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Best Practice Guidelines for Vegetation Management and In Stream Works

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Contents

Figures

Photos

1 Introduction

These best practice guidelines cover activities undertaken by the River and Catchment Services group of Environment Waikato involving works within watercourses and vegetation management (including bioengineering). The guidelines do not cover activities associated with management of drainage districts as those are covered in a separate guideline document (Environment Waikato Technical Report 2006/06).

This document is divided into activities that the River and Catchment Services group of Environment Waikato is involved with undertaking and sets out site assessment, planning, operational and follow-up practices that should be applied to those activities, regardless of whether an activity requires a resource consent or not.

The purpose of the guidelines is to:

- list and describe the operational activities carried out by the River and Catchment Services Group of Environment Waikato
- describe what is considered to be practical best management in each of the operational activities carried out
- ensure all staff working across the Waikato region work in a manner which is consistent with best practice
- assist in the training of new staff
- ensure that the day to day activities of the River and Catchment Services group have a no more than minor impact on the environment and wherever possible that they have a positive environmental effect.

1.1 What is best practice?

Best practice involves using the best methods to achieve certain goals when undertaking an activity. Best practice methods are environmentally sound methods. Best practice will improve or maintain natural habitat and ecological processes.

These guidelines are intended for anyone involved in undertaking vegetation management or works within a waterway, to ensure that their methods are appropriate and that the values associated with waterways and their surrounding environment are protected and wherever possible enhanced.

These guidelines may also assist those involved in authorising and auditing vegetation management activities and activities that involve works within a waterway within the Waikato region, as they provide an indication of what should be expected from such activities.

In undertaking river management, soil conservation and riparian management activities the long-term outcomes Environment Waikato is trying to achieve, within the constraints of providing and maintaining an efficient flood control system are:

Environmental outcomes

- Maintain (and where possible) enhance and restore indigenous biodiversity in the region.
- Maintain stable rivers and streams.
- Where possible avoid and as a minimum reduce the effects of accelerated erosion across the region.
- Maintain and improve water quality within rivers and streams.

1.2 Legislative requirements/responsibilities

Environment Waikato performs a range of statutory functions and roles relating to river systems management. The roles and responsibilities of the regional council regarding river systems management are detailed in the following statutes.

- Orders in Council for Local Government Re-organisation 9 June 1989 (OCLGR).
- Resource Management Act 1991 (RMA).
- Local Government Act 2002 (LGA).
- Soil Conservation and Rivers Control Act 1941 (SCRCA).

The various statutory provisions relating to river systems management and the control of flooding and erosion on occasion overlap. The RMA is the predominant statute and its provisions prevail in the event of any conflict. Appendix one contains detailed explanation of the legal responsibilities that River and Catchment Services has under each of these Acts.

2 Waikato Regional Plan

The Waikato Regional Plan (WRP) has been developed by Environment Waikato under the Resource Management Act (1991). It provides direction regarding the use, development and protection of natural and physical resources in the Waikato region.

The plan contains rules that control various activities within the Waikato region, including in-stream works and vegetation management. The following rule types are included in the WRP.

- **Permitted activities**, which do not require resource consent although there are controls on specific aspects of the activity.

- **Controlled activities**, which require resource consent that will be granted but with controls placed on specific aspects of the activity. The types of controls that may be imposed are defined in the WRP under the applicable rule.

- **Discretionary activities**, which require resource consent that may or may not be granted at Environment Waikato's discretion. Consents that are granted have controls placed on any aspects of the activity at the discretion of the consent authority.

- **Restricted discretionary activities,** which require resource consent. The consent authority will specify in the plan or proposed plan the matters to which it has restricted its discretion. The consent authority's powers to decline resource consent and to impose conditions are restricted to matters that have been specified. The activity must comply with the standards, terms, or conditions, if any are specified in the plan or proposed plan.

- **Non-complying activities**, which require resource consent that may or may not be granted at the consent authority's discretion. The presumption is that such applications will be declined. The activity for which consent is required, is provided for as a non-complying activity, by a rule in a plan or proposed plan. A non-complying activity can also be an activity that contravenes a rule in a plan or proposed plan.

The WRP rules that control in-stream works and activities that disturb river and lake beds are included in chapters 4.2 and 4.3.

3 River and Catchment Services activities

The River and Catchment Services group of Environment Waikato undertakes a range of functions including the following.

Flood protection
Construction, operation, and maintenance of stop banks, floodgates, and pump stations throughout the Waikato region, to protect assets from flooding.

Water level controls
Construction, operation and maintenance of water level controls in some lakes and wetlands in the Waikato region to maintain water levels within specific upper and lower limits.

Erosion control
Treatment and prevention of stream bank and channel erosion within selected river and stream systems in the Waikato region.

River management
Proactive management and maintenance of river and stream systems to reduce the risk of flooding and erosion problems as well as achieve a stable natural river system.

Riparian management
Provision of information, advice and incentives, to encourage land owners to undertake appropriate riparian management. Some active riparian management by Environment Waikato on specific streams.

Drainage management
Control of specific drainage schemes (including pumped schemes) in the Waikato region. Note: Guidelines associated with drainage management are not covered in this document but can be found in Environment Waikato Technical Report 2006/06.

3.1 The role of vegetation (willows and natives)

River and Catchment Services commonly use vegetative systems and structures to assist with the management of rivers and streams. By combining vegetative controls with river engineering principles, the energy of the flowing water can be absorbed, and/or redirected, so that erosion of the river banks and channels is less likely to occur. Examples of activities that utilise vegetation include:

- designing and building erosion control structures that have a substantial vegetative component (for example, groynes)
- planting/layering trees at critical locations to help control meander patterns
- riparian planting of trees to help stabilise river and stream banks

Tree willows and shrub willows are two of the many types of vegetation used. Tree willows are used in two different ways. Firstly they can be planted on river banks and layered as they grow to provide heavy vegetative protection to the river banks. Secondly as part of a live engineering structure (such as a groyne) to control severe bank erosion.

Shrub willows are planted on berm and banks of rivers where the erosion is less severe, stabilisation of the stream bed or banks is required, and velocity of flow is to be reduced by the vegetation.

Tree willows tend to have good primary and secondary root systems, whereas shrub willows tend to have a dense root mass, but with finer roots. When used together, the two types of willow complement each other and provide excellent bank protection in the harsh river environment.

Willows have a number of attributes that make them ideal for use in river control.

- Willows will grow in a range of conditions from relatively dry sites to very wet sites, where the willow may be partially submerged in water.
- Willows will grow rapidly, even in relatively poor soils.
- Willows have excellent soil binding characteristics provided by their fibrous roots. This is important for the stabilisation of river margins, as the banks are often formed from non-cohesive silts sands and gravels.
- Willows can be propagated relatively easily and cheaply. They can be planted out from small cuttings, stakes, branches or even whole trees.
- A wide range of specially selected and bred willow varieties are available.

The extensive use of willow in river management has caused some concern as willows are seen by some people as being easily spread and capable of becoming a plant pest. Environment Waikato is careful to use non-invasive willow species/clones that have been specially bred for soil conservation and river control purposes.

An alternative option to use of willows is to plant native species. Native planting increases biodiversity and for this reason Environment Waikato seeks to use native plants whenever possible. Unfortunately native shrubs and trees are not always appropriate as a *direct alternative* to willows for erosion control. Some native species exhibit many of the attributes listed above but none have all of these attributes.

However, in many situations native vegetation can be planted outside the primary buffer of willow or inter-planted between willows. Unlike willows many native tree species have very long life spans and require very little long-term maintenance. They are therefore considered a more sustainable long-term solution to erosion control. Willow trees inter-planted with native species can be removed once the native tree species mature.

4 Vegetative protection works for waterway management

A range of vegetative protection works are utilised as part of normal waterway management including:

- native planting
- pole planting along waterways
- vegetation lopping/layering
- brushing/tying in vegetation
- poplar/willow groynes
- maintenance of tree plantings
- mechanical vegetation removal.

Anyone undertaking tree work is required to comply with the approved code of practice for Safety and Health in Tree Work – Part 3: River and Stream Operations. Although not legally required, it is also recommended that an excavator with a thumb or positive grab is used when undertaking tree work.

4.1 Poplar/willow vegetation groynes and training lines

This activity includes the use of anchored willows or poplars to train the river to flow in a certain path and is usually used to control erosion. For example works may be undertaken to divert flow away from an eroding bank or to make it take a particular flow path around an island. Groynes and training lines can be constructed using a range of methods.

In large rivers, especially where there are steep banks Environment Waikato often uses training lines. This involves anchoring vegetation to the bed of the river by using steel pipes, railway iron or screw anchors. A training line creates a new river bank alignment

different to that existing before the works. This provides relatively heavy vegetative protection and where willows are used, trees develop strong root systems. The vegetative barrier formed encourages low flow velocities behind the barrier which result in the deposition of sediment and infilling of the area during times of flood.

In rivers where the banks are sloped and the river channel needs to be trained to a particular width, groynes are commonly used. This involves burying the trunks of poplar or willow trees in the bank of a river, with foliage extending into the river channel. The trees are anchored in series so that they form a continuous protective live buffer along the river bank. Water velocities will be slower behind each groyne encouraging the deposition of sediment at the toe of the banks.

Photo 1: Newly constructed groynes on the right bank.

Photo 2: River training line with newly planted willow poles.

4.1.1 Opportunities for enhancement

Constructing training lines and groynes is an easy and relatively quick solution to remedying erosion and training a channel to a particular width. However, there are also further works that can be undertaken to both enhance the environment and provide further long-term stability for the erosion prone site. Most New Zealand native plants have a life span of several hundreds of years (if not longer) so although slow to establish can provide long-term stability to a site when used in conjunction with other methods such as training lines and groynes.

As well as providing long-term stability, additional plantings will provide riparian shade and shelter, helping to lower stream water temperatures and provide habitat for in-stream life. Leaf litter and small twigs that fall into the stream are an important food source for microbes and many species of aquatic invertebrates on which fish feed. Best practice should therefore involve follow-up riparian fencing and planting.

4.1.2 Guidelines for best practice

Site assessment

a) Does the site require human intervention? (What would be the impacts of doing nothing?).
b) What level of intervention is necessary? A low key approach may be successful and have less environmental impact.
c) Where is the activity proposed? For example if it is near the coast, you may have to consider issues such as whitebait spawning areas. If it is in the upper catchment, the waterway may be an important trout fishing area.
d) Is the work a priority for Environment Waikato funding?

Planning

a) Scope the works to assess the costs (including any resource consent costs).
b) Determine the class of the waterway (for example, trout fishery/spawning, indigenous fishery) from the Waikato Regional Plan (or Environment Waikato's Smart Maps system).
c) Check the relevant sections in the Waikato Regional Plan to determine whether resource consent is needed. If consent is required allow **at least** 12 weeks to go through the process.

Relevant sections in Waikato Regional Plan

Section	Name
4.2.14	Lines, cables, pipelines, ropeways & associated structures
4.2.15	Erosion control structures
4.2.16	Channel training structures
4.3.4	Disturbance of the beds of lakes and rivers
4.3.6	Disturbance of river and lake beds associated with the maintenance of a lawfully established structure
4.3.8	Introduction or planting of vegetation on the beds of rivers and lakes and tree layering

d) What is the appropriate funding level from Environment Waikato?
e) Investigate whether other groups/agencies could assist with costs?
f) When siting the works, consider any likelihood that the works could become a navigation hazard.
g) Consider potential impacts of the work on recreational river users (for example, anglers, swimmers, canoeists) and take steps to minimise these.
h) Consider whether the work can be undertaken from the river bank or whether a barge is needed.

i) Use native tree species wherever possible and if willow is used ensure male hybrids are selected (for example, Matsudana).
j) If the site has high public visibility purchase signage to explain the works.
k) Follow Environment Waikato's Spill Contingency Guidelines (Technical Report TR2006/24, www.ew.govt.nz/publications/technicalreports/tr0711.htm).

Consultation

a) If on a trout fishery/spawning class waterway (as per the Waikato Regional Plan) consult with the local branch of Fish and Game so they are aware of when and how the activity will be undertaken.
b) If the river where works are proposed is an indigenous fishery (as per the Waikato Regional Plan) and the Department of Conservation (DOC) have an active interest in the area discuss your plans with DOC.
c) Consult any other potentially affected parties such as neighbouring property owners and/or iwi.

Physical works

a) Ensure that all works are carried out in a manner that minimises the operation of machinery within the flowing river channel.
b) The use of machinery and all other activities shall be undertaken in a manner that minimises disturbance of existing vegetation cover and the disturbance of sediment.
c) Take measures to prevent silt run-off from the work site into the watercourse. This may involve diverting water flow to one side of the channel. Resource consent may be required for this.
d) Ensure that all material is securely anchored to prevent any material breaking free and being washed downstream.
e) Minimise the extent and duration of river bed and riverbank disturbance.
f) Plant willow poles or stakes along banks between groynes.
g) When siting the works, consider any likelihood that the works could become a navigation hazard.
h) Ensure the butts of the poles/stakes are planted into wet ground.
i) Ensure that no fuel storage or machine refuelling occurs where fuel could enter a water body in the event of a spillage.
j) Ensure that an appropriate oil spill cleanup kit is kept on site during the works to contain any contaminants that enter the river, particularly on the barge.
k) Ensure that machinery and materials are removed from the floodway at the end of each working day, to avoid the possibility of floodwater washing machinery or materials downstream.

Ensure machinery is washed down prior to and following works to prevent the spread of unwanted organisms such as alligator weed and didymo.

Timing

a) Undertake planting during May to October inclusive to ensure successful establishment of plantings.
b) If consent is not required for the work and the work will involve earthworks on the banks of a fishery class waterway as per the Waikato Regional Plan, time the earthworks to avoid the fish spawning periods as outlined in the table below. If work can not be undertaken during these times seek ecological advice specific to the site.

Timing of works in fishery class waterways

Location of work	Desired timing of work
Within tidal reach	June to February (to avoid Inanga spawning peak)
Lake Taupo and tributaries	November to April (to avoid spawning)
Within Trout fishery waterway not within Lake Taupo or tributary	September to April (to avoid spawning)
Within indigenous fish waterway	December, January, February

For greater detail on fish spawning and migration timing see Environment Waikato's freshwater fish spawning and migration calendar (Technical Report TR07/11 - www.ew.govt.nz/publications/technicalreports/tr0711.htm).

Follow-up

a) Ensure that all exposed ground is re-grassed and/or effectively stabilised to control surface erosion, as soon as practicable following completion of the works.
b) Carry out riparian fencing and planting as follow up works.
c) When carrying out riparian planting use native tree species wherever possible. If willows are required ensure male hybrids are selected (for example, male matsudana).
d) Undertake regular maintenance inspections and undertake maintenance as required.

Other relevant chapters

- Sediment control.
- Brushing/tying in vegetation.
- Pole planting along waterways.
- Native planting.
- Vegetation lopping and layering.

4.2 Vegetation lopping and layering

Lopping is the felling of existing vegetation around the outside of a bend in a river. They are lopped in a downstream direction so that felled material may be anchored in place and re-grow to provide vegetative protection to protect or remedy bank erosion. Layering is very similar to lopping except that the material is brought to the site from another location and tied to the stream bank or bed.

Vegetation lopping and layering is a widely used method for controlling lateral erosion in watercourses as it armours the bank in its existing locality. Willow is a common species used and the method is generally used in places where stream flow velocities are such that normal willow stakes or native plantings won't initially withstand the forces of the flood events (such as outsides of bends). The method is often used in preference to rock riprap as it is cheaper to construct and is a much 'softer' option. It cannot be used where water velocities are severe and where the channel will be significantly restricted when the willows grow. It can be used in conjunction with rock work to reduce the quantity of rock required.

