PART D APPENDICES

Contents

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Abbreviations

asl	Above sea level
AEP	Annual exceedance probability
ARI	Average recurrence interval
BFM	Bonded fibre matrix (see section 6.2.2)
BPO	Best practicable option
DEB	Decanting earth bund (see section 7.2.2)
HIRDS	High intensity rainfall design system (NIWA, 2002)
l/sec	litres per second
m^3/day	cubic metres per day
NRRP	Natural Resources Regional Plan
OSH	Occupational Safety and Health
RMA	Resource Management Act 1991
RPS	Canterbury Regional Policy Statement (26 June 1998)

Glossary

AEP (Annual exceedance probability): a statistical term defining the probability of an event occurring annually. 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. This has replaced the return period concept. A five percent AEP event expresses the twenty year return period in more probability terms.

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): the average period between exceedances of a given rainfall or flow rate.

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.

Berm: in this guideline, berm usually means a small earthen bank, rather than roadside berm.

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.

Channel stabilisation: stabilisation of the channel profile by erosion control and/or velocity distribution through reshaping, the use of structural linings, mass blocks, vegetation and other measures.

Channel storage: the amount of water temporarily stored in channels while en route to an outlet.

Chute: see Flume.

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.

Cohesive soil: a soil that, when unconfined, has considerable strength when air-dried and significant cohesion when submerged.

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 drainage area: all of that 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.

Crimping: the embedding of straw mulch into the soil surface by using implements such as a disc cultivator set at zero cut.

Critical twenty year return period storm: a rainfall event that has a five percent annual exceedance probability and a duration equal to the time of concentration.

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).

Detention dam: a dam constructed for the temporary storage of storm flow, which releases the stored water at controlled rates in order to reduce flooding hazard downstream of the dam.

Dewatering: the removal of impounded water, generally by pumping.

Di-ammonium phosphate (DAP): a high-percentage nitrogen and phosphate fertiliser suitable for the rapid establishment of grass.

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.

Drainage basin: refer catchment.

Ephemeral watercourse: a watercourse that flows only part of the year; includes overland flowpaths such as grassland swales and dry gullies which only flow during more intensive rainstorms.

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: 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 (see below).

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 salt water, where the tide meets the river current (e.g. bays, mouths of rivers, salt marshes and lagoons). Estuaries serve as 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.

Evapotranspiration: 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 blanket: a layer of sand and/or gravel designed to prevent the movement of fine-grained soils.

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.

Filter strip: a long, narrow vegetative planting used to retard or collect sediment for the protection of adjacent properties or receiving environments.

Fines (soil): generally refers to the silt- and clay-size particles in soil.

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.

Gabion basket: a flexible woven-wire basket comprising: two to six rectangular cells filled with small stones. Gabions may be assembled into many types of structures, such as retaining walls, channel liners, drop structures and groynes.

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 in section 6.2.3.

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.

Gley soils: formed under the influence of poor drainage, gley soils are typically grey or blue-grey in colour, sometimes with reddish-brown iron deposits.

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.

Guar: a drought-tolerant herb grown for forage and for its seed, which yields a gum used as a thickening agent or sizing material. This biodegradable gum can be used as a tackifier, or an adhesive applied directly to the soil, or over a layer of mulch. It acts as a glue to hold the soil in place or increase the holding power of the mulch.

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.

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 stream that maintains water in its channel throughout the year or maintains a series of discrete pools that provide habitats for the continuation of the aquatic ecosystem.

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 aluminum 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.

Reno mattress: a shallow (three to five hundred millimetres deep), wide, flexible woven-wire basket comprised of two to six rectangular cells filled with small stones. Often used at culvert inlets and outlets to dissipate energy and prevent channel erosion.

Return period: the statistical interpretation of the frequency of a given intensity and duration of a rainstorm event. Refer AEP.

Revegetation: the establishment of vegetation to stabilise a site.

Riparian protection area: An area adjacent to a watercourse designated as a non-disturbance zone to provide a buffer between receiving environments (e.g. watercourses) and the area of operation.

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).

Saturation point: in soils, the point at which a soil or an aquifer will no longer absorb any amount of water without losing an equal amount.

