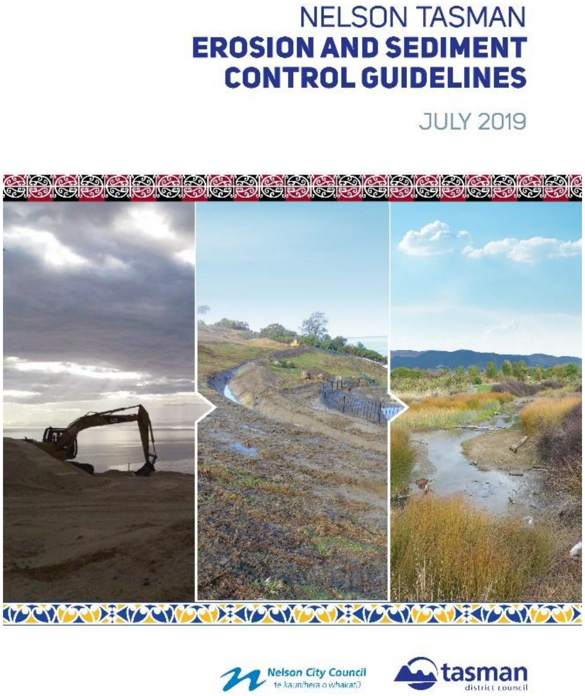
Chapter 13

Appendices



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13.1 Glossary

Term	Definition
AEP - Annual Exceedance Probability	Is the probability of an event occurring or being exceeded in any given year. Expressed as a percentage and generally used in hydrology to define rainstorm intensity and frequency. For example, a five percent AEP event has a five percent chance of being exceeded in any one year. A five percent AEP event expresses approximately the same sized event as a twenty-year return period event.
Anti-seep collar	An impermeable barrier, usually of concrete, constructed at intervals within the zone of saturation along the conduit of a primary outlet pipe to increase the seepage length along the conduit and, thereby prevent piping or seepage in the compacted fill material along the outside of the pipe.
Area of disturbance	The area of soil exposed as a result of the development process.
ARI - Average Recurrence Interval	Is the average time between events, taken over a long time (eg 1000yrs). ARI is the same as "return period" eg a 100-year return event is the same as a 100yr ARI event. Keep in mind that a "1 in 100" year event means there is a 1 per cent chance of the event occurring in a single year, not that the event only occurs once every 100 years.
Baffles	Semi-permeable or solid barriers placed in a sediment retention pond to deflect or regulate flow and effect a more uniform distribution of velocities, hence creating better settling conditions.
Batter	A constructed slope of uniform gradient.
Best practicable option (BPO)	Best practicable option. In relation to a discharge of a contaminant, BPO means the best method for preventing or minimising the adverse effects on the environment having regard, among other things, to: (1) the nature of the discharge or emission and the sensitivity of the receiving environment to adverse effects; (2) the financial implications, and the effects on the environment, of that option when compared with other options; and (3) the current state of technical knowledge and the likelihood that the option can be successfully applied.
Bulk earthworks	This term is generally used to describe the cut to fill earthworks required to re-grade an area. It also applies to larger-scale earthworks such as for building excavations.
Catchment	A geographical unit within which surface runoff is carried under gravity by a single drainage system to a common outlet or outlets. Also commonly referred to as a watershed or drainage basin.
Catchpit	Small chamber incorporating a sediment trap that runoff flows through before entering a reticulated stormwater system (also termed a sump).
Channel	That part of a watercourse system where normal flow is contained. The channel is generally incised into the floodplain and for many of the stable stream systems in New Zealand can be defined in capacity as being just able to accommodate the annual return period flow (one hundred percent AEP) without overtopping. Also refers to an artificial conduit such as a ditch excavated to convey water.
Clay (soils)	A mineral soil consisting of particles less than 0.002mm in equivalent diameter. A soil texture class.
Clean water	Any water that has not been polluted by construction activities and has no visual signs of suspended solids, e.g. Overland flow (sheet or channelled) originating from stable well-vegetated or armoured surfaces.
Cohesion	The capacity of a soil to resist shearing stress, exclusive of functional resistance.

Term	Definition
Compaction	For construction work in soils, engineering compaction is any process by which the soil grains are rearranged to decrease void space and bring them into closer contact with one another, thereby increasing the weight of solid material per unit of volume, increasing their shear and bearing strength and reducing permeability.
Concentrated flow	The accumulation of sheet flow into discrete rills, gullies or channels, significantly increasing erosive forces.
Conduit	Any channel intended for the conveyance of water, whether open or closed.
Contaminant	Includes any substance (including gases, liquids, solids, and micro-organisms) or energy (excluding noise) or heat, that either by itself or in combination with the same, similar, or other substances, energy, or heat: (a) When discharged into water, changes or is likely to change the physical, chemical, or biological condition of water; or (b) When discharged onto or into land or into air, changes or is likely to change the physical, chemical, or biological condition of the land or air onto or into which it is discharged.
Contour	A line across a slope connecting points of the same elevation.
Contributing catchment	All of the drainage area that contributes to the flow into a treatment device. A contributing drainage area can include both clean and sediment-laden water flows. Commonly referred to as the catchment area of a device.
Cumulative effect	The combination of discrete isolated effects, the sum of which can have a major long-term detrimental impact.
Dam	A barrier to confine or raise water for storage or diversion, to create a hydraulic head, to prevent gully erosion, or to retain soil, rock or other debris.
Decant rate	The rate at which surface water is decanted from a sediment retention pond.
Deposition	The accumulation of material that has settled because of reduced velocity of the transporting agent (water or wind).
Dewatering	The removal of impounded water, generally by pumping.
Disturbed area	An area of exposed soil.
Diversion	A channel or bund constructed to convey concentrated flow.
Drainage	The removal of excess surface water or groundwater from land by means of surface or subsurface drains.
Ephemeral watercourse	A watercourse that only flows during or following more intensive rainstorms such as grassland swales and dry gullies.
Erodible	An erodible soil is a soil that is readily entrained (moved) by actions such as raindrop impact, overland flow or wind.
Erosion and Sediment Control Plan (E&SCP)	A detailed plan normally prepared by the developer's engineer that details the way erosion is to be minimised and the treatment of sediment-laden overland flow that is to be undertaken.
Erosion control blankets	Manufactured blankets and matting of either synthetic or natural fibre used to minimise surface erosion by protecting soil from raindrop impact and shallow sheet flows. Similar to but lighter and less durable than erosion-control mats.
Erosion control matting	Manufactured matting of either synthetic or natural fibre used to minimise surface erosion by concentrated flows and, in some cases, to promote revegetation.
Erosive power	Refers to the ability of erosional agents such as wind or water to cause erosion. Not to be confused with erodible, as a quality of soil.
Erosive velocities	Velocities that are high enough to wear away the land surface. Exposed soils erode faster than stabilised soils. Erosive velocities vary according to the soil type, slope, and structural or vegetative stabilisation used to protect the soil.
Estuary	Area where freshwater meets saltwater, where the tide meets the river current (e.g. Bays, mouths of rivers, salt marshes and lagoons). Estuaries serve as

Term	Definition
	nurseries and spawning and feeding grounds for large groups of marine life and provide shelter and food for birds and wildlife. Estuaries are typically low energy systems where sediment readily settles.
Evapo-transpiration	A measure of water movement into the atmosphere from plants, waterways and soil being the sum of surface evaporation and plant transpiration.
Emergency spillway	A sediment retention pond or dam spillway designed and constructed to discharge flow in excess of the structure's primary spillway design discharge.
Energy dissipator	A designed device such as an apron of rip-rap or a concrete structure placed at the end of a water conduit such as a pipe, paved ditch or flume for the purpose of reducing the velocity and energy of the discharged water.
Fill	Earth placed (normally under a strict compaction regime) to raise the land surface.
Filter fabric	A woven or non-woven, water-permeable geotextile made of synthetic products such as polypropylene used for such purposes as preventing clogging of aggregate by fine soil particles. Refer Geotextile fabric.
Flocculation	The process whereby fine particles suspended in the water column clump together and settle. In some instances, this can occur naturally, such as when fresh clay-laden flows mix with saline water, as occurs in estuaries. Flocculation can be used to promote rapid settling in sediment retention ponds by the addition of flocculating chemicals (flocculants).
Flume	A high-velocity, open channel for conveying water to a lower level without causing erosion. Also referred to as a chute, although, technically, a chute is part of a flume; namely, the steeply inclined section of a flume or other similar hydraulic structure, between the inlet and the outlet, that conveys flows directly from one level to another.
Geosynthetic erosion control systems (GECS)	The artificial protection of erodible channels and slopes using artificial erosion control material such as geosynthetic matting, geotextiles or erosion matting. Also see Erosion control blankets and Erosion control matting.
Geotextile fabric	A woven or non-woven, impermeable or semi-permeable material generally made of synthetic products such as polypropylene and used in a variety of engineering, stormwater management, and erosion and sediment control applications.
Grade	(1) The slope of a road, channel or natural ground. (2) The finished surface of a channel bed, road bed, top of embankment or bottom of excavation. (3) Any surface prepared for the support of construction like paving or for laying conduit. (4) To finish the surface of a channel bed, road bed, top of embankment or bottom of excavation.
Gravel	Aggregate consisting of mixed sizes of 5mm to 75mm particles which normally occur in or near old streambeds and have been worn smooth by the action of water.
Headwater	The source of a watercourse; the water upstream of a structure or point on a watercourse.
Hydrology	The science of the behaviour of water in the atmosphere, on the surface of the earth and underground.
Hydroseeding	The pressure-spraying of a slurry of water, seed, fertiliser and paper or wood pulp over a surface to be revegetated.
Impervious	Not allowing infiltration of water.
Intermittent Stream	A stream or stream reach which carries water a considerable portion of the time, but which ceases to flow occasionally or seasonally because bed seepage and evapo-transpiration exceed the available water supply. Those that maintain a

