Environment Waikato Technical Report 2006/06R

Best Practice Environmental Guidelines - Land Drainage

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1 Introduction

The Waikato Region has a large network of drains that among other things are managed to ensure adequate land drainage and alleviate flooding. Without adequate management of these waterways large areas would be unproductive or inaccessible.

In many areas the main focus has been to dig drains to lower the water table to improve pasture growth and to remove water as fast as possible from the land without much thought given to the environmental and economic impacts this may cause. It is now recognised that drains are also often important habitats, or could be important habitats, and have multiple uses and values. Drains have replaced wetlands in much of the Waikato region and some of the flora and fauna that used to inhabit wetlands now inhabit the drains. By following best practice guidelines people can achieve effective land drainage that is more environmentally sustainable and is cheaper to maintain in the long term.

These best practice guidelines have been prepared to assist regional and local authorities, landowners, consultants, and contractors with the creation of new drains and maintenance of existing land drainage. While focusing on environmental outcomes that can be achieved this document also recognises the operational need for maintaining drainage outfall and minimising long term costs.

By following the recommendations land drainage activities:

- should have only minor adverse impact on the environment.
- will be consistent with the requirements of the existing Proposed Waikato Regional Plan.
- will not compromise the levels of service provided by Regional and District flood protection or land drainage schemes.

The topics covered by this best practice guideline include:

- The Waikato Regional Plan
- Land Drainage Schemes
- Best Practice design guidelines for achieving land drainage.

1.1 What is best practice?

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

These guidelines are intended for anyone involved in undertaking or maintaining land drainage 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 land drainage activities within the Waikato region, as they provide an indication of what should be expected from land drainage activities.

2 Legislation

Prior to local government reorganisation in 1989 the former drainage boards were established and managed under the Land Drainage Act 1908 (LDA) and territorial authorities established land drainage districts under the Local Government Act 1974 (LGA). Local government reorganisation resulted in the constitution of the Waikato Regional Council and the Council was given the nine drainage boards in its region to manage, amongst many other roles. The nine areas were deemed to be constituted under the LGA 1974, and therefore they are to be managed in accordance with the LGA. The district council drainage districts remained with the relevant district councils and are also managed under the LGA

The introduction of the Resource Management Act 1991 (RMA) changed the way that natural resources were managed and resulted in amendments and repeal of many of the former acts that the regional council operated under. The roles and responsibilities of the regional council regarding drainage management are now 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)
- Land Drainage Act 1908 (LDA)
- Taupiri Drainage and River District Act 1929

2.1 The Waikato Regional Plan

The Waikato Regional Plan (WRP) has been developed by Waikato Regional Council 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 the drainage of land and maintenance of existing drains. The following rule types are included in the WRP:

- **Permitted activities**, which do not require Resource Consent although there are restrictions on specific aspects of the activity.

- **Controlled activities**, which require Resource Consent 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 Waikato Regional Council.

- **Restricted discretionary activities,** which require Resource Consent. The consent authority will specify in the plan or proposed plan matters to which it has restricted its discretion, and the consent authority's powers to decline a 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 specified in the plan or proposed plan.

- **Non-Complying activities**, which require Resource Consent that may or may not be granted at the Waikato Regional Council's discretion.

There are several WRP rules that control the drainage of land and maintenance of land drainage. At the time of publication the relevant regional plan rules that need to be considered are as follows:

Note: Under the WRP some drains will fall under the definition of a river so although the rules often refer to rivers they may still be applicable.

Activity	**Rule**
Drainage in or near a wetland	3.7.4.6, 3.7.4.7
Drain digging and/or drain maintenance	4.2.21, 4.3.4.4, 4.3.6.1
Vegetation clearance including weed spraying in or beside waterways (including drains)	4.3.9.2, 4.3.9.3, 5.1.4, 6.2.4.8, 6.2.4.9
The take, diversion and discharge of pumped water to other water courses.	3.5.10.1, 3.5.10.2, 3.5.10.3
Drain/waterway cleaning and disposal of tailings	5.2.5.7, 5.2.5.8
Stock access to drains/waterways	4.3.5
Planting and fencing next to a drain/waterway that is managed by the Waikato Regional Council or a district council	4.2.18.1
Drain diversion and discharges	3.6.4.8
Removal of Obstructions	4.3.10.1

Note: It is likely that excavation works within a drain which has a natural channel at its headwaters will require Resource Consent. Therefore it is advisable that the Waikato Regional Council is contacted before work starts.

Drain deepening or digging of new drains within 200 metres of a wetland or lake listed in the Waikato Regional Plan also requires resource consent.

3 Land drainage schemes

Within the Waikato Region there are over fifty land drainage scheme areas, which allow landowners within the schemes to manage the water table on their properties and reduce surface flooding resulting from rainfall events.

Nine land drainage scheme areas (former drainage boards) are managed by the Waikato Regional Council. The largest is the Thames Valley drainage area with over 5,000 ratepayers and the smallest is the Rotomanuka drainage area with 160 ratepayers. District Council-managed drainage scheme areas range from two ratepayers to several hundred. Each property within a drainage scheme pays a targeted rate towards the maintenance and upkeep of that scheme. Activities such as drain cleaning, erosion control, pump maintenance, stop bank maintenance and general scheme upkeep are organised by the relevant management agency. Appendix 1 illustrates the location of drainage schemes within the Waikato Region and the management agency responsible for scheme maintenance.

The larger drainage scheme areas are usually split into smaller subdivisions to make management simple. Within the Thames Valley Drainage Scheme there are approximately 200 properties in each subdivision. Within each subdivision there is one landowner representative who represents the other landowners on a drainage advisory sub-committee. Drainage advisory sub-committees meet quarterly and make recommendations which are forwarded on to Council.

Waikato Regional Council maintains the condition and capacity of existing drains within land drainage schemes by using cleaning methods and best practice as set out in this document. Drains are cleaned only if required and on average this involves spraying once or twice a year and mechanical clearance once every ten years (with the exception of peat drains which are cleaned more frequently). Mechanical clearing is undertaken in stages so that approximately 10% of a drain network is cleaned in any one year, reducing the chance for erosion and reducing the time it takes for the ecosystem within a drain network to recover. Drain fencing is also encouraged as this prevents stock from pushing in the drain banks and adding sediment, nutrients and faecal material directly to the drain. Over time this also results in a reduction in the need for mechanical clearance.

Rule 4.2.18.1 within the Proposed Waikato Regional Plan ensures that access to drains (that are part of an EW of district council scheme) for maintenance is not compromised and that the effectiveness of the scheme is not compromised by farm activities such as fencing and planting. Rule 4.2.18.1 requires **landowners who are within an EW or territorial authority drainage scheme** to contact Environment Waikato if they wish to do any of the following within 10 metres of a drainage scheme drain (except in the Hauraki District Council area where a 15 metre distance shall apply,):

- plant trees, shrubs and/or construct any structure
- place fences perpendicular to a scheme drain without a gate
- place fences greater than 1,200mm high parallel to scheme drains
- place fences parallel to scheme drains that prevents access for maintenance
- place an artificial watercourse without a culvert perpendicular to a scheme drain

Many district councils have Land Drainage Bylaws that control land drainage activities undertaken in drainage scheme areas that are under district council jurisdiction. Rules within Land Drainage Bylaws are in addition to those in the Proposed Waikato Regional Plan.

4 Ecological considerations

It is important to realise that farm drains are not isolated as they almost always flow into natural streams that connect into rivers, wetlands, lakes and estuaries. Drains and other waterways can carry sediment, nutrients and other pollutants into larger waterways. As a result land drainage activities can have detrimental effects on the aquatic life and water quality in connecting waterways. Even seepages and ephemeral drains/waterways that flow intermittently have significant biological values which can be compromised by drainage activities.

For a number of our endangered wetland plants and indigenous fish species such as eels and whitebait drains can provide significant habitat. For species such as mudfish drains are one of the few remaining habitats.

4.1 Aquatic life

Whitebait

The fish collectively known as whitebait are actually made up of six species of native fish. Inanga are the most abundant of these species and the most important species in the whitebait catch. They live in slow moving channels in low altitude, low gradient waterways, with most fish found at altitudes of less than 20m and less than 10km from the coast. Preferred sites for young and mature Inanga are slow moving (3 to 7 cm/s for feeding) and relatively deep pools (>30 cm); usually with fine bed materials.

Spawning occurs along the banks of gently sloping vegetated waterways and drains in tidal areas, above normal water levels up to the area flooded at extreme tides (spring tides). Inanga eggs develop out of water between spring tide events. For this reason spawning habitats are vulnerable to damage by stock, mechanical clearance of channels, pollution, and a reduction in bank vegetation by spraying or mowing. These areas should be identified and activities within these areas avoided during the main period of spawning (February to mid-April). Permanent fencing of significant spawning areas (native vegetation and long grass at the freshwater-saltwater transition at spring tide levels) is recommended and in most cases required by the Waikato Regional Plan.