Scarified: shallow subsurface disturbance with a tine implement to provide surface roughening, used before topsoiling and revegetation.

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.

Sediment delivery ratio: the proportion of the soil eroded from within a catchment area that actually reaches sediment treatment controls or water bodies.

Sediment texture: the relative proportions of different sizes of sediment and soil particles that can be separated by screening. Refer also to Soil texture.

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.

Sensitive areas: include water bodies used for public water supply, any river, lake, stream, pond or wetland, sensitive crops or farming systems (e.g. organic farms) and any place, area or feature of special significance to tangata whenua as identified in the Environment Canterbury Natural Resources Regional Plan.

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. Refer Figure 3.4.

Silt loam: a soil textural class containing a large amount of silt and small quantities of sand and clay. Refer Figure 3.5.

Silty clay: a soil textural class containing a relatively large amount of silt and clay and a small amount of sand. Refer Figures 3.4 and 3.5.

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), as 2:1. A 2:1 slope is a fifty percent slope.

Expressed in degrees, the slope is the angle from the horizontal plane, with a 90° slope being vertical (maximum) and a 45° slope being a 1:1 slope. (Source: USEPA Polluted Runoff (Nonpoint Source Pollution) Management Measures for Forestry - III. Glossary http://www.epa.gov/nps/MMGI/Chapter3/ch3-3.html, accessed 24 May 2006).

Small site: small areas of earth disturbance that normally do not require a consent from Environment Canterbury or the city or district council, such as individual residential building sites. Refer Permitted activities.

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. Refer Sediment texture and Figures 3.4 and 3.5.

Spreader (hydraulics): a device for distributing water uniformly in or from a channel.

Stabilisation: providing adequate measures, vegetative and/or structural that will protect exposed soil to prevent erosion.

Stabilised area: an area sufficiently covered by erosion-resistant material such as a good cover of grass, or paving by asphalt, concrete or aggregate, in order to prevent erosion of the underlying soil.

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.

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. See Guar.

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 roadbanks, subsoils, parent material, etc., to provide a suitable medium for plant growth.

Unified soil classification system (engineering): a classification system based on the identification of soils according to their particle size, gradation, plasticity index and liquid limit.

Uniform flow: a state of steady flow occurring when the mean velocity and cross-sectional area are equal at all sections of a reach.

Universal soil loss equation: 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.

Watershed: refer Catchment.

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.

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. Note: Environment Canterbury is in the process of compiling an inventory of wetlands in the region. When that inventory has been completed, the term wetland in this plan will refer to wetlands listed in that inventory. In the interim, the term wetland has the same meaning as in section 2 of the Resource Management Act 1991.

Appendix A Key design decisions and assumptions

A 1 Runoff design criteria

The design storm was chosen to be the ten minute, five percent AEP (20-year) event. Ten minutes was chosen as the time of concentration for many small sites fits within this. A twenty year storm was selected because larger storms have been shown to generate greatly increased sediment levels than smaller storms (TP 51, ARC, 1994).

Storm intensities are based on version 2 of NIWA's HIRDS (high intensity rainfall design system) database. This has been found to under-estimate by thirty percent the rainfall intensities in Christchurch in comparison with a specific Christchurch study and other areas of the Canterbury region when compared to measured ECan rainfall data (Tony Oliver, ECan, pers comm*.)*. Therefore, using HIRDS a twenty year storm may in reality be closer to a ten year event.

Where more comprehensive rainfall data is available, then it should be used to derive the twenty year design storm pending review of the HIRDS database. Note that for areas of Banks Peninsula, HIRDS V2 grossly under-estimates rainfall events and V1.5 should be used: Akaroa rainfall depths are one-third of those in V2 (Allen Ingles, pers. comm., 12 June 2006).

Another source of rainfall data is Pearson (1992) Frequency of high intensity rainfalls in Christchurch.

A basic extrapolation of the HIRDS V2 model for a ten minute twenty percent AEP (five-year) storm event compared with a ten minute five percent AEP (twenty year) event was undertaken for a variety of locations in Canterbury. The increase in runoff was significantly higher: forty to sixty percent, Table A1.

