National works in waterways guideline

Best practice guide for civil infrastructure works and maintenance

Ministry for the Environment
Manatū Mō Te Taiao

New Zealand Government

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Introduction

New Zealand's freshwater environments are under immense pressure, with declining water quality and quantity, continuing degradation of habitat conditions, loss of critical habitats for freshwater fauna, barriers to fish passage, and pressures from invasive species.

These pressures are impacting the health of our waterways and the conservation, recreation, cultural and social values they bring. Degraded water quality, quantity and habitat conditions, loss of critical habitats, and barriers to fish passage, present management challenges when balancing the protection of freshwater fauna and their recreational and cultural values with providing for development.

Regional councils manage water quality and quantity, and the effects that works in waterways can have on these, and on habitats and fauna. This is done under the Resource Management Act 1991 (RMA), through national policy statements, national environmental standards and regional plans. Regional councils must give effect to these national directions: defining rules, regulating activities, and telling users of freshwater environments what they can and cannot do. The planning provisions, objectives and rules laid out by councils vary however, and few councils go as far as guiding users on the appropriate controls to use to avoid or minimise adverse effects on water quality, quantity, habitat and fauna when working in waterways (discussed in **Planning provisions across regional and unitary authorities**). While there are some exceptions (eg, when conducting works under a council's comprehensive consent), it is usually the applicant's responsibility to provide a methodology for works in waterways that includes measures to manage potential adverse effects. The lack of consistent direction has sometimes led to poor outcomes.

While some regional councils have guidelines or codes of practice for works in waterways, these also vary in both detail and the weight given to environmental, habitat and faunal management considerations (discussed in **Codes of practice and guidelines**). Inconsistencies across regions and in the measures employed by end users (eg, contractors, private landowners, city and district councils), and the lack of policy at a national level, mean there's no way to ensure best practice for works in waterways (discussed in **Legislative context**).

Aims of the guideline

One of the challenges of working in and around waterways is determining how to avoid or minimise the adverse effects of the activity on the ecology, habitats and freshwater life. While many activities are temporary in nature, the adverse effects generated can continue for extended periods of time, especially if appropriate mitigation or remediation does not occur.

The need for a national works in waterways guideline fits strategically within freshwater priority areas of regional councils' strategies.

This national works in waterways guideline will:

- support decision-makers (eg, consent planners), compliance managers, applicants, contractors and/or persons undertaking work in and adjacent to waterways
- make the consenting process more streamlined, consistent and transparent
- provide a clear and consistent level of practice for councils, government agencies, and companies/persons undertaking the work

- provide clear guidance to Treaty of Waitangi partners and stakeholders on the implementation of the new freshwater policies of the National Policy Statement for Freshwater Management 2020 (NPS-FM 2020) and National Environmental Standards for Freshwater 2020 (NES-F 2020)
- clearly outline what steps need to be followed in undertaking works in waterways
- enable councils and applicants to meet legislative requirements
- result in improved outcomes for biodiversity in our waterways
- ensure that resources are managed in a way that prioritises the health and wellbeing of waterbodies and freshwater ecosystems.

This national works in waterways guideline is intended to be used in place of region- or activity-specific guidelines and codes of practice for civil infrastructure works and maintenance in waterways.

Scope and application of the guideline

The primary focus of this guideline is on civil infrastructure works and maintenance in and adjacent to waterways, including activities such as waterway clearance and maintenance, restoration activities and construction works (eg, culvert and bridge installation and maintenance, dewatering and diversions).

For the purposes of this guideline, a waterway refers to all freshwater environments that have continually or intermittently flowing freshwater or surface water present. Waterways include natural, modified, and human-made or artificial waterways (also referred to as drains).

While this guideline focuses on civil infrastructure works and maintenance, it is also relevant for routine waterway maintenance and management activities undertaken on private land, or by regional councils, territorial authorities and unitary councils – for example, macrophyte (freshwater plants) and drain clearance, waterway maintenance for flood-carrying capacity, culvert installation.

This guideline does not include design elements for permanent structures (eg, culverts, bridges) and should be used in conjunction with other standard design procedures and technical guidance, including (but not limited to) the New Zealand Fish Passage Guidelines.

This guideline forms part of the National Works in Waterways toolbox, and sets out the legislative framework, environmental risks, management objectives and principles, and current best practice. This guideline provides a framework of best practice to support decision-making and management of activities in and adjacent to waterways. To provide for changing and ever-increasing knowledge, and the development of new tools and controls, this guideline does not provide activity-specific information on best practice controls. Protocols, best practice controls, fact sheets and pocket guides are available on the National Works in Waterways Hub,[1] and users should download the guideline from there to ensure they are consulting the most up-to-date version.

This guideline is an interactive document and the reader can quickly find further information in particular topics by selecting the appropriate hyperlinks, shown in **bold**.

[1] https://works-in-waterways-boffa.hub.arcgis.com/

Intended audience

This guideline has been developed to assist a wide audience, including infrastructure owners, designers and managers, contractors, waterway managers and environmental advisors, council planners, scientists and compliance officers, iwi, private landowners and the local community. Anyone who carries out works in or adjacent to waterways may use this guidance.

The guideline sets out best-practice approaches and minimum standards for works in and adjacent to waterways, to ensure that the values associated with waterways and their surrounding environment are protected and enhanced wherever possible.

While the approaches and controls used may vary and are often site-specific, by following the general principles and fundamentals set out in this guideline, the most appropriate solution can be determined for most situations across New Zealand.

More detailed information on specific controls, particularly where the best approach is determined by local geomorphological conditions, is available on the National Works in Waterways Hub.[2]

How this guideline was developed

A comprehensive review of recent national and international research, reports, and regional and local councils' guidelines and codes of practice was carried out in preparing this guideline, to understand current approaches and recommended controls.

We also carried out a desktop review of all regional and unitary authorities' planning provisions, to understand how works in and adjacent to waterways are being managed, and if there is consistency across New Zealand (see **Planning provisions across regional and unitary authorities**).

Technical expertise and operational knowledge and experience were gathered through a series of workshops with the Works in Waterways Advisory Group (WiWAG), and numerous councils provided feedback on the guideline. The WiWAG draws on the technical experience and operational knowledge of a variety of external industry practitioners, consultants and contractors from across New Zealand, as well as iwi representatives, Department of Conservation (DOC) and regional council staff.

The guideline was also peer reviewed at the scoping, draft and final stages. We will continue to develop the guideline, particularly in relation to educational materials and best-practice methodologies that can be found on the National Works in Waterways Hub.[3]

[2] https://works-in-waterways-boffa.hub.arcgis.com/

[3] https://works-in-waterways-boffa.hub.arcgis.com/

Why freshwater matters

Our freshwater ecosystems take many forms, from rivers and lakes to streams and springs; they are the lifeline of Papatūānuku (the Earth Mother) and the land. “Ki uta ki tai, from the lands to the sea” reminds us of the interconnectedness of our freshwater ecosystems as they make their journey across the land, from the mountains to the sea. The intrinsic ecological and cultural values of our freshwaters are encompassed by Te Mana o te Wai, a fundamental concept underpinning the NPS-FM 2020.

Te Mana o te Wai recognises the holistic approach we need to take when caring for and using our precious freshwater resources. It prioritises the need to restore and protect the integrity of water, the intrinsic values and health of freshwater ecosystems, and human health needs over and above enabling our consumption of water. Te Mana o te Wai recognises that protecting the health of freshwater protects the health and wellbeing of the wider environment, protecting the mauri of the wai. We must work together to restore and protect our freshwater ecosystems for generations to come.

Our freshwater habitats are under immense pressure from more than 150 years of land-use change and human activities, and water quality and quantity has deteriorated in some areas. These degraded water quality, quantity and habitat conditions are putting New Zealand’s unique flora (plant) and fauna (animal) communities at risk.

Importance of freshwater habitats

New Zealand freshwater ecosystems are habitats for a wide variety of plants and animals, many of which are found nowhere else in the world.

Water is a taonga (treasure) of the utmost importance to Māori; it provides for and sustains life and is a direct reflection of the health of Papatūānuku. Water is not only a source of food and physical nourishment, but a source of mauri (life force) and spiritual sustenance being intricately linked to, and reflective of, the wellbeing of Māori.

Te Ao Māori

The relationship between mana whenua and our awa (rivers, streams, creeks) is rooted in tribal traditions and a worldview that understands waimāori (freshwater) as a flowing and perpetual cycle between Ranginui (the Sky Father) and Papatūānuku. The health and wellbeing of water sources, in all forms, are inextricably linked to the health of mana whenua; it enables the act of mahinga kai (food gathering) and provides habitats for taonga species.

This relationship between people and water is encapsulated in the concept of mauri; many of New Zealand’s water bodies reflect the tīpuna (ancestors) who first discovered them, or specific events that have influenced the history of an iwi, hapū or whānau Māori. Consistent with this interconnected worldview, mana whenua have the responsibility as kaitiaki (guardians) to ensure the mana and mauri of our awa are maintained for future generations.

The Te Ao Māori worldview emphasises the holistic consideration that the environment is whole and not components or parts. Holistic concepts that emphasise integration, interdependency and

interrelationships are common to indigenous cultures, rather than those that fragment and compartmentalise the environment.

Traditional resource management was founded on a set of cultural values that arose from the Te Ao Māori worldview. These cultural values highlight the holistic relationship between people and the environment, and how sustaining balance between the needs and demands of humans and the health of the natural world is important. The following cultural concepts are significant elements of the Te Ao Māori worldview which, when understood together, approximate the non-Māori concept of 'sustainable management'.

Whakapapa

For Māori, physical and mental wellbeing is directly related to cultural identity and is founded on whakapapa. Whakapapa is embedded in the landscape and is inherent to understanding the relationship between Māori and the natural world; Māori believe that humanity arises from the natural environment and remains linked through genealogical ties.

The depth of knowledge of the environment and its natural resources in the ever-changing landscape of Aotearoa New Zealand was extensive. Knowledge of natural resources came from detailed observation of the environment, and through the handing down of knowledge through generations and whakapapa.

Kaitiakitanga

To ensure the wellbeing of future generations was secure, natural resources had to be protected and managed. This system of management and protection was based on the concept of kaitiakitanga.

Responsibility, reciprocity and respect are inherent in the concept of kaitiakitanga. Māori, like many other indigenous cultures, view the earth's natural resources as a gift necessitating reciprocity; you give in order to receive, every gift requires a return, and you must leave a place in better condition than you found it. To respect the natural environment is to know and understand your connection to it.

Mauri

Mauri is a life force, passed down from Ranginui and Papatūānuku to their children; all forms of life, such as plants and trees, water and its life, owe their continued existence and health to mauri. When mauri is strong, flora and fauna flourish; when mauri is depleted and weak, those forms of life too become sickly and weak. If mauri has been degraded, then its restoration is a matter of immense importance.

Mahinga kai

The natural resources, the places where these resources are obtained, and the philosophies and practices that surround them are all part of the system of mahinga kai. Mahinga kai is of central importance to Māori culture and identity; it means to work (mahi) the food (ngā kai). Māori lived a highly mobile life, centred on waterways and their surrounding landscapes; mahinga kai practices followed the seasons and provided opportunities to reinforce relationships with the landscape, develop and share knowledge, and provide them with resources to sustain their whānau, hapū and iwi.

Mahinga kai ensures the continuation of traditional practices and the passing down of values to tamariki/children and mokopuna/grandchildren, ensuring the continued survival of the practices through the generations.

Mātauranga Māori

The growth and transfer of traditional ecological knowledge is important in understanding the Te Ao Māori perspective of the environment; from an early age, tikanga and kawa were taught in order to respect waterways and associated bodies of water, as they were extremely important wāhi taonga.

Whether directly relating to the harvesting and working of natural resources, or its associated activities, the teaching of traditional ecological knowledge to the young, and ensuring the safekeeping of traditional knowledge and practices for future generations, are important.

Freshwater fish

New Zealand has 51 indigenous freshwater fish species, plus three non-resident natives, and 21 introduced species including trout and salmon (Dunn et al, 2018). Many of our indigenous species are endemic (only found in New Zealand) and taonga or mahinga kai species, so are of significant biodiversity and cultural value. Eels, whitebait, trout and salmon are also an important part of recreational and commercial fisheries.

Of the 51 indigenous freshwater fishes, more than 75 per cent are threatened with or at risk of extinction; four freshwater fish species[4] are listed as nationally critical (on par with our famous forest parrot, the kākāpō).

[4] Lowland longjaw galaxias, Canterbury mudfish, Clutha flathead galaxias, and Teviot flathead galaxias are listed as threatened, nationally critical (Dunn et al, 2018).

8 More than 75 per cent of New Zealand's freshwater fish are threatened or at risk of extinction.◀◀

Photo: Canterbury mudfish, *Neochanna burrowsius*. Boffa Miskell, 2018

New Zealand's freshwater fish fauna is unique, with an unusually high proportion of diadromous species that undergo migrations between freshwater and marine habitats as part of their natural life cycle. Although around two-thirds of New Zealand's fish species are non-migratory, completing their life cycles entirely in freshwater habitats, they still need to move between habitats and freshwater bodies, reiterating the importance and connected nature of freshwaters – ki uta ki tai.

Many of New Zealand's fish species are small, cryptic (often well camouflaged and/or like to hide), and nocturnal, so people are often surprised at the number and diversity of species that can be present in an otherwise benign-looking water body. As discussed below (**Legislative context**), freshwater fish and habitats are protected under the various statutes. This is an important consideration when undertaking works in waterways.

Freshwater fish are found in a wide array of waterbodies, from rivers and streams, to lakes, wetlands, urban waterways and human-modified or human-made stormwater and drainage networks. Habitat requirements for New Zealand's fish species are varied, with factors such as water velocity and depth, substrate size and complexity (eg, large boulder river versus a spring-fed cobbly stream), in-stream cover (eg, undercut banks, boulders, large wood and log jams), and riparian vegetation all playing a role in which species are found in a waterway. Some species (such as bluegill bullies, redfin bullies and torrentfish) tend to prefer fast-flowing riffle habitats, while other species (including common, giant and upland bullies, common smelt, and īnanga) prefer gently flowing or near-still habitats. Many of our indigenous species burrow into substrates, mud and gravel; and freshwater plants (macrophytes) and boulder-cobble habitats can provide important cover.