Excessive aquatic weeds are also a problem for Inanga as they live near the edges of weed beds and require clear patches of water for feeding. Mechanical clearing or spraying in late autumn or winter after Inanga adults have moved back to the estuaries to spawn is preferable.

Trout

Trout spawning occurs in riffles in cool water streams. When Trout Juveniles hatch (alevins) they stay in the gravel for a few weeks. Trout that have absorbed their yolk sacs then emerge from the gravel to disperse and feed. The first year of life is usually spent near where they hatched. As the fish get older they utilise a variety of stream habitats including undercut banks, in stream debris, rocks, deep pools and turbulent water at the surface.

Most of the spawning occurs in May and June, with alevins emerging from gravel riffles in September – October. When undertaking drain maintenance works upstream of a trout spawning stream, care should be taken to avoid undertaking work in the period from May to October. Damage to spawning beds can be avoided by preventing deposition of fine sediment over spawning areas. Trout are visual feeders and sensitive to reduced water clarity.

Eels

Short-finned eels are common in waterways and drains throughout the Waikato Region and fill an important role in the food chain as the only significant large predator.

While they appear to be common throughout New Zealand, eels are actually becoming smaller and less common. The main reasons for this are loss of habitat due to barriers such as dams and culverts, and modification and drainage of wetlands. Eels are particularly vulnerable because they are so long lived (eels can live for more than 60 years and have been recorded at over 100 years of age) and only breed once.

Eels can tolerate a wide range of environmental conditions but best management drainage practices reduce impacts on their habitat and help ensure their long term survival.

Mudfish

There is one species of mudfish within the Waikato region, the Black Mudfish. This species is cigar-shaped and can grow up to 160mm long. Mudfish are nocturnal creatures that generally occupy wet habitats that dry out over summer months. When

the waterways in which they live dry up the Mudfish burrow into the soil and aestivate, breathing air, until the first flood of autumn refills the waterway and washes them from their refuge. The reclusive nature of Mudfish can make them difficult to find and as a result their existence is not widely known to the public (Ling, 2001).

Photo 1 Black Mudfish

The loss and drainage of wetland habitat for agriculture has confined mudfish to a few remaining wetlands, swamps and drains and placed their survival under serious threat. However, in some locations within the Waikato Region where wetlands have been drained for pasture there are still quite significant populations of mudfish. Mudfish seem to be surviving well in some farm drains so long as they are left relatively undisturbed. They need the food and shelter provided by emergent vegetation growing in an along drain banks. The biggest threat to these populations is the damage caused by drain cleaning. Drain cleaning degrades the Mudfish habitat and eventually leads to their elimination (Ling, 2001).

Invertebrates

Invertebrates are a significant element of New Zealand's biodiversity and provide food for native fish, trout and some birds. Even very small wet areas such as seeps and ephemeral channels can support diverse invertebrate fauna. Insects such as Caddisflies, Mayflies and Stoneflies are commonly found in cool waterways often in close proximity forests with high water quality. Closer to the sea, crustaceans such as shrimps and crabs are more common. In developed lowland areas quite often the only aquatic habitat left has been drained. In these drains Damselflies, beetles, snails and fly larvae are common.

In soft-bottomed lowland streams invertebrates usually live on stable substrates such as macrophytes and submerged wood. Like other aquatic organisms land drainage activities such as chemical spraying and mechanical works will have a negative effect on their habitat if best management practices are not adhered to.

While some riparian aquatic vegetation is beneficial, waterways and drains closed with aquatic vegetation do not provide good habitat for a wide range of invertebrate species which prefer a more diverse range of environments.

4.2 Effects on water quality

Land drainage activities can have significant adverse effects on water quality if best management practices are not followed.

4.2.1 Unstable banks/sediment

Disturbance of the bed and banks of water courses by machinery and stock can cause excess sediment to enter the water. Suspended sediment not only makes the water murky but it can directly affect fish populations by clogging their gills and reducing visibility. Suspended sediment also reduces light penetration inhibiting periphyton and aquatic plant productivity. The invertebrates that feed on periphyton and aquatic plants and the fish that feed on invertebrates will eventually be affected. Settled sediment can also smother important habitat such as submerged wood and rocks.

To avoid, remedy and mitigate the effects of suspended sediment see section 5.1.1 on dealing with sediment.

4.2.2 Dissolved oxygen

Dissolved Oxygen is the oxygen which is carried by the water in our rivers, lakes, wetland and drains and it is essential for the survival of aquatic communities. High weed numbers growing within the water can cause wide fluctuations in Dissolved Oxygen because plants produce oxygen during the day and use it up at night. Activities such as weed spraying in drains can cause extended reductions in dissolved oxygen as the dead plant material breaks down and decays drawing more oxygen out of the water. The removal of shade vegetation from drain banks and the consequent increase in water temperatures also results in lower dissolved oxygen levels as warm water naturally holds less dissolved oxygen.

Rules 3.5.10.1 and 3.5.10.2 in the Proposed Waikato Regional Plan require that any discharge from a waterway in a drainage and flood control scheme does not cause dissolved oxygen in the receiving water to fall below 80% of saturation concentration. If the concentration of dissolved oxygen in the receiving water body is below 80 percent, the discharge shall not lower it further. All discharges of pumped drainage water which are not part of a council drainage or flood control scheme require resource consent under rule 3.5.10.3 in the Proposed Waikato Regional Plan.

To avoid, remedy and mitigate the negative effects associated with dead and decaying plant material only the bed of the drain should be sprayed so that the vegetation on the bank remains. Also consider spraying a short section of waterway at a time and spraying so that it does not coincide with Inanga spawning (Feb – April) or mudfish spawning and hatching (April-Oct) and so that spray drift does not affect marginal vegetation. Another option is to spray weeds more often or when they are small so that the amount of dead vegetation that decays in the waterway is reduced. See section 5.1.2 for more guidelines on dealing with weeds.

4.2.3 Nutrient levels and biological contaminants

Apart from sediment, nitrogen, phosphorus and faecal matter (containing bacteria and viruses) are the main contaminants entering waterways from agricultural pasture land. This usually occurs via overland water run-off, seepage into groundwater or direct deposition into the waterways.

Faecal matter in particular can contain disease pathogens which can affect the health of stock and humans that come in contact with it. Excess nutrients can also lead to the growth of toxic algal blooms and increased growth of aquatic plant and weeds in open drains/waterways.

Nutrient and biological contaminants in drains can be reduced by undertaking better land management practices outlined in section 5.1.1.1, 5.1.1.2, 5.1.1.3, 5.1.1.4 and include such measures as erosion control, installing filterstrips, maintaining wetlands and boggy areas, and excluding stock from drains/waterways by fencing.

4.2.4 Water temperature

Removing vegetation from the banks of drains reduces the amount of shading and results in an increase in maximum water temperature. Water temperature has a direct impact on many aquatic species as many fish and invertebrate species do not like the high temperatures that can occur in un-shaded waterways. By minimising the need for disturbing drains and riparian vegetation by following best management practices the negative impacts on water temperature can be minimised.

4.3 Native plant biodiversity

Many species of New Zealand native plants are commonly found growing along the banks of drains and waterways. Activities associated with land drainage such as mechanical cleaning and spraying often result in the destruction of these native plants, thus decreasing the region's biodiversity.

New Zealand native plants are used to define our national identity (for example the silver fern), they provide aesthetic value, often add to recreational and real estate values and add to the clean green image New Zealand portrays to the world to sell tourism and products. Native plants provide a valuable role in the ecosystem by providing habitat for birds and insects, aiding in control of erosion and uptake carbon dioxide and agricultural nutrients. In addition to this many of New Zealand's native species are valued by tangata whenua for their medicinal, food and weaving values.

While it may not always be desirable for management reasons to have a drain margins enclosed by native vegetation there are many benefits to having some native vegetation. This may be in the form of cluster planting or intermittent spaced shrubs along the bank. See appendix 2 for guidelines on planting drains.

5 Existing drainage

5.1 Minimising the need for drain cleaning

The main reasons for cleaning drains are to remove sediment and/or weed growth which is impeding drainage. Drain cleaning can be expensive as it usually involves the use of a digger or similar machinery. Unless the sources of sediment and nutrient (which accelerates weed growth) are controlled, frequent removal, rather than occasional removal, may be required. Prevention is always better than cure so the best strategy is to manage drains to reduce the need for maintenance thereby keeping costs down.

5.1.1 Dealing with sediment

Effective sediment and erosion control will reduce costs by reducing the need or frequency of cleaning drains and waterways.

As well as benefits to land productivity from controlling erosion controlling excessive sediment results in down stream environmental benefits. These include improved water quality, improved fish habitat and spawning site quality and increased biodiversity (where other factors are not limiting). Nutrients which cause weed growth are commonly bound to sediment particles so controlling sediment may also reduce growth of unwanted weeds.