Table A 1 Percentage increase in runoff volume for a five percent AEP (twenty year) compared to a twenty percent AEP (five-year) storm event (ten minute duration)

Christchurch – 40%	Rangiora – 40%	Ashburton – 60%
Timaru – 55%	Tekapo – 55%	Otematata – 60%

A 2 Sediment retention pond: assessment of capacity

Summary of assessment

- Pond sizing in Canterbury has been based on a ten hour, twenty percent AEP (five-year) rainfall event and runoff coefficients reflecting different soil types and slopes.
- Pond sizes for Christchurch are shown in Table A 3.
- Pond sizes for sites with markedly different rainfall can be determined from: pond volume (Table A 3) x [site ten hour, five-year rainfall/50]
- Sediment retention efficiency from these ponds is expected to be higher than that of Auckland, where pond efficiency research has been undertaken.
- The maximum catchment/pond is suggested to be ten hectares.
- Drain the live storage portion of a pond over twenty-four hours with decants.
- Most flat to moderately sloping silt loam soils should require only one dewatering decant for catchment of less than four hectares.
- Insert drainage holes in the decant in proportion to the soil type and catchment area.
- Ponds should be a minimum of 10m long to maximise settling prior to outlet.
- General widths of spillways can be approximated by:

gravels	0.5m wide/ha x 0.5m deep
flat silt loams <5%	0.5m wide/ha x 0.5m deep
silt loams 10–20%	0.75m wide/ha x 0.5m deep
steep silt loams >20%	1.0m wide/ha x 0.5m deep
clay soils <20%	1.0m wide/ha x 0.5m deep
clay soils >20%	1.25m wide/ha x 0.5m deep

A 2.1 Storm and pond sizing

A ten hour twenty percent AEP (five-year) storm has been selected by Canterbury earthworks industry representatives as the basis on which to size sediment retention ponds. This was based on an assessment of Auckland pond sizes and known efficiencies of ponds in that area coupled with local rainfall and experience. In Christchurch, this rainfall event is approximately fifty millimetres, which equates to five hundred cubic metres of runoff/hectare. However, the actual quantity discharged will depend on matters such as the type of soil and topography. This is reflected by the use of representative runoff coefficients. The Rational Formula is used in CCC's Waterways, Wetlands and Drainage Guide and the runoff coefficients from that guide are used in this one for consistency.

The Rational Formula is:

Qv[2] = KCiA where Qv $= m^3$

K = 0.00278

C = runoff coefficient (depends on soil type and topography)

i = 50mm

A = hectares

Representative coefficient values are in Table A 2.

[2] This is termed Cv or Volumetric C to differentiate it from peak flow C.

Table A 2 Representative Cv3 values for different soil types and slope

Soil type/slope	Cv
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

Table A 3 below shows indicative pond sizing for Christchurch:

Table A 3 Cv values and pond sizing/hectare for different soil types and slope, based on Christchurch rainfall

Soil type/slope	Cv	Pond sizing (m^3/ha)
Flat gravel (<5%)	0.15	75
Sloping gravel (>10 %)	0.25	125
Flat silt loam (<5%)	0.3	150
Sloping silt loam (10–20%)	0.4	200
Steep silt loam (>20%)	0.5	250
Clay (<20%)	0.45	225
Clay (>20%)	0.55	275

Rainfall varies markedly around the region and so pond sizes will also vary from that shown in Table A 3. Sizing ponds in these areas can be determined from:

Above pond volume x [site ten hour, five year rainfall/50]

Because rainfall can vary markedly over short distances as topography changes, it will be important to ensure that the right rainfall information is used.

A 2.2 Comparison with Auckland pond efficiency

Research into sediment pond efficiencies in Auckland indicates that ponds in that area are about seventy-five percent efficient in retaining sediment from construction sites from soils that generally have a higher component of fine-textured soil particles than is common ion Canterbury. Auckland ponds are either two or three hundred cubic metres per hectares depending on the size of the contributing catchment and are thus slightly bigger than the size indicated above.

