by disturbing large areas of ground simultaneously, which can lead to significant detrimental erosion, sedimentation, and dust-related effects in particular.

Prior to works within each earthworks area commencing, perimeter ESCs (including stabilised access, where required) will first be installed, followed by the remaining ESCs. As earthworks progress, ESCs for the next bulk earthworks area will be prepared, with stabilisation of the earlier area(s) timed such that there is only a very short period within which any multiple stages are exposed at the same time.

Infiltration basins (IBs) will be constructed in key locations, to detain sediment-laden runoff and encourage infiltration of runoff through the native gravels.

Where present, topsoil will be stripped and stockpiled in appropriate locations for later reuse. Vegetation removals other than grass are likely to be negligible, with any small mulch stockpiles to be situated adjacent to (but separate from) topsoil stockpiles. An exception to this will be the cycleway works, which will be predominantly within Crown Land, both adjacent to and (occasionally) over Lake Dunstan/Te Wairere. Where larger vegetation (such as exotic trees, including willows) is scheduled for removal as part of the works, it will also be mulched and stockpiled separately for onsite reuse in ESC or landscaping.

Following vegetation clearance and topsoil stripping, bulk earthworks within designated cut and full areas will commence, succeeded by topsoiling and vegetation of lots. For earthworks within the southernmost areas, civils works will follow a different order to the bulk earthworks (due to other infrastructure constraints), as per the below indicative plan:



Where an area has been bulk earthworked to design grades, lots and reserves will be topsoiled and seeded, while road reserves will be direct-drilled to establish grass cover and stabilise these areas in the interim. When ready, the contractor will then return to these areas to install the services and then seal roads and footpaths. An exception to this is where a sub-area is to have services installed immediately post-bulk earthworks – such as in the case of Stage 1A above. In this instance, services will be installed and roads and footpaths sealed immediately following.

As final grades are achieved, exposed areas will be successively topsoiled and seeded to stabilise exposed soil and prevent erosion. Where grass establishment is not practical or possible (particularly during the winter), temporary stabilisation will consist of hay mulch or polymer. Hay mulch may also be used to assist in the grass establishment process.

Site access will be via the existing sealed road off State Highway 6.

2.3 Hours of operation

It is expected that hours of operation will be stipulated in the consents being sought, however anticipated hours are as follows:

- Monday to Friday: 7:00 AM to 6:00 PM
- Saturday: 7:30 AM to 5:30 PM
- Sundays and public holidays: No activity

Note that no heavy vehicles are to enter or exit the site prior to 8:00 AM or after 6:00 PM.

2.4 Nearby sensitive receptors

2.4.1 Natural receptors

The key sensitive receptor in relation to the project is Lake Dunstan/Te Wairere, which forms the full eastern boundary of the site (Figure 7). Additionally, the Park Burn flows through the northeast section of the site, ultimately discharging to Lake Dunstan/Te Wairere as shown in the below figure.

Lake Dunstan/Te Wairere is a Statutory Acknowledgment Area and is of significant cultural significance to Kāi Tahu whānui. Approximately 7km to the south of the site is the Nohoanga entitlement at McNulty Inlet.

As can be seen in Figure 8, the generalised overland flow path for the site is to the southeast, directly to the lake. Runoff beyond the western side of the property (including SH6) tends to flow away from the site, in a southwest direction.

Figure 7: Sensitive environmental receptors within/adjacent to the development area (source: GRIP)

Figure 8: Generalised direction of overland flow in relation to sensitive receptors (source: GRIP)

Lake Dunstan/Te Wairere is a man-made lake formed by damming the Clutha River/Mata-au above the township of Clyde. Land Air Water Aotearoa (LAWA) lists the current lake water quality as Good, with a trophic level index of 2.1. Lake Dunstan/Te Wairere is an important recreation feature for the region, with popular activities including boating, swimming and fishing. Further, Lake Dunstan/Te Wairere is of cultural significance to local Iwi. Any uncontrolled discharge from the site must be treated as a potential contaminant in the lake, therefore extra care must be taken to intercept and treat all dirty runoff prior to discharging to the lake.

The Park Burn has a catchment of approximately 2,000 hectares, draining the eastern face of the Pisa Range. While there are a number of consented water takes from the creek, it is understood that the creek naturally reverts to subsurface flows in its lower reach for much of the year. While this means that the creek bed within and adjacent to the site will likely be dry for most of the year, any discharges from the site to the creek should always be monitored to ensure they meet the relevant discharge standards.

2.4.2 Anthropogenic receptors

The below figure provides a summary of potentially sensitive anthropogenic receptors adjacent to the site.

Figure 9: Key anthropogenic receptors adjacent to the site (source: Google Earth; Koordinates)

As can be seen, the residential area of Pisa Moorings is directly to the south, along with a fruit packhouse (CentralPac Ltd), cherry orchard, and workers' accommodation. On the western side of SH6 is predominantly vineyards, while to the north is another active quarry (also potentially subject to future subdivision by another developer).

The western Lake Dunstan/Te Wairere cycle trail runs through the eastern margin of the site, between the applicant's property and the lake.

2.5 EMP risk level

The project is considered to be **High Risk** under the ORC Guidelines, for the following reasons:

- Large-scale, complex project with multiple stages;
- Close proximity to sensitive receptors, including Lake Dunstan/Te Wairere, the Park Burn, and residential receptors directly to the south; and
- Potential for adverse effects on ecological, cultural and recreational values.

2.6 Site overview

Key environmental details relating to the site are presented in the below table.

Table 2: Site environmental details overview

Existing topography	The site is predominantly flat, with a gentle slope from northwest to southeast, towards the lake. Average slope of unmodified ground is estimated at approximately 2%. However, much of the site has either been previously quarried or remains actively quarried, and it is understood that large undisturbed areas may yet be quarried prior to bulk earthworks for the present subdivision beginning. Quarried areas generally follow the flat to gently-sloping nature of the surrounding terrain, interspersed with large stockpiles and steep batters between work platforms/terraces.  *Figure 10: Facing south towards quarry floor, from southern edge of proposed Earthworks Area 4* Existing quarry floors are virtually completely flat.

Geology	Insight Engineering have prepared a Geotechnical and Earthworks Assessment for the proposed subdivision. The report notes that the majority of the site is underlain by Late Pleistocene outwash deposits, described as *unweathered to slightly weathered, loose, sandy to silty, well rounded gravel*.
	
	Lithology records indicate that the subsoils below and around the site are primarily comprised of silty and sandy gravel extending to approximately 28 m depth below original ground level.
	
	The report states that *maximum excavations heights are indicated to be up to 15 m, and are generally expected to expose native materials like those visible in the quarry sides. Native deposits could include surficial Loess, layers and lenses of silts, and fine to coarse sands and gravels that are typical of Pleistocene outwash deposits.*
	
	Another geotechnical report, prepared by Geotago[1] in 2022 for the proposed development, undertook a site investigation via 12 test pits to a maximum depth of 2.2 m. A summary of the findings are as follows:
	• Fill was encountered across the quarry in three main forms:
	  ○ Crusher dust (tightly packed sand with gravels used as a finishing surface or operational roadway)
	  ○ General fill (coarse granular material used to backfill previously quarried areas. Contains extraneous materials such as timber, wood, concrete etc. Encountered in northeast corner of site)
	  ○ Pea gravel (5-8 mm diameter gravel that is too small to crush and too large to be included in sand-based products. This is loose, free-running gravel that collapses on excavation)
	
	In unworked areas, the investigation reported the following:
	• Topsoil, comprising organic sandy SILT, with roots to depths of approx. 0.2 m.
	• Loess, comprising SILT, to a maximum depth of 1.2 m.
	• Outwash deposits, comprising sandy GRAVELS with cobbles and occasional boulders (see below figure).

[1] Geotago Ltd, 2022. *Geotechnical Assessment for Proposed Residential Development*.

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Figure 1: Outwash Deposits Vertical Sequence

In addition to the above, limited soil permeability testing was undertaken by Insight Engineering and Landpro to inform ESCP development and implementation (see Appendix H). The results are briefly summarised below:

Test 1 (central section of earthworks staging area 4 – see Figure 6): infiltration rate of 1,380 mm/hr
Test 2 (approx. midpoint between earthworks staging areas 1 and 2): infiltration rate of 175 mm/hr
Test 3: (eastern side of earthworks staging Area 3 – west of Lake Dunstan/Te Wairere): water did not soak away.

The Insight Engineering soil permeability testing report also provided a limited assessment of soil erodibility, based on pit run material sampled from the quarry. Based on an assumed composition of sand (13%), silt (1%) and clay (1%), the calculated K-factor is 0.0182 (SI units). This is considered to fall within the low to moderate soil erodibility band[2].
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<td>Groundwater</td>
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The Geotago report encountered groundwater in three test pits on the basal floor of the quarry in the southern section of the property. Groundwater depth below ground level ranged from 1.1 m to 1.6 m. The report notes that groundwater below the quarry is reasonably static and in hydraulic conductivity with the lake, which has a reported daily fluctuation of approx. 750 mm (with a normal operating range of 193.5 to 194.5 m AOD).
For context, the approximate average minimum elevation of the quarried southern section of the property is 195 m AOD. It is anticipated that a small portion of this area may need to be excavated down to approximately 194 m, however generally this is the minimum operating
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[2] Donovan, M (2022) *Modelling soil loss from surface erosion at high-resolution to better understand sources and drivers across land uses and catchments; a national-scale assessment of Aotearoa, New Zealand*.

	level for earthworks, noting that all of the southern quarry floor will be infilled (elevation increasing).
Climate	**Precipitation**: Reported annual rainfall of 437 mm for Cromwell, with Dec-January comprising the average wetted months, and July-September the driest months[3] (based on data collected for Cromwell between 1981 and 2010). ORC's growOTAGO indicates 71-80 annual rain days for the site, and a median annual rainfall of 401-450 mm (which correlates NIWA's reported annual average). NIWA reports an average of 4 snow days per year for Alexandra, with the site expected to largely mirror this. **Wind**: No officially-reported wind statistics are available for Cromwell, with the closest monitoring stations being Wanaka Airport and Lauder[3]. The predominant wind direction for Wanaka Airport is westerly, while the predominant wind direction for Lauder is northeast. The strongest winds for both locations are from the northwest. For Wanaka, summer and spring have the greatest incidence of strong winds, whereas most strong wind in Lauder is experienced in spring. From a diurnal perspective, late afternoon is when there is the highest probability of experiencing strong winds. **Temperature**: Clyde (the closest station to the site) has an average of 93 days where the temperature drops below 0˚C. Average daily temperatures are strongly seasonal, and range from a high of 19˚C and low of 8˚C in February, to a high of 3˚C and low of -4˚C in July.
Vegetation	Where the site has not been quarried, vegetation largely consists of exotic grass and ground cover species. Exotic shelterbelt trees flank the property on the southern, western and northwestern boundaries, with occasional incidence of willows on the margins of Lake Dunstan/Te Wairere, and at the Park Burn confluence.
Contaminated land	Insight Engineering have produced a Remediation Action Plan[4] for the development. The plan details that potentially contaminated areas were identified during a PSI, with HAIL areas shown in the below figure.

[3] NIWA, 2015. *The climate and weather of Otago*.

[4] Insight Engineering (2026) *Remediation Action Plan for the Parkburn Quarry*

Figure 11: On-site HAIL areas (source: e3 Scientific, via Insight Engineering)

As can be seen, contaminants are concentrated in the northeast section of the site, in the vicinity of the asphalt plant, concrete block manufacturing facility, equipment storage areas and cleanfill stockpile. Small isolated areas of potential impact were also identified in the active quarry area to the south, associated with bitumen and fuel storage, and location of a generator.

'Cleanfill' stockpile and yards

A small percentage of the 'cleanfill' stockpile is expected to contain contaminants at concentrations marginally exceeding soil contaminant standards. However, separating contaminated material from material that meets the definition of cleanfill is difficult, therefore the entire stockpile must be treated as contaminated – this volume is estimated at 180,000 m^3. The contractors' yards, used for storing machinery and treated timber poles, are estimated to contain approximately 100 m^3 of contaminated material.

Asphalt plans

The volume of contaminated (hydrocarbon-impacted) material associated with the plant is conservatively estimated at up to 100 m^3.

Fuel storage areas

It is conservatively estimated that up to 50 m^3 of potentially contaminated material associated with fuel storage areas (particularly below-ground tanks) may be encountered.

Orchard

	The former orchard area is unlikely to contain significant contaminant concentrations from persistent pesticide use, however there is a chance that up to 70 m^3 of contaminated material may be encountered.

3. EMP updates

The Guidelines state the Consent Holder (subsequent to the applicant) or Contractor is to develop and document a process of periodically reviewing the EMP. This process is to focus on continuous improvement of processes and practices to ensure that the EMP is relevant to the project works.

These updates should ensure that any environmental incident corrective actions and/or relevant legislative changes are factored into the EMP. The Consent Holder or Contractor is to establish and implement document version control, noting that the responsibility of ensuring this is done lies with the Consent Holder.

Updates to the EMP will be undertaken when:

1. Any significant changes have been made to the construction methodology or erosion and sediment control plan (ESCP) since the original EMP was accepted; or
2. There has been an Environmental Incident and investigations have found that the management measures are inadequate; or
3. As directed by ORC's and CODC's compliance teams.

Any updates to the EMP are to be submitted to ORC and CODC for acceptance at compliance@orc.govt.nz and monitoring@codc.govt.nz, respectively.

Works implementing the updated EMP/ESCP must not commence until the updated EMP has been accepted by ORC and CODC. All works must be undertaken in accordance with the most current accepted version of the EMP.

4. Administrative requirements

4.1 Site environmental induction

The purpose of the site environmental induction is to ensure that all staff and subcontractors onsite are aware of their environmental responsibilities.

Prior to commencing ground-disturbing activities, the Consent Holder or Contractor will ensure that all staff involved with onsite works have attended an environmental site induction. This includes, as a minimum, all site management staff, employees and subcontractors working on activities which disturb the ground surface.

The Consent Holder or Contractor will maintain a register signed by those inducted. This register will contain, but not be limited to, the name of the inductee, the name of the inductor, the date inducted and confirm that the inductee is familiar with the EMP.

A copy of the draft environmental site induction is provided in Appendix B. Note that a finalised induction will be provided with the final EMP, to be submitted to ORC for acceptance prior to start of ground-disturbing activities.

4.2 Management of sub-contractors

All sub-contractors must attend the environmental site induction and must be recorded on the site environmental induction register. The Consent Holder or Contractor must ensure that all sub-contractors comply with the EMP at all times.

4.3 Environmental incidents

The Consent Holder or Contractor will notify ORC of the details of any Environmental Incident where the EMP has failed, leading to any adverse environmental effects offsite (including nuisance effects associated with dust as well as spills of fuels and chemicals to ground onsite). Concrete contamination is a common source of environmental incidents on construction and earthworks sites, meaning concrete pouring and deliveries must be strictly managed onsite to prevent a discharge to a water body or stormwater reticulation.

All Environmental Incidents will be notified to ORC within 12 hours of becoming aware of the incident, as specified in the below table:

Table 3: Council contact details in the event of an incident or compliance-related matter

Type	Contact
Environmental incident	1. pollution@orc.govt.nz /0800 800 033 and 2. The site's ORC Compliance Officer 3. The site's CODC Compliance Officer (if required)
Compliance-related matters	1. pollution@orc.govt.nz /0800 800 033 and 2. The site's ORC Compliance Officer

The Consent Holder or Contractor will undertake immediate remedial actions to mitigate adverse environmental effects. Once the immediate risk from the Environmental Incident is alleviated, the Consent Holder or Contractor will investigate the cause of the breach and/or environmental effects, then identify and implement corrective actions as soon as practicable.

The Consent Holder or Contractor will provide an Environmental Incident Report to ORC within 10 working days of the incident occurring. This report must detail:

- The nature of the Environmental Incident.
- What management measures were in place to prevent the incident from occurring.
- Probable causes of the incident.
- What corrective actions have been undertaken to prevent incidents reoccurring.

An Environmental Incident Report template is provided in Appendix C.

4.4 Environmental roles and responsibilities

The following table identifies relevant environment-specific roles and responsibilities of personnel involved with the project. The table will be populated with all relevant personnel in the final EMP.

Table 4: Project key environmental personnel

Role	Name	Phone Number	Email
Project Manager	Tim James	027 484 4004	tjdjames.nz@gmail.com
Site Supervisor			
Environmental Representative			
Environmental Consultant (SQEP)	Will Nicolson	027 459 8090	will@landpro.co.nz

Qualifications/experience for key environmental personnel can be provided upon request.

4.4.1 Environmental Representative

The Environmental Representative should actively support the Project Manager and/or Supervisor with the day-to-day implementation of environmental controls and administrative activities. In particular, the role includes:

- Implementation of environmental management:

    - Undertake thorough environmental site inductions to all staff and sub-contractors
    - Ensure installation of environmental controls as per the EMP and ESCP
    - Undertake environmental site inspections of the project
    - Oversee the maintenance and improvement of defective environmental controls
    - Undertake Environmental Incident reporting
    - Ensure the chemical treatment systems for SRPs and DEBs are operating correctly where appropriately trained or supervised by a SQEP
- Communication:
    - Keep project leadership informed of environmental performance of the project
    - Inform staff of procedures and constraints applicable to managing specific environmental issues
- Complaints and Incidents:
    - Assist the project leadership in attending to Environmental Incidents and Complaints
- Familiarity with:
    - Environmental aspects of the project
    - This EMP, ESCP, CTMP and contaminated-land plans and documents
    - Best practice erosion and sediment control from:
        - *Guidance Document 2016/005: Erosion and Sediment Control Guide for Land Disturbing Activities in the Auckland Region (GD05)*; and/or,
        - *Residential Earthworks in Otago – A guide for developers, landowners, contractors and service providers* 2023 (ORC Guidelines)

4.5 Records and registers

Environmental records are to be collated onsite and shall be made available to ORC upon request:

- immediately if the request is made by an ORC official onsite, and
- within 24 hours if requested by an ORC officer offsite.

Records and registers to be managed onsite shall include the following:

- Environmental Induction attendance register
- Environmental incident reports and associated corrective actions undertaken
- Complaints register and associated corrective actions undertaken
- Daily diary entries (including pre-start inspection observations)
- Post-rain event inspection observations and corrective actions
- Weekly site inspection checklists
- Water quality monitoring results
- EMP non-conformance register and associated corrective actions taken

4.5.1 Complaints register

The complaints register will include, but is not limited to:

a) The date, time, location and nature of the complaint;

b) The name, phone number, and address of the complainant, unless the complainant elects not to supply this information; and

c) Action taken by the Consent Holder to remedy the situation and any policies or methods put in place to avoid or mitigate the problem occurring again.

A record of the complaints must be submitted to ORC in the Monthly Environmental Report, or as specified in the consent.

4.6 Inspections

The Environmental Representative or appropriate delegate shall undertake and document weekly and pre- and post-rain event[5] site inspections for the purpose of monitoring the following:

- Verifying that the management measures prescribed in the EMP are present, functional and adequate
- Observing the site for actual or potential adverse environmental effects
- Identifying maintenance requirements for implemented management measures
- Verifying preparedness for adverse weather conditions where rain and/or wind is forecast

[5] A rain event is defined in the QLDC Standard for EMPs as 'any precipitation event that generates overland flow'. A significant rain event is defined in the same document as 'a rain event at an intensity of 20mm/12 hrs'.

In some situations, such as during sensitive phases in the works or following Environmental Incidents, weekly inspections may need to be undertaken by the SQEP.

The Consent Holder or Contractor shall undertake corrective actions to rectify issues identified by the site inspections. Each weekly inspection shall be recorded, including date, observations and corrective actions.

The weekly and post-rain event site inspections shall be made available to QLDC within 24 hours of a request being made.

Between the weekly and post-rain event inspections, the Environmental Representative shall also undertake a daily pre-start inspection to ensure that no new environmental issues have arisen or mitigation measures have been compromised from the previous day's work. Observations should be recorded (e.g., in a works diary).

During significant rain or adverse weather events, inspections/monitoring may also be necessary to ensure ESCs are correctly functioning, undertake water quality monitoring and implement any contingencies necessary to prevent an environmental incident from occurring. Inspections or monitoring during these events should only be undertaken if safe to do so.

The following table summarises the Consent Holder's duties to undertake environmental inspections:

Inspection type	Frequency	Tasks
Weekly	Once per week	• Inspect all environmental controls and schedule maintenance as required • Identify any activities that may cause an environmental incident, and if identified, communicate these to the project team.
Pre-event	Prior to a rain, snow or high-wind event.	• Inspect all environmental controls well in advance of a forecast adverse weather event • Use the inspection to schedule urgent ESC maintenance or preventive works prior to the weather event.
Event monitoring	During a significant weather event	• Inspect all critical ESCs to ensure they are functioning correctly • Implement contingency steps as outlined in Section 5.1.8 • Undertake water quality monitoring where offsite discharges are occurring.

Inspection type	Frequency	Tasks
Post-event	Following a significant weather event	• Inspect all environmental controls and schedule maintenance as required • Document opportunities for environmental control improvement, and implement corrective actions.

4.7 Monthly monitoring

Monthly inspections of the site will be undertaken by the SQEP (Environmental Consultant). Monthly inspections will ensure that the site is complying with this EMP, identify any new environmental risks arising that could cause an environmental effect, and suggest alternative solutions that will result in more effective and efficient management.

The outcome of these inspections will be reported and included in the Monthly Environmental Report referred to in the section below.

4.1 Monthly environmental reporting

The Consent Holder or Contractor will complete and submit exception reporting to ORC (and CODC, if requested) in the form of a monthly environmental report. The monthly environmental report will be submitted to ORC's compliance team within five working days of the end of each month.

The monthly environmental report will include exception reporting and statements actively addressing, but not limited to, the following that occurred during the reporting month:

- Updates to the EMP and the Erosion and Sediment Control Plan (ESCP)
- Weekly site inspections – number of inspections completed, and summary of corrective actions undertaken
- Monitoring reporting – summary of monitoring and whether non-conforming results were obtained
- Reporting on monitoring undertaken, including pre- and post-rain events
- Positive environmental outcomes achieved and opportunities identified by the Consent Holder or Contractor
- Complaints received
- Water quality monitoring results of any discharges (controlled and/or uncontrolled) from the discharge point or any waters crossing the boundary and/or the receiving environment.
- Summary of monthly visual assessment of fuel and chemical management controls, including spill kits.

Where exception reporting demonstrates repeated or multiple non-conformances of the same issue, ORC may instruct the Consent Holder or Contractor to undertake a review of the adequacy of management measures outlined in the EMP and provide a response back to ORC within five working days (or as otherwise specified), either confirming and justifying the suitability of the existing EMP or notifying of updates to the EMP and the justification.

5. Operational requirements

5.1 Erosion and sedimentation

The Consent Holder or Contractor is responsible for temporary erosion and sediment control and for ensuring that controls are adequately designed, installed, adapted, maintained and decommissioned.

5.1.1 Project risk

Based on criteria in the Guidelines, the Erosion Risk of the project is considered to be **High**. This is based on the assessment provided in the following table. Note that the parameters used to quantify the risk level are based on Queenstown Lakes District Council's Guidelines for Environmental Management Plans 2019 (QLDC EMP Guidelines), acknowledging that the development site is not located within QLDC's jurisdiction.

Table 5: Project Erosion Risk assessment

Erosion risk	Characteristics of risk level	Proposal assessment
Low	<2500m^2 disturbed surface area open at any one time	>2,500 m^2 will be disturbed at any one time
Medium	All projects not meeting the characteristics above and below	Cannot meet all characteristics of Low risk level. Multiple High-Risk characteristics apply.
High (projects with 2 or more of the following characteristics)	Project duration > 6 months	Project duration is greater than 6 months
	Project working within or discharging to Sensitive Environmental Receptors such as a Waterbody	Works within the Park Burn riverbed are proposed. In-water works within Lake Dunstan/Te Wairere, and along the lake margins, are proposed.

	Projects which have > 1 hectare of land exposed	>1 ha will be exposed
	Topography where any slope is greater than 15% (6.6 degrees)	The majority of the site ranges from entirely flat to lightly sloping. Only small areas (batters) would come close to a 15% slope.
	Soils with high erodibility (e.g. silts or other soil types with high silt content) as determined by geotechnical advice.	Based on information provided in Geotago's *Preliminary Geotechnical Assessment* (2022) for the development, soil erosivity varies spatially and with depth across the site. Overall, highly erosive soils are generally unlikely but may be encountered at least periodically.

5.1.2 Erosion and sediment control principles and standards

To the extent possible, erosion and sediment controls for the project will be designed, installed, maintained and decommissioned in accordance with the following principles:

- Erosion and sediment controls are integrated with construction planning
- Effective and flexible erosion and sediment control plans are developed based on soil, site slope, weather, construction conditions and the receiving environment
- The extent and duration of soil exposure is minimised
- Water movement through the site is controlled – in particular, clean water is diverted around the site and 'dirty' and 'clean' water is kept separated as far as practicably possible
- Soil erosion is minimised as far as reasonable and practical (to the satisfaction of ORC)
- Disturbed areas are promptly stabilised
- Sediment retention on site is maximised
- Controls are maintained in proper working order at all times

- The site is monitored and erosion and sediment control practices adjusted to maintain the required performance standard
- Discharges are avoided, especially offsite discharges of sediment-laden runoff, but also dust from wind erosion.

Where practicable, erosion and sediment controls are to be designed, installed and maintained in accordance with current ESC best practice, including (but not limited to) the following guidelines:

- Auckland Council's *Erosion and Sediment Control Guide for Land Disturbing Activities in the Auckland Region* (2016; reprinted 2023)(GD05)
- Queenstown Lakes District Council's *Guidelines for Environmental Management Plans* 2019 (QLDC EMP Guidelines)
- Otago Regional Council's *Residential Earthworks in Otago* 2023 (ORC Guidelines)

Given some of the site's unique characteristics, however, departure from default measures outlined in these guidelines is necessary to ensure ESCs remain efficient and effective. Notably, the following key characteristics apply to much of the site:

- Former quarry.
- Internal drainage.
- Significant bunding around the perimeter, separating most of the site from the receiving environment.
- High soil infiltration in most locations.
- Very low gradients.
- Generally low runoff coefficients.
- Coarse gravel the most common working medium.
- Relatively low assumed soil erodibility.
- High water table on the southern quarry floor.

The above factors mean that traditional GD05-recommended sediment retention ponds (SRPs) are unlikely to be an effective means of runoff detention and treatment in most instances. SRPs are not proposed because:

1. There is a very low fraction of silts and clays.
2. Soil infiltration is generally very high.
3. The native gravels are likely to be prohibitive towards the relatively steep embankments of a traditional SRP – a lack of cohesion means they're likely to fail and/or require constant maintenance.

4. The water table is high in quarried areas of the site. Any SRP in these areas would therefore need to be very shallow, which would mean the SRP surface footprint would be huge, in order to achieve the required storage volume.

Instead, a shallow, infiltration-driven system is being proposed for most of the site. This generally entails large, shallow swales with dropout pits leading to large, shallow infiltration basins that fully utilise high soakage potential while avoiding interception of the water table. Given extremely low gradients and relatively low soil erodibility, scour is not expected to present a significant problem, and any overflow from the infiltration basins will simply spill onto the surrounding gravels and be contained within the bunded site.

Notwithstanding the above, there remains a possibility of the site still implementing SRPs in some of the later stages of the works, if site conditions are more conducive to this form of sediment retention.

5.1.3 Erosion and Sediment Control Plan scope

It is expected that a condition of consent will require that, prior to any works commencing on site, the Consent Holder shall submit for review and acceptance, a final ESCP. The ESCP is to be implemented prior to any onsite disturbance.

Figure 5 of this report shows the extent of earthworks proposed for the development. As can be seen, bulk earthworks encompass all of the property, along with narrow sections of Crown Land on the margins of Lake Dunstan/Te Wairere, along with minor in-water works within Lake Dunstan/Te Wairere itself.

The present ESCP encompasses the full extent of earthworks that will take place within the southwestern portion of the property, along with draft measures for managing water quality risk associated with earthworks on Crown land (adjacent to Lake Dunstan/Te Wairere) and works within and adjacent to the Park Burn. Thus, the ESCP presented in this version of the EMP covers bulk earthworks within the following areas and activities:

- Cut to fill from Area 4a to Area 1
- Cut to fill from Area 4b to Area 2
- Earthworks within Crown Land and directly adjacent to Park Burn (may run in tandem with other earthworks phases)

Access and egress to the earthworks areas from SH6 is also included in this version of the ESCP.

Due to the large size of the property and the length of time it will take for the works to progress to Area 3/4c and above, it is more prudent to develop ESCs for these areas closer to these works starting – this will be addressed via an updated ESCP and EMP, and submitted to ORC for review and acceptance well in advance of scheduled start of works.

While in-water works associated with construction of the two coves are likely to occur during or after Area 3 earthworks, an indicative ESCP for these works has been provided due to their high-risk nature. A more detailed ESCP for these works will be developed and submitted for council review and acceptance prior to these works starting.

