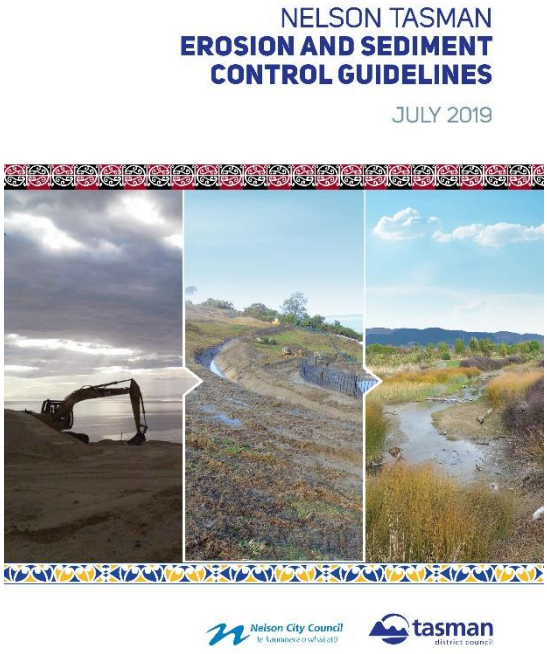
Chapter 6

EROSION AND SEDIMENT CONTROL CONCEPTS



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6.1 Key principles of erosion and sediment control

The first principle of erosion and sediment control is to limit erosion and sediment generation in the first instance and then to enhance deposition to retain sediment onsite.

Erosion and sediment controls have different roles.

First priority - Erosion controls to minimise any sediment from being generated and mobilised, Sediment controls capture the sediment generated and remove sediment from suspension to minimise overall sediment yield.

An Erosion and Sediment Control Plan (ESCP) should prioritise erosion control ie minimising erosion followed by control of sediment.

Solutions selected need to be appropriate for the local circumstances and will depend on the duration of earthworks and the potential yield of sediment that could discharge off-site.

Use the best tools for the site that reflect correct management of the risks for the site and activity.

6.2 Key Management Concepts of Erosion and Sediment Control

To ensure that erosion and sediment controls are effective and cost efficient, there are some key management concepts that should be considered throughout the project's planning, design and construction phases and in particular when developing an ESCP:

Refer to the "Ten commandments" of Erosion and Sediment Control; see Appendix 13.4.

Table 6-1 Key Management Concepts of Erosion and Sediment Control

Pre-Planning	• Develop and implement an evolving ESCP o Determine the risks on and off site o Utilise a treatment train approach o Make sure the plan evolves
	• Plan to minimise extent and duration of disturbance o Stage and sequence construction
	• Experience and Training o Use suitable qualified personnel to develop and implement the ESCP o Ensure all contractors understand the ESCP before their work begins
Before work begins	• Install perimeter controls o Control upper catchment water o Contain all dirty water and ensure it flows to treatment device
	• Protect watercourses

During work - Erosion Control	• Protect the land surface from erosion as much as possible
	  ○ Protect steep slopes
	  ○ Separate onsite clean water from disturbed areas
	  ○ Stabilise exposed areas rapidly

During work - Sediment Control	• Minimise sediment from leaving the site
	  ○ Employ detention devices
	  ○ Assess and adjust

Stabilise the site	• Stabilise all exposed areas with temporary or permanent stabilisation

These management concepts are discussed below.

6.2.1 Develop and Implement an ESCP that is capable of continuous improvement

Erosion and Sediment Control Planning is more than just creating a site map of controls, it is a process. Setting aside time to consider the potential impacts of your project or activity and identifying ways of avoiding or minimising these impacts from the outset can save time, money and our environment. It is important to consider HOW you will undertake the works not just which controls you will implement, as a change to the design, sequence of works or methodology could minimise erosion and sediment generation allowing the use of simpler, less expensive and more effective controls or reduce maintenance costs (refer to Chapter 7 for information on the content of ESCPs).

6.2.1.1 Determine the risks on and off site

The process for device selection and sizing as part of the ESCP should include the following aspects (refer also Appendix 13.7):

- A risk analysis to determine:
  - the potential for erosion and expected sediment yields'
  - the size, land cover and soil types of contributing catchments'
  - the sediment transport pathways on and off the site'
  - the types and sensitivity of receiving environments.
- A soils analysis (including a soil particle analysis if sediment retention ponds are considered)
- Determination of works methodologies including staging and sequencing
- Sizing of storage requirements as per Appendix 13.7
- Determination if flocculation is required.