[3] From CCC Waterways, Wetlands and Drainage Guide and verified by industry earthworks representatives.

It is considered that the commonly used Auckland figure of seventy-five percent efficiency would be conservative for Christchurch, as the common silt loam is a slightly smaller particle size that would settle out faster than the finer-textured silty clay or clay-loam soil particles of Auckland. Figure 3.5 of this guideline shows the distribution of particle sizes in typical Canterbury soils (note these are surface soils). No direct comparison between the settling characteristics of different soil particle sizes has been undertaken, although these are available in Appendix 7 of the Christchurch Waterways, wetlands and drainage guide (CCC, 2003).

Conclusions:

a) Pond sizing in Canterbury has been based on ten hour, twenty percent AEP (five-year) storm event and runoff coefficients reflecting different soil types and slopes.

b) Pond sizes for Christchurch are shown in Table A 3.

c) Pond sizes for sites with markedly different rainfall can be determined from:

pond volume (Table A 3) x [site ten hour, five year rainfall/50]

d) Sediment retention efficiency is expected to be higher than that of Auckland.

e) The maximum catchment/pond is suggested to be ten hectares.

A 2.3 Peak flow comparison between Christchurch and Auckland

Assumptions:

a) Peak flows are worked out from five percent AEP (twenty year), ten minute storm records using the Rational Formula. The twenty year storm is selected because ARC research indicates that sediment yield increases markedly with higher-intensity storm events. Use 78.5 mm/hr for Christchurch[4] and 106 mm/hr for central Auckland[5].

Table A 4 Christchurch/Auckland peak flow comparison

Site	Christchurch peak runoff (m^3/s)	Auckland peak runoff (m^3/s)
Flat gravel	0.033	Soils not found
Flat silt loam (<5%)	0.065	Soils not found
Sloping silt loam (10–20%)	0.087	Soils not found
Clay soil (<5%)	0.1	0.192

Conclusion:

a) For the nominated storm, peak flow from a Christchurch silt loam soil is about one-third that from the typical Auckland clay soil.

[4] From Waterways, Wetlands and Drainage Guide. CCC

[5] From ARC TP 108

A 2.4 Decant rates

TP 90 (ARC, 1999) stipulates a decant rate of three litres/second/hectare to drain the live storage of sediment retention ponds. The live storage component is the top 70 percent of the pond. This rate would drain the live storage volume from a 300m^3 pond in about 19.5 hours (i.e. 300 x 70 percent x 1000/3 x 3600). TP 90 indicates that approximately 133 x 10mm diameter holes/ha drilled into the floating decant will achieve the discharge rate of 3 l/s/ha. A 10mm diameter hole then drains 3/133 or 0.0225 l/s. The lesser rainfall of Christchurch suggests that a twenty-four hour draining period should be possible and which should achieve slightly better sediment retention (because water is retained slightly longer) and, therefore, better environmental protection. The decant rates in which to drain the live storage from the pond over twenty-four hours, the drainage holes necessary to achieve this rate, and the area that each decant can serve for the Christchurch situation are assessed as follows in Table A 5.

Assumption:

a) Live storage is 70 percent of the pond volume

Table A 5 Decant details

Site	Volume (m^3/ha)	Live storage (m^3/ha)	24-hour decant rate (l/s/ha)[6]	Holes / hectare	Hectares / decant
Flat gravel	75	52	0.6	27	7.4
Flat silt loam (<5%)	150	105	1.2	54	3.7
Sloping silt loam (>10%)	200	140	1.6	742	2.8
Steep silt loam (>20%)	250	175	2.0	90	2.2
Clay soil (<20%)	225	158	1.8	81	2.5
Clay soil (>20%)	275	193	2.2	99	2.0

Conclusions:

a) Drain the live storage of a pond over a 24-hour period.

b) Most flat to moderately sloping silt loam soils should require only one dewatering decant for a three or four hectare catchment.

c) Insert drainage holes in the decant in proportion to the soil type and catchment area.

d) Ponds should be a minimum of 10m long to maximise settling prior to outlet.