Term	Definition
	series of discrete pools that provide habitat for the continuation of the aquatic ecosystem are important for maintaining aquatic health. 'Intermittent' in the NRMP means a river or stream that is dry at certain times and has one or more of the following characteristics: It is mapped as riparian overlay in the NRMP maps or listed as conservation priority 1 or 2 in Table 6.1 of NRMP Appendix 6, or Has natural stable pools having a depth at their deepest point of not less than 150mm and a surface area not less than 2m2 present throughout the period commencing 1 February and ending 30 April of any year.
Land disturbance	The destruction or removal of vegetation, soil disturbance, or earthworks.
Level spreader	A device used to convert concentrated flow into sheet flow.
Mitigation	Measures taken to off-set adverse environmental effects.
Mulch	Covering on surface of soil to protect it and enhance certain characteristics, such as protection from raindrop impact and improving germination. Mulching can be extended to include gravelling of compound areas, haul roads and access tracks.
Overland flow path	The route of concentrated flow.
Perennial Stream	A permanently flowing stream that normally maintains water in its channel throughout the year, but may dry up in extreme conditions
Permeability (soil)	The rate at which water will move through a saturated soil.
Permitted activities	Activities described in the Resource Management Act, regulations, or a plan or proposed plan that does not require a resource consent if it complies with the standards, terms, or conditions, if any, specified in the plan or proposed plan.
Pervious	Allowing movement of water.
Poly aluminium chloride (PAC)	A long chain chemical that is used as a flocculant in certain situations.
Primary spillway	The riser inlet within a sediment retention pond. See Riser.
Rainfall intensity	The volume of rainfall falling in a given time. Normally expressed as mm/hour.
Receiving environment	The ultimate destination of a discharge, whether via a reticulated stormwater system, from surface runoff or via direct discharge.
Rehabilitation	Restoration to as near to pre-disturbance conditions as possible. This may entail such measures as revegetation for erosion control, enhancement planting, modification and armouring of watercourses.
Return period	Refer Average Recurrence Interval (ARI)
Revegetation	The establishment of vegetation to stabilise a site.
Riser	In a sediment retention pond, a vertically placed pipe to which decant pipes are attached, which forms the inlet to the primary spillway.
River	A continually or intermittently flowing body of fresh water; and includes a stream and modified watercourse; but does not include any artificial watercourse (including an irrigation canal, water supply race, canal for the supply of water for electricity power generation, and farm drainage canal).
Scour	The erosive, tractive or digging action of flowing water; the downward or lateral erosion caused by water. Channel-forming stream scour is caused by the sweeping away of mud and silt from the outside bank of a curved channel (meander), particularly during a flood.
Sediment	Solid material, both mineral and organic, that is in suspension, is being transported, or has been moved from site of origin by air, water, gravity, or ice and has come to rest on the earth's surface either above or below water.

Term	Definition
Sediment delivery ratio	The proportion of the soil eroded from within a catchment area that actually reaches sediment treatment controls or water bodies.
Sediment yield	The quantity of sediment discharged from a particular site or catchment in a given time, measured in dry weight or by volume. When erosion and sediment control measures are in place, sediment yield is the sediment discharged from the site after passing through those measures.
Settling	The downward movement of suspended solids through the water column.
Shear strength	The ability to resist shear (slip) forces.
Sheet flow	Shallow dispersed overland flow.
Shutter boards	Plywood or similar sheeting supported by light timber framing normally used for boxing concrete forms.
Silt	A soil consisting of particles between 0.05 and 0.002 millimetres in equivalent diameter; a soil textural class.
Silt loam	A soil textural class containing a large amount of silt and small quantities of sand and clay.
Silty clay	A soil textural class containing a relatively large amount of silt and clay and a small amount of sand.
Slope	Degree of deviation of a surface from the horizontal, measured as a numerical ratio, as a percent, or in degrees. Expressed as a ratio, the first number is the horizontal distance (run) and the second number is the vertical distance (rise), eg 2h:1v. A 2:1 slope is a fifty percent slope or a slope of 26.57 degrees. A 90° slope is vertical (maximum) and a 45° slope is a 1:1 slope.
Small site	Small areas of earth disturbance such as a residential building site (dwelling and surrounds) that normally do not require a resource consent for land disturbance from Tasman District Council.
Soil	The unconsolidated mineral and organic material on the surface of the earth that serves as a natural medium for the growth of land plants. Earth and rock particles resulting from the physical and chemical disintegration of rocks, which may or may not contain organic matter. Includes fine material (silts and clays), sand and gravel.
Soil structure	Soil structure reflects the pore space within a soil available for aeration and storage of water. It is a measure of bulk density, and as a rule the higher the soil bulk density the poorer the structure. The combination or arrangement of primary soil particles into secondary particles, units or peds. Good soil structure is important for plant growth.
Soil texture	The relative proportions of various particle sizes in a soil material.
Stabilisation	Providing adequate measures, vegetative and/or structural that will protect exposed soil to prevent erosion.
Staging of construction	The completion of bulk earthworks in successive time phases to minimise the area of bare earth exposed at any one time.
Subsoil	The B-horizons of soils with distinct profiles. In soils with weak profile development, the subsoil can be defined as the soil below the ploughed soil (or its equivalent of surface soil), in which roots normally grow.
Sump	Small chamber incorporating a sediment trap that runoff flows through before entering a reticulated stormwater system (also termed a catchpit).
Surface runoff	Rain that runs off rather than being infiltrated into or retained on the surface on which it falls.
Surface water	All water with its surface exposed to the atmosphere.
Suspended solids	Solids either floating or suspended in water.

Term	Definition
Swale	A constructed, elongated depression in the land surface that can be seasonally wet, is usually heavily vegetated, and is normally without flowing water. Swales conduct stormwater into primary drainage channels and can provide some pollutant retention and groundwater recharge.
Tackifier	A compound that is added to straw mulch to bind it together and prevent it being blown around by the wind.
Temporary watercourse crossing	A stable watercourse crossing that is installed for the duration of an operation and is removed in its entirety at the completion of the operation.
Tensile strength	Resistance to elongation and tearing.
Time of concentration	The time for runoff to flow from the most remote part of the drainage area to the outlet.
Toe (of slope)	Where the slope stops or levels out. Bottom of the slope.
Topsoil	Fertile or desirable soil material (suitable organic and structural properties) used to top-dress road banks, subsoils, parent material, etc., to provide a suitable medium for plant growth.
Treatment Train	A treatment train comprises a series of best management practices (structural and non-structural) and/or natural features, each planned to treat a different aspect of pollution prevention, that are implemented in a linear fashion to maximise pollutant removal.
Universal soil loss equation (USLE)	An equation used for the design of a water erosion control system A = RKLSCP where: A = the soil loss in tonnes per ha per annum; R = the rainfall factor; K = the soil erodibility factor; LS = the slope length and gradient factor C = the vegetation factor; P = the surface roughness factor.
Water body	Any type of surface water such as watercourses, lakes and wetlands.
Watercourse	Any pathway for concentrated overland flow, including rivers, streams and ephemeral channels.
Water table	The upper surface of the free groundwater in a zone of saturation; locus of points in soil water at which hydraulic pressure is equal to atmospheric pressure. (not to be confused with a 'water table drain')
Water table drain	A drain that parallels a carriageway to drain surface and subsurface water from the road formation.
Wetland	Includes permanently or intermittently wet areas, shallow water, and land water margins that support a natural ecosystem of plants and animals that are adapted to wet conditions.

13.2 Erosion and Sediment Control Plan Symbols

Erosion and Sediment Control Plans (E&SCP) are expected to be of a proportionate scale to that of the project works and erosion and sedimentation risk. The following symbols are intended to provide a consistent basis for production of erosion and sediment control plan maps and provide spatial references for associated text in written methodologies..