The distance inland from the sea and the elevation of a waterway are important factors in whether diadromous species occur within a waterway. This very much depends on the species' climbing ability, with some species, such as giant kōkopu and īnanga, tending to occur in lowland rivers, streams and wetlands, while kōaro, eels and to a lesser extent banded kōkopu, can 'climb' up natural barriers such as waterways. Many of New Zealand's waterways are short and steep, with waterfalls and other natural barriers limiting access to upstream reaches for some species. In-stream structures, such as culverts, can pose significant barriers to the movement of fish and other fauna along waterways. These human-made barriers are a significant and ongoing threat to our indigenous and sports fish. We recommend referring to the New Zealand Fish Passage Guidelines for detailed information on the effects of in-stream structures on fish passage and best-practice design approaches (Franklin et al, 2018).

More details about the locations and habitat preferences of New Zealand's freshwater fish fauna can be found on the National Works in Waterways Hub.[5]

[5] https://works-in-waterways-boffa.hub.arcgis.com/

Freshwater macroinvertebrates

The freshwater macroinvertebrate fauna in New Zealand is less well understood than freshwater fish fauna. However, of more than 600 known freshwater macroinvertebrates, 25 per cent are listed as threatened or at risk, including 46 species ranked as nationally critical, 11 nationally endangered and 16 nationally vulnerable (Grainger et al, 2018).

⏩ Macroinvertebrates are the freshwater insects, snails and worms that live on rocks and logs on the stream bed. ⏪

Photo: Boffa Miskell, 2020

Macroinvertebrates (eg, freshwater insects, snails and worms that live on the stream bed) can be abundant in waterways and are a fundamental part of freshwater ecosystems. They provide essential ecosystem functions, such as litter breakdown and nutrient cycling, and are an important food source for fish and birds.

Like fish, many macroinvertebrate species require cobbles clear of algae, fine sediment and macrophytes as habitat and for reproduction. For example, the successful recruitment of some freshwater insect groups depends on the availability of suitable egg-laying habitat. Because in-stream activities can dislodge or discharge sediments, stream-bed substrates can sometimes become covered by fine silts and sands, and larger gravels, cobbles and boulders can become unavailable for macroinvertebrate (and fish) habitat.

Macroinvertebrates vary widely in their tolerance to both physical and chemical conditions, and are therefore used regularly in biomonitoring, providing a long-term picture of the health of a waterway. The freshwater insects, stoneflies, mayflies and caddisflies, are considered “clean-water species” and it’s often these groups that are lost from waterways with degraded habitats and poor water quality.

Many macroinvertebrates have relatively short life cycles and produce many offspring, but some are long lived, and have specialised reproductive strategies.

Freshwater mussels/kākahi and freshwater crayfish/ kēkēwai are also of conservation concern and are included in the definition of ‘fish’ in the Conservation Act (Indigenous Freshwater Fish) Amendment Bill 2019. This means kākahi and kēkēwai are afforded the same protection from disturbance and taking as New Zealand’s freshwater fish species.

Freshwater fishes include kēkēwai and kākahi

Kēkēwai and kākahi are included by the Indigenous Freshwater Fish Bill in the definition of freshwater fish (see **Legislative context** for more information).

There are three known species of kākahi in New Zealand, *Echyridella aucklandica*, *E. menzeisii* and *E. onekaka*. Habitat preferences of kākahi are not well documented, although adult *E. menziesii* have been found in a wide range of habitats from soft-bottomed lakes to fast-flowing streams with hard substrates (Phillips, 2007). Little is known about the distribution and habitat preferences of *E. aucklandica*, which is only present in the North Island, while *E. onekaka* is only present in the Nelson region (Phillips, 2007). All three species are considered threatened or at risk of extinction (Grainger et al, 2018).

Kākahi have an unusual reproductive and dispersal strategy, where larvae (glochidia) are dispersed out of the female mussel's siphon and latch on to the gills of passing indigenous fish, staying there until they have grown large enough to disperse to a suitable habitat on the streambed (Clearwater et al, 2014). After this stage kākahi are relatively immobile, and this needs to be considered before undertaking works in waterways.

⏩ There are three species of freshwater mussel in New Zealand, all of which are threatened or at risk of extinction.⏪

Photo: Boffa Miskell, 2020

There are two species of kēkēwai, both of which are found only in New Zealand. *Paranephrops zealandicus* is found along the eastern side of the South Island and on Stewart Island, and is listed as at risk of extinction (Grainger et al, 2018). *Paranephrops planifrons* is found in the North Island and in the northwest and west of the South Island, separated from *P. zealandicus* by the Southern Alps. *Paranephrops planifrons* is listed as not threatened (Grainger et al, 2018). Kēkēwai prefer pools and areas of slow or no flow and require suitable habitat cover (eg, large wood, tree roots, undercut banks, cobbles and boulders) for shelter from predation and cannibalism. These woody debris habitats are usually absent in urban streams. Kēkēwai often burrow into the banks of waterways, which needs to be considered before starting activities such as diversion and stream maintenance.

Legislative context

There are many laws and regulations governing how New Zealand's freshwaters are to be managed. The main ones specific to works in and adjacent to waterways are described below.

Resource Management Act 1991

The Resource Management Act 1991 (RMA) is the main legislation for managing our freshwater environments. It promotes sustainable management of natural and physical resources, while safeguarding the life-supporting capacity of air, water, soil and ecosystems, and avoiding, remedying and mitigating any adverse effects of activities on the environment. The RMA covers aspects including (but not limited to) water use (ie, how the water is taken, used, dammed or diverted), discharges to water (eg, how pollutants enter the water), and activities that can or cannot be undertaken in waterways (eg, bed disturbance and reclamation of waterways). Regional councils are responsible for implementing the requirements of the RMA.

The Government administers (and occasionally amends) the RMA and is responsible for making regulations that councils and water users must follow. The Government is also responsible for providing 'national direction' for water through regulations including national policy statements, national environmental standards, and other regulations.

These regulations give councils direction and instruction on how they should carry out their functions and responsibilities under the RMA, ultimately to achieve the outcomes the Government considers nationally important.

National Policy Statement for Freshwater Management 2020

The National Policy Statement for Freshwater Management 2020 (NPS-FM) is the main source of national direction for how councils should manage freshwater. The objectives of the revised NPS-FM, which came into effect on 3 September 2020, include to:

- manage freshwater in a way that 'gives effect' to Te Mana o te Wai through:[6]
  - involving tangata whenua
  - working with tāngata whenua and communities to set out long-term visions in the regional policy statement
  - prioritising the health and wellbeing of water bodies, then the essential needs of people, followed by other users
- improve degraded water bodies and maintain or improve all others using bottom lines defined in the NPS
- avoid any further loss or degradation of wetlands and streams, and promote their restoration

[6] Te Mana o te Wai is a fundamental concept of the NPS-FM, prioritising the need to restore and protect the integrity of water, the intrinsic values of freshwater ecosystems and the importance of ensuring the health and wellbeing of water is protected and that human health needs are provided for before enabling other uses of water.

- identify and work towards target outcomes for fish abundance, diversity and passage and address in-stream barriers to fish passage over time
- set an aquatic life objective for fish and address in-stream barriers to fish passage over time
- monitor and report annually on freshwater (including the data used)
- publish a synthesis report every five years containing a single ecosystem health score and respond to any deterioration.

The NPS-FM is implemented through the regional planning framework. The NPS-FM 2020 expanded the national objectives framework, adding a further two compulsory national values, threatened species and mahinga kai, to ecosystem health. The NPS-FM sets out requirements to maintain or improve ecosystem health, mahinga kai, and threatened species in freshwater ecosystems. In-stream structures and works in waterways can adversely affect ecosystem health and mauri of a waterway, disrupting the state of river connectivity, and impacting the status of fish and other freshwater communities. As the requirements of the NPS-FM 2020 are implemented by national and regional government agencies, there is likely to be more focus on maintaining connectivity of waterways.

National Environmental Standards for Freshwater

The National Environmental Standards for Freshwater 2020 (NES-F) will also be implemented by regional councils. The NES-F came into effect on 3 September 2020 and set standards for carrying out certain activities that pose risks to freshwater and freshwater ecosystems. This includes the need to support the presence, survival and recovery of freshwater systems and the species that inhabit them, ensure connectivity of fish habitat (fish passage), and ensure that mahinga kai species are safe to harvest and eat.

National Environmental Standards for Plantation Forestry

In addition to the NES-F, the National Environmental Standards for Plantation Forestry (NES-PF) provides nationally consistent regulations to manage the environmental effects of forestry activities. Of particular relevance to works in waterways, the NES-PF sets standards to manage the potential effects of earthworks, river crossings, forestry quarrying, harvesting, mechanical land preparation, and slash traps on fish passage, sedimentation of waterways and water quality.

Iwi management plan

An iwi management plan (IMP) (sometimes referred to as an iwi environmental plan) is a resource management plan prepared by an iwi, iwi authority, rūnanga or hapū. IMPs are generally prepared as an expression of rangatiratanga, to help iwi and hapū exercise their kaitiaki roles and responsibilities. IMPs include issues, objectives, policies and methods relating to ancestral taonga, such as rivers, lakes, the seabed and foreshore, mountains, land, minerals, wāhi tapu and wāhi taonga, wildlife and biodiversity, and places of tribal significance. IMPs may also address a single issue or resource, such as freshwater, or provide a regional assessment of significant resource management issues.

IMPs provide a starting point for achieving the purposes of the RMA in recognising and providing for Māori cultural values and interests, and are a useful resource for understanding potential effects of a proposed activity on these values when applying for resource consent.

Historic Places Act 1993

Under the Historic Places Act 1993, an archaeological site is defined as any place associated with pre-1900 human activity where there is material evidence relating to the history of New Zealand. It is unlawful for any person to destroy, damage or modify the whole or any part of an archaeological site (known or unknown) without the prior authority of Heritage New Zealand Pouhere Taonga. This is regardless of the legal status of the land on which the site is located, whether the activity is permitted under the district or regional plan, or whether a resource consent has been granted.

Regional plans

Regional plans are the main tools used to set policy and rules that implement the RMA and NPS-FM. Regional rules vary across the country regarding the management of water, including quality, quantity and ecology, so it is essential to refer to regional plans to understand local legislative requirements and responsibilities. Most regional plans require consent to undertake many types of works in waterways, especially if the works are large in scale, likely to have significant or long-term adverse effects, or likely to discharge to water.

Conservation Act 1987

While the RMA, NPS-FM, NES-F and NES-PF provide protection to habitats for fauna, freshwater species are not given the same level of protection as indigenous land snails, lizards, bats, or even kiwi and kākāpō.

The Conservation Act 1987, which includes the Freshwater Fisheries Regulations 1983 and the Conservation (Indigenous Freshwater Fish) Amendment Act 2019 (Indigenous Freshwater Fish Act), sets out DOC's and the Ministry for Primary Industries' (MPI) statutory responsibilities for freshwater conservation, including responsibilities to preserve (as practicable) all indigenous freshwater fisheries and protect recreational freshwater fisheries and freshwater fish habitats.

These regulations determine specific responsibilities, including protecting freshwater habitats and advocating for freshwater life and freshwater fisheries, and new rules in the Conservation Act provide some additional protection for freshwater fish, eggs, larvae, spawning fish and their spawning habitats.

A new regulation-making power allows control of activities that kill or injure fish. The intent is to enforce best practice for activities such as dewatering activities, drainage pumps, turbines, and construction works in waterways generally.

It is also illegal to disturb, take or possess eggs or larvae of any freshwater fish without authorisation, to carry out an activity that would make a spawning site less suitable for spawning or to disturb fish spawning in the area.

It's important to note that the Indigenous Freshwater Fish Act's definition of freshwater fish includes kēkēwai and kākahi, and spawning sites relevant to all freshwater fish species, not just īnanga and salmonids as may have previously been the case.

Some of the key considerations for works in waterways

- Protection of species and habitats
  - It is an **offence** for any works in waterways **to disturb or damage** spawning grounds of any freshwater fish (section 26ZJ, Conservation Act 1987).
  - Unless an authorisation to *take* (capture, handle) indigenous fish is in place, fish must not be taken in a manner that results in injury or death, and the fish must be returned (alive) to the water as soon as practicable after taking them (section 26ZHB(2), Conservation Act 1987).
- Fish salvage and relocation
  - There are requirements for permits and approvals for **fish salvage, relocation and translocation** (sections 26ZHC and 26ZM, Conservation Act 1987).
- Fish passage
  - **Fish passage** must always be provided for when undertaking any activity in the bed of a water body (RMA 1991, NPS-FM 2020 & Freshwater Fisheries Regulations 1983).

Biosecurity Act 1993

The Biosecurity Act 1993 also plays an important role in managing our freshwater environments, by providing the legal framework for management agencies (eg, MPI, regional councils, and others) to help keep harmful organisms out of New Zealand, respond to new incursions across the national border, and manage established invasive species – in this case freshwater weeds and other organisms.

Summary

There are many legislative requirements and standards that apply under several documents, making a complex regulatory environment. Together these provide for fish passage, protect significant indigenous vegetation and significant habitats of indigenous fauna, and require the need to improve, or maintain, existing water-quality standards.

The intent of this national guideline is to create a simple, nationally consistent approach to address these requirements and manage works in waterways.

Planning provisions across regional and unitary authorities

To understand the current statutory provisions for working in waterways and how disparate these provisions are across regions and throughout New Zealand, we carried out a desktop review of the planning provisions of works in waterways in regional and unitary authority areas throughout New Zealand.

How disparate are the planning provisions?

We considered the permitted, controlled and restricted discretionary activities within the regional or combined plans and grouped these according to various common activities within the margin of a river.

We considered the most up-to-date plans;[7] where proposed plans existed, we considered those provisions over operative plans. This is because proposed provisions are more likely to give greater effect to the higher order statutory documents (eg, national direction through National Policy Statements), than operative plans.

Many councils' regional plans allow for small-scale activities, such as placement of crossings, small structures and limited bed disturbance, under permitted activity rules. Where the permitted activity standards cannot be met, resource consent is required, generally as a discretionary activity. Some councils, such as Auckland Council, Horizons Regional Council, Greater Wellington Regional Council and Environment Canterbury, include overlays, such as significant natural areas or sensitive habitats, to the permitted activity rules to provide an added level of protection for sensitive areas. For most other councils, the permitted rules tend to be general and effects based, as opposed to prescriptive, in how works should be undertaken, particularly in relation to differing receiving environments.