A 2.5 Spillway sizing

To compare the spillway requirements for a two percent AEP (fifty year), ten minute intensity storm[7] for a one-hectare catchment with varying soil types:

Assumptions:

(a) C values as before.

b) Spillway sized from $Q = 1.7wh^{1.5}$ or $w = Q/1.7\ h^{1.5}$ (where h = depth of flow).

c) The dewatering effect of the primary spillway and decants is ignored.

[6] From live storage volume x 1000/24 x 3600

[7] From Waterways, etlands and Drainage Guide. CCC

Table A 6 Christchurch two percent (fifty year) peak runoff assessment

Site	2% (50-yr), 10-min rain (mm/hr)	$Q_{50\ yr,\ 10\ min}$ (l/s/ha)	Spillway width/ha (m) with 0.2m depth
Flat gravel	95.4	39.8	0.26
Flat silt loam (<5%)	95.4	79.6	0.52
Sloping silt loam (10–20%)	95.4	106.1	0.70
Steep silt loam (>20%)	95.4	132.6	0.87
Clay (<20%)	95.4	120	0.79
Clay (>20%)	95.4	172.4	1.13

Conclusions:

a) Christchurch has less total volume of runoff and lower peak flow than Auckland. Therefore, spillway widths can be reduced.

b) A freeboard depth of 0.3m is assumed over the design depth.

c) General spillway widths:

gravels	0.5m wide/ha x 0.5m deep
flat silt loams	0.5m wide/ha x 0.5m deep
silt loams 10–20%	0.75m wide/ha x 0.5m deep
steep silt loams >20%	1.0m wide/ha x 0.5m deep
clay soils <20%	1.0m wide/ha x 0.5m deep
clay soils >20%	1.25m wide/ha x 0.5m deep

A 2.6 Over-all conclusions

a) ten hour, five-year rainfall event and runoff coefficients reflecting different soil types and slopes.

b) Pond sizes for Christchurch are shown in Table A 3.

c) Pond sizes for sites with markedly different rainfall can be determined from:

pond volume (Table A 3) x [site ten hour, five-year rainfall/50]

d) Sediment retention efficiency from these ponds is expected to be higher than that of Auckland (where pond efficiency research has been undertaken).

e) The maximum catchment/pond is suggested to be ten hectares.

f) Drain the live storage portion of a pond over twenty-four hours with decants.

g) Most flat to moderately sloping silt loam soils should require only one dewatering decant for a three or four hectare catchment.

h) Insert drainage holes in the decant in proportion to the soil type and catchment area.

i) Ponds should be a minimum of ten metres long to maximise settling prior to outlet.

j) Spillways: general widths:

gravels	0.5m wide/ha x 0.5m deep
flat silt loams	0.5m wide/ha x 0.5m deep
silt loams 10–20%	0.75m wide/ha x 0.5m deep
steep silt loams >20%	1.0m wide/ha x 0.5m deep
clay soils <20%	1.0m wide/ha x 0.5m deep
clay soils >20%	1.25m wide/ha x 0.5m deep

A 3 Peak flow runoff and channel sizing

The following is an assessment of a diversion channel to divert run-on water from a typical small pasture catchment around an earthworks site.

A 3.1 Flow assessment

Assume:

a) Peak flows are worked out from CCC (2003) records for the ten minute five percent (twenty year AEP) storm, using the Rational Formula. This is a conservative approach as storm durations are expected to be longer than ten minutes for five-hectare catchments, and intensity declines with longer storm duration. Use 78.5 mm/hr[8]. Assume run-on water is from a pasture catchment with c values (based on the underlying soils) of 0.1 for gravel, 0.2 for silt loam and 0.25 for clay. Add 0.1 adjustment factor for steep (>20%) slopes.

Table A 7 Christchurch peak flow

Site	Q_{20} peak runoff (m^3/s) 1 ha	Q_{20} peak runoff (m^3/s) 3 ha	Q20 peak runoff (m3/s) 5 ha
Flat gravel	0.02	0.06	0.1
Flat silt loam (<5%)	0.04	0.12	0.2
Steep silt loam (>20%)	0.087	0.26	0.44
Clay soil (<20%)	0.55	0.16	0.27
Clay soil (>20%)	0.98	0.29	0.49

A 3.2 Capacity of channel

Assume trapezoidal channel with 0.5m wide base, fabric-lined, 1:3 side slopes and on two percent grade.

