Works within watercourses have very high potential for erosion and discharge of sediment. This is because such work is undertaken in or near flowing water – the major cause of erosion. Flowing water causes ongoing scour and provides the transport mechanism to allow sediment to be dispersed downstream of the works and ultimately, into the marine environment.

The following erosion and sediment control methods and techniques are specific to temporary watercourse works only. Such works may also require a range of control measures additional to those detailed below. These other measures are described in other sections of these Guidelines and include both erosion control and sediment control techniques.

Design and planning consideration for a permanent watercourse crossing need to take into account the permanent nature of the crossing in question. Be sure that they are constructed in accordance with all relevant requirements.

3.1 Temporary Watercourse Crossings

Plate 3.1 Temporary Watercourse Crossing

Definition

A bridge, ford or temporary structure installed across a watercourse for short term use by construction vehicles.

Purpose

To provide a means for construction vehicles to cross watercourses without moving sediment into the watercourse, damaging the bed or channel, or causing flooding during the construction, maintenance or removal of the structure.

Application

Where heavy equipment is required to be moved from one side of a watercourse to the other, or where traffic must cross the watercourse frequently for a short period of time.

Design

Careful planning can minimise the need for watercourse crossings. Wherever possible, avoid crossing watercourses by completing the development separately on each side of the channel, thus leaving the watercourse in its natural state.

If no other option exists and a watercourse crossing is required, select a location where the potential effects of the crossing (including construction) are minimised.

Plan watercourse crossings well before you need them and if possible, construct them during periods of dry weather. Complete construction as rapidly as possible and stabilise all disturbed areas immediately during and following construction.

Do not build a watercourse crossing during the fish migration period for the watercourse. The Auckland Regional Council can help identify these periods for particular watercourses.

There are three main types of crossing; bridges, culverts and fords.

Bridges

Where available materials and designs are adequate to bear the expected loadings, bridges are the preferred temporary watercourse crossing method. They provide the least obstruction to flow and fish migration, cause little or no modification of the bed or banks and generally require little maintenance.

It should be noted, however, that bridges can be a safety hazard if not designed, installed and maintained appropriately.

Culvert Crossings

Culverts are the most commonly used type of temporary watercourse crossing, and can be easily adapted to most site conditions. The installation and removal of culverts, however, causes considerable damage to watercourses and can also create the greatest obstruction to flood flows.

Fords

Made of stabilising material such as rock, fords are often used in steep catchments subject to flooding, but where normal flows are shallow. Only use fords where crossing requirements are infrequent. They can offer little or no obstruction to flows, are relatively easy to install and maintain, and in most cases can be left in place at the end of the construction activity.

As well as erosion and sediment control measures, structural stability, utility and safety must also be taken into account when designing temporary watercourse crossings. These details must be supplied to the Auckland Regional Council for approval prior to construction. In addition, a resource consent may be required for the construction of the proposed crossing. This can be determined by consultating with the Auckland Regional Council.

Any temporary crossing shall comply with the technical requirements of the various agencies involved and any specific requirements imposed by the Auckland Regional Council.

If the structure is no longer needed, remove the structure and all material from the site. Immediately stabilise all areas disturbed during the removal process by revegetation or artificial protection as a short term control measure. Keep machinery clear of the watercourse while removing the structure.

Maintenance

Inspect temporary watercourse crossings after rain to check for blockage in the channel, erosion of the banks, channel scour or signs of instability. Make all repairs immediately to prevent further damage to the installation. Permanent crossings need to be inspected following major storm events, again with all repairs being made immediately.

3.2 Temporary Watercourse Diversion

Plate 3.2 Temporary Watercourse Diversion

Definition

A short term watercourse diversion to allow works to occur within the main watercourse channel under dry conditions.

Purpose

To enable watercourse works to be undertaken without working in wet conditions and without moving sediment into the watercourse.

Application

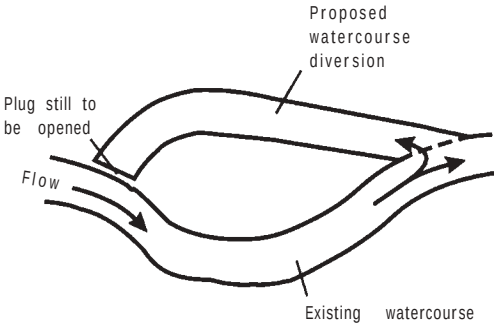
Temporary watercourse diversions are used as temporary measures to allow any works to be undertaken within permanent and ephemeral watercourses.