Sedimentation in drains can be reduced by better Land Management Practices such as controlling erosion and managing riparian areas so that livestock are unable to access drains. A filter strip of vegetation can reduce the amount of nutrient and sediment entering the drain and in some situations it may be appropriate to consider installing a sediment trap. The following four sections list the best management practices that may be applicable for reducing sediment input into drains.

Erosion control

- Manage stock (type, number and timing of grazing in relation to ground conditions) to reduce soil pugging and surface runoff of soil (and associated contaminants).
- Bridge stock crossings
- Grow crops in strips across the general slope of the land (along the contour not up and down the slope) to reduce water erosion.
- Plant vegetation, such as trees, shrubs, vines, grasses, or legumes, in critically eroding areas such as gullies and along banks (does not include woodlot planting).
- When cropping and re-grassing use non tillage methods. This is especially important on peat soils where cultivation will cause accelerated peat shrinkage.

- When cropping paddocks leave at least a two metre buffer between the waterway and the cropped area. Cropping any closer to a Council drain or waterway will require resource consent (Rule 5.1.4.12). Photo 2 illustrates cropping which has been undertaken too close to the drain.

Photo 2 Example of cropping which has been undertaken too close to the drain

- Divert stormwater runoff from tracks and races into a paddock rather than directly into a drain.
- Repair erosion of drains using appropriate methods (contact your regional council for information on erosion control methods).
- Where drain bank erosion is severe rock rip rap and sometimes bank planting is required. If planting is to take place careful thought is needed to determine the appropriate planting regime and plant species for the site. See appendix 2 for guidance with regard to planting along drains.

Filterstrips

A filter strip is a strip of herbaceous vegetation along a drain margin that acts to retain sediments (and contaminants) on the land before they get into the drainage network. Effectiveness of filterstrips depends on the volume of sediment, topography, vegetative cover and the width of the filter strip. Filterstrips will not be as effective if the flow becomes concentrated and channelled. Subsurface drains such as novaflow and tile drains take nutrients straight to the waterway, thereby by-passing any filterstrip.

Experimental studies found that the first 5 metres of a grass filter strip were critical for sediment removal. The larger easily removable particles were captured within the first few metres of the filter strip. However, small size particles which generally stayed in suspension were difficult to remove and the only mechanism that helped in removal of these particles was infiltration. It was concluded that sediment removal efficiency did not increase much beyond 10m filter strip widths (Gharabaghi et al, 2002 in Parkyn, 2004).

A grass filter strip was found to trap 91% of incoming sediment particles in the first 0.6 metres with much of the larger sediment particles removed in 5 metres of grass buffer. Finer particles may require a larger buffer strip of 10 metres (Neibling & Alberts, 1979 in Parkyn, 2004). Other studies found that grass filterstrips of 10-13 metres were capable of reducing suspended sediment by over 80% (Smith, 1989 in Parkyn, 2004).

Create filter strips by fencing alongside the waterway to exclude stock. A minimum width of 3 m is recommended (5 m for highly erodable soils), with the width increasing based on the amount of soil erosion, land slope and other factors.

If a drain on flat land is being fenced and access is needed for maintenance purposes it may be more practical to construct the fence as close as 0.5 metre on one side of the drain (see section 5.1.1.4 for more information).

- Filter strips can be left as long rank grass or can be planted with other desirable vegetation. Grasses however are best for trapping sediment. Wet areas should be included within the fenced area (perhaps temporarily) to prevent pugging and help with soluble nutrient uptake. Also make the strip wider at low points in the ground where runoff collects. Photos 3 and 4 illustrate a drain before and after filter strip development. If drain shading is also desired but it can't be achieved by grasses along then a wider margin could be fenced to allow for shrub planting as well as a narrow filterstrip.

Photo 3 A drain prior to fencing

Photo 4 A modified watercourse/drain following fencing

- Adequate soil drainage must be maintained. Exclude livestock and vehicle traffic from the filter strips as they rely on infiltration for reducing fine sediment and contaminants.
- During the spring and summer months, in areas that are not used for whitebait spawning it is an option to lightly graze (with sheep or calves for half a day), mow or harvest filter strip grasses to maintain moderate vegetation height (~10 to 20 cm) and encourage dense vegetative growth. No soil should be visible between the grass stems - runoff can bypass patches. Do not graze if other trees have been planted on the filter strip.
- In areas where whitebait spawn light grazing is acceptable during dry periods but avoid grazing during January, February, March, April and May as this time is critical for whitebait spawning.
- If the grass is buried or eroded frequently, increase the width of the strip; prevent concentrated flow in the filter strip; and look at ways to reduce erosion and runoff from the contributing area.

Livestock

Bank erosion and drain habitat degradation can be reduced by excluding stock from the banks of drains. Photo 5 shows drain bank erosion caused by stock damage and photo 6 shows the same drain following fencing. Stock watering facilities should be located in the paddock (e.g. nose pumps or reticulated water troughs) and if feasible shade should be provided away from the waterway.

Photo 5 Drain bank erosion caused by stock

Photo 6 The same drain as in photo 5 following fencing to exclude stock

The type of fencing required will depend in particular on the type of stock managed and the potential threat from erosion and flooding while keeping in mind that the cost of erection/repair/maintenance of conventional post and batten fences can be up to 6 times that of electric fences. Table 1 below explains the advantages and disadvantages of conventional fencing versus electric fencing.

Table 1 Advantages and disadvantages of conventional fencing vs. electric fencing (Hudson, H.R.; editor. 2005)

	Conventional	Electric
Advantages	Relatively little day to day maintenance. Not reliant on external power source. Functions when overgrown. Long life (unless washed out).	Inexpensive and quick to construct and repair. Particularly useful for flood gates. Curves do not need corner assemblies. Options for permanent and 'wash away' flood gates. Animals can escape from floods. Gates can be inexpensive and simple.
Disadvantages	Can be costly. Labour intensive to install. Time consuming to repair.	Requires regular checking to ensure proper function. Electricity required (mains, battery, solar).

- *If planting shrubs along drain margins plan your larger planting on the northern drain bank to maximise drain shading (reduced weed growth) and minimise pasture shading (increased pasture growth and stock shelter)*
- *Planting options will be limited if drain maintenance is required. See appendix 2 for a decision support guidelines on planting drain banks.*

Any fencing or riparian planting must consider how this may interfere with drain maintenance. Fencing and management options include:

- Having temporary fences to allow access.
- Make permanent fences on one side of the channel close to the top of the bank so that an excavator can reach over the top and clear the channel. Photo 7 illustrates fencing constructed close to the top of the bank to allow for digger access OR, make the fenced area wide enough to allow an excavator to work between the fence and the top of bank. While there is a loss of land, there may be advantages in terms of more practical fence lines, more forage behind the fence, and greater benefits for nutrient and sediment trapping. If a wider area is created it should be located on the uphill side of the drain as this would provide a better filter strip.
- Along drains where there is a wide riparian margin (greater than 5m) and the only vegetation is grass, controlled grazing with light stock may be required to maintain pasture grasses and control weeds. Grazing periods should be limited to minimise animal wastes entering the drain and minimise erosion.
- Paddock grazing should be managed to minimise erosion, and to maintain good soil structure and vegetation cover (>70% density). Avoid mob-stocking or heavy-set stocking during wet soil conditions.
- Repair any flood damage or livestock damage as soon as possible.

Photo 7 Fencing constructed close to the drain to allow space for an excavator to reach over the top and undertake maintenance if required.

Consider installing a sediment trap

Sediment traps are relatively wide, short and deep excavations in the bed of the drain where usually silt, sand or gravel can settle. Sediment traps don't deal efficiently with finer clay particles but they work by reducing water velocity and allowing the larger sediment particles to settle out stopping them from progressing downstream where deposition would reduce channel capacity. The trap itself has to be excavated more frequently when it fills up but this reduces the frequency of cleaning downstream. Sediment traps confine sediment deposition to a small reach of channel and reduce excavation costs. They are best located upstream of reaches where habitat is degraded because of excessive sediment deposition (e.g. sand covering riffles).

The sediment trap is best located in a relatively straight channel reach where the drain gradient flattens, with good access, room to operate an excavator, room to stockpile or dispose of sand and gravel, and suitable ground conditions are required. Diagram 1 below illustrates a typical sediment trap design.

Before installing a sediment trap obtain expert advice on design requirements (e.g. the river engineers at the Regional Council) and discuss resource consent requirements with the Regional Council.