5.1.4 Earthworks staging

While earthworks and associated civils staging is still in the preliminary stages of design, the following provides an indicative summary of anticipated sequencing and timeframes. Sequencing should be read in conjunction with the earthworks staging plans, and the subdivision staging plan (excerpt provided below).

- Year 1: cut to fill from Area 4a to Area 1
- Year 2: cut to fill from Area 4b to Area 2
- Year 3: cut to fill from Areas 4c-8 to Area 3; civil works for subdivision Stage 1A
- Year 4: civil works for subdivision Stage 1B; formation of southern cove (including in-water works within Lake Dunstan/Te Wairere)
- Year 5: civil works for subdivision Stage 2

Staging beyond this point is yet to be determined, with this section to be updated as works progress and the construction programme is developed.

Importantly, however, progressive stabilisation is the be implemented at all times. It is expected that, as bulk earthworks within a given area progress, formed lots, reserves and roads will be stabilised either prior to or in tandem with ongoing earthworks elsewhere in the area. This is likely to mean that where an area of approximately 1 ha of bulk earthworks is completed, it will be topsoiled and hydroseeded (in the case of lots and reserves) or seed drilled (in the case of roads). This is critical for minimising disturbed catchments, alleviating pressure on ESCs, and reducing dust generation risk.

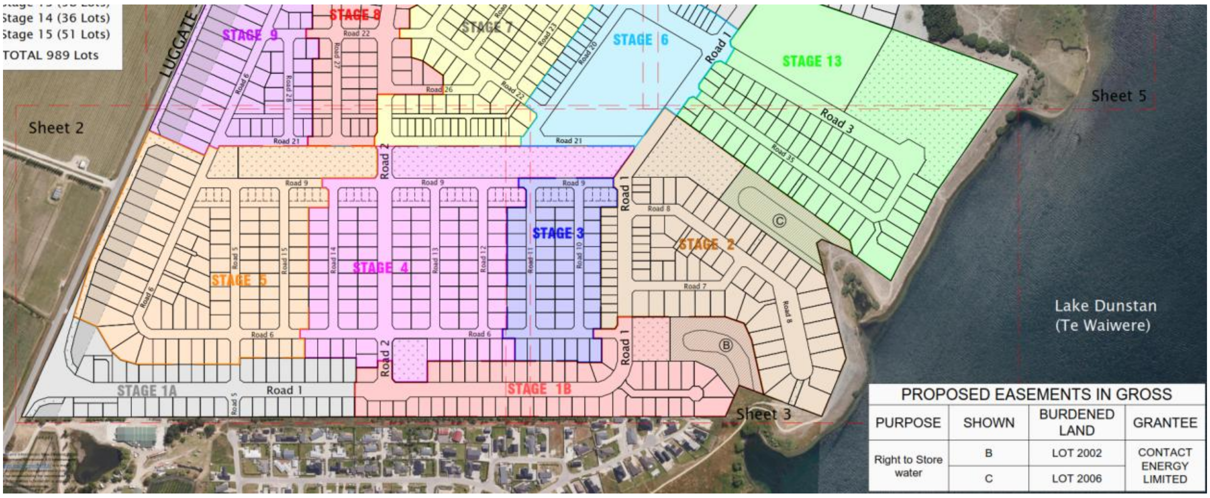


Figure 12: Subdivision staging plan (the coves are demarcated by easements B and C)

5.1.5 ESC plans and methodologies

Due to the size of the site, and the varied activities that will take place across the site, the ESCP features a number of plans that specify specific controls for individual earthworks areas – both before and after bulk earthworks. The following subsections explore earthworks for Areas 1, 2, 4a-4b, Crown Land works and Park Burn works. Further details will be added to this section for successive earthworks areas as the works progress.

5.1.5.1 Earthworks Areas 1 and 2 (and associated cut to fill)

The below plan provides a generalisation of large-scale overland flow paths associated with the existing site (full-scale existing contour plan provided in Appendix A). As can be seen, most of the site drains towards the south, where the excavated quarry floor effectively presents the end-point for virtually all runoff. This, along with the relatively high soakage rates for much of the area, provides the critical context for the proposed ESC methodology outlined below.

Area 1

1. Retain western boundary bund and/or swale adjacent to SH6 to continue diverting clean water to west.
2. Construct Infiltration Basins 1 and 2 (IB1, IB2) beyond eastern end of Area 1, as shown in the ESCP and as per the associated designs in Appendix F.

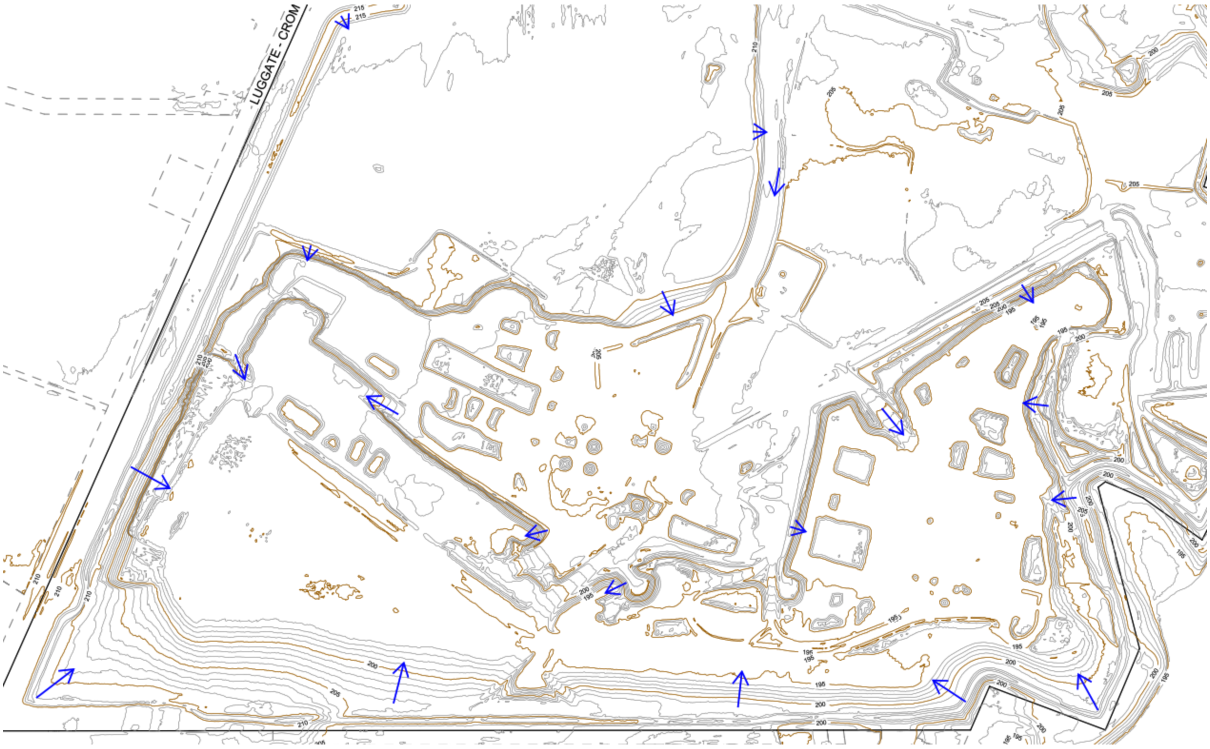
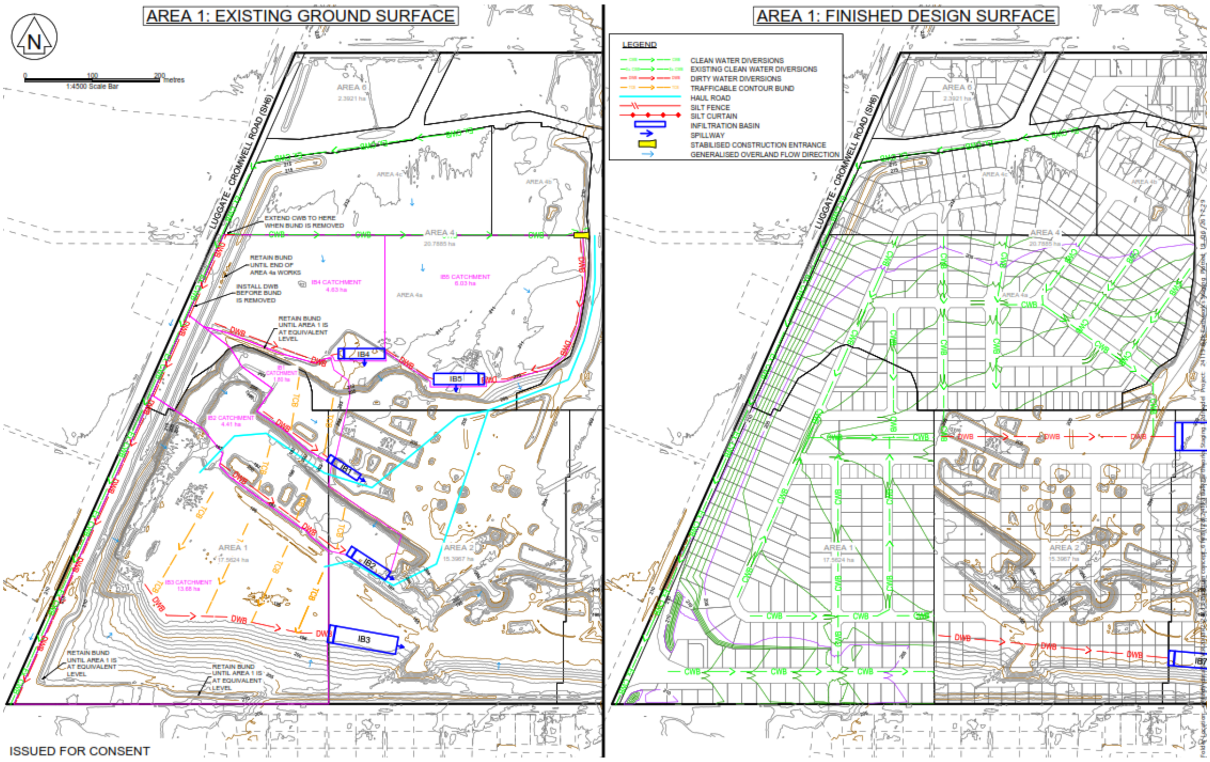


Figure 13: Existing overland flow paths for southern portion of site

3. Construct dirty water diversion channels/swales (DWBs) from west to east within Area 1.
4. Construct shallow dropout pits at approximately 50 m intervals along the DWBs, as shown on ESCP.
5. Construct lateral trafficable contour bunds/drains as shown on ESCP, to break up the larger catchments and direct runoff towards the two main diversion channels.
6. Begin bulk earthworks.
7. As infilling progresses roughly from west to east, adjust diversion channels and contour bunds as needed. At the batter interface between the infill zone and the existing quarry floor, diversion channel stabilisation (or fluming) may be required where the longitudinal slope exceeds 2%.
8. As works progress and design grades are achieved, lots and reserves will be successively topsoiled and hydroseeded, and road subgrades will be seed drilled to provide interim stabilisation until civil works can start. Each grassed road will feature at least one swale (also seed drilled, for long-term stabilisation), which will direct flows in a generally easterly direction. Most road swales will eventually discharge into a centralised swale, that will be successively constructed as bulk earthworks move from west to east. Subject to detailed design, there is an option to construct small soak pits at

regular intervals along these roadside swales, to both encourage localised infiltration and reduce runoff velocities within the swales.

9. Once all bulk earthworks in Area 1 are complete, and design grades are achieved, most grassed roadside swales will discharge into the central grassed swale. This swale will be continued through Area 2, initially as a large, shallow gravel swale that will terminate in a large infiltration basin east of the Area 2 earthworks extent, then formally graded and stabilised as per detailed design.



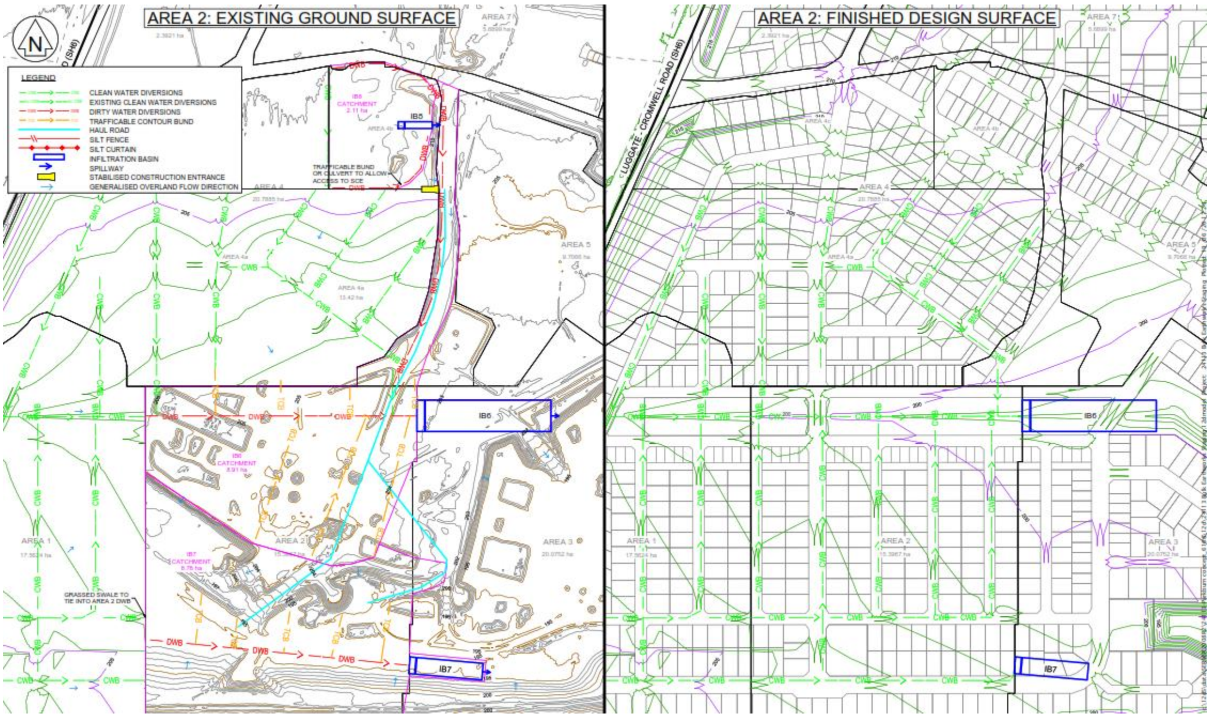
Area 4a

1. Construct clean water diversion bund at northern end of works area, to divert any uncontaminated overland runoff around the works and to the east.
2. Retain western boundary bund and/or swale adjacent to SH6 to continue diverting clean water to west.
3. Construct SCE. Note, the proposed SCE location connects the earthworks area to an existing sealed road. Vehicles that travel from here back to the site entrance at SH6 will have close to 600 m of sealed road to travel along, meaning the risk of tracking mud onto the state highway is minimal – however the SCE and regular internal road sweeping will further minimise this risk.
4. Construct Infiltration Basins 3 and 4 (IB3, IB4) along southern zone of Area 4a, as shown in the ESCP and as per the associated designs in Appendix F.

5. Construct dirty water diversion channels/swales (DWDCs) into the IBs as shown.
6. Construct shallow dropout pits at approximately 50 m intervals along the DWDCs, as shown on ESCP.
7. Begin bulk earthworks. As earthworks within this area are virtually all cut, internal contour bunds or catchment breaks are not considered necessary, as soil disturbance will only be within large depressions, that due to the high soakage rates will act as an oversized infiltration basin.
8. Towards the end of the Area 4a bulk earthworks, Infiltration Basins 3 and 4 will need to be decommissioned. At this point, swales from this area will be constructed to connect runoff from this area to the central swale that will drain through Area 2 to a large infiltration basin on the western side of Area 3.

Area 2

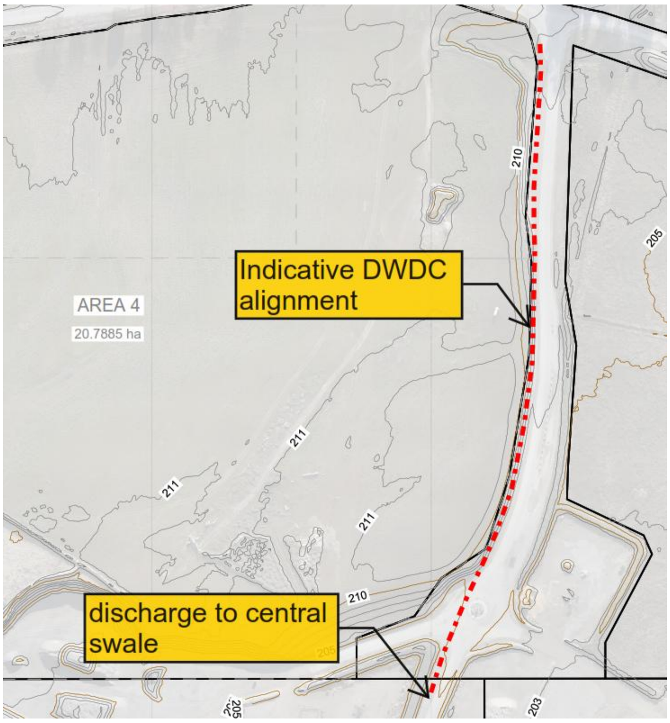
1. Prior to works progressing into Area 2, IBs 1 and 2 will be decommissioned. IBs 5 and 6 will subsequently be constructed beyond the eastern extent of Area 2, with corresponding DWBs, contour drains and dropout pits designed similar to Area 1.
2. Begin bulk earthworks.
3. As infilling progresses roughly from west to east, adjust diversion channels and contour bunds as needed. At the batter interface between the infill zone and the existing quarry floor, diversion channel stabilisation (or fluming) may be required where the longitudinal slope exceeds 2%.
4. Progressive stabilisation of lots, reserves and roads, and formation of roadside swales, which themselves discharge to two large swales that drain into IBs 5 and 6. IBs 5 and 6 will remain operational for as long as possible following completion of bulk earthworks in Area 2 – at least until Area 2 is fully stabilised.



Area 4b

1. Construct clean water diversion bund at western end of works area, to divert any uncontaminated overland runoff around the works and to the south and north.
2. Maintain SCE. Note, the proposed SCE location connects the earthworks area to an existing sealed road. Vehicles that travel from here back to the site entrance at SH6 will have close to 600 m of sealed road to travel along, meaning the risk of tracking mud onto the state highway is minimal – however the SCE and regular internal road sweeping will further minimise this risk.
3. Construct Infiltration Basin 7 (IB7) to west of existing internal road, as shown in the ESCP and as per the associated designs in Appendix F.
4. Construct dirty water diversion channels/swales (DWBs) into the IB as shown.
5. Construct shallow dropout pits at approximately 50 m intervals along the DWBs, as shown on ESCP.
6. Begin bulk earthworks. As earthworks within this area are all cut, internal contour bunds or catchment breaks are not considered necessary, as soil disturbance will only be within a large depression, that due to assumed the high soakage rate will act as an oversized infiltration basin.
7. Towards the end of the Area 4b bulk earthworks, IB7 will need to be decommissioned. To subsequently manage runoff/stormwater from this area following the removal of IB7, a large DWB will be constructed running

along the western side of the existing sealed road (care must be taken not to damage the seal), to divert runoff draining from Area 4b to the central swale (see below indicative drawing), until such time as subdivision earthworks progress to the east of 4b.



5.1.5.2 *Crown land earthworks*

The below plan provides an indicative ESCP for the southern section of proposed Crown Land works. This includes in-water earthworks associated with the formation of two "coves", localised linear earthworks associated with improvements to the existing cycle track, and fringe earthworks associated with battering adjacent infilling within the applicant's property back to existing ground level.

The generalised ESC methodology for these works is as follows:

1. Coves (instream works):
    a. Install floating boom with silt curtain across full width of existing inlets prior to start of cove earthworks.
    b. Install DWB/CWB upslope of landward cove earthworks to divert upslope runoff from interior of property away from cove works, should rainfall occur during those works.
    c. Excavate landward side of coves first – remove existing boundary bunds. Insight Engineering note that excavation down to or below 195 masl may require dewatering via sump pump to a protected outlet or

infiltration basin within the property. Install landward cove edge protection via rock armouring.

d. Use long reach excavator on stabilised gravel platform to excavate the in-water portion of the cove from the shore, where possible.

e. Where required, use excavator on floating platform/barge to excavate cut on landward side of silt curtain.

f. Cut material to be transferred to truck for stockpiling/reuse in the interior of the site.

g. Silt curtain removed once all in-water works are complete, and suspended sediment has settled out of the water column.

2. Crown land earthworks (Lake Dunstan/Te Wairere margin):

   a. Install silt fencing with returns parallel to proposed earthworks on lake side of earthworks, below cycle track. Existing vegetated ground to remain as undisturbed as possible.

   b. Silt fencing removed once earthworks are completed and disturbed ground is topsoiled, seeded, and 80%+ vegetation cover is achieved.

As Lake Dunstan/Te Wairere is a highly sensitive environmental receptor, every effort must be taken to prevent sediment-laden runoff generated from the works from reaching the lake edge. To this end, additional ESC equipment and materials, such as spare silt fencing and waratahs, geofabric, coir logs and sediment socks will be stockpiled close to the works for emergency applications, should they be required.

There is also an option to use interlocking coir logs or silt socks instead of silt fencing as an acceptable means of protecting lake water quality from possible sediment-laden runoff from the adjacent earthworks. Provided these logs or socks aren't damaged during installation (i.e. they are installed interlocking and staked on the downslope side, rather than through the middle of each log), they can be installed in shorter sections and be shifted multiple times as earthworks progress along the lake margins. This would potentially save significant waste, as an alternative to well over 1 km of silt fence.

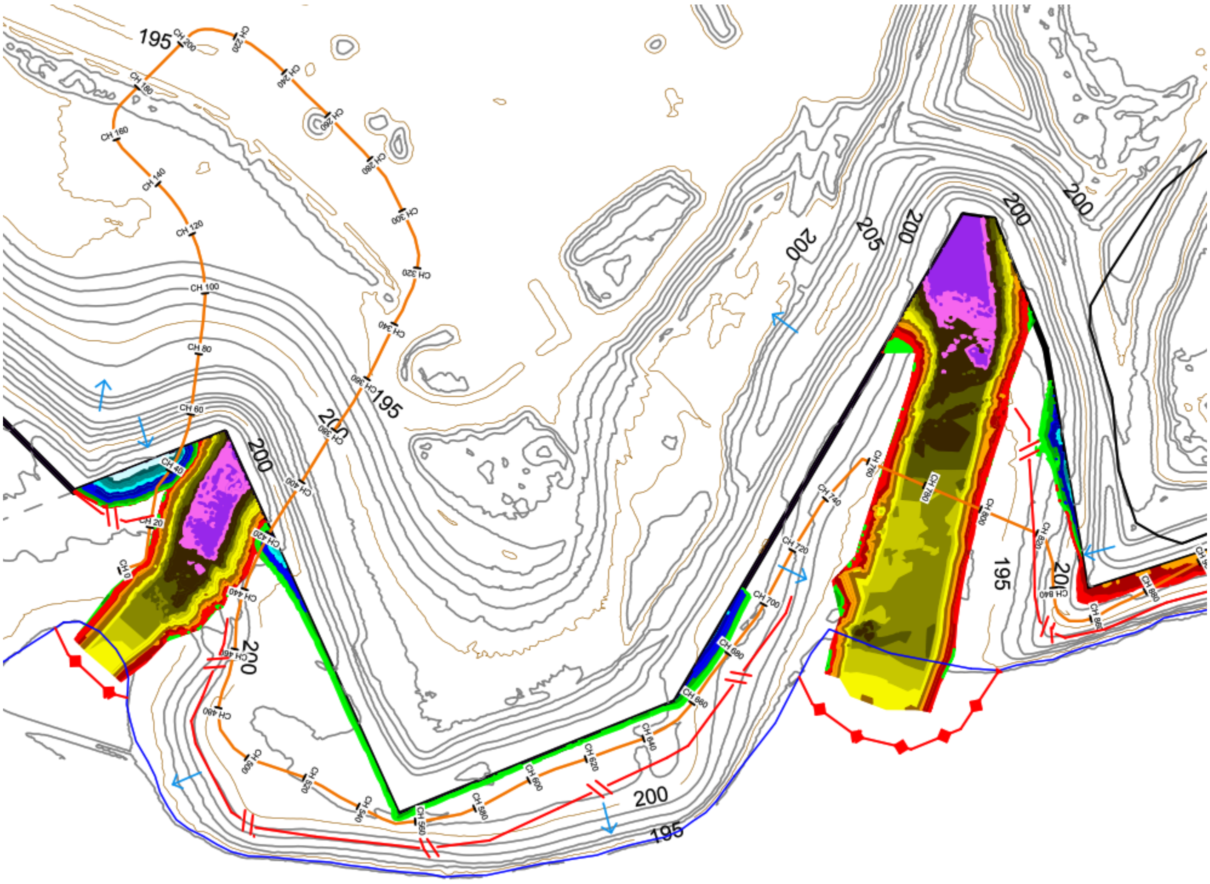


Figure 14: Close up of Crown Land works ESCP, focussing on the two coves

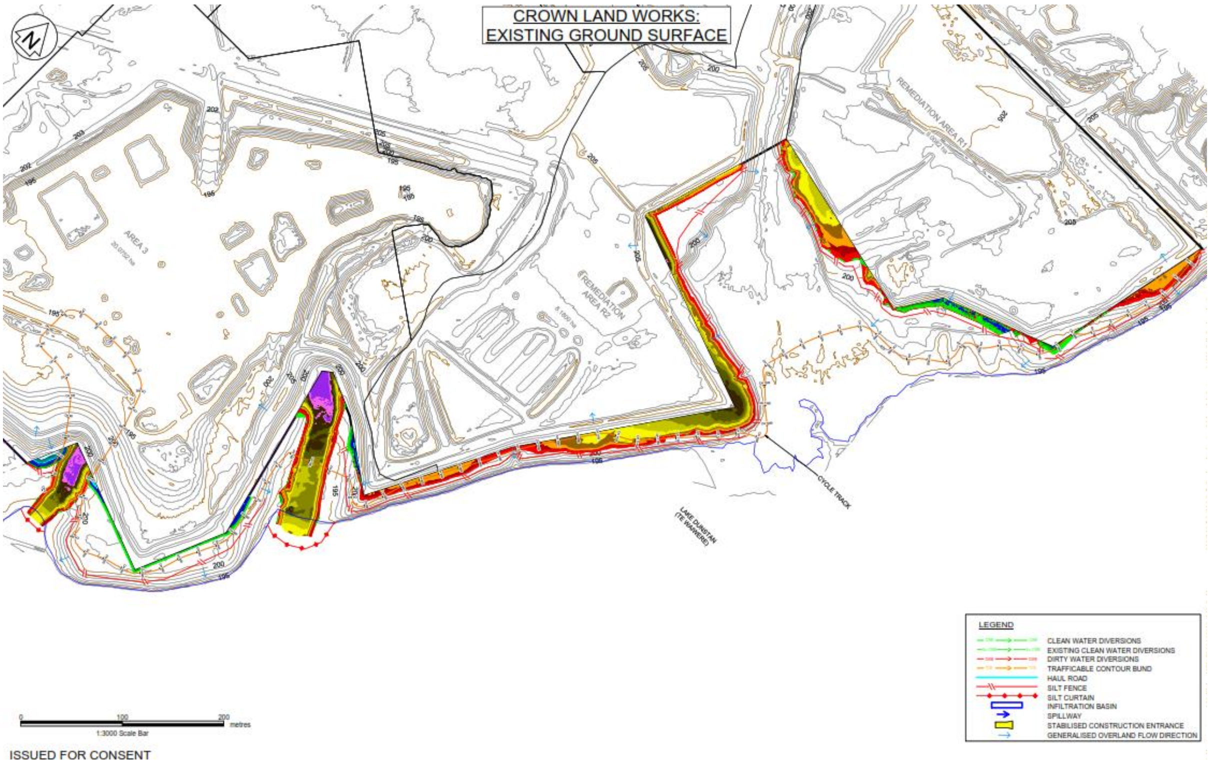


Figure 15: Crown Land works full ESCP

5.1.5.3 Park Burn floodplain works

It is understood that earthworks are required both within and adjacent to the active Park Burn channel to enable safe conveyance of flood flows in the creek to Lake Dunstan/Te Wairere. The below bulk earthworks excerpt shows proposed earthworks in the vicinity of the creek – constituting both cut and fill activities.