A number[8] of the regional councils use general rules (or standards) for all permitted activities within the margins of a lake or river. While not all regions have required these general standards, those available provide an indication of many regional councils' current expectations for works in waterways. These general standards are summarised in the table in **Appendix 1: Plan rules**.

As noted above, we have considered the up-to-date regional plan, whether that be the operative or proposed plan. Given the current status of national direction, in particular the NPS-FM, all regional plans are either in the process of being reviewed or a proposed plan has been notified (or part thereof).

The NES-F introduced rules in relation to work in or directly adjacent to waterways (eg, new structures, reclamation or drainage). This and other rules take effect over the rules of the regional

[7] Regional councils and unitary authorities are required to update their plans on a regular basis. This desktop review was completed on plans that were current up until August 2020. Where operative and proposed plans existed, we consulted the operative and proposed plans.

[8] Northland Regional Council, Auckland Council, Gisborne District Council, Waikato Regional Council, Horizons Regional Council, Greater Wellington Regional Council, Marlborough District Council, Tasman District Council and Environment Southland.

plans where they are more stringent; in most cases, the NES-F takes effect over the relevant regional plan.

Codes of practice and guidelines

We also examined the codes of practice or guidelines readily available for public access from these councils' websites, as well as guidelines produced by other entities such as Waka Kotahi NZ Transport Agency, Civil Contractors New Zealand, and DOC. We carried out a gap analysis to assess the differences across these guidelines.

In summary, these guidelines and codes of practice outline good practice for permitted activities or for when activities are carried out under a council's global consent **(Appendix 2: Gap analysis of codes of practice and guidelines**). Auckland Council has a series of focused best practice guides for civil infrastructure works and maintenance in stormwater systems. Some of these documents have been recently updated to include new research, such as effects on freshwater fauna sedimentation and macrophyte removal. Other documents are bespoke guidelines of limited relevance for regions other than the one it has been prepared for.

There is limited detail on critical habitats of fauna, or on fauna salvage, when this would be required, or how it should be undertaken. We were only able to find one fauna salvage guideline by a regional council (Environment Waikato) and another by Waka Kotahi NZ Transport Agency, with the latter being specific to a particular infrastructure project.

Why activities within and adjacent to waterways are of concern

Works in and adjacent to waterways include activities such as construction works (eg, culvert and bridge installation and maintenance, dewatering and diversions), waterway clearance and maintenance and restoration activities. These can have various impacts, depending on the nature and scale of the activity and how the activity is managed. For example, erosion and discharge of sediments can smother and kill freshwater life; in-stream works may block the passage of fish; and removal of riparian vegetation can destroy important habitat for both terrestrial and freshwater species, and remove shading integral for ecosystem health and function.

Works in waterways can also affect the mauri of an area or water body, and damage to habitats can affect threatened, at risk, taonga and mahinga kai species. A poor state of the environment can compromise mana whenua relationships with the environment and their rights as kaitiaki, and may affect the ability of iwi to practice mahinga kai.

The following section provides a summary of the potential effects of civil infrastructure works and maintenance activities in and adjacent to waterways.

Discharge of sediment and sedimentation

Some activities within and adjacent to waterways can suspend a large amount of fine sediment in the water column. For example, earthworks in riparian zones and on the banks of waterways can mobilise soils during rainfall events. If these soils are not captured and retained on land, they can enter waterways. Works within waterways can also remobilise deposited sediment already present in a waterway.

Suspended sediment in waterways can alter water quality, reducing dissolved oxygen concentrations, increasing turbidity,[9] and reducing light penetration and visual clarity (Rowe et al, 2009). Deposited sediment in waterways can also impact on floodwaters, potentially retarding flows and causing issues through change in flows, erosion and scour.

If resuspended sediment has a large organic component (eg, in waterways with lots of decomposing leaf litter), water can become deoxygenated very quickly and kill fish and other freshwater life (Greer et al, 2017). There are other potential risks from sediment resuspension, particularly if these are contaminated from past industrial use.

Elevated turbidity can also have adverse ecological effects, particularly if it is sustained for a long time. Increased turbidity levels can affect the growth of freshwater plants and algae (the food source of many macroinvertebrates), limit feeding abilities of visually foraging fish (eg, trout) and alter behaviour of indigenous fish species, such as banded kōkopu (Richardson et al, 2001; Rowe et al, 2009).

High loads of suspended sediments will also settle downstream, increasing the sedimentation of the waterway, which can damage fish gills and make them more susceptible to disease (Rowe et al, 2009), reduce habitat quality, and even kill freshwater life by smothering animals and the habitat

[9] Turbidity is an index of cloudiness of water, measuring the scattering of light caused by fine particles suspended in the water column.

that they live and feed on. Deposited sediment can result in macroinvertebrate communities shifting to those dominated by burrowing taxa like chironomids and freshwater worms, which are less suitable food for fish communities.

Discharge of contaminants

Contaminants, such as fuels and lubricants from machinery, concrete slurry and cement particles, dissolved heavy metals, plastics, construction debris, general waste and chemical contaminants from flocculants, may enter waterways as a result of some activities.

Fuels/oils

Fuels, lubricants and hydraulic fluids from machinery can enter waterways when machinery is used in or adjacent to waterways. Contaminants can have toxic and lethal or sublethal impacts, and may adversely affect freshwater communities and stream health. Impacts are likely to be infrequent and short, and relatively localised spills may have further reaching spatial and temporal effects on ecological values.

Concrete, cement and lime

Accidental discharge of concrete, cement and lime slurry and waste water to waterways can have significant adverse effects on the environment. Lime is often specified by councils to stabilise fill material in steep terrain. In areas where the groundwater table is high, or where there are leaking pipes, water can enter lime stabilised back-filled areas, discharging lime particles to waterways via the stormwater network. Crushed concrete is also used as back-fill material and more frequently as contractors seek ways to be more sustainable and reuse materials. When used near waterways, there is a risk of high pH being discharged to freshwater habitats.

Fresh concrete, cement and lime particles dramatically alter the pH concentration of a water body, making the water highly alkaline. This can be extremely toxic to freshwater plants and animals. Discharge of concrete, cement and lime particles could also block interstitial spaces and embed substrates, smothering the habitat, and destroying spawning and feeding grounds. These particles can also cause burning of gills, and suffocation of fishes and other fauna, ultimately killing freshwater life. New structures (bridges, culverts, concrete and timber linings, built ramps, and retaining walls) can also leach contaminants into waterways (Marshall & Margetts, 2020). While there is some uncertainty about the likelihood of contaminants leaching from in-stream structures, newly treated timber and concrete structures pose the most risk of this. We need further research in this area.

Flocculants

Contractors can apply flocculants as an erosion and sediment control tool, and use them to improve the efficiency of sediment retention devices, increasing the settlement rate of fine soil particles. While this should not affect freshwater systems, if used in a controlled manner (eg, chemical bench testing should take place to determine the most suitable flocculant to use and at what dosage rate, with the application via automatic dosing stations), it could contaminate freshwater habitats when dosing stations are not maintained and/or flocculants are applied through non-approved applications.

International evidence suggests that the toxicity of flocculants to freshwater life depends on the type of flocculant used (eg, anionic flocculants may have low toxicity, while cationic flocculants may be

highly toxic) (Harford et al, 2011). Some flocculants are non-toxic to fish, but highly toxic to macroinvertebrates (Harford et al, 2011).

There is little information on the potential effects of flocculants on New Zealand's freshwater habitats and fauna.

Noise and vibration

Sound is a critical cue for some species in freshwater and marine environments. There's little information available on the potential effects of noise and vibration on freshwater fauna in New Zealand, but persistent or continuous noise (eg, from pumping, excavators or vehicles nearby, dredging) or 'impulsive' noises (eg, from pile driving) may act as stressors, and could have a range of behavioural effects on fish (Popper et al, 2003). Research from the USA suggests that elevated anthropogenic noises along a waterway may lead to fauna avoiding preferred habitat and foraging areas, and may disrupt migration and reproductive behaviours. Loud noises may also cause temporary hearing loss, and impulsive noises can even cause physical injury to fish.

Loss of riparian vegetation

Riparian vegetation sometimes needs to be cleared to access sites or enable some construction activities. This vegetation serves essential functions to the waterway and for terrestrial and freshwater species; it protects the bank from erosion and acts as a buffer, filtering sediments and contaminants from runoff before entering waterways. Riparian vegetation also shades waterways, regulating water temperatures and minimising nuisance algae and freshwater plant growth (Figure 1). Riparian vegetation provides both in-stream habitat (ie, stable undercut banks, log jams) for fish and macroinvertebrates, and terrestrial habitat for birds, insects, and lizards. Leaves, woody debris, and terrestrial insects falling into the waterway provide food essential to fish and macroinvertebrates.

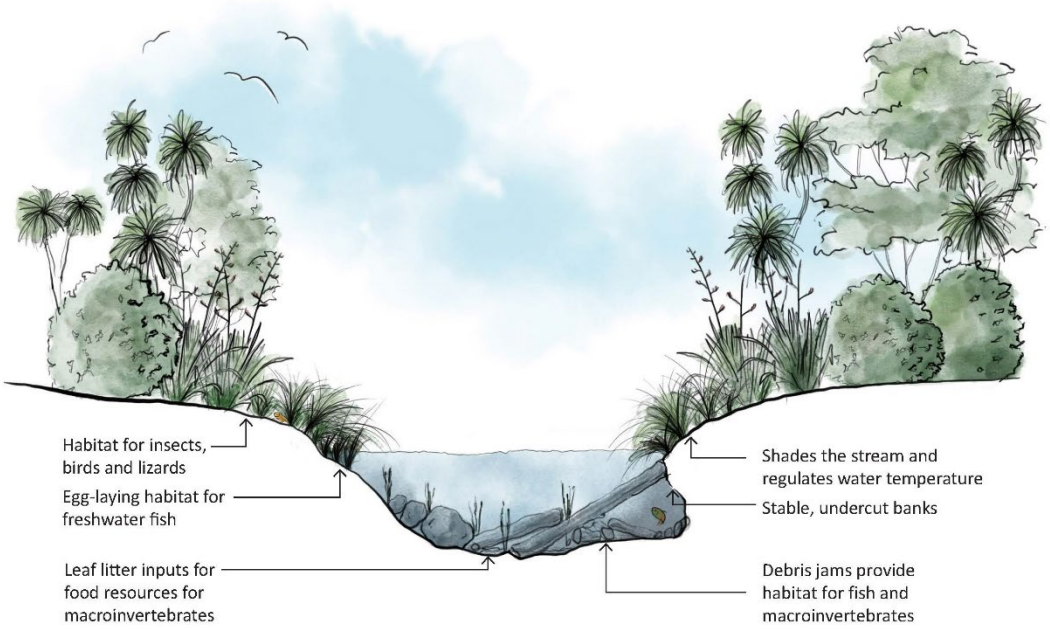

Figure 1 Importance of riparian vegetation for waterways. Drawn by Boffa Miskell, 2020

The juvenile stages of five migratory galaxiid species (īnanga, giant kōkopu, banded kōkopu, shortjaw kōkopu and kōaro) are collectively referred to as whitebait. Īnanga makes up the majority of New Zealand's whitebait catch, and this species lays its eggs in riparian vegetation in the tidal reaches of lowland waterways. Banded kōkopu, shortjaw kōkopu and giant kōkopu also lay their eggs among bankside vegetation during high flow events. For all of these species, egg development occurs out of water, and high flow events (either from rainfall or spring tides) re-submerge eggs, promoting these to hatch and transporting larvae to sea (McDowall, 1990).

Riparian vegetation damage and removal can have important implications for the spawning habitats of these and other species. Loss of vegetation can also decrease detrital inputs (eg, leaf litter, woody debris), increase sedimentation and excessive algal and freshwater plant growth, and result in fluctuating and very high water temperatures, all of which can have detrimental effects on in-stream habitat quality and ecosystem health. Vegetation removal can also result in the loss of terrestrial habitat, and disturbance and mortality of terrestrial fauna (eg, birds, lizards).

Woody debris and log jams are often removed from waterways during routine maintenance (eg, to reinstate carrying capacity for flood flows), removing natural and stable structures for freshwater life. For example, macroinvertebrates and fish use these as egg-laying substrates and as refuge from predation and during flood events and woody debris is an important habitat for kēkēwai.

Disturbance, injury and mortality of terrestrial fauna

Works in and adjacent to waterways can include disturbing or clearing of riparian habitats, works within riverbeds, or excavation of exposed river gravels (eg, in braided rivers). Riparian vegetation provides habitats for a variety of terrestrial fauna and braided rivers support feeding and breeding populations of over 80 species of birds, several lizard species, and some specialist insects. Braided river birds can be particularly vulnerable to activities within or adjacent to waterways. Gravel extraction from riverbeds can contribute to nest site flooding, reduce the amount of nesting habitat available and, if activities are carried out during breeding season (typically between August and February for most species), can disturb, injure or kill braided river birds.

Vehicles tracking across rivers, and through riparian or braided river habitats, can also disturb, injure and kill birds and other land-based animals.

As discussed in **Biosecurity**, plant and animal pest establishment and encroachment is also of concern for birds, lizards and other terrestrial fauna.

Mortality and stranding of freshwater fauna

Works in waterways activities could cause localised disturbance of habitat, downstream sediment discharge and sedimentation (also see **Discharge of sediment and sedimentation**), and injury and mortality of macroinvertebrates and fish in the waterway. While habitat disturbance and some mortality of freshwater life occurs during natural disturbance events such as flooding and drying, there are usually environmental cues first (eg, rising or falling water levels, increased/decreased velocities), which enable freshwater life to seek refuge (eg, by burrowing into substrates, moving to river margins or smaller, tributary waterways). In-river works don't have the same environmental cues, so many activities can cause higher mortality than natural disturbances. Fish and other fauna will not swim away, and some indigenous species will hide in or under substrates, debris and banks, so active removal must be carried out.

Activities in flowing water or that disturb the bed and/or banks of waterways have the potential to disturb, crush or bury macroinvertebrates and freshwater fishes, including threatened, at risk,[10] and taonga or mahinga kai species. Maintenance activities can also damage or remove habitats.