Tree material is secured in place using wire or rope fastened to anchors driven into the stream bed or bank or (in the case of lopping) by partially cutting the tree trunk so that the tree topples but does not detach from the stump (as shown in photo 4). Anchoring must be adequate to retain the material on site during all expected flow conditions until sufficient new roots have formed to anchor the willow material.

Photo 3: Willow layering.

Photo 4: Willow lopping.

4.2.1 Guidelines for best practice

Site assessment

a) Does the site require human intervention? (What would be the impacts of doing nothing?).

b) Would normal willow/poplar stake planting successfully control the erosion? What level of intervention is necessary?

c) Lopping and layering is not suitable where deep water at the toe of an eroding bank will undermine the works.
d) Is the work a priority for Environment Waikato funding?

Planning

a) If it is likely more lopping or layering will be required in the area in the future, plant more species that could be used in the future (for example, poplar and willow).
b) The design of layering must take account of future maintenance requirements. Layering, once established requires maintenance works including layering and placing additional trees. Clear access to the works is required for that purpose.
c) Check the relevant sections in the Waikato Regional Plan to determine whether resource consent is required. If consent is required allow **at least** 12 weeks to go through the process.

Relevant sections in Waikato Regional Plan

Section	Name
4.2.14	Lines cables, pipelines, ropeways and associated structures
4.2.16	Channel training structures
4.3.8	Introduction or planting of vegetation on the beds of rivers and Lakes and tree layering

d) Consider potential impacts of the work on recreational river users (for example, anglers, swimmers, canoeists) and take steps to minimise these.
e) Plan to use appropriate species (for example, male hybrid willows) and not invasive species or weeds.
f) Consider carefully the most appropriate time to carry out the activity (see timing below).
g) What is the appropriate funding level from Environment Waikato?
h) Investigate whether other groups/agencies could assist with costs.
i) Follow Environment Waikato's Spill Contingency Guidelines (Technical Report TR2006/24, www.ew.govt.nz/publications/technicalreports/tr0711.htm).

Consultation

a) If layering work is to take place on a trout fishery/spawning class waterway (as per the Waikato Regional Plan) consult with the local branch of Fish and Game so they are aware of when and how the activity will be undertaken.
b) If the river where layering works are proposed is an indigenous fishery (as per the Waikato Regional Plan) and DOC have an active interest in the area discuss your plans with DOC.
c) Consult any other affected parties such as neighbouring property owners and/or iwi.

Physical works

a) Ensure that all works are carried out in a manner that minimises the operation of machinery within flowing water. Where machinery has to enter the water course, measures shall be taken to minimise temporary effects (for example, temporary diversions, bunding off sections of work).
b) Ensure that no fuel storage or machine refuelling occurs where fuel could enter a water body in the event of a spillage.
c) Trees should be felled and placed in a downstream direction.
d) Each tree should overlap the butts of the next tree by at least 25% to provide adequate coverage of vegetation.
e) Secure material to suitable anchors to prevent movement/floatation during floods
f) Ensure that machinery and materials are removed from the floodway at the end of each working day, to avoid the possibility of floodwater washing machinery or materials downstream.

Ensure machinery is washed down prior to and following works to prevent the spread of unwanted organisms, for example alligator weed and didymo.

Timing

a) Best undertaken from June to October inclusive to ensure the willow 'strike rate' is at its optimum.
b) If consent is not required for the work and the work will involve earthworks on the banks of a fishery class waterway as per the Waikato Regional Plan, time the earthworks to avoid the fish spawning periods as outlined in the table below. If work can not be undertaken during these times seek ecological advice specific to the site.

Timing of works in fishery class waterways

Location of work	Desired timing of work
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For greater detail on fish spawning and migration timing see Environment Waikato's freshwater fish spawning and migration calendar (Technical Report TR07/11 - www.ew.govt.nz/publications/technicalreports/tr0711.htm).

Follow-up

a) Ensure that all exposed ground is re-grassed and/or effectively stabilised to control surface erosion, as soon as practicable following completion of the works.
b) Carry out riparian fencing and planting as follow up works.

Other relevant chapters

- Pole planting along waterways.
- Native planting.

4.3 Native planting

There are a range of benefits from planting native species along waterways. Such benefits include shading and cooling of water for freshwater life, food for fish and insect life, improved bank stability, filtration of some faecal matter, sediment and nutrients out of surface run-off, increased biodiversity and an attractive feature to look at.

One of the secrets of successful waterway planting is to be clear about the goals and to plan the planting approach to achieve them. While protecting freshwater life and local biodiversity may be the key benefits of replanting, you might also want to maintain bank stability, improve water quality and enhance the area. It is important to incorporate these extra goals into a planting plan, as they will require different planting combinations and management.

Providing shade is probably the most important way to enhance stream life. Shade keeps water temperatures down for stream life and prevents nuisance water weeds and algae from growing. Leaf litter from planting also provides a food source for stream life. Small, shallow streams are more susceptible to cooling as a result of planting than large, deep streams so if temperature reductions are desired it is best to focus planting efforts on small shallow streams.

Research indicates that if you want to replant a stream bank with natives but keep the banks stable, it is important to maintain a good cover of grasses on the bank edge. Planting too densely can shade out the native grasses and sedges on the very edge of the bank that often do the most to stabilise it (Rutherford et al., 1999).

Under natural conditions, forest streams are wider and shallower than pasture streams. Restoring dense native riparian vegetation with maximum shade for stream life is likely to result in the channel widening and becoming shallower over a period of up to 20 years. In practice, this means bank erosion will probably increase for a reasonable period of time, which is not good news for many farmers.

If bank erosion is an issue, here are some practical tips to help achieve a balance between replanting and erosion control.

- Keep shade levels between 50 to 70 per cent to make sure the grasses and sedges on the bank are not shaded out. Scientists estimate that 50 to 70 per cent shade occurs when combined bank and vegetation height is about equal to the stream channel width (Davies-Colley and Rutherford, 2001).
- Keep shade levels low in areas where erosion is a problem.
- Plant long grass such as native sedge species (such as native *Carex secta*) or pasture grasses near the water. Shrub species such as toetoe, mountain flax (low growing flax) and hebe can be planted several metres back from the water edge. This will provide some stream shade, native habitat and bank stability. If the retired waterway margin is greater than four metres wide, larger trees can be planted back from the stream (at least four metres). Take care not to plant too many large bushy species such as swamp flax in the floodplain where it may restrict flood flows.

Photo 5: Native riparian planting.

4.3.1 Guidelines for best practice

Site assessment

a) Does the site require human intervention? (What would be the impacts of doing nothing?).
b) For guidelines on planting along drains (artificial watercourses) see Environment Waikato Best Practice Environmental Guidelines for Land Drainage (Environment Waikato Technical Report 2006/06).
c) What type of planting is necessary? For example, erosion protection, sediment filtering, shading, whitebait habitat, woody debris for fish.

Think about the function of the planting (for example, erosion protection, sediment filtering, shading, whitebait spawning habitat, woody debris for fish). The function of the planting will determine the species and planting regime.

For a successful replanting project that provides maximum benefits for freshwater life while allowing some filtering and bank stability, it is best to retire a minimum of 5 to 10 metres of waterway margin. To create a self-sustaining piece of bush on the edge of a waterway where weed management is minimal, you'll need at least 10 metres[1] retirement.

d) Is the site fenced to exclude stock?
e) Is the work a priority for Environment Waikato funding?

Planning

a) Check the relevant sections in the Waikato Regional Plan to determine whether resource consent is needed. If consent is required allow **at least** 12 weeks to go through the process.

Relevant sections in Waikato Regional Plan

Section	Name
4.3.8	Introduction or planting of vegetation on the beds of rivers and lakes and tree layering
4.2.18	Maintaining access for maintenance of artificial watercourses and beds of rivers in drainage districts and river control scheme areas
6.2.4	Discharge of agrichemicals to air

b) When selecting species and planting patterns consider the requirement for machinery access for future maintenance activities. For further information see Environment Waikato's Best Practice Environmental Guidelines - Land Drainage (Technical Report TR2006/06).
c) Consider potential impacts of the work on recreational river users (for example, anglers, swimmers, canoeists) and take steps to minimise these.
d) Consider the mature size and characteristics of species prior to planting.
e) Use plants eco-sourced from the local area wherever possible.
f) Plant appropriate species. Use plants that are in planter bags at least PB2 or PB3 in size.
g) Factor in site preparation costs, for example plant and animal pest control.
h) Factor in future maintenance costs, for example spot spraying, weed spraying.

i) Plant large species (including flax) well away from the tops of stream banks (at least three metres). **Consider how big the plant will be when it is fully grown.**

j) It is a good idea to plan access points along the waterway where a digger or machinery can access the waterway if needed. Access points should only be

[1] Parkyn et al, 2000

planted with vegetation that a digger can drive over such as toe toe, carex, mountain flax (smaller growing than swamp flax) or left in rank pasture grass.

k) What is the appropriate funding level from Environment Waikato?
l) Investigate whether other groups/agencies could assist with costs.

Consultation

a) Discuss options with the land owner. The width of the area to be planted will play a large part in what species can be planted.
b) If the waterway is part of a land drainage scheme consult the management agency for the scheme (such as Environment Waikato or the district council) as you will need permission to undertake planting.
c) If the waterway is popular for recreation (for example, fishing/duck shooting) consult with the relevant parties before planting as provision may need to be made for access.

Physical works

a) Ensure weeds are under control on the site prior to planting.
b) Ensure any animal pest control is undertaken prior to planting.
c) Plant large species (including *Phormium tenax)* well away from the tops of stream banks (at least three metres).
d) Keep plantings away from the fence so that stock can not reach them through the fence.
e) Remove all rubbish including planter bags from the site following planting.
f) It is a good idea to place a bamboo stake beside each plant so that they are easy to find amongst the long grass when they are due for releasing.

Timing

a) Undertake planting from May to September (inclusive).
b) Wet areas can be planted in the warmer months as long as the ground is still moist.
c) If possible order plants well in advance to secure desired species.

Follow-up

a) Undertake maintenance releasing on native planting approximately every three months until plants are well established. This will vary depending on plant size and site characteristics.
b) Continue animal pest control as required.
c) Undertake in-fill planting in year two to replace any plants that did not survive.

4.4 Pole planting along waterways – poplar/willow

A poplar or willow pole is a young tree cutting that is between one and 3.5 metres long, which roots and sprouts when planted in the ground. Poles have a ‘head start’ over seedlings and are less likely to be damaged by browsing animals. Some varieties can grow up to 40 metres high. Their extensive root systems make them excellent for erosion control as they bind and hold the soil in place. The species of willow used for soil conservation today should not be confused with the invasive species (for example, crack willow and grey willow) that are commonly found choking and causing erosion within many of the Waikato region’s waterways.

Non invasive willow species are ideal for gully, stream and river erosion control. Where debris dams and other gully structures or riverbank works have been carried out, willows can reinforce protection. They can also be planted to protect bridges, crossings and tracks. Poplars and willows produce useful stock feed, which can be an extra reserve during droughts. For example, about 1.4 kg of fresh poplar leaves maintains a ewe for a day. They also provide shade in summer and if adequately pruned allow maximum light through to the pasture in winter. More importantly they improve pasture in rush infested areas by helping to dry out the ground.

Before planting willow considers the impacts should there be a willow sawfly outbreak. Willow sawfly caterpillars feed on willow leaves and are proving to be a considerable

problem as they have the ability to quickly defoliate willow trees. The stress caused by the constant defoliation can quickly lead to the death of willow trees. Such a situation will reduce the effectiveness of river-edge plantings and can lead to increased riverbank erosion during a flood, resulting in a greater risk of stopbank failure and flooding.

At present there is no known effective control measure for sawfly. However, trial plantings of alternative species have been established in various locations to determine sawfly resistant trees that may be suitable for river edge protection.

Note: Plant native plant species instead of poplar and willow or interplant with native plant species wherever possible as they are more sustainable in the long-term. Poplar and willow trees have a life span of approximately 30 years and shrub willow 13-15 years. Willows require coppicing or topping to rejuvenate them and extend their life spans. Most native species have life spans of hundreds of years.

Photo 6: Poplar planting for stream bank stability.

Photo 7: Shrub willow planting for erosion control.

4.4.1 Guidelines for best practice

Site assessment

a) Does the site require human intervention? (What would be the impacts of doing nothing?).
b) What level of intervention is necessary?
c) Think about the function of the planting, for example erosion protection, shading, woody debris for fish. The function of the planting will be a factor in determining the planting regime.
d) Is the site fenced to exclude stock?
e) Is the work a priority for Environment Waikato funding?

Planning

a) It is recommended that waterways are fenced to exclude stock prior to any planting taking place. If planting inside the fenced area the fencing should be a minimum of four metres back from the top of the bank (terrace edge) to allow sufficient room for tree growth and cater for any erosion in the short-term.
b) If it is not possible to exclude stock from the plantings consider using protective sleeves and graze light stock that will not rub against the trees.
c) Plant native species instead of poplar and willow wherever possible. Consider inter-planting with native species as a more long-term solution. Note: native planting is only suitable where stock have been excluded.
d) Factor in site preparation costs, for example plant and animal pest control.
e) Factor in future maintenance costs, for example pruning, animal and plant pest control (see section on 'Follow-up').
f) Consider the mature size and characteristics of species prior to planting.

Where to plant

- Plant trees well away from the tops of stream banks (at least 3 or 4 metres) so they won't impede water flow.
- On waterways with steep erodible banks large trees should be planted at 5 metres back from the edge.
- Contact Environment Waikato for permission before carrying out planting along rivers that are 100% managed/maintained by them and/or have associated stop banks.
- On large rivers such as the Waikato, lower Waipa, Waihou and lower Piako plantings on the lower banks are acceptable but they should be at least 3 metres from the water.
- Avoid planting on the insides of bends where mature trees will deflect flow to the outside bend on the opposite side, causing erosion.

g) When selecting species and planting patterns consider the requirement for machinery access for future maintenance activities.
h) Consider potential impacts of the work on recreational river users (for example anglers, swimmers, canoeists) and take steps to minimise these.
i) As well as many varieties, poles come in lengths from 1 metre stakes to 3.5 metre poles. Generally, 3 metre poles or larger are planted where there are stock, but should be protected with a sleeve to stop ring-barking. Shorter, 2.5 metre poles are used where there are sheep only, and 2 metre poles can be used on rough sites such as a slip that has been fenced from stock. The 1 metre stake is suitable for areas where stock will be excluded for several years.
j) Check the relevant sections in the Waikato Regional Plan to determine whether resource consent is needed. If consent is required allow at least 12 weeks to go through the process.

Relevant sections in Waikato Regional Plan

Section	Name
4.3.8	Introduction or planting of vegetation on the beds of rivers and lakes and tree layering
4.2.18	Maintaining access for maintenance of artificial watercourses and beds of rivers in drainage districts and river control scheme areas
6.2.4	Discharge of agrichemicals to air

k) When selecting poles for planting it is important to take the site and prevailing climatic conditions into consideration as there are a wide variety of poles available with specific characteristics and site requirements. For instance, most poplars and willows are not suitable for planting on very exposed or dry sites. However, Veronese poplar will handle windy and dry sites reasonably well. Willows, besides being suitable for windy conditions also tolerate wetter sites more easily than poplars. Some varieties, such as Kawa, Yunnanensis and Toa are resistant to browsing by possums. Erodano and Kawa are recommended for timber.
l) Consider planting different varieties of trees to spread the risk of disease.
m) Only use hybrids rather than invasive species that may become weeds (for example, crack willow, alders).

n) If using willow, use only male clones to reduce the potential for spreading. Suitable species include matsudana willow, tangoio willow, moutere willow, hiwinui willow, adair willow, booth willow, irette willow, Holland.