Table 13-1 Standard Symbols for use on Erosion and Sediment Control Plans

Map feature	Symbol	Map feature	Symbol	Map feature	Symbol
North arrow	N	Turfing	T	Historical / Cultural Sites	H23
ESC unique identifying numbers	ESC12	Geotextile / geosynthetic control system	GT	Natural Features	NF15
Extent of land disturbance	D	Dust control	DC	Site Entranceways	E
Topsoil / materials stockpiles	SP	Sediment retention pond		Site/Property Boundaries	
Check dams (One symbol per dam structure)		Silt fence		Contour lines	
Contour drains	CD	Super silt fence	SSF	Vegetation to be retained	native
Dirty Water Diversion Channel/Bund	DWD	Decanting earth bund	DEB Earth Bund	Vegetation to be removed	remove
Clean Water Diversion Channel/Bund	CWD	Flocculation shed	FS	Trade Activity Zones	TAZ
Pipe drop or flume structure		Dewatering device/system	DWS	Project Stages	Stage 1
Surface roughening		Stormwater inlet protection		Earth bund	Earth Bund
Benched slopes		Stormwater inlet/sump		Level spreader	
Stabilised entranceway		Contributing catchments	CC:ESC12	Outlet protection	
Topsoil and grassing - Temporary	TS	No-go or buffer areas	NO GO	Temporary watercourse crossing	T
Topsoil and grassing - Permanent	PS	Cut and Fill areas	CUT FILL	Temporary watercourse diversion	
Revegetation (trees, shrubs & ground covers)	R	Secondary flood flow path		Temporary watercourse dam and pump (or dam and pipe)	
Hydroseeding	HS	Watercourses			
Mulching	M	Overland flow paths			

Use as many symbols as necessary to clearly communicate the erosion and sediment control methods and devices. However, keep maps as simple as possible, using multiple maps where necessary to clearly convey aspects such as staging or temporary and permanent stabilisation practices.

Symbols for features not provided in the following table can be used on ESCPs if they are clearly identified in the map legend. Should be clear and legible in both B&W and colour print on Plans.

13.3 Accidental Discovery Protocol - Land Disturbance for Construction Sites / Building Sites

There is a high risk of disturbance and accidental discovery of Māori cultural material in the Nelson/ Tasman region resulting from earthworks and/or erosion. Cultural material includes: taonga (Māori artefacts), kōiwi (human bone) or wāhi tapu (places sacred to Māori of traditional, spiritual, or cultural significance). Many potential permitted activity construction/ land disturbance activities will be in areas that are not identified cultural precincts or discovery 'hotspot' areas. Iwi/Māori generally do not support activities that require earthworks – due to the threat to, and risk of damage of, both taonga and wāhi tapu sites.

Where there is an archaeological authority granted by Heritage New Zealand Pouhere Taonga to modify or destroy a cultural site, any finds uncovered are to be recorded and a report provided to mana whenua

given to iwi/Māori.

In the event of an accidental discovery, the following protocols will be implemented. These protocols aim to mitigate any damage to and/or fossicking of wāhi tapu, taonga and kōiwi. It is important that adequate measures are taken to protect the area and cultural material.

Taonga/Māori treasures Discovery Protocol Explanation [refer to flow chart 13.3.1**]**

Taonga or 'ngā taonga tuku iho' (gifts handed down from the ancestors) are recognised, but not exclusive to, physical tangible heritage places that can be described as those land-based places created, formed or shaped by earlier inhabitants or tūpuna[1]. These are cultural sites, such as urupā (burials), pā, hangi pits, terraces, oven stones, middens, stone/rock structures, rock art, waka, house sites, pounamu (greenstone), modified soils, gardens, pakohe (argillite), fishing nets, sinkers, toki (artefacts), tools, weapons, Māori built heritage places such as marae buildings, wharenui (carved meeting house), pataka (food storage house), whare (house), post holes from remnant whare, occupation sites, carvings, artworks, and other structures such as waharoa (gateways) and various other taonga.

Taonga also reflects natural heritage sites such as natural features, with traditional activities (e.g. springs, trees, wetlands, caves) or a hapū and iwi landmark (e.g. mountain, river, lands, sea/lake, village, taonga species, pā harakeke (flax harvesting area) where no human activity is evident.

Taonga also includes intangible heritage, places where no visible feature or evidence is present but where a significant event or traditional activity may have occurred such as a battlefield, waka landing sites, places of meeting, of learning, of ritual, fishing grounds, taniwha den to name a few.

Various traditional activities have taken place across the region. There is evidence of occupation (pā and village sites), warfare, burials, marakai (gardens), large māhinga kai sites where natural resources and kai species were harvested, and other taonga have been found.

The diagrams on the following pages outline the processes to follow in the event of a taonga discovery (refer to **13.3.1** process flow chart) and for kōiwi tangata discovery (refer to **13.3.2** process flow chart) in the Nelson/Tasman region.

Note that, under the Protected Objects Act[2], all taonga tūturu are in the first instance (prima facie) Crown owned, to allow claims for ownership to be heard by the Māori Land Court.

[1] Heritage New Zealand - Pouhere Taonga website, retrieved from: http://www.heritage.org.nz/protecting-heritage/maori-heritage.

[2] Protected Objects Act: http://www.mch.govt.nz/nz-identity-heritage/protected-objects/taongatuturu

13.3.1 Process for follow for any Taonga site find

To be confirmed - process will be in place at the end of August

13.3.2 Process when there is a discovery of kōiwi tāngata/human remains.

To be confirmed DRAFT process will be in place at the end of August

13.4 Ten Commandments of Erosion and Sediment Control

1) Minimise Disturbance - Fit land development to land sensitivity.

Land development should be fitted to land sensitivity and where possible, disturbance should avoid steeper slopes and other features such as streams and wetlands.

For any development, the total area of earthworks should be the minimum necessary to achieve the design outcome (including temporary works). The area of earthworks exposed to erosion at any given time should also be minimised through staging and progressive stabilisation.

2) Stage Construction

Carrying out bulk earthworks over the whole site maximises the time and area of soil that is exposed and prone to erosion. "Construction staging", where the site has earthworks undertaken in small units over time with progressive revegetation, limits erosion.

Careful planning is needed. Temporary stockpiles, access and utility service installation all need to be planned. Construction staging differs from sequencing. Sequencing sets out the order of construction to contractors.

3) Protect Steep Slopes

If slopes are worked and require stabilisation, simple vegetative covers such as topsoiling and seeding may not be immediately effective and additional measures may be required. Disturbance of existing slopes should be avoided wherever possible, particularly steep slopes which have a higher risk of erosion. To minimise erosion, clean water runoff from above the site must be diverted away from the exposed slopes.

4) Protect receiving environments

Receiving environments including sensitive receiving environments, existing streams, watercourses and proposed drainage patterns need to be mapped. Earthworks and the removal of vegetation beside or within streams (including intermittent streams), wetlands and the coast, may require consents from Nelson City Council or Tasman District Council. Councils should be consulted on these matters prior to finalising project designs.

All receiving environments, limits of disturbance and protection measures should be mapped on the ESC Plan. In addition, all practices to be used to protect new drainage channels should be marked, as well as crossings, disturbances and associated construction methods.

5) Stabilise Exposed Areas Rapidly

Disturbed soils should be progressively stabilised with vegetation, mulch, grassing or other stabilising methods after each earthworks stage and at specific milestones within stages.

6) Install Perimeter Controls

Perimeter controls above the site keep clean runoff out of the worked area - a critical factor for effective erosion control. Perimeter controls can also retain or direct sediment laden runoff within the site. Common perimeter controls are diversion drains, silt fences and earth bunds.

Detail the type and extent of perimeter controls in the E&SCP along with design parameters.

7) Employ Detention Devices

Even with the best erosion and sediment practices, earthworks will discharge sediment-laden runoff during storms. Along with erosion control measures, sediment retention structures are needed to capture runoff so sediment generated can settle out. The presence of fine grained soils means sediment retention ponds are often not highly effective. Ensure the other control measures used are appropriate for the project and adequately protect the receiving environment.

The fine-grained nature of Moutere Clays and other local soils means sediment retention ponds will usually require flocculant treatment (flocculation) to maximise their efficiency. Include sediment retention structure design specifications, detailed inspection and maintenance schedules of structures in the E&SCP.

8) Get trained and develop experience

As contractors are generally responsible for installing and maintaining ESC practices, a trained and experienced contractor is an important element of an ESC Plan. Trained and experienced staff can save projects time and money through proactive construction and maintenance of ESCs. Staff should be encouraged to become experienced in ESC. Key staff should also be assigned to provide that role, so that the appropriate level of experience and supervision is available for each new project.

9) Adjust the ESC Plan as needed

An effective E&SCP is modified as the project progresses from bulk earthworks to project completion. Factors such as weather, changes to grade and altered drainage can all mean changes to planned erosion and sediment control practices. Update the E&SCP to suit site adjustments in time for the pre-construction meeting and initial inspection of installed erosion and sediment controls, and make sure it is regularly referred to and available on site.

Note: For sites with resource consents, adjustments to the ESC Plan may require sign-off from relevant Council.

10) Assess and Adjust Inspect, monitor and maintain control measures.

ESC measures need to be inspected, monitored and maintained.

Inspection and maintenance of controls is especially important prior to and following a storm event. A large or intense storm can leave ESC measures in need of repair, replacement, reinforcement or cleaning out. Maintaining and repairing measures as soon as possible after a storm event will maximise the ongoing efficiency of the measures and minimise adverse environmental effects.

13.5 Slope Conversion and Terminology

Ideally any slopes shown on the plans should be provided in percentage, ratio and degrees as given in the conversion table below.