Design

Divert all flow via a stabilised system around the area of works and discharge it back into the channel below the works to avoid scour of the channel bed and banks. Figure 3.2.1 shows the suggested steps to minimise sediment generation and discharge from works within a watercourse.

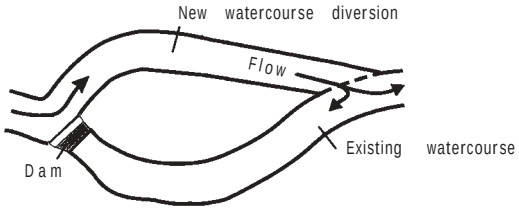
Step 1

Excavate the diversion channel leaving a plug at each end so that the watercourse does not breach the diversion. Size the diversion channel to allow for a 5% AEP rain event. Stabilise the diversion channel appropriately to ensure it does not become a source of sediment. Anchor suitable geotextile cloth in place to the manufacturer's specifications, which will include trenching into the top of both sides of the diversion channel to ensure that the fabric does not rip out. Open the downstream plug and allow water to flow up the channel, keeping some water within the channel to reduce problems when the upstream plug is excavated. Open the upstream plug and allow water to flow into the channel.



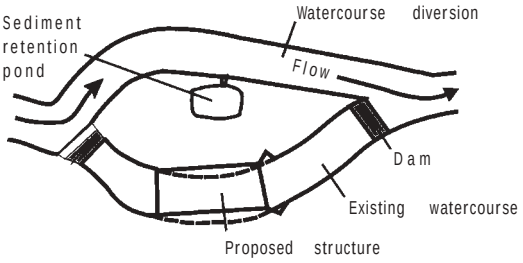
Step 2

Immediately place a non-erodible dam in the upstream end of the existing channel. Construct the dam as specified in Figure 3.2.2 ,where a compacted earth bund has shotcrete/ concrete placed, or appropriate geotextile pinned over it, with rock rip-rap extending over the upper face and adjacent to the lower face for scour protection.



Step 3

Immediately install a non-erodible downstream dam to prevent backflow into the construction area. Drain the existing watercourse by pumping to a Sediment Retention Pond where treatment of the ponded water can occur prior to re-entering the live section of the watercourse. Construct the structure and complete all channel work.



Step 4

Remove the downstream dam first, allowing water to flood back into the original channel. Remove the upstream dam and fill in both ends of the diversion channel with non-erodible material. Pump any sediment-laden water to a Sediment Retention Pond. Fill in the remainder of the diversion and stabilise.