Consultation

a) Discuss options with the land owner.
b) If the waterway is regularly cleaned consult with the neighbouring land owner/s before undertaking any planting.
c) If the waterway is part of a land drainage scheme consult the management agency for the scheme (for example, Environment Waikato or the district council).
d) If the waterway is popular for recreation (for example, fishing or duck shooting) consult with the relevant parties before planting.

Physical works

a) Ensure weeds are under control on the site prior to planting.
b) Ensure any animal pest control is undertaken prior to planting.
c) When transporting poles take care not to bruise or damage the bark.
d) Soak poles in water for 5-14 days prior to planting to allow the pole to build up a reservoir of water.
e) Poles left in the sun or exposed to winds for several days before planting have little chance of survival when planted.
f) If using protective sleeves they should be put on the poles prior to planting. To do this pull the sleeve onto the base of the pole so the bottom of the sleeve is 75 cm from the butt of the pole – this will indicate when the correct planting depth is achieved.
g) Secure the sleeve with two small staples, one 15 cm from either end, making sure that with Dynex sleeves the bottom end is slightly off the ground to allow for free drainage.
h) For more specific guidelines on planting poplar and willow poles see Environment Waikato's publication on "Poplar and Willow Planting".
i) Plant well away from the tops of stream banks (at least three metres).
j) Keep planting away from fences so that stock can not reach them through the fence.
k) If future digger access is needed ensure trees are planted far enough apart to allow access.

Timing

a) Undertake planting from May to October (inclusive) before they produce new shoots.

Follow-up

a) Continue animal pest control as required.
b) As trees grow, they can be thinned – shrub willows to 4 metre spacing at between 5 and 10 years of age and tree willows to 8-12 metre spacing between 10 and 20 years.
c) Shrub willows degenerate after 10 years so consider following up with native planting as a more long-term solution.
d) Maintenance pruning/cutting out will always be necessary with poplars and willows.

Other relevant chapters

- Native planting.
- Brushing/tying in vegetation to the bank for erosion protection.

4.5 Brushing/tying in vegetation to the bank for erosion protection

Where banks are already eroding but not severely, they can be stabilised by placing a layer of live willow material, held in place by poles, wires, netting, or bolsters. It protects against scour in the short-term while taking root, eventually providing long-term re-vegetation. This method is used on small rivers, particularly where beds are shallow and open.

Photo 8: Shrub willow tied into bank for erosion control.

4.5.1 Opportunities for enhancement

This activity is a simple and relatively quick solution to remedy erosion. However, there are also further works that can be undertaken to both enhance the environment and provide further long-term stability for the erosion prone site. Most New Zealand native plants have a life span of several hundreds of years (if not longer) so although slow to establish can provide long-term stability to a site when used in conjunction with other methods such as brushing and/or tying in vegetation.

As well as providing long-term stability additional plantings will provide riparian shade and shelter helping to lower stream water temperatures and habitat for in stream life. Leaf litter and small twigs that fall into the stream are an important food source for microbes and many species of aquatic invertebrates on which fish feed. Best practice should therefore involve follow-up riparian fencing and planting (Meleason, M. et al, 2002).

4.5.2 Guidelines for best practice

Site assessment

a) Does the site require human intervention? (What would be the impacts of doing nothing?).
b) What level of intervention is necessary?
c) Is the site fenced to exclude stock?
d) Is the work a priority for Environment Waikato funding?

Planning

a) Determine the class of the waterway (for example, fisheries class waterway).
b) Check the relevant sections in the Waikato Regional Plan to determine whether resource consent is needed. If consent is required allow **at least** 12 weeks to go through the process.

Relevant sections in Waikato Regional Plan

Section	Name
4.2.14	Lines cables, pipelines, ropeways and associated structures
4.2.15	Erosion control structures
4.3.8	Introduction or planting of vegetation on the beds of rivers and lakes and tree layering

c) What is the appropriate funding level from Environment Waikato?
d) Investigate whether other groups/agencies could assist with costs.
e) Consider potential impacts of the work on recreational river users (for example, anglers, swimmers and canoeists) and take steps to minimise these.
f) Use hybrid willow species.

Consultation

a) Consult with the land owner.

Physical works

a) Ensure that all works are carried out in a manner that minimises the operation of machinery within the flowing river channel.
b) The use of machinery and all other activities shall be undertaken in a manner that minimises disturbance of existing vegetation cover and the disturbance of sediment.
c) Ensure that all material is securely anchored to prevent any material breaking free and being washed downstream.
d) Ensure the butts of the trees are planted into wet ground.
e) Ensure that no fuel storage or machine refuelling occurs where fuel could enter a water body in the event of a spillage. Follow Environment Waikato's "Spill Contingency Guidelines" (Technical Report TR2006/24, www.ew.govt.nz/publications/technicalreports/tr0711.htm).
f) Ensure that an appropriate oil spill cleanup kit is kept on site, particularly on any barge, during the works to contain any contaminants that enter the river.
g) Ensure that machinery and materials are removed from the floodway at the end of each working day, to avoid the possibility of floodwater washing machinery or materials downstream.

Timing

a) Works are best undertaken from May to October (inclusive) to ensure that the willow strike rate is at its optimum.
b) If consent is not required for the work and the work will involve earthworks on the banks of a fishery class waterway as per the Waikato Regional Plan, time the earthworks to avoid the fish spawning periods as outlined in the table below. If work can not be undertaken during these times seek ecological advice specific to the site.

Timing of works in fishery class waterways

Location of work	Desired timing of work
Within tidal reach	June to February (to avoid Inanga spawning peak)
Lake Taupo and tributaries	November to April (to avoid spawning)
Within Trout fishery waterway not within Lake Taupo or tributary	September to April (to avoid spawning)
Within indigenous fish waterway	December, January, February

For greater detail on fish spawning and migration timing see Environment Waikato's freshwater fish spawning and migration calendar (Technical Report TR07/11 - www.ew.govt.nz/publications/technicalreports/tr0711.htm).

Follow-up

a) Ensure that all exposed ground is re-grassed and/or effectively stabilised to control surface erosion, as soon as practicable following completion of the works.
b) Carry out riparian fencing and planting as follow up works.
c) Undertake regular maintenance inspections and undertake maintenance as required.

Other relevant chapters

- Native planting.
- Sediment control.
- Pole planting along waterways.

4.6 Mechanical vegetation removal – willows and other plant pests

The purpose of this activity is to remove trees where they are growing within or restricting the flow of a waterway, causing erosion. Willows are the most common tree species causing such problems. They were introduced into New Zealand in the 1840s, as ornamental specimens in the gardens of early settlers. Cuttings were soon planted on river banks, in a similar manner to their use in Britain and other European countries. The willows were intended to confine channels, prevent them from eroding land cleared for farming, and protect roads and bridges from flood damage. Land owners, and public agencies have continued to use willows for the same purposes for some 150 years, to the present day.

Brittleness was a characteristic of several species planted prior to the 1960s. Branches easily broke, floated downstream and struck root where they lodged. A few species also dispersed fertile seed downstream. The result has been dense infestation of willow in positions where far from protecting land adjacent to rivers, the trees obstruct floodwater and direct it against banks, causing local erosion. The species in use today are non-brittle, sterile willows, but the progeny of earlier plantings remain throughout most rivers.

Photo 9: Removal of invasive willow from riparian area.

Photo 10: Invasive willow being cut and lifted from a waterway.

4.6.1 Opportunities for enhancement

Undertaken poorly this activity can introduce debris into waterways, spread unwanted plant species, remove shading, destroy wildlife habitat areas and result in a new cycle of erosion. If time is taken to carefully plan a vegetation removal project many environmental enhancement opportunities can be incorporated. Undertaken correctly a vegetation removal project will result in the removal of unwanted invasive species in riparian areas, assist in the maintenance of a clear waterway and provide access to water. It will also result in enough habitat and shade to sustain a variety of wildlife

(including in-stream life), increase and/or enhance biodiversity and maintain stream bank stability if adequate planting is done.

Replacing the riparian vegetation removed with desirable plantings will provide bank stability and riparian shade and shelter. Shade is especially important as it helps to lower stream water temperatures, providing suitable conditions for in-stream life. Leaf litter, small twigs and insects that fall into the stream from riparian plants provide an important food source for microbes and many species of aquatic invertebrates on which fish feed.

It is also desirable to leave some large woody material in the stream as wood is an integral part of stream ecosystems. For example, fish use logjams to spawn under and hide from predators, or as shelter during big floods. Wood in the stream channel also helps to trap the small fragments of leaf litter and twigs preventing them from being flushed away quickly (Meleason, M. et al, 2002). In addition to habitat enhancement large logs across a stream can provide excellent gradient control preventing the stream bed from degradation.

Habitat enhancement can be undertaken by securing large woody material adjacent to the stream bank or on a 20 – 40 degree angle with the bank and just above the water level, as shown in Figure 1. If it is aligned with the flow in this way on the channel margin or in areas of low flow velocity, wood will have very little impact on flooding or erosion (Land and Water Australia, 2002).

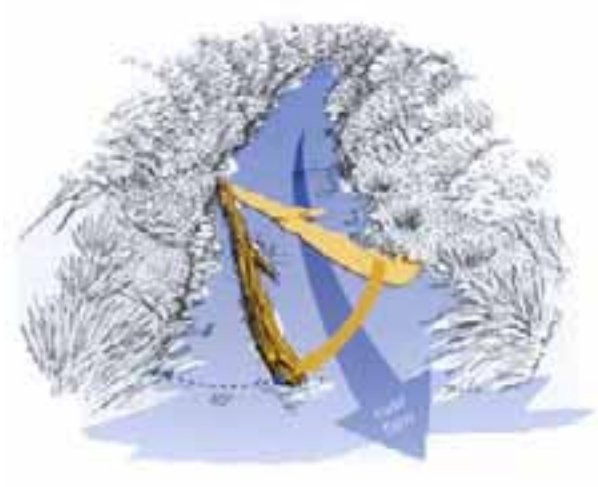

Figure 1: How to place logs for habitat enhancement.

4.6.2 Guidelines for best practice

Site assessment

a) Does the site require human intervention? (What would be the impacts of doing nothing?).
b) What level of intervention is necessary? That is, how many trees are affecting the channel capacity?
c) Is the work a priority for Environment Waikato funding?

Planning

a) Determine the class of the waterway (for example, fisheries class waterway).
b) Check for any significant historical sites.
c) Check the relevant sections in the Waikato Regional Plan to determine whether resource consent is needed. If consent is required allow **at least** 12 weeks to go through the process.

Relevant sections in Waikato Regional Plan

Section	Name
4.3.4	Disturbance to the beds of lakes and rivers
4.3.8	Introduction or planting of vegetation on the beds of rivers and lakes and tree layering
4.3.9	Clearance of vegetation in, on or under the beds of rivers and lakes
5.1.4	Accelerated erosion (Including soil disturbance, roading and tracking and vegetation clearance)
6.2.4	Discharge of agrichemicals to air

d) No more than 1.5 km of dense willows should be removed during the initial operation. It is recommended that the clearance should be staged to minimise habitat disruption. Strategically placed shade trees that can easily be removed at a later date should be left to provide shade while new plantings establish.
e) Consider potential impacts of the work on recreational river users (for example, anglers, swimmers and canoeists) and take steps to minimise these.
f) Consider carefully when is the most appropriate time to carry out the activity. Avoid undertaking major works when the activity conflicts with the migratory patterns of the fish found in the affected waterway.
g) Determine the appropriate sized excavator. For example, for efficiency you will need an excavator with a thumb. Will a 12 tonne machine be big enough to lift the logs or is a larger 20 tonne machine or long reach needed?
h) Factor in follow-up costs such as re-growth spraying, fencing and riparian planting.
i) Scope the works to assess the costs (including any resource consent costs).
j) What is the appropriate funding level from Environment Waikato?
k) What other groups/agencies could assist with costs.
l) When siting the works, consider any likelihood that the works could become a navigation hazard.
m) Take upstream and downstream water samples during works to demonstrate compliance with regional plan requirements.
n) If the site has high public visibility purchase signage to explain the works.
o) Follow Environment Waikato's "Spill Contingency Guidelines" (Technical Report TR2006/24, www.ew.govt.nz/publications/technicalreports/tr0711.htm).

Consultation

a) If on a trout fishery/spawning class waterway (as per the Waikato Regional Plan) consult with the local branch of Fish and Game (or DOC in the Taupo area) so they are aware of when and how the activity will be undertaken.
b) If the river where works are proposed is an indigenous fishery (as per the Waikato Regional Plan) and DOC has an active interest in the area discuss your plans with DOC.
c) Consult any other potentially affected parties such as neighbouring property owners and/or iwi.

Physical works

a) Follow the OSH Code of Practice for River and Stream Operations.
b) Vehicles and machinery shall not enter or work in flowing water as far as practicable.
c) Remove only those trees causing a problem, selectively prune some so they can be left.
d) Begin removal works at the upstream end and work downstream to reduce the impacts of sediment disturbance and catch floating debris in the downstream trees.
e) Cut trees as close to the ground as practical.

f) Fell trees away from watercourses, use machine assistance where practical.
g) Poison stumps immediately after cutting – use Glyphosate (10%) with a penetrant and marker dye.
h) Ensure that operations are carried out in a manner that minimises the possibility of sediment entering the watercourse.
i) Do **not** pull out stumps or remove stumps from the bed of waterways unless they will cause erosion.
j) Machinery should grab and lift slash, not pull or drag it. A digger with a "thumb" or grapple is advised.

k) Do not remove existing snags from the bed, except where needed to improve passage of floodwater and reduce erosion.

l) Pile debris in high piles as far away from the floodway as possible. If there is a risk that piles will be moved by a flood then they should be disposed of immediately or anchored in place.
m) Burn willow logs as soon as possible following removal using diesel as an accelerant. Green trees will produce a lot of smoke so if this is likely to be a problem, wait three to four months for the trees to dry out before burning. Poplars will need to be left for several months to dry out before they can be burnt. Check with the local authority regarding fire restrictions prior to burning.
n) Undertake work as quickly as possible, that is, with sufficient resources and appropriate sized machinery.
o) Ensure that no fuel storage or machine refuelling occurs where fuel could enter a water body in the event of a spillage.
p) Ensure that machinery and materials are removed from the floodway at the end of each working day, to avoid the possibility of floodwater washing machinery or materials downstream.

Ensure machinery is washed down prior to and following works to prevent the spread of unwanted organisms, for example, alligator weed or didymo.

Timing

a) Liaise with the land owner so that works are timed to avoid critical farming events, for example lambing or maize harvest.
b) Undertake works during periods of dry weather and low river flows.
c) If the works do not require resource consent and are located within a fishery class waterway time the works to avoid fish spawning periods as outlined in the table below. If work can not be undertaken during these times seek ecological advice specific to the site.
d) Works are best undertaken from December to April inclusive when the sap is flowing into the roots (senescence) because this will result in the best kill. However, also note that March/April are peak spawning times for Inanga in tidal streams.
e) Time works so that follow-up spraying can be undertaken before autumn leaf fall and riparian planting undertaken that same year. For example if works are undertaken in December or January, follow-up spraying can be undertaken in February/March (before autumn leaf fall) and riparian planting undertaking during the winter months.

Timing of works in fishery class waterways

Fishery class	Desired timing of work
Within tidal reach	June to February inclusive (to avoid inanga spawning peak)
Trout fishery/spawning	October to April inclusive
indigenous fishery	January to July inclusive

For greater detail on fish spawning and migration timing see Environment Waikato's freshwater fish spawning and migration calendar (Technical Report TR07/11 - www.ew.govt.nz/publications/technicalreports/tr0711.htm).