Table 13-2 Slope conversion table (percent-ratio-degrees)

Percent	Grade/Ratio (h:1v)	Degrees
2.00%	50.00	1.15
3.00%	33.33	1.72
4.00%	25.00	2.29
5.00%	20.00	2.86
7.00%	14.29	4
8.33%	12.00	4.76
8.75%	11.43	**5**
10.00%	10.00	5.71
12.00%	8.33	6.84
15.00%	6.67	8.53
15.15%	6.60	8.62
17.63%	5.67	**10**
20.00%	5.00	11.31
25.00%	4.00	14.04
26.79%	3.73	**15**
30.00%	3.33	16.7
32.00%	3.13	17.74
33.00%	3.03	18.26
36.36%	2.75	19.98
36.40%	2.75	**20**
40.00%	2.50	21.8
46.63%	2.14	**25**
50.00%	2.00	26.57
58.00%	1.72	30
70.00%	1.43	35
84.00%	1.19	40
100.00%	1.00	45

13.6 Universal Soil Loss Equation Information

The USLE is a simple model originally developed for agricultural practices in the USA. It is a suitable sediment yield estimation tool for activities such as earth working operations.

Rather than providing an accurate estimate of actual total sediment yield the most beneficial use of the USLE is to help identify variations of potential sediment yields across a particular site. It is critical that a site is divided up into logical sectors based on gradient, slope length and surface cover. Other factors are the proximity and nature of the receiving environment. Once completed the USLE will then allow the erosion and sediment control methodology to be tailored to suit the site's variations.

While the overall estimate of yield is indicative of the magnitude of sediment likely to be discharged, the range of assumptions required in the USLE calculation means that it should not be relied on as an accurate assessment of actual total yield.

The USLE is represented by the following equation which provides an estimate of sediment generation (A) in tonnes/ha/yr for a given site:

A = R *K * (LS) * C * P

Where:

A	=	sediment generation (tonnes/hectare/year)
R	=	rainfall erosion index (J/hectare)
K	=	soil erodibility factor (tonnes/unit of R)
LS	=	slope length and steepness factor (dimensionless)
C	=	ground cover factor (dimensionless)
P	=	roughness factor (dimensionless)

Once the estimate of sediment generation (A) has been determined, the sediment yield from a specific site is estimated by the following equation:

Site Net Sediment Yield Calculation = A*Sa*SDR*SCE*D

Where:

A	=	the Sediment generation calculated from the USLE
Sa	=	the area of bare soil in hectares
SDR	=	Sediment Delivery Ratio (how much sediment makes it to the control devices)
SCE	=	Sediment Control Efficiency (how much sediment passes through control devices)
D	=	the duration of the works – how long the soil is exposed for.

13.6.1 Rainfall Erosion Index (R in J/hectare)

R is calculated by the formula **R = 0.00828*P^$^{2.2}$*1.7**

Where p is the total rainfall (in mm) for the 6-hour duration two-year storm event for the subject site. The value of P can be derived from the HIRDS website (refer 13.7.11). The multiplier of 1.7 converts the R value from imperial to metric units.

13.6.2 Soil Erodibility Factor (K in tonnes/unit of R)

To calculate K, the percentage of sand, silt and clay should be known for each dominant soil type within a site. For the purposes of calculation, the soil type is usually taken as being uniform across the site however, this is not always the case and soil analysis should be undertaken to determine if significant variations occur within the site.

Once the soil type is known, K is calculated as follows:

K = (kn+kc)*1.32
Were kn is the value taken from the nomograph and kc is the correction factor from the table below). Multiplying by 1.32 gives the value in metric units.

Step 1. Using **Error! Reference source not found.** below, estimate the K value for the basic soil type from t he nomograph. The example **shown** in the nomograph is based on a soil with 40% sand, 40% clay and 20%

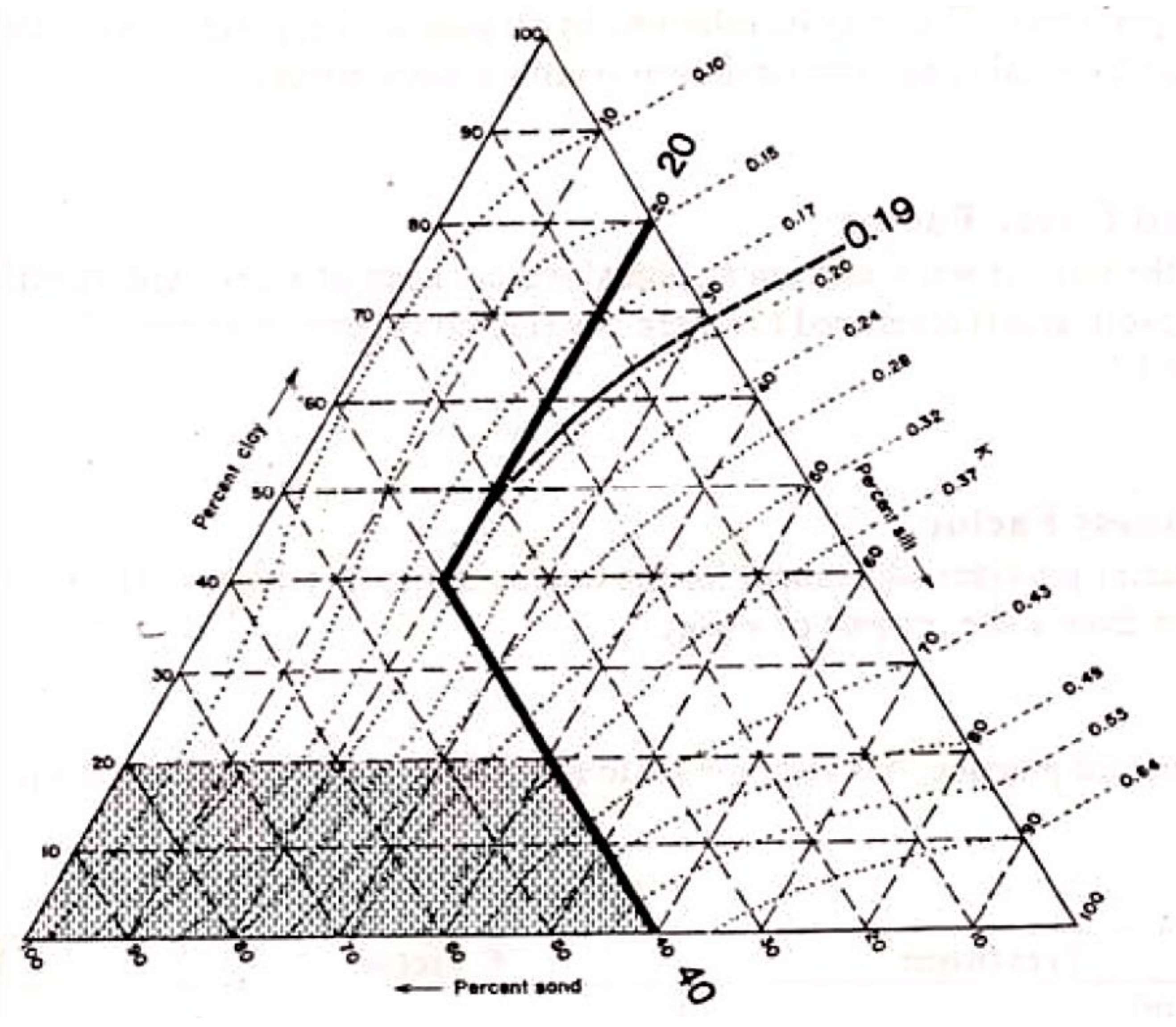


Figure 13-1 Nomograph for Estimating K Values

silt.

Table 13-3 K Value Correction Factor

K Value	Correction factor when percent organic matter is: 0% (exposed clay)	1%	2%	3%	4% (topsoil)
More than 0.4	+0.14	+0.07	0	-0.07	-0.14
0.2-0.4	+0.10	+0.05	0	-0.05	-0.10
Less than 0.2	+0.06	+0.03	0	-0.03	-0.06

Step 2. Correct for organic content using

Table 13-3 (the nomograph assumes 2% organic matter). In this table exposed clay is considered 0% organic, topsoil 4% organic. In the example shown on the nomograph, for an exposed site, the value (0.19) would be corrected by 0.06 (exposed clay) giving a K value of 0.25.

Step 3. Multiply the corrected K Value by 1.32 to convert from imperial to metric. The above example would give a resulting K value of 0.33.

13.6.3 Slope Length and Steepness Factor (LS - dimensionless)

To determine the LS factor, the slope length and slope gradient for the area of the site being assessed is required. Using these parameters, the LS factor for a particular slope is read from Table 13-4. In developing the USLE methodology, a standardised slope was used to determine soil loss. The LS factor derived from the table provides correction for variation in the actual slope gradient and length compared to the standardised slope.

It should be noted that the potential sediment generation on a site increases with an increase in both slope angle and slope length. Thus, it is essential that bare area, slope length and where possible slope angle are minimised (refer Chapter 6).