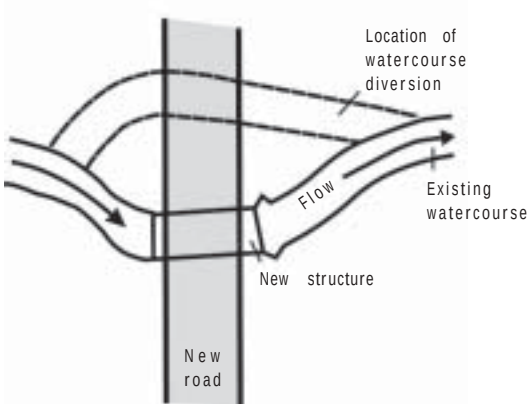


Figure 3.2.1 Temporary Watercourse Diversion Works Sequence

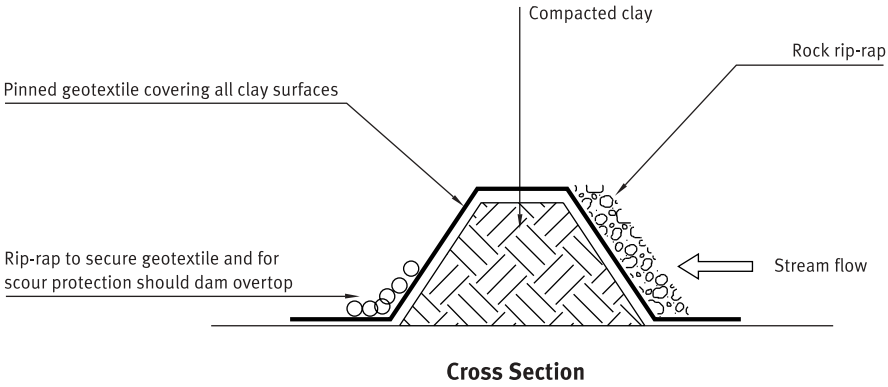


Figure 3.2.2 Temporary Watercourse Diversion Dam Detail

Maintenance

Any works within a watercourse will require ongoing and vigilant maintenance to minimise sediment generation. To achieve this, identify and correct any signs that may indicate a potential problems. Take particular notice of the following signs.

- The geotextile lining ripping.
- Scour occurring where the flow re-enters the channel.
- Undercutting of the diversion lining.

Make repairs immediately.

3.3 Rock Outlet Protection

Plate 3.3 Rock Outlet Protection

Definition

Rock placed at the outfall of channels or culverts.

Purpose

To break up concentrated flows, to reduce the velocity of flows to non erosive rates and to stabilise the outfall point.

Application

This practice applies where discharge velocities and energies at the outlets of pipes, culverts or flumes are sufficient to cause erosion. This will apply to most concentrated flow outfalls and outlets of all types such as sediment retention ponds, stormwater management ponds and road culverts.

Design

The following design does not apply to rock lining of watercourse channels. Detailed design of Rock Outlet Protection depends on the location.

- Do not use ROP to protect pipe outlets at the top of cuts or on slopes steeper than 10 % because they reconcentrate flows and generate high velocities after the flow leaves the apron.
- Ensure the channel containing the Rock Outlet Protection is straight throughout its entire length and is constructed using rock rip rap or gabion baskets/reno mattresses.
- Remove soft material down to a firm bed and smooth and level the outfall area to eliminate voids.

- Ensure rip rap is composed of a well graded mixture of washed rock and has an appropriate geotextile placed underneath it at all times to prevent soil movement into and through the rip-rap.
- Construct gabion baskets of hexagonal twist mesh with heavy galvanised steel wire. Ensure foundation conditions for the gabion baskets/reno mattresses are the same as for rock rip rap and place filter cloth beneath all gabion baskets. In some circumstances a key may be needed to prevent undermining of the main gabion structure.
- Design the structure in accordance with Auckland Regional Council approval and use materials within the relevant manufacturer's and engineering specifications.
- Remember that works within a watercourse such as the placement of rock rip rap or gabion baskets may require a resource consent from the Auckland Regional Council. Contact the Council well ahead of time so that any consents needed may be obtained before works are due to start.

Maintenance

Once installed, the maintenance requirements of the such structures is very low. Inspect after high flows to check scour and dislodgement and make repairs immediately.

Quarries are potentially a major source of sediment. They are often exposed for long periods of time and the area of bare earth can be considerable. Their continuous operation means that site conditions continually change. Careful planning is required to ensure that the operations are carried out with minimal environmental impact. It is the responsibility of the quarry operator to minimise the adverse environmental effects of the operation.

This section of these Guidelines is designed to help quarry operators address soil and water problems which may arise as a result of quarry operations. It should be read in conjunction with Part B, Sections 1 and 2 of these Guidelines, which detail specific erosion and sediment control practices. Quarries are required to produce management plans covering the various aspects of their operation. These Guidelines will help in the production of such plans.

The following specific issues associated with quarry operations are discussed below.

- Road access
- Stormwater
- Overburden disposal
- Stockpile areas
- Rehabilitation of worked out areas
- Riparian protection areas
- Maintenance schedule for erosion and sediment control treatment structures

Road Access

Many quarries in the Auckland Region are serviced by metal roads, used in all weather conditions. Vehicle movements during rain can generate a lot of sediment. These roads, however, are not always within the designated quarry area and therefore, are not covered by the Quarry Management Plan. Careful consideration needs to be given to managing roads and traffic. In cases such as these, erosion and sediment control measures need to be installed along roads as outlined in Part B, Sections 1 and 2 of these Guidelines.