Follow-up

a) Ensure that all exposed ground is re-grassed and/or effectively stabilised to control surface erosion, as soon as practicable following completion of the works.
b) Undertake a programme of willow regrowth spraying. It may take several years of regrowth before it is under control. Regrowth spraying is best carried out during February/March when regrowth shoots are most active.
c) Carry out riparian fencing to exclude cattle from the banks of the waterway.
d) Undertake riparian replanting as follow up works to ensure bank stability, aesthetic and wildlife values are not degraded. Ensure willow regrowth is under control before undertaking riparian planting.
e) Where riparian planting is to take place use native tree species wherever possible. If willow is used ensure male hybrids are selected (for example, matsudana).

Other relevant chapters

- Poplar/willow vegetation groynes.
- Native planting.
- Pole planting along waterways.
- In-stream debris management and removal.
- Sediment control.

5 Hard engineering protection works

5.1 Gabion baskets and rock riprap (including rock groynes)

Rock riprap and gabion baskets are often used to stabilise river banks or repair eroding river banks where other softer methods such as willow layering or vegetation groynes are not effective. They may require some prior excavation of the bank, and in some cases, an associated loss of riparian vegetation.

In places where the water is deep and the bank is being severely undercut, rock riprap and gabion baskets can be placed below the water level with riparian planting above the water level. This stabilises the toe and prevents the undercutting occurring, and allows the riparian planting to establish without slumping in. In other places where erosion is occurring over a long length of bank (30 m +) rock groynes may be used with infill willow planting or layering between the rock groynes.

Photo 11: Rock riprap used to stabilise an eroding river bank.

Photo 12: Gabion baskets used to protect a riverbank from erosion.

If possible hard engineering works should be avoided and only used where other methods are not appropriate. Rock rip rap and gabion baskets do **not** provide good bank side habitat for fish, insects or riparian vegetation and in large areas can significantly limit habitat variability. However, in areas where severe erosion can not be remedied without these structures the following best management practices will minimise their negative effects.

Opportunities for enhancement

Rock lined banks provide very little habitat for in-stream life which generally prefer overhanging banks and streamside vegetation. In situations where rock work is required, habitat enhancement can be undertaken by securing large woody material/logs into the stream in the vicinity of the rock work.

Wood is an integral part of stream ecosystems providing hiding and spawning places for fish and shelter during big floods. Leaf litter and small twigs that fall into the stream from riparian plants are an important food source for microbes and many species of aquatic invertebrates on which fish feed. Wood in the stream channel also helps to trap the small fragments of leaf litter and twigs preventing their being flushed away quickly. Wood is especially important in streams when there is little other stable substrate (such as boulders) as some aquatic insects attach to large wood in order to feed, pupate, or lay eggs (Meleason, M. et al, 2002).

Logs should be secured in stable parts of the river adjacent to the rock work or on a 20 – 40 degree angle with the bank and just above the water level, as shown in figure 2. If it is aligned with the flow in this way on the channel margin or in areas of low flow velocity wood will have very little impact on flooding or erosion (Land and Water Australia, 2002).

Figure 2: How to place logs for habitat enhancement.

5.1.1 Guidelines for best practice

Site assessment

a) Does the site require human intervention? (What would be the impacts of doing nothing?).
b) What level of intervention is necessary? Would a softer option such as willow layering or vegetation groynes address the issue?
c) Consider whether there is adequate access to the site.
d) Is the work a priority for Environment Waikato funding?
e) Will temporary stream diversion be required?

Planning

a) Seek design advice from an Environment Waikato engineer experienced with this type of work.
b) Determine whether the work requires resource consent (including any district council consents and traffic management plans, for example). If consent is required allow **at least** 12 weeks to go through the process.

Relevant sections in Waikato Regional Plan

Section	Name
4.2.15	Erosion control structures
4.3.4	Disturbance of the beds of lakes and rivers
4.3.8	Introduction or planting of vegetation on the beds of river & lakes and tree layering
5.1.4	Accelerated erosion (Including soil disturbance, roading and tracking and vegetation clearance)

c) Consider potential impacts of the work on recreational river users (for example, anglers, swimmers and canoeists) and take steps to minimise these.
d) Determine whether filter cloth will be required to stop sediment coming through the riprap.
e) Factor in costs associated with follow-up fencing and riparian planting.
f) Use adequately sized and well graded rock to withstand all anticipated flood flows. It is recommended and an appropriately qualified engineer is consulted at the design stage.
g) Plan for future maintenance requirements. Do not plant trees amongst the rock and only plant low growing shrubs behind the rock work to allow access for future maintenance.
h) What is the appropriate funding level from Environment Waikato?
i) Investigate whether other groups/agencies could assist with costs.
j) Plan to minimise the removal of vegetation and sediment disturbance.
k) The rock used should be clean quarry spalls ex face, or other suitable rock material, which is free of soil, mud, clay or other soluble debris.
l) If concrete is used instead of rock, it should be *clean*, stable material, appropriately sized, not readily broken down, and free of iron, steel, soil, mud, clay, contaminants, or any soluble material and be well graded.
m) Rock structures should always be located so that they do not cause a navigation hazard.
n) If the site has high public visibility purchase signage to explain the works.
o) Follow Environment Waikato's "Spill Contingency Guidelines" (Technical Report TR2006/24, www.ew.govt.nz/publications/technicalreports/tr0711.htm).

Consultation

a) If on a trout fishery/spawning class waterway (as per the Waikato Regional Plan) consult with the local branch of Fish and Game (or DOC in the Taupo area) so they are aware of when and how the activity will be undertaken.
b) If the river where works are proposed is an indigenous fishery (as per the Waikato Regional Plan) and DOC has an active interests in the area discuss your plans with DOC.
c) Consult any other potentially affected parties such as neighbouring property owners and/or iwi.

Physical works

a) Remove minimum amounts of vegetation.
b) Rock should be placed on a specified design slope. This is generally 1.5:1 or 2:1.
c) Take photos before, during and after completion of the works.
d) Minimise the construction time.
e) Batter preparation, foundation excavation and rock placement shall be undertaken by machinery operating from the river bank where practicable. Where machinery has to enter the watercourse, measures shall be taken to minimise temporary effects (for example, temporary diversions and bunding off sections of work).
f) Ensure structures do not obstruct stream flows or reduce the stream cross sectional area.

g) Take upstream and downstream water samples prior to works, during works and following completion to demonstrate compliance with relevant rules.
h) Ensure that no fuel storage or machine refuelling occurs where fuel could enter a water body in the event of a spillage.
i) Take measures to prevent silt run-off from the work site (for example, erecting silt fences).

Ensure machinery is washed down prior to and following works to prevent the spread of unwanted organisms, for example, alligator weed and didymo.

Timing

a) Works are best undertaken during summer months and periods of dry weather.
b) If consent is not required for the work and the work will involve earthworks on the banks of a fishery class waterway as per the Waikato Regional Plan, time the earthworks to avoid the fish spawning periods as outlined in the table below. If work can not be undertaken during these times seek ecological advice specific to the site.

Timing of works in fishery class waterways

Location of work	Desired timing of work
Within tidal reach	June to February (to avoid inanga spawning peak)
Lake Taupo and tributaries	November to April (to avoid spawning)
Within Trout fishery waterway not within Lake Taupo or tributary	September to April (to avoid spawning)
Within indigenous fish waterway	December, January, February

Follow-up

a) Ensure that all exposed ground is re-grassed and/or effectively stabilised to control surface erosion, as soon as practicable following completion of the works.
b) Carry out riparian fencing to exclude cattle from the banks of the waterway.
c) Undertake riparian re-planting as follow up works to ensure bank stability, aesthetic and wildlife values are not degraded.
d) Where riparian planting is to take place use native tree species wherever possible. If willow is used ensure male hybrids are selected (for example, matsudana).
e) Undertake regular inspections to check that the structure is working as planned. Well designed and placed rock riprap will settle as the channel stabilises. The rock material may then require maintenance by topping up with further rock.

Other relevant chapters

- Native planting.
- Pole planting along waterways.
- Sediment control.

5.2 Flumes and drop structures

Flumes and drop structures concentrate the overland surface flow of water and discharge it safely over a gully head or scarp slope to prevent erosion. They are often used in conjunction with diversion bunds and detention dams. Design of these structures will vary depending on the situation and should be undertaken by an appropriately qualified person.

Flumes are commonly constructed from wood and installed at gully head sites to control headward movement of erosion. This is achieved by concentrating water to a central channel and conveying it safely over a drop or escarpment where it falls into a plunge pool. In many situations, flumes are used as a short to medium term measure to control active erosion until protection planting has stabilised the gully head. Drop

structures can be constructed from a range of materials including wood, concrete, steel or concrete pipes and flexible plastic or PVC pipes.

Photo 13: Flume designed to pass overland flow safely over the gully head without causing erosion.

5.2.1 Guidelines for best practice

Site assessment

a) Does the site require human intervention? (What would be the impacts of doing nothing?).
b) What level of intervention is necessary?
c) Is the work work a priority for Environment Waikato funding?

Planning

a) Check the rules in the Waikato Regional Plan to determine whether resource consent is required. If consent is required allow **at least** 12 weeks to go through the process.

Relevant sections in Waikato Regional Plan

Section	Name
5.1.4	Accelerated erosion (Including soil disturbance, roading and tracking and vegetation clearance)
4.2.15	Erosion control structures
3.6.4	Damming and diverting

b) What is the appropriate funding level from Environment Waikato?
c) For information on design and construction of flumes refer to:
   - Ministry for the Environment, 2001: “Soil Conservation Technical Handbook”
   - Eyles, G.O, 1993: “Gully erosion control techniques for pumice lands”.
d) Investigate whether other groups/agencies could assist with costs.
e) Ensure the structure is designed to accommodate peak water flows (at least a 10 year storm event).

f) Incorporate alternative flow paths into the design so that larger storm events can be catered for safely.
g) Minimise the installation period.
h) Consider the consequences of a storm occurring half way through the construction. If possible divert storm water away from the works site until the project has been completed.
i) If using wood use H4 treated timber.
j) Design structure to maintain natural character.
k) Ensure necessary protection (for example, rock) is put in place to protect the plunge pool from serious erosion.
l) Undertake plantings around the structure to provide long-term erosion protection and stability.

Consultation

a) Consult with the local branch of Fish and Game if earthworks may lead to siltation in a trout fishery/spawning waterway (as per the Waikato Regional Plan).
b) Consult with the local DOC if earthworks may lead to siltation in an indigenous fishery waterway (as per the Waikato Regional Plan).
c) Discuss works with the land owner.

Physical works

a) A detailed guide to undertaking the works can be found in Eyles, G.O, 1993: “Gully erosion control techniques for pumice lands”. Installation works should follow this guide.

Ensure machinery is washed down prior to and following works to prevent the spread of unwanted organisms, for example, alligator weed and didymo.

Timing

a) Undertake works during periods of dry weather.

Follow-up

b) Re-grass any areas where soil disturbance has occurred.
c) Ensure a regular maintenance programme is adhered to.
d) Undertake follow-up monitoring to ensure the structure is working appropriately.

Other relevant chapters

- Native planting.
- Pole planting along waterways – poplar/willow.
- Sediment control.
- Diversion bunds/detention dams.

5.3 Diversion bunds/detention dams

Diversion bunds are banks that guide surface water flows across a slope to a safe or controlled outlet (for example, drop structure). They may be constructed on slopes with surface instability thus reducing the quality of run-off by increasing infiltration. They may also be used to divert water away from an erosion site or assets requiring protection such as fencing, buildings, and stockyards. Detention dams are similar but collect surface storm water and discharge it through a safe outlet.

Photo 14: Newly created detention bund with concrete outlet.

5.3.1 Guidelines for good practice

Site assessment

a) Does the site require human intervention? (What would be the impacts of doing nothing?).
b) What level of intervention is necessary?
c) Is the work a priority for Environment Waikato funding?

Planning

a) Check the Waikato Regional Plan rules to determine whether resource consent is required. If consent is required allow **at least** 12 weeks to go through the process.

Relevant sections in Waikato Regional Plan

Section	Name
5.1.4	Accelerated erosion (Including soil disturbance, roading and tracking and vegetation clearance)
3.6.4	Damming and diverting

b) What is the appropriate funding level from Environment Waikato?
c) Investigate whether other groups/agencies could assist with costs.
d) Ensure the structure is designed to accommodate peak water flows (at least a 10 year storm event).
e) Incorporate alternative flow paths into the design so that larger storm events can be catered for safely (for example, a spillway).
f) Minimise the installation period.
g) Consider the consequences of a storm occurring half way through the construction. If possible divert storm water away from the works site until the project has been completed.
h) Design structure to maintain natural character as much as possible.
i) For further design guidelines consult Environment Waikato's Guidelines on the Design of Small Homogeneous Earth fill Dams (Environment Waikato Library).

Consultation

a) Consult with the local branch of Fish and Game if earthworks may lead to siltation in a trout fishery/spawning waterway (as per the Waikato Regional Plan).
b) Consult with the local DOC if earthworks may lead to siltation in an indigenous fishery waterway (as per the Waikato Regional Plan).
c) Discuss works with the land owner.

Physical works

a) All vegetation and topsoil should be excavated where the fill will be placed to fill the dam. Excavation should be down to the subsoil.
b) The dam should be keyed into the ground by excavation into the subsoil between 500 m to one metre depth.
c) Embankments should be constructed of suitable mineral soils free of wood, humus or other organic matter, and well compacted in uniform layers not exceeding 150 mm loose depth.
d) All compacting should be carried out with a rubber tyre machine (wheel tractor or scraper) rather than a tracked machine (bulldozer or excavator).
e) Final batter slopes should be no steeper than 3:1.

Ensure machinery is washed down prior to and following works to prevent the spread of unwanted organisms, for example, alligator weed and didymo.

Timing

a) Undertake works during periods of dry weather.

Follow-up

b) Topsoil should be re-spread over the area and grass seed sown at optimal times of the year if possible (autumn or spring).
c) The new grass can be lightly grazed with sheep or mown to encourage the grass sward to thicken before grazing the area normally.
d) Inspect diversion bunds and detention dams regularly after heavy rainfall to ensure:
    - pipes are not blocked
    - embankments are well grassed and not prone to erosion
    - emergency spillways are able to operate satisfactorily with no signs of erosion or reduction in waterway capacity.

Other relevant chapters

- Sediment control.
- Flumes and drop structures.

6 In-stream works

A range of in-stream works are undertaken including:

- debris traps
- gravel management and extraction
- in-stream debris management/obstruction removal
- channel diversion
- battered banks
- silt removal
- gradient control structures.

6.1 Debris traps

Debris traps are low level (usually lower than one metre high) dams sited on the bed of a stream channel and constructed from netting and post materials. They can have a number of functions including stabilising channel beds and providing lateral channel

stability by collecting sediment and assisting to control the gradient of the river. They also trap debris, preventing it from blocking the stream channel further downstream.

Photo 15: Debris trap across a stream.

6.1.1 Guidelines for best practice

Site assessment

a) Does the site require human intervention? (What would be the impacts of doing nothing?).

a) What level of intervention is necessary?
b) Is the work a priority for Environment Waikato funding?