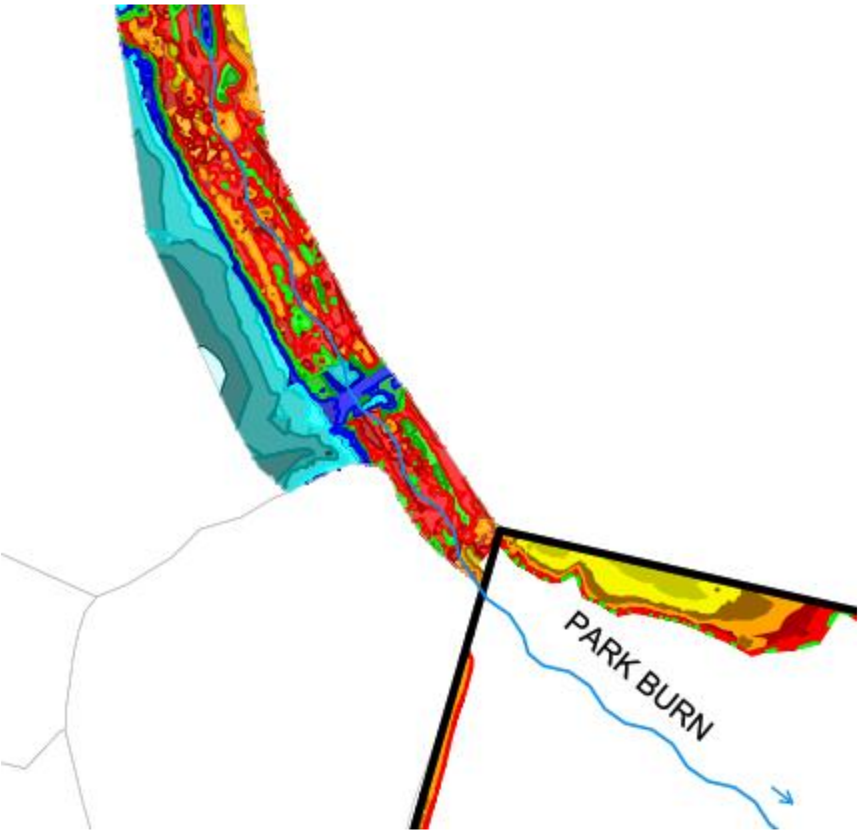


Figure 16: Park Burn bulk earthworks

The generalised ESC methodology for these works is as follows:

1. Where possible, undertake earthworks close to the Park Burn when there are no active flows present. This is a viable approach, as the Park Burn is an ephemeral creek that has a well-documented tendency to revert to subsurface flows outside of high rainfall and snowmelt events.
2. Works within the active Park Burn channel (wetted bed, when the creek is flowing) must not occur when there is flowing surface water present. A requirement to work in flowing water will necessitate a dedicated stream diversion plan, to ensure significant adverse effects to creek and lake water quality do not occur due to instream works.
3. Time Park Burn earthworks to avoid forecasted rain events, where possible.
4. Strictly enforce localised and limited earthworks in sections, with a requirement to stabilise disturbed areas prior to moving into another earthworks subsection. Stabilisation of the active channel may involve

placement of clean gravel and cobbles, with the specifics to determined via detailed design. Recommended rapid stabilisation of the floodplain and associated embankments would involve topsoil spread, hydroseed application (with an appropriate seed mix to be determined by a specialist), then placement and stapling of biodegradable erosion control blankets (such as coir or jute).

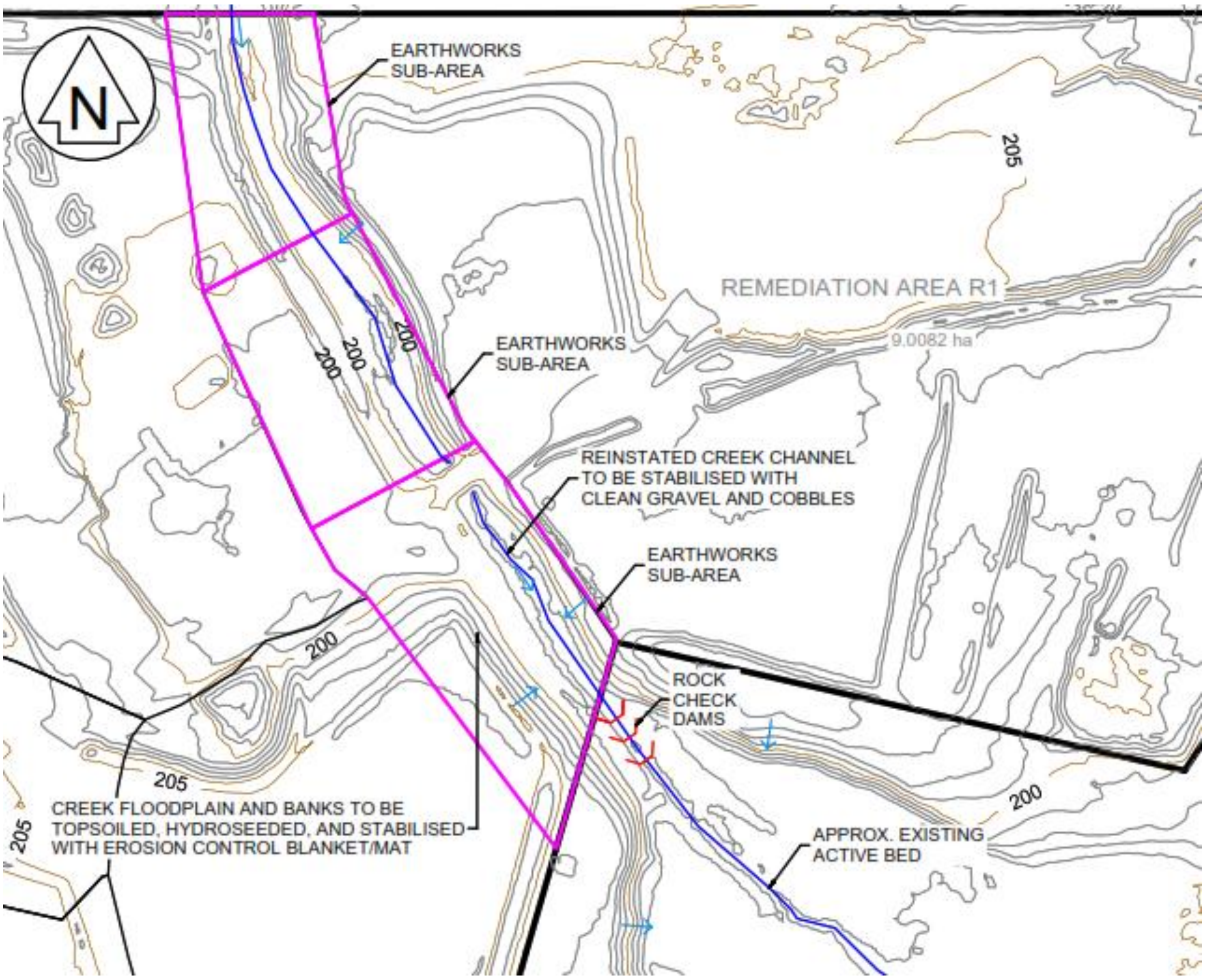


Figure 17: ESCP for works in and around the Park Burn

The above measures are the most critical in reducing erosion and sedimentation risk associated with works in and adjacent to the creek. Generally speaking, most sediment controls would not be appropriate for placement in the active creek bed itself, due to concentrated flow velocities. As such, rock check dams, placed in the dry channel downstream from the works as shown in the indicative plan above, would provide an appropriate final layer of water quality protection by being able to withstand concentrated flows in the creek (should they occur during earthworks), while detaining any sediment-laden flows and encouraging sediment to drop out of suspension. Any collected fine sediment behind the rock check dams can then be cleaned out when the creek bed dries again. The check dams should be removed following completion and full stabilisation of the creek works.

5.1.6 ESC design details

Full details of design guidance for ESCs are provided in Appendix E. The sections below provide a summary of these details, and are to be read in conjunction with those in the appendix.

5.1.6.1 Erosion controls

Hydroseed and hydromulch

Hydroseeding and hydromulching will be used to provide rapid vegetative stabilisation of exposed soils.

- Hydroseeding may be applied to completed earthworks surfaces, topsoiled areas and batters to promote vegetation establishment.
- Hydromulch may be used where enhanced erosion protection is required, particularly on steeper slopes, exposed batters and areas subject to high wind erosion.
- Seed mixes shall be selected to provide rapid germination and long-term stabilisation appropriate to the site conditions.

Hay mulch

Hay mulch may be applied to exposed soils as a temporary erosion control measure where immediate stabilisation is required.

- Mulch provides protection from raindrop impact, reduces wind erosion and assists moisture retention for vegetation establishment.
- Hay mulch may be applied in conjunction with hydroseeding, particularly where grass establishment is limited by cooler seasonal temperatures.
- Mulch shall be anchored where necessary to prevent displacement by wind.

Note that straw mulch is not an acceptable replacement for hay mulch, which has a much greater erosion control efficacy than the former.

Soil binders (polymers)

Environmentally-approved soil binders/polymers may be used for temporary stabilisation of exposed soils and stockpiles.

- Soil binders assist by forming a surface crust that reduces susceptibility to wind and water erosion.
- Polymers are the most common form of soil binders used for erosion control in Otago, and are intended as a short-term stabilisation measure and do not constitute permanent stabilisation.
- Soil binders shall not be used within areas of concentrated flow, active drainage channels or locations subject to frequent inundation. High-traffic

areas should also be avoided in relation to polymer application, unless a dedicated high-traffic polymer is used.

Aggregate Stabilisation

Aggregate may be used to stabilise trafficable surfaces, laydown areas and completed earthworks areas.

- Aggregate reduces soil erosion, sediment tracking and dust generation.
- Aggregate surfacing is particularly applicable to haul roads, access tracks, laydown areas and completed building platforms.
- Aggregate surfaces shall be maintained throughout construction to ensure effectiveness.

Clean Water Diversion Channels and Bunds

Clean water diversion channels (CWDCs) and bunds (CWBs) shall be installed where required to intercept and divert runoff originating from undisturbed catchments around active earthworks areas.

- Diversions shall be located upslope of disturbance areas wherever practicable.
- Diversions shall discharge to stable receiving areas.
- Diversion channels and bunds need to be stabilised (such as with grass, erosion control blankets, or geofabric) to prevent clean water being contaminated via scour in the channel or on the bund.
- The objective is to minimise the volume of runoff requiring treatment within sediment control devices.

Dirty Water Diversion Channels and Bunds

Dirty water diversion channels (DWDCs) and bunds (DWBs) shall be installed to collect runoff from disturbed areas and direct flows to sediment retention devices.

- Diversions shall be designed to prevent uncontrolled runoff from disturbed areas.
- Channels and bunds shall discharge to the inlet of the relevant infiltration basin or other approved sediment control device.
- Diversions shall be inspected regularly and maintained free of excessive sediment accumulation.

Trafficable Contour Bunds

Trafficable contour bunds shall be used to intercept and convey runoff while allowing construction vehicle access.

- Bunds function similarly to contour drains but are designed to withstand regular vehicle crossings. They are installed roughly parallel with the contour, meaning their longitudinal gradient is close to flat, and concentrated runoff velocities are very low.
- Bunds shall reduce flow velocities, break up catchment lengths and direct runoff to designated treatment devices via DWDCs.
- Bunds shall be maintained to prevent rutting, erosion or loss of capacity.

Stockpiles

Stockpiles of topsoil, subsoil and imported materials shall be managed to minimise erosion and sediment generation.

- Stockpiles shall be located away from drainage paths, watercourses and the Lake Dunstan/Te Wairere margin where practicable.
- Stockpile heights shall be minimised where practical.
- Long-term stockpiles shall be stabilised using seeding, hydroseeding, hydromulch, mulch or polymers.
- Perimeter controls on the downslope side of stockpiles shall be installed where necessary to intercept sediment-laden runoff. This is higher priority closer to the lake and creek, and lower priority within the quarried areas of the site.

5.1.6.2 Sediment controls

Infiltration Basins

Infiltration basins will be the primary sediment retention device used across the site.

The infiltration basins have been specifically designed for the site's highly permeable outwash gravels, and are intended to provide both sediment retention and runoff infiltration.

- Runoff from disturbed catchments shall be directed to infiltration basins via dirty water diversion channels and bunds.
- Each basin incorporates a sediment forebay to promote coarse sediment settlement prior to discharge into the main basin.
- The basins have been designed to store at least the volume of runoff generated for their given catchment up a 24 hour, 1 in 20 year storm event (5% AEP) in a worst-case scenario where no infiltration occurs.
- Emergency spillways shall be provided to safely manage flows during extreme rainfall events.

- Basins shall be inspected regularly and accumulated sediment removed when necessary to maintain storage and infiltration capacity.
- Detailed design calculations and construction specifications are provided in Appendix F.

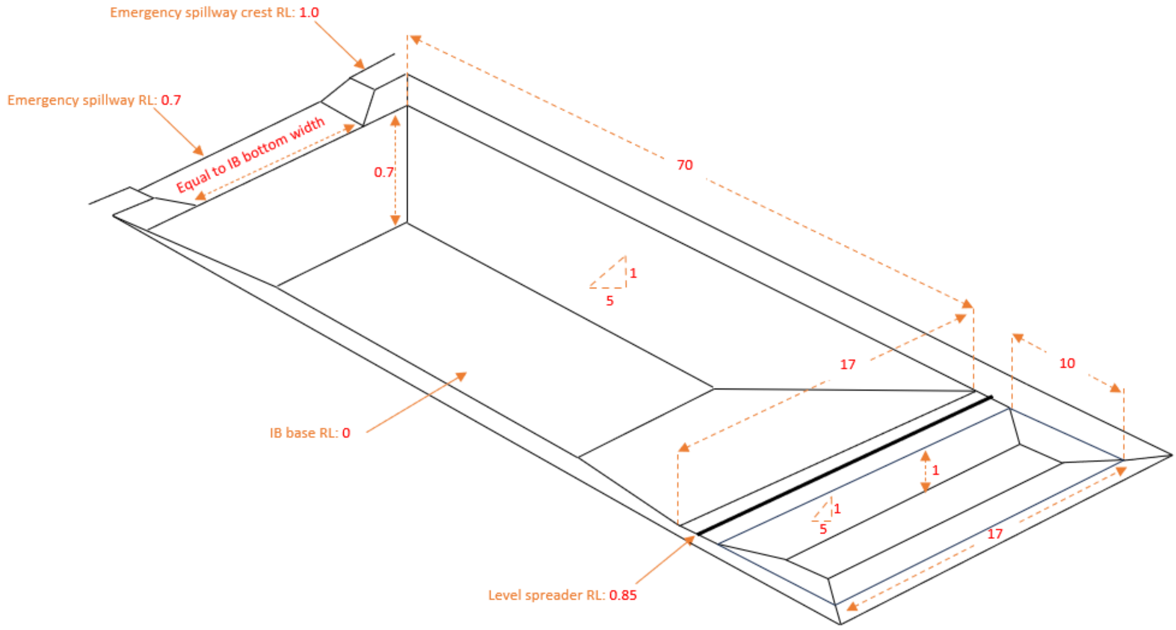


Figure 18: Indicative infiltration basin design

Silt Fencing

Silt fences will be used to intercept sheet flow runoff from small, disturbed areas.

- Silt fences are suitable for low-gradient areas where concentrated flow paths are not expected.
- Silt fences shall be installed along contour lines (to prevent concentrated "weak spots") and keyed into the ground to prevent underflow.
- Sediment is to be removed before accumulated material reaches one-third of the fence height.

Silt Socks and Coir Logs

Silt socks and coir logs shall be used to intercept sediment-laden runoff and provide temporary flow attenuation, and can be used as an alternative to silt fences.

- These controls are suitable for small drainage paths, stockpile protection, perimeter controls and disturbed areas adjacent to sensitive environments.
- Coir logs may also be used to provide temporary stabilisation of channel edges and batters.

Silt Curtains

Silt curtains shall be used where earthworks are undertaken within or immediately adjacent to the Lake Dunstan/Te Wairere margin – specifically, at the two proposed cove construction areas.

- Silt curtains provide a floating barrier that limits the migration of suspended sediment within the water column.
- Curtains shall be installed prior to commencement of works and remain in place until disturbed sediments have settled and water clarity has recovered.
- Installation shall account for anticipated lake level fluctuations, wind fetch and wave action.
- Curtains shall be inspected regularly and repaired immediately if damaged.

5.1.7 Chemical treatment

Based on the information available, it is not expected that chemical treatment of runoff in sediment retention devices will be necessary. This is on the basis of the apparent lack of fine sediment (clays and silts) and most of the works taking place well away from any sensitive receptors.

Certain areas, however, may require development of a chemical treatment management plan CTMP), to ensure any risk to surface water quality is appropriately mitigated. This may be the case for eastern earthworks areas, where infiltration basins may not be as effective at detaining and dissipating runoff, or where there is a heightened risk of uncontrolled runoff into the lake or creek. As works progress and the ESCP is updated to match progress, the need for a CTMP will be reassessed and, if necessary, submitted for council review ahead of works.

5.1.8 Adverse weather and contingencies

Significant weather events have the potential to overwhelm ESCs and greatly increase risk to sensitive environmental receptors. The following provides a summary of steps to be taken to mitigate this risk.

Forecast monitoring

The Environmental Representative (ER) will check the forecast daily, and ideally review multiple different forecast platforms (e.g. Metservice, Windy, MetVUW) to help to calibrate a reliable forecast. The project team is to review and document the forecast at weekly project meetings.

Significant and/or successive rain events

Any forecasted rain event that is expected to reach or exceed 20 mm over 12 hours will trigger the following actions at least 1 day prior to the forecasted event:

a. Where possible, all IBs, forebays, dropouts, check dams and channels/swales are to be checked to ensure they are in good working order. Maintenance, including accumulated sediment removal, to be undertaken immediately if not.

b. Install temporary stabilisation measures in high-risk areas – particularly those in close proximity to water bodies. Measures may include erosion control blankets, hay mulch, or polymers.

c. If works are taking place in or adjacent to the Park Burn or Lake Dunstan/Te Wairere, stop works well in advance and stabilise disturbed ground to the extent possible.

d. Where safe to do so, monitor ESCs and high-runoff risk locations actively during the rain event. Undertake immediate maintenance or corrective actions (such as pumping runoff from one area to another) where required.

Ice or snow

a. Inspect and maintain ESCs prior to forecasted snow events.

b. Inspect ESCs prior to, and during, ice or snow thaw. Devices that may have appeared operational while cover in snow/ice may fail as the thaw begins.

c. Be aware of and manage where meltwater is likely to flow. This may differ from overland flow paths during rain events.

ESC stockpile

An important aspect of preparedness for adverse weather events is having easy access to spare ESC equipment. These should ideally be available at all key earthworks activity areas, to reduce lag time. Recommended spare ESCs include (as a minimum):

- At least 1 roll of standard silt fence, and 1 roll of super silt fence, including waratahs, fasteners and wire.
- Spare polythene.
- At least 4 large rolls of geofabric.
- Bales of hay (for hay mulch application).
- 10 large coir logs or silt socks.
- Sandbags (for rapid and localised water diversions or small check dams).
- Clean rock riprap for emergency check dams and SCEs.
- At least 1 pump, long hose and generator.

5.1.9 Monitoring and maintenance

Weekly and post-rain EMP inspections shall take into account the state and suitability of erosion and sediment control measures, and schedule maintenance where appropriate. Additionally, all personnel on site have a duty to inform the Environmental Representative, Project Manager or Site Supervisor of any issues relating to the ESC measures, and these are to be rectified as soon as practicable.

Monthly inspections undertaken by the Environmental Consultant (SQEP) will examine the state and suitability of the ESC measures in more detail, with the ESCP subsequently amended or updated where any problems are identified.

Indicative maintenance to erosion and sediment controls is presented in the following table.

Table 6: ESC maintenance requirements

Control/device	Maintenance requirements
Silt fencing, diversion bunds/channels & swales, check dams, IBs, drop out pits	Remove sediment build-up from all ESC controls at or before 20% capacity is reached. Also remove any sediment prior to any forecast significant rainfall event[6]. Removed sediment must be placed on stable ground where it cannot re-enter the device or be washed into any runoff conveyance feature.
Silt fences and/or coir logs and silt socks	Check for damage, including rips, tears, bulges, broken support wires or loose waratahs. Unclog muddy/sediment-laden geotextile with a light broom or brush.
Diversion bunds	Inspect weekly and after every rainfall for scour and potential breach points. Repair immediately. Scour points may require geotextile lining, if not already lined.

5.1.10 ESCP implementation

The Consent Holder and/or Contractor will:

- Provide and implement As Built plans for the ESCP
- Monitor the continued effectiveness of the ESCP during the contract
- Update the ESCP where necessary

The plan will be updated when:

[6] An event likely to cause runoff

- The construction program moves from one earthworks area to another; or
- Any significant changes have been made to the construction methodology since the original plan was accepted for that area; or
- There has been an Environmental Incident and investigations have found that the management measures are inadequate; or
- As directed by council's compliance team.

Bulk earthworks may not commence until the following has been completed:

- The ESCP has been accepted by council, in conjunction with the overarching EMP; and
- The ESC devices have been installed correctly; and
- As Built plans have been provided to and accepted by council.

5.1.11 Decommissioning and removal

ESCs may only be decommissioned when permanent stormwater management measures for a given catchment are operational and/or site stabilisation (defined as at least 80% revegetation cover) has occurred.

Note that sealed surfaces (e.g. asphalt or concrete) or aggregate (in certain circumstances, with complete coverage and appropriate design) also constitute permanent stabilisation.

5.2 Water quality

Erosion and sediment control is directly linked to water quality management, whereby the discharge of runoff containing high sediment loads or other contaminants can significantly alter the receiving water chemistry and adversely impact physical freshwater ecosystems. This dictates a strategic, diligent approach to any earthworks activities that take place in, adjacent to, or in areas that ultimately discharge to surface water bodies.

5.2.1 Surface water

With regards to the project, the greatest risk to surface water quality relates to works on the Lake Dunstan/Te Wairere and Park Burn margins, and physically within both of those water bodies. There is also a lower risk contamination from earthworks within the property (and further from those water bodies), should those works be poorly managed.

5.2.2 Groundwater

As discussed earlier in this report, the water table largely mimics Lake Dunstan/Te Wairere water levels. In the southern part of the site, on the lowest quarry floor, groundwater is relatively shallow and may be encountered during excavations in this area. Furthermore, the shallow water table means there is a higher risk of groundwater contamination from fuel or chemical spills in particular.

5.2.3 Performance criteria

Water quality is to be monitored at any location where runoff flows from any disturbed area onsite beyond the boundary, or into a receiving water body (the Park Burn or Lake Dunstan/Te Wairere). During in-water works required for the coves in Lake Dunstan/Te Wairere, water quality monitoring will also be undertaken on the lakeward side of the silt curtains, to ensure in-water controls are working as required.

The below table presents proposed discharge water quality criteria, that are recommended in order to avoid significant adverse effects on receiving waters. It is likely that discharge quality criteria will be imposed by way of resource consent conditions from ORC, meaning this section will likely be subject to update following grant of the relevant discharge consent.

Table 7: Discharge water quality limits

Parameter	Discharge criteria
Total suspended solids (TSS) [7]	≤ 50 mg/L
Turbidity	≤ 150 NTU
pH	5.5 – 8.5
Hydrocarbons, tannins, paint	No visible trace
Waste	No visible trace

5.2.1 Stormwater reuse

The reuse of collected runoff for dust suppression, roadworks or landscaping is preferred over discharge. Where collected water is likely to be encountered, ESCs (such as infiltration basins or SRPs) will be designed to enable abstraction for reuse onsite.

[7] To provide an instantaneous onsite estimate of TSS, turbidity monitoring will be used as the proxy measure for TSS monitoring in the field; however if the correlated TSS-turbidity limit is reached, samples will be taken and sent to a lab for TSS analysis.

5.2.2 Water quality management measures

To ensure water discharges from site meet the criteria outlined above, water quality management measures are outlined in the following table.

Table 8: Management measures to protect water quality

Measure no.	Action(s) required
1	Refuelling of machinery only to occur within designated locations at least 30 m from onsite water features, including IBs, pipe inlets, and swales. See Section 5.8.2 for further details.
2	Concrete washout pits to be provided well away from onsite water features (including IBs, pipe inlets and swales). Washout pits should be regularly checked and maintained, and drivers made aware of their locations and appropriate procedures for their use. No uncontrolled concrete washout is to occur elsewhere on site.
3	Where possible, stockpiles are to be located at least 30 m from IBs and/or major drainage lines/pipes.
4	All machinery is to be inspected for oil, fuel or other fluid leaks prior to use onsite, then on a daily basis prior to start of works.
5	If deemed necessary, only flocculants appropriate for the treatment of native soils, and for the receiving environment, are to be used. Flocculants must be dosed, monitored and stored in accordance with best practice, GD05 (specifically, Section F2.0) and the subsequent chemical treatment management plan (CTMP).

5.2.3 Water Quality Monitoring Plan

The primary goal of the WQMP, provided below, is to ensure that any non-airborne discharges beyond the property boundary remain within the discharge limits outlined in Table 7, above.

Table 9: Water Quality Monitoring Plan

Sampling scope	
Objectives of sampling	To ensure all offsite stormwater discharges are within the discharge limits outlined in Table 7.

Spatial boundaries	While the property boundary would typically form the sampling catchment, in this instance there are works proposed both adjacent to and within two water bodies. Therefore, any discharge from disturbed areas associated with the works that is **likely to enter a surface water body** is to be sampled.	
Frequency	• Sampling when water is discharging beyond the site boundary OR to the Park Burn or Lake Dunstan/Te Wairere. • If a Significant Rain Event[8] has occurred overnight and water is discharging beyond the site boundary or to surface water, sampling is to occur the following morning. • Visual water quality monitoring of IBs or SRPs (if used) will be undertaken following Significant Rain Events and during Weekly Environmental Inspections.	
Sampling design		
Sampling suite	Sampling for TSS (via turbidity) and pH. Visually inspecting for hydrocarbons, tannins, paint and waste.	
Sampling locations	Primary sampling locations: 1. At the Park Burn active channel, where works are taking place in this area. 2. At the Lake Dunstan/Te Wairere shoreline. 3. Within Lake Dunstan/Te Wairere, on the immediate lakeward side of the silt curtain, during and following in-water works.	
Sampling methodology	**Parameter**	**Method of assessment**
	TSS	Use of a portable turbidimeter or turbidity probe sensor, with turbidity correlated to TSS via lab analysis. Provides an instant turbidity reading as an acceptable proxy for TSS,

[8] A rain event at an intensity of 20mm/12hrs.

		avoiding delays associated with TSS lab analysis.
	pH	pH meter
	Hydrocarbons	Visual inspection for oily films[9] on water surface, or small.
	Tannins, paint	Visual inspection for discolouration of waters leaving the site.
	Waste	Visual inspection for litter in erosion and sediment controls and water conveyance features, including IBs/SRPs, swales and pipes.
Quality control	All water quality meters or equipment used are to be maintained and calibrated in accordance with manufacturer's instructions. Visual inspections are to be recorded and actioned as appropriate.	
Records	The results of all sampling and visual water quality inspections are to be recorded on the **Water Quality Monitoring Log**, provided in Appendix C.	
Non-conformance	Any exceedance of the discharge criteria is to be immediately reported to the Site Supervisor/Environmental Representative or Project Manager, who is to coordinate immediate remedial action. Actions may include: 1. Cease or modify work in the area to discontinue any potential source of contamination. 2. Take action to ensure contaminants present in water leaving the site do not migrate to receiving water bodies. 3. Contact the SQEP, if appropriate (as SQEP may already be undertaking inspections/sampling). 4. Contact ORC Pollution Control on 0800 800 033.	

[9] Excluding films created by naturally-occurring bacteria, which tend to form geometric shapes that break apart. Hydrocarbons form as globules on the water surface.

	5. Investigate the Environmental Incident and develop remedial measures to ensure it does not occur again. 6. Report the incident to ORC within 48 hours of discovery, and prepare and submit an incident report as per Section 4.3 of this EMP. 7. Update the EMP to incorporate additional/revised environmental controls as appropriate. Any sample that has exceeded the discharge criteria is to be sent to lab within 24 hours to verify all of the measured discharge parameters.

5.3 Dust

Dust from earthworks and associated construction activities has the potential to generate the following adverse effects:

- Nuisance effects on neighbouring residents, members of the public and motorists on adjacent roads.
- Safety issues for motorists in particular, where dust plumes are significant and can obscure vision.
- Health issues for adjacent residents, members of the public and even personnel working on the job site generating the dust.
- Sedimentation on adjacent land and directly into nearby surface water bodies, contributing to water quality degradation.

Dust is primarily a function of wind-based (aeolian) erosion. Where vegetation and topsoil is removed, the underlying subsoils are more prone to wind erosion, which can lead to increased incidence of significant dust events. The contractor and the consent holder have an obligation to minimise dust generation onsite in the first instance, and secondarily ensure that dust does not migrate beyond the site boundary.

5.3.1 Performance requirements

The Consent Holder and Contractor shall at all times take reasonable and practicable management measures to avoid dust moving beyond the boundaries of the site.

5.3.2 Monitoring

Weekly inspections shall include observations of the site for visual evidence of dust travelling beyond the site boundary, and evidence of dust fallout from the works on adjacent vegetation. Daily (pre-start) inspections will take into account the forecast for the day, and schedule works accordingly.

5.3.3 Dust management

The following figure is a reproduction of Figure 9, with the addition of a wind rose taken from Windy.com showing the historic average predominant wind directions (northwest to west the predominant wind directions).