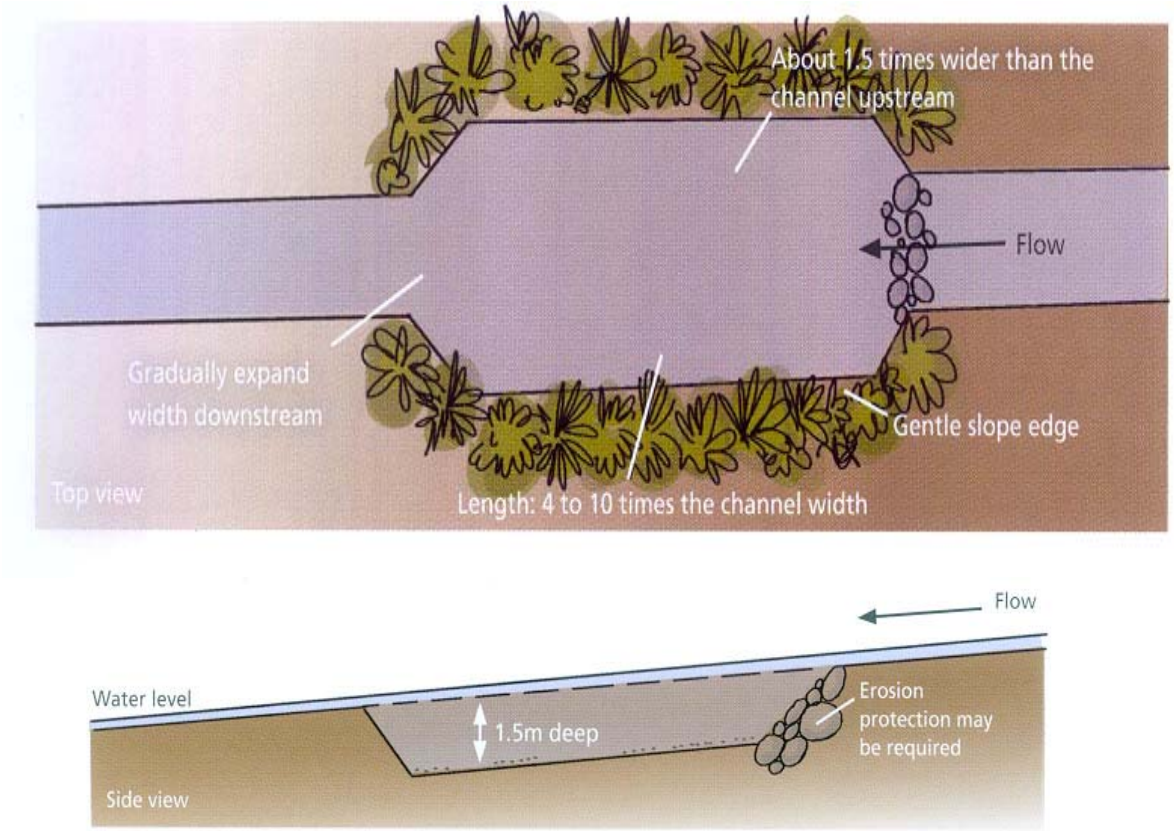


Diagram 1 An example sediment trap design

5.1.2 Dealing with nuisance plants growing in and along drains

Effective vegetation management requires careful planning, preparation, and practices to maximise beneficial vegetation growth (e.g. erosion control and habitat), minimise potential adverse effects (e.g. flow impedance; and excessive growth causing erosion) and at the same time prevent the growth of unwanted vegetation (weeds).

Prevention

Direct treatment of vegetation will remain necessary for many drains but the frequency and intensity of treatment may be significantly reduced if nutrient inputs are reduced and if shading is introduced in an integrated catchment management programme. In certain situations native riparian planting can be established or encouraged to grow along the channel margin and on the banks to provide erosion protection, habitat, visual amenity and to enhance water by reducing light and temperature. Desirable species may provide enough shading to suppress weeds growing in the waterway.

Dense shading should be selectively implemented and is not always desirable along drains. Dense shading may shade out under storey plants and grasses (which buffer the drain bank from erosion) and lead to drain bank erosion. Planting may also interfere with drain maintenance practices. See appendix 2 for a decision support guideline on when it is appropriate to plant along drains.

Different types of shading are required for temperature and periphyton control and depend on the size and location of the channel. Drains located in headwaters are generally narrow and a grass filter strip (native Carex grasses) may provide adequate shading whereas wider channels further down the catchment will require larger growing shrubs to provide any shading. The alignment of the channel is also important, with north bank planting being more effective at shading.

Another way to prevent weed growth is to limit the spread of weeds. One step toward this is to ensure weeds are cleaned from hydraulic excavators, weed cutters and watercraft to prevent transfer between waterways.

Preventing pollutants such as fertilisers and effluent from farms from entering drains will also help to prevent excessive weed growth. This can be achieved through a number of ways including:

- fencing drains to exclude stock
- irrigating dairy effluent to land rather than depositing it directly from effluent ponds into drains.
- applying fertiliser with care, especially near waterways
- minimising runoff from farm tracks and races by providing cut-offs into grassed areas
- retaining wet and swamp areas as nutrient filters.

5.2 Best management practices

Fencing drains to exclude stock and undertaking regular maintenance with spray can significantly reduce the need for mechanical cleaning. This approach will mean that drains (excluding peat) only need to be cleaned every five to ten years instead of every year or two. In deep, slow-flowing drains such as peat drains, weeds can build up more. By fencing and spraying emergent weeds, these drains should only need to be cleaned every two to five years instead of every year.

At Environment Waikato the cost for mechanical cleaning of drains is between 0.50c and $1 per metre. This is compared to between 0.08c and 0.12c per metre for spraying using glyphosate. Undertaking a twice yearly spray program has more than halved the need for mechanical clearance and reduced costs considerably.

5.2.1 Salt water flushing

For drains located in the area of salt water intrusion, weed management by salt water flushing may be an option. This involves the flushing of salt water into drains and canals, by allowing the incoming tide to discharge back into the drains, by securing the floodgates open or by installing a tide regulated flood gate which remains open until a certain tide level causes it to shut. The purpose of this type operation is to encourage salt water into the drainage system where it will kill excessive freshwater weed growth and flush oxygen depleted water and sediment out of the drainage system on the outgoing tide. This management can very effectively reduce drain blockages in these lower reaches

A significant additional benefit of this type of drain management is that by allowing tidal waters to enter the lower reaches of drains in a controlled manner, and with appropriate fencing or managed grazing, these areas become available for whitebait spawning during the autumn months (March – May).

5.2.2 Drain cleaning

Definition & purpose
Channel excavation to restore the hydraulic depth and capacity of drains which are severely obstructed by sediment deposition and aquatic plants

Objectives

a) Re-establish the drainage depth required for the drain and its feeder drains (e.g. side drains and field tiles) by removing only the bed obstructions. The channel should not be enlarged or deepened below its original depth.
b) Provide the required outfall and water-table levels for agricultural productivity and access.
c) Minimise disturbance, avoid sensitive areas (e.g. patches of native vegetation), and rehabilitate disturbed land (e.g. smooth spoil heaps; reseed exposed soil) particularly if erosion is likely to occur.
d) Maintain existing bends in the channel

Before you start

a) Obtain necessary approvals from the local authority.
b) Check if there is an outfall problem, or just the perception there is a problem.
c) Assess if excavation is the most effective means of obtaining outfall (e.g. would hand removal of small blockages achieve outfall; would spraying be more effective?).
d) Assess whether it is necessary to clean the entire drain or just cleaning sections where there are blockages.
e) Consult with District/Regional Council staff and landowners about habitat value, and the requirements for avoiding sensitive times and places.

Timing

If there is significant habitat value schedule work to avoid adverse effects (e.g. fish migration, spawning, nesting). Mechanical clearing of drains in late autumn, winter or early spring is preferable in coastal areas to avoid whitebait spawning. Channel disturbance that may affect downstream trout spawning reaches should be avoided in the period from May to October.

Don't clean all of your drains in any one year. Instead, if your drains need cleaning every five years, do one fifth every year.

Procedures

- Inspect the drain with the digger driver beforehand and identify any riffles, pools or areas that shouldn't be disturbed and mark these with aerosol paint or pegs.
- Only excavate material from the bed, avoid disturbing the banks.
- Work from one bank if possible to minimise land disturbance. If there is a choice of banks, use the side that will have the least disturbance and maximise preservation of drain bank vegetation. Try and retain vegetation for erosion protection and preserve native vegetation.
- Do not over-dig the bed of the drain.
- Drains do not have to be perfectly flat bottomed and even edged. Small imperfections will have little effect on hydraulic efficiency and will provide some habitat diversity. Create 'V' shaped drains with a gradual slope rather than wide, flat bottomed ones with steep sides as they will erode less and require less long term maintenance.
- In some highly sensitive situations it may be necessary to control the flow of dirty water downstream. Filter fabrics or straw bales could be used. A good idea is to leave a buffer of weed at the lower end of the drain to trap silt and clean this area last.
- To minimise soil compaction the use of wide tracked equipment is preferred over the use of rubber tired vehicles.
- Materials excavated from the drain should not be placed in wetlands or boggy areas.
- Clean spoil can be used to build a working platform along the drain, but this should not stop drainage or cause ponding of water. Excess spoil should be incorporated into fields or taken from the site.
- Exposed soils that are prone to surface wash erosion and channel erosion should be seeded or planted.
- Use a digger with a weed-rake or a stream-cleaning bucket because this allows water and some stream life to escape back into the drain

5.2.3 Drain spraying

Definition & purpose

Application of chemical to kill unwanted vegetation growing in a drain.