Where possible, incorporate road access into the Quarry Management Plan, ensuring all measures necessary are put in place to protect receiving environments.

Stormwater

Clean Runoff

As far as it is possible, divert clean water flow away from working and bare areas to prevent them from becoming contaminated by sediment. This aids in reducing the volume of contaminated runoff needing to be controlled and treated. Runoff Diversion Channels around the working site, as outlined in Part B, Section 1.1, are the simplest way to deal with the clean runoff.

Contaminated Runoff

Any runoff from bare areas will collect sediment and become contaminated. This contaminated runoff, which includes runoff from aggregate wash processes, must be contained and treated in an appropriate manner before being discharged to natural watercourses. The Quarry Management Plan must detail the methods for containment and treatment of all contaminated runoff. Particular attention should be paid to sensitive areas such as permanent watercourses, watercourse crossings and steeply sloping bare areas. Design all structures for the 5% AEP rainfall event.

Overburden Disposal

Methods of overburden disposal vary for each quarry operation. Overburden removal and disposal sites can be a major source of erosion and sediment discharges from quarries, particularly if the disposal site is not properly located and managed. The Quarry Management Plan for the site should give a reasonable indication of the following.

- The timing and extent of overburden stripping, which will be related to an expected volume and area of extraction.
- The methods to be employed for disposing the overburden.
- Ongoing management of disposal sites, including provision for regular disposal of material trapped in sediment retention ponds.

If overburden disposal is dealt with in isolation from the Quarry Management Plan, consideration must be given to the following points.

- Selection of disposal site (why the site was chosen).
- Stability of the site and subsequent overburden fill (batter slopes, safety factors, benching, underlying material, drainage).
- Erosion and sediment control measures.
- Rehabilitation of disposal site (revegetation, contouring).

Stockpile Areas

Stockpile areas include those used for stockpiling both raw or finished quarry products prior to further processing or final despatch. These areas can be a major source of contaminated runoff if not properly controlled. Position stockpiles well away from any watercourses and runoff flow paths.

Rehabilitation of Worked Out Areas

Planning for rehabilitation must be an integral part of all quarry operations. A properly planned and implemented rehabilitation programme will reduce the need for expensive ongoing erosion control, and control and treatment of contaminated runoff. The aim of site rehabilitation, whether temporary or permanent, is to maintain the site in a condition such that erosion and contaminated runoff are limited to an acceptable level. The prime areas for consideration are:

- establishing suitable final ground contours;
- establishing a suitable environment for vegetation growth;
- revegetating the site with suitable vegetation cover.

Riparian Protection Areas

Riparian protection areas rely on vegetation to provide a buffer between the quarry operations and a water body such as a watercourse or wetland. These margins act as a physical barrier to keep machines away from sensitive areas as well as serving as a last resort sediment trap for diffuse runoff and/or unforeseen discharges. Do not, however, rely on riparian protection areas as a primary sediment control mechanism.

Maintenance Schedule for Erosion and Sediment Control or Treatment Structures

Because quarry operations continue over a very long time frame, it is important to develop a maintenance schedule for any control/treatment structures that are put in place. Money spent on designing and constructing control/treatment structures will be wasted if these structures are not adequately maintained.

Properly maintained structures will provide optimum performance at all times, thereby minimising the adverse environmental effects of the quarry operation. Conversely, poorly maintained structures are likely to result in unsatisfactory environmental protection despite being initially well designed and constructed.

Develop a maintenance schedule for the site that clearly indicates what is to be done in terms of visual inspections and maintenance works. Undertake routine maintenance works when they will cause the least possible detrimental environmental effects (either directly or indirectly). For example, do not clean sediment retention ponds during or immediately after rainfall events. To ensure that the operation of the pond is not affected at these critical times, maintenance should be done prior to events.

It is also particularly important that all control/treatment structures are inspected after significant rainfall events, or during prolonged rainfall, in addition to any regular scheduled inspections.

In the maintenance schedule include a procedure for immediately repairing and remedying any damage caused to control/treatment structures from daily quarry activities.

Within the overall quarry operation, give the inspection and maintenance of control/treatment structures a high priority. Ensure every person involved in the quarry operation is familiar with all aspects of erosion and sediment control on the site, including any special conditions of consents that are relevant. For example, specific water quality sampling requirements.