Figure 19: Potential sensitive receptors to dust that may be generated via site works (inset: wind rose for Cromwell, via Windy.com)

Northwest winds pose a risk of significant dust effects on residents in the northern section of Pisa Moorings, directly to the south of earthworks areas 1-3 in particular. Strong westerly and northwest winds also present a water quality risk to Lake Dunstan/Te Wairere from all areas of the site, and to the Park Burn from earthworks in the northern sector of the property. Cycle trail users to the east of the property are also at risk of dust nuisance.

The following table addresses key considerations and management approaches relating to dust onsite.

Table 10: Dust considerations and proposed onsite management

Requirement	Response/proposal
Works likely to cause adverse environmental effects including Environmental Nuisance effects in relation to dust and location of these works onsite	Key project activities with potential to cause environmental effects in relation to dust: • Site strip/vegetation removal • Earthworks • Stockpiling • Gravel/subsoil processing • Civils works
Prevailing wind direction and speeds generally expected for the site location	Based on NIWA climate data relating to Wanaka and Lauder (the closest stations to the site), the strongest winds are from northwest, with this statistic reflected in Windy for Cromwell. This means that residents in the northern part of Pisa Moorings (south of the site), users of the cycle trail to the east, and the lake and Park Burn themselves are at significant risk from strong northwesterlies. Summer and spring have the highest frequency of strong winds. For Wanaka, summer and spring have the greatest incidence of strong winds, whereas most strong wind in Lauder is experienced in spring.
Evaluation outcome of which air quality sensitive receivers will likely experience Environmental Nuisance effects or adverse environmental effects in relation to dust	Without mitigation, residents to the south of the site are most likely to be impacted by dust generated from the works – particularly during bulk earthworks in Areas 1 to 3, but also in Area 4 as this is elevated. While a lower risk, there remains potential for dust effects on the adjacent state highway, in the event of a strong easterly wind.
Management measures and strategies for mitigating Environmental Nuisance and adverse environmental effects associated with dust	Dust nuisance and environmental effects will be kept to a minimum onsite via the following: • Dust suppression via water carts. Approximately 5 mm/day across all exposed areas of the site when the ground is not already damp, including stockpiles as

Requirement	Response/proposal
	necessary. Water is to be sourced from an onsite bore, which the applicant is seeking approval for. The ground is to be kept moist (but not wet) at all times. Where access is limited, sprinkler systems can be utilised for dust suppression. • Establish sprinkler systems in concentrated high-risk areas, such as where regular load-outs to stockpiles are occurring. As winds increase, the sprinklers can be activated to continuously suppress dust as load-outs continue. • High-risk dust generating areas within the site are to be sprayed via water cart utilising GRT Haul-Loc (dust suppressant). GRT Haul-Loc is advertised as being environmentally safe and biodegradable. • Compact fill within the disposal area on a regular basis. • Use soil binders/polymers where required. • High-risk dust generating areas within the site can be sprayed via water cart utilising GRT Haul-Loc (dust suppressant). GRT Haul-Loc is advertised as being environmentally safe and biodegradable, and can be used in trafficable areas (such as haul roads or laydown areas) or to provide a longer-term stabilisation alternative to standard polymers. • Seed or mulch exposed areas that are sitting idle for extended periods of time. • Topsoil and hydroseed formed allotments and reserves as soon as practicable. Seeded areas to be irrigated for optimum grass strike and growth.

Requirement	Response/proposal
	• Once formed, internal roads and berms to be trimmed to subgrade and direct drilled to encourage grass stabilisation, until such time as permanent sealing can occur as part of the civils works. • No small stockpiles to be allowed onsite – excavated material is to be carted to designated larger stockpiles. • Designated stockpiles are to be kept as low as possible, smoothed and tamped down, and dampened via water cart or hose. Where stockpiles are no longer to be added to, they will be sprayed with polymer. • Stop/adjust works during times of high winds, particularly during the earthworks phase. Forecasting should be used to avoid undertaking disturbance activities near sensitive receptors during windy periods. • Limit onsite speed limit to 20 km/hr.

5.3.4 Dust contingency measures

The below table outlines measures that are to be followed in the event of significant dust-related issues.

Table 11: Contingency measures for dust-related issues

Issue	Contingency measures to be followed
Dust migration beyond the site boundary due to earthworks	• Cease dust-generating activities, particularly excavation. • Increase water cart dust suppression. Activate any sprinkler systems set up in the area.

Dust migration beyond the site boundary due to stockpiling	• Cease any further additions to the stockpile, until wind speeds have reduced. • Use water cart hoses to dampen stockpiles, or position sprinklers to continuous spray stockpiles with water. • Apply polymer to stockpiles that will be left for more than a month. • Location stockpiles away from site boundaries, and away from ridgelines or exposed areas. Given the strongest winds are likely to be from the west or northwest, locate stockpiles where they are screened from this direction.
Dust migration beyond the site boundary due to haulage	• Increase water cart activity to regularly spray roads. • Further reduce vehicle speeds. • Consider applying a trafficable polymer like Haul-Loc, or apply a thin layer of clean aggregate.

5.4 Cultural heritage

The Consent Holder or appointed sub-Contractor shall be responsible for the management and protection of Cultural Heritage within and adjacent to the site to avoid adverse environmental effects to Cultural Heritage. While there are no known locations of Cultural Heritage significance within or adjacent to the site, it is noted that Lake Dunstan/Te Wairere holds cultural and spiritual significance to Kāi Tahu, and is formally recognised by the Crown through a Statutory Acknowledgement under section 61 of the Ngāi Tahu Claims Settlement Act 1998.

While a large portion of the site has already been heavily modified and excavated as part of the ongoing quarry operations, should information become available that indicates there are areas or items of cultural significance within the site, then this section will be updated accordingly.

5.4.1 Accidental discovery

In the event of an accidental cultural heritage discovery, the Consent Holder or Contractor shall adhere to the Accidental Discovery Protocol found in Appendix 4 of the QLDC EMP Guidelines. This is also provided in Appendix G of this document for convenience.

5.5 Noise and vibration

The Consent Holder or Contractor is responsible for the management of construction noise and vibration.

5.5.1 Performance requirements

5.5.1.1 Noise

Under the Central Otago District Plan (CODP), construction noise is exempt from standard residential zone limits if it complies with *NZS 6803:1999 (Acoustics – Construction Noise)*. This standard allows for significantly higher noise levels during typical working hours, categorised by the type of equipment used and the duration of the project.

The following table provides a summary of noise limits relating to long term (>20 weeks) construction activities. If these cannot be adhered to, resource consent will need to be sought from CODC for exceeding the limits. All decibel levels (L_{eq} and L_{max}) are measured at a distance of 1 metre from the facade of any neighbouring occupied building or at the designated notional boundary of adjacent rural/residential properties.

Days/ timeframe	Permitted hours	L_{eq} limit (average)	L_{max} limit (peak)	Activity suitability/ earthworks focus
Weekdays & Saturdays *(Morning Prep)*	6:30 am – 7:30 am	55 dBA	75 dBA	Unpacking light gear, site arrivals, engine idling. No heavy earthmovers.
Weekdays & Saturdays *(Core Work Window)*	7:30 am – 6:00 pm	70 dBA	85 dBA	Main earthworks window: Diggers, heavy dump trucks, rollers, and loaders.
Weekdays & Saturdays *(Evening Wind-Down)*	6:00 pm – 8:00 pm	65 dBA	80 dBA	Restricting heavy compactors. Interior site tasks or final equipment parking.
Night-time *(All Days)*	8:00 pm – 6:30 am	45 dBA	75 dBA	No active earthworks. Only minor, silent maintenance or security watch.
Sundays & Public Holidays	All Hours	45 dBA	75 dBA	Heavy machinery banned. Site must revert to baseline quiet residential limits.

5.5.1.2 Vibration

The following publications typically guide vibration monitoring associated with large projects in New Zealand:

- DIN 4150-3:1999 (to prevent cosmetic structural damage); and
- BS 5228-2:2009 (to manage human comfort/amenity).

Vibration is quantified using Peak Particle Velocity (PPV), measured in millimetres per second (mm/s).

The following table summarises vibration limits set under these standards.

Criteria target	Timeframe	PPV limit at receptor	Target application and risks
Structural / Building Damage *(DIN 4150-3)*	All Hours	5.0 mm/s	Standard residential dwellings (prevents plaster cracking, brick/facade cosmetic damage).
Human Amenity / Comfort *(BS 5228-2)*	Daytime (7:00 am – 6:00 pm)	1.0 mm/s	Vibration is clearly perceptible to neighbours, but tolerated for necessary daytime earthworks.
Human Amenity / Comfort *(Night-time / Rest Periods)*	Night-time & Sundays (6:00 pm – 7:00 am)	0.3 mm/s	Just at the cusp of human perception. High-vibration heavy plant is functionally unviable.

The above limits for noise and vibration are to be adhered to for the full duration of the development.

In addition, the Consent Holder will ensure that earthworks are constrained to any hours of operation specified in any consents or approvals granted by CODC. Adhering to these hours of operation will help to minimise noise and vibration effects on nearby receptors.

5.5.2 Noise and vibration management

The following table summarises measures that should be implemented onsite to ensure noise and vibration effects on neighbouring properties are minimised to the extent practicable. Note that the most at-risk receptors are those in the northern part of Pisa Moorings, directly to the south of the property.

Table 12: Management measures for noise and vibration

Measure	Details

Require broadband reversing alarms on all applicable vehicles	Replace standard, high-pitch "beep-beep" alarms on all trucks and diggers with white-noise "squawker" alarms. These direct sound only behind the vehicle and dissipate rapidly with distance.
Use modern plant	The contractor and any sub-contractors are only to use heavy earthworks machinery that is modern, with well-maintained mufflers and acoustic engine enclosures. Regularly service all machinery.
Maintain smooth haul roads	Regularly grade and water the internal site haul roads. Eliminating potholes and ruts stops large empty dump trucks from rattling, bouncing, and creating sudden transient vibration spikes.
Switch to static compaction near residential boundaries	Near residential boundaries (within 50–60 metres), switch vibration rollers to "static mode" or use smaller pneumatic rollers to meet the 1.0 mm/s PPV human amenity limit. Alternatively, track rolling (which produces lower vibration than standard rollers) may be an acceptable alternative near boundaries.
Enforce restricted high-impact work windows	Schedule the loudest and most vibration-heavy activities between 9:00 am and 4:00 pm only, avoiding the highly sensitive early morning and evening periods.

5.5.2.1 Monitoring

Weekly inspections by the Environmental Representative and monthly inspections by the Environmental Consultant will include a subjective assessment of whether the site is adhering to the noise and vibration limits outlined above.

In the event that a noise or vibration-related complaint is received, site management in association with the Environmental Consultant may need to engage an acoustic consultant or engineer. As part of this process, the above management measures will be reviewed, amended and/or supplemented depending on the outcome of the review.

Note that a noise or vibration complaint constitutes an environmental incident, and must be addressed as specified in Section 4.3 of this EMP.

5.6 Contaminated sites

A full summary of potential contaminants that may be encountered within the site is provided in Table 2 of this EMP. As a brief recap, contaminants are concentrated in the northeast section of the site, while small isolated areas of potential impact were also identified in the active quarry area to the south, associated with bitumen and fuel storage, and a generator (see below figure).

Insight Engineering have subsequently prepared a Remediation Action Plan (RAP) that details methods for reducing the risk to human health associated with these contaminated areas of the site, and presents procedures that must be followed to undertake remedial work associated with the contaminants.

If unexpected contamination outside of the areas identified in the RAP is discovered by sight or odour during earthworks, the Contractor will:

- Immediately cease all earthworks in the area of contamination, including a conservative buffer zone;
- Notify ORC within 24 hours of the discovery;
- Engage a contaminated land specialist (CL-SQEP) to perform an assessment of the discovery;
- Appropriately remediate the subject area and dispose of the contaminated soils under the direction of the CL-SQEP.

Works in the affected area cannot recommence until the site has been remediated to the CL-SQEP's acceptance and any consents or approvals have been obtained.

Figure 20: On-site HAIL areas (source: e3 Scientific, via Insight Engineering)

5.7 Vegetation management

Viridis Environmental Consultants have undertaken an Ecological Impact Assessment for the proposed development, with existing vegetation both within and adjacent to the site summarised below.

5.7.1 Exotic vegetation

Vegetation within the site was mostly limited to exotic vegetation planted as shelterbelts or large individual or groups of trees. Species present included poplar, macrocarpa, gum and occasional willows. Crack willow was abundant along the Lake Dunstan/Te Wairere margins and the Park Burn (Figure 21), and pines were also present on elevated land above the Park Burn. The remainder of the site that was not currently part of the active quarry or associated yards, was vegetated with mixed exotic pasture species and pasture associated weeds (Figure 22).

Species observed in these latter areas included sheep's sorrel, viper's bugloss, goosefoot, California poppy, mallow, yarrow, rabbitfoot clover and plantain. Much of these unworked areas may yet be quarried prior to the development earthworks beginning in these locations, meaning the majority of this vegetation may be removed by the time works start.

Where land has been quarried, vegetation was either absent, or exotic grass species had re-established.

Figure 21: Willows and scrub on the margins of Lake Dunstan/Te Wairere, from eastern site boundary

Figure 22: Facing west from central portion of proposed Earthworks Area 4

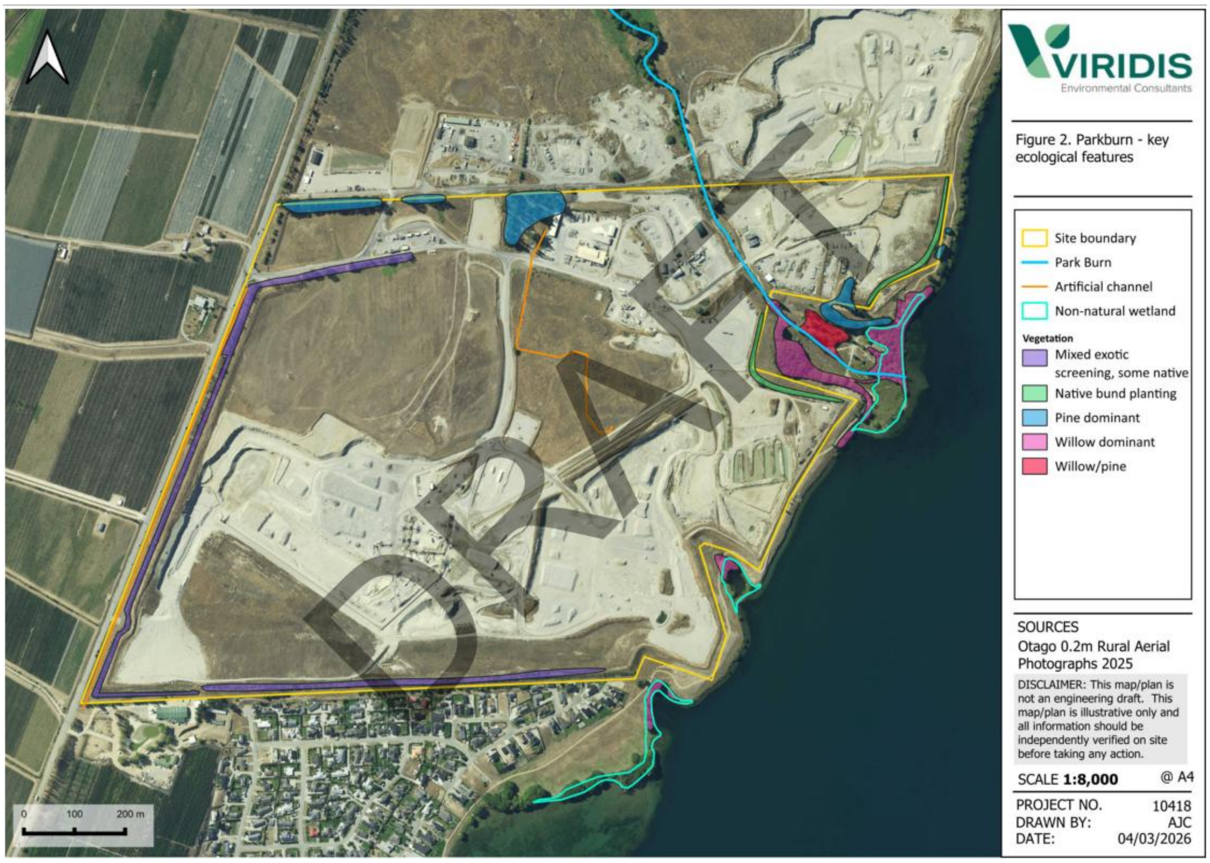


Figure 23: Draft plan showing key vegetation features within and adjacent to the site (source: Viridis EcIA)

5.7.2 Indigenous vegetation

There are small areas of planted native vegetation around the perimeter of the site, mostly in association with the perimeter bunds. Species present along the eastern boundary included common native species such as mingimingi (Coprosma propinqua), toetoe (Austroderia sp.), hebe (Hebe sp.), koromiko (Veronica salicifolia), cabbage tree (Cordyline australis), and Olearia sp. Species present along the western boundary included mingimingi, Coprosma rugosa, marsh ribbonwood (Plagianthus divaricatus), kohuhu (Pittosporum tenuifolium), koromiko, and hebe.

Overall, native vegetation was determined by the assessment to have little ecological or habitat value.

5.7.3 Vegetation management measures

The Consent Holder (or nominated Contractor) will at all times take reasonable and practicable management measures to avoid disturbance to vegetation or ground surfaces outside the limits of clearing.

The Contractor will install identification markers along the limits of clearing prior to commencing vegetation clearing and ground disturbance. Identification markers will be maintained for the duration of the works or at least until works are complete in the adjacent area.

Where works encroach on individual trees or vegetation to be protected/retained, ground disturbance or other works, including stockpiling, will not encroach within the dripline of the tree unless advised otherwise by an arborist in association with any relevant resource consent conditions.

General management measures to minimise unnecessary clearance of unprotected vegetation on the property include:

- Ensuring the proposed disturbance area (extent of earthworks) is clearly marked out with stakes, to ensure no more vegetation is cleared than needs to be.
- Taking a cautious approach to clearance, whereby only those areas that are certain to be disturbed by the works are cleared.
- Ensuring the recommendations and mitigations provided in the Ecological Impact Assessment are known and adhered to.
- Adhering to any conditions of consent concerning ecology or vegetation clearance.
- The Environmental Representative is to be onsite during clearance to ensure the clearance boundary is not trespassed.

The Contractor should ensure that care is taken to avoid disturbing any nesting birds during vegetation clearance. Should nesting birds be encountered, a suitably qualified ecologist or ornithologist should be retained to assess the situation and establish an exclusion zone so that construction activities may continue.

5.8 Chemicals and fuel management

The Consent Holder or appointed Contractor is responsible for the management of all chemicals and fuels within the site so as not to cause adverse environmental effects (including environmental nuisance off-site).

5.8.1 Performance requirements

Spill response equipment is to be available at all times around the site for use in an emergency. Spill response equipment shall be commensurate with the site location, topographical features, type and quantity of chemicals and fuels being stored on site.

The Contractor shall promptly remediate any contamination resulting from spills, leaks and discharges to a condition similar to that existing before the contamination.

Refuelling of machinery shall conform to the following requirements:

- Occur at least 30 m from a waterway or runoff management feature (including CWDs, DWDs and infiltration basins)
- Fuelling activity to be supervised at all times
- Hoses to be fitted with a stop valve at the nozzle end.

Machinery shall be maintained to minimise the leakage of oil, fuel, hydraulic and other fluids.

5.8.2 Chemical and fuel management during construction

Prior to works starting onsite, the Contractor is to provide the following to the Environmental Consultant:

- A list of fuels and chemicals to be used on site, where those volumes are likely to exceed 2,000 l.
- The expected maximum volume and proposed storage location for the above fuels and chemicals.
- The number, size and location of all spill kits to be provided onsite.
- Fuel and chemical containment measures to be employed.

The Environmental Consultant will use the above supplied information to update this section of the EMP, to ensure it is accurate and fit for purpose.

General management measures for avoiding contamination or discharge to land or water include:

- Refuelling is to take place in designated refuelling areas only, ideally at least 30 metres from any IB, drain or swale. **Absolutely no refuelling is to take place within 30 metres of a watercourse or water body** – specifically, the Park Burn or Lake Dunstan/Te Wairere.
- Drip trays or absorbent mats are to be used while refuelling to catch any spilled fuel.
- Chemical and fuel storage areas are to have bunds that are sized based on 110% of the largest container stored inside the bunded area.
- Chemical and fuel storage areas are to be located as far from drainage features (including swales and drains) as possible, to avoid contamination of water and movement of chemicals away from site.
- Store the least amount of fuel on site as possible. Fuel and chemicals are only to be stored within designated, bunded chemical and fuel storage areas.
- Only designated pits are to be used for concrete washout. Drivers to be made aware of these designated washout locations and appropriate procedures for their use.
- All onsite staff are to be trained in spill response and are to be familiar with the spill contingency plan below. Work in the area must immediately cease in the event of a chemical or fuel spill, and the contingency plan in the following section followed.
- Spill kits are to be clearly identified and readily available onsite.
- If a significant rainfall event is forecast, undertake pre-event inspections of chemical and fuel storage areas and immediately rectify any issues found.

A plan showing indicative designated locations for refuelling, fuel and chemical storage, site office(s), laydown areas and waste disposal areas will be provided in the finalised EMP.

5.8.3 Anticipated chemical storage

The below table provides a list of chemicals and fuels, and associated maximum volumes, that are expected to be used and stored onsite. This list will be updated following receipt of further information from the Contractor, as specified above.

Table 13: Onsite chemicals and fuels

Fuel or chemical	Use	Storage area	Volume
Diesel	Construction equipment	Fuel bowser or trailer close to site entrance	≤2,000 l
Oil	Construction equipment	TBD	≤20 l
Grease / lubricant	Construction equipment	Grease gun in all large machinery	≤5 l
Paint	Spot marking	TBD. Likely in diggers and light vehicles.	≤2 l

5.8.4 Spill contingency plan

If a spill or emergency situation occurs with regards to chemicals or fuels onsite, the following protocol should be followed:

1. **Safety first:** Ensure you know what has been spilt, how much, and whether you can rectify the situation without endangering your life or the lives of others. Use personal protective equipment (PPE) as required.
2. **Stop the source (if safe to do so):** Turn off, plug the leak or right the container.
3. **Protect stormwater:** Confine the spill with booms (these should be stocked in spill kits), sandbags or other suitable material. Block off any drains, races or swales to prevent migration of the spill offsite.
4. **Notify:** Inform the site supervisor and/or the Environmental Representative and/or the Project Manager. ORC's Pollution Hotline can be contacted via 0800 800 033.
5. **Clean up:** Neutralise hazardous substances, pump or sweep into safe container. Clean up residuals without allowing wash or sweepings into stormwater. Ask for advice if required.
6. **Dispose responsibly:** Use an appropriate disposal contractor to remove the contaminated material.
7. **Restock and review:** Restock spill kit(s) and review incident to prevent recurrence.

This EMP is to be reviewed following any spill to determine whether it is fit for purpose. Amendments are to be made to the EMP where any issues or inconsistencies are identified, in order to prevent incident recurrence in future.

5.9 Waste management

The Contractor is responsible for the management of all wastes within the site to ensure no environmental or nuisance effects occur. Uncontrolled construction waste/rubbish can pollute the environment, adversely impact flora and fauna, and signal to members of the public that the site is not well-managed.

5.9.1 Waste management during construction

The Contractor shall ensure that all wastes have been removed from site. No waste shall be burnt on site.

The Contractor shall provide bins at common areas at all times. Bins shall be fitted with lids and serviced prior to being filled to capacity. During construction, the Consent Holder shall maintain the site free of litter and ensure that no litter leaves the boundary of the site.

Particular care is to be taken around Lake Dunstan/Te Wairere, with any rubbish generated to be secured such that wind cannot blow it out into the lake.

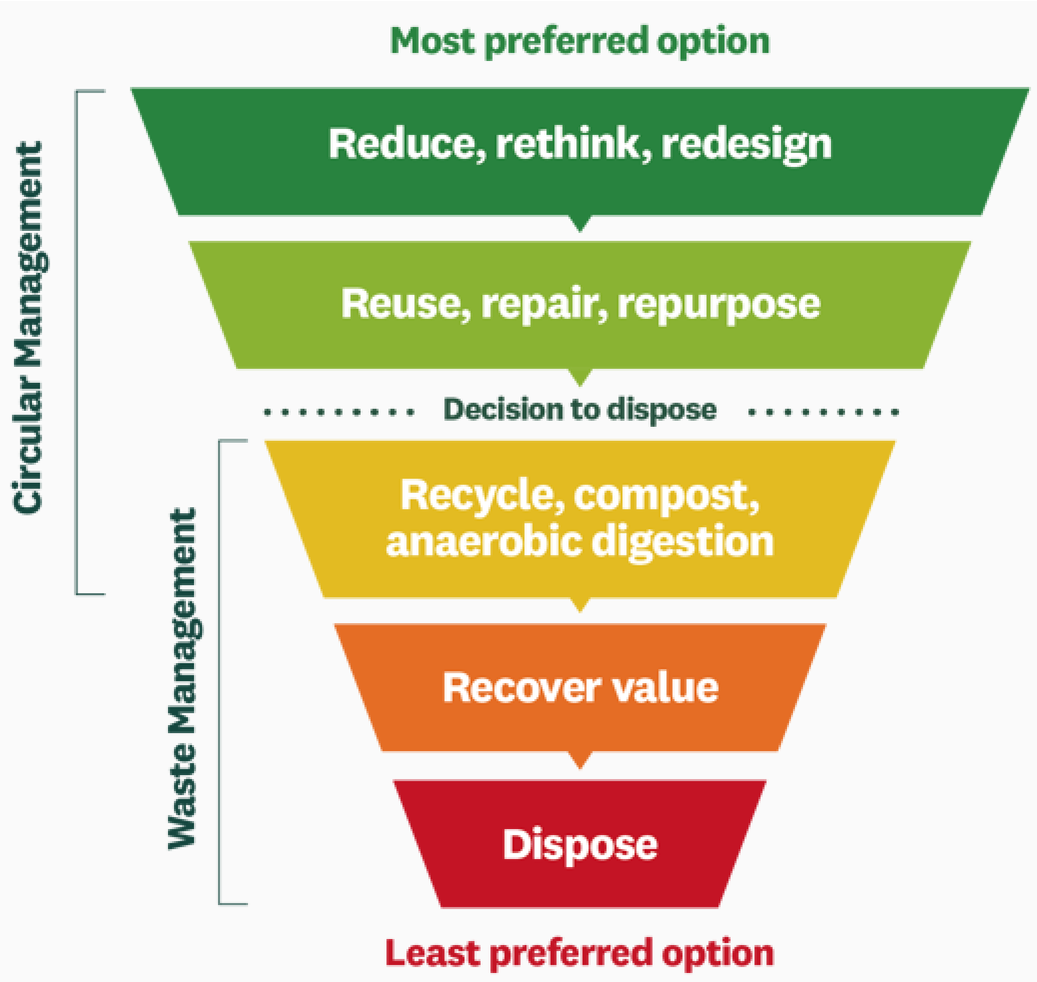
Vegetation waste from clearing and stripping that is free of noxious plants may be used in conjunction with soil erosion and sediment control measures such as brush matting or mulching.

Mulch stockpiles shall be separated from drainage lines and waterways. Mulch stockpiles shall be no higher than 2.5 m. When ambient temperatures exceed 30 degrees Celsius mulch stockpiles should be no higher than 1.5 m and monitored regularly for excess leachate and heat.

Stockpile locations are TBD by the Consent Holder in conjunction with the Environmental Representative and/or SQEP.

5.9.2 Waste minimisation

Both the Consent Holder and Contractor are to prioritise waste minimisation at all times. This includes designing project components to minimise waste generation at the outset (for example, implementing ESC perimeter controls that utilise coir logs or compostable silt socks instead of silt fencing where possible, or constraining earthworks that require silt fencing in the first place), reducing use of consumptive materials, reusing materials, or recycling, prior to resorting to disposing via landfill. This is summarised in the waste management hierarchy, as presented below:



As a minimum, separate waste streams will be maintained, with clearly-marked bins for general waste, recycling, and hazardous waste.

5.9.3 Monitoring

All staff will be briefed on waste management requirements as part of the site environmental induction. Daily pre-start inspections will look for, identify and address any visible unmanaged waste onsite. Weekly and monthly environmental inspections will also include a visual assessment of site waste management, and implemented remedial actions where required.

Appendix A: Project plans

Appendix B: Environmental site induction and emergency contacts

Emergency contact list

The below table provides a non-exhaustive list of contacts that may be appropriate to inform/involve in the event of an environmental incident or emergency. The Environmental Representative should always be contacted and consulted prior to contacting any outside parties regarding an incident.

Print this table and pin it to your site office and smoko room walls for quick reference!