1. Assume 0.1m depth of water in channel

Use $Q = \frac{A R^{2/3} S^{1/2}}{n}$ where $A = 0.08m^2$

$R^{2/3} = 0.171$

$S^{1/2} = 0.1414$ (2% fall)

$n = 0.012$ (fabric)

$Q_{20} = 0.161\ m^3/s$

2. 0.2m depth of water in channel where $A = 0.22m^2$ and $R^{2/3}$ is 0.249

$Q_{20} = 0.64\ m^3/s$

A 3.3 Conclusion

Using a fabric-lined channel with 0.5m base, 0.5m depth (which gives 0.3m freeboard) and 1:3 sides will convey the run-on flow from five hectares of steep pasture catchment on all soil types.

[8] From Waterways, Wetlands and Drainage Guide. CCC (2003)

Appendix B Stormwater soakage testing and design guidelines

This Appendix supplements the information in section 5.2 of this guideline. Use the map in Figure 5.1 together with the matrix in step 3 to identify whether onsite soakage is feasible for managing runoff from your development. If it is not clear from this map if the site has highly permeable soil, or the development is in another part of the region where soakage may be a solution, then refer to the guidelines below. Note that Environment Canterbury reserves the right to take a precautionary approach when assessing soil permeability for the purposes of developing erosion and sediment control plans for earthworks.

Comments on guidelines that provide design methodologies for stormwater soakage disposal
Source: NZWERF, 2004

Guideline	Comment
ARC TP 10 (Auckland Regional Council, 2003)	Design procedure is for disposal of the water quality storm; presumably this procedure would be relevant for larger storms, i.e. to provide full disposal
Christchurch City Council (2003)	This provides for water quality aspects and flood protection, developed for Christchurch conditions, namely free-draining alluvial soils. Expected to be relevant for other locations with free-draining soils.
Auckland City Council (ACC, 2003)	Relevant for areas of fractured basalt and associated highly permeable soils. Includes details on percolation testing. Uses design charts specifically prepared for Auckland City rainfall.
Approved Document for New Zealand Building Code Surface Water Clause E1 (BIA, 2003)	Design procedure for disposal of stormwater from individual buildings, including procedures for field testing of soakage and soak pit design methodology
University of Technology, Sydney (2001)	Method not reviewed

References:

Auckland City Council. (2003). *Soakage design manual.* (ACC, 2003)

Auckland Regional Council. (2003). *Stormwater treatment devices: design guideline manual*. ARC Technical Publication No. 10 (ARC TP10). From: http://www.arc.govt.nz/arc/index.cfm?34C9C2A8-1BCF-4AA1-91AF-CC49CFE4A80C.

BIA (Building Industry Authority). (2003). *Building Code Clause E1– Verification method E1/VM1: Surface water*. (BIA, 2003)

Christchurch City Council. (2003). *Waterways, Wetlands and Drainage Guide*. (CCC 2003).

University of Technology, Sydney. (2001). *SWITCH design*. From: http://services.eng.uts.edu.au/~simonb/Switch%20site/Other%20pages/References.htm

Appendix C Further support

From time to time, Environment Canterbury will prepare supporting resources to help users of this guideline. This information will be made available on the Environment Canterbury website.

If you would like to be notified as this information becomes available, please register on the website at http://www.ecan.govt.nz/ to go on our email list.

Currently available information includes:

- case studies
- factsheets

Case studies

Environment Canterbury, the earthworks industry and city and district councils in the region are currently working together to:

- develop case studies to help people preparing erosion and sediment control plans;
- carry out further research on the effectiveness of the erosion and sediment control practices in this guideline; and
- assess the need for further measures such as chemical treatment.

Factsheets

Factsheets are available:

- a summary factsheet about this guideline; and
- an information factsheet on control of sediment runoff from mature industrial sites that accompanies this guideline as part of Environment Canterbury's Pollution Prevention Guide.; and
- a factsheet for Small Site developers.