For all aspects of quarry operations where erosion and sediment controls are required, install the erosion and sediment control practices as specified in these Guidelines.

Vegetation removal operations can be a major source of sediment. They often involve earthworks associated with roading and landing (skid site) formation, as well as the direct disturbance and exposure of the soil surface. Careful planning is required to ensure that these operations are carried out with minimal environmental impact.

This section of these Guidelines is designed to help people involved with vegetation removal operations to address soil and water problems which may arise as a result of their operation. This section should be read in conjunction with Part B, Sections 1 and 2 of these Guidelines, which detail specific erosion and sediment control practices. Vegetation removal operations are also required to produce Harvesting Management Plans that cover the various aspects of their operation. These Guidelines can be used to assist in the production of these plans.

Various specific issues associated with vegetation removal operations are discussed below.

- Roading
- Firebreaks
- Landings and tracks
- Land preparation
- Harvesting and management after harvesting

Roading

Roading activities undertaken as part of vegetation removal operations have a large potential impact on soil and water values.

Planning, Location and Design

- Locate roads on ridge tops, natural benches and flatter slopes, avoiding steep side slopes where possible.
- Do not locate roads in gully bottoms.
- Minimise gully crossings where possible.
- Locate roads a safe distance from watercourses and gullies.
- Do not discharge runoff directly to a watercourse, and where possible, ensure runoff is filtered through vegetation.
- Where steep side cuts cannot be avoided, ensure adequate cross-formation drainage is installed and that these channels flow onto stable or erosion proof areas such as spurs. Ensure they do not discharge onto areas of soft fill.

Construction

- Where construction operations are to be undertaken in erosion-prone areas or adjacent to a watercourse, use an excavator to enable soil and other loose material to be placed in a stable position.
- Do not bulldoze loose material into watercourses or areas where it may wash into watercourses.
- Keep machines out of watercourses and minimise the number of crossings.
- If operations are suspended, put adequate drainage provisions in place to avoid concentration of runoff and scour problems until work resumes.
- Stabilise cut and fill slopes where required, using measures such as hydroseeding and straw mulching.
- Install contour drains and flumes to prevent scouring.
- Flume or pipe runoff to solid ground and then discharge onto logging slash, gravel, rock rip-rap, or geotextiles.
- Plan the operational sequence of installing culverts and bridges across watercourses. Ensure all materials, machinery and labour are on hand before commencing construction.
- Ensure that the supervision of culvert and bridge installations is carried out by a suitably experienced person.
- Complete the construction of watercourse crossings, approach roads and associated erosion and sediment control measures as a continuous operation.

Firebreaks

- Locate firebreaks to minimise the possibility of debris entering watercourses.
- Keep earthworks associated with firebreaks clear of steep drop-offs and watercourses. Consideration must be given to the erosion potential of tracks formed along gully bottoms. These areas should be avoided.
- Maintain firebreaks to a reasonable standard to control runoff, rilling and gully erosion.
- Construct contour drains as required.
- Avoid ponding of water above steep drop-offs and, if ponding occurs, implement an appropriate drainage design to prevent gully erosion.
- At the completion of operations, check firebreaks for any potential erosion problems.

Landings and Tracks

Landings and tracks are generally permanent features and therefore require careful location preparation, direction of fall and control of runoff. Skid tracks, while generally more of a temporary feature, also require careful consideration of the above.

Any tracking results in concentration of runoff and consequently, an increase in erosion. Minimise erosion by tracking across contours and where possible, locating tracks on ridges rather than in gullies.

Ensure that extraction tracks do not lead directly down towards watercourses where runoff may go directly into the channel.

Where possible try to keep skid tracks and landings at least 20 o away from watercourses.

At the completion of logging operations, construct contour drains across skid tracks wherever runoff may be concentrated. Ensure that contour drains discharge to solid ground and not to areas of fill.

Keep landings well clear of permanent watercourses. Where no alternative exists, ensure that the watercourse is not obstructed. Form all landings so that surface runoff does not flow down towards or directly into a watercourse. Construct earth bunds along watercourse edge boundaries to prevent debris and sediment from entering watercourses. Extra caution must also be exercised in the planning and construction measures which control water flowing off skid tracks onto landings, so as to minimise water runoff onto the landing.