Incident/emergency	Contact	Phone number
Pollution or spill	ORC pollution hotline	0800 800 033
	ORC compliance officer	TBD
	CODC compliance officer	TBD
Fire	Fire and Emergency New Zealand	111
Human remains discovery	New Zealand Police	111
Public utilities issue	CODC	03 440 0056
Contaminated land discovery	Environmental Representative	TBD
Accidental heritage discovery		
Environmental complaint		

Environmental roles and responsibilities

Key personnel relating to onsite environmental management are as follows:

- Project manager: Tim James (027 484 4004)
- Site supervisor:
- Environmental Representative:
- Environmental Consultant: Will Nicolson (027 459 8090)

It is important to remember that all personnel working on site have a responsibility to ensure the provisions of the Environmental Management Plan (EMP) are enforced. This includes preventing sediment-laden water from leaving site, keeping erosion and sediment controls in good working order, minimising dust, keeping the site clean and tidy, and being familiar with the spill contingency plan outlined in Section 5.8.4 of the EMP.

A copy of the EMP will be available onsite at all times.

Significant environmental locations

Environmentally sensitive areas

The two key environmentally sensitive features are Lake Dunstan/Te Wairere, immediately east of the site, and the Park Burn – a small creek that runs through the northeast part of the site, and drains into the lake. Any earthworks near these water bodies must be undertaken with extreme care, and in exact accordance with the erosion and sediment control plan (ESCP) – see Appendix D of the EMP.

Environmentally sensitive receptors

Neighbouring residents to the south of the project site are at risk of adverse effects from dust, noise and vibration in particular. Also be conscious of motorists using the adjacent state highway, and of users of the cycle trail that is located between the eastern boundary of the property and the lake.

Relevant resource consents

To be updated following grant of consents sought.

Earthworks staging and vegetation clearance

Earthworks staging plans are provided in Appendix A of this EMP, and staging area outlines are shown on the ESCP. This sequencing must be adhered to, in order to avoid increased environmental risk from the works. In order to reduce the potential for stormwater contamination, ground disturbance should always be kept to a minimum.

Changes to the approved earthworks sequencing is to be approved by the Environmental Representative/Site Supervisor (in collaboration with ORC).

While much of the site has already been cleared of vegetation, ground cover vegetation should be maintained as far as practicable – this protects the soil and helps to minimise generation of dirty runoff and dust.

Key EMP measures to be aware of

The following is a brief summary of measures presented in the EMP that all site personnel, including subcontractors, should be aware of:

Environmental issue	Mitigation measures
Erosion, runoff and sedimentation (EMP Section 5.1)	• Ensure the erosion and sediment control plan is implemented at all times. • Report issues with ESC measures (e.g. silt fences, basins, etc) to the Site Supervisor or Environmental Representative immediately. • Avoid working immediately adjacent to drainage

Environmental issue	Mitigation measures
	ditches, swales, inlet pipes and basins. • Report any uncontrolled movement of sediment-laden water away from site to the Site Supervisor immediately. • Keep clean water and dirty water separate, to reduce pressure on water treatment controls. • Stabilise and/or revegetate disturbed ground ASAP. • Make sure stockpiles are covered or dampened to prevent dust issues. • Check ESCs both before and after storm events to ensure they're in good working order.
Dust (EMP Section 5.3)	• Ensure exposed soil is dampened regularly via the water carts or sprinklers. • Keep offsite roads clean and free of silt or dirt. • Ensure stockpiles are securely covered, stabilised or dampened, especially prior to/during high winds • Report any dust issues to the Site Supervisor immediately. • If dust suppression during high winds is difficult, works must cease.
Cultural heritage (EMP Section 5.4)	• In the case of an accidental discovery, stop works in the vicinity and report to the Site Supervisor.
Noise (EMP Section 5.5)	• Noise-producing activities (including larger machinery operation) only to occur between 8am and 6pm Monday to Saturday. No work to occur on Sundays and public holidays. • Particularly noisy work should be undertaken towards the middle of the day, during normal business hours.
Fuel and chemicals (EMP Section 5.8)	• Only refuel in designated areas, away from drainage features such as swales, channels and ponds. • No refuelling is to occur within 30 m of the lake or creek. • Use drip trays or absorbent mats during

Environmental issue	Mitigation measures
	refuelling. • Only store chemicals and fuels in designated areas that are bunded to at least 110% of the largest container stored there. • Locate chemical and fuel storage areas away from drainage features. • All onsite staff are to be trained in spill response and are to be familiar with the spill contingency plan provided in Section 5.8.4 of the EMP. • Spill kits are to be clearly identified and readily available onsite. Spill kits should be regularly audited and items replaced after use. • Only designated pits are to be used for concrete washout. Drivers to be made aware of these designated washout locations and appropriate procedures for their use.

Notifying Environmental Incidents

An Environmental Incident is one that causes a significant environmental effect or nuisance offsite or to sensitive receptors like waterways (e.g. a dust complaint from a neighbour, dirty water discharge to the lake).

Environmental Incidents are to be reported immediately to the Site Supervisor/Environmental Representative, who will follow the procedures outlined in Section 4.3 of the EMP. The Environmental Incident form, attached in Appendix C of the EMP, is to be completed and submitted accordingly.

Procedures for managing storm events

The Site Supervisor should regularly monitor the weather forecast and manage onsite works with the forecast in mind. If a storm is approaching, the following procedures will be followed:

- **Wind**: Stop works in advance and secure all loose items that may be prone to being blown away by high winds. Ensure all areas of exposed soil are thoroughly dampened, stabilised or covered to prevent dust generation. After the wind has abated, check that nothing has blown onto adjacent properties or roads.

- **Rain**: Perform a full inspection of erosion and sediment control measures well prior to a rain event. Any issues identified (holes in silt fencing, infiltration basins in need of cleaning out, etc) should be rectified immediately, where practicable to do so. Perform the same inspection after the rain has passed, and rectify issues as needed.

Appendix C: EMP forms

1. Site environmental induction register

2. Environmental Incident Report template

3. Weekly inspection proforma

4. Environmental complaints register

5. EMP non-conformance register

6. Water quality monitoring log

EMP induction register

Date	Inductee			Inductor		
	Name	Phone #	Signature	Name	Phone #	Signature

ENVIRONMENTAL INCIDENT REPORT FORM

Project address/description: Parkburn Subdivision, Cromwell	**CODC consent no.:** **ORC consent no.:**

<u>Instructions</u>

Complete this form for all environmental incidents that cause contaminants (including sediment) or environmental nuisance to leave the site. Please be succinct, stick to known facts and do not make assumptions.

<u>Incident details</u>

Date and time	Date:	Time:
Description Provide a brief and factual description of what happened during the incident. Include relevant details such as: • The estimated distance to the nearest waterway (including storm water and dry courses) • Estimated distance to the nearest sensitive receiver • The activity being undertaken when the incident occurred Sketches/diagrams/photos may be referenced and appended to this report to aid in the description of the incident		
Location of the incident Include address, landmarks, features, nearest intersection, etc. Maps and plans can be attached to the incident report if appropriate.		
Who identified the incident?	☐Community ☐Contractor ☐Council ☐Other	

What immediate actions or control measures were taken to rectify or contain the incident?

What corrective action will be taken to prevent similar incidents recurring?

Approvals

Name:	Role/organisation:
Date:	Signature:

Parkburn – Weekly Environmental Inspection

Date:	Inspector:	Weather/general conditions:

Inspection item	**Compliance** (Not applicable, complies, non-compliance)			**Comments** List any observations relating to the item inspected, and any remedial action required	**Timeframe** Remedial action to be completed by date or within certain timeframe
	N/A	**C**	**NC**		
Admin					
Is a hard copy of the EMP available onsite?					
Is a register of environmental records (inductions, inspections, etc) available onsite and up-to-date?					
Erosion and sediment control					
Are controls installed as per the ESCP and in good working order?					
Are IBs, swales, silt fences etc in need of sediment removal?					
Are completed earthworks being stabilised?					
Are stockpiles, storage and refuelling areas ≥30 m from water/drainage features?					

Inspection item	Compliance (Not applicable, complies, non-compliance)			Comments List any observations relating to the item inspected, and any remedial action required	Timeframe Remedial action to be completed by date or within certain timeframe
	N/A	C	NC		
Are stockpiles stabilised and surrounded by silt fencing or similar?					
Is uncontrolled contaminated runoff discharging beyond the site boundary?					
Is mud being tracked onto SH6?					
Water quality					
Is the Water Quality Monitoring Plan being adhered to?					
Has the Dosing System Maintenance Checklist been completed?					
Dust and vibration					
Is there evidence of dust migrating beyond the boundary?					
Have any dust or vibration complaints been received in the 7 days prior?					

Inspection item	Compliance (Not applicable, complies, non-compliance)			Comments List any observations relating to the item inspected, and any remedial action required	Timeframe Remedial action to be completed by date or within certain timeframe
	N/A	C	NC		
Are stockpiles sufficiently stabilised or covered to prevent dust generation?					
Noise & vibration					
Have any noise or vibration complaints been received in the 7 days prior?					
Has monitoring been conducted in response to a complaint?					
Vegetation					
Is ground disturbance limited to those shown in the plans? Has surrounding vegetation been retained?					
Chemicals and fuel					
Are designated refuelling areas at least 30 m from IBs, swales, and water bodies?					
Is suitable onsite chemical storage provided?					
Are spill kits well maintained and in suitable locations?					

Inspection item	Compliance (Not applicable, complies, non-compliance)			Comments List any observations relating to the item inspected, and any remedial action required	Timeframe Remedial action to be completed by date or within certain timeframe
	N/A	C	NC		
Waste management					
Are sufficient bins provided for onsite waste?					
Is there evidence of uncontained waste/litter onsite?					

Parkburn – Environmental Complaints Register

Complaint No.	Date & time complaint received	Complainant details (Name, address, phone or email)	Complaint details	Investigation and findings	Remedial actions, if applicable?	Date complaint closed

Parkburn – EMP Non-Conformance (NC) Register

NC no.	Date	Source of NC (e.g. inspection, complaint, etc.)	Details of NC	Remedial actions	Remedials undertaken by?	Close-out date

Parkburn – Water Quality Monitoring Log

Date:	Person:	Monitoring trigger:

	Location 1	Location 2	Location 3 (optional)
Location description			
Sampling results			
TSS			
Turbidity			
pH			
Visual monitoring			
Hydrocarbons			
Tannins & paint			
Waste			
Non-compliance and remedial actions?			

Appendix D: Erosion and sediment control plan

Appendix E: ESC design details

CWBs/CWDCs – GD05 pgs 38-43

Also referred to as clean water diversions (CWDs), clean water diversion channels (CWDCs) are to be constructed as maintained as per the below GD05 typical detail, unless indicated otherwise – in some cases, CWDs may be existing and not necessarily designed to GD05 standards, but it is preferable to leave these vegetated and undisturbed rather than re-work them and expose potentially clean upslope water to contamination.

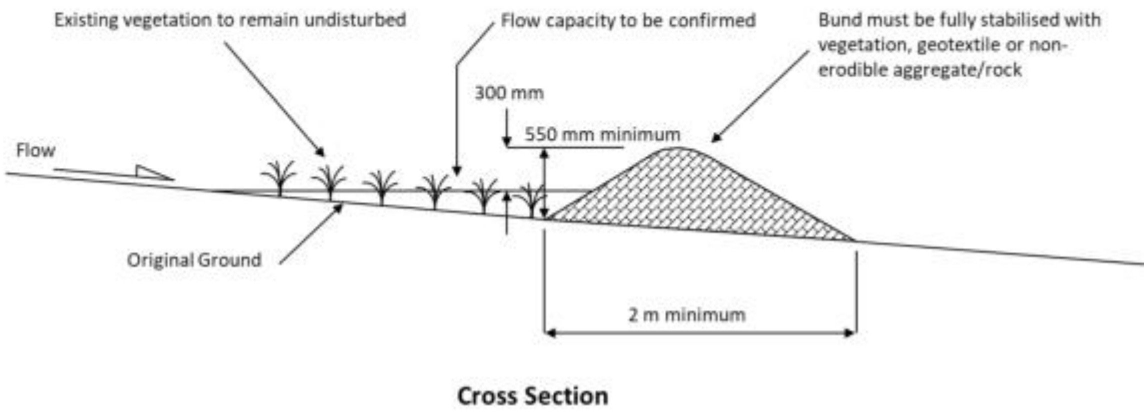


Figure 24: Clean water diversion typical detail (GD05)

Figure 25: Clean water bund with grass establishing

Figure 26: Clean water bund with established grass stabilisation

Key design criteria for CWDs are as follows:

- Ensure bunds are compacted and immediately stabilised – this may require erosion control blankets or a thick layer of hay mulch until grass can establish.
- Ensure bunds roughly follow the contour, to avoid steep gradients and runoff velocities.
- CWDs must have a stabilised outlet to prevent scour, such as riprap.

<u>DWBs/DWDCs</u> – GD05 pgs 43-46

Dirty water diversion channels (DWDCs; DWBs; DWDs) are to be constructed and maintained as per the below GD05 typical detail unless the attached calculations indicate otherwise. Where DWDC longitudinal grade exceeds 2%, they should be lined (preferably with HDPE) or stabilised with either a thick coating of polymer or topsoil and hydroseed, to prevent scour. Unlined DWDCs should be monitored for scour, and may require retrospective lining where scour risks undermining the integrity or shape of the channel as shown below.

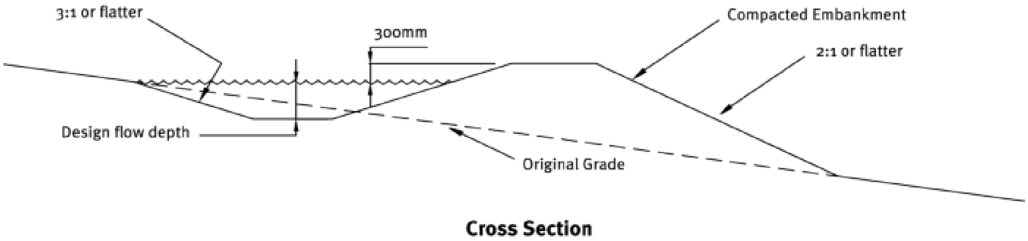


Figure 27: GD05 DWDC typical detail

Figure 28: DWDC with establishing direct-drilled grass. When all of the catchment and the channel itself is fully stabilised, it will become a clean water diversion

Figure 29: DWDC with rock check dams

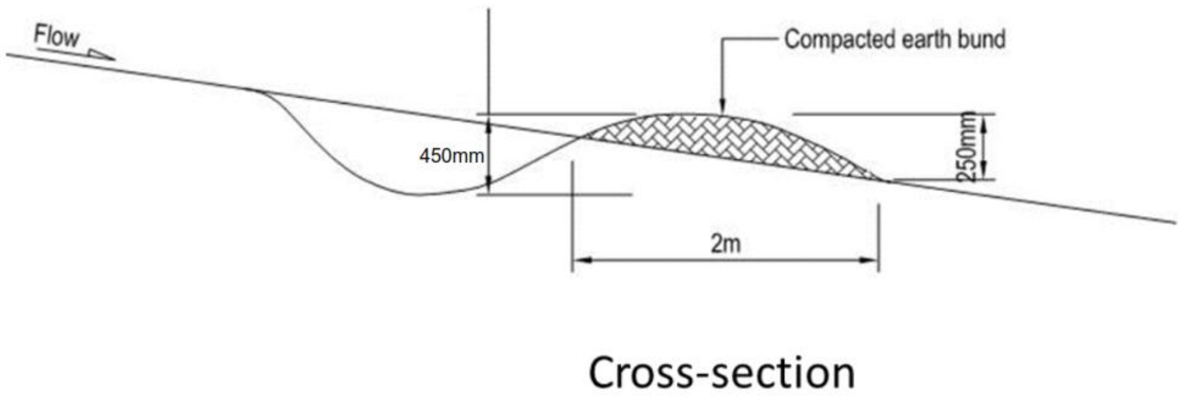
Key design criteria for CWDs are as follows:

- Ensure bunds are compacted and a shallow grade – at least 2:1 or flatter
- The upslope batter into the channel needs to be 3:1 or flatter – the flatter the channel batters are, the less likely they are to scour or fail

- Formally design diversion channels where catchments exceed 5 ha, ensuring they have capacity to carry the 5% AEP storm plus 300 mm freeboard
- Consider lining channels where gradients exceed 2% - however check dams can also help reduce flow velocities and scour in steeper drains.

<u>Trafficable contour bund</u> – GD05 pgs 47-50

Contour drains or contour bunds are constructed parallel to the contour to break up flowpaths, reduce slope catchments and minimise runoff velocities. Bunds need to be well-compacted, low and wide, to ensure heavy machinery can track over the bunds without damaging them. A shallow drain it to be formed on the upslope side of the bund.



Due to the virtually flat gradient of most of earthworks Areas 1-3, contour bunds can be installed every 50 to 100 m, and adjusted to suit vehicle movements and site needs.

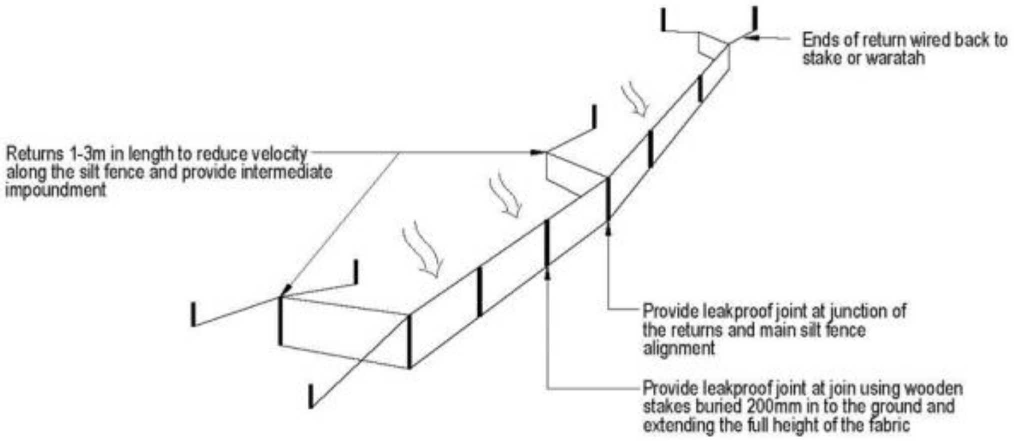
<u>Silt fencing</u> GD05 pgs 111-118

Silt fences are very effective perimeter sediment controls when installed correctly, however they are not designed to treat concentrated flows, and should only be relied on as a final element in a runoff treatment train – not a standalone ESC solution. For larger catchments, super silt fences provide more robust sediment control.

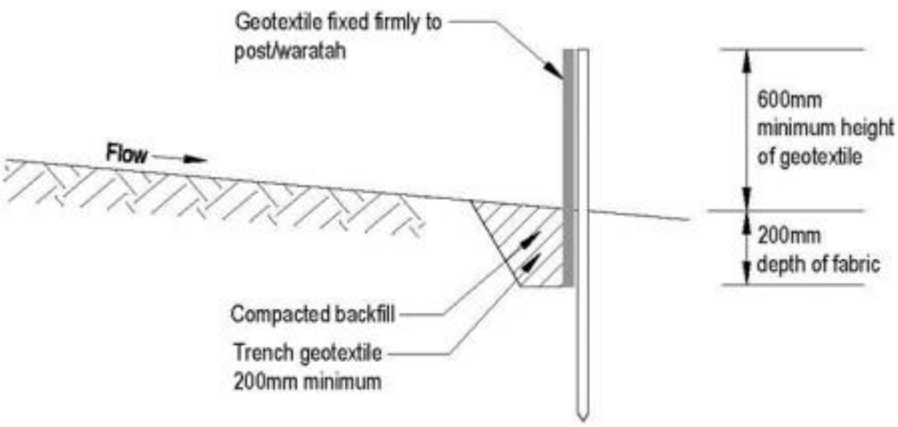
Key design criteria for installing silt fencing is as follows:

- Ensure silt fence height is 600 mm above ground level and 200 mm below ground level.
- Install silt fence **parallel to contours** to avoid formation of low points, where runoff can collect and destabilise the fence.

- Locate supporting posts/waratahs for silt fences 2-4 m apart with support provided by a tensioned wire (2.5 mm HT) along the top of the silt fence.
- Join lengths of silt fence by doubling over fabric ends around a waratah or by stapling the fabric ends to a batten and butting the two battens together.



Silt fence with returns and support wire



Cross-section

Figure 30: Super silt fence treating dirty upslope water

<u>Silt socks</u> – GD05 pgs 125-129

Silt socks are a tubular runoff sediment control consisting of either a mesh tube filled with filter material (e.g. compost, sawdust) or a log composed entirely of coconut fibre (coir log). They are used to intercept and slow sediment-laden runoff for smaller catchments, and (in the case of completely biodegradable products like coir logs) can be left to degrade into soil over time and/or be directly seeded to provide vegetated filtration bunds or check dams.

Key design criteria for installing silt socks includes:

- install socks/logs flush with the ground, to prevent runoff from flowing under the device. Where necessary, prepare the ground first to ensure 100% contact.
- similar to silt fencing, socks/logs should be installed parallel to the contour
- for perimeter control, ensure there is sufficient overlap with the next sock so that runoff can't flow in between the socks
- for 300 mm diameter silt socks, install as indicated below:

Slope steepness (%)	Maximum slope length (m)	Spacing of returns (m)
Flatter than 2%	100	N/A
2% - 10%	40	30
10% - 20%	30	25

<u>Stabilised construction entrance</u> – GD05 pgs 60-64

SCEs provide a stabilised access and egress point for construction/earthworks sites that is designed to vibrate/shake mud and dirt off wheels and minimise the amount of dirt tracked onto public roads, along with keeping dust to a minimum. To be effective, they must be regularly maintained/refurbished as mud begins to accumulate between the aggregate. For sites with mud issues or a high volume of traffic entering and exiting the site, combining an SCE with a series of trackout mats can be effective.

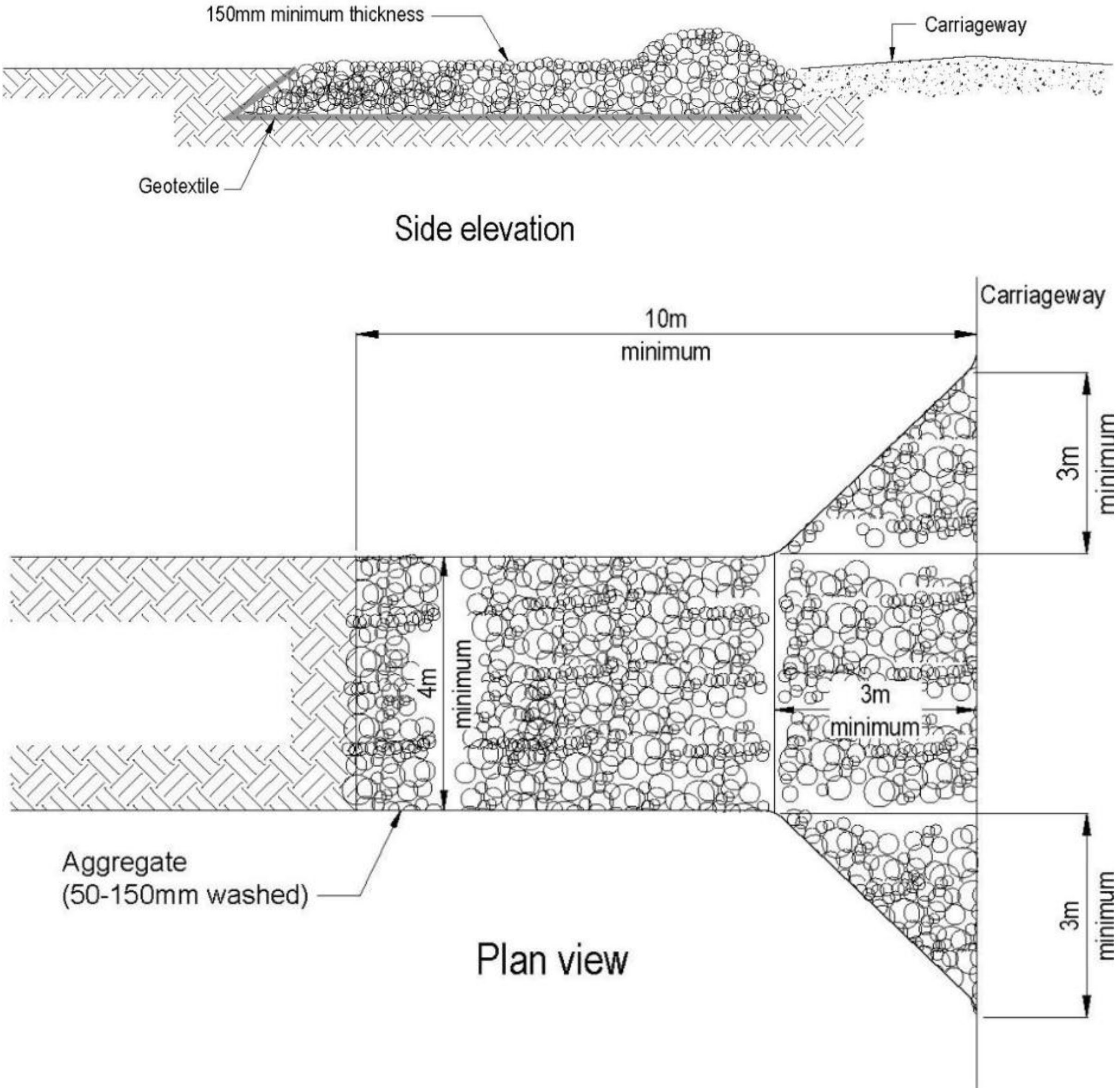
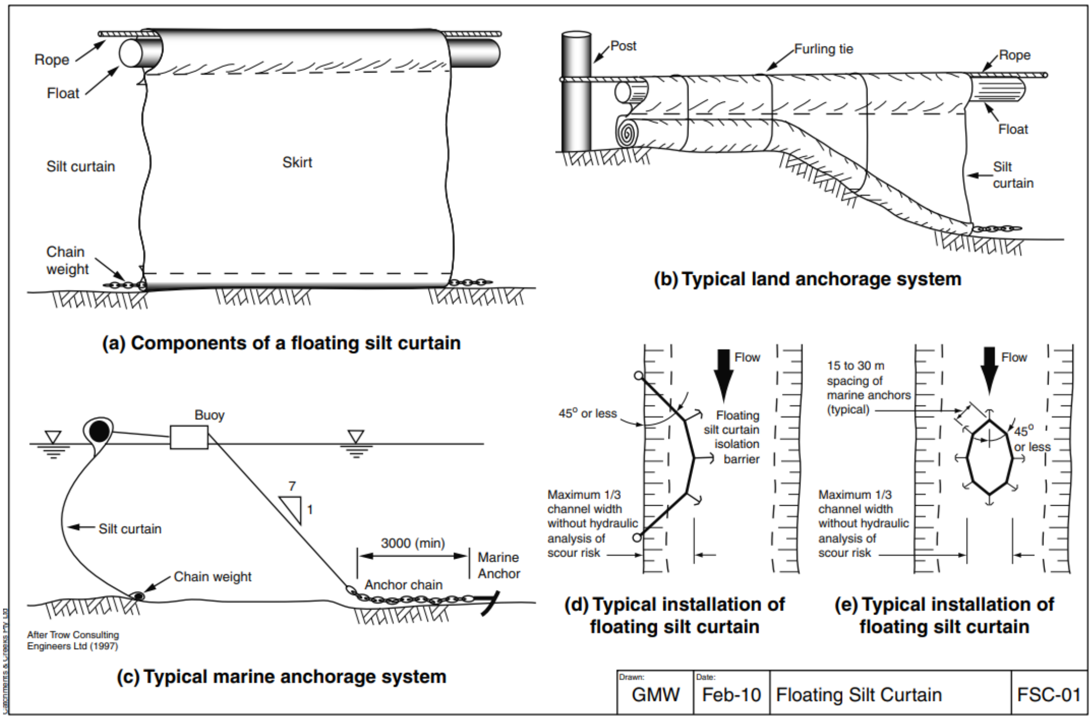


Figure 31: SCE design - section (above) and plan view (below)

Figure 32: Combination of trackout mats and SCE at site entrance

Silt curtains

A specification for silt curtains in relation to the cove construction in-water works will be developed in association with a domestic supplier of this specialised equipment. The below specification is taken from the IECA's Best Practice Erosion and Sediment Control (BPESC) manual, and is provided for indicative purposes only – noting that the specific design for the proposed applications will likely vary from that specified below.