Planning

a) Consider potential impacts of the work on recreational river users (for example, anglers, swimmers and canoeists) and take steps to minimise these.
b) Locate the debris trap in a location where it can be easily accessed for cleaning.
c) Locate the debris trap in a wide point of the waterway where the gradient is relatively flat and debris can easily settle out.
d) Have the debris trap designed so that a 100 year flood can easily pass over the top.
e) Determine whether the work requires resource consent (including any district council consents, traffic management plans, etc). If consent is required allow **at least** 12 weeks to go through the process.
f) Determine the class of the waterway (for example, trout fishery or spawning class waterway).
g) Select an appropriate disposal site for when cleaning the debris trap.
h) Follow Environment Waikato's "Spill Contingency Guidelines" (Technical Report TR2006/24, www.ew.govt.nz/publications/technicalreports/tr0711.htm).

Relevant sections in Waikato Regional Plan

Section	Name
4.2.4	Structures in, on, under or over the beds of rivers and lakes
4.3.4	Disturbances of the beds of lakes and rivers

Consultation

a) If on a trout fishery/spawning class waterway (as per the Waikato Regional Plan) consult with the local branch of Fish and Game so they are aware of when and how the activity will be undertaken.
b) If the river where works are proposed is an indigenous fishery (as per the Waikato Regional Plan) and DOC have an active interest in the area discuss your plans with DOC.
c) Consult any other potentially affected parties such as neighbouring property owners and/or iwi.

Physical works

d) Minimise the time of works and level of disturbance.
e) Ensure that no fuel storage or machine refuelling occurs where fuel could enter a water body in the event of a spillage.

Ensure machinery is washed down prior to and following works to prevent the spread of unwanted organisms, for example alligator weed and didymo.

Timing

a) Works are best undertaken during summer months and periods of dry weather.
b) If consent is not required for the work and the work will involve earthworks on the banks of a fishery class waterway as per the Waikato Regional Plan, time the earthworks to avoid the fish spawning periods as outlined in the table below. If work can not be undertaken during these times seek ecological advice specific to the site.

Timing of works in fishery class waterways

Location of work	Desired timing of work
Lake Taupo and tributaries	November to April (to avoid spawning)
Within Trout fishery waterway not within Lake Taupo or tributary	September to April (to avoid spawning)
Within indigenous fish waterway	December, January, February

For greater detail on fish spawning and migration timing see Environment Waikato's freshwater fish spawning and migration calendar (Technical Report TR07/11 - www.ew.govt.nz/publications/technicalreports/tr0711.htm).

Follow-up

a) Ensure regular inspections are undertaken to ensure debris trap is operating as expected and cleaned out when needed.

6.2 Gravel management and extraction

The process of managing and maintaining a river system includes ensuring the river and tributary stream channels are stable; and ensuring the channels are free of obstructions and are of adequate capacity to effectively minimise the effects of flooding onto surrounding land. To achieve this, gravel may occasionally need to be moved within or from the bed of a channel in key areas that will help to train the watercourse in a stable path.

This activity can be clearly separated into two distinct types.

Gravel movement and channel training
This is where gravel movement is carried out, normally in conjunction with planting or willow lopping/layering and involves the movement and repositioning of deposited material within the channel or floodway. An eroding or unstable system will often deposit material on the insides of bends which forces the channel to concentrate its flow onto the outsides of the bends, resulting in bank erosion. When planting or other

methods are used stabilise the outside of bends, the strategic movement of deposited gravel will assist in the overall stability of the channel.

Gravel extraction
This is the removal of surplus bed load material that a waterway carries and deposits in an area that creates or worsens flooding or erosion. It often results from a significant flood event or a series of minor events.

Photo 16: Movement of gravel from the right bank to alleviate erosion on the left bank.

6.2.1 Opportunities for enhancement

Undertaken poorly this activity can result in significant stream disturbance, destroying fish spawning areas, riparian and aquatic habitats. If time is taken to carefully plan the project many environmental enhancement opportunities can be incorporated.

Taking care to avoid areas of native riparian vegetation and replanting riparian vegetation in other areas will provide riparian shade and shelter, helping to lower stream water temperatures and provide habitat for wildlife. Leaf litter and small twigs that fall into the stream from riparian plants are an important food source for microbes and many species of aquatic invertebrates on which fish feed. It is also desirable to leave some large woody material in the stream as wood is an integral part of stream ecosystems. For example, fish use logjams to spawn under, hide from predators or as shelter during big floods. Wood in the stream channel also helps to trap the small fragments of leaf litter and twigs preventing their being flushed away quickly. Wood is especially important in streams when there is little other stable substrate (such as boulders) as some aquatic insects attach to large wood in order to feed, pupate, or lay eggs (Meleason, M. et al, 2002).

Large woody material can be secured adjacent to the stream bank or on a 20–40 degree angle with the bank and just above the water level, as shown in figure 3. If it is aligned with the flow in this way on the channel margin or in areas of low flow velocity wood will have very little impact on flooding or erosion (Land and Water Australia, 2002).

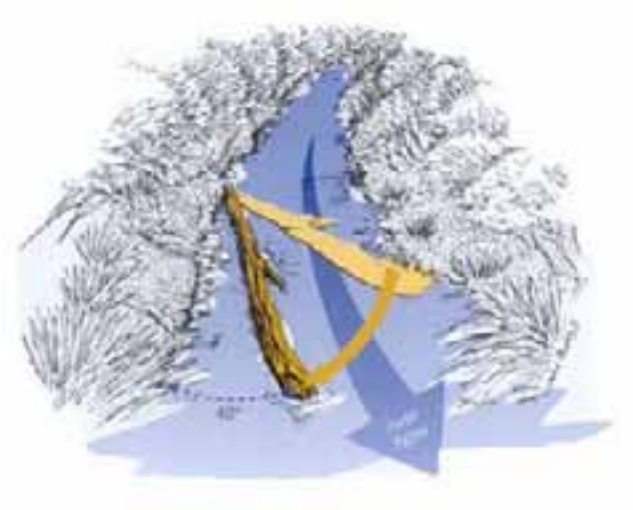

Figure 3: How to place logs for habitat enhancement (Land and Water Australia, 2002).

It is also import to re-create the run, riffle and pool habitats (as shown in figure 4) that would have existed in the stream prior to works taking place. This is important as pools are used by many fish species for example trout, common smelt and common bully as resting and spawning areas. Other fish such as torrent fish prefer the faster flowing riffle sections of streams. Fish such as koaro and banded kokopu spawn amongst leaf litter and rocks on the upper edge of stream banks during high stream flows. It is therefore import to replace large rocks along stream banks leaving them rough rather than out.

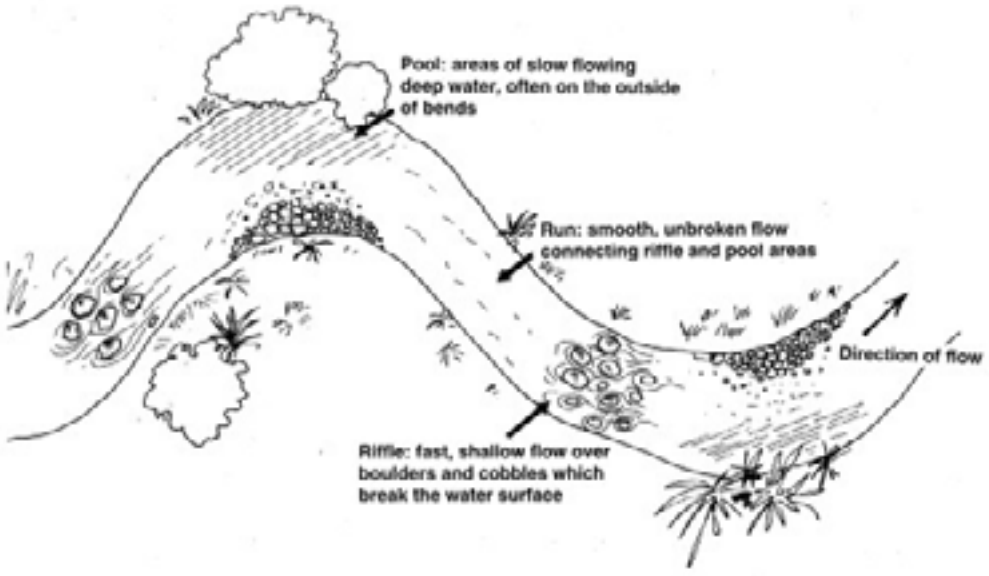

Figure 4: Run-riffle-pool sequence in a stream.

6.2.2 Guidelines for best practice

Site assessment

a) Does the site require human intervention? (for example, instability is natural, is the work actually required to protect infrastructure?).
b) What level of intervention is necessary?
c) Is the work a priority for Environment Waikato funding?

Planning

d) Consider potential impacts of the work on recreational river users (for example, anglers, swimmers and canoeists) and take steps to minimise these.

e) Only extract the amount of gravel required to maintain the channel flood carrying capacity.
f) Plan works so that runs, riffle and pool habitats are maintained in the stream ecosystem. To do this look at the run, riffle pool layout upstream and recreate the pattern once you have completed gravel management/extraction works.
g) Factor in costs associated with follow-up fencing and riparian planting.
h) Minimise in-stream metal extraction. Extract metal only from beaches and on the inside of bends, above water level.
i) Minimise the time of works and level of disturbance.
j) Determine whether the work requires resource consent (including any district council consents, traffic management plans, etc). If consent is required allow **at least** 12 weeks to go through the process.

Relevant sections in Waikato Regional Plan

Section	Name
4.3.4	Disturbance of the beds of lakes and rivers
4.3.7	Sand and gravel extraction
4.3.8	Introduction or panting of vegetation on the beds of rivers and lakes and tree layering
5.1.4	Accelerated erosion (Including soil disturbance, roading and tracking and vegetation clearance)
4.3.9	Clearance of vegetation in, on or under the beds of rivers and lakes

k) What is the appropriate funding level from Environment Waikato?
l) Investigate whether other groups/agencies could assist with costs.
m) Determine the class of the waterway (for example, trout fishery or spawning class waterway).
n) Select an appropriate disposal site for extracted gravels. If placing it on a beach, deposit river gravels with the same size beach gravels.
o) Check for any significant historical sites.
p) If the site has high public visibility purchase signage to explain the works.
q) Follow Environment Waikato's "Spill Contingency Guidelines" (Technical Report TR2006/24, www.ew.govt.nz/publications/technicalreports/tr0711.htm).

Consultation

a) If on a trout fishery/spawning class waterway (as per the Waikato Regional Plan) consult with the local branch of Fish and Game so they are aware of when and how the activity will be undertaken.
b) If the river where works are proposed is an indigenous fishery (as per the Waikato Regional Plan) and DOC have an active interest in the area discuss your plans with DOC.
c) Consult any other potentially affected parties such as neighbouring property owners and/or iwi.

Physical works

a) Take before, during and after photos of the works.
b) Operate machinery on dry land as much as possible – avoid working in the stream channel and avoid excavation from flowing water.
c) If removing metal from a beach leave an appropriate buffer strip (1-5 m) untouched around the river edge of the beach or remove metal from the beach to within 500 mm of the water surface. Leave a bund between the works site and the waters edge to reduce any run-off into the waterway.
d) Use a large machine to limit excavation time.
e) If excavating within the stream channel leave the stream bed rough rather than smooth and uniform and ensure the depth of the channel is varied (especially in channels with low flows).

f) Leave logs and buried debris providing they don't create an obstruction or diversion that may promote erosion (see figure 4 for more information).
g) If the work involves diverting the water flows to one side of the channel ensure that at least one third of the channel has flowing water.
h) Ensure that no fuel storage or machine refuelling occurs where fuel could enter a water body in the event of a spillage.

Ensure machinery is washed down prior to and following works to prevent the spread of unwanted organisms, for example alligator weed and didymo.

Timing

a) Undertake works during low flow conditions.
b) Undertake follow-up planting from May to September.
c) If consent is not required for the work and the work will involve earthworks on the banks of a fishery class waterway as per the Waikato Regional Plan, time the earthworks to avoid the fish spawning periods as outlined in the table below. If work can not be undertaken during these times seek ecological advice specific to the site.

Timing of works in fishery class waterways

Location of work	Desired timing of work
Within tidal reach	June to February (to avoid inanga spawning peak)
Lake Taupo and tributaries	November to April (to avoid spawning)
Within Trout fishery waterway not within Lake Taupo or tributary	September to April (to avoid spawning)
Within indigenous fish waterway	December, January, February

For greater detail on fish spawning and migration timing see Environment Waikato's freshwater fish spawning and migration calendar (Technical Report TR07/11 - www.ew.govt.nz/publications/technicalreports/tr0711.htm).

Follow-up

a) Carry out protection fencing and riparian planting as follow up works.
b) Where riparian planting is to take place use native tree species wherever possible. If willow is used ensure male hybrids are selected (for example, matsudana).
c) Ensure a regular maintenance programme is adhered to.

Other relevant chapters

- Poplar/willow vegetation groynes.
- Native planting.
- Pole planting along waterways.
- Sediment control.

6.3 Channel diversion/realignment

This involves the creation of a new stream channel or realignment of an existing stream channel. The activity requires resource consent from Environment Waikato and should be planned using expertise from a river engineer and an ecologist.

Photo 17: River prior to diversion.

Photo 18: Excavator working from dry ground re-aligns the river.

6.3.1 Opportunities for enhancement

Undertaken poorly this activity can result in significant stream disturbance, destroying fish spawning areas, riparian and aquatic habitats. If time is taken to carefully plan the project many environmental enhancement opportunities can be incorporated.

Fencing the stream bank to exclude stock and planting riparian vegetation will provide riparian shade and shelter, helping to lower stream water temperatures and provide habitat for wildlife. Leaf litter and small twigs that fall into the stream from riparian plants are an important food source for microbes and many species of aquatic

invertebrates on which fish feed. It is also desirable to leave some large woody material in the stream as wood is an integral part of stream ecosystems. For example, fish such use logjams to hide from predators or as shelter during big floods. Wood in the stream channel also helps to trap the small fragments of leaf litter and twigs preventing their being flushed away quickly. Wood is especially important in streams when there is little other stable substrate (such as boulders) as some aquatic insects attach to large wood in order to feed, pupate, or lay eggs (Meleason, M. et al, 2002).

Large woody material can be secured adjacent to the stream bank or on a 20 – 40 degree angle with the bank and just below the water level. If it is aligned with the flow in this way on the channel margin or in areas of low flow velocity wood will have very little impact on flooding or erosion (Land and Water Australia, 2002).

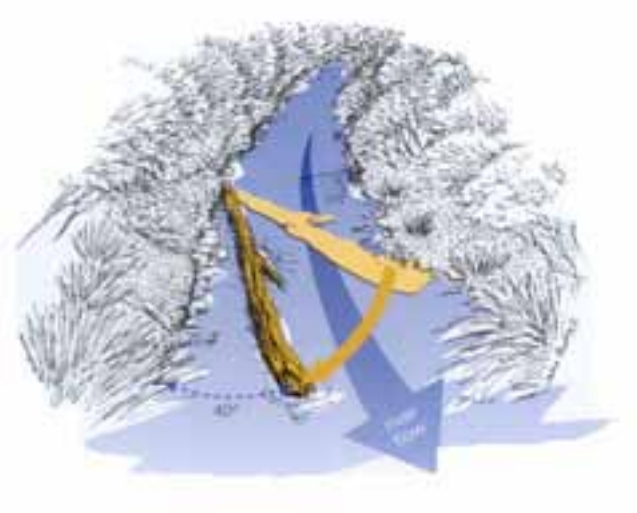

Figure 5: How to place logs for habitat enhancement (Land and Water Australia, 2002).

If diversion is being undertaken in gravely streams is also import to re-create the run, riffle and pool habitats that would have existed in the stream prior to works taking place. This is important as pools are used by many fish species for example trout, common smelt and common bully as resting and spawning areas. Other fish such as torrent fish prefer the faster flowing riffle sections of streams. Fish such as koaro and banded kokopu spawn amongst leaf litter and rocks on the upper edge of stream banks during high stream flows. It is therefore import to replace large rocks along stream banks and leaving the banks rough rather than smoothing them out.