Fish may also become stranded in a dewatered channel, stranded in adjacent waterways due to drawdown effects, sucked into pumps, crushed by machinery (eg, during excavations) or removed from the waterway during macrophyte and sediment removal maintenance works. Diversion of flows and dewatering can also delay or impede migration or impact on spawning, particularly when the activity coincides with peak migration/spawning periods (also see **Critical periods for migration and spawning**).

Works in waterways must not disturb or damage spawning grounds of any freshwater fish (disturbing or damaging spawning grounds is an offence under section 26JZ, Conservation Act 1987), and indigenous fish must not be taken (captured, handled or attempted to capture, handle) in a way that causes injury or death. They must be returned alive to the water as soon as practicable, unless an authorisation is in place (section 26ZHB(2), Conservation Act 1987).

Where works in flowing water cannot be avoided, fish and other fauna need to be captured and relocated from the work area before and/or during the activity. See **Appendix 5: Fauna capture, relocation and salvage** for further information.

[10] Under the New Zealand Threat Classification System (Townsend et al, 2008), threatened species have the greatest risk of extinction in the immediate to medium term, while at risk species are not considered threatened but could quickly become so if declines continue or a new threat(s) arises.

⏩Fish and other freshwater life should be captured and relocated from the waterway if there is a risk of mortality and stranding ⏪

Photo: Boffa Miskell, 2018

Critical periods for migration and spawning

Many of New Zealand's freshwater fish are migratory, so need unimpeded passage between the sea and freshwater habitats to complete their life cycles. Even for non-migratory species, it's important not to restrict their movement within a waterway. There are legislative requirements to provide for fish passage and to avoid disturbing freshwater fish spawning habitat.

In-river works can interfere with migration and spawning of freshwater fishes, including when turbidity levels are elevated as a result of the work. Increased turbidity levels have been found to cause avoidance behaviours in some fish species. Upstream migration of banded kōkopu, for example, is reduced in high turbidity conditions (Richardson et al, 2001) and similar avoidance behaviours are seen in kōaro (Boubée et al, 1997). High turbidity can limit the ability of visually foraging fish to feed (eg, trout), and high loads of suspended sediments can also damage fish gills and make them more susceptible to disease, or even cause death (Rowe et al, 2009).

It's important for contractors to know what species are present or likely to be present in a waterway, and to avoid in-river activities during critical periods for migration and spawning wherever possible. This is especially important for threatened and at-risk species.

The spawning and migration calendars developed for New Zealand fish species provide a guide on critical periods to avoid activities within and near waterways. These can be found on the National Works in Waterways Hub.[11]

Fish passage

Culverts, fords, weirs and other structures placed in waterways can impede or block the movements of freshwater fish and other fauna.

Many of New Zealand's freshwater fish are diadromous, migrating between freshwater and marine habitats to complete their natural life cycles; some of New Zealand's macroinvertebrate fauna are also migratory (eg, the freshwater shrimp, *Paratya*) and the winged adult stages of freshwater insects can also be affected by in-stream barriers (Blakely et al, 2006). Most of New Zealand's freshwater fauna need to move between habitats (freshwater and marine, water and terrestrial habitats), reiterating the importance of and connected nature of freshwaters – ki uta ki tai.

Where passage is blocked there can be major changes to the numbers and diversity of fish and other fauna found in our waterways. Incorrect design, construction and implementation of these structures can dramatically change physical characteristics and processes of a waterway, including increased

[11] https://works-in-waterways-boffa.hub.arcgis.com/

water velocities within and immediately surrounding the structure, altered water depths, increased erosion and scouring, changes to tidal fluctuations (eg, where tide gates are installed). These aspects can block the free movement of freshwater fauna along a waterway, ultimately reducing ecosystem connectivity.

You should maintain passage, or only temporarily disrupt it, during works. A suitably qualified and experienced freshwater ecologist should assess any temporary interruption of fish passage, to ensure it has no adverse effects on fish.

Consult the New Zealand Fish Passage Guidelines for detailed information on the effects of in-stream structures on fish passage and best-practice design approaches (Franklin et al, 2018).

Biosecurity

Many animal and plant freshwater pest species cause serious ecological harm to our freshwater environments. Machinery, vehicles, footwear and clothing, and other equipment can transport both freshwater and terrestrial pest species through seeds, eggs, plant parts or other matter, and potentially move them over very long distances and introduce them to new areas.

Freshwater pests can significantly degrade water quality, reduce native biodiversity, may cause local extinctions, and can impact commercial fisheries, water intakes for irrigation and hydropower, drinking water and recreation and tourism values.

There are national and regional registers of "unwanted organisms", and regional pest management plans may outline obligations regarding a pest organism in that region.

Didymo is a serious freshwater pest and has been declared an unwanted organism under the Biosecurity Act 1993; it is an offence to spread an unwanted organism. Didymo is found in the South Island but not yet known to occur in the North Island. Because of this, the South Island is a controlled area for didymo; it is a legal requirement to clean all gear used in the water before going from one waterway to another.

It is essential that best practice measures, to **check**, **clean** and **dry** machinery, vehicles, and equipment before using in and moving between waterways. See MPI's 'Check, clean, dry: preventing didymo and other pests' web page for more information.[12]

[12] www.mpi.govt.nz/outdoor-activities/boating-and-watersports-tips-to-prevent-spread-of-pests/check-clean-dry/

Activities within and adjacent to waterways

The following sections set out general information and guidelines on avoiding or minimising the ecological and cultural effects of works in and adjacent to waterways. This information is limited to civil infrastructure works and maintenance, but is relevant for routine waterway maintenance and management activities on private land or by regional councils, territorial authorities and unitary councils – for example, macrophyte and drain clearance, waterway maintenance for flood carrying capacity, and culvert installation.

Activities can be broken down into the following five stages:

- project planning and design
- pre-construction
- during construction
- post-construction
- monitoring.

There is some overlap in the potential effects and key points to consider. To avoid repetition, the following section summarises the potential effects and key considerations of each broad activity type. Hyperlinks to the relevant sections within the guideline are shown in bold.

You can find other information in this guide, and on the National Works in Waterways Hub.[13]

Construction works

Temporary crossings

Bridges and culverts or other temporary structures can be installed to provide designated crossing locations across a waterway, for short-term use by vehicles, machinery and other equipment. The use of a temporary crossing limits or avoids the need for vehicles and machinery to enter and cross the bed of a waterway, avoiding further sediment discharge and damage to habitats, and minimising compaction of the bed.

Bridges are the preferred (best practice) temporary crossing method, as the construction requires little modification of the banks and little or no modification of the bed. Bridges also usually result in little change to in-stream habitats or disturbance of freshwater fauna, and generally do not obstruct fish passage.

Culverts are generally the most used structure for temporary crossings; they can be easily adapted to most site conditions, and installation and removal is relatively quick and easy from a construction perspective. However, the installation and removal can reduce flood capacity, and damage in-stream and riparian habitats, result in mortality of fauna, and impede or block fish passage.

[13] https://works-in-waterways-boffa.hub.arcgis.com/

Potential effects

Potential effects of temporary crossings include:

- Contaminants from fuel and lubricants: using machinery in and adjacent to waterways increases the risk of contaminants entering the waterway.
- Sediment discharge: installation/removal of most structures (except Bailey bridges) requires some work in the bed of the waterway. There will be sediment discharge and potential sedimentation of downstream habitats.
- Mortality of freshwater life: installation and removal of in-stream structures can also disturb, injure or kill fish (crush or bury) and other freshwater life.
- Fish passage: poorly installed culverts and other in-stream structures can result in erosion and scouring at the outlet, impeding or blocking fish passage along the waterway.
- Disturbance of riparian habitats: including impacts on indigenous vegetation, lizards and birds.
- Biosecurity risks: temporary culverts are often re-used so there is risk of spreading freshwater pests.

Key considerations

Key considerations include:

- **Discharge of sediment and sedimentation**
- **Discharge of contaminants**
- **Disturbance, injury and mortality of terrestrial fauna**
- **Mortality and stranding of freshwater fauna**
- **Critical periods for migration and spawning**
- **Fish passage**
- **Biosecurity.**

Key best practice principles

All “overarching best practice principles” apply, as well as the following (see pages 45-50):

- avoiding or minimising in-stream works
- critically assessing the operational methodology
- maintaining the streambed profile
- retaining vegetation on the bank
- stabilising exposed areas as soon as possible
- avoiding discharge of sediment into water
- avoiding or minimising sediment release downstream
- avoiding discharge of contaminants onto riverbeds or into waterways
- avoiding impediments to free passage
- avoiding or minimising disturbance and mortality of freshwater fauna
- avoiding in-stream works during critical spawning and migration periods

- avoiding the spread of freshwater plant and animal pests
- avoiding archaeological or wāhi tapu (sacred) sites.

Temporary diversions

Temporary diversions of waterways (either partial or full diversions) are often used to create a safe and dry area for workers. Diversions allow:

- in-stream activities to occur “in the dry”
- access to otherwise submerged parts of the bed
- avoidance of sediment and contaminant discharges while installing pipes or culverts, trenching, or pouring or installing concrete footings.

Diversions of flows (either partially or fully), involves constructing a dam across the waterway, directing surface water flow along the temporary diversion channel.

There are numerous advantages to working “in the dry”, including reducing the ecological effects of sediment discharge and downstream sedimentation. Unlike natural processes, such as river drying that occurs in naturally intermittent watercourses, river diversions don’t have the environmental cues that warn freshwater life to the onset of drying. As a result, diverting watercourses causes local disturbance, and injury and mortality of freshwater life, such as stranding and desiccation of fish and other freshwater life.

⏩ Temporary diversions allow work to be carried out “in the dry”. Suitable streambed material should be added to the channel to provide habitat and refuge for freshwater life. ⏪

Photo: Boffa Miskell, 2017

Potential effects

Potential effects of temporary diversions include:

- Sediment generation: there can be significant discharge of suspended sediments and downstream sedimentation during diversions.
- Contaminants from fuel and lubricants: contaminants may enter the waterway as a result of using machinery in and adjacent to waterways.
- Mortality of freshwater life: fish and other freshwater fauna can be crushed by machinery, or stranded as surface water is redirected, resulting in disturbance, injury or death.
- Disruption or loss of habitat: habitat in the old channel is lost and habitat quality in the temporary diversion channel may be poor.
- Fish passage: poorly constructed diversion channels, or those using culverts or pipes, can temporarily impede or block fish passage.

- Disturbance of riparian habitats: including impacts on indigenous vegetation, lizards and birds, and spawning habitats.

Key considerations

Key considerations include:

- **Discharge of sediment and sedimentation**
- **Discharge of contaminants**
- **Mortality and stranding of freshwater fauna**
- **Critical periods for migration and spawning**
- **Fish passage**
- **Biosecurity.**

Key best practice principles

All "overarching best practice principles" apply, as well as the following (see pages 45-50):

- avoiding or minimising in-stream works
- critically assessing the operational methodology
- avoiding discharge of sediment into water
- avoiding or minimising sediment release downstream
- avoiding discharge of contaminants onto riverbeds or into waterways
- avoiding impediments to free passage
- avoiding or minimising disturbance and mortality of freshwater fauna
- avoiding in-stream works during critical spawning and migration periods
- avoiding the spread of freshwater plant and animal pests
- avoiding archaeological or wāhi tapu (sacred) sites.

Coffer dams

Coffer dams are water barriers, usually temporary, used when dewatering sites to create safe and dry areas for workers and works to occur. The dam structure can be made of a variety of impermeable materials, typically using sheet plates, sandbags, gravel or sometimes hydrobarriers. The area inside the dam is then dewatered using a sump pump or similar.

Establishing coffer dams can damage in-stream and riparian habitats, result in mortality of fauna, and impede or block fish passage. Coffer dams are often associated with other activities, such as Dewatering, Temporary diversions, or **Overpumping or bypass pumping**, which can also result in disturbance and mortality of freshwater fauna, erosion of bed and margins and potentially reduced water quality as a result of erosion and sediment discharge.

⏩ Coffer dams can be constructed from various materials to create safe and dry work areas. ⏪

Photo: Boffa Miskell, 2018

Potential effects

Potential effects of coffer dams include:

- Sediment generation: coffer dam installation and removal can cause significant but temporary discharge of suspended sediments and downstream sedimentation.
- Discharge of contaminants: using machinery and working with cement in and adjacent to waterways can cause contaminants to enter the waterway.
- Mortality of freshwater life: installing in-stream structures can disturb, injure or kill fish (crush or bury) and other freshwater life.
- Disturbance of riparian habitats: including impacts on indigenous vegetation, lizards and birds.
- Biosecurity risks: temporary culverts are often re-used so there is risk of spreading freshwater pests.

Key considerations

Key considerations include:

- **Discharge of sediment and sedimentation**
- **Discharge of contaminants**
- **Loss of riparian vegetation**
- **Disturbance, injury and mortality of terrestrial fauna**
- **Mortality and stranding of freshwater fauna**
- **Critical periods for migration and spawning**
- **Fish passage**
- **Biosecurity.**

Key best practice principles

All “overarching best practice principles” apply, as well as the following (see pages 45-50):

- avoiding or minimising in-stream works
- critically assessing the operational methodology
- retaining vegetation on the bank
- avoiding discharge of sediment into water
- avoiding or minimise sediment release downstream

- avoiding discharge of contaminants onto riverbeds or into waterways
- avoiding impediments to free passage
- avoiding or minimise disturbance and mortality of freshwater fauna
- avoiding in-stream works during critical spawning and migration periods
- avoiding the spread of freshwater plant and animal pests.

Dewatering

Dewatering is the removal of groundwater from excavations and trenches using well points, spears or submersible pumps, to create a safe and dry area for workers. Dewatering is typically done by pumping and is made up of three activities:

- pumping the groundwater
- treatment and removal of silt
- discharge of clean water.

Dewatering not only relates to groundwater; it is also used to temporarily remove surface water from a watercourse. Dewatering is often done when surface water needs to be removed from a section of waterway that has been blocked off by a coffer dam. This activity usually involves using a "sump pump", where a suction head is placed directly into surface water to be pumped out of the area by a small generator.

Dewatering of groundwater may be needed when laying pipes and foundations, deep excavations, working in or adjacent to waterways, or general excavations where the groundwater table is shallow.

Dewatering of surface water may be necessary when installing pipes or culverts, trenching, pouring or installing concrete footings, to both a create safe and dry area for workers and to "work in the dry" and avoid or minimise effects on the freshwater ecology.