6.2.1.2 Utilise a Treatment Train approach

A treatment train comprises a series of best management practices and/or natural features, each planned to treat a different aspect of erosion and sediment control that are implemented in a linear fashion to maximise sediment removal.

Erosion and sediment control measures should generally be planned to link functionally to form a "treatment train" with each measure having a specific role within the framework of surface water management, soil protection, stabilisation, and sediment capture. This approach can be a combination of structural (e.g. sediment ponds, hydroseeding) and non-structural (e.g. seasonal timing of works) practices.

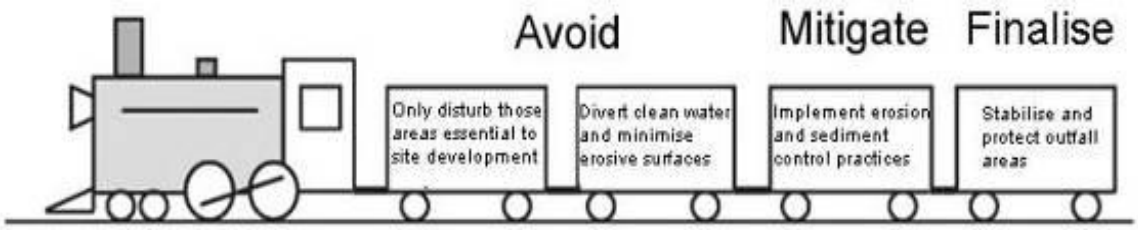

Figure 6-1 Treatment Train Elements for Good Site Control

Key fact

This approach needs to be considered during the early phases of project planning and followed through to the completion of the project.

6.2.1.3 Make sure the plan is subject to continuous improvement

An effective ESCP is modified as the project progresses from bulk earthworks to permanent drainage and stabilisation. Factors such as weather, changes to grade and altered drainage can all mean changes to planned erosion and sediment control practices.

Update the ESCP 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.

6.2.2 Plan to minimise the extent and duration of disturbance

Fit earthworks, construction techniques and methodologies to site conditions, constraints and opportunities land sensitivity. This may be difficult depending on the development approach and where space is limited, but the concept should always be considered.

Some parts of a site should never be worked, and others need very careful working. Watch out for and, if practicable, avoid areas that are wet (streams, wetlands and springs), have steep or fragile/vulnerable soils, or are conservation or outstanding landscape sites or features.

Utilise a minimum earthworks strategy where possible and practical. Only clear areas required for structures or access. Show all limits of disturbance on the ESCP and their timing. On site, clearly show the limits of disturbance using fences, signs and flags.

6.2.2.1 Stage and sequence construction

Carrying out bulk earthworks over the whole site at once maximises the extent and time that soil is exposed and prone to erosion.

"Construction staging", where the site has earthworks undertaken in small units over time with progressive revegetation, limits erosion.

For example, if a large project were to limit bare soil to 5 ha then staging would ensure that the disturbance in one area was stabilised prior to another area being disturbed. Careful planning is needed, including for aspects such as temporary stockpiles, site access and utility service installation. There are occasions when a large area is needed to be open, when this is the situation attention will be needed to ensure robust controls are in place to manage the larger scale and size.

In addition to construction staging, sequencing of construction is an important element. Sequencing sets out the order of construction to contractors and determines the order that erosion and sediment control practices are done in. For example, construction sequencing should ensure that sediment control practices are installed downslope from where the overall land disturbance is being done prior to land disturbance commencing, as well as identifying when works completion and stabilisation occurs in each area.

Key Fact

Identify both, constructions staging and sequencing in the ESCP.

6.2.3 Experience and training

A trained and experienced contractor is an important element of an ESCP. Contractors are individuals responsible for installing, maintaining and decommissioning erosion and sediment control practices.

Critical on-site staff should go through an erosion and sediment control training programme that may be available either locally or elsewhere in New Zealand. Better knowledge can save project time and money, by allowing for identification of threatened areas early on and putting into place correct practices. This upfront expenditure could potentially save much more in time and money by avoiding work stoppages, poor public relations, enforcement action and fines resulting from poor site controls and pollution events.

Making arrangements for a pre-construction meeting, regular inspection visits, and final inspection is also important. These meetings should be done by the developer, designer and contractor on a routine basis and there will need to be frequent interaction with Council representatives to ensure that site controls are functioning as needed and also reflect the relevant conditions of any consent.

Identify key responsibilities and appropriate personnel for each aspect of the ESCP, in particular identifying those responsible for monitoring and maintenance of devices. Also identify any training of personnel required to ensure appropriate implementation of the ESCP and onsite controls.