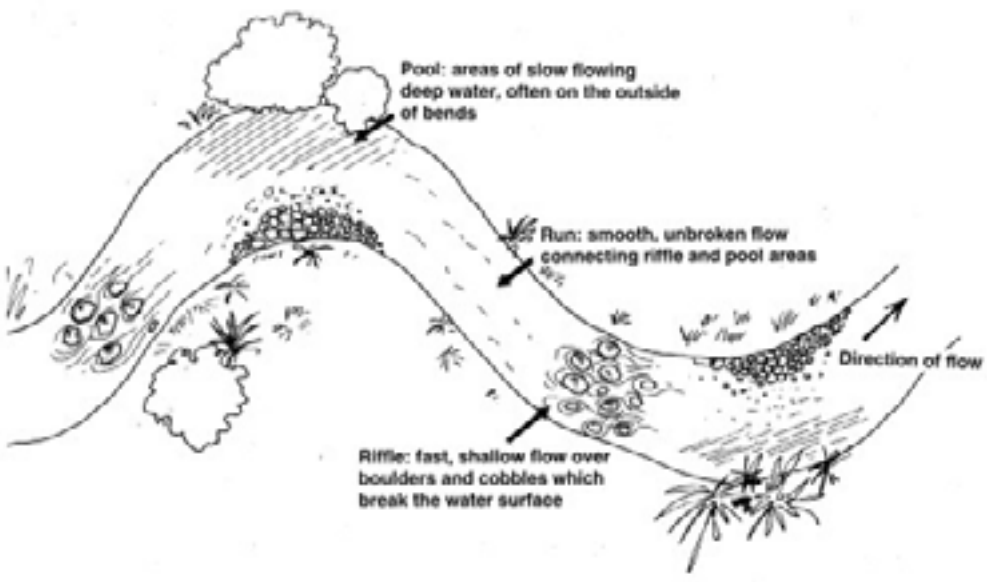

Figure 6: Run-riffle-pool sequence in a stream.

6.3.2 Guidelines for best practice

Site assessment

a) Does the site require human intervention? (What would be the impacts of doing nothing?).
b) What level of intervention is necessary?
c) Is the work a priority for Environment Waikato funding?

Planning

a) A suitably qualified or experienced engineer shall determine a suitable alignment for the river/stream reach, having regard to stable meander curvatures, observable elsewhere in the river/stream. The history of reach shall be determined using aerial photography held on Environment Waikato files from the preceding two decades.
b) Check the rules in the Waikato Regional Plan to determine whether resource consent is required. If consent is required allow **at least** 12 weeks to go through the process.

Relevant sections in Waikato Regional Plan

Section	Name
3.6.4	Daming and diverting
4.2.21	Suspended solids discharge standards
4.3.4	Disturbances of the beds of lakes and rivers
4.3.8	Introduction of planting of vegetation on the beds of rivers and lakes and tree layering
4.3.9	Clearance of vegetation in, on or under the beds of rivers and lakes
5.1.4	Accelerated erosion
5.2.5	Clean filling and overburden disposal

c) Consider potential impacts of the work on recreational river users (for example, anglers, swimmers and canoeists) and take steps to minimise these.
d) If the site has high public visibility purchase signage to explain the works.
e) Factor in costs associated with follow-up fencing and riparian planting.
f) Allow sufficient time for design and the resource consent process.
g) What is the appropriate funding level from Environment Waikato?
h) What other groups/agencies could assist with costs.
i) Determine the class of the waterway (for example, fisheries class waterway).
j) Check for any significant historical sites.
k) If creating a new channel alignment consider the upstream and downstream impacts caused by changes in gradients.
l) Follow Environment Waikato's "Spill Contingency Guidelines" (Technical Report TR2006/24, www.ew.govt.nz/publications/technicalreports/tr0711.htm).

Consultation

a) Consultation with potentially affected parties will be required as part of the resource consent process. Potentially affected parties may include DOC, Fish and Game, local iwi, neighbouring land owners, district council and downstream water users.
b) Land owner/s involved.

Physical works

a) Allow time to take before and after photos and photos during the works.
b) Take water samples upstream and downstream of the works to determine the nature and duration of the effects.
c) Ensure the contractor uses machinery suitable for the job.

d) Ensure that no fuel storage or machine refuelling occurs where fuel could enter a water body in the event of a spillage.
e) Minimise the duration of works and level of disturbance.
f) Operate machinery on dry land as much as possible – avoid working in the flowing stream channel. This may involve temporary diverting the stream to one side so that works can be undertaken in an area of "no flow".
g) Take measures to prevent silt run-off from work sites (for example, erect silt fences).

Ensure machinery is washed down prior to and following works to prevent the spread of unwanted organisms, for example alligator weed and didymo.

Timing

a) Undertake works during low flow conditions.
b) Undertake follow-up planting from May to September.
c) Discuss timing of the works with the relevant land owner. You may have to work around things like crop harvesting and hay making.
d) If consent is not required for the work and the work will involve earthworks on the banks of a fishery class waterway as per the Waikato Regional Plan, time the earthworks to avoid the fish spawning periods as outlined in the table below. If work can not be undertaken during these times seek ecological advice specific to the site.

Timing of works in fishery class waterways

Location of work	Desired timing of work
Within tidal reach	June to February (to avoid inanga spawning peak)
Lake Taupo and tributaries	November to April (to avoid spawning)
Within Trout fishery waterway not within Lake Taupo or tributary	September to April (to avoid spawning)
Within indigenous fish waterway	December, January, February

For greater detail on fish spawning and migration timing see Environment Waikato's freshwater fish spawning and migration calendar (Technical Report TR07/11 - www.ew.govt.nz/publications/technicalreports/tr0711.htm).

Follow-up

a) Carry out protection fencing and planting as follow up works. If the land owner is undertaking planting you may need to stake out the plant/pole locations.
b) Where riparian planting is to take place use native tree species wherever possible. If willow is used ensure male hybrids are selected (for example, matsudana).
c) Ensure a regular maintenance inspection programme is adhered to.

Other relevant chapters

- Native planting.
- Pole planting along waterways.
- Sediment control.

6.4 In-stream debris management/obstruction removal

Channel obstructions are site specific and normally require removal as special work. They generally involve fallen trees, flood delivered logs, a mat or raft of vegetation, or a collapsed length of riverbank. Removal is required to maintain floodway capacity, reduce or prevent erosion and prevent damage to structures.

Removal is best undertaken with adequately sized machinery and experienced operators. The obstructions are best removed by cutting, grabbing and lifting rather than pulling and dragging. The least amount of damage that is done to the stream banks the better. Care should be taken not to remove obstructions that are providing desirable gradient control where removal may trigger headward channel erosion. Selective removal of a part of the obstruction may be appropriate to avoid unnecessary bed disturbance.

Photo 19: Typical example of stream blockage and resulting erosion.

6.4.1 Opportunities for enhancement

It is not always necessary to completely remove all debris from a waterway. Large woody material in the stream is an integral part of stream ecosystems. For example, fish such use logjams to hide from predators or as shelter during big floods. Wood in the stream channel also helps to trap the small fragments of leaf litter and twigs on which many species of aquatic invertebrates feed. Many fish then feed on these aquatic invertebrates. Wood is especially important in streams when there is little other stable substrate (such as boulders) as some aquatic insects attach to large wood in order to feed, pupate, or lay eggs (Meleason, M. et al, 2002).

In some cases is may be possible to simply adjust the position and/or size of large woody material and secure it in a position adjacent to the stream bank or on a 20–40 degree angle with the bank, resting at water level. If it is aligned with the flow in this way on the channel margin or in areas of low flow velocity wood will have very little impact on flooding or erosion (Land and Water Australia, 2002).

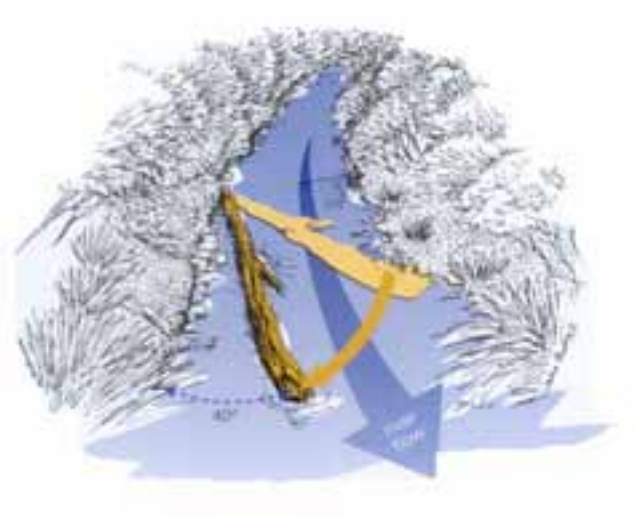

Figure 7: How to place logs for habitat enhancement (Land and Water Australia, 2002).

6.4.2 Guidelines for best practice

Site assessment

a) Does the site require human intervention? (What would be the impacts of doing nothing?).
b) What level of intervention is necessary?
c) Is the work a priority for Environment Waikato funding?

Planning

a) Determine whether the work requires resource consent (including any district council consents, traffic management plans, etc). If consent is required allow **at least** 12 weeks to go through the process.

Relevant sections in Waikato Regional Plan

Section	Name
4.3.4	Disturbances of the beds of lakes and rivers
4.3.9	Clearance of vegetation in, on or under the beds of rivers and lakes
4.3.10.1	Removal of obstructions

b) Check for any significant historical sites.
c) What is the appropriate funding level from Environment Waikato?
d) Investigate whether other groups/agencies could assist with costs.
e) If possible remove unstable material before it falls into a watercourse.
f) Ensure machinery is sufficient in size so that it stays out of the channel and minimises time of operation and disturbance.
g) Undertake work frequently to ensure small amounts are done often rather than a lot done seldom, to minimise impact.
h) Dispose of material by burning, burial or removal from floodway as soon as it is removed.
i) Follow Environment Waikato's "Spill Contingency Guidelines" (Technical Report TR2006/24, www.ew.govt.nz/publications/technicalreports/tr0711.htm).

Consultation

a) If on a trout fishery or spawning class waterway (as per the Waikato Regional Plan) consult with the local branch of Fish and Game so they are aware of when and how the activity will be undertaken.
b) If the river where works are proposed is an indigenous fishery (as per the Waikato Regional Plan) and DOC have an active interest in the area discuss your plans with DOC.

Physical works

a) Follow the OSH Code of Practice for River and Stream Operations.
b) Operate machinery from the top of the riverbank, not in the channel.
c) Cut and lift debris rather than pull and drag. Do not disturb the riverbed more than is necessary to reduce the flood hazard to an acceptable level.

Ensure machinery is washed down prior to and following works to prevent the spread of unwanted organisms, for example alligator weed and didymo.

Timing

a) Undertake works during low flow conditions.
b) If the works do not require resource consent and are within a fishery class waterway time the works to avoid fish spawning periods as outlined in the table below. If works can not be undertaken within these times seek advice from and ecologist specific to the site.

Timing of works in fishery class waterways

Fishery class	Avoid works during the following times
Within tidal reach	June to February (to avoid inanga spawning peak)
Trout fishery/spawning	May to September inclusive
Indigenous fishery	August to December inclusive

For greater detail on fish spawning and migration timing see Environment Waikato's freshwater fish spawning and migration calendar (Technical Report TR07/11 - www.ew.govt.nz/publications/technicalreports/tr0711.htm).

Follow-up

a) Ensure a regular inspection and maintenance programme is adhered to.
b) Re-grass all areas where soil disturbance has occurred.

Other relevant chapters

- Sediment control.

6.5 Battered banks

This is the activity of establishing a sloped bank with protective surface cover to reduce to potential for stream bank erosion. The activity normally involves re-grading over steep stream banks and establishing ground cover and shrub vegetation. The final result is a stabilised river or stream bank that is less prone to lateral erosion. However, care needs to be taken when undertaking bank battering to ensure the amount of sediment deposition into the watercourse is minimised and that appropriate re-vegetation occurs.

Photo 20: Excavator undertaking bank battering.

6.5.1 Opportunities for enhancement

Undertaken poorly this activity can result in significant stream disturbance, destroying fish spawning areas and riparian and aquatic habitats. If time is taken to carefully plan the project many environmental enhancement opportunities can be incorporated.

Fencing the stream bank to exclude stock and planting riparian vegetation will provide riparian shade and shelter, helping to lower stream water temperatures and provide habitat for wildlife. Leaf litter and small twigs that fall into the stream from riparian plants are an important food source for microbes and many species of aquatic invertebrates on which fish feed. It is also desirable to leave some large woody material in the stream as wood is an integral part of stream ecosystems. For example, fish such use logjams to hide from predators or as shelter during big floods. Wood in the stream channel also helps to trap the small fragments of leaf litter and twigs preventing their being flushed away quickly. Wood is especially important in streams when there is little other stable substrate (such as boulders) as some aquatic insects attach to large wood in order to feed, pupate, or lay eggs (Meleason, M. et al, 2002).

Large woody material can be secured adjacent to the stream bank or on a 20 – 40 degree angle with the bank and just below the water level. If it is aligned with the flow in this way on the channel margin or in areas of low flow velocity wood will have very little impact on flooding or erosion (Land and Water Australia, 2002).

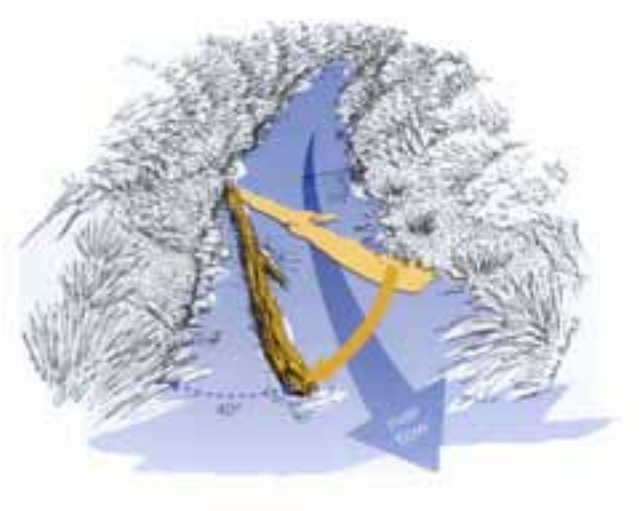

Figure 8: How to place logs for habitat enhancement (Land and Water Australia, 2002).

If the works is within a whitebait spawning area, spawning habitat could be enhanced by benching the stream bank and planting it in native or pasture grass. The benched area needs to be at a level that so that it is flooded on a spring tide as this is when whitebait lay their eggs and spawn within the streamside vegetation.

Fish such as koaro and banded kokopu spawn amongst leaf litter and rocks on the upper edge of stream banks during high stream flows. If work is being undertaken in a gravelly stream it is import to replace large rocks along stream banks and leave the banks rough rather than smoothing them out.

6.5.2 Guidelines for best practice

Site assessment

a) Does the site require human intervention? (What would be the impacts of doing nothing?).
b) What level of intervention is necessary?
c) Is the work a priority for Environment Waikato funding?

Planning

a) Check the relevant sections in the Waikato Regional Plan to determine whether resource consent is needed. If consent is required allow **at least** 12 weeks to go through the process.