Objectives

a) Re-establish the drainage outfall required for drains and their tributaries (including side drains and field tiles) by spraying unwanted vegetation growing in the channel
b) Minimise disturbance and avoid sensitive areas (e.g. patches of native vegetation and whitebait spawning sites).

Before you start

a) Check if there is an outfall problem, or just the perception there is a problem. Some plants may provide many benefits such as helping stabilise banks and bed sediments and helping to reduce erosion. Some weeds may also provide habitat for fish and eels.
b) Identify the problem plant species and determine the risk of not intervening.
c) Assess if spraying is the most effective means of obtaining outfall (e.g. would hand removal of small blockages achieve outfall)
d) Consult with District/Regional Council staff and landowners about habitat value, and the requirements for avoiding sensitive times and places.
e) Obtain necessary approvals from the local authority.

Always avoid spraying native vegetation growing on the banks of drains. This can include vegetation such as grassy sedges, rushes, ferns, toetoe, cabbage trees and flax).

Timing

If there is significant habitat value, schedule work to avoid adverse effects (e.g. fish migration, spawning, nesting). Spraying of drains in late autumn, winter or early spring is preferable to avoid whitebait spawning. Spraying in close proximity to trout spawning waterways should be avoided in the period from May to October as trout need high levels of dissolved oxygen to survive.

If ephemeral waterways (seasonally wet) require spraying this should be undertaken in the summer when they are dry. Spraying should **not** be undertaken on a windless day as spray will linger in the air and may drift away from the site. A slight breeze is preferable.

Procedures for spraying emergent aquatic weeds:

Treatment of emergent aquatic weeds varies with the species and the time of year. Successful vegetation management must be based on the correct species identification and knowledge of the species; otherwise treatments can be ineffective or even counterproductive. For example:

Glyceria maxima (reed sweet grass) quickly become a large and vigorous plant that can block drains. New infestations should be treated as early as possible. Destroying the young plants at an early growth stage, before they have become established or produce seed, is the most economical and effective method of treatment. If treatment is delayed until the infestation is established, eradication in one season is improbable. Follow-up work over at least two or three seasons will be required. In some cases a broader view of the problem may be required. Local treatment may be ineffective if re-invasion occurs from upstream or from the import of material on equipment or in soil.

Common vegetation treatments used in New Zealand are:

- Planting shade trees to shade the water and prevent emergent macrophytes from growing
- Chemicals
- Mechanical (e.g. hand pulling and cutting, flair harvesters, weed baskets, and hydraulic excavators)
- More experimental approaches include:
- Biological (e.g. grass carp)

- Hydrological (e.g. flushing flows; drawdown to expose aquatic plants; enhancing channels to indirectly control weeds by changing water depth and velocity).

Timing, frequency and duration of treatment are often critical as a better kill can be achieved if plants are sprayed during the time when they are most actively growing, for example spring for convolvulus. Care should be taken to only spray the centre of the drain where faster flows occur, as shown in photo 8. This is so that the edges of the drain remain undisturbed to provide cover for erosion control, wildlife food and habitat. Photo 9 illustrates a drain that has been sprayed too close to the edge.

Photo 8 The correct procedure – spraying only the centre of the drain

Photo 9 Bank erosion resulting from spraying the drain edge. The proximity of the waterway to the road will result in storm water runoff and pollutants directly entering the waterway

- Spray weeds when they're smaller to reduce the amount of dead vegetation that stays in the drain and reduce the risk of blockages.
- Contamination of water is most likely to occur as a result of careless or excessive application of chemicals; that sensible and effective application will not only benefit the environment but reduce management costs. Suggested management precautions for on-farm applications include:
  - only use Glyphosate as it is the only chemical registered for use over water. Spray only at rates recommended. Glyphosate is a broad spectrum herbicide used to control floating leaf plants (e.g. water lilies) and shoreline plants (e.g. purple loosestrife). It is a systemic herbicide that enters the plant through active green plant tissue and is translocated throughout the plant often killing the entire plant. It is non-selective; all treated plants die. It is generally applied as a liquid to leaves. Glyphosate is readily adsorbed by soil. Environment Waikato use Glyphosate 360 with the addition of an organosilicone penetrating agent because of the silt on the vegetation.
  - avoid spraying when rain is likely
  - take all necessary precautions to minimise spray drift
  - do not mix, fill or empty spray containers in stream beds, nor use contaminated containers to source water from the drain.
  - where practical, targeted or spot application of a chemical is preferable to broadcast application

Only spray down the centre of the drain, not along the banks.

Submerged & floating weeds

Submerged weeds are perhaps the hardest aquatic weeds to kill because chemicals used need to be maintained at a sufficiently high concentration in the water for enough time to kill the weeds. Water volumes need to be determined reasonably accurately and the chemicals must be applied uniformly to achieve the desired results.

Glyphosate is not effective on submerged plants as at least 75% of the plant must be above water level or efficiency may be reduced. Submergence will wash off the herbicide and rainfall within 2 hours of application will reduce effectiveness. The rain free period may be reduced to 30 minutes if a wetting agent (e.g. Pulse®) is added.

Diquat dibromide is the only registered chemical for aquatic application in New Zealand. Diquat dibromide is reportedly non-selective, and will affect non-target plants; with varying susceptibility. Diquat (Reglone®) was found to be effective on target weed species (e.g. Elodea, Lagarosiphon and hornwort) while not affecting most of the desirable native New Zealand species (eg Chara and Nitella species). Diquat was only partially successful in the control of aquatic weeds, particularly those that re-grow from stems or shoots buried in bottom sediments (Hudson, H.R.; editor. 2005).

6 Peat drainage

The Waikato Region is home to half of New Zealand's peat country, covering an area of 94,000 hectares. About 80% of these peat soils have been developed mainly for farming. For farming to be economical on peat land, effective land drainage is essential and farming peat land adjacent to wetland areas requires very careful management to avoid damaging them (Environment Waikato, 1997).

While drainage and cultivation of peat is essential to establish productive pasture, it lowers the water table and slowly damages the peat resource by causing the organic matter it is made from to dry out and shrink. As the peat dries and shrinks it cracks, making soils difficult to re-wet. Rainwater flows down into the subsoil through cracks in the peat. When peat dries it becomes waxy and doesn't reabsorb water easily (Environment Waikato, 1997).

The rate of peat shrinkage depends on a number of things. The factor which people have the most control over is the management of peat drainage. Peat shrinkage is estimated to be on average 20cm/year after the initial cultivation, reducing to around two cm/year as the peat become consolidated. Shrinkage will continue until eventually there is no peat left and in many areas the underlying soils that will remain have poor fertility and require high inputs to maintain productivity. Peat subsidence also increases the risk of flooding and pumping costs in low lying areas may have the potential to render farms in such areas uneconomic (Environment Waikato, 1997).

Development and drainage of peat also damages nearby wetlands and peat lakes, which are rare and at-risk ecosystems. The Waikato peat lakes for example are the largest remaining collection of such unique habitats in New Zealand and their ecosystems are highly dependent on the careful balancing of water levels. Wetlands and peat lakes are important storage areas for floodwaters, nutrient recycling as well as valuable habitats for rare and threatened species such as the native Black Mudfish and the Australasian Bittern (Environment Waikato, 1997). For information on creating new peat drainage and drainage near wetlands refer to section 7 as there are rules in the Waikato Regional Plan restricting the creation of new drainage and drainage within 200m of a wetland.

To minimise the shrinkage of peat, damage to neighbouring wetlands, damage to peat lakes and farm the land profitably in the long term it is important to follow best management practices.

6.1 Best management practices

There are two main methods of peat drainage with paddocks
- conventional open ditch drains
- hump and hollow formations

Conventional open ditch drains as shown in photo 10 often form the boundaries between paddocks and feed into secondary drains. By drawing water from the water table they act to maintain it below the pasture root zone. Hump and hollow contouring of paddocks as shown in photo 11 encourages surface water and groundwater to move to the hollowed portions of the paddocks from where the shallow ‘spinner’ drains direct the water to the larger conventional drains and the main drainage system. The hollows do not need to be fenced to exclude stock but it is important that they are well maintained to prevent pugging. Stock management is also important in particularly in the wet season

Photo 10 Conventional open ditch peat drain

Photo 11 Hump and hollow peat drainage

Definition & purpose

Channel maintenance to restore the hydraulic capacity of drains which are obstructed by sediment deposits, aquatic plants and peat movement

Objectives

a) Re-establish the drainage outfall required for the drain and its feeder drains (e.g. side drains and field tiles) by removing only the obstructions. The channel should not be enlarged.

b) Provide the required outfall and water-table levels for agricultural productivity and access.

c) Minimise disturbance, avoid sensitive areas (e.g. patches of native vegetation and wetlands), and rehabilitate disturbed land (e.g. smooth spoil heaps; reseed exposed soil) particularly if erosion is likely to occur.