Ensure all contractors on site have viewed and understand the ESCP and understand their responsibilities before their work begins.

6.2.4 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 to sediment control (detention) devices. Common perimeter controls are diversion drains, silt fences and earth bunds.

Detail the type and extent of perimeter controls in the ESCP along with the design parameters for those controls.

Figure 6-2 Perimeter Bund Leading to Sediment Retention Pond, Estuary in Background

6.2.4.1 Control upper catchment water

Upper catchment water is runoff from above the area of disturbance that would normally flow through the site. The key consideration in **reducing the contributing catchment** is to control this upper catchment water (clean water) and minimise the amount of water crossing exposed areas, avoiding the potential for this flow to generate sediment. This is done by controlling clean water through interception, diversion and safe disposal to a location below the area of disturbance as shown in Figure 6-3 below.

Reducing the area of the catchment contributing to just water flowing through the site will also reduce the volume of water to be treated thereby minimising the sizing of any controls, saving time, space and money.

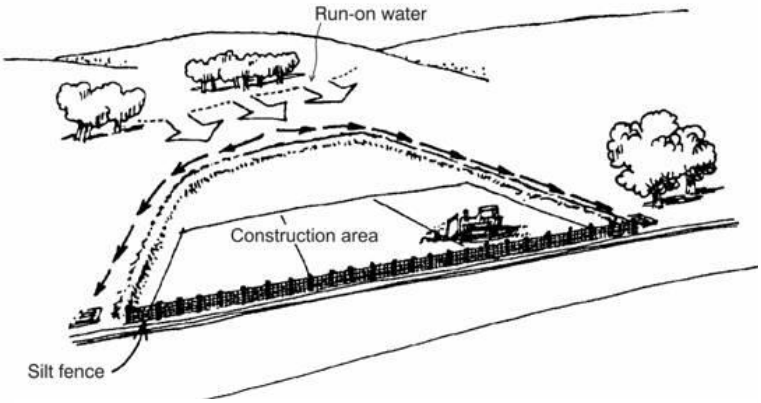

Figure 6-3 Diversion of clean water from above the site (Goldman et al 1986

6.2.5 Protect watercourses

Existing streams and watercourses, and proposed drainage patterns need to be mapped and included in the ESCP. Resource consent may be required for clearance works within or adjacent to a watercourse.

Map all watercourses and show all limits of disturbance and protection measures in the ESCP. Also, the ESCP should show all practices to be used to protect new drainage channels. Indicate crossings or disturbances and associated construction methods in the ESCP.

Figure 6-4 Silt Fence Provided for Stream Protection

6.2.6 Protect the land surface from erosion

To minimise the rates of soil loss, techniques as outlined in Chapter 8 will assist in protecting the land surface from erosion, however methods can be as simple as:

- Project design taking into account terrain limitations.
- Project scheduling to known climatic and soil variations.
- Minimising land clearance.
- Limiting areas of disturbance.
- Progressively stabilising disturbed areas (e.g. grassing and mulching).

Figure 6-5 Good Example of Straw Mulch,

Temporary Seeding and Aggregate Stone to Limit Exposed Area

6.2.6.1 Protect steep slopes

Where possible avoid existing steep slopes. If clearing of steep slopes is necessary, runoff from above the site can be diverted away from the exposed slope to minimise erosion. If steep slopes are worked and need stabilisation, traditional vegetative covers like topsoiling and seeding may not be enough - special protection is often needed in the form of geotextile blankets, slope drains to limit vertical flow of runoff or flumes to prevent overland flow down steep slopes.

Highlight steep areas on the ESCP showing limits of disturbance and any works and areas for special protection.

Figure 6-6 Flume Installed to Protect Steep Slope

6.2.6.2 Separate onsite clean water from disturbed areas

Clean water is onsite water that has not flowed through disturbed areas, whilst discharges from disturbed areas are considered to be dirty water. Diverting onsite clean water away from disturbed areas in another way of reducing the contributing catchment and minimising the volume of water that is required to be treated by sediment control devices.

Practices to achieve this include diversion channels and pipe drop structures/flumes which are outlined in Chapter 8 of this guideline.

Figure 6-7 Diversion channels separating clean water from disturbed areas (Photos courtesy of BOPRC and Ridley Dunphy Environmental Limited)

6.2.6.3 Stabilise exposed areas rapidly

An important objective is to fully stabilise disturbed soils with vegetation after each stage and at specific milestones within stages. Methods are site specific and can range from conventional sowing through to straw mulching (refer Chapter 8.3.3).