Relevant sections in Waikato Regional Plan

Section	Name
4.3.4	Disturbance of the beds of lakes and rivers
4.3.8	Introduction or planting of vegetation on the beds of rivers and lakes and tree layering
4.3.9	Clearance of vegetation in, on or under the beds of rivers and lakes
5.1.4	Accelerated erosion (Including soil disturbance, roading and tracking and vegetation clearance)

b) Consider potential impacts of the work on recreational river users (for example, anglers, swimmers and canoeists) and take steps to minimise these.
c) Factor in follow-up costs such as weed spraying, fencing and riparian planting.
d) Where riparian planting is to take place use native tree species wherever possible. If willow is used ensure male hybrids are selected (for example, matsudana).
e) What is the appropriate funding level from Environment Waikato?

f) Investigate whether other groups/agencies could assist with costs.
g) Determine the appropriate machinery (for example, is a 20 tonne long reach excavator required or will at 12 tonne machine do the job). Use machinery that will minimise the risk of depositing sediment into the watercourse.
h) Check for any significant historical sites.
i) If the site has high public visibility purchase signage to explain the works.
j) Follow Environment Waikato's "Spill Contingency Guidelines" (Technical Report TR2006/24, www.ew.govt.nz/publications/technicalreports/tr0711.htm).

Consultation

a) If on a trout fishery or spawning class waterway (as per the Waikato Regional Plan) consult with the local branch of Fish and Game so they are aware of when and how the activity will be undertaken.
b) If the river where works are proposed is an indigenous fishery (as per the Waikato Regional Plan) and DOC have an active interest in the area discuss your plans with DOC.
c) Discuss timing of works with the land owner to ensure easy access to the site.
d) Inform downstream land owners and water users of works and potential increases in sediment over a short period of time.

Physical works

a) Consider taking a water sample before works begin and following completion of the works.
b) If the stream is high in sediment and has a low gradient, consider digging a section of the stream lower at the downstream end of the works. This will act as a sediment trap and reduce the amount of sediment being transported downstream of the works site.
c) Do not carry out excavations or earthworks below the waterline, unless it is necessary to provide for bank stability (resource consent is required for such work) or to create a sediment trap.
d) Vehicles and machinery shall not enter or work in flowing water as far as practicable.
e) Ensure the excavator undertaking the work takes cuts to the water level with the final cut just above the water.
f) If digging below water level bulk out all the dry material first then work on the section below water level. This will reduce the amount of sedimentation in the stream.
g) Always pull material away from the watercourse.
h) Place spoil heaps away from the stream in a manner whereby they will not increase flooding effects on other properties.

Ensure machinery is washed down prior to and following works to prevent the spread of unwanted organisms, for example alligator weed and didymo.

Timing

a) Undertake works during low flow conditions.
b) Undertake follow-up planting from May to September.
c) If in a whitebait spawning area consider benching the banks to enhance spawning habitat.
d) If the stream is used for recreation avoids periods of high use.
e) If the works do not require resource consent and are within a fishery class waterway time the works to avoid fish spawning periods as outlined in the table below. If works can not be undertaken within these times seek advice from and ecologist specific to the site.

Timing of works in fishery class waterways

Location of work	Desired timing of work
Within tidal reach	June to February (to avoid inanga spawning peak)
Lake Taupo and tributaries	November to April (to avoid spawning)
Within Trout fishery waterway not within Lake Taupo or tributary	September to April (to avoid spawning)
Within indigenous fish waterway	December, January, February

For greater detail on fish spawning and migration timing see Environment Waikato's freshwater fish spawning and migration calendar (Technical Report TR07/11 - www.ew.govt.nz/publications/technicalreports/tr0711.htm).

Follow-up

a) Level out/dispose and re-vegetate spoil heaps in locations that do not raise flood levels on other properties.
b) Re-vegetate/re-grass exposed areas to control surface erosion as soon as practicable following completion of earthworks disturbance.
a) Carry out protection fencing to exclude stock.
c) Undertake riparian planting on the stream margins.
d) Ensure regular maintenance inspections are undertaken.

Other relevant chapters

- Native planting.
- Pole planting along waterways.
- Sediment control.

6.6 Gradient control structures/weirs

Gradient control structures are normally constructed across the bed of a waterway to control scour and provide a stable bed level. In the Waikato region, weirs are commonly constructed on lake outflows to set an appropriate level for the lake ecosystem to function. Gradient control structures/weirs can be constructed from a range of materials including wood, concrete and rock rip rap.

Gradient control structures are particularly effective where a stream has active bed erosion and is gradually scouring downwards. This result in both bed and bank scour and often contributes large volumes of material to the bed load downstream. By stabilising the bed gradient, material is less likely to erode and 'soft' erosion control techniques such as riparian planting can be more effective

Photo 21: Lake Koromatua weir.

6.6.1 Guidelines for best practice

Site assessment

a) Does the site require human intervention? (What would be the impacts of doing nothing?).
b) What level of intervention is necessary?
c) Is the work a priority for Environment Waikato funding?

Planning

a) Check the relevant sections in the Waikato Regional Plan to determine whether resource consent is needed. If consent is required allow **at least** 12 weeks to go through the process.

Relevant sections in Waikato Regional Plan

Section	Name
3.6.4	Damming and diverting
4.2.4	Structures in, on, under or over the beds of lakes and rivers
4.2.19.1	Gradient control structures
4.3.4	Disturbances of the beds of lakes and rivers

b) Consider potential impacts of the work on recreational river users (for example, anglers, swimmers and canoeists) and take steps to minimise these.
c) Factor in follow-up costs such as weed spraying, fencing and riparian planting.
d) What other groups/agencies could assist with costs.
e) Construction material must be adequate for intended use and for all anticipated flood flows.
f) Obtain technical advice during the design stage.
g) Water velocity should be kept less than 0.5 m/sec, or if constructed with high surface roughness can have water velocities up to 1 m/sec and should include riffles and pools when in significant wildlife streams.

h) Shape the structure as a shallow V across the stream so a depth of flow is maintained as the flow reduces.
i) Investigate fish pass options and the importance of fish access.
j) Plant low growing vegetation around the structure to provide shading. Low growing vegetation will enable machinery to access the site for any future maintenance.
k) Follow Environment Waikato's "Spill Contingency Guidelines" (Technical Report TR2006/24, www.ew.govt.nz/publications/technicalreports/tr0711.htm).

Consultation

a) If on a trout fishery or spawning class waterway (as per the Waikato Regional Plan) consult with the local branch of Fish and Game so they are aware of when and how the activity will be undertaken.
b) If the river where works are proposed is an indigenous fishery (as per the Waikato Regional Plan) and DOC has an active interest in the area discuss your plans with DOC.
c) Discuss timing of works with the land owner to ensure easy access to the site.
d) Inform downstream land owners and water users of works and potential increases in sediment over a short period of time.
e) Consult any other potentially affected parties such as neighbouring property owners and/or iwi.

Physical works

a) Keep installation time to a minimum.
b) Machinery to operate from dry ground as much as possible.
c) Put in place sediment control measures to minimise sediment entering the waterway.

Ensure machinery is washed down prior to and following works to prevent the spread of unwanted organisms, for example alligator weed and didymo.

Timing

a) Undertake works during low flow conditions.
b) If the stream is used for recreation avoids periods of high use.
c) Undertake follow-up planting from May to September.
d) If the works do not require resource consent and are within a fishery class waterway time the works to avoid fish spawning periods as outlined in the table below. If works can not be undertaken within these times seek advice from and ecologist specific to the site.

Timing of works in fishery class waterways

Location of work	Desired timing of work
Within tidal reach	June to February (to avoid inanga spawning peak)
Lake Taupo and tributaries	November to April (to avoid spawning)
Within trout fishery waterway not within Lake Taupo or tributary	September to April (to avoid spawning)
Within indigenous fish waterway	December, January, February

For greater detail on fish spawning and migration timing see Environment Waikato's freshwater fish spawning and migration calendar (Technical Report TR07/11 - www.ew.govt.nz/publications/technicalreports/tr0711.htm).

Follow-up

a) Ensure maintenance inspections are undertaken regularly. The riprap may move in the initial stages so some topping up may be required.
b) Re-grass any disturbed areas immediately.
c) Undertake riparian planting.

Other relevant chapters

- Native planting.
- Fish passage structures.
- Sediment control.

6.7 Silt removal

This activity involves the excavation of material from the bed of a waterway using a hydraulic excavator. The purpose of the work is to remove excess sediment deposited on bed of the waterway. This ensures that the channel capacity is maintained.

Photo 22: Silt removal.

6.7.1 Guidelines for best practice

Site assessment

a) Does the site require human intervention? (What would be the impacts of doing nothing?).
b) What level of intervention is necessary?
c) Is the work a priority for Environment Waikato funding?

Planning

a) Always consider other alternatives prior to carrying out desilting operations.
b) Determine whether the work requires resource consent (including any district council consents, traffic management plans, etc). If consent is required allow **at least** 12 weeks to go through the process.

Relevant sections in Waikato Regional Plan

Section	Name
4.3.4	Disturbance of the beds of lakes and rivers
4.3.9	Clearance of vegetation in, on or under the beds of rivers and lakes

c) Consider potential impacts of the work on recreational river users (for example, anglers, swimmers and canoeists) and take steps to minimise these.

d) What is the appropriate funding level from Environment Waikato?
e) What other groups/agencies could assist with costs.
f) Determine an appropriate disposal location for excavated silt.
g) Works should be designed, supervised and implemented to carry out the minimum amount of excavation necessary.
h) Machinery used to do the work should be suitable for completing the work quickly and with minimal impact.
i) Use an experienced operator.
j) Follow Environment Waikato's "Spill Contingency Guidelines" (Technical Report TR2006/24, www.ew.govt.nz/publications/technicalreports/tr0711.htm).

Consultation

a) If on a trout fishery or spawning class waterway (as per the Waikato Regional Plan) consult with the local branch of Fish and Game so they are aware of when and how the activity will be undertaken.
b) If the river where works are proposed is an indigenous fishery (as per the Waikato Regional Plan) and DOC have an active interest in the area discuss your plans with DOC.
c) Discuss timing of works with the land owner to ensure easy access to the site.
d) Inform downstream land owners and water users of works and potential increases in sediment over a short period of time.
e) Consult with iwi if they are active in the area.

Physical works

a) Have the excavator undertake works from dry ground wherever possible
b) Where work is to be undertaken in a public place give prior warning to public and erect signage explaining the work.

Ensure machinery is washed down prior to and following works to prevent the spread of unwanted organisms, for example alligator weed and didymo.

Timing

a) Undertake works during low flow conditions or if in the coastal marine area during low tide.
b) Undertake works during dry weather.
c) If the waterway is used for recreation avoid periods of high use.
d) If the works do not require resource consent and are within a fishery class waterway time the works to avoid fish spawning periods as outlined in the table below. If works can not be undertaken within these times seek advice from and ecologist specific to the site.

Timing of works in fishery class waterways

Location of work	Desired timing of work
Within tidal reach	June to February (to avoid inanga spawning peak)
Lake Taupo and tributaries	November to April (to avoid spawning)
Within trout fishery waterway not within Lake Taupo or tributary	September to April (to avoid spawning)
Within indigenous fish waterway	December, January, February

For greater detail on fish spawning and migration timing see Environment Waikato's freshwater fish spawning and migration calendar (Technical Report TR07/11 - www.ew.govt.nz/publications/technicalreports/tr0711.htm).

Follow-up

a) Re-grass any areas that have been severely disturbed.

Other relevant chapters

- Sediment control.

6.8 Fish passage structures

Within the Waikato region there are 22 species of indigenous and 14 species of introduced freshwater fish. Most of these species are diadromous migrating between freshwater and marine environments to complete their lifecycle. Examples of such fish include short and long finned eels, inanga (whitebait), giant kokopu and banded kokopu. Structures such as culverts, floodgates, flumes, weirs and other gradient control structures can be barriers to fish passage if not constructed properly. Even long stretches of fast flowing water caused by the installation of a structure can be a barrier to fish migration. These barriers can restrict fish distributions and may lead to a decline in numbers of that species.

Some migratory species are excellent climbers (such as eels and koaro) so can climb up the wetted margins of waterfalls, spillways, culverts and weirs. However, other fish species (such as smelt and mullet) must swim past such obstacles and need deeper water and rely on short bursts of fast swimming to get past high-velocity areas. It is therefore important when building artificial structures in a waterway to consider whether fish are able to swim past easily.

Fish passage structures will vary depending on the size and type of waterway and the swimming ability of the fish species present. Examples of successful fish passes include ramps made from rock and/or wood with various surfaces for climbing fish, rock placement that creates a slow flowing layer of water suitable for fish to navigate, development of slow flowing margins and construction of a separate channels around the structure. To ensure construction of a successful fish passage structure expert advice should be sought at the design stage.

Photo 23 Native redfinned bully.

6.8.1 Guidelines for best practice

Site assessment

a) Is there or will there be an impedance to fish passage, for example perched culvert, dam or high-velocity water that may be impassable by some fish.
b) What species of fish are found in the waterway (if you are not sure seek expert advice).

Planning

a) Perched culverts can be fixed by re-setting the culvert low in the stream bed.
b) Consider roughing up smooth bottom culverts with cement or rocks to slow water flow.
c) Some juvenile fish are able to climb wet surfaces. A flexible corrugated pipe with water trickling through it can help fish to travel short distances between two wetland areas that have no natural fish access.
d) Plan follow-up planting. Overhanging species like flax and sedges create shelter for fish and keep the water cool.
e) Weirs should be notched or have rock ramps included ensuring fish passage can continue. Fish passes in the form of rock ramps over weirs or embankments should have slopes of around 1:20 (very mild) with provision for changes in the flow patterns and velocities and stilling areas on the ramp structure itself.
f) **For other structures get advice from a freshwater ecologist and/or a river engineer about what sort of fish pass is best suited for the type of waterway.**
g) Check the relevant rules in the Waikato Regional Plan to determine whether resource consent is required. If consent is required allow **at least** 12 weeks to go through the process.

Relevant sections in Waikato Regional Plan

Section	Name
3.6	Damming and diverting
4.2.4	Structures in, on, under or over the beds of lakes and rivers
4.3.4	Disturbances of the beds of lakes and rivers

Consultation

a) If on a trout fishery or spawning class waterway (as per the Waikato Regional Plan) consult with the local branch of Fish and Game so they are aware of when and how the activity will be undertaken.
b) If the river where works are proposed is an indigenous fishery (as per the Waikato Regional Plan) and DOC have an active interest in the area discuss your plans with DOC.
c) Discuss timing of works with the land owner to ensure easy access to the site.

Ensure machinery is washed down prior to and following works to prevent the spread of unwanted organisms, for example alligator weed and didymo.

Timing

a) Undertake works during low flow conditions or if in a tidal waterway during low tide.
b) If the works do not require resource consent and are within a fishery class waterway time the works to avoid fish spawning periods as outlined in the table below. If works can not be undertaken within these times seek advice from and ecologist specific to the site.

Timing of works in fishery class waterways

Location of work	Desired timing of work
Within tidal reach	June to February (to avoid inanga spawning peak)

Lake Taupo and tributaries	November to April (to avoid spawning)
Within trout fishery waterway not within Lake Taupo or tributary	September to April (to avoid spawning)
Within indigenous fish waterway	December, January, February

For greater detail on fish spawning and migration timing see Environment Waikato's freshwater fish spawning and migration calendar (Technical Report TR07/11 - www.ew.govt.nz/publications/technicalreports/tr0711.htm).

Follow-up

a) Follow-up with riparian planting to provide overhanging vegetation and cover for fish.
b) Undertake regular inspections/monitoring to ensure the fish passage is operating as planned. Sometimes growth of weed, erosion or sedimentation may affect the operation of a fish pass and regular maintenance is required.

Other relevant chapters

- Native planting.