Potential effects

Potential effects of dewatering include:

- Sediment generation: the dewatering process (of ground- and surface water) can generate large quantities of fine silts, which need to be captured and treated to avoid sediment discharge and sedimentation of downstream receiving environments. Scour and erosion at the downstream end of dewatering discharge point can also resuspend sediment.
- Discharge of contaminants: fuels and other contaminants may enter the waterway as a result of using pumps for dewatering. Contaminants from hazardous and industrial activities can also be discharged by dewatering contaminated groundwater.
- Drawdown effect: where dewatering occurs adjacent to waterways, this can cause a local 'drawdown' effect where surface water levels in the adjacent waterway may be lowered as a result of dewatering groundwater. Drawing down surface water levels in adjacent waterways can disturb, or potentially strand, fish and other fauna.
- Mortality of freshwater life: using pumps in waterways, or groundwater connected to waterways, can draw freshwater fauna into the pumps, resulting in injury and mortality.

Key considerations

Key considerations include:

- **Discharge of sediment and sedimentation**
- **Discharge of contaminants**
- **Mortality and stranding of freshwater fauna**
- **Critical periods for migration and spawning**
- **Fish passage**
- **Biosecurity.**

Key best practice principles

All "overarching best practice principles" apply, as well as the following (see pages 45-50):

- critically assessing the operational methodology
- avoiding discharge of sediment into water
- avoiding or minimising sediment release downstream
- implementation of robust erosion and sediment control measures
- avoiding discharge of contaminants onto riverbeds or into waterways
- avoiding impediments to free passage
- avoiding or minimising disturbance and mortality of freshwater fauna
- avoiding in-stream works during critical spawning and migration periods
- avoiding the spread of freshwater plant and animal pests.

Overpumping or bypass pumping

Overpumping or bypass pumping is where surface water is managed by damming a waterway (usually limited to small waterbodies) and pumping the flows around the work site. This often involves securing sandbags or other suitable clean construction materials in the waterway at both the upstream and downstream extent of the work site, and using a sump pump to take surface water and pump it around the work site and back into the waterway.

Also see **Coffer dams** and **Dewatering**.

Potential effects

Potential effects of overpumping or bypass pumping include:

- Sediment generation: discharge of suspended sediments and downstream sedimentation during dam installation/removal and overpumping.
- Contaminants from fuel and lubricants: using machinery in and adjacent to waterways can cause contaminants to enter the waterway.
- Mortality of freshwater life: installation of in-stream structures can also disturb, injure or kill fish (crush or bury) and other freshwater life.

- Disturbance of riparian habitats: including impacts on indigenous vegetation, lizards and birds, and spawning habitats.
- Drawdown effect: where dewatering occurs adjacent to waterways, this can cause a local 'drawdown' effect where surface water levels in the adjacent waterway lower as a result of dewatering groundwater. Drawing down surface water levels in adjacent waterways can disturb, or potentially strand, fish and other fauna.
- Mortality of freshwater life: using pumps in waterways, or groundwater connected to waterways, can draw freshwater fauna into pumps, resulting in injury and mortality.
- Also see **Coffer dams** and **Dewatering**.

Key Considerations

Key considerations include:

- **Discharge of sediment and sedimentation**
- **Discharge of contaminants**
- **Mortality and stranding of freshwater fauna**
- **Loss of riparian vegetation**
- **Disturbance, injury and mortality of terrestrial fauna.**

Key best practice principles

All "overarching best practice principles" apply, as well as the following (see pages 45-50):

- critically assessing the operational methodology
- avoiding discharge of sediment into water
- avoiding or minimising sediment release downstream
- avoiding discharge of contaminants onto riverbeds or into waterways
- avoiding impediments to free passage
- avoiding or minimising disturbance and mortality of freshwater fauna
- avoiding in-stream works during critical spawning and migration periods
- avoiding the spread of freshwater plant and animal pests.

Drilling underneath waterways

Horizontal directional drilling is a technique used to pass a pipeline under a waterway without digging a trench. The activity uses a mobile drilling rig, which drills a pilot hole from one surface point to the other and then uses a reamer to incrementally increase the size of the opening under the waterway. The pipe or cable is then pulled through this line.

Drilling fluid is used to cool the drill head and sonde, provide lubrication for the drill rod and pipe, and support the drill hole (ie, to prevent the newly excavated area from collapsing and filling with soil). Drilling fluid is usually a mixture of water and bentonite clay; adding bentonite gives the fluid enough viscosity to carry soil and debris in the drill path back to the surface, to create a clean line for the pipe or cable work. Polymers or non-foaming detergents may also be added to aid the drilling process.

Drill rigs are usually quite small (eg, the size of a small car) and able to track across relatively rough terrain. However, other machinery and equipment is required for this work, and riparian vegetation clearance is often needed to provide suitable site access and space for the drill rig and other machinery and equipment, and for sediment containment devices (eg, to contain drilling fluid and material excavated from the drill line).

Potential effects

Potential effects of drilling underneath waterways include:

- Disturbance of riparian habitats: including impacts on indigenous vegetation, lizards and birds, and spawning habitats.
- Contaminants from fuel and lubricants: using machinery in/adjacent to waterways risks contaminants entering the waterway. Drilling fluid may also have polymers added, which could be discharged to waterways if not properly contained or form frac-outs.[14]
- Sediment discharge and sedimentation to downstream habitats: use of directional drilling risks frac-outs occurring, where drilling fluid breaks to the surface, and can result in significant sediment discharge and sedimentation of in-stream habitats.
- Mortality of freshwater life: if frac-outs or sediment discharge occur, this could result in injury and mortality.

Key considerations

Key considerations include:

- **Loss of riparian vegetation**
- **Disturbance, injury and mortality of terrestrial fauna**
- **Discharge of contaminants**
- **Discharge of sediment and sedimentation**
- **Mortality and stranding of freshwater fauna**
- **Noise and vibration.**

Key best practice principles

All “overarching best practice principles” apply, as well as the following (see pages 45-50):

- critically assessing the operational methodology
- maintaining the streambed profile
- retaining vegetation on the bank
- stabilising exposed areas as soon as possible
- avoiding the use of synthetic materials for in-stream and riparian applications
- avoiding discharge of sediment into water
- avoiding or minimising sediment release downstream

[14] A frac-out is where drilling fluid is released or breaks to the surface as a result of excessive pressure in the borehole.

- implementing robust erosion and sediment control measures
- avoiding or minimising disturbance and mortality of freshwater fauna.

Extraction of bed material

Some activities in waterways require riverbed material to first be excavated or extracted from the beds. Extracting bed materials can cause adverse effects on the ecological values of waterways; the riverbed can become degraded if not well managed (eg, where a particular size of bed material is removed and substrate size diversity is reduced); fuels, lubricants and other contaminants can be discharged to the river from machinery; and conducting works in flowing water can cause sediment discharges and downstream sedimentation, disturbance, and injury and mortality of freshwater life.

Temporary diversions are often used to avoid working in flowing water (see **Temporary diversions**).

Potential effects

Where works are conducted "in the dry", see **Temporary diversions**, **Coffer dams**, **Dewatering** and **Overpumping or bypass pumping.**

Key considerations

Key considerations include:

- **Discharge of sediment and sedimentation**
- **Discharge of contaminants**
- **Noise and vibration**
- **Mortality and stranding of freshwater fauna**
- **Critical periods for migration and spawning**
- **Fish passage**
- **Biosecurity.**

Key best practice principles

All "overarching best practice principles" apply, as well as the following (see pages 45-50):

- avoiding or minimise in-stream works
- critically assessing the operational methodology
- maintaining the streambed profile
- avoiding discharge of sediment into water
- avoiding or minimising sediment release downstream
- implementing robust erosion and sediment control measures
- avoiding discharge of contaminants onto riverbeds or into waterways
- avoiding impediments to free passage
- avoiding or minimising disturbance and mortality of freshwater fauna
- avoiding in-stream works during critical spawning and migration periods

- avoiding the spread of freshwater plant and animal pests
- avoiding archaeological or wāhi tapu (sacred) sites.

Trenching

Trenching through waterways is an alternative way of laying pipe, cables or other services. This activity may also require **Temporary diversions**, **Coffer dams**, **Dewatering** and **Overpumping or bypass pumping**, the potential effects of these activities have already been discussed.

Potential effects

Potential effects of trenching include:

- Disruption or loss of habitat: habitat in the excavation area will be lost during the trenching activity.
- Mortality of freshwater life: fish and other freshwater fauna can be crushed by machinery or stranded as surface water is removed, resulting in disturbance, injury or death.
- Also see **Temporary diversions**, **Coffer dams**, **Dewatering** and **Overpumping or bypass pumping.**

Key considerations

Key considerations include:

- **Discharge of contaminants**
- **Noise and vibration**
- **Loss of riparian vegetation**
- **Disturbance, injury and mortality of terrestrial fauna**
- **Mortality and stranding of freshwater fauna**
- **Critical periods for migration and spawning**
- **Fish passage**
- **Biosecurity.**

Key best practice principles

All “overarching best practice principles” apply, as well as the following (see pages 45-50):

- avoiding or minimising in-stream works
- critically assessing the operational methodology
- maintaining the streambed profile
- retaining vegetation on the bank
- stabilising exposed areas as soon as possible
- avoiding the use of synthetic materials for in-stream and riparian applications
- avoiding discharge of sediment into water
- avoiding or minimising sediment release downstream
- implementing robust erosion and sediment control measures

- avoiding discharge of contaminants onto riverbeds or into waterways
- avoiding impediments to free passage
- avoiding or minimising disturbance and mortality of freshwater fauna
- avoiding in-stream works during critical spawning and migration periods
- avoiding the spread of freshwater plant and animal pests
- avoiding archaeological or wāhi tapu (sacred) sites.

Working with concrete, cement and lime

Concrete and cement is used extensively in construction, including curbs, footpaths, foundations, road and driveway surfaces, headwalls and culverts. Many activities require in situ pouring of concrete into purpose-built boxing or form work, or installing pre-cast structures (eg, culverts, headwalls) into waterways. Cement and lime are also used for pavement and trench back-fill stabilisation works. Uncured concrete, concrete slurry, cement and lime fines, dust, or washings can make water highly alkaline (with a pH of 11–13). This highly alkaline water will burn, injure and kill fish and other freshwater life that come into contact with it.

Water contaminated with concrete, cement and lime cannot be diluted or filtered to a safe level for discharge to the receiving environment, so washings, dust, fines, or slurry must never be allowed to enter stormwater or freshwater receiving environments. Concrete-, cement- and lime-contaminated water must be collected in a contained area and removed from site, to avoid discharging to the receiving freshwater environment.

Even once cured, concrete structures will leach for some time when immersed in water, producing alkaline water (Marshall & Margetts, 2020). There is little information available on how long concrete structures will leach and cause alkaline water. In addition to potential mortality of fauna, any localised increases in pH (alkaline conditions) leaching from concrete structures may also create a barrier to fish passage.

Pre-cast structures may need to be soaked, with soakage water replaced (and appropriately discharged) periodically. Where pre-cast structures cannot be used and in situ pouring is required, this must be done in the dry (eg, using **Coffer dams**) and the structure may need to be soaked as above before removing the coffer dam and exposing the structure to the waterway.

Potential effects

Potential effects of working with concrete include:

- Mortality of freshwater life: highly alkaline water (high pH), burning, injuring, or killing fish and other freshwater life.
- Disturbance to wildlife and temporary fish passage barriers.

Key considerations

Key considerations include:

- **Discharge of contaminants**
- **Mortality and stranding of freshwater fauna**
- **Critical periods for migration and spawning**

- **Fish passage.**

Key best practice principles

All “overarching best practice principles” apply, as well as the following (see pages 45-50):

- critically assessing the operational methodology
- avoiding discharge of contaminants onto riverbeds or into waterways
- avoiding impediments to free passage
- avoiding or minimise disturbance and mortality of freshwater fauna.

Maintenance works

Maintenance of culverts and other structures

Culverts and other in-stream structures have a limited life and need to be inspected, cleaned and maintained, repaired or replaced. Sometimes this maintenance will require **Temporary diversions**, **Coffer dams**, **Dewatering** and **Overpumping or bypass pumping** to expose and provide suitable access to the structure. The potential effects of these activities have already been discussed.

Potential effects

Potential effects of maintenance of culverts and other structures include:

- Mortality of freshwater life: fish and other freshwater fauna can be crushed by machinery or stranded as surface water is removed, resulting in disturbance, injury or death.
- Also see **Temporary diversions**, **Coffer dams**, **Dewatering** and **Overpumping or bypass pumping.**

Key considerations

Key considerations include:

- **Discharge of sediment and sedimentation**
- **Discharge of contaminants**
- **Mortality and stranding of freshwater fauna**
- **Critical periods for migration and spawning**
- **Fish passage**
- **Biosecurity.**

Key best practice principles

All “overarching best practice principles” apply, as well as the following (see pages 45-50):

- avoiding or minimising in-stream works
- critically assessing the operational methodology
- avoiding impediments to free passage
- avoiding or minimising disturbance and mortality of freshwater fauna
- avoiding in-stream works during critical spawning and migration periods.

Freshwater weed management

Freshwater plants (or macrophytes) are an important component of freshwater ecosystems, providing habitat for freshwater life, substrate for algae (macroinvertebrate food) to grow on, and spawning habitats for fish, as well as removing nutrients and binding sediments in waterways.

Many waterways are dominated by exotic macrophytes and in some areas there can be excessive growth due to high nutrient levels and a lack of riparian vegetation shading the stream. Because of this, aquatic weeds in waterways are often managed to maintain effective drainage and channel capacity for flood flows, and to manage water quality (eg, where excessive exotic species growth binds and builds up a lot of sediment). There are a variety of methods used to manage freshwater weeds, including:

- riparian planting to shade and limit growth of macrophytes
- mechanical removal with an excavator or a freshwater weed harvester
- weed cutting and raking
- herbicide spraying.

Shading is the best practice long-term management option. Removal management options only provide short-term control, typically only a few months, and can adversely affect water quality, in-stream habitat and fish and macroinvertebrate communities.

Riparian planting

Riparian planting and stream shading, particularly with multiple tiers or heights of indigenous, evergreen species, is the best practice long-term management option. Stream shading by riparian planting will reduce direct sunlight and restrict excessive growth of macrophytes and algae.

Because riparian planting is a long-term management option, it may need to be supplemented with other options to manage freshwater weeds in the shorter term.