Take extra caution when forming landings within dry gullies. Where this is done, ensure the following.

- A slash is placed across the gully floor to act as a sediment barrier.
- Fill batters are sown with a suitable vegetation cover.

Land Preparation

Planning

Plan and implement all land preparation and forest establishment to match an appropriate proposed method of harvesting.

Protection Areas (Riparian Margins)

Retain or establish protection areas along all watercourses. Where protection areas do not exist, they can be established in conjunction with the following operations.

- Land clearing or site preparation on areas being converted to production forestry.
- Planting on farm land or similar sites.
- Replanting on exotic clearfelled areas.
- Vegetation removal on terrain which may be difficult, very steep or erosion prone.

Re-evaluate all existing protection areas when harvesting or replanting adjacent to production stands.

Generally, protection areas can be left to regenerate naturally. However, in some cases it may be appropriate to accelerate revegetation by actively planting protection species.

Planting Boundaries

When re-planting, establish planting boundaries adjacent to watercourses in order to minimise potential watercourse damage from future harvesting operations. Establish planting boundaries on a 'case by case' basis with consideration to both topography and soil stability.

V-Blading/Line Raking

Where possible operate across the contour, to minimise runoff concentration down the blade lines.

Where downhill runs are unavoidable, limit them to 50 o maximum length. Do not attempt these runs on slopes too steep for the tractor to reverse up. Blade or rake at

least one line on the contour along the lower boundary of downhill operations to prevent runoff concentration at low points or gully systems. Finish downhill runs well before any fill batter slopes such as landings and access roads.

Near watercourses, ensure the operation runs parallel to them at a minimum distance of 20 0. At the completion of the operation, inspect the site for areas of erosion potential and undertake appropriate remedial action.

Establishing and Tending

During establishing and tending stages, minimise soil loss and prevent contamination of watercourses with chemicals, fertilisers, debris or detritus and.

During thinning to waste operations, fell trees away from watercourses where possible.

Harvesting and Management After Harvesting

Planning of Logging Operations

Plan all logging operations, particularly the location of skid tracks and roads, to protect water and soil values.

Off-site adverse effects must be avoided or minimised when determining the ability and management of a catchment to be harvested. When harvesting near sensitive areas, extract towards landings located away from them.

Felling Operations

When trees are being felled within reach of a watercourse, ensure an experienced feller is in control of the operation. Where possible, fell trees away from watercourses. Extract any trees that have fallen into watercourses before delimbing and cross cutting them. Back pull, or employ other acceptable directional felling techniques to fell problem trees, particularly on steep or unstable watercourse faces and edges. Remove all large logging debris from watercourses at the completion of the operation, keeping machinery out of the watercourse.

Extraction Operations

- Ground Based Systems
  - Keep tracking and stumping activities to a practical minimum. Use a few carefully chosen tracks and stay on these rather than taking shortcuts which cause unnecessary ground disturbance.
  - Carry logs off the ground or on the machine where possible.
  - Keep the machines blade up and do not bulldoze soil and stumps needlessly.
  - Do not cross watercourses (other than at approved crossing points) and do not haul along them.
  - On soft and/or wet soils or steeper slopes, use low-ground-pressure machines such as flexible-track or wide-tyre skidders.
- Cable Systems
  - Where cable systems are used in environmentally sensitive areas, keep the settings small, the haul distances short and the hauling direction uphill wherever practicable. Avoid cross slope haul lines that damage protection areas or sweep slash and soil into watercourses.
  - Whenever possible when hauling across watercourses, use a system such as a skyline which allows full suspension of logs. Lift logs clear of watercourse banks and protection areas.

Cleanup Operations

On completion of logging operations, carry out the following procedures.

- Remove all temporary crossings.
- Construct contour drains on skid tracks to prevent runoff concentration and sediment flow.
- Ensure landings are properly drained and that sediment and debris are unable to directly enter any watercourse.
- Stabilise fill batters on landings and tracks by sowing with suitable grass seed.
- Ensure runoff is channelled safely over batter slopes and onto stable areas.

On all aspects of vegetation removal operations where erosion and sediment controls are required, install the erosion and sediment control measures as specified in these Guidelines.