Appendix F: Infiltration basin and diversion drain calculations

Infiltration basin Identifier: **IB1**

Input	Value 1	Value 2	Total/design	Units	Notes / Reference
Catchment information					
Contributing catchment	1.8			ha	Based on project shapefiles and assumed ESC installations
Slope length (longest flow path)	220			m	Longest flow path within contributing catchment
Slope gradient (longest)	**6.36**			%	
Slope gradient (immediately upslope)	0.50			**%**	Greater of slope immediately (within 20 m) above IB OR average slope over contributing catchment
Project duration	24			months	Assumed worst case for Area 1 works until 80%+ stabilisation achieved
Peak runoff calculation					Q = 0.00278CiA
Catchment ground cover	Flat gravel	Sloping gravel			
% cover	92%	8%			Flat gravel interspersed with small areas of sloping gravel at quarry level interfaces.
Runoff coefficient (C)	0.15	0.25			From NZTA ESC Guidelines Table 6.5
Rainfall (i)	2.59	2.59		mm/hr	HIRDS V4 'Northburn' 5% AEP (20-year ARI), 24-hr duration
Catchment area (A)	1.66	0.14		ha	Assumed catchment based on prelim design
Peak runoff flow (Q)	0.0018	0.0003		m^3/s	
IB design calculations					
Hourly volume required	6.4	0.9	**7.4**	m^3	Based on accumulated peak runoff flow over 1 hour
24-hour volume required	154.5	22.4	**176.9**	m^3	Based on accumulated peak runoff flow over 24 hours
Assumed infiltration rate	175	175	**175**	mm/hr	Based on indicative soakage testing within the catchment
Minimum basal area required	36.8	5.3	**42.1**	m^2	Calculated via A=V/ft, where V = infiltration volume (m^3), f = infiltration rate (m/hr) and t = time (hrs)
Top length (A)			45.00	m	
Top width (B)			11.25	m	
Basal length (a)			38.00	m	
Basal width (b)			4.25	m	
Depth (h)			0.7	m	Shallow to enable easy maintenance and avoid high water table
Internal batter ratio			1:5	rise/run	1:5 ratio as not space limited. Reduces scour and stability risk and is trafficable if needed
Calculated actual volume (V)			228.0	m^3	
Actual basal infiltration area			161.5	m^2	
Length-width ratio			4:1	ratio	Ratio must be ≥3:1 & ≤5:1, measured at height of primary spillway
Additional storage buffer			28.9	%	~29% additional storage above minimum storage required (not including infiltration capacity)
Forebay					
Depth			0.7	m	
Width			8.00	m	1:5 batters with 1 m wide forebay flat bottom
Length			11.25	m	Full width of basin
Level spreader					
Width			11.25	m	Must span full width of basin
Height above emergency spillway invert			0.15	m	Must be 0.1 - 0.2 m above emergency spillway invert
Downstream inlet batter gradient			1:5	rise/run	
Emergency spillway					
Spillway invert depth from crest			0.3	m	Minimum 0.3 m below top of IB embankment
Spillway bottom width			4.25	m	Full width of the IB base

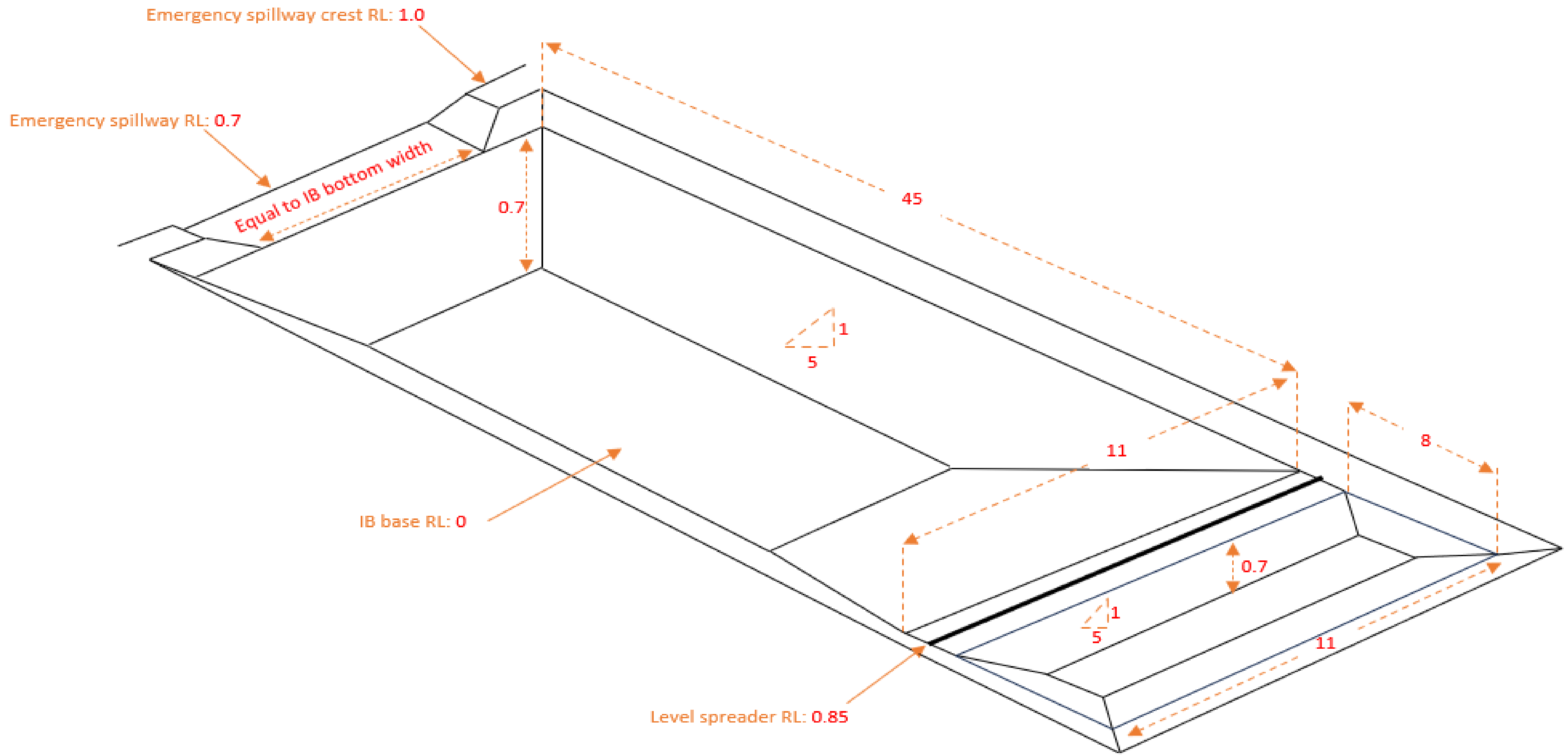
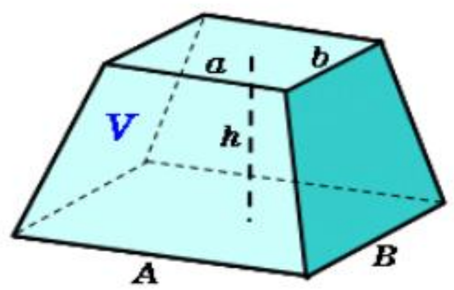


Table 6.5 Representative C values for different soil types and slope (Environment Canterbury, 2007)

Soil types/slope	C factor
Flat gravel (<5%)	0.15
Sloping gravel (>10%)	0.25
Flat silt loam (<5%)	0.3
Sloping silt loam (10-20%)	0.4
Steep silt loam (>20%)	0.5
Clay (<10%)	0.65
Clay (>10%)	0.75

IB dimensions at emergency spillway invert

A	45	m	Pond volume calc:
B	11.25	m	**228.00**
a	38.00	m	
b	4.25	m	
h	0.7	m	



Obelisk

(1) *volume* : $V = \frac{h}{6}(Ab + aB + 2(ab + AB))$

Infiltration basin Identifier: **IB2**

Input	Value 1	Value 2	Total/design	Units	Notes / Reference
Catchment information					
Contributing catchment	4.41			ha	Based on project shapefiles and assumed ESC installations
Slope length (longest flow path)	220			m	Longest flow path within contributing catchment
Slope gradient (longest)	**6.82**			%	
Slope gradient (immediately upslope)	0.50			**%**	Greater of slope immediately (within 20 m) above IB OR average slope over contributing catchment
Project duration	24			months	Assumed worst case for Area 1 works until 80%+ stabilisation achieved
Peak runoff calculation					Q = 0.00278CiA
Catchment ground cover	Flat gravel	Sloping gravel			
% cover	87%	13%			Flat gravel interspersed with small areas of sloping gravel at quarry level interfaces.
Runoff coefficient (C)	0.15	0.25			From NZTA ESC Guidelines Table 6.5
Rainfall (i)	2.59	2.59		mm/hr	HIRDS V4 'Northburn' 5% AEP (20-year ARI), 24-hr duration
Catchment area (A)	3.83	0.58		ha	Assumed catchment based on prelim design
Peak runoff flow (Q)	0.0041	0.0010		m^3/s	
IB design calculations					
Hourly volume required	14.9	3.8	**18.6**	m^3	Based on accumulated peak runoff flow over 1 hour
24-hour volume required	357.4	90.2	**447.6**	m^3	Based on accumulated peak runoff flow over 24 hours
Assumed infiltration rate	175	175	**175**	mm/hr	Based on indicative soakage testing within the catchment
Minimum basal area required	85.1	21.5	**106.6**	m^2	Calculated via A=V/ft, where V = infiltration volume (m^3), f = infiltration rate (m/hr) and t = time (hrs)
Top length (A)			60.00	m	
Top width (B)			15.00	m	
Basal length (a)			53.00	m	
Basal width (b)			8.00	m	
Depth (h)			0.7	m	Shallow to enable easy maintenance and avoid high water table
Internal batter ratio			1:5	rise/run	1:5 ratio as not space limited. Reduces scour and stability risk and is trafficable if needed
Calculated actual volume (V)			457.7	m^3	
Actual basal infiltration area			424.0	m^2	
Length-width ratio			4:1	ratio	Ratio must be ≥3:1 & ≤5:1, measured at height of primary spillway
Additional storage buffer			2.3	%	~2% additional storage above minimum storage required (not including infiltration capacity)
Forebay					
Depth			0.7	m	
Width			8.00	m	1:5 batters with 1 m wide forebay flat bottom
Length			15.00	m	Full width of basin
Level spreader					
Width			15.00	m	Must span full width of basin
Height above emergency spillway invert			0.15	m	Must be 0.1 - 0.2 m above emergency spillway invert
Downstream inlet batter gradient			1:5	rise/run	
Emergency spillway					
Spillway invert depth from crest			0.3	m	Minimum 0.3 m below top of IB embankment
Spillway bottom width			8.00	m	Full width of the IB base

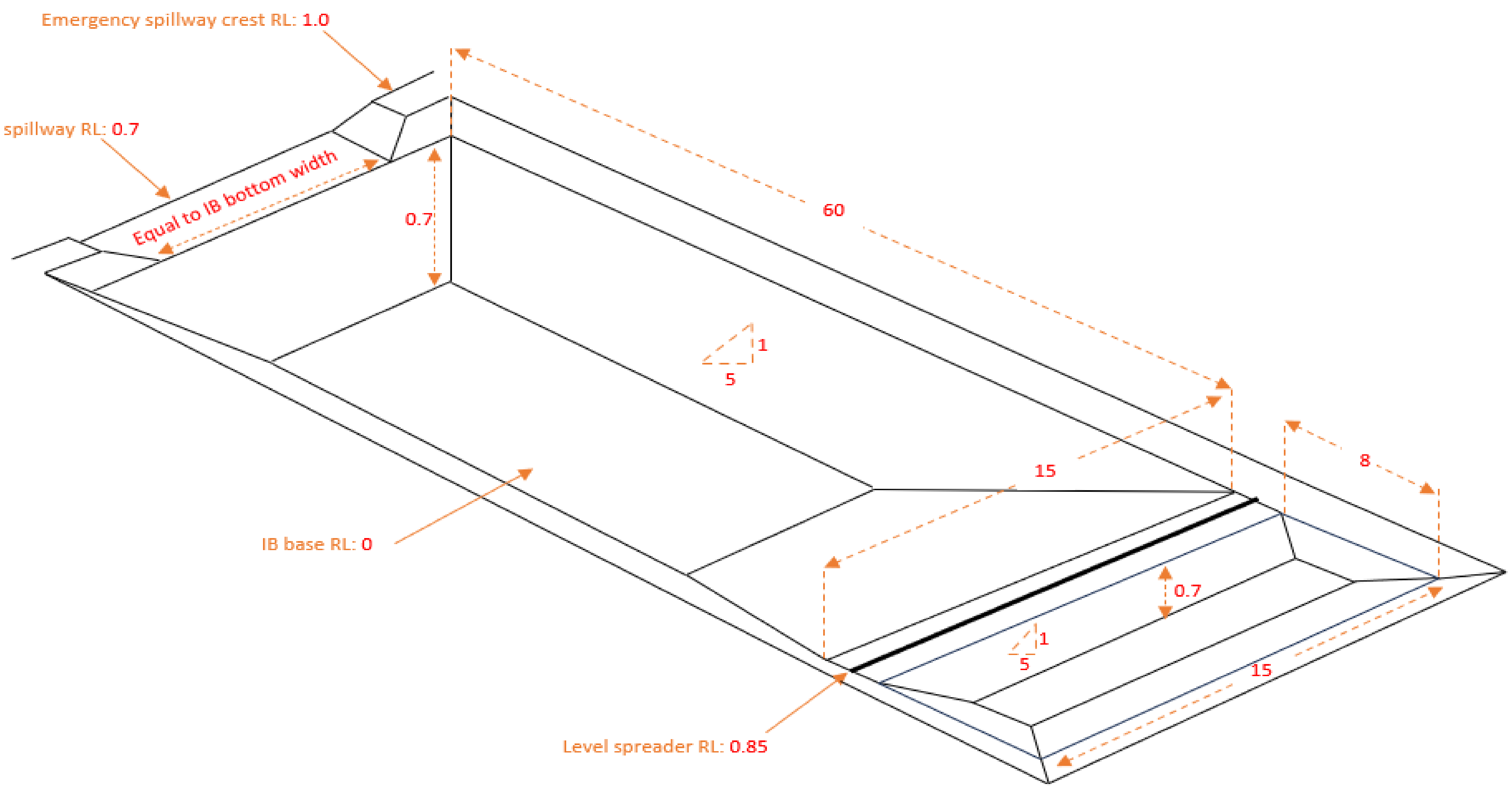
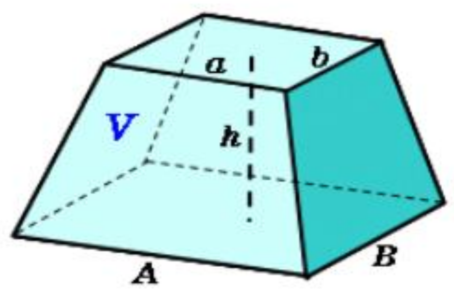


Table 6.5 Representative C values for different soil types and slope (Environment Canterbury, 2007)

Soil types/slope	C factor
Flat gravel (<5%)	0.15
Sloping gravel (>10%)	0.25
Flat silt loam (<5%)	0.3
Sloping silt loam (10-20%)	0.4
Steep silt loam (>20%)	0.5
Clay (<10%)	0.65
Clay (>10%)	0.75

IB dimensions at emergency spillway invert

A	60	m	Pond volume calc:
B	15.00	m	**457.68**
a	53.00	m	
b	8.00	m	
h	0.7	m	



Obelisk

(1) *volume* : $V = \frac{h}{6}(Ab + aB + 2(ab + AB))$

Infiltration basin Identifier: **IB3**

Input	Value 1	Value 2	Total/design	Units	Notes / Reference
Catchment information					
Contributing catchment	13.68			ha	Based on project shapefiles and assumed ESC installations
Slope length (longest flow path)	482			m	Longest flow path within contributing catchment
Slope gradient (longest)	**3.73**			%	
Slope gradient (immediately upslope)	0.50			**%**	Greater of slope immediately (within 20 m) above IB OR average slope over contributing catchment
Project duration	24			months	Assumed worst case for Area 1 works until 80%+ stabilisation achieved
Peak runoff calculation					Q = 0.00278CiA
Catchment ground cover	Flat gravel	Sloping gravel			
% cover	66%	34%			
Runoff coefficient (C)	0.15	0.25			From NZTA ESC Guidelines Table 6.5
Rainfall (i)	2.59	2.59		mm/hr	HIRDS V4 'Northburn' 5% AEP (20-year ARI), 24-hr duration
Catchment area (A)	8.97	4.710677196		ha	Assumed catchment based on prelim design
Peak runoff flow (Q)	0.0097	0.0085		m^3/s	
IB design calculations					
Hourly volume required	34.9	30.5	**65.4**	m^3	Based on accumulated peak runoff flow over 1 hour
24-hour volume required	837.0	732.6	**1569.6**	m^3	Based on accumulated peak runoff flow over 24 hours
Assumed infiltration rate	175	175	**175**	mm/hr	Based on indicative soakage testing within the catchment
Minimum basal area required	199.3	174.4	**373.7**	m^2	Calculated via A=V/ft, where V = infiltration volume (m^3), f = infiltration rate (m/hr) and t = time (24 hrs)
Top length (A)			104.00	m	
Top width (B)			26.00	m	
Basal length (a)			97.00	m	
Basal width (b)			19.00	m	
Depth (h)			0.7	m	Shallow to enable easy maintenance and avoid high water table
Internal batter ratio			1:5	rise/run	1:5 ratio as not space limited. Reduces scour and stability risk and is trafficable if needed
Calculated actual volume (V)			1585.7	m^3	
Actual basal infiltration area			1843.0	m^2	
Length-width ratio			4:1	ratio	Ratio must be ≥3:1 & ≤5:1, measured at height of primary spillway
Additional storage buffer			1.0	%	~1% additional storage above minimum storage required (not including infiltration capacity)
Forebay					
Depth			0.7	m	
Width			8.00	m	
Length			26.00	m	Full width of basin
Level spreader					
Width			26.00	m	Must span full width of basin
Height above emergency spillway invert			0.15	m	Must be 0.1 - 0.2 m above emergency spillway invert
Downstream inlet batter gradient			1:5	rise/run	
Emergency spillway					
Spillway invert depth from crest			0.3	m	Minimum 0.3 m below top of IB embankment
Spillway bottom width			19.00	m	Full width of the IB base

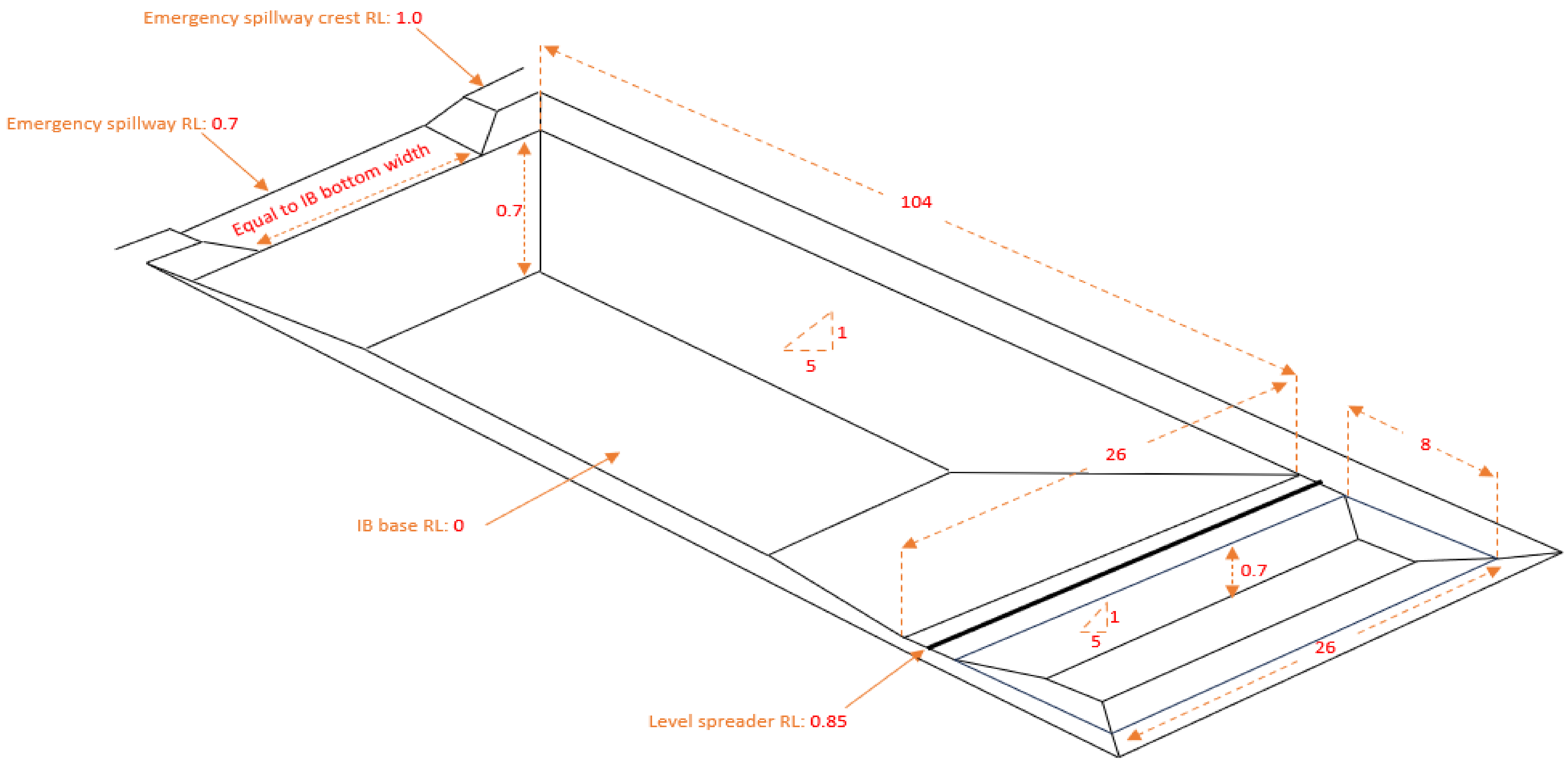
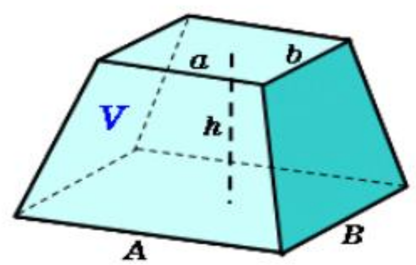


Table 6.5 Representative C values for different soil types and slope (Environment Canterbury, 2007)

Soil types/slope	C factor
Flat gravel (<5%)	0.15
Sloping gravel (>10%)	0.25
Flat silt loam (<5%)	0.3
Sloping silt loam (10-20%)	0.4
Steep silt loam (>20%)	0.5
Clay (<10%)	0.65
Clay (>10%)	0.75

IB dimensions at emergency spillway invert

A	104	m	Pond volume calc:
B	26.00	m	**1585.73**
a	97.00	m	
b	19.00	m	
h	0.7	m	



Obelisk

(1) *volume* : $V = \frac{h}{6}(Ab + aB + 2(ab + AB))$

Infiltration basin Identifier: **IB4**

Input	Value 1	Value 2	Total/design	Units	Notes / Reference
Catchment information					
Contributing catchment	4.63			ha	Based on project shapefiles and assumed ESC installations
Slope length (longest flow path)	284			m	Longest flow path within contributing catchment
Slope gradient (longest)	**1.41**			%	
Slope gradient (immediately upslope)	0.50			**%**	Greater of slope immediately (within 20 m) above IB OR average slope over contributing catchment
Project duration	24			months	Assumed worst case for Area 1 works until 80%+ stabilisation achieved
Peak runoff calculation					Q = 0.00278CiA
Catchment ground cover	Flat gravel				
% cover	100%				
Runoff coefficient (C)	0.15				From NZTA ESC Guidelines Table 6.5
Rainfall (i)	2.59			mm/hr	HIRDS V4 'Northburn' 5% AEP (20-year ARI), 24-hr duration
Catchment area (A)	4.63			ha	Assumed catchment based on prelim design
Peak runoff flow (Q)	0.0050			m^3/s	
IB design calculations					
Hourly volume required	18.0		**18.0**	m^3	Based on accumulated peak runoff flow over 1 hour
24-hour volume required	432.0		**432.0**	m^3	Based on accumulated peak runoff flow over 24 hours
Assumed infiltration rate	175		**175**	mm/hr	Based on indicative soakage testing within the catchment
Minimum basal area required	102.9		**102.9**	m^2	Calculated via A=V/ft, where V = infiltration volume (m^3), f = infiltration rate (m/hr) and t = time (24 hrs)
Top length (A)			60.00	m	
Top width (B)			15.00	m	
Basal length (a)			53.00	m	
Basal width (b)			8.00	m	
Depth (h)			0.7	m	Shallow to enable easy maintenance and avoid high water table
Internal batter ratio			1:5	rise/run	1:5 ratio as not space limited. Reduces scour and stability risk and is trafficable if needed
Calculated actual volume (V)			457.7	m^3	
Actual basal infiltration area			424.0	m^2	
Length-width ratio			4:1	ratio	Ratio must be ≥3:1 & ≤5:1, measured at height of primary spillway
Additional storage buffer			5.9	%	~6% additional storage above minimum storage required (not including infiltration capacity)
Forebay					
Depth			0.7	m	
Width			8.00	m	
Length			15.00	m	Full width of basin
Level spreader					
Width			15.00	m	Must span full width of basin
Height above emergency spillway invert			0.15	m	Must be 0.1 - 0.2 m above emergency spillway invert
Downstream inlet batter gradient			1:5	rise/run	
Emergency spillway					
Spillway invert depth from crest			0.3	m	Minimum 0.3 m below top of IB embankment
Spillway bottom width			8.00	m	Full width of the IB base

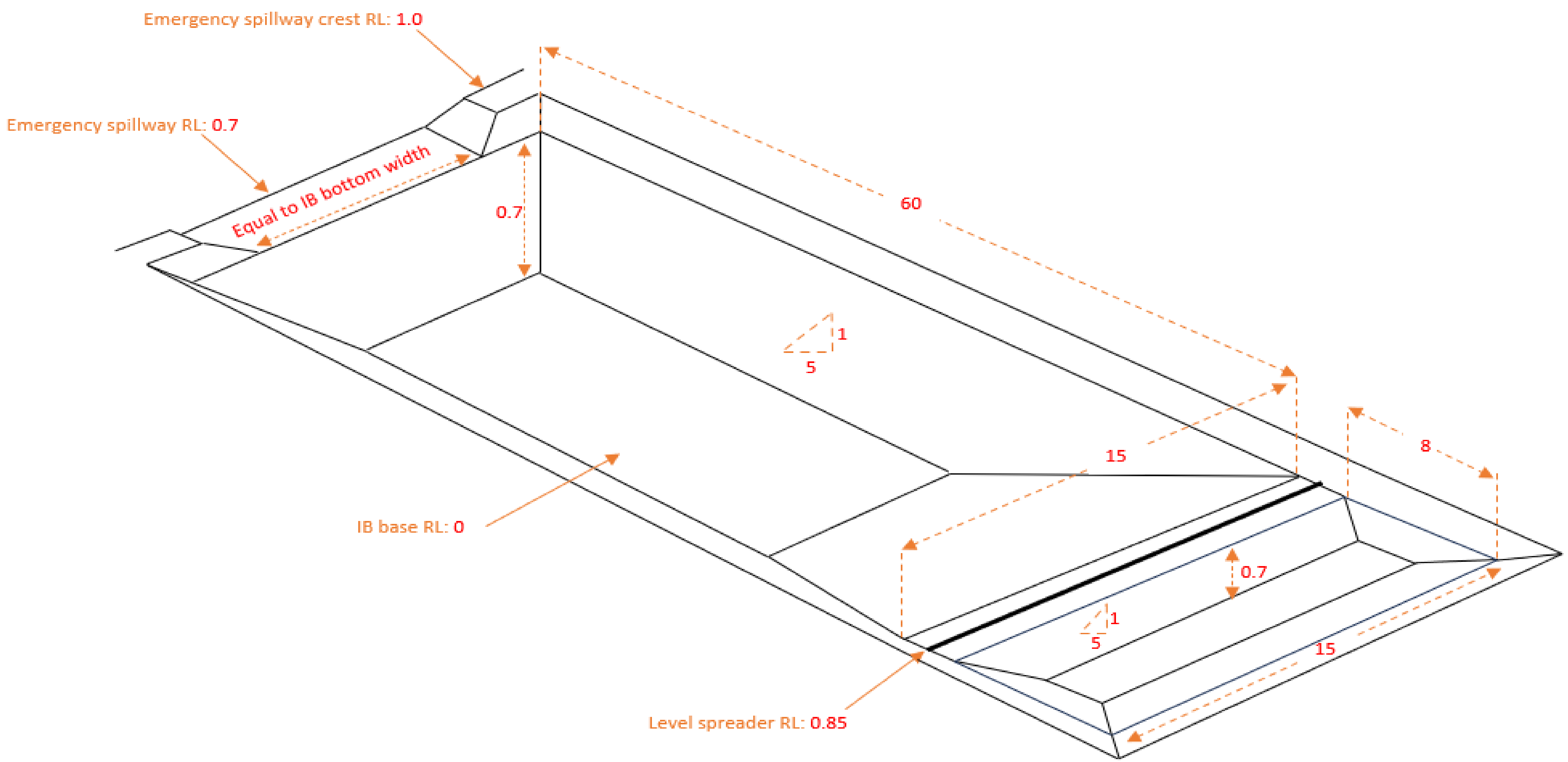
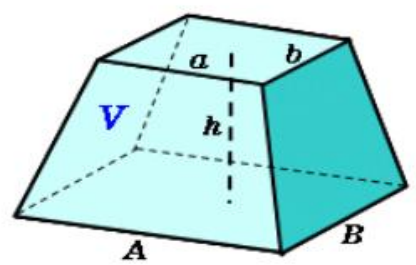