Table 13-4   for Determining Slope Length and Steepness Factor (LS)

Slope Ratio s,%	Slope Length, m 10.00	25.00	50.00	75.00	100.00	125.00	150.00	175.00	200.00	225.00	250.00	275.00	300.00
0.50	0.08	0.09	0.11	0.11	0.12	0.13	0.13	0.14	0.14	0.14	0.15	0.15	0.15
1.00	0.09	0.12	0.15	0.17	0.18	0.20	0.21	0.22	0.23	0.23	0.24	0.25	0.26
2.00	0.14	0.19	0.23	0.26	0.29	0.31	0.32	0.34	0.35	0.37	0.38	0.39	0.40
3.00	0.21	0.27	0.33	0.38	0.41	0.44	0.46	0.48	0.50	0.52	0.54	0.56	0.57
4.00	0.26	0.37	0.49	0.57	0.64	0.70	0.76	0.80	0.85	0.89	0.93	0.96	1.00
5.00	0.31	0.48	0.69	0.84	0.97	1.08	1.19	1.28	1.37	1.45	1.53	1.61	1.68
6.00	0.39	0.61	0.86	1.06	1.22	1.36	1.49	1.61	1.72	1.83	1.93	2.02	2.11
7.00	0.47	0.75	1.06	1.29	1.49	1.67	1.83	1.98	2.11	2.24	2.36	2.48	2.59
8.00	0.57	0.90	1.27	1.56	1.80	2.01	2.20	2.38	2.54	2.70	2.84	2.98	3.11
9.00	0.67	1.06	1.50	1.84	2.13	2.38	2.60	2.81	3.01	3.19	3.36	3.53	3.68
10.00	0.78	1.24	1.75	2.15	2.48	2.77	3.04	3.28	3.51	3.72	3.92	4.11	4.30
11.00	0.91	1.43	2.02	2.48	2.86	3.20	3.51	3.79	4.05	4.29	4.53	4.75	4.96
12.50	1.10	1.74	2.46	3.02	3.48	3.89	4.26	4.61	4.92	5.22	5.51	5.77	6.03
15.00	1.47	2.32	3.28	4.02	4.64	5.19	5.68	6.14	6.56	6.96	7.34	7.69	8.04
16.70	1.74	2.76	3.90	4.77	5.51	6.16	6.75	7.29	7.79	8.27	8.71	9.14	9.55
20.00	2.34	3.70	5.23	6.40	7.39	8.26	9.05	9.78	10.45	11.09	11.69	12.26	12.80
22.00	2.73	4.32	6.11	7.49	8.65	9.67	10.59	11.44	12.23	12.97	13.67	14.34	14.98
25.00	3.38	5.34	7.55	9.25	10.68	11.94	13.08	14.12	15.10	16.01	16.88	17.70	18.49
30.00	4.56	7.21	10.19	12.48	14.41	16.12	17.65	19.07	20.39	21.62	22.79	23.90	24.97
33.30	5.41	8.55	12.09	14.80	17.09	19.11	20.93	22.61	24.17	25.64	27.03	28.34	29.61
35.00	5.86	9.26	13.10	16.05	18.53	20.71	22.69	24.51	26.20	27.79	29.30	30.73	32.09
40.00	7.25	11.47	16.22	19.86	22.93	25.64	28.09	30.34	32.43	34.40	36.26	38.03	39.72
45.00	8.71	13.78	19.48	23.86	27.55	30.80	33.74	36.45	38.96	41.33	43.56	45.69	47.72
50.00	10.22	16.15	22.84	27.98	32.31	36.12	39.57	42.74	45.69	48.46	51.08	53.57	55.95
55.00	11.74	18.56	26.25	32.15	37.13	41.51	45.47	49.12	52.51	55.69	58.71	61.57	64.31
57.00	12.35	19.53	27.62	33.83	39.06	43.67	47.84	51.68	55.24	58.60	61.77	64.78	67.66
60.00	13.27	20.98	29.67	36.34	41.96	46.91	51.39	55.51	59.34	62.94	66.35	69.59	72.68
66.70	15.29	24.18	34.20	41.88	48.36	54.07	59.23	63.98	68.40	72.55	76.47	80.20	83.77
70.00	16.27	25.73	36.39	44.57	51.46	57.53	63.03	68.08	72.78	77.19	81.37	85.34	89.13
75.00	17.72	28.03	39.63	48.54	56.05	62.67	68.65	74.15	79.27	84.08	88.62	92.95	97.08
80.00	19.13	30.25	42.78	52.39	60.50	67.64	74.10	80.03	85.56	90.75	95.66	100.33	104.79
85.00	20.49	32.39	45.81	56.11	64.78	72.43	79.34	85.70	91.62	97.18	102.43	107.43	112.21
90.00	21.79	34.45	48.72	59.67	68.90	77.03	84.38	91.14	97.43	103.35	108.94	114.25	119.33
95.00	23.03	36.41	51.50	63.07	72.83	81.42	89.19	96.34	102.99	109.24	115.15	120.77	126.14
100.00	24.21	38.28	54.14	66.31	76.57	85.61	93.78	101.29	108.29	114.85	121.07	126.98	132.62

Calculated From:

$$LS = \left(\frac{65.41\times s^2}{s^2+10,000} + \frac{4.56\times s}{\sqrt{s^2+10,000}} + 0.065\right)\times\left(\frac{l}{72.5}\right)^m$$

LS= topographic factor
l = Slope length, m
s = Slope steepness
m = Exponent dependent on slope steepness
0.2 for slopes<1%, 0.3 for slopes 1-3%, 0.4 for slopes 3.5-4.5%, and 0.5 for slopes > 5%)

13.6.4 Ground Cover Factor (C) and Roughness Factor (P)

The Ground Cover Factor (C) is the ratio of soil loss from an actual site (or parts of a site) with specific ground cover (e.g. clay, topsoil, grass) compared to a bare site (i.e. no vegetation or topsoil). A bare site is given a C value of 1.0.

The P factor provides adjustment for the degree to which surface roughness affects the erosion of sediment from a site (or part of a site).

As a standard practice, it is appropriate to use the range of C and P values given in Table 13-5.

Table 13-5 USLE C and P Factors

Treatment	C Factor	P Factor
Bare soil - Compacted and smooth	1.0	1.32
Bare soil - Track walked on contour	1.0	1.2
Bare soil - Rough irregular surface	1.0	0.9
Bare soil - Disked to 250mm depth	1.0	0.8
Native vegetation (undisturbed)	0.01	1.0
Pasture (undisturbed)	0.02	1.0
Establishing grass	0.10	1.0
Mulch – on subsoil	0.15 (3mth period only)	1.0
Mulch – on topsoil	0.05 (3mth period only)	1.0

13.6.5 Estimating Sediment Yield

Once the value for sediment generation potential (A - in tonnes/ha/yr) is calculated the quantity of sediment likely to be discharged to the receiving environment (sediment yield) can be determined by including the site area, sediment delivery ratio, sediment control efficiency and duration of the works. The USLE and associated sediment yield should always be carried out for each part of a site where slope, soil type or surface cover varies.

13.6.6 Area of Exposed Soil (Sa in hectares)

To derive an estimate of sediment yield from a particular site, or part of a site, the actual area (in hectares) of exposed ground should be taken into account.

13.6.7 Sediment Delivery Ratio (SDR, 0.0 – 1.0)

In general, some of the sediment that is initially eroded within a site will not be transported to the sediment control measures. This sediment will be retained within depressions, rough surfaces and vegetation. The Sediment Delivery Ratio takes this into account.

The value used for the sediment delivery ratio has a big impact on the estimated yield, however accurate assessment is difficult and dependent on several site variables. As the sediment yield calculation given in this guideline is to be used primarily for comparison purposes in development of Erosion and Sediment Control Plans it is considered that the sediment delivery ratios in the following table are sufficient. Use of other values should be accompanied by an explanation and more conservative values should be considered for particularly steep sites and small drainage areas.

Table 13-6 Sediment Delivery Ratios

Sediment Delivery Ratio	Slopes up to 10% (10:1, 5.71°)	Slopes greater than 10% (10:1, 5.71°) or close to waterways
	0.5	0.7

13.6.8 Sediment Control Efficiency (SCE in %)

Sediment control efficiency is a measure of how much sediment makes it through the sediment control device and into receiving environments. For coarse grained soils or with the use of chemical flocculation, the efficiency may be high, while for fine grained soils (eg high clay content) or where device designs are not ideal, efficiencies may be lower.

Values given in the table below have been collated from various research into control efficiencies (refer Chapter 6, section 6.2.7.1). Use of other values should be accompanied by explanation or references.

The value of SCE is determined by **SCE = (100%- control efficiency %)** as we need to include how much sediment makes it past the control device, rather than how much is retained.

Table 13-7 Sediment Control Efficiencies

Control type	Control Efficiency without flocculation	Control Efficiency with flocculation
Sediment Ponds	0.5 -0.8	0.75 -0.95
Decanting Earth Bunds	0.60	0.8[A]
Silt fence and super silt fence	0.4-0.75	na

Estimated from relative average efficiencies for ponds with and without flocculation

13.6.9 Duration of Exposure (D in years)

The USLE provides an estimate of average annual soil loss. As most sites will only be exposed for part of the year, the duration of the works should be taken into account.