Before you start

a) Check if there is an outfall problem, or just the perception there is a problem.
b) Assess if spraying is the most effective means of obtaining outfall (e.g. would hand removal of small blockages achieve outfall)
c) Consult with District/Regional Council staff and landowners about habitat value, and the requirements for avoiding sensitive times and places.
d) Obtain necessary approvals from the local authority.

Timing

If there is significant habitat value, schedule work to avoid adverse effects (e.g. fish migration, spawning, nesting).

Procedures

Avoid deep drainage as shown in photo 12. Drainage systems should be designed so they don't just remove excess water during the winter but maintain the water table during summer to prevent over-drainage.

Photo 12 Excessively dug drain

- In most cases drainage can be optimised by maintaining water levels at round 0.5 metres below the surface. If extra capacity is needed drains should be widened instead of deepened. Main artery drains may need to be deeper but are usually not deeper than 1.5 – 1.8 metres. Continual deepening will lead to over-drainage causing the peat to dry out and subside, thus affecting pasture production.

- Block secondary drains off in late spring before they run dry. This can be done by installing a structure similar to a weir and will prevent the water table dropping too much in summer and help to reduce peat shrinkage.

- Fence drains to exclude stock and control weeds with spray to reduce maintenance costs (refer to section 5 for more information).

7 New drainage

Agricultural development has resulted in the drainage of extensive areas of the Waikato Region and caused significant loss and degradation of wetlands and streams. Many drains are new streams or remnants of meandering streams and wetlands that existed prior to agricultural development. These ecosystems often contain valuable fish populations and generally sustain diverse animal and plant communities. Before any new land drainage takes place close consideration should be given to the environment and ecosystems that will be destroyed in the process. Before you start consult with Environment Waikato regarding the relevant rules in the regional plan as it is likely you will require resource consent.

7.1 Wetlands – to drain or not to drain?

The term wetland includes permanently or intermittently wet areas, swamps, shallow water, and land water margins that support a natural ecosystem of plants and animals that are adapted to wet conditions. Photos 13, 14 and 15 are examples of wetlands that are commonly found on farms.

Photo 13 Raupo wetland

Photo 14 A wet gully - commonly referred to as a swamp

Photo 15 A wet swampy area fenced and planted with native species

Wetlands are important storage areas for floodwaters as they act like giant sponges. Wetland plants slow the flow of water off the land and in times of flood, water is absorbed into the organic wetland soils. In summer stored water is released slowly to maintain water flows, providing better habitat for stream life.

Wetland plants trap sediment suspended in water, improving water quality. Bacteria living in wetland soils absorb and break down nitrogen from farm run-off and leaching, improving water quality. In the right conditions, bacteria living in damp wetland soils can **convert up to 90 percent** of the nitrogen from farm run off into nitrogen gas, which is then released into the atmosphere. This process is called de-nitrification. By

converting nitrogen from farm runoff into nitrogen gas, wetlands reduce the amount of nitrogen entering waterways and therefore help to prevent algal blooms and nuisance plant growth.

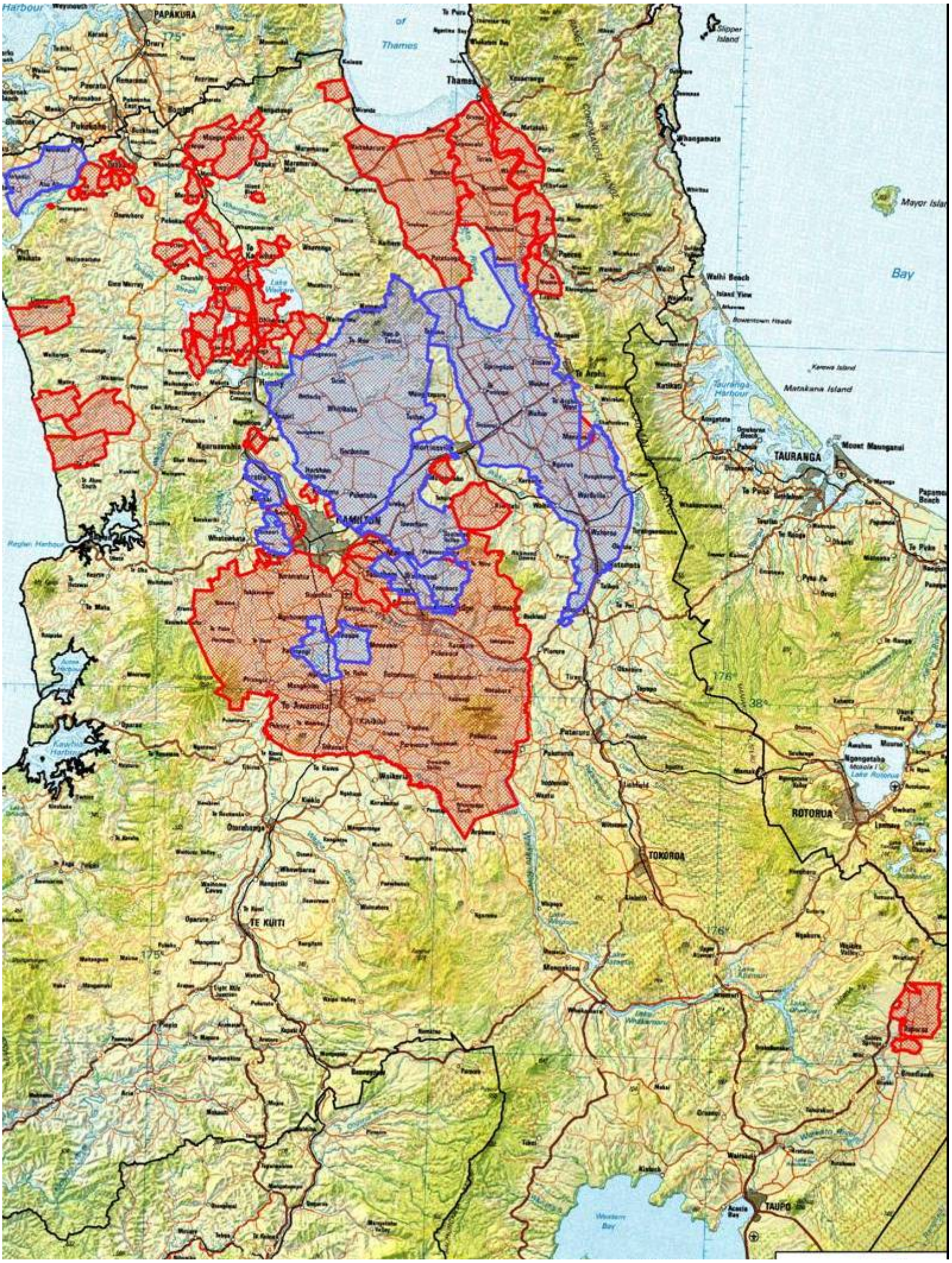
Wetlands once covered large areas of New Zealand. Now they are some of our rarest and most at-risk ecosystems. Intact wetlands often contain a diverse range of plants and animals and are home to many rare and threatened species. Wetlands are also highly valued by tangata whenua and local communities for their recreational, educational, scientific, aesthetic, spiritual and cultural values. The conservation and restoration of wetland habitats can make a real difference for species living in wetlands associated with aquatic environments and also benefit us directly.

Research carried out in the Waikato region at the Whatawhata research station found a headwater wetland removed more than 50% of nitrate and dissolved reactive phosphorus from the inflowing groundwater and runoff.

Although the cost of draining wet areas might be less than buying more land, other factors should be considered. A resource consent may be required and there is usually a risk that the drained area will remain wet and requires significant ongoing costs of drain maintenance. In the long run it may be more economical and certainly better environmental practice to put a fence up instead and leave the wetland intact. In some cases fencing out stock can also save money in animal health and time spent on stock management.

Drain deepening or digging of new drains within 200 metres of a wetland listed as significant in the Waikato Regional Plan requires resource consent from Environment Waikato. Any new drainage in a wetland that provides a habitat for native plant or animal community's will also require resource consent (Proposed Waikato Regional Plan Section 3.7.4.6, 3.7.4.7). You may be required to restore or create another wetland of equal area and quality as part of a consent to drain a wetland, therefore it pays to carefully consider the value of seeking to drain an existing wetland. The Waikato Regional Plan rules can be viewed on Environment Waikato's website www.ew.govt.nz.