Table 6.5 Representative C values for different soil types and slope (Environment Canterbury, 2007)

Soil types/slope	C factor
Flat gravel (<5%)	0.15
Sloping gravel (>10%)	0.25
Flat silt loam (<5%)	0.3
Sloping silt loam (10-20%)	0.4
Steep silt loam (>20%)	0.5
Clay (<10%)	0.65
Clay (>10%)	0.75

IB dimensions at emergency spillway invert

A	60	m	Pond volume calc:
B	15.00	m	**457.68**
a	53.00	m	
b	8.00	m	
h	0.7	m	



Obelisk

(1) *volume* : $V = \frac{h}{6}(Ab + aB + 2(ab + AB))$

Infiltration basin Identifier: **IB5**

Input	Value 1	Value 2	Total/design	Units	Notes / Reference
Catchment information					
Contributing catchment	6.03			ha	Based on project shapefiles and assumed ESC installations
Slope length (longest flow path)	311			m	Longest flow path within contributing catchment
Slope gradient (longest)	**0.32**			%	
Slope gradient (immediately upslope)	0.50			**%**	Greater of slope immediately (within 20 m) above IB OR average slope over contributing catchment
Project duration	24			months	Assumed worst case for Area 1 works until 80%+ stabilisation achieved
Peak runoff calculation					Q = 0.00278CiA
Catchment ground cover	Flat gravel				
% cover	100%				
Runoff coefficient (C)	0.15				From NZTA ESC Guidelines Table 6.5
Rainfall (i)	2.59			mm/hr	HIRDS V4 'Northburn' 5% AEP (20-year ARI), 24-hr duration
Catchment area (A)	6.03			ha	Assumed catchment based on prelim design
Peak runoff flow (Q)	0.0065			m^3/s	
IB design calculations					
Hourly volume required	23.4		**23.4**	m^3	Based on accumulated peak runoff flow over 1 hour
24-hour volume required	562.7		**562.7**	m^3	Based on accumulated peak runoff flow over 24 hours
Assumed infiltration rate	175		**175**	mm/hr	Based on indicative soakage testing within the catchment
Minimum basal area required	134.0		**134.0**	m^2	Calculated via A=V/ft, where V = infiltration volume (m^3), f = infiltration rate (m/hr) and t = time (24 hrs)
Top length (A)			66.00	m	
Top width (B)			16.50	m	
Basal length (a)			59.00	m	
Basal width (b)			9.50	m	
Depth (h)			0.7	m	Shallow to enable easy maintenance and avoid high water table
Internal batter ratio			1:5	rise/run	1:5 ratio as not space limited. Reduces scour and stability risk and is trafficable if needed
Calculated actual volume (V)			571.6	m^3	
Actual basal infiltration area			560.5	m^2	
Length-width ratio			4:1	ratio	Ratio must be ≥3:1 & ≤5:1, measured at height of primary spillway
Additional storage buffer			1.6	%	~2% additional storage above minimum storage required (not including infiltration capacity)
Forebay					
Depth			0.7	m	
Width			8.00	m	
Length			16.50	m	Full width of basin
Level spreader					
Width			16.50	m	Must span full width of basin
Height above emergency spillway invert			0.15	m	Must be 0.1 - 0.2 m above emergency spillway invert
Downstream inlet batter gradient			1:5	rise/run	
Emergency spillway					
Spillway invert depth from crest			0.3	m	Minimum 0.3 m below top of IB embankment
Spillway bottom width			9.50	m	Full width of the IB base

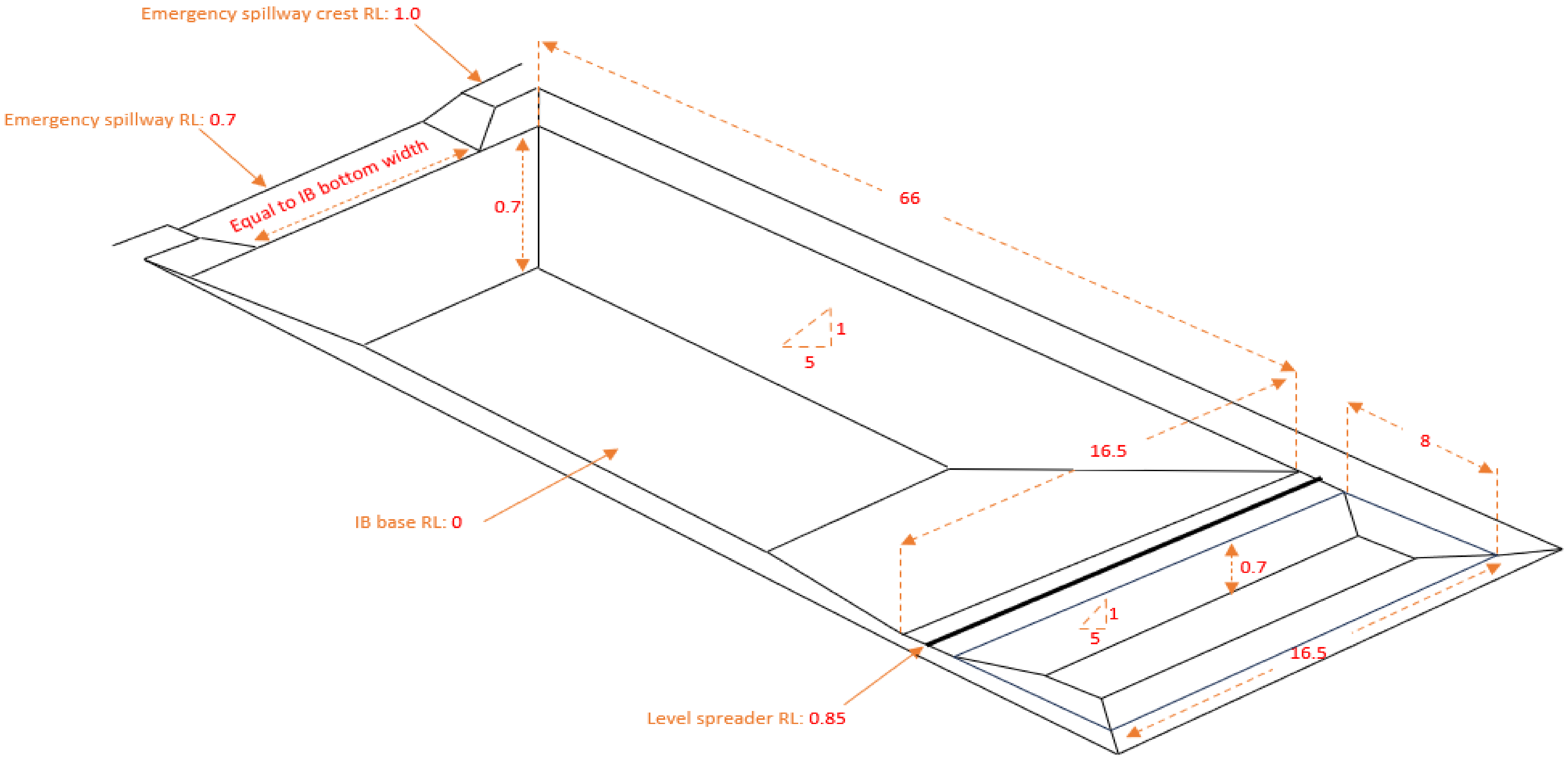
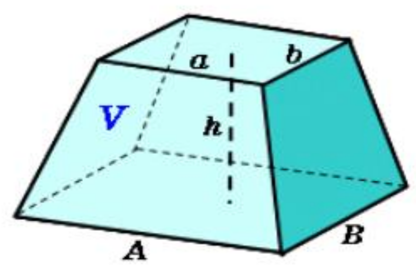


Table 6.5 Representative C values for different soil types and slope (Environment Canterbury, 2007)

Soil types/slope	C factor
Flat gravel (<5%)	0.15
Sloping gravel (>10%)	0.25
Flat silt loam (<5%)	0.3
Sloping silt loam (10-20%)	0.4
Steep silt loam (>20%)	0.5
Clay (<10%)	0.65
Clay (>10%)	0.75

IB dimensions at emergency spillway invert

A	66	m	Pond volume calc:
B	16.50	m	**571.61**
a	59.00	m	
b	9.50	m	
h	0.7	m	



Obelisk

(1) *volume* : $V = \frac{h}{6}(Ab + aB + 2(ab + AB))$

Infiltration basin Identifier: **IB6**

Input	Value 1	Value 2	Total/design	Units	Notes / Reference
Catchment information					
Contributing catchment	36.09			ha	Based on project shapefiles and assumed ESC installations
Slope length (longest flow path)	650			m	Longest flow path within contributing catchment
Slope gradient (longest)	**0.46**			%	
Slope gradient (immediately upslope)	0.50			**%**	Greater of slope immediately (within 20 m) above IB OR average slope over contributing catchment
Project duration	24			months	Assumed worst case for Area 1 works until 80%+ stabilisation achieved
Peak runoff calculation					Q = 0.00278CiA
Catchment ground cover	Flat gravel	Flat grass			
% cover	25%	75%			Flat gravel within the active works area; flat grass underlain by topsoil and then compacted fill for rest
Runoff coefficient (C)	0.15	0.2			From NZTA ESC Guidelines Table 6.5
Rainfall (i)	2.59	2.59		mm/hr	HIRDS V4 'Northburn' 5% AEP (20-year ARI), 24-hr duration
Catchment area (A)	8.91	27.18		ha	Assumed catchment based on prelim design
Peak runoff flow (Q)	0.0096	0.0391		m^3/s	
IB design calculations					
Hourly volume required	34.6	140.9	**175.5**	m^3	Based on accumulated peak runoff flow over 1 hour
24-hour volume required	831.4	3381.7	**4213.2**	m^3	Based on accumulated peak runoff flow over 24 hours
Assumed infiltration rate	175	175	**175**	mm/hr	Based on indicative soakage testing within the catchment
Minimum basal area required	198.0	805.2	**1003.1**	m^2	Calculated via A=V/ft, where V = infiltration volume (m^3), f = infiltration rate (m/hr) and t = time (hrs)
Top length (A)			166.00	m	
Top width (B)			41.50	m	
Basal length (a)			159.00	m	
Basal width (b)			34.50	m	
Depth (h)			0.7	m	Shallow to enable easy maintenance and avoid high water table
Internal batter ratio			1:5	rise/run	1:5 ratio as not space limited. Reduces scour and stability risk and is trafficable if needed
Calculated actual volume (V)			4325.4	m^3	
Actual basal infiltration area			5485.5	m^2	
Length-width ratio			4:1	ratio	Ratio must be ≥3:1 & ≤5:1, measured at height of primary spillway
Additional storage buffer			2.7	%	~3% additional storage above minimum storage required (not including infiltration capacity)
Forebay					
Depth			0.7	m	
Width			10.00	m	1:5 batters with 3 m wide forebay flat bottom
Length			41.50	m	Full width of basin
Level spreader					
Width			41.50	m	Must span full width of basin
Height above emergency spillway invert			0.15	m	Must be 0.1 - 0.2 m above emergency spillway invert
Downstream inlet batter gradient			1:5	rise/run	
Emergency spillway					
Spillway invert depth from crest			0.3	m	Minimum 0.3 m below top of IB embankment
Spillway bottom width			34.50	m	Full width of the IB base

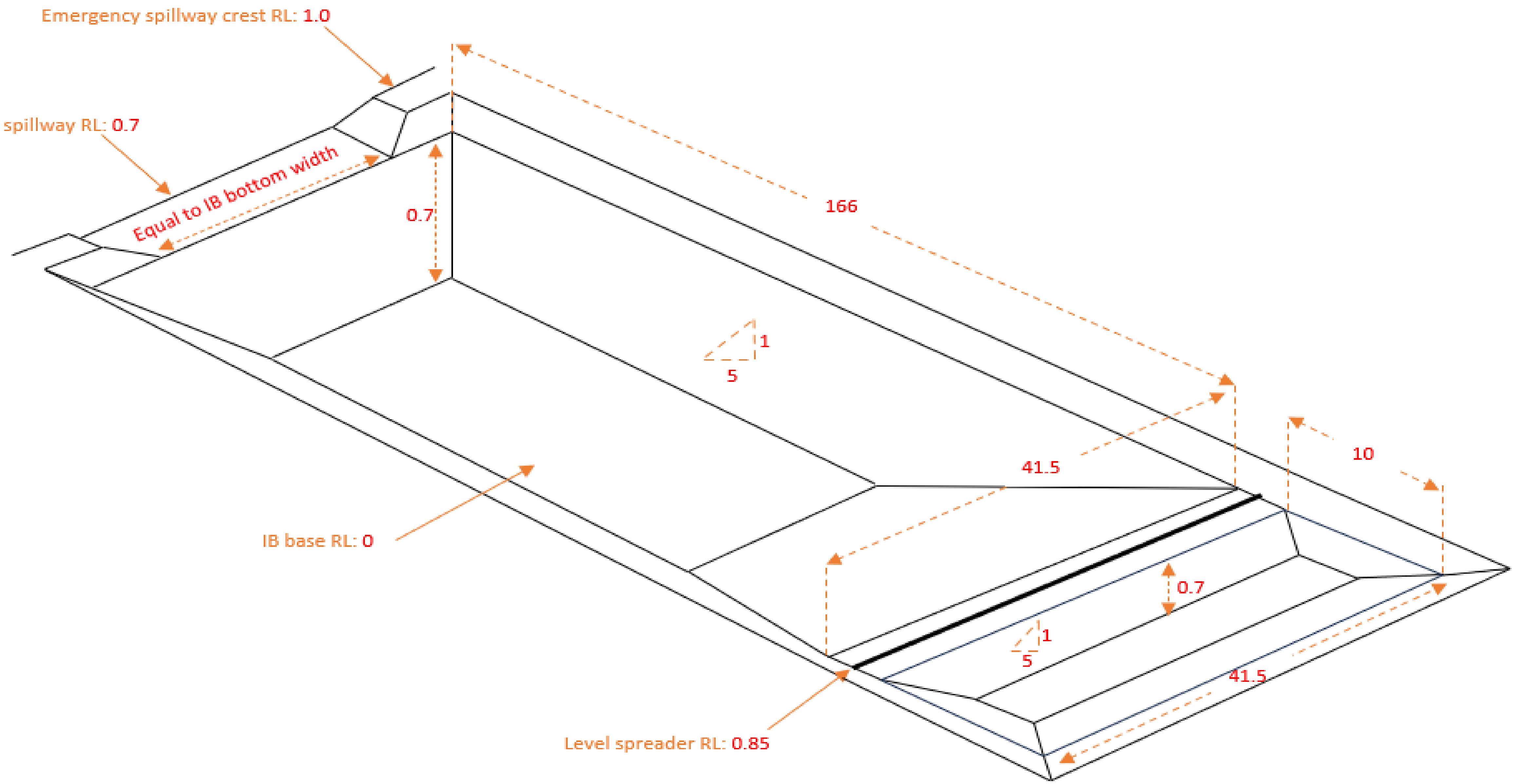
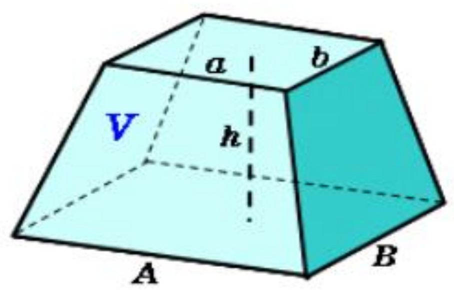


Table 6.5 Representative C values for different soil types and slope (Environment Canterbury, 2007)

Soil types/slope	C factor
Flat gravel (<5%)	0.15
Sloping gravel (>10%)	0.25
Flat silt loam (<5%)	0.3
Sloping silt loam (10-20%)	0.4
Steep silt loam (>20%)	0.5
Clay (<10%)	0.65
Clay (>10%)	0.75

IB dimensions at emergency spillway invert

A	166	m	Pond volume calc:
B	41.50	m	**4325.36**
a	159.00	m	
b	34.50	m	
h	0.7	m	



Obelisk

(1) *volume :* $V = \frac{h}{6}(Ab + aB + 2(ab + AB))$

Infiltration basin Identifier: **IB7**

Input	Value 1	Value 2		Total/design	Units	Notes / Reference
Catchment information						
Contributing catchment	12.58				ha	Based on project shapefiles and assumed ESC installations
Slope length (longest flow path)	800				m	Longest flow path within contributing catchment
Slope gradient (longest)	**1.88**				%	
Slope gradient (immediately upslope)	0.50				**%**	Greater of slope immediately (within 20 m) above IB OR average slope over contributing catchment
Project duration	24				months	Assumed worst case for Area 1 works until 80%+ stabilisation achieved
Peak runoff calculation						Q = 0.00278CiA
Catchment ground cover	Flat gravel	Sloping gravel	Flat grass			
% cover	58%	12%	30%			Flat gravel within the active works area; flat grass underlain by topsoil and then compacted fill for rest
Runoff coefficient (C)	0.15	0.25	0.2			From NZTA ESC Guidelines Table 6.5
Rainfall (i)	2.59	2.59	2.59		mm/hr	HIRDS V4 'Northburn' 5% AEP (20-year ARI), 24-hr duration
Catchment area (A)	7.27	1.51	3.80		ha	Assumed catchment based on prelim design
Peak runoff flow (Q)	0.0079	0.0027	0.0055		m^3/s	
IB design calculations						
Hourly volume required	28.3	9.8	19.7	**48.0**	m^3	Based on accumulated peak runoff flow over 1 hour
24-hour volume required	678.4	234.8	472.8	**1386.0**	m^3	Based on accumulated peak runoff flow over 24 hours
Assumed infiltration rate	175	175	175	**175**	mm/hr	Based on indicative soakage testing within the catchment
Minimum basal area required	161.5	55.9	112.6	**330.0**	m^2	Calculated via A=V/ft, where V = infiltration volume (m^3), f = infiltration rate (m/hr) and t = time (hrs)
Top length (A)				100.00	m	
Top width (B)				25.00	m	
Basal length (a)				93.00	m	
Basal width (b)				18.00	m	
Depth (h)				0.7	m	Shallow to enable easy maintenance and avoid high water table
Internal batter ratio				1:5	rise/run	1:5 ratio as not space limited. Reduces scour and stability risk and is trafficable if needed
Calculated actual volume (V)				1455.2	m^3	
Actual basal infiltration area				1674.0	m^2	
Length-width ratio				4:1	ratio	Ratio must be ≥3:1 & ≤5:1, measured at height of primary spillway
Additional storage buffer				5.0	%	~5% additional storage above minimum storage required (not including infiltration capacity)
Forebay						
Depth				0.7	m	
Width				8.00	m	1:5 batters with 1 m wide forebay flat bottom
Length				25.00	m	Full width of basin
Level spreader						
Width				25.00	m	Must span full width of basin
Height above emergency spillway invert				0.15	m	Must be 0.1 - 0.2 m above emergency spillway invert
Downstream inlet batter gradient				1:5	rise/run	
Emergency spillway						
Spillway invert depth from crest				0.3	m	Minimum 0.3 m below top of IB embankment
Spillway bottom width				18.00	m	Full width of the IB base

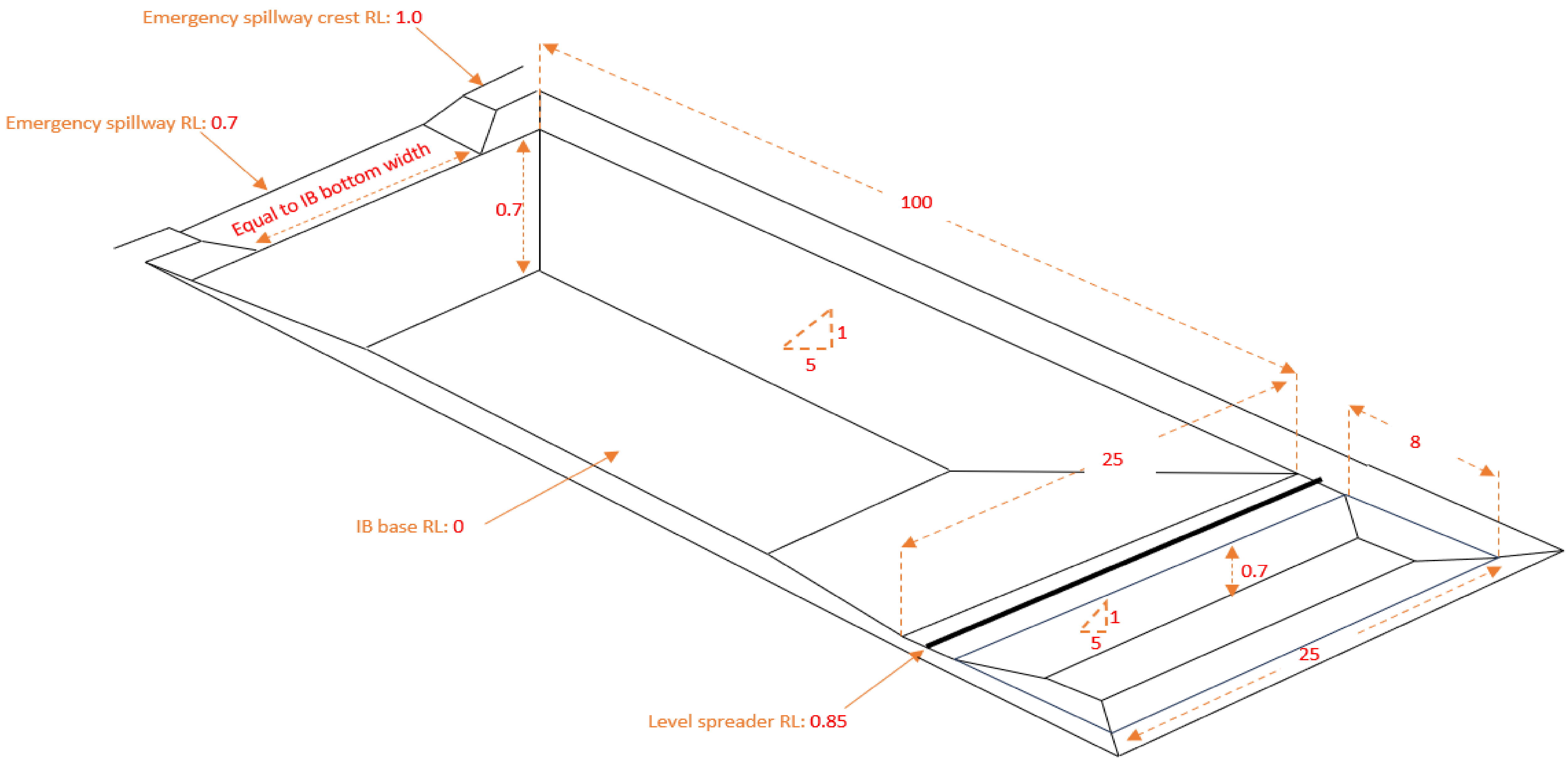
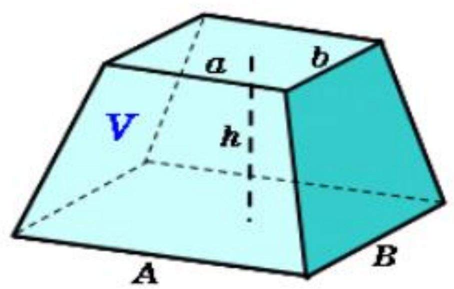


Table 6.5 Representative C values for different soil types and slope (Environment Canterbury, 2007)

Soil types/slope	C factor
Flat gravel (<5%)	0.15
Sloping gravel (>10%)	0.25
Flat silt loam (<5%)	0.3
Sloping silt loam (10-20%)	0.4
Steep silt loam (>20%)	0.5
Clay (<10%)	0.65
Clay (>10%)	0.75

IB dimensions at emergency spillway invert

A	100	m	Pond volume calc:
B	25.00	m	**1455.18**
a	93.00	m	
b	18.00	m	
h	0.7	m	

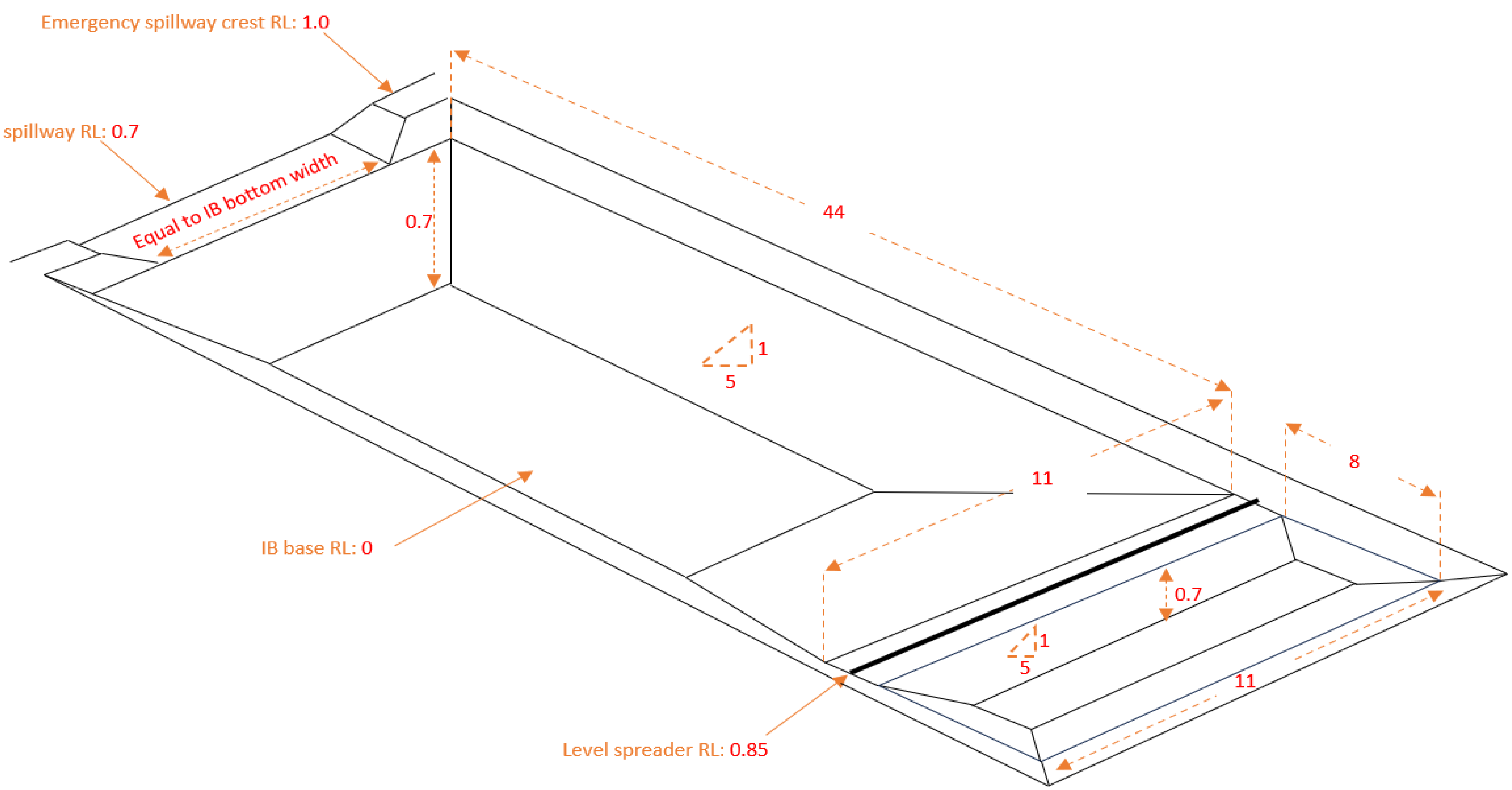


Obelisk

(1) *volume* : $V = \frac{h}{6}(Ab + aB + 2(ab + AB))$

Infiltration basin Identifier: **IB8**

Input	Value 1	Value 2	Total/design	Units	Notes / Reference
Catchment information					
Contributing catchment	2.11			ha	Based on project shapefiles and assumed ESC installations
Slope length (longest flow path)	141			m	Longest flow path within contributing catchment
Slope gradient (longest)	**0.71**			%	
Slope gradient (immediately upslope)	0.50			**%**	Greater of slope immediately (within 20 m) above IB OR average slope over contributing catchment
Project duration	24			months	Assumed worst case for Area 1 works until 80%+ stabilisation achieved
Peak runoff calculation					Q = 0.00278CiA
Catchment ground cover	Flat gravel				
% cover	100%				
Runoff coefficient (C)	0.15				From NZTA ESC Guidelines Table 6.5
Rainfall (i)	2.59			mm/hr	HIRDS V4 'Northburn' 5% AEP (20-year ARI), 24-hr duration
Catchment area (A)	2.11			ha	Assumed catchment based on prelim design
Peak runoff flow (Q)	0.0023			m^3/s	
IB design calculations					
Hourly volume required	8.2		**8.2**	m^3	Based on accumulated peak runoff flow over 1 hour
24-hour volume required	196.9		**196.9**	m^3	Based on accumulated peak runoff flow over 24 hours
Assumed infiltration rate	175		**175**	mm/hr	Based on indicative soakage testing within the catchment
Minimum basal area required	46.9		**46.9**	m^2	Calculated via A=V/ft, where V = infiltration volume (m^3), f = infiltration rate (m/hr) and t = time (24 hrs)
Top length (A)			44.00	m	
Top width (B)			11.00	m	
Basal length (a)			37.00	m	
Basal width (b)			4.00	m	
Depth (h)			0.7	m	Shallow to enable easy maintenance and avoid high water table
Internal batter ratio			1:5	rise/run	1:5 ratio reduces scour and stability risk and is trafficable if needed
Calculated actual volume (V)			215.5	m^3	
Actual basal infiltration area			148.0	m^2	
Length-width ratio			4:1	ratio	Ratio must be ≥3:1 & ≤5:1, measured at height of primary spillway
Additional storage buffer			9.4	%	~9% additional storage above minimum storage required (not including infiltration capacity)
Forebay					
Depth			0.7	m	
Width			8.00	m	1:5 batters with 1 m wide forebay flat bottom
Length			11.00	m	Full width of basin
Level spreader					
Width			11.00	m	Must span full width of basin
Height above emergency spillway invert			0.15	m	Must be 0.1 - 0.2 m above emergency spillway invert
Downstream inlet batter gradient			1:5	rise/run	
Emergency spillway					
Spillway invert depth from crest			0.3	m	Minimum 0.3 m below top of IB embankment
Spillway bottom width			4.00	m	Full width of the IB base