13.6.10 USLE and Sediment Yield - Example Calculation

In the following example, based in Takaka (NZTM E1583666, N5477378), the site is to be worked for four months, the site soil type is 32% clay, 20% sand and 48% silt. The total rainfall (from HIRDS) for the 6hr 2year event at this location is 77.6mm. It is assumed that the sediment control efficiency will be 25% (ie. 75% removal). There are the following areas, slope lengths and slope angles for three differing parts of the site:

- Area A: 3.3ha and 150m slope length, 5% slope
- Area B: 5.0ha and 200m slope length, 10% slope
- Area C: 1.0ha and 100m slope length, 20% slope

A = R *K * (LS) * C * P

R = 0.0082*(77.6^2.2)*1.7 =**202.4**

K = 0.37(from nomograph) + 0.1 (bare clay correction factor)* 1.32 (converts to metric)=**0.62**

LS: (from table) Area A=**1.19**, Area B=**3.51**, Area C=**7.39**

C (from table) = **1.0** (compacted bare soil)

P (from table) = **1.32** (compacted bare soil)

Table 13-8 Example USLE Calculation Summary

	USLE						Sa	SDR	SCE	D	
Section of site	R	K	LS	C	P	Sediment Generation (A) (tonnes/ha/yr)	Site Area (ha)	Sediment Delivery Ratio	Sediment Control Efficiency (%)	Duration (yrs)	Net Sediment Yield (tonnes)
A	202.4	0.62	1.19	1.0	1.32	197	3.3	0.5	25	0.33	27
B	202.4	0.62	3.51	1.0	1.32	581	5.0	0.7	25	0.33	168
C	202.4	0.62	7.39	1.0	1.32	1224	1.0	0.7	25	0.33	71
Total						**2003**	**9.3**				**265**

13.7 Design of Erosion and Sediment Controls

13.7.1 Introduction

Erosion and sediment control practice performance and relative effectiveness depends on appropriate hydrological design of the controls. Hydrological design is based on the following parameters:

- Soil
- Slope
- Ground cover
- Rainfall
- Size of contributing catchments
- Risk associated with the design (including receiving environment sensitivity and duration of works).

There are three issues to consider in sizing storage practices:

1. Storage volume for sediment retention performance, and
2. Design discharge rate to ensure that downstream stream channel erosion is not increased during construction (water quantity attenuation).
3. Secondary overflow management.

13.7.2 Storage Volume Sizing for Sediment Control Performance

The volumes of storage can be calculated by using the rational formula and calculating a volume by using a trapezoidal hydrograph approach.

Firstly the peak discharge (Q) is calculated:

$$Q=0.00278CiA$$

Where:

Q =	Peak discharge (m^3/s)	
C =	Runoff coefficient (unit less)	Determined from Table 13-11 (refer section 13.7.4)
i =	Rainfall (mm/hr)	Determined using the most recent NIWA HIRDS data or local data for a 1 hour duration storm with the appropriate storm probability selected from Table 13-12 (refer section 13.7.8)
A =	Catchment area (ha)	Contributing catchment from site measurements (refer section 13.7.3)

(note: multiplying by 0.00278 converts results to metric and units to m3/s)

Once Q is calculated the volume of the storage practice (V) can be calculated:

$$V = QD$$

Where:

V =	Volume of storage practice (m^3)	
Q =	Peak discharge (m^3/s)	Determined from the previous calculation
D =	Storm duration (sec.)	With D = 3600 seconds for a 1-hour storm.

The volume calculated is then used to size the storage system.

If a lesser volume is proposed by the Designer, a detailed soil particle analysis should be provided when approval is sought.

Identification of values for Catchment Area (A), Runoff Coefficient (C), and Rainfall Intensity (i) are outlined in the following sections.

13.7.3 Contributing Catchment Area (A)

The area value (A) to be included in the rationale formula includes the entire catchment that contributes flow to the device being sized. This includes both disturbed and undisturbed areas, but excludes any areas diverted away from the device, for example up catchment clean water diverted around the works.

In order to keep device sizes to a minimum it is important to reduce the contributing catchments areas as much as practicable by:

1. Minimising the area of land disturbed (retaining existing ground cover), and
2. Utilising up catchment clean water diversion drains (refer Chapter 6, section 6.2) to redirect water around disturbed areas
3. Utilizing sub catchment dirty water diversion drains to direct dirty water to additional treatment devices

Using these methods will minimise the volume of dirty water requiring treatment at each device.

Once the extent of the contributing catchment has been identified, it is important to identify sub-catchments within this that may have differing soils, slopes and ground cover. These aspects are used to identify the appropriate Runoff Coefficient (C) value to use in the design calculations. Selection of an appropriate Runoff Coefficient (C) is covered below in Section 13.7.7.

13.7.4 Runoff Coefficient (C)

Determination of the appropriate runoff coefficient is dependent on slope, soil type, and ground cover.

13.7.4.1 Slope

Increases in slope increase site discharge and velocity of runoff. In fact, with all other factors remaining equal, slope has the most influence on the generation of sediment (if the slope angle is doubled, three times the sediment is generated and if slope length is doubled 1.5 times the sediment is generated).

The slope gradient for use in determining the runoff coefficient is determined by the slope immediately above the device being sized, or by the average slope angle over the contributing catchment, whichever is greater.

For practicality slopes of interest are divided into three categories: less than 10 %; between 10% and 20%; and greater than 20%.

Table 13-9 Slope conversion table (percent, ratio and degrees)

Slope %	As Slope ratio (h:v)	In degrees
10%	10:1	5.71
20%	5:1	11.31

It is important to realise that the human eye invariably distorts slopes by exaggerating them. People will often judge a 1:3 slope to be a 1:1 slope. Similarly, a slope of 15° will often be estimated to be close to 45°. Ensure measurements (eg using contour maps) are use when determining the appropriate slope on your site.

Slope is included in the selection of a Runoff Coefficient (C) value through the use of the slope correction factors in Table 13-11 (refer section 13.7.4).

13.7.5 Soil Type

Soils have variable permeability rates and sizing of control practices will be based on the amount of water that runs over the soil rather than what goes into it.

The Tasman District has a wide variety of soils, however for the purposes of determining an appropriate runoff coefficient factor (C) to use in the design calculation, we are concerned primarily with the clay, silt and sand/gravel components and the subsequent level of soakage (refer Table 13-10)

Due to the highly variable nature of soils, every project should have a soils analysis done to determine the appropriate runoff coefficient(s) and identify whether flocculation is required. Consideration also needs to be made of not just the surface soil, but all soil horizons that may be disturbed, for example a sandy loam topsoil can have a clay loam subsoil.

Table 13-10 Soil Types

Soil Type	Soil particle characteristics (average%)			Soakage
	clay	silt	sand	
Clay	60%	20%	20%	Low
Clay loam	35%	30%	35%	Low
Silt loam	23%	40%	37%	Medium
Sandy Loam	15%	15%	70%	High
Sands and Gravels	5%	5%	90% (sand or gravel)	High

Note: Soil type relates to the soil horizon being exposed (a sandy loam topsoil can have a clay loam subsoil)

Soils are also significantly altered during site development including:

- stripping off the topsoil
- compaction
- removing large amounts of native soils in cut operations
- bringing in large amounts of new material if fill is needed
- erosion of surface soils.

This will affect the amount of site runoff for different construction stages. Where compaction occurs, the effect is a significant reduction in water infiltration into the ground. This applies across the board to all soils, but to a lesser extent for sands and gravels.

It is important to do the following when planning erosion and sediment control practices:

- Determine what the soils are on site – including all soil horizons to be disturbed, and determining the clay content.
- Determine whether soil characteristics will be changed by the earthworks;
  - If fill material is brought on site, what changes will that material make to the existing soil?
  - How much cut and fill will be done on site and how will the soil profile be changed?

Selection of the appropriate soil type for determining the Runoff Coefficient should include consideration of all soil types that will be affected by land disturbance and the variability of soil types across the area of the contributing catchment, either due to natural variability or to land disturbance activities.

13.7.6 Ground Cover

Relevant ground covers are listed in Table 13-11 and cover bare areas, vegetated areas and developed areas with surfaces of varying permeability.

Where possible clean water from undisturbed areas of the contributing catchment should be diverted away from treatment devices, thereby reducing the volume of water to be treated and minimising the required device size.

Determination of the area to be disturbed should be precautionary. If there is any uncertainty as to the extent of earthworks required, a larger proportion of the contributing catchment should be calculated using the bare soil C values from Table 13-11. Underestimating the area of disturbed land could result in devices being undersized, requiring their redesign and/or rebuild resulting in costly work stoppages.

13.7.7 Selection of Runoff Coefficient (C)

Table 13-11 provides runoff coefficient values for different soil types and ground cover with correction factors for different slopes.

For contributing catchments with more than one type of soil, slope or cover two approaches to C factor selection, and subsequent volume calculation, are acceptable:

- Use the highest C factor identified in the sub catchments as the C value for the whole contributing catchment, or
- Calculate the volume for each sub catchment separately, using the C values appropriate to each sub-catchments soil type, slope and ground cover and sum the volumes to find the total volume for the device.