In the ESCP clearly define time limits for grass or mulch application, specify grass rates and species and define conditions for temporary cover in the case of severe erosion or poor germination.

Figure 6-8 Road Construction with Slope Revegetation

6.2.7 Minimise sediment leaving the site

It is imperative that a suite of controls are used to limit sediment discharge where earthworks or other land disturbance is occurring. Sediment controls should be selected taking into account the site constraints, the sediment transport pathways and the proximity and sensitivity of receiving environments. Steps should be taken to ensure that the controls are integrated with the permanent features of the project where appropriate. Refer to the practices outlined in Chapter 9.

Figure 6-9 Sediment Control Diversion and Sediment Retention Pond

6.2.7.1 Efficiency and effectiveness of controls

The ability of an erosion and sediment control practice to prevent sediment from being generated in the first place and then transported or to remove sediment once entrained is a measure of its efficiency. This efficiency (as a %) can be represented as the volume removed by the practice measured against the volume of sediment that arrives at the practice. This percentage can be within a wide range for each method depending on site and design factors. Data is not available for all control types, however Table 6-2 provides a summary of controls for which efficiencies have been identified.

Table 6-2 Efficiency of erosion and sediment controls

Control Practice	Efficiency for erosion or sediment reduction
Erosion control	
Slope benches	49% less erosion than a uniform slope (Zhu, et al. 1999)
Hydroseeding	50-60% (Caltrans, 2002)
Mulching eg with straw	53-99% (Harding, 1990)
Placement of turf	98-99% (USEPA, 1993)
Phasing of construction	42% reduction (Claytor, 1997)
Surface roughening	18% (Dane County, 2007)

Control Practice	Efficiency for erosion or sediment reduction
Sediment Control	
Sediment retention pond (no chemical treatment)	50-80%
Sediment retention pond (with chemical treatment)	75-95%
Silt fence	40-75% depending on type of fabric, overflow rate and detention time (Barrett et al., 1995)
Storm drain inlet protection	No specific data available, but when filter fabric is used, performance could be similar to silt fence performance (40-75%)
Decanting earth bund	60% depending on sizing of device and rainfall intensity (NZTA 2010)

To be effective as well as efficient control practices also need to be located appropriately constructed correctly and monitored and maintained regularly.

Design of controls should also consider other factors such as the timing, cost, and sensitivity of the receiving environments.

6.2.7.2 Employ sediment retention devices

Even with the best erosion control practices, land disturbance will discharge sediment laden runoff during storms. Along with erosion control measures, sediment control structures are needed to capture runoff so sediment generated can settle out. A number of different types of devices or practices, employed in a 'treatment train', may be needed to effectively manage sediment in runoff.

Include sediment retention structure design specifications; detailed inspection and maintenance schedules of structures and conversion plans for permanent structures (if this is to occur), in the ESCP.

Figure 6-10 Sediment Retention Pond

6.2.7.3 Assess and adjust

Inspect, monitor and maintain control measures.

Assessment of controls is important before, during and particularly following a storm. Before the storm to check all is in order, during to see if the actual design is performing to the specifications and after to see if any repairs are needed.

A large or intense storm may leave erosion and sediment controls in need of repair, reinforcement or cleaning out. Repairing without delay reduces further soil loss and environmental damage.

Figure 6-11 Storm damage needing new management and repair

Assessment and adjustment is an important erosion and sediment control practice -make sure it figures prominently in the ESCP and ensure contractors are aware of their responsibilities. Assign responsibility for implementing the ESCP and monitoring control measures as the project progresses.

It is not enough to just have controls in place on site it is also essential that the controls work for the duration of the project.

6.2.8 Stabilise all exposed areas with permanent stabilisation

Sites are considered permanently stabilised when all exposed soils are covered and protected from raindrop impact and erosion from overland flows, in a way that will provide ongoing protection over the long term. This includes sealing with concrete, asphalt or aggregate, use of geotextiles designed for long-term use and growth of self-sustaining vegetation (including exotic or native grasses, ground covers, shrubs and trees).

Self-sustaining vegetation means not requiring ongoing intense maintenance or watering, past the initial establishment phase, to ensure ongoing survival of at least 80% ground coverage. If this is unlikely to be achievable due to site constraints, some other method of permanent stabilisation may be more appropriate.

It is important to consider the steepness and aspect of batter slopes, soil moisture, topsoil and nutrient needs and the plant species used, to ensure the plants selected can cope with the specific site conditions over the long term, particularly with hot dry summers and harsh sun of the region.