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Soil types/slope	C factor
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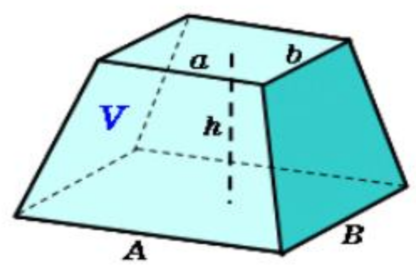
Sloping gravel (>10%)	0.25
Flat silt loam (<5%)	0.3
Sloping silt loam (10-20%)	0.4
Steep silt loam (>20%)	0.5
Clay (<10%)	0.65
Clay (>10%)	0.75

IB dimensions at emergency spillway invert

A	44	m	Pond volume calc:
B	11.00	m	**215.48**
a	37.00	m	
b	4.00	m	
h	0.7	m	



Obelisk

(1) *volume* : $V = \frac{h}{6}(Ab + aB + 2(ab + AB))$

Indicative DWDC and CWDC design

Swale drains to: IB6 (DWDC) & Area 4c & 4b southern (CWDC)

	DWDC	CWDC	
Catchment area (ha)	36.09	6.00	
Catchment flowpath length (m)	450	229	
Catchment elevation fall (m)	4	6	
Gradient (%)	0.9	2.6	
Retardance coefficient (N)*	0.01	0.01	*Representative of smooth, packed gravel

Conveyance capacity requirements: 5% AEP storm plus 300 mm freeboard (assumed)

5% AEP rainfall intensity calculations

DWDC catchment	DWDC	CWDC	Unit
Area	36.09	6	ha
Rainfall intensity (10 min duration)*	44.5	44.5	mm/hour

*Based on hirds.niwa.co.nz for Site ID: NORTHBURN

source: https://www.maine.gov/dep/land/stormwater/stormwaterbmps/vol3/appendixa.pdf

Peak runoff calculations

Using Rational Method: Q = CiA/360

	DWDC	CWDC	Unit	
C (runoff coefficient)	0.55	0.55	N/A	Generally flat, compacted gravels
i (rainfall intensity)	44.5	44.5	mm/hour	
A (catchment area)	36.09	6	ha	
Q (peak flow)	2.4536	0.4079	m^3/s	

Calculate channel design

Using Manning's Formula Trapezoidal Channel Flow calculator

Roughness coefficient (n): 0.025 (Earth, gravelly)

	DWDC	CWDC	Unit
Channel flow path (length)	360	548	m
Elevation fall	2	4	m
Slope	0.6	0.7	%

Source: https://www.engineeringtoolbox.com/mannings-roughness-d_799.html

RUNOFF COEFFICIENTS FOR THE RATIONAL FORMULA

Typical Composite Runoff Coefficients by Land Use		Normal Range of Runoff Coefficients	
Area Description	C-value	Surface Characteristic	C-value
Business		**Lawns**	
Downtown Areas	0.70-0.95	Sandy Soil, Flat (2%)	0.05-0.10
Neighborhood Areas	0.50-0.70	Sandy Soil, Ave. (2-7%)	0.10-0.15
		Sandy Soil, Steep (>7%)	0.15-0.20
Residential		Heavy Soil, Flat (2%)	0.13-0.17
Single Family Areas	0.30-0.50	Heavy Soil, Ave. (2-7%)	0.18-0.22
Multi-Units (detached)	0.40-0.60	Heavy Soil, Steep (>7%)	0.2500.35
Multi-Units (attached)	0.60-0.75		
Suburban	0.25-0.40	**Agricultural**	
Apartments	0.50-0.70	Bare Packed Soil	
		Smooth	0.30-0.60
Industrial		Rough	0.20-0.50
Light Use	0.50-0.80	Cultivated Rows	
Heavy Use	0.60-0.90	Heavy Soil, no crop	0.30-0.60
Railroad Yards	0.20-0.35	Heavy Soil, with crop	0.20-0.50
Unimproved Areas	0.10-0.30	Sandy Soil, no crop	0.20-0.40
		Sandy Soil, with crop	0.10-0.25
Park		Pasture	
Park/Cemeteries	0.10-0.25	Heavy Soil	0.15-0.45
Playgrounds	0.20-0.35	Sandy Soil	0.05-0.25
Pavement		**Woodland**	0.05-0.25
Asphalt and Concrete	0.70-0.95		
Brick	0.70-0.85		
Roof	0.75-0.95		

The presented C-values are typical for return periods of 2-10-year storms with the higher values for the larger design storms. Judgement must be used to select the appropriate C-value within the range for the land use. Generally, larger areas with permeable soils, flat slopes, and dense vegetation should have the lower C-value; and smaller areas with low permeability soils, steep slopes and sparse vegetation should be assigned higher a C-value.

Surface Material	Manning's Roughness Coefficient - *n* -
Asbestos cement	0.011
Asphalt	0.016
Brass	0.011
Brick and cement mortar sewers	0.015
Canvas	0.012
Cast or Ductile iron, new	0.012
Clay tile	0.014
Concrete - steel forms	0.011
Concrete (Cement) - finished	0.012
Concrete - wooden forms	0.015
Concrete - centrifugally spun	0.013
Copper	0.011
Corrugated metal	0.022
Earth, smooth	0.018
Earth channel - clean	0.022
Earth channel - gravelly	0.025
Earth channel - weedy	0.030
Earth channel - stony, cobbles	0.035
Floodplains - pasture, farmland	0.035
Floodplains - light brush	0.050
Floodplains - heavy brush	0.075
Floodplains - trees	0.15
Galvanized iron	0.016
Glass	0.010
Gravel, firm	0.023
Lead	0.011
Masonry	0.025
Metal - corrugated	0.022
Natural streams - clean and straight	0.030
Natural streams - major rivers	0.035
Natural streams - sluggish with deep pools	0.040
Natural channels, very poor condition	0.060
Plastic	0.009
Polyethylene PE - Corrugated with smooth inner walls	0.009 - 0.015
Polyethylene PE - Corrugated with corrugated inner walls	0.018 - 0.025
Polyvinyl Chloride PVC - with smooth inner walls	0.009 - 0.011

Sizing calculations for DWDC:

Inputs

Bottom width, b	2	m	X
Side slope 1 (horiz./vert.)	3		X
Side slope 2 (horiz./vert.)	3		X
Manning roughness, n ? ○Strickler ○B/B (See notes)	0.025		X
Channel slope, S	1	% rise/run	X
Flow depth, y	0.43	m	X

Results

Flow area, a	1.4147	m^2	X
Wetted perimeter, P_w	4.7196	m	X
Hydraulic radius, R_h	0.2998	m	X
Velocity, v	1.7916	m/s	X
Flow, Q	2.5345	m^3/s	X
Velocity head, h_v	0.1637	m	X
Top width, T	4.5800	m	X

Thus with a bottom width of 2m, side slopes of 3:1, and a design flow depth of 0.43 m,
flow capacity of 2.53 m^3/s is achieved. This exceeds the 2.45 m^3/s design flow for the DWDC.

Sizing calculations for CWDC:

Inputs

Bottom width, b	1	m	X
Side slope 1 (horiz./vert.)	3		X
Side slope 2 (horiz./vert.)	3		X
Manning roughness, n ? ○Strickler ○B/B (See notes)	0.025		X
Channel slope, S	1	% rise/run	X
Flow depth, y	0.25	m	X

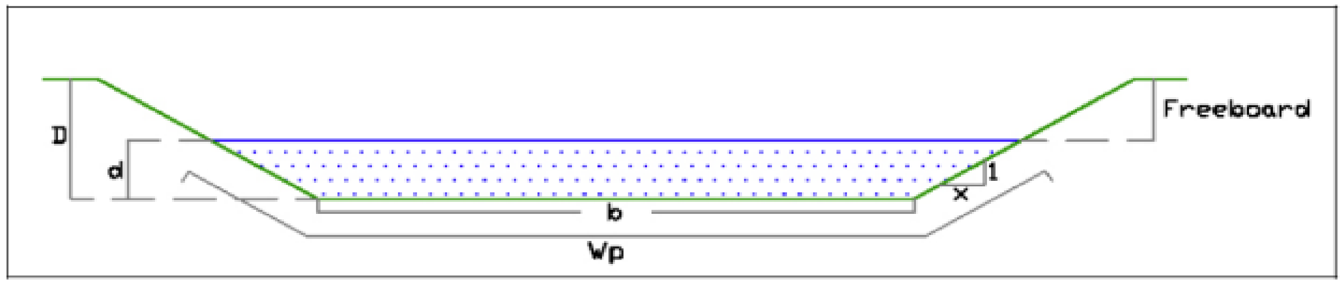
Results

Flow area, a	0.4375	m^2	X
Wetted perimeter, P_w	2.5811	m	X
Hydraulic radius, R_h	0.1695	m	X
Velocity, v	1.2251	m/s	X
Flow, Q	0.5360	m^3/s	X
Velocity head, h_v	0.0765	m	X
Top width, T	2.5000	m	X

Thus with a bottom width of 1m, side slopes of 3:1, and a design flow depth of 0.25 m,
flow capacity of 0.54 m^3/s is achieved. This exceeds the 0.41 m^3/s design flow for the DWDC.

Summary of dimensions for all swales

	Swale 1	Swale 2	Unit
Bottom width (b)	2	1	m
Side slope gradient	3	3	H:V
Effective depth (d)	0.43	0.25	m
Depth + 300 mm freeboard (D)	0.73	0.55	m
Average channel slope	0.6	0.7	%
Flow capacity (Q)	2.5300	0.5400	m^3/s
Q (peak flow)	2.4536	0.4079	m^3/s



Appendix G: Accidental Discovery Protocol

APPENDIX 4: HERITAGE NEW ZEALAND POUHERE TAONGA ARCHAEOLOGICAL DISCOVERY PROTOCOL

HERITAGE NEW ZEALAND
POUHERE TAONGA

Heritage New Zealand Pouhere Taonga Archaeological Discovery Protocol

Under the Heritage New Zealand Pouhere Taonga Act (2014) an archaeological site is defined as any place in New Zealand that was associated with human activity that occurred before 1900 and provides or may provide, through investigation by archaeological methods, evidence relating to the history of New Zealand. For pre-contact Maori sites this evidence may be in the form of bones, shells, charcoal, stones etc. In later sites of European/Chinese origin, artefacts such as bottle glass, crockery etc. may be found, or evidence of old foundations, wells, drains or similar structures. Burials/koiwi tangata may be found from any historic period.

In the event that an unidentified archaeological site is located during works, the following applies;

1. Work shall cease immediately at that place and within 20m around the site.
2. The contractor must shut down all machinery, secure the area, and advise the Site Manager.
3. The Site Manager shall secure the site and notify the Heritage New Zealand Regional Archaeologist. Further assessment by an archaeologist may be required.
4 If the site is of Maori origin, the Site Manager shall notify the Heritage New Zealand Regional Archaeologist and the appropriate iwi groups or kaitiaki representative of the discovery and ensure site access to enable appropriate cultural procedures and tikanga to be undertaken, as long as all statutory requirements under legislation are met (*Heritage New Zealand Pouhere Taonga Act*, *Protected Objects Act*).
5. If human remains (koiwi tangata) are uncovered the Site Manager shall advise the Heritage New Zealand Regional Archaeologist, NZ Police and the appropriate iwi groups or kaitiaki representative and the above process under 4 shall apply. Remains are not to be moved until such time as iwi and Heritage New Zealand have responded.
6. Works affecting the archaeological site and any human remains (koiwi tangata) shall not resume until Heritage New Zealand gives written approval for work to continue. Further assessment by an archaeologist may be required.
7. Where iwi so request, any information recorded as the result of the find such as a description of location and content, is to be provided for their records.
8. Heritage New Zealand will determine if an archaeological authority under the *Heritage New Zealand Pouhere Taonga Act* 2014 is required for works to continue.

It is an offence under S87 of the *Heritage New Zealand Pouhere Taonga Act 2014* to modify or destroy an archaeological site without an authority from Heritage New Zealand irrespective of

Appendix H: Parkburn soil permeability testing report

29 April 2026

Fulton Hogan Land Development Ltd
C/- Tim James
Via email: tjdjames.nz@gmail.com
CC: Will@landpro.co.nz

Re: Soil Permeability Testing, Parkburn Quarry

Our Reference: 24019_4

1 Introduction and Scope of Report

JKCM Ltd, trading as Insight Engineering (IE), was requested to arrange and observe three soil permeability tests at the Parkburn Quarry (herein referred to as 'the site'). The tests were requested to inform the erosion and sediment control plans for the future land development earthworks proposed to be carried out at the site.

This letter presents a brief description of the tests, calculations and a summary of results.

2 Soil Permeability Tests

2.1 Methodology

Three soil permeability tests were completed at the site on 24 April 2026. As the tests were arranged with short notice, we opted to use test pits, rather than boreholes or standpipes to complete the tests.

The test pits were excavated using a 1.8T excavator. Due to the relatively dense ground conditions, the test pits were all terminated at a depth of 0.6 m. The sides and base of the test pits were squared and cleaned as much as practicable prior to commencing the tests.

Each test pit was filled with water to approximately 100-150 mm below the top, with the water level measured from a fixed point.

It was not possible to pre-soak the test pits, however at Test 1, where the water drained away rapidly (in less than 10 minutes), the test was repeated three times. At Test 2 the rate at which the water drained was significantly slower than Test 1, and therefore the test was terminated after an hour when the remaining water depth was less than 0.25 m above the base of the pit.

At Test 3, the base of the test pit was approximately 0.5 to 1 m above the lake level (as estimated from information provided by Fulton Hogan quarry operators). The water was not observed to drain for a period of 45 minutes and therefore the test was terminated and no calculations were performed.

2.2 Test Pits

The locations of the three test pits are shown on the attached plan.

2.2.1 Test 1

The soil conditions encountered at Test 1 included 100mm of topsoil overlying dry, brown sandy, fine to coarse GRAVEL with some cobbles and trace silt. The gravel was observed to be loosely packed, well graded and sub-rounded to sub-angular.

2.2.2 Test 2

No topsoil was present at the location of Test 2. The test pit exposed dry, brownish-grey sandy, fine to coarse GRAVEL with some cobbles and trace silt and boulders. The gravel was observed to be tightly packed, well graded and sub-rounded to sub-angular.

2.2.3 Test 3

No topsoil was present at the location of Test 3. The test pit exposed dry, brownish-grey sandy, fine to coarse GRAVEL with some cobbles and trace silt and boulders. The gravel became wet at a depth of 0.3 m and was observed to be loosely to tightly packed, well graded and sub-rounded to sub-angular.

3 Results

3.1 Percolation/Infiltration Rates

Percolation/infiltration rates were calculated for Test 1 and Test 2 using two methods. The more conservative result for each are presented below. As discussed in the preceding section, no results were able to be calculated for Test 3 as the water did not soak away.

Calculation worksheets are attached to this letter.

Test 1

The calculated infiltration rate is 3.85×10^{-4} m/s or 1,380 mm/hr.

Test 2

The calculated infiltration rate is 4.9×10^{-5} m/s or 175 mm/hr.

3.2 Erodibility Factor K

We attempted to assess the erodibility factor K for the typical site materials based on observations in the field, as well as making some assumptions on the material properties. It must be noted that our assessment of this factor is limited and based on several assumptions of the soil properties. Therefore further laboratory or field testing may be required (noting that an emersion test and a specific sieve and hydrometer analysis has not been carried out yet).

Erodibility factor K is estimated using the Wischmeier and Smith nomograph.

$$100K = 2.1M^{1.14}(10^{-4})(12 - a) + 3.25(b - 2) + 2.5(c - 3)$$

Where:
M = (%silt + %sand) x (100 - % clay)
a = % organic
b = soil structure code (taken as 2 in this case, fine granular)
c = soil permeability class (taken as 5 in this case, slow materials exposed by deep excavation of the quarry).

In this case, we estimated the percentage sand, silt and clay from a prior grading curve for pit run material sampled from the quarry (attached). Taking the percentage of sand as 13%, and assuming 1% for silt and clay respectively, the calculated M value is 1,287.

Therefore, the calculated K factor is 0.14 (US units) or 0.0182 (SI units).

We reiterate again that this factor is based on several assumptions and we strongly advise that this factor should be reviewed once further laboratory and/or field test data is available.

4 Limitations

i. We have prepared this report in accordance with the brief as provided. This report has been prepared for the use of our client, Fulton Hogan Land Development Ltd, their professional advisers and the relevant Territorial Authorities in relation to the specified project brief described in this report. No liability is accepted for the use of any part of the report for any other purpose or by any other person or entity.

ii. The recommendations in this report are based on the ground and material conditions indicated from published sources, inspections and tests described in this report based on accepted normal methods of site investigations. Only a limited amount of information has been collected to meet the specific financial and technical requirements of the Client's brief and this report does not purport to completely describe all the site and material characteristics and properties. The nature and continuity of the ground between test locations has been inferred using experience and judgement and it must be appreciated that actual conditions could vary from the assumed model.

iii. Subsurface conditions relevant to construction works should be assessed by contractors who can make their own interpretation of the factual data provided. They should perform any additional tests as necessary for their own purposes.

iv. This Limitation should be read in conjunction with the IPENZ/ACENZ Standard Terms of Engagement.

v. This report is not to be reproduced either wholly or in part without our prior written permission.

Report prepared by

Jana Kruyshaar, CMEngNZ, MIPENZ
Principal Geotechnical Engineer

Appendix 1: Test Location Plan

Appendix 2: Soil Permeability Calculation Worksheets

Appendix 3: Laboratory Particle Size Distribution Result (Pit Run)

Appendix 1

Test Location Plan

Description	Soil Permeability Test Locations (Not to scale, for information only)		
Project	Parkburn Development	Date drawn	24/04/2026
Client	Fulton Hogan Land Development Ltd	Drawn by	JK
Reference Number	24019	Approved by	CM

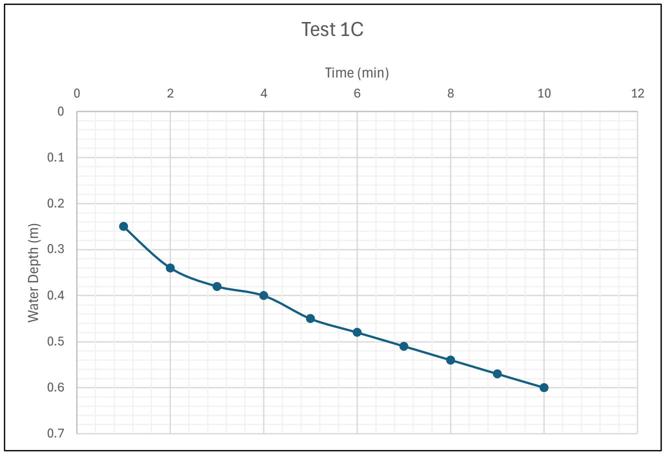
Appendix 2

Soil Permeability Calculation Worksheets

Measurements

Test 1C

Time (min)	Difference in depth (m)
0	
1	0.25
2	0.34
3	0.38
4	0.4
5	0.45
6	0.48
7	0.51
8	0.54
9	0.57
10	0.6
	empty



Calculations

Percolation Rate Calculation (Method 1):

$P = V_y/(AT \times X)$

Length pit	1.2	m
width pit	1	m
y*	0.03	m
d**	0.045	m
water vol V_y	0.036	m^3
wall area A1	0.06	m^2
wall area A2	0.072	m^2
base area AB	1.2	m^2
total area AT	1.332	m^2
Percolation rate P	0.027	m/min
Percolation rate P	27.027	mm/min
Percolation rate P	**1621.622**	**mm/hr**
Percolation rate P	**4.50E-04**	**m/s**

*y is the depth difference btw the last 2 points
**d is the distance btw the midpoint of the last 2 readings and the base of the pit
X is the time interval between the last two points in minutes

BRE Digest Method:

$$f = \frac{V_{p75-25}}{a_{p50} \times t_{p75-25}}$$

Length	1.2	m
Width	1	m
Depth	0.6	m
Area Base Abase	1.2	m^2
H eff storage depth	0.4	m
*V_{p75-25}	0.24	m^3
75% depth	0.3	m
25% depth	0.1	m
50% depth	0.2	m
**A_{p50}	2.08	m^2
***Tp75	1.5	min
****Tp25	6.5	min
T_{p75-25}	5	min
	300	s
Infiltration rate f	**3.846E-04**	**m/s**
Infiltration rate f	**1384.615**	**mm/hr**

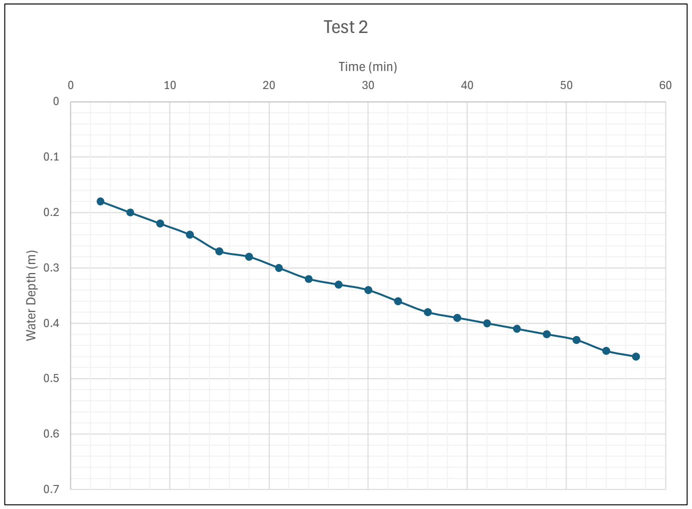
*Vol lost btw 75% and 25% of effective depth
**Mean surface area at 50% depth (incl base)
***Time at 75% depth of effective depth
****Time at 25% depth of effective depth

Measurements

Test 2

Time (min)	Difference in depth (m)
0	
3	0.18
6	0.2
9	0.22
12	0.24
15	0.27
18	0.28
21	0.3
24	0.32
27	0.33
30	0.34
33	0.36
36	0.38
39	0.39
42	0.4
45	0.41
48	0.42
51	0.43
54	0.45
57	0.46

Base of TP is 0.6m



Calculations

Percolation Rate Calculation (Method 1):

$P = V_y/(AT \times X)$

Length pit	1.2	m
width pit	1.1	m
y*	0.01	m
d**	0.145	m
water vol V_y	0.0132	m^3
wall area A1	0.022	m^2
wall area A2	0.024	m^2
base area AB	1.32	m^2
total area AT	1.366	m^2
Percolation rate P	0.003	m/min
Percolation rate P	3.221	mm/min
Percolation rate P	**193.265**	**mm/hr**
Percolation rate P	**5.37E-05**	**m/s**

*y is the depth difference btw the last 2 points
**d is the distance btw the midpoint of the last 2 readings and the base of the pit
X is the time interval between the last two points in minutes

BRE Digest Method:

$$f = \frac{V_{p75-25}}{a_{p50} \times t_{p75-25}}$$

Length	1.2	m
Width	1.1	m
Depth	0.6	m
Area Base Abase	1.32	m^2
H eff storage depth	0.45	m
*V_{p75-25}	0.297	m^3
75% depth	0.3375	m
25% depth	0.1125	m
50% depth	0.225	m
**A_{p50}	2.355	m^2
***Tp75	14	min
****Tp25	57	min
T_{p75-25}	43	min
	2580	s
Infiltration rate f	**4.888E-05**	**m/s**
Infiltration rate f	**175.974**	**mm/hr**

*Vol lost btw 75% and 25% of effective depth
**Mean surface area at 50% depth (incl base)
***Time at 75% depth of effective depth
****Time at 25% depth of effective depth

Appendix 3

Laboratory Particle Size Distribution Result (Pit Run)

Work Order ID: CTS25W1915

[redacted]

Central Testing Services

Report No: MAT:CTS25S-01765

Issue No: 1

Material Test Report

Client: [redacted]

Project: Parkburn Investigations

The tests reported herein (unless otherwise indicated) have been performed in accordance with the laboratory's scope of accreditation. Samples are tested as received, in natural condition, unless stated otherwise in the comments. This report may only be reproduced in full.

ACCREDITED IANZ TESTING LABORATORY

The results in this report relate only to the items / samples that were tested

[redacted] 6/06/2025

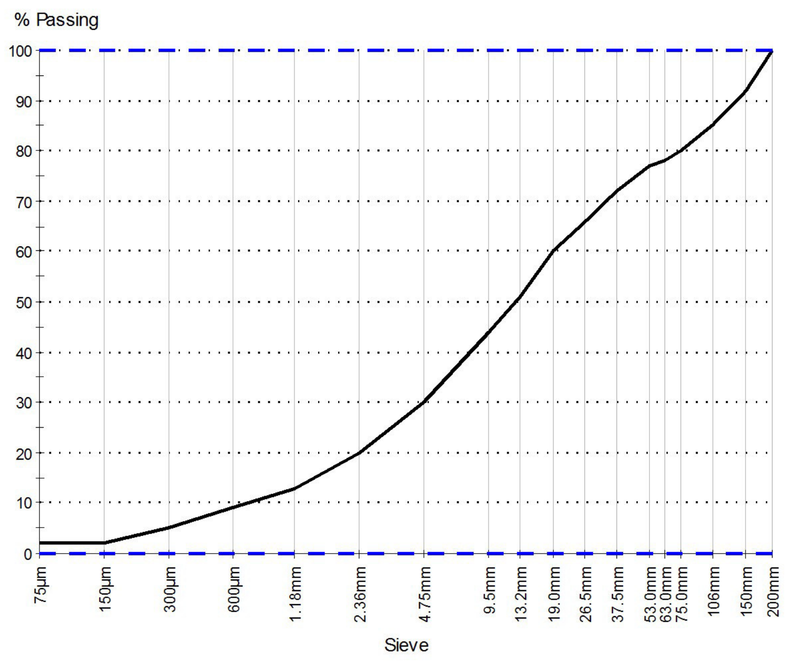
Sample Details

Sample ID: CTS25S-01765
Client Sample ID: 09674
Material: Pit Run - Cobbly GRAVEL with minor sand and trace of silt
Sample Source: Central - Parkburn Quarry
Site/Sampled From: Stockpile
Date Sampled: 26/05/2025
Specification: No Specification
Sampled By: Cam Maxwell
Sampling Method: NZS 4407:2015 2.4.6.3.2 (SP/WG/MACHINE)
Technician: Adam Rowe
Sampling Endorsed?: Yes

Other Test Results

Description	Method	Result	Limits

Particle Size Distribution



Method: NZS 4407:2015 Test 3.8.1
Drying By: Oven
Date Tested: 30/05/2025
Tested By: Adam Rowe
Note: [a] Obtained by difference.

Sieve Size	% Passing	Limits
200mm	100	0 – 100
150mm	92	0 – 100
106mm	85	0 – 100
75.0mm	80	0 – 100
63.0mm	78	0 – 100
53.0mm	77	0 – 100
37.5mm	72	0 – 100
26.5mm	66	0 – 100
19.0mm	60	0 – 100
13.2mm	51	0 – 100
9.5mm	44	0 – 100
4.75mm	30	0 – 100
2.36mm	20	0 – 100
1.18mm	13	0 – 100
600µm	9	0 – 100
300µm	5	0 – 100
150µm	2	0 – 100
75µm	2[a]	0 – 100

Comments

Date Received: 27-May-25