Table 13-11 Representative C (runoff coefficients) values for different soil types and slope

Natural Surface Types	C
Low soakage soil types:	
– bare uncultivated soil	0.70
– pasture and grass cover	0.40
– bush and scrub cover	0.35
– cultivated	0.30
Medium soakage soil types:	
– bare uncultivated soil	0.60
– pasture and grass cover	0.30
– bush and scrub cover	0.25
– cultivated	0.20
High soakage soil types:	
– bare uncultivated soil	0.50
– pasture and grass cover	0.20
– bush and scrub cover	0.15
– cultivated	0.10

Developed Surface Types	C
Fully roofed and/or sealed developments	0.90
Steel and non-absorbent roof surfaces	0.90
Asphalt and concrete paved surfaces	0.85
Near flat and slightly absorbent roof surfaces	0.80
Stone, brick and pre-cast concrete paving panels:	
– with sealed joints	0.80
– with open joints	0.60
Unsealed roads	0.50
Unsealed yards and similar surfaces	0.35

Slope Correction Factor	
Slope	**Adjustment Factor**
<5%	subtracting 0.05
5-10%	no adjustment
10-20%	adding 0.05
20% or steeper	adding 0.10

(Based on: Compliance Document for New Zealand Building Code Clause E1 Surface Water 2011. The coefficients in this table assume saturated ground conditions from previous rain).

13.7.8 Rainfall Intensity (i)

Rainfall around the district is variable and having a sizing criterion based on one area alone is not suitable for the whole district.

Rainfall intensities for appropriate storm sizes can be obtained through the online NIWA High Intensity Rainfall Design System (HIRDS) (refer section 13.7.11).

13.7.9 Storm size selection

The storm duration used in this guideline is for a 1-hour duration storm. The one-hour storm was chosen as providing reasonable sizing requirements if the duration of the storm is provided in seconds. Longer times provide significantly larger volumes and the storage requirements become unreasonable.

The storm probability which determines the size of the storm is selected from Table 13-12 which uses a risk based approach dependent on the sensitivity of receiving environments and duration of the works.

The sensitivity of receiving systems as prioritised in Chapter 4, section 4 are used in Table 13-12, in combination with the desired level of risk, to identify the frequency of storm to be used in the design calculations. If a site drains into more than one receiving systems, design of storage controls should be based on the more stringent criteria.

Table 13-12 Receiving environments and design storms

Category	Receiving system type	Potential for Adverse Effects from Erosion and Sedimentation	Desired design risk (chance of event occurring during works)		Storm frequency (Average Recurrence Interval) to design for (1-hour duration) (Years) — Site disturbance Duration				
			%	chance	up to two weeks	up to one mth	up to three mths	up to six mths	up to 12 mths
A	Estuaries	Highest	<2.5%	1 in 40	2 yr	5 yr	10 yr	20 yr	40 yr
A	Water Conservation Order Areas	Highest	<2.5%	1 in 40	2 yr	5 yr	10 yr	20 yr	40 yr
A	Spring fed streams	Highest	<2.5%	1 in 40	2 yr	5 yr	10 yr	20 yr	40 yr
B	Streams and Rivers	High	<5%	1 in 20	*85% of 2yr	2 yr	5 yr	10 yr	20 yr
B	Wetlands	High	<5%	1 in 20	*85% of 2yr	2 yr	5 yr	10 yr	20 yr
B	Karst	High	<5%	1 in 20	*85% of 2yr	2 yr	5 yr	10 yr	20 yr
B	Lakes	Moderate	<5%	1 in 20	*85% of 2yr	2 yr	5 yr	10 yr	20 yr
C	Open coast	Low	<10%	1 in 10	*85% of 2yr	*85% of 2yr	2 yr	5 yr	10 yr
C	Land	Low	<10%	1 in 10	*85% of 2yr	*85% of 2yr	2 yr	5 yr	10 yr

* For practicality, 85% of the 2yr ARI is use as an approximation of the annual ARI event, as data for the 2yr ARI is readily available from the HIRDS website. For temporary culverts in watercourses that fall in this category, culvert size can be determined using 85% of the channel width at bank full.

For other durations the relevant storm frequency to achieve the desired risk level can be determined using the equation:

$$T = \frac{1}{1-[(1-P)^{1/n}]}$$

Where **T** is the storm frequency (Annual Recurrence Interval in years),
P is the desired risk level (ie 0.025, 0.05 or 0.1), and
n is the duration of the works in years.

The potential effects of climate change on storm frequency does not need to be accounted for in the design of sediment and erosion controls, as it does with stormwater design, as land disturbance is of relative short duration.

13.7.10 Example calculation

13.7.10.1 Sizing of storage practices

Steps

1. Determine site location and from that determine latitude and longitude.
2. Determine project duration.
3. Using latest HIRDS (from NIWA website) - or local data - select the 1-hour storm using the appropriate frequency storm from Table 13-12 to obtain the Rainfall Intensity (i) value.
4. Determine site soils, slope and ground cover to select the Runoff Coefficient C Factor.
5. Determine the site area in hectares that would drain to the storage practice (A).
6. Use the Rational Formula to calculate the peak discharge (Q).
7. Multiply the peak discharge (Q) by 3,600 seconds to get the volume of the sediment storage practice.

For example a project in Takaka, which drains to the Takaka River.

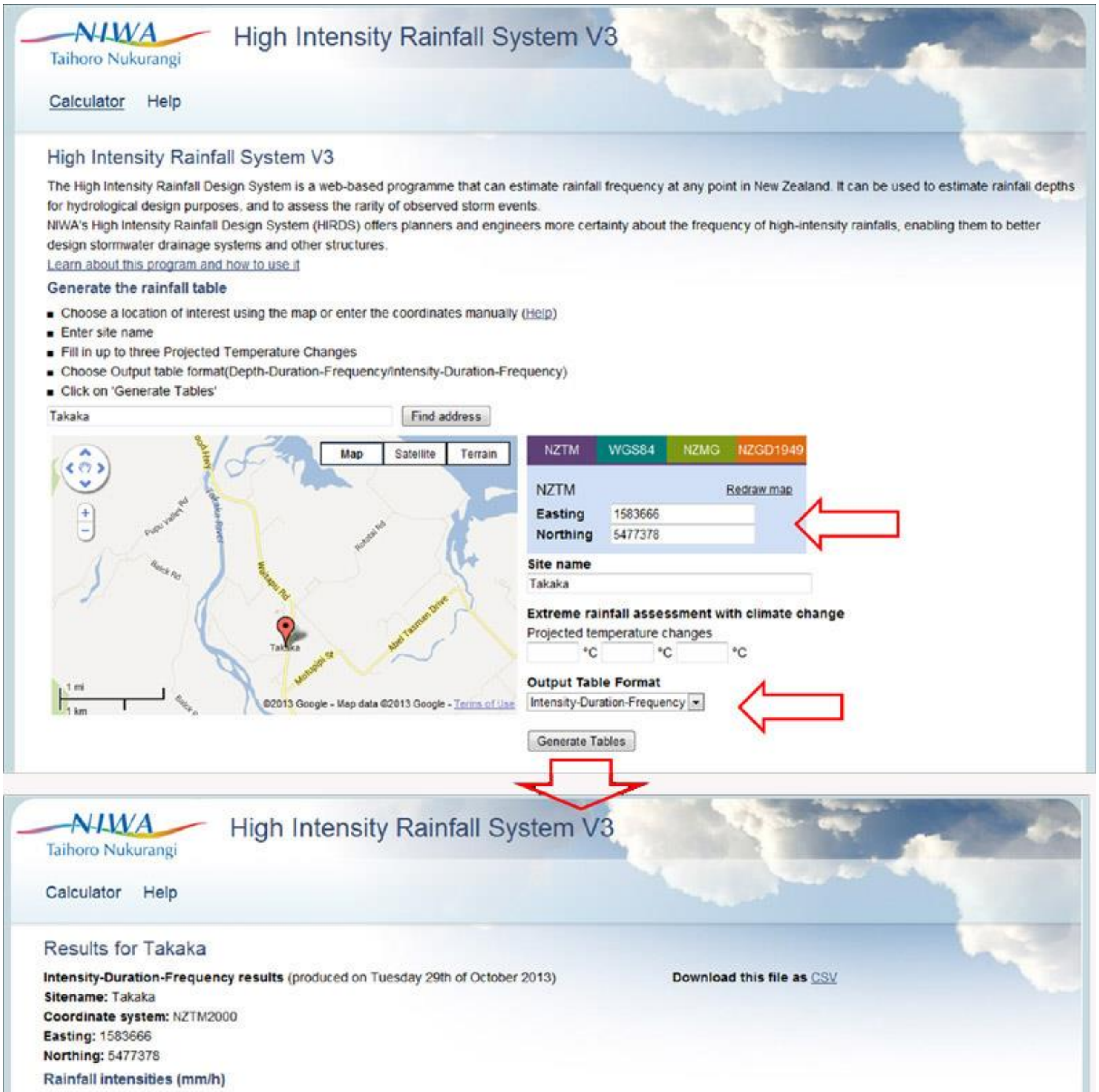
1. NZTM2000 Easting 1583666 Northing 5477378.
2. Site soils are bare melanic soils with moderate soakage having slopes <10% so the runoff coefficient 'C' factor is 0.65 (refer Table 13-11).
3. As the project duration is 12 months and the site drains to the Takaka River, sizing of the sediment retention pond should be on a 20-year, 1-hour storm (refer Table 13-12), which gives a rainfall intensity 'i' of 53.5 mm/h (from HIRDS as of 29-Oct-13).
4. Site area 'A' draining to the device is 1 hectare.
5. Q = 0.00278*C*i*A which in this case: Q = 0.00278*(0.65)*(53.5)* (1) = 0.097 m^3/s.
6. V = Q*D (where D is 3600), so in this case: Storage volume = 0.097*(3600) = 350 m^3.