Appendix 1 Drainage district areas

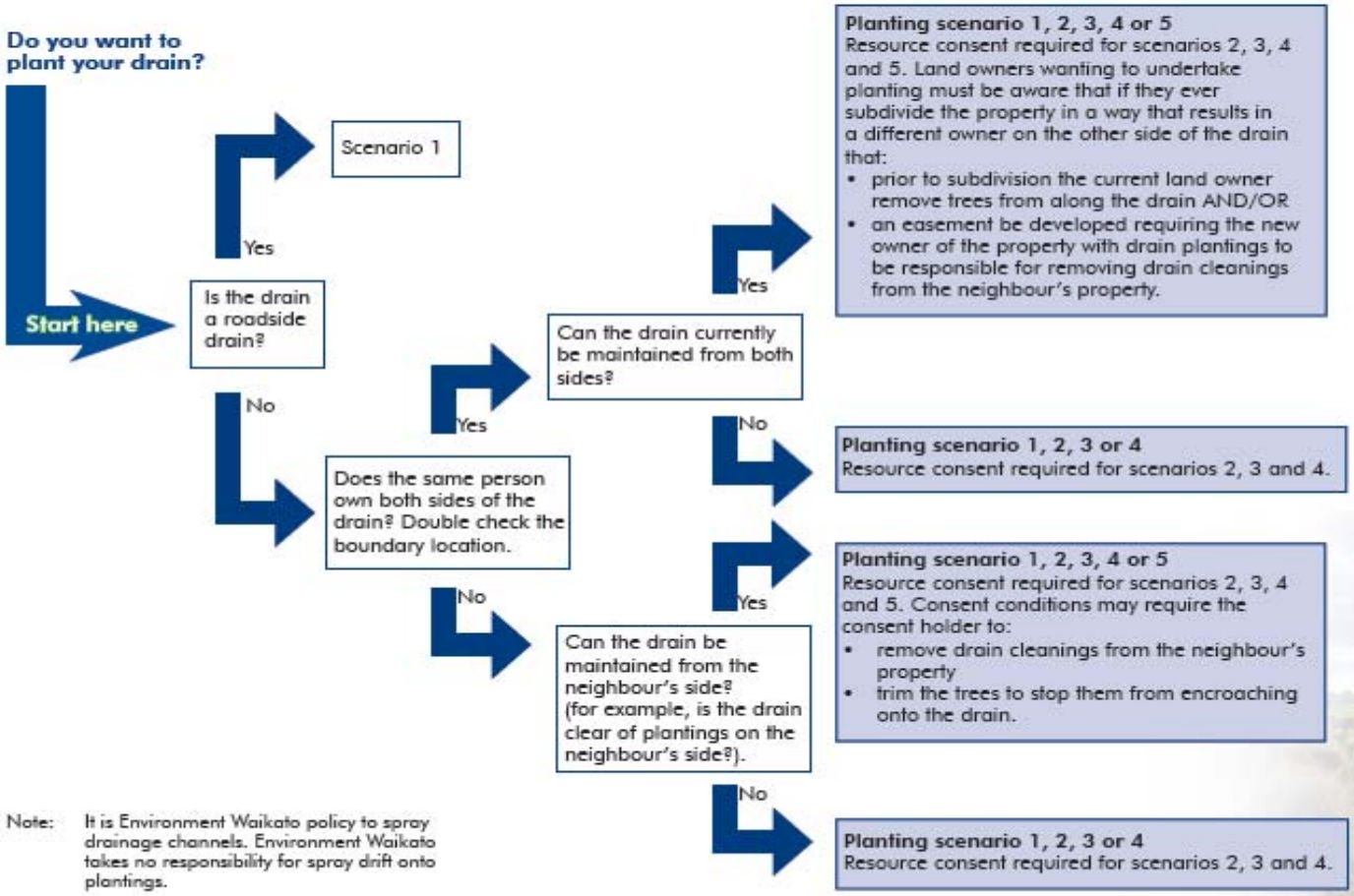


Appendix 2: Decision support guideline – planting along drains

When is it appropriate to plant drain banks?

Guidelines for drains managed by Environment Waikato or a territorial authority.

Follow the arrows to determine the types of planting that is suitable for any chosen drain (excluding peat drains) that are managed by Environment Waikato or a territorial authority. The diagrams of each planting scenario are over the page.



Important notes

In accordance with Rule 4.2.18.1 of the Waikato Regional Plan, resource consent must be obtained before undertaking planting along a drain managed by Environment Waikato or a territorial authority.

For more information contact the River and Catchment Services on 0800 800 401.

Note: It is Environment Waikato policy to spray drainage channels. Environment Waikato takes no responsibility for spray drift onto plantings.

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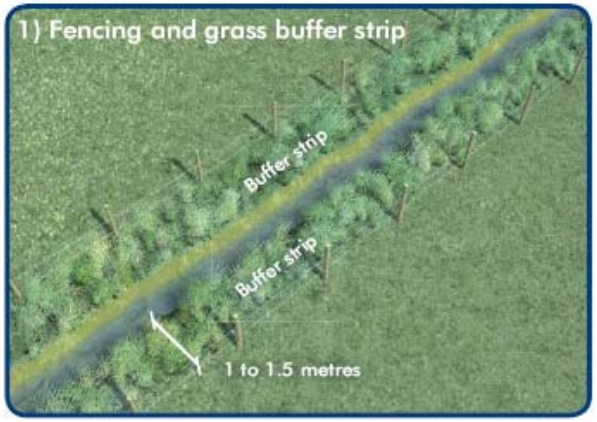
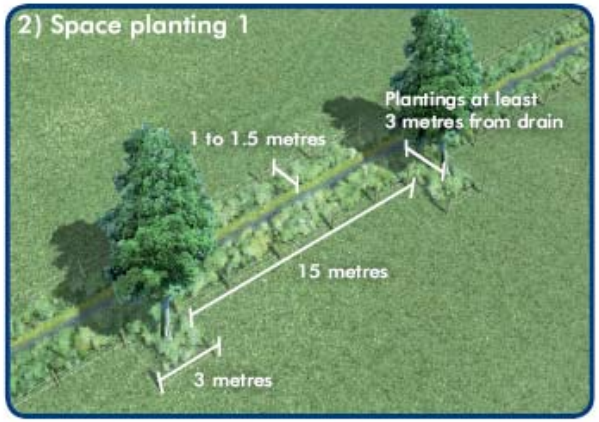
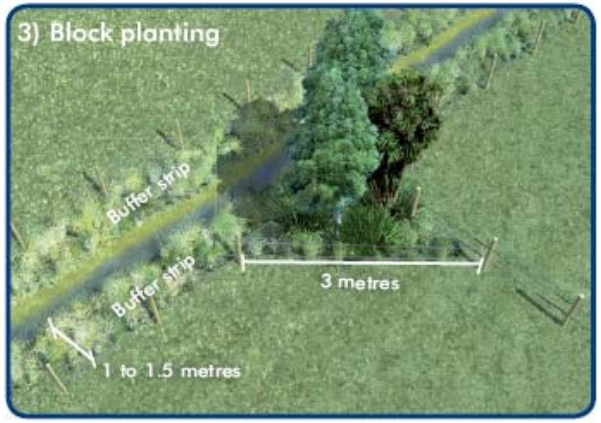


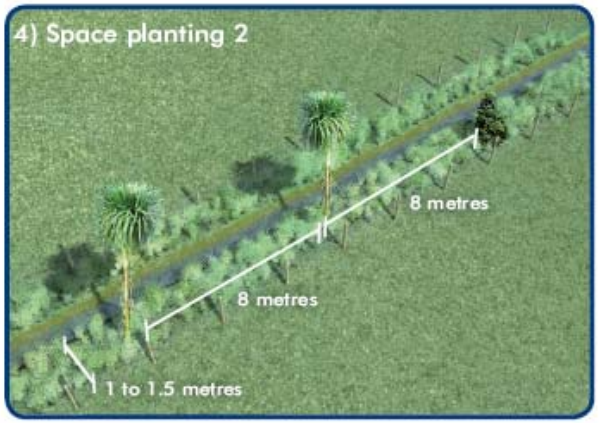
- Fencing should be 1 to 1.5 metres back from the edge of the wdrain.



- Focus the planting on the northern side of drain to maximise shading.
- If the drain is mechanically cleared plants should be planted at least 15 metres apart to allow a digger space to swing and place drain cleanings. Extra digger manouvering may result in increased pasture damage.
- Care will need to be taken when spraying herbicide.



- Focus the planting on the northern side of drain to maximise shading.
- Care will need to be taken when spraying herbicide.



- Focus the planting on the northern side of drain to maximise shading.
- Plant trees that won't grow too big and encroach on the drain – hebe, manuka and coprosma are suitable.
- Avoid large leaved plants such as flax as they may grow large and block the drain.
- In some cases stock may be able to reach over and graze plants – consider installing an electric outrigger on your fence.
- Care will need to be taken when spraying herbicide.

- Boggy riparian areas are best left in ungrazed grass as they are excellent nutrient filters.
- Focus the planting on the northern side of drain to maximise shading.
- Plant shrubs and large trees at least 3 metres back from the drain edge to avoid plants encroaching on the drain, reducing capacity and dropping excess debris.
- Care will need to be taken when spraying herbicide.