Mechanical removal

The mechanical removal of freshwater weeds involves either using machinery (eg, an excavator on the bank with a long-reach bucket or rake), purpose-built cutter boats, hand cutting (eg, with scythes), or hand-raking macrophytes from the bed by maintenance workers walking along wadeable waterways. All these methods involve the removal of macrophytes (either the actively growing plants, or also roots) from the waterway. The plant matter is generally stockpiled on the bank for disposal. When using hand cutting or hand raking, the cut freshwater weeds are often caught in a

temporary ‘fence’ downstream before being gathered, removed, and stockpiled on the bank of the river until the material is disposed of.

Mechanical removal, particularly with an excavator, will disturb and resuspend sediment that has been trapped by the plant material and roots. Often streambed sediments are intentionally mechanically removed at the same time as freshwater plants. A slotted, self-draining weed-clearing bucket (rake) can be used when only freshwater plants are being targeted. The excavator works from one bank (or both banks for wider waterways) and this may require disturbing or removal of riparian vegetation.

Compared to mechanical removal using an excavator, hand cutting and raking have the least disturbance to the bed and banks of the waterway, and do not require the use of chemicals. Riparian margins and associated vegetation and fauna are generally unaffected by hand cutting and raking activity.

Mechanical removal is labour intensive, and macrophyte recovery can occur within weeks to months, so it is a short-term control option. Mechanical removal using an excavator can also cause marked resuspension of sediment, resulting in increased suspended sediment levels and sedimentation of downstream habitats, both of which can have significant adverse effects on fish and macroinvertebrate communities (Greer et al, 2012, 2017).

Herbicide spraying

Herbicide spraying involves using chemicals to control target weed species, both on the bed and banks of waterways. It requires spot-spraying, actively targeting problem species.

Diquat and endothall are often used for controlling submerged macrophytes, and both of these herbicides are listed as “very toxic to aquatic organisms”. Glyphosate (or Roundup) is used to control bankside macrophytes in areas where it cannot directly discharge to waterways. However, there’s limited evidence of direct effects on macroinvertebrates due to toxicity. Nevertheless, macroinvertebrate community composition has been shown to change (with reduced taxonomic richness) after spraying of macrophytes with diquat. This is thought to be due to an increase in detritus and decomposing organic material after spraying (James, 2013). Large volumes of decaying plant material from herbicide spraying can also significantly depress dissolved oxygen levels in waterways (due to increased oxygen demand from bacteria decomposing the plant matter). These quick and severe changes in oxygen levels can be lethal to freshwater life.

Potential effects

Potential effects of freshwater weed management include:

- Disruption or loss of habitat: disturbance and loss of habitats and food resources for freshwater life due to the removal of the freshwater plants, and terrestrial habitats (eg, riparian vegetation) to access the waterway.
- Mortality of freshwater life: disturbance and potential removal of fish and macroinvertebrates from the waterway, which may result in stranding of fish and other fauna.
- Sediment discharge: temporary mobilisation and resuspension of fine sediments.
- Downstream effects: on water quality and freshwater fauna from decomposition of freshwater weed if it is not removed from the waterway.
- Deterioration of water quality: particularly deoxygenation of water and mobilisation of sediments and contaminants during excavation and plant decomposition from spraying.

- Disruption to fish migration and spawning.
- Disturbance or removal of riparian habitats: including impacts on indigenous vegetation, lizards, birds, and spawning habitats.
- Contaminants from fuel and lubricants: as a result of using machinery in waterways, there is the risk of contaminants entering the waterway.
- Contaminants from chemical use/spill: potential to spill into adjacent waterways with adverse effects on freshwater life, non-target spraying from spray drift.

Key considerations

Key considerations include:

- **Discharge of sediment and sedimentation**
- **Discharge of contaminants**
- **Mortality and stranding of freshwater fauna**
- **Critical periods for migration and spawning**
- **Fish passage**.

Key best practice principles

All "overarching best practice principles" apply, as well as the following (see pages 45-50):

- avoiding or minimising in-stream works
- critically assessing the operational methodology
- maintaining the streambed profile
- retaining vegetation on the bank
- stabilising exposed areas as soon as possible
- avoiding the use of synthetic materials for in-stream and riparian applications
- avoiding discharge of sediment into water
- avoiding or minimising sediment release downstream
- implementing robust erosion and sediment control measures
- avoiding discharge of contaminants onto riverbeds or into waterways
- avoiding or minimising disturbance and mortality of freshwater fauna
- avoiding in-stream works during critical spawning and migration periods.

Sediment or silt management

Sediment or silt removal involves excavating material from the bed of a waterway. The objective of this activity is to remove excess sediment deposited in the waterway (from inputs from the adjacent land), to maintain effective drainage and channel capacity for conveyance of flood flows. The potential effects are similar to those of **Freshwater weed management** (when using an excavator).

Potential effects

Potential effects of sediment or silt management include:

- Disruption or loss of habitat: disturbance and loss of habitats and food resources for freshwater life.
- Mortality of freshwater life: disturbance and potential removal of fish and macroinvertebrates from the waterway, which may result in stranding of fish and other fauna.
- Sediment discharge: temporary mobilisation and resuspension of fine sediments.
- Deterioration of water quality: particularly deoxygenation of water and mobilisation of sediments and contaminants during excavation.
- Disruption to fish migration and spawning.
- Disturbance or removal of riparian habitats: including impacts on indigenous vegetation, lizards, birds, and spawning habitats.
- Contaminants from fuel and lubricants: using machinery in waterways risks contaminants entering the waterway.
- Contaminants from sediments: resuspension of sediments can result in contaminants from past land-use activities being released downstream.

Key considerations

Key considerations include:

- **Discharge of sediment and sedimentation**
- **Discharge of contaminants**
- **Disturbance, injury and mortality of terrestrial fauna**
- **Mortality and stranding of freshwater fauna**
- **Critical periods for migration and spawning**
- **Fish passage**
- **Biosecurity.**

Key best practice principles

All “overarching best practice principles” apply, as well as the following (see pages 45-50):

- avoiding or minimising in-stream works
- critically assessing the operational methodology
- maintaining the streambed profile
- retaining vegetation on the bank
- avoiding discharge of sediment into water
- avoiding or minimising sediment release downstream
- avoiding impediments to free passage
- avoiding or minimising disturbance and mortality of freshwater fauna
- avoiding in-stream works during critical spawning and migration periods.

Best practice principles

The principles below should be considered when carrying out works in and adjacent to waterways, to avoid, remedy or mitigate any adverse environmental effects, including those detailed in **Why activities within and adjacent to waterways are of concern**.

Overarching best practice principles for works in waterways

- Avoid as far as practicable permanent habitat loss.
- Avoid as far as practicable loss of rare ecosystem types and habitats for threatened, at-risk, taonga and mahinga kai species.
- Avoid as far as practicable impacts on habitat connectivity, including barriers to fish passage.
- Avoid as far as practicable impacts on threatened, at-risk, taonga and mahinga kai species.
- Create safe habitats, especially for threatened, at-risk, taonga and mahinga kai species.
- Avoid as far as practicable effects on water quality and sediment, including for mahinga kai and mauri.
- Avoid as far as practicable altering natural hydrology patterns.
- Avoid as far as practicable the potential for spread and/or establishing pest plants or animals in freshwater habitats (including riparian margins).
- Avoid as far as practicable impacts on important habitats for the life cycle and ecology of freshwater fauna.
- Avoid as far as practicable disturbing archaeological or wāhi tapu (sacred) sites.

The following provides more specific information on achieving the overarching best practice principles above. Recommended 'standard conditions' have also been developed based on best practice and current conditions placed on resource consents by the regional and unitary authorities. These recommended conditions are provided in **Appendix 3: Example standard conditions**.

1. Avoid in-stream works as a first principle

Carrying out work outside the wetted bed of a watercourse avoids direct effects on freshwater fauna and reduces potential for sediment discharges. Best practice is to avoid working in flowing water wherever possible. Where critical works or access are required, minimise the use of machinery in the waterway by working from the banks wherever possible.

Where the watercourse is ephemeral or intermittently flowing, works should be undertaken while there are no visible flows.

In perennial watercourses, where possible, works should be undertaken in the dry bed either by diverting or dewatering prior to undertaking works. Critical periods for fauna (eg, spawning, migration) should be avoided where possible.

Where waterway diversions are required, the length of watercourse to be diverted should be kept to a minimum.

Dedicated crossing points or temporary bridges (eg, Bailey bridge) should be established to minimise disturbance to the waterway.

Where work in the bed of a waterway is required, all practicable measures should be taken to minimise disturbance and mortality of freshwater fauna, bed disturbance and the release of sediment.

Refer to Standard Conditions 1, 2, 4 and 5 of **Appendix 3: Example standard conditions.**

2. Critically assess the operational methodology

Activities are completed with minimal environmental impact, and the following measures should all be used:

- appropriate project planning, including selection and use of appropriate machinery
- timing of works to avoid critical periods for riverine birds and/or freshwater fauna
- other seasonal considerations
- long-range weather forecast.

Refer to Standard Conditions 1, 2 and 6 of **Appendix 3: Example standard conditions**.

3. Maintain the streambed profile

Repeated works, such as clearing sediment and macrophytes and gravel extraction from a waterway, can result in steepened banks and channels becoming too wide and deep, which can reduce habitat quality and create ongoing erosion issues.

Refer to Standard Condition 2 of **Appendix 3: Example standard conditions**.

4. Retain vegetation on the bank

Riparian vegetation stabilises banks and minimises erosion and sediment discharge into waterways. Vegetation on the bank should be retained wherever possible.

Avoid unnecessary vegetation clearance during construction and avoid clearance of large indigenous trees where possible.

To avoid loss of shade, habitat, and bank protection, minimise vegetation clearance from the immediate water's edge, maintaining a vegetation buffer along all waterways.

Where riparian vegetation must be cleared, minimise disturbance to waterways by felling vegetation away from them.

Consider whether felled vegetation needs to be temporarily left in place on the ground (eg, 2–3 days), to allow for passive dispersal of terrestrial fauna (eg, lizards) from the felled vegetation.

5. Stabilise exposed areas as soon as possible

Where activities require vegetation removal, the banks should be stabilised to avoid erosion and sediment discharge into water. Keep disturbed areas small, and time of exposure short.

On completing the activity, or in the event of an extended suspension of works, all areas of disturbed earth should be stabilised using an ecologically suitable method.

Use 100 per cent biodegradable products to avoid persistence of plastics and synthetic products in the environment.

Refer to Standard Condition 11 of **Appendix 3: Example standard conditions**.

6. Avoid using synthetic materials for in-stream and riparian applications

A range of geotextile products are available for bank and bed construction and stabilisation, or restoration and landscape planting of riparian margins. Many of these products are made from synthetic products, which bring great durability; however, these products can take many decades to break down and result in plastic remnants remaining in the environment – either in streams or in the marine receiving environment. Wherever possible, 100 per cent biodegradable stabilisation and plant protection options (eg, entirely biodegradable hessian matting, Combi plant guards) should be used instead of synthetic products. This is particularly important for permanent solutions, or where temporary uses may result in degradation of products.

⏩ Use 100 per cent biodegradable materials. ⏪

7. Avoid discharge of sediment into water

When carrying out works in or adjacent to waterways, contractors should plan and implement works to avoid sediment discharge into the waterway.

Establish designated crossing points, bridges, fords, or culvert crossings to minimise sediment disturbance.

8. Avoid sediment release downstream

Activities such as clearing freshwater weeds and fine sediment from a waterway, stream diversions or bank works, can result in an immediate spike in suspended sediment concentrations downstream, which can adversely affect freshwater life.

Refer to Standard Conditions 12 of **Appendix 3: Example standard conditions**.

9. Implement robust erosion and sediment control measures

Erosion and sediment control should be considered in all instances. Appropriate erosion and sediment control measures must be in place to avoid fine sediment entering waterways during works in or adjacent to waterways.

The number and types of controls required will depend on the scale of the activity and characteristics of the receiving environment. If works can be undertaken outside the wetted bed, or during dry conditions, the potential for sediment discharge and sedimentation is reduced or may be avoided.

Refer to Standard Conditions 6 of **Appendix 3: Example standard conditions**.

10. Avoid discharge of contaminants onto riverbeds or into waterways

Avoid contaminants entering waterways by ensuring that refuelling occurs outside of the waterway and in a place where no fuel can enter the waterway if it's spilt. Ensure fuels and other chemicals are stored safely away from waterways, and spill kits are available for immediate use for any chemical fuel or other spill. Store all machinery and equipment above the anticipated flood level at the end of each working day and/or when the site is unattended.

Do not use machinery that is leaking fuels, lubricants, hydraulic fluids or solvents in works in waterways.

Refer to Standard Conditions 9 and 10 of **Appendix 3: Example standard conditions**.

11. Avoid impediments to free passage

Some activities, including installation and maintenance of structures and culverts, stream diversions, and sediment discharge, can impede movement of fish along the waterways.

Always provide for fish passage when undertaking any activity in the bed of a water body. This applies to all situations regardless of scale. Fish passage must be maintained or only temporarily disrupted during activities. Any temporary interruption of fish passage should be assessed by a suitably qualified and experienced freshwater ecologist, and have no adverse effects on fish.

Refer to Standard Condition 3 of **Appendix 3: Example standard conditions.**

12. Avoid disturbance and mortality of freshwater fauna

Works in waterways can cause localised disturbance of habitat, downstream sediment discharge and sedimentation, and injury and mortality of macroinvertebrates and fish in the area. For example, fish and other fauna can become stranded in shallow, drying or dry areas, particularly during activities such as diversions and overpumping that allow works to occur in dry conditions, or during waterway maintenance such as freshwater weed and sediment removal. Freshwater fauna can be disturbed, injured, crushed, buried and/or killed when machinery and vehicles are used in waterways or when structures are installed.

It is an offence to intentionally kill or destroy indigenous fish (note, freshwater fish includes kākahi and kēkēwai; see **Legislative context**).

Because of this, works should be designed and implemented to avoid cutoffs and diversions (either temporary or permanent) that result in fish becoming dewatered and stranded in shallow, or drying areas.

Fish and other fauna may need to be captured and relocated from a water body prior to, or during, certain activities.

Water take pumps (eg, pumps used for overpumping, dewatering, or during diversions) should be screened with appropriately 2–3-millimetre mesh to avoid fish mortality due to being drawn into the pumps.