7 Other works

7.1 Sediment/erosion control

Environment Waikato undertakes a range of works that have long-term benefit to people and/or the environment which in the short term, may cause local soil disturbance which if not treated could result in sediment run-off into waterways. To minimise the short term impacts it is important to put in place sediment and erosion controls to ensure there is no run-off into water and the site is re-vegetated as soon as possible. The photo below is an example of a silt fence which is a simple and common way to minimise sediment run-off into water.

All earthworks sites where there are significant spoil heaps, bare earth and have a potential to discharge sediment laden water to surface water should have a simple to follow and site specific 'erosion and sediment control plan'. This plan should include such things as location of works, placement of erosion control measures, timing and re-vegetation.

Photo 24: An example of a silt fence built to reduce sediment entering the water.

7.1.1 Guidelines for best practice

Site assessment

a) If the activity involves soil disturbance of any kind and is near to a waterway, in a high risk erosion area (as described in the Waikato Regional Plan), or has potential to discharge sediment laden water to surface water then sediment control measures will be required.

b) Consider what sort of sediment control is required. See Environment Waikato's erosion and sediment control guidelines for more information. The can be found on our website http://www.ew.govt.nz/enviroinfo/land/erosion/sediment.htm.

Planning

a) Plan works to minimise disturbance to land as much as possible. Avoid areas that are wet, have steep or fragile soils or are conservation sites or features.
b) Adopt a low impact design with minimum earthworks – ideally only clear areas required for structures or access.
c) Stage construction so that earthworks are undertaken in small units over time with progressive re-vegetation.
d) If it is absolutely necessary to clear a steep slope, divert run-off from above the slope away from the exposed slope.
e) Plan to stabilise exposed areas rapidly, after each stage of construction. Methods are site specific and range from re-grassing through to straw mulching.
f) Install perimeter controls to keep clean run-off out of the work area. Common perimeter controls are diversion drains, silt fences and earth bunds.
g) Ensure you hire a trained and experienced contractor who will be responsible for installing and maintaining erosion and sediment control practices.
h) Check with Environment Waikato to check if resource consent is required. If consent is required allow **at least** 12 weeks to go through the process.

Relevant sections in Waikato Regional Plan

Section	Name
3.5.4	Discharges

4.2.21	Suspended sediment discharge standards for permitted activity rules in chapters 4.2 and 4.3
5.1.4	Accelerated erosion

Physical works

a) Ensure that no fuel storage or machine refuelling occurs where fuel could enter a water body in the event of a spillage. Follow Environment Waikato's Spill Contingency Guidelines (Technical Report TR2006/24, www.ew.govt.nz/publications/technicalreports/tr0711.htm).
b) Make sure the contractor establishes sediment controls before undertaking any works.

Ensure machinery is washed down prior to and following works to prevent the spread of unwanted organisms, for example alligator weed and didymo.

Timing

a) Undertake works during periods of dry weather and low river flows if applicable.
b) Put sediment controls in place before any works taking place.

Follow-up

a) Re-grass and/or re-plant disturbed areas.

Other relevant chapters

- Native planting.

Appendix 1 - Statutory functions and roles of RCS in relation to river systems management

The following is a review of the statutory functions and roles required to be observed and performed by Environment Waikato (EW) relating to river systems management. This information has been compiled by Tompkins Wake Lawyers and commences by referring to the various relevant statutes.

1. Resource Management Act 1991 (RMA)

- The sole purpose of the RMA is prescribed in s5 as *to promote the sustainable management of natural and physical resources.*

  The RMA deals with the integrated management of all natural resources, including water resources. EW in discharging its functions and responsibilities under the Act is obliged to make decisions intended to achieve the purpose of the Act while recognising and providing for the matters of national importance in s6 and taking into account the other matters in s7. In all situations likely to be relevant, the provisions of the RMA prevail over the provisions of other statutes.

- S30 prescribes the functions of regional councils under the RMA. Those relevant for present purposes are:

  30(1)(a) The establishment, implementation and review of objectives, policies and methods to achieve integrated management of the natural and physical resources of the region.

  30(1)(b) The preparation of objectives and policies in relation to any actual or potential effects of use, development, or protection of land which are of regional significance.

  Land by definition under s2 includes land covered by water.

  30(1)(c) The control of the use of and for the purpose of-
  - (i) Soil conservation;
  - (ii) The maintenance and enhancement of the quality of water in water bodies and coastal water;
  - (iii) The maintenance of the quantity of water in water bodies and coastal water;
  - (iii)(a) The maintenance and enhancement of ecosystems in water bodies and coastal water;
  - (iv) The avoidance or mitigation of natural hazards.

  A natural hazard is defined in s2 RMA as:

  Natural hazard means any atmospheric or earth or water related occurrence (including earthquake, tsunami, erosion, volcanic and geothermal activity, land slip, subsidence, sedimentation, wind, drought, fire or flooding), the action of which adversely effects or may adversely effect human life, property or other aspects of the environment

  30(1)(e) The control of the taking, use, damming, and diversion of water, and the control of the quantity, level, and flow of water in any water body including-
  - (i) the setting of any maximum or minimum levels or flows of water.-
  - (ii) the control of the range, or rate of change, of levels or flows of water.

30(1)(f) The control of discharges of contaminants into or onto land, air, or water and discharges of water into water.

30(1)(g) In relation to any bed of a water body, the control of the introduction or planting of any plant in, on, or under that land, for the purpose of:

(i) Soil conservation;
(ii) The maintenance and enhancement of the quality of water in that water body;
(iii) The maintenance of the quantity of water in that water body;
(iv) The avoidance or mitigation of natural hazards;

The statutory functions are performed by EW through its:

- Regional Policy Statement (RPS)

  Prepared pursuant to s59 to provide an overview of the resource management issues and policies and methods to achieve integrated management of the regional natural and physical resources.

- Proposed Regional Plan (PRP)

  Prepared pursuant to s63 to insist in the carrying out of its functions to achieve the purpose of the RMA.

- Decisions on resource consent applications.

- Enforcement orders or abatement notices under Part XII RMA.

  Ss13 and 14 impose restrictions on certain uses of the beds of lakes and rivers (s13) and in respect of the take, use, dam or diversion of water (s14) unless expressly allowed by a Rule in the PRP or by a resource consent. These restrictions apply to all activities including those intended by EW itself. An example is the application for resource consent by EW to enable it to carry out flood protection works on the Tongariro River.

  The RMA includes provisions enabling EW to take preventative or remedial action by way of emergency woks. The relevant part of s330 provides:

> 330(1) Where -
>
> (b) any natural and physical resource for which a local authority or consent authority has jurisdiction under this Act...
>
> is in the opinion of the authority affected by or likely to be affected by:
> (d) an adverse effect on the environment which requires immediate preventative measures; or
> (e) an adverse effect on the environment which requires immediate remedial measures; or
> (f) any sudden event causing or likely to cause loss of life, injury or serious damage to property –
>
> the provisions of section 9, 12, 13, 14, and 15 shall not apply to any activity undertaken by or on behalf of that …authority… to remove the cause of, or mitigate any actual or likely adverse effect of the emergency.
>
> 330(2) Where a local authority or consent authority-
>
> (a) has financial responsibility for any public works; or
> (b) has jurisdiction under this Act in respect of any natural and physical resource or area -
>
> which is, in the reasonable opinion of that local authority or consent authority, likely to be affected by any of the conditions described in paragraphs (d) to (f) of sub-section (1), the local authority or consent authority by its employees or agents may, without prior notice, enter anyplace... and take such action or direct the occupier to take such

> action, as is immediately necessary and sufficient to remove the cause of, or mitigate any actual or likely adverse effect of, the emergency.

This section was considered by the Environment Court in *Auckland City Council v Minister for the Environment* (1998) 5ELRNZI. There, the City Council sought a declaration to clarify the extent of the emergency works powers available to local authorities. The Court considered that the situation which would justify action by the local authority must be such that there was an element of probability of adverse effects on the environment or loss of life, injury or serious damage to property. It noted that the words used were strong in their tenor, embracing a mandatory factor (require) and a factor of immediacy and concluded that the nature of the effect and its adversity must be commensurate with the type of situation predicated by the mandatory and immediacy factors of each paragraph. At page 15 of the judgment, the Court observed:

> From that analysis, it is evidence the section cannot be regarded as a general fallback' provision that can automatically be relied on in any perceived 'emergency' as an effective answer to complaints of unlawful interference with private rights. Because of the section's specifically defined circumstances of applicability, we agree with Mr Cavanagh's submission that local authorities and others should not forsake or compromise their responsibility under the Act's wider framework of regional and district planning and control on a footing that s330 is 'always available if things go wrong'. Important though the section is, its terms are such that it cannot be viewed as an ultimate resort for every contingency.

2. Soil Conservation and Rivers Control Act 1941 (SCRCA)

Pursuant to the Local Government Reorganisation Order 1989, Environment Waikato inherited the functions and powers of former Catchment Boards. The function of Catchment Boards under s126 SCRCA is *to minimise and prevent damage within its district by floods and erosion.*

- S10 SCRCA provides the objects of the Act which are:

> (a) The promotion of soil conservation;
> (b) The prevention and mitigation of soil erosion;
> (c) The prevention of damage by floods;
> (d) Utilisation of land in such a manner as will tend towards the attainment of the said object.

The powers and duties of former Catchment Boards are prescribed in Part VII SCRCA. S 126 prescribes the general functions and powers:

> 126(2) Each Board shall have all such powers, rights and privileges as may reasonably be necessary or expedient to enable it to carry out its functions, and in particular each Board shall have power to construct, reconstruct, alter, repair and maintain all such works and do and execute all such other acts and deeds [including the breaching of any stock bank] as may in the opinion of the board be necessary or expedient for:
>
> (a) Controlling or regulating the flow of water towards and into water courses;
> (b) Controlling or regulating the flow of water in and from water courses;
> (c preventing or lessening any likelihood of the overflow or breaking of the banks of any water courses;
> (d) Preventing or lessening any damage which may be occasioned by any such overflow or breaking of the banks;
> (e) Preventing or lessening erosion or the likelihood of erosion; promoting soil conservation.
> (f) Promoting soil conservation

In addition to the general functions and powers, particular powers are conferred by:

- S131 which provides that all of the powers and authority conferred on local authorities by the Public Works Act 1981 (PWA) can be utilised in executing any works under the SCRCA.

- S 132 which imports the provisions of ss110, 111 and 112 of the PWA relating to the right to enter property and survey for investigation.

- S133 which confers rights of cleansing, repairing, deepening, widening water courses or making new water courses, diverting, impounding or taking away water from a water course. S133(2) provides that except in the case of urgent work to meet an emergency, these powers are required to be exercised on notice to relevant drainage board, river board, local authority or other public bodies.

  There is no specific procedure prescribed for urgent work to meet an emergency, or definition of emergency. S133(1)(c) empowers EW to carry out any work it thinks necessary or desirable for the purpose of controlling or preventing damage by flood waters.

- S135 which confers incidental powers including the right of entry over any land for the purpose of constructing, reconstructing, altering, repairing and maintaining any works or the laying or depositing of materials and all other such matters and things as are deemed expedient, necessary or proper for making, cleansing, repairing, maintaining and improving any water course.

The SCRCA is the statutory instrument which imposes general responsibility on EW to minimise and prevent damage within its district by floods and erosion. The responsibility is not absolute. Liability at common law in respect of damage could arise only if it could be established that EW had been negligent in not taking reasonable preventative or remedial steps or taking inadequate or inappropriate preventative or remedial steps to address a known problem. The seriousness of the likely consequences of non-action, the extent of other, possibly more urgent work requiring action, and the resources available to EW will be amongst the factors relevant in determining whether EW has met its statutory responsibilities.

3. Local Government Act 2002 (LGA)

Prior to the LGA becoming operative, EW, in common with other local authorities relied upon prescriptive legislation for its jurisdiction to undertake activities. The LGA introduced a new and different approach by conferring a generalised power on local authorities to have the capacity to undertake anything for the purpose of performing their function and role. S12 confers on Local Authorities for the purposes of performing their statutory role, full capacity to carry on or undertake any activity or business, do any act, or enter into any transaction. The purpose of the Act is set out in s3 and is to *provide for democratic and effective local government that recognises the diversity of New Zealand communities.* The purpose of local government is set out in s I 0 which provides:

> 10 The purpose of local government is-
> (a) to enable democratic local decision making and action by, and on behalf of, communities; and
> (b) to promote the social, economic, environmental and cultural well being of communities, in the present and for the future.

- Part 6 LGA deals with planning, decision making and accountability and sets out the obligations of local authorities in relation to the making of decisions, including involvement of Maori and consultation with interested and affected persons. Local authorities are required to identify outcomes sought by communities through the process of consultation, identify the outcomes that will be promoted and delivered, how these will be achieved, and the expense of those outcomes and how the expense is to be met. Part 6 includes s93 requiring a local authority at all times to have a long-term council community plan (LTCCP) adopted utilising the special consultative procedure.

The LTCCP has been described by the editor of Lexis Nexis Local Government as *plainly by far the most important of the planning and policy documents that a local authority is required to produce. The plan must integrate the strategies, policies and activities of a local authority, in the context of identified community outcomes, in a way that promotes public accountability and integrated decision making.*

The essential requirements of a LTCCP are listed in Schedule 10 Part 1 which deals with the identification of community outcomes and how these will be achieved and monitored. Those community outcomes must necessarily include the particulars of the statutory functions and duties imposed in respect of rivers control and management and Regional Hazards/Emergency Management.

- S181 LGA confers specific powers in respect of the construction of works on private land. It concludes the power for a local authority to construct works on or under private land or under a building on private land that it considers necessary for *(d) land drainage and rivers clearance.* Either the consent in writing of the owner of the affected land is required or a process of notice/right of objection/hearing provided by Schedule 12 followed.

- Although EW's River System Management publication at p56 refers to statutory responsibilities under Part XXIX of the Local Government Act 1974, I note that *Council* is defined in s503 as a *territorial authority and District as the district of a territorial authority* - both definitions expressed as applying unless the context otherwise requires. It may be that EW has entered into agreements with some territorial authorities and assumed the powers in respect of drainage channels and land drainage works prescribed in s5O9 and the removal of obstruction from drainage channels and watercourses prescribed in s511.

4. Local Government (Rating) Act 2002 (LGRA)

The LGRA has significance in the context of River System Management and Hazards/Emergency Management as it provides for differential rates (s14) and targeted rates (s16) to enable the beneficiaries of, or contributors to, a river management situation to be rated. Differential rates and/or targeted rates can be set where categories of land are identified in EWs funding impact statement and where they are defined in terms of the matters listed in Schedule 2. Those matters include the use to which the land is put and where the land is situated. Land which is flood prone and dependent on flood protection mechanisms and systems for protection can be rated as a beneficiary of the system. Land which contributes to a river management problem (e.g. run-off entering the system) can be rated as a contributor.

5. Summary

The various statutory provisions relating to river systems management and the control of flooding and erosion on occasion overlap and do not always provide a single consistent framework for responding to a situation which requires to be addressed. The RMA is the predominant statute and its provisions prevail in the event of any conflict. It requires the preparation of planning instruments to, inter alia, achieve integrated management of the region's natural and physical resources. The purpose of the RMA is achieved via those planning instruments which form the basis on which resource consent applications are considered and any enforcement steps are taken.

The SCRCA imposes specific obligations and functions on EW in respect of flooding and erosion. Those duties are relevant for both the planning instruments that EW is required to prepare and administer, and for works which EW undertakes or requires to be undertaken. S181 of the LGA 2002 confers specific powers in respect of land drainage and rivers clearance. This somewhat confusing mosaic of different functions and powers all requires to be considered in the context of the RMA and its single purpose.

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