13.7.11 HIRDS website

Use of the HIRDS website (http://hirds.niwa.co.nz) requires the following steps (refer Figure 13-2).

Find your site using the google map. Coordinates for the site selected (ie the approximate centre) should be recorded in NZTM (easting and northing) to be compatible with the Council GIS system

1. Enter an appropriate site name (eg physical address).
2. Leave the "Projected Temperature Changes" blank - climate change considerations are not required.
3. Set the "Output Table Format" to "Intensity-Duration-Frequency".
4. Generate Tables.
5. Ensure rainfall intensity is taken from the correct duration (60m) and the appropriate storm ARI event (data is available for return intervals of 1.58, 2, 5, 10, 20, 30, 40, 50, 60, 80 and 100 years).



		Duration									
ARI (y)	aep	10m	20m	30m	60m	2h	6h	12h	24h	48h	72h
1.58	0.633	42.6	35.4	31.8	26.6	19.5	12.0	8.8	6.4	3.7	2.7
2.00	0.500	46.2	38.7	34.8	29.0	21.2	12.9	9.5	6.9	4.0	2.9
5.00	0.200	60.6	50.4	45.4	37.8	27.4	16.5	12.0	8.7	5.0	3.6
10.00	0.100	72.0	60.3	54.2	45.1	32.5	19.3	13.9	10.0	5.8	4.2
20.00	0.050	85.8	71.4	64.2	53.5	38.3	22.6	16.2	11.6	6.7	4.9
30.00	0.033	94.2	78.6	70.8	59.0	42.1	24.7	17.6	12.6	7.3	5.3
40.00	0.025	100.8	84.3	75.8	63.2	45.0	26.3	18.7	13.3	7.7	5.6
50.00	0.020	106.2	88.8	79.8	66.6	47.4	27.6	19.6	13.9	8.1	5.9
60.00	0.017	111.0	92.7	83.4	69.5	49.4	28.7	20.3	14.4	8.4	6.1
80.00	0.012	118.8	99.3	89.2	74.5	52.7	30.5	21.6	15.3	8.9	6.4
100.00	0.010	125.4	104.7	94.2	78.5	55.5	32.0	22.6	16.0	9.3	6.7

Figure 13-2 HIRDS Webpage Example

13.8 Tasman/Nelson region fish migration and spawning calendars

Source: Reproduced from: *State of the Environment Report: The Health of Freshwater Fish Communities in Tasman District. September 2011*. TDC Report #: 11001. James, T. and Kroos,T.

Fish migration calendar for the Tasman District showing the peak and range periods for migration activity, migration status and life stage at time of migration. Modified from Hamer 2004. Key: u/s=upstream, d/s=downstream ■ Peak □ Range

Species	Directio n	Life stage	Summer			Autumn			Winter			Spring		
			Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
Lamprey[25]	u/s	Adult						Range (part)	Peak	Peak	Peak	Peak	Range (part)	
Lamprey	d-s	Juvenile					Range	Range	Range	Range	Range			
Longfin & shortfin eel	To	Glass								Range	Peak	Peak	Peak	Range
Longfin eel [1,2,22]	u/s	Juvenile	Peak	Peak	Peak	Peak	Peak							Range (part)
Longfin eel [1]	d-s	Adult					Range	Range						
Shortfin eel[1,2,22]	u/s	Juvenile	Peak	Peak	Peak	Peak	Peak							Range (part)
Shortfin eel[1]	d-s	Adult			Range	Range	Range							
Common smelt (sea	u/s	Juvenile									Range (part)	Peak	Peak	Range
[1]	d-s	Larvae				Range	Range	Range	Range					
Inanga [5,22]	u/s	Juvenile						Range	Range	Range	Peak	Peak	Peak	Range (part)
[1]	d-s	Larvae	Range	Range	Peak	Peak	Peak	Range	Range					
Giant kokopu [1,2,4,22,25]	u/s	Juvenile	Peak									Range (part)	Peak	Peak
[1,22]	d-s	Larvae						Range	Peak	Peak	Range			
Shortjaw kokopu [1,2,4,22]	u/s	Juvenile										Range	Range	Range
[13]	d-s	Larvae						Range (part)	Peak / Range					
Banded kokopu [1,2,22]	u/s	Juvenile									Range	Peak	Peak	Range
[1,22]	d-s	Larvae						Range	Range	Range				
Koaro[1,7]	u/s	Juvenile										Peak	Peak	Range
[1,13]	d-s	Larvae					Range	Peak	Peak					
Torrentfish [1,25]	u/s	Juvenile	Peak	Peak	Peak	Range (part)								Peak
[1]	d-s	Larvae			Range	Range	Range	Range						
Redfin bully [1,22]	u/s	Juvenile	Peak											Peak
[1,22]	d-s	Larvae									Peak	Peak	Peak	Peak
Common bully [1,22,25]	u/s	Juvenile	Peak	Peak	Peak	Range (part)							Range	Range
[1]	d-s	Larvae											Range	Range
Bluegill bully [1]	u/s	Juvenile	Peak											Peak
[1]	d-s	Larvae	Range	Range	Range							Range	Range	Range
Giant bully [1]	u/s	Juvenile	Range	Range	Range									Range
[1]	d-s	Larvae	Range											Range

Table 13-13 Fish migration calendar for the Tasman District

Fish spawning calendar for Tasman District showing the peak and range periods of spawning activity and spawning habitat.

Species	Spawning habitat	Summer			Autumn			Winter			Spring		
		Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov
Lamprey	Upper catchment	Range									Range	Range	Range
Long & shortfin eel	Pacific ocean												
Long & shortfin eel	Pacific ocean												
Common smelt (sea run)	Sand banks of rivers	Range	Range	Range	Peak	Peak	Peak	Range	Range				
Inanga	Tidal estuary edge vegetation			Range	Peak	Peak	Peak	Range	Range				
Giant kokopu	Mid-low reaches (unconfirmed)					Range	Range	Peak	Peak	Peak			
Banded kokopu	Stream margins at flood among vegetation and debris					Range	Peak	Peak					
Shortjaw kokopu	Stream bank rocks, debris and vegetation during flood						Peak	Peak					
Koaro	Cobbles at stream edge					Peak	Peak	Peak/Range					
Dwarf galaxias	Small cobbles instream	Range									Range	Range	Range
Brown mudfish	Freshwater wetlands					Range	Range	Range	Range	Range/Peak	Peak/Range	Range	
Torrentfish	Lowland rivers/estuaries	Range	Peak	Peak	Peak	Peak	Range				Range	Range	Range
Redfin bully	Under rocks in flowing water								Range	Range	Range	Range	Range
Common bully	Under firm flat surfaces	Range	Range	Range								Range	Range
Bluegill bully	Similar to other bullies	Range	Range	Range							Range	Range	Range
Giant bully	Estuaries (unconfirmed)	Range	Range	Range									
Upland bully	Under large flat rocks	Peak	Range	Range								Peak	Peak

Key: Peak (dark) Range (light)

Table 13-14 Fish spawning calendar for Tasman District

13.9 Discharge design for T-bar floating decant

Stream channel erosion is an issue for storage practices that release site runoff as concentrated flow where streams are the receiving environment.

Sediment retention ponds and decanting earth bunds are required to use floating decant systems to drain the live storage (available storage volume for storm runoff) over an extended period of time (ie 24 hours).

Chapter 9, section 9.1.5 discusses use of standardised decant pipes that achieve a discharge rate of 4.5 litres per decant. This section outlines the methodology for determining the required number of holes in a floating T-bar decant that is not based on the standard design.

The volume that should be available for live storage is 70% of the total volume on which the storage practice size is based. This ensures that there will be water in the bottom of the device to reduce resuspension of already trapped sediments.

Figure 13-3 Sediment Pond with Floating Decants also Showing Live Storage

The floating decant design is based on using holes in the decant that have a discharge rate of 0.0225 l/s for 10 mm diameter holes. Discharge from the individual holes does not vary as decants will be floating and therefore provide constant head.

Providing 24-hour detention and release to protect stream physical structure is done in the following manner:

1. Take 70% of the total volume of required storage (V) (refer section 13.7.2) to determine the live storage volume.
2. Divide the total volume by 86,400 seconds (number of seconds in a day) and convert the volume to litres (multiply by 1000). This will give the maximum flow rate to achieve detention over a 24-hour period.
3. Divide the flow rate by 0.0225 l/s to obtain the number of holes that are necessary.

This approach provides the extended detention to ensure adequate water quality treatment. The number of holes should not exceed the number calculated.

13.9.1 Discharge rate example calculation

Example for Takaka (following on from previous storage volume calculation example)

- Take 70% of the total storage volume calculated, to calculate the live storage volume (0.7 of 35:0m3 = 245 m^3).
- Divide the total volume by 86,400 seconds (number of seconds in a day) and convert the volume to litres. This will give the maximum flow rate to achieve detention over a 24-hour period = 0.0028 m^3/s or 2.8 l/s.

Divide the flow rate by 0.0225 l/s to obtain the number of holes that are necessary = 126 holes.

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