⏩ Fish screens of 2–3-millimetre mesh should be used on all pumps. ⏪

Photo: Fulton Hogan, 2017

A fauna relocation and salvage protocol is provided in **Appendix 5: Fauna capture, relocation and salvage**, outlining best practice for avoiding and mitigating effects on freshwater fauna. These protocols should be followed in all situations; however, as noted in the protocols, differing measures may be applied depending on the scale of the activity and characteristics of the receiving environment.

Refer to Standard Conditions 1–5 of **Appendix 3: Example standard conditions**.

13. Avoid in-stream works during critical spawning and migration periods

Spawning habitats and critical periods for spawning of freshwater fauna are particularly sensitive to disturbance from some activities. It is an offence for any works in waterways to disturb or damage spawning grounds of any freshwater fish (freshwater fish includes kākahi and kēkēwai; see **Legislative context**).

Where spawning habitats cannot be avoided, undertake work outside the spawning seasons of fauna at the site. The National Works in Waterways Hub[15] provides information on known spawning locations and periods for a variety of fauna.

Avoid or minimise disturbance to waterways during critical migration and spawning seasons of freshwater fauna, and particularly for threatened, at-risk, taonga, mahinga kai species and salmonids.

Refer to Standard Condition 5 of **Appendix 3: Example standard conditions**.

14. Avoid the spread of freshwater plant and animal pests

Ensure all vehicles, machinery and plant are free from freshwater pests (including didymo) before entering the work area. Comply with Biosecurity New Zealand check, clean, dry protocols to ensure machinery and other equipment do not spread didymo or other invasive plants to waterways.

[15] https://works-in-waterways-boffa.hub.arcgis.com/

Refer to Standard Condition 8 of **Appendix 3: Example standard conditions**.

15. Avoid archaeological or wāhi tapu (sacred) sites

Works in or adjacent to waterways can disturb artefacts of significance (both taonga and wāhi tapu) to tangata whenua. Accidental discoveries may be indicators of additional sites in the area and, therefore, require appropriate care and protection, including being retrieved and handled with the correct tikanga and kawa.

Work should be well planned to ensure archaeological or wāhi tapu sites are avoided. If an unknown archaeological or historic feature is disturbed, cease work immediately and follow the appropriate accidental discovery protocol.

An accidental discovery protocol is provided in **Appendix 4: Accidental discovery protocol**, outlining best practice for avoiding and mitigating effects on cultural and heritage values.

Monitoring

The National Environmental Standards for Freshwater (NES-F) sets standards for activities that pose risks to freshwater and freshwater ecosystems. Works in waterways need to support the presence, survival and recovery of freshwater systems and the species that inhabit them, ensure connectivity of fish habitat (fish passage), and ensure that mahinga kai is safe. These standards require monitoring, which needs to be implemented by regional councils, contractors and end users.

Monitoring on aspects such as biosecurity, faunal relocation success, new best practice techniques and tools, is also recommended.

Research gaps

This section summarises the current research gaps where more information is needed to better understand and develop best practice protocols.

Fish and other fauna (especially kēkēwai and kākahi) relocation and salvage

- What are the best practice methods for fish and other fauna salvage?
- Do the best practice methods vary across regions or waterway morphology?
- How successful is relocation?
- What are the mortality rates of relocated individuals?
- Should local population sizes be considered when selecting suitable relocation sites?
- Is predation on resident individuals increased when relocating piscivorous fish?

Temporary diversion channels

- Does a temporary diversion channel need suitable habitat to provide for fish passage and refuges?
- Are gravel bunds used as dam structures also keeping fish out of work areas?

Use of geotextile materials

- Do geotextile materials contribute microplastics to the freshwater receiving environment?

Leaching from new structures

- Do new structures (eg, concrete, treated timber) need to be soaked before deploying in waterways to avoid contaminant leaching?

Noise and vibration

- Does persistent, continuous, or impulsive noise stress, disrupt, or cause mortality to freshwater fauna?

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Appendices

Appendix 1: Plan rules

Table 1: General conditions relevant to works in waterways for each of the 17 regional and unitary authorities

Council	Activity Status	Standards
Northland Regional Council	Permitted	**River, lake or wetland disturbance** Note: Work affecting archaeological sites is subject to an authority process under the Heritage New Zealand Pouhere Taonga Act 2014. If any activity could modify, damage or destroy any archaeological site(s), an authority (consent) from Heritage New Zealand must be obtained for the work to proceed lawfully.
		Sediment discharges 1. Discharge of contaminants must comply with the following conditions: (a) the activities must release no contaminants into water, other than sediment or organic matter, and (b) bed disturbance must not occur for more than five consecutive days, and (c) beyond the zone of reasonable mixing, the discharge must not give rise to any conspicuous change in the colour or visual clarity, and (d) any conspicuous change in the colour or visual clarity within the zone of reasonable mixing must not occur for longer than 12 hours per day.
		Vehicles, vessels and equipment in water bodies 3. All vehicles, vessels and equipment must be kept out of flowing or standing water bodies, except where it is necessary for the purpose of the activity, and then: (a) machinery must be clean and leak free, and (b) the extent and duration of any disturbance is minimised. 4. All equipment and excess materials must be removed from the bed of the water body on completion of the activity.
		Avoiding pest introduction 5. All plant, machinery, equipment or material operating or used in a water body, must be free of plant contaminants, seeds or vegetative material, which is capable of germinating or reproducing pest species.
		River alignment and flooding effects 6. The activities must not:

		(a) cause more than minor bed or bank erosion, scouring or undercutting immediately upstream or downstream, or (b) compromise the structural integrity or use of any other authorised structure or activity in the bed of the river or lake, or (c) dam or divert water in a way that causes flooding or ponding on any other property. 7. Any dammed water must not raise sub-surface or surface water levels to the extent that drainage of other property is adversely impeded.
		Natural wetlands 8. The activities must not cause change to the seasonal or annual range in water level of any natural wetland to an extent that may adversely affect the wetland's natural ecosystem. 9. The vegetation and the bed of any natural wetland are not disturbed to a depth or an extent greater than that required to give effect to the permitted activities.
		Fuel storage and refuelling 11. Fuel must not be stored and machinery must not be refuelled in any location where fuel may enter water, including: (a) on, over, or in the bed of a surface waterbody or the coastal marine area, or (b) within 10 metres of a surface waterbody or coastal water. 12. Fuel must not be discharged to water, or the bed of a surface waterbody, or to land, in circumstances where the fuel can enter water.
		Fresh water structures Erosion and sediment discharges associated with a structure 13. The presence of the structure must not cause more than minor bed or bank erosion, scouring or undercutting immediately upstream or downstream. 14. Approaches to and abutments of the structure within the bed or on the banks of the water body must be stabilised to avoid scour and sediment discharges.
		Structure durability, maintenance and off-site effect avoidance 15. The structure must be maintained in a sound condition and function for the purpose it was designed for, and at all times be capable of withstanding a one percent annual exceedance probability (AEP) flood without structural failure or risk to people or other property. 16. The one percent AEP flood must be accommodated by the structure and/or by an overland flow path without increasing flood levels upstream or downstream of the structure, beyond the land or structures owned or controlled by the person undertaking the activities. 17. The activities must not cause damage to, or restriction of the use of, any other authorised structure. 18. The activities must not prevent existing lawful public access or navigation to or along a continually or intermittently flowing river or lake, unless provided by an existing authorisation.

		19. Dam structures must be designed, constructed, operated and maintained so that: (a) vegetation does not weaken the dam or prevent inspection of the dam embankment and trees are not allowed to grow on or near the embankment, and (b) stock must not damage the dam crest or faces of the dam. 20. Dams with a reservoir capacity greater than 20,000 cubic metres and associated spillways must be inspected at least once every 12 months and following any operation of the flood spillway. Any damage recorded at times of inspection, or noticed at any other time, must be remedied as soon as practicable. Note: For good design practice and advice on dams, reference should be made to the New Zealand Dam Safety Guidelines, 2015 – NZSOLD.
		Fish passage 21. The upstream and downstream passage of fish in continually or intermittently flowing rivers must be provided for and be effective under a wide range of flow conditions and, excluding soft bottom rivers, river bed material must be maintained throughout the full length of any culvert, ford and bridge structures, except: (a) where the statutory fisheries manager provides written advice confirming that providing for passage of fish would have an adverse effect on the fish population upstream of the structure, or (b) during permitted temporary activities such as works to enable structure repair and replacement, or (c) when otherwise provided for by an existing design and authorisation. Note: Advice on the potential pest fish populations located downstream of the structure can be obtained from the Regional Council, the Department of Conservation, or the Northland Fish and Game Council.
		Construction activity controls 22. Construction material and ancillary structures must be removed from the bed following completion of the activities, or earlier if reasonably practicable. 23. The contact of wet concrete or concrete ingredients with flowing or standing water must be avoided. **Notifying the Regional Council** 24. The person undertaking the activities must notify the Regional Council's Compliance Manager (in writing or by email) at least 10 working days before the start of works in the bed of the water body, when: (a) the contributing catchments are greater than 50 hectares and the activities involve construction, placement or removal of any culvert, ford, weir or bridge, and (b) the notification must include: i. the name, address, and phone number of the person responsible for the works, and

		ii. the location of the structure, and iii. the structure design including its contributing catchment area, flood flow estimates and measures necessary to control erosion or prevent increased upstream flood risk, along with the minimum flow to provide for fish passage and the method by which that minimum flow will be maintained, and iv. the proposed date of commencement and duration of the activities.
		Temporary flow diversion around work sites 25. The temporary damming, diverting or pumping of river flow around work sites in the bed of a water body must: (a) only be undertaken during a period of low flow when there is a low risk of flooding, and (b) not cause more than minor impediment to flood flows, and (c) when damming, have a dam height no greater than 600 millimetres, and (d) when pumping, use a fish screen with the intake screen mesh spacing not greater than three millimetres, and (e) be removed or discontinued as soon as practicable and the bed of the water body returned to its original condition no later than 14 days from commencement of the activity.
Auckland Council	Permitted, Controlled and Restricted Discretionary	**E3.6.1.1. General standards** 1. The activity must not, after reasonable mixing, result in any of the following effects in receiving waters: (a) the production of conspicuous oil or grease films, scums or foams, or floatable or suspended materials; (b) any conspicuous change in the colour or visual clarity; (c) any emission of objectionable odour; (d) the rendering of fresh water unsuitable for consumption by farm animals; and (e) any significant adverse effects on aquatic life. 2. The activity must not result in an increase of existing flood levels up to and including the 1 per cent annual exceedance probability (AEP) flood plain on land or structures other than that owned or controlled by the person undertaking the activity. 3. The activity must not result in more than minor erosion or land instability. 4. Machinery must not sit directly on the wetted cross-section of the bed at the time of the work. 5. Explosives must not be used in the bed. 6. Mixing of construction materials and refuelling or maintenance of equipment must not occur within 10m of the bed and best site management practice must be used to avoid contaminant discharging into the water.

		7. The activity must not destroy, damage or modify any sites scheduled in the Historic Heritage Overlay or the Sites and Places of Significance to Mana Whenua Overlay. 8. The activity must not prevent public access along the lake, river, stream or wetlands.
Waikato Regional Council	Permitted	(a) In any river or stream (including Hydro Electricity Reservoirs): the suspended solids concentrations as a result of works associated with a structure in the stream downstream of the structure shall not exceed the suspended solids concentration as measured at the same time in the stream immediately upstream of the structure. (b) In any lake (excluding Hydro Electricity Reservoirs): as a result of works associated with a structure the suspended solids concentration in the lake shall not exceed the ambient lake concentration (i.e. as measured in the lake in areas unaffected by the discharge). (c) The restrictions in a) and b) shall not apply with regard to the erection, reconstruction, placement, alteration or removal of a structure within a water body within any 24 hour period within 30 days from commencement of the works, except in: i. Significant Indigenous Fisheries and Fish Habitat Class waters during August to December inclusive. ii. Significant Trout Fisheries and Trout Habitat class waters during May to September inclusive. The point at which compliance with standards a) and b) shall be measured is: i. For rivers and streams (including Hydro Electricity Reservoirs): at a distance downstream of the discharge point (or site of the activity) which is three times the width of the river or stream and which in any instance does not exceed 200 metres from the point of discharge. ii. For lakes (other than Hydro Electricity Reservoirs): at a distance of 15 metres from the location of the discharge or the activity
Bay of Plenty Regional Council	N/A	No general conditions / standards
Gisborne District Council	Permitted	(a) Native fish passage shall not be impeded by physical barriers or other means; (b) Activities shall not reduce the flood carrying capacity or the ability of the stream or river to carry floating debris; (c) Activities shall not cause any increase in induced bank erosion or permanent destabilisation of the bed or river; (d) All practicable steps shall be taken to avoid the release of sediment from the activity, and no clearly discernible change in visual clarity of the water shall occur after reasonable mixing downstream of the activity site more than 48 hours after any construction work commences in the lake, river or stream; (e) No works shall be carried out in the wet part of the bed in the tidal reaches of rivers and streams between 1 March and 30 June; (f) No works shall be undertaken in the bed of a waterbody listed in Schedule 1E (trout) between 1 May and 30 September; (g) No works shall be undertaken in the bed of a waterbody listed in Schedules 1A or 1B (Aquatic habitat) between 1 May and 30 August;

		(h) No works shall be undertaken in the bed of a waterbody listed in Schedule 1C (Habitats of Threatened Indigenous Flora and Fauna) where NZ or Banded Dotterel or other river bed nesting and/or roosting birds are found between 31 August to 31 December; (i) The activity shall not alter the natural course of the stream or river; (j) No contaminants (including, but not limited to, oil, hydraulic fluids, petrol, diesel, other fuels, paint, solvents, or anti-fouling paints), excluding sediment, shall be released to water from the activity; (k) No machinery refuelling or fuel storage shall occur at a location where fuel can enter any waterbody; (l) The activity shall not compromise the structural integrity or use of any other authorised structure or activity in the bed of the stream, river or lake, including flood control works in Council Administered Drainage Areas (defined in Schedule 8).
Taranaki Regional Council	N/A	No general conditions / standards
Horizons	Permitted	**Life-supporting Capacity conditions which apply to all water bodies and their beds** (a) The activity must not adversely reduce the ability of the water body or its bed to convey flood flows, floating debris or sediment, except for a period of not more than 12 consecutive hours during construction. (b) There must be no discharge of contaminants, other than sediment and other contaminants inherent to the water or bed, into the river or lake except where the discharge is explicitly allowed by the activity description of a rule in this chapter. (c) Any discharge of sediment into water directly caused by the activity, that causes the visual clarity standards in Schedule E to be breached, must not be undertaken for more than 24 hours in total across 5 consecutive days. There must be no more than one activity per river per property* in any 12 month period. (d) Any discharge of sediment into water under (c) must not, after reasonable mixing*, cause any conspicuous change in the colour of water in the receiving water or any change in horizontal visibility greater than the target set in the visual clarity % change column of Schedule E, more than 12 hours after completion of the activity. (e) Any materials used must be necessary for the activity and must not be toxic to aquatic ecosystems. (f) Any materials no longer required as part of the activity, including any temporary structures, must not be stored in or on the bed of any river or lake and must be removed after completion of the activity. (f) Refuelling of machinery must not take place in any area where spills may enter surface water. (g) The activity must be undertaken in a manner that provides for the safe passage of fish both upstream and downstream, including past any structure. (h) Any diversion of water required for works ancillary to a structure must be temporary, must be within the bed of the river, must not exceed 100 m in length, must not be between catchments, must not involve a lake, and the diversion channel must have sufficient capacity to carry the same flow as the original channel.