Benefits of drain planting

- Shading in the upper reaches may assist to lower water temperature. Lower water temperature may mean there will be less algal blooms and more aquatic life.
- Shading may limit growth of nuisance plants in the drain channel.
- Increased visual amenity.
- Increased native biodiversity.
- Leaf litter and woody debris provide habitat for invertebrates such as damselflies, beetles, snails, midges and larvae.
- Invertebrates are important food for fish such as eels, mudfish and galaxids.

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When is it appropriate to plant drain banks?

Guidelines for drains managed by private land owners (not Environment Waikato or a territorial authority).

If you want to plant a drain managed by Environment Waikato, please contact your local land drainage officer on 0800 800 401. Follow the arrows to determine the types of planting suitable for any chosen drain (excluding peat drains) not managed by Environment Waikato or a territorial authority. The diagrams of each planting scenario are over the page.

Do you want to plant your drain?

Start here

Do you own both sides of the drain?

- Yes → Does the drain ever get sprayed or mechanically cleaned?
  - Yes → **Planting scenario 1, 2, 3, 4 or 5**
    Planting scenarios 2-4 could be undertaken on both sides of the drain if desired.
  - No → Is the drain prone to erosion? For example, banks falling in.
    - Yes → **Planting scenario 1, 2, 3, 4, 5**
      If digger access is not required, fencing and planting could be undertaken further back from the water if desired and scenarios 1-4 could be undertaken on both sides.
    - No → **Planting scenario 1, 2, 3, 4, 5 or 6**
      Planting scenarios 2-4 could be undertaken on both sides of the drain if desired.
- No → Does the drain ever get sprayed or mechanically cleaned?
  - Yes → **Planting scenario 1, 2, 3 or 4**
  - No → **Planting scenario 1, 2, 3, 4 or 5**
    Discuss your plans with your neighbour, as depending on the type of planting any future maintenance may have to be undertaken from the neighbour's side.

Important notes

- If you wish to plant along a roadside drain obtain permission from the agency responsible for drain maintenance (such as district or city council).
- Planting is not recommended along peat drains due to maintenance requirements.
- Boggy riparian areas next to drains are best left in grass as they are excellent nutrient filters.

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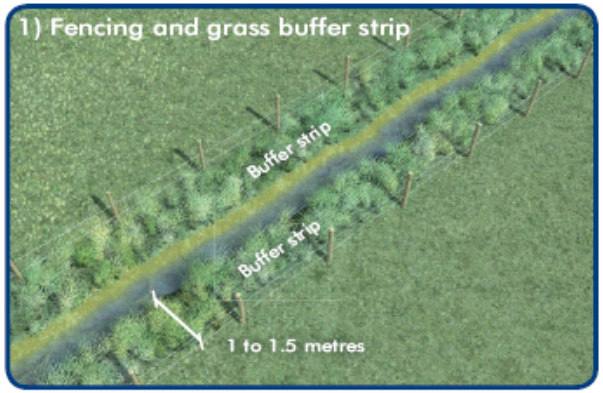
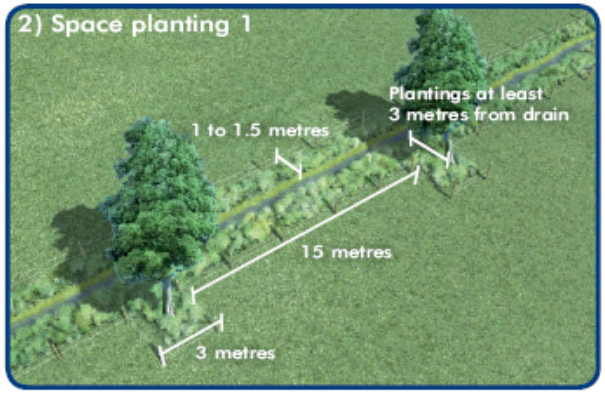
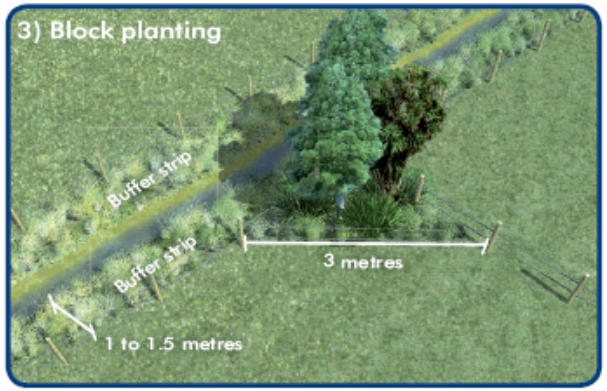


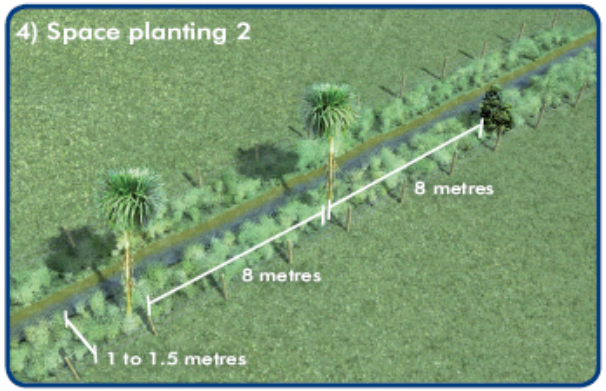
- Fencing should be 1 to 1.5 metres back from the edge of the drain.



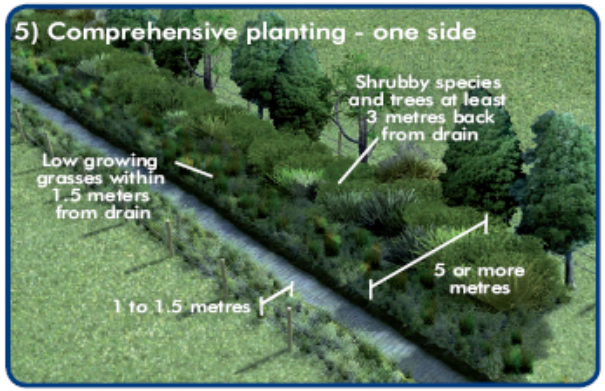
- Focus the planting on the northern side of drain to maximise shading.
- If the drain is mechanically cleared plants should be planted at least 15 metres apart to allow a digger space to swing and place drain cleanings. Extra digger manouvering may result in increased pasture damage.



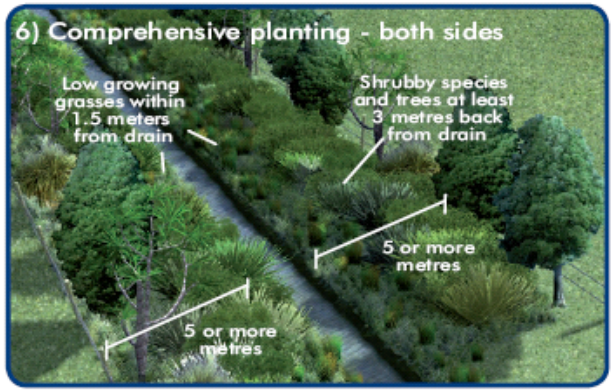
- Focus the planting on the northern side of drain to maximise shading.
- Care will need to be taken if spraying herbicide.



- Focus the planting on the northern side of drain to maximise shading.
- Plant trees that won't grow too big and encroach on the drain – hebe, manuka and coprosma are suitable.
- Avoid large leaved plants such as flax as they may grow large and block the drain.
- In some cases stock may be able to reach over and graze plants – consider installing an electric outrigger on the fence.



- Boggy riparian areas are best left in ungrazed grass as they are excellent nutrient filters.
- Focus the planting on the northern side of the drain to maximise shading.
- Plant shrubs and large trees at least 3 metres back from the drain edge to avoid plants encroaching on the drain. Grasses are acceptable within 3 metres.
- Care will need to be taken when spraying herbicide.



- Boggy riparian areas are best left in ungrazed grass as they are excellent nutrient filters.
- This planting regime will restrict access for maintenance.
- Plant shrubs and large trees at least 3 metres back from the drain edge to avoid plants encroaching on the drain, reducing the capacity and dropping excess debries. Grasses are acceptable within 3 metres.

Benefits of drain planting

- Shading in the upper reaches may assist to lower water temperature. Lower water temperature may mean there will be less algal blooms and more aquatic life.
- Shading may limit growth of nuisance plants in the drain channel.
- Increased visual amenity and native biodiversity.
- Leaf litter and woody debris provide habitat for invertebrates such as damselflies, beetles, snails, midges and larvae.
- Invertebrates are important food for fish such as eels, mudfish and galaxids.

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Definitions

For the purpose of this document the definition of drain includes:

Artificial watercourses

- A watercourse that has **no natural portions** from its confluence with a river or stream to its headwaters. Artificial Watercourses include irrigation canals, water supply races, farm drainage canals and canals for the supply of water for electricity power generation.

Modified watercourses

- An artificial or modified channel that may or may not be on the original watercourse alignment and which has a **natural channel at its headwaters.**