		(i) Upon completion of any channel bank works, the banks must be reinstated to a natural contour and revegetated. (j) Any straightening or channelling of a river must not exceed a length equal to two times the bed width of the river in any 2 km length of river in any 12 month period. (k) There must be no removal of instream woody debris less than 2 m3 in size unless this is required to reduce the risk of flooding or erosion.
		Riparian (applies to all reaches in water bodies and their beds with a Schedule B Value of Sites of Significance – Riparian) (l) For the purpose of minimising disturbance to nesting dotterels 1August to 31 December (inclusive), gravel extraction and bed disturbance on gravel beaches must only take place: iii. within 7 days following a flood of the area of beach that is the subject of the activity, or iv. where the extraction or disturbance commenced at the same location prior to 1 August and has not been interrupted for more than 7 days.
		Inanga Spawning (applies to all reaches in water bodies and their beds with a Schedule B Value of Inanga Spawning) (m) The use of mobile machinery in or on the bed of a river or lake in a manner that disturbs the bed must not take place 1 February to 1 May (inclusive).
		Whitebait* Migration (applies to all reaches in water bodies and their beds with a Schedule B Value of Whitebait* Migration) (n) The use of mobile machinery in or on the bed of a river or lake in a manner that disturbs the bed of the active flowing channel must not take place 15 August to 30 November (inclusive).
		Trout Spawning (applies to all surface water management zones and their beds with a Schedule B reach Value of Trout Spawning for this provision) (o) The use of mobile machinery in or on the bed of a river or lake in a manner that disturbs the bed of the active flowing channel must not take place 1 May to 30 September (inclusive).
		Trout Fishery (applies to all reaches in water bodies and their beds with a Schedule B Value of Trout Fishery) (p) Activities must not result in suspended sediment that causes the visual clarity standards in Schedule E to breached during Saturdays, Sundays and public holidays 1 December to 28 February (inclusive).
		Contact Recreation (applies to all reaches in water bodies and their beds with a Schedule B Value of Contact Recreation) (q) Existing public access to or along a river or lake must not be rendered unsafe by the activity. (s) Existing public access to or along a river or lake may be rendered unavailable where this is necessary for public safety or for the purpose of undertaking the activity, provided the public access is re-opened as soon as practicable. (t) Activities must not result in suspended sediment that causes the visual clarity standards in Schedule E to be breached at reaches with a Schedule B Value of Contact Recreation, during Saturdays, Sundays and public holidays 1 December to 28 February (inclusive).

		Existing Infrastructure (r) Excavation, drilling, tunnelling or other disturbance of the bed of a river must not take place within 500 m upstream or downstream of any flow-recording site.1 (v) Excavation, drilling, tunnelling or other disturbance of the bed of a river must not take place within 20m upstream or downstream of a high pressure gas transmission pipeline identified by a district plan or regional plan or by a marker2 on the bank of the river.
Hawke's Bay Regional Council	N/A	No general conditions / standard
Greater Wellington Regional Council	Permitted	**Rule 55A: Beds of lakes and rivers general conditions for activities in the beds of lakes and rivers that apply as specified in Rules R112 to R125:** (a) except where the discharge is expressly allowed by the activity description of a rule in this chapter there shall be no discharge of contaminants (including but not limited to oil, petrol, diesel, paint, or solvent, heavy metals or other toxicants) to water or the bed, except where this is the result of the disturbance of sediment and other materials already existing in the water or bed, and (b) no cleaning or refuelling of machinery or equipment, or storage of fuel shall take place in, or within 10m of, a river or lake bed, or at any location where fuel can enter any water body, and (c) all machinery, equipment and materials used for the activity shall be removed from the river or lake bed every night and on completion of the activity. This includes any excess material from the construction operation, any materials used during construction of any structure but not part of that structure, and any material removed or demolished from any structure, and (d) structures are designed, installed and maintained, and activities are carried out in a manner to ensure that fish passage is maintained at all times, unless a temporary restriction of no more than 48 hours is required for construction or maintenance activities. This shall include avoiding any aggradation or scouring of the bed of the river or lake that may inhibit fish passage, and (e) in any part of the river bed identified as inanga spawning habitat in Schedule F1 (rivers/lakes), no bed disturbance, diversions of water or sediment discharge shall occur between 1 January March and 31 May, and (f) in any part of the river or lake bed covered by water, which is identified as trout spawning waters in Schedule I (trout habitat), disturbance of the bed or diversions of water shall not take place during the spawning period of between 31 May and 31 August, and (g) all reasonable steps shall be taken to minimise the generation and release of sediment from the activity, and the discharge of any sediment to water from any activity in, on, over or under the bed of a river or lake must not, after reasonable mixing, result in any conspicuous change in the colour of water in the receiving water or change in horizontal visibility of greater than 30%, and (h) car bodies or demolition rubble shall not be used for any purpose on the bed of any river or lake, and (i) all reasonable steps shall be taken to minimise the duration of the diversion of water, and any diversion of water required to undertake the activity shall: i. only be temporary and for a period no longer than that required to complete the activity, and

		ii. must not involve a lake, and iii. any diversion channel required must have sufficient capacity to carry the same flow as the original channel, so as not to cause flooding or erosion of any neighbouring property, and (j) the activity shall not result in erosion or scour of the river banks or shall not result in flooding of any neighbouring property, and (k) any structure, other than a stormwater intake structure or debris arrestor, shall be designed so that it does not reduce the ability of the river to convey flood flows. All structures shall be maintained to manage flood debris accumulated against the structure and the conveyance of flood flows, and (l) any structure shall not alter the natural course of the river, including any diversion of water from the natural course during floods. Tree planting or vegetative bank edge protection works that are limited to the banks of the river and do not extend into the active channel are not considered to alter the course of the river for the purpose of this condition, and (m) the river or lake bed shall not be disturbed to a depth or an extent greater than that required to undertake the activity., and (n) in any part of a river or lake bed identified in Schedule F2a (birds-rivers) or Schedule F2b (birds-lakes), no structure shall be constructed, and no disturbance shall take place, during the critical period identified in Schedule F2a (birds-rivers) or Schedule F2b (birds-lakes) if the named birds are identified as nesting, roosting and foraging at the work site, and (o) beds of lakes and rivers general conditions (a) to (m) that apply as specified in Rule R112 to R125 do not cover any activities regulated by Sub-Part 4 – River crossings and Sub-Part 10 – General provisions in the Resource Management (National Environmental Standards for Plantation Forestry) Regulations 2017.
Tasman District Council	Permitted	**General** 1. Provision for and maintenance of the passage of fish. 2. Safe passage of flood water. 3. Potential adverse effects of the activity on indigenous biodiversity, including indigenous vegetation and aquatic habitats. 4. Measures to prevent damage to riparian vegetation or soil. 5. The potential adverse effects on bed and bank stability and water quality. 6. Adverse effects on the natural character and amenity of the river or lakes and effects on public access to the river, and values and uses, including those listed in Schedule 30A. 7. Safe navigation and the maintenance of public access, where appropriate. 8. Measures to prevent damage to any cultural heritage site, including those listed in Schedule 16.13C. 9. Monitoring compliance with conditions, effects of the activity on the environment, and the provision of information to Council. 10. The duration of the consent as provided for in Schedule 28A (Section 123 of the Act), timing of reviews, and the purposes of reviews (Section 128 of the Act).

		11. Financial contributions, bonds and covenants in respect of the performance of conditions, and administration charges (Section 108 of the Act).
		Structures 12. The design, location, construction and maintenance of the structure, including preparation of construction management plans. 13. Adverse effects of the activity on upstream or downstream properties and other structures.
		Culverts, Fords and Bridges 14. The design, location and construction of the structure, including the invert level of the culvert or ford and preparation of construction management plans. 15. Techniques for ensuring safe passage of flood water (spillway requirements), including fill material used in construction.
		Bed Disturbances 16. The location, extent, timing and duration of the activity. 17. Opportunities for enhancing bed stability, meander pattern, channel morphology, bed substrate or other aspect of habitat adversely affected by the activity
Nelson City Council	N/A	No general conditions / standards
Marlborough District Council	Permitted	No refuelling or fuel storage or the storage or placement of any hazardous substance, including but not limited to oil, hydraulic fluid or other fluid lubricants, must take place within 20m of surface water The activity must not cause flooding or erosion of private land The activity must be planned and conducted in a manner that does not compromise public safety. Any discharge of sediment into water must not, after reasonable mixing, cause a conspicuous change in colour of more than 5 Munsell units or a decrease in clarity of more than 20% for more than 8 hours in any 24 hour period and more than 40 hours in total in any calendar month. During the period of 1 September to 31 December in any year no activity must occur within 50m of an indigenous nesting bird in a lakebed or riverbed. An activity within the wetted area of a riverbed must not be carried out in a tidal reach between 1 February and 30 April, and 1 August and 30 November in any year. The works or structures do not prevent any existing fish passage.

West Coast Regional Council	N/A	No general conditions / standards
Canterbury Regional Council	N/A	No general conditions / standards
Otago Regional Council	N/A	No general conditions / standards
Southland Regional Council	Permitted	(a) Fish passage is not impeded as a result of the activity; and (b) There is no disturbance of roosting and nesting areas of the black fronted tern, black billed gull, banded dotterel or black fronted dotterel; and (c) Any activity in the water is kept to a minimum to avoid, as much as possible, discoloration of the water in the water bodies listed in the chapeau of the rule, including from any temporary sediment release; and (d) Any bed disturbance is kept to the minimum necessary to undertake the activity and the bed is returned as near as practicable to its original channel shape, area, depth, and gradient on completion of the activity (with the exception of revegetation); and (e) No fuel storage or machinery refuelling occurs on any area of the bed; and (f) No contaminants, other than sediment released from the bed, are discharged to water as a result of use of the structure unless allowed by a relevant permitted activity rule in this Plan or a resource consent; and (g) Before any equipment, machinery, or operating plant is moved to a new activity site it is effectively cleaned to prevent the spread of "pests" or "unwanted organisms" as defined by the Biosecurity Act 1993; and (h) All equipment, machinery, operating plant and debris associated with the structure or bed disturbance activity is removed from the site on completion of the activity; and (i) The structure or bed disturbance activity does not cause significant erosion of, or deposition on, the surrounding bed or banks; and (j) Any build-up of debris against the structure which may adversely affect flood risk, drainage capacity or bed or bank stability is removed as soon as practicable; and (k) The structure is maintained in a state of good repair; and (l) From the beginning of November until the end of May, there is no disturbance of whitebait spawning habitat.
Chatham Islands Council	Permitted	No general conditions / standards

Appendix 2: Gap analysis of codes of practice and guidelines

Table 2: Gap analysis of codes of practice and guidelines

Entity producing the guide	Guidance document	What does it cover?	Principles outlined	Methodology	Key gaps identified
Auckland Council	*Erosion and sediment control guide for land disturbing activities in the Auckland region. Auckland Council Guideline Document GD2016/005. Incorporating amendment 1.* Leersnyder et al (2016)	Erosion and sediment control (ESC), most of which is for land-disturbing activities not related to works in waterways. There is a specific section on works within a watercourse, which covers: • temporary watercourse crossings – bridges and culverts • dam and pump, or dam and divert devices • temporary watercourse diversions • coffer dam diversions.	Overarching principles of relevance to works in waterways: • protect receiving environments – sensitive receiving environments, streams, watercourses, and drainage patterns need to be mapped prior to works; use perimeter controls and diversions; sediment retention devices to control sediment laden runoff • use trained and experienced staff/contractors • assess ESC measures, adjust plan as necessary. Works in waterways specific principles: • permanent crossings should be in accordance with relevant design and regulations • select location where crossing effects are minimised, ie, select a location that will be least affected by the permanent design • plan crossings before you need them • construct during periods of dry weather	**Temporary watercourse crossings:** • locate temporary bridges and culverts in areas that are to be modified by final design • culverts should be 85 per cent of channel cross-section • scour protection is required in the event of overtopping of culverts • stream flows need to be diverted during installation (and removal) of temporary culverts • check temporary watercourse crossings after rain to check for blockages, bank erosion, scour or instability. Make repairs immediately. **Dam and pump method:** • dam is built from stabilised materials (eg, sandbags, sheet metal plate or other suitable materials) • install pump in dam with sufficient hose to discharge beyond downstream extent of works, with scour protection	• The reader is referred to separate guidelines for fish relocation and fish passage, but no mention of when these guidelines apply in the ESC activities specific to works in watercourses. • No mention of what "structural stability, utility and safety" standards are for temporary culverts. • There is no step-by-step method for installation of temporary watercourse crossing. • Bulka bags filled with sand could be viable product for dam creation. • No aperture sizing on fish screen recommendation on pump inlet. • What constitutes a "short duration" for pumping activities with respect to using the dam and pump method?

Entity producing the guide	Guidance document	What does it cover?	Principles outlined	Methodology	Key gaps identified
			• construct temporary crossings outside of peak migration periods • complete construction as quickly as possible • stabilise all areas as soon as possible during and after construction • bridges preferred over culverts, though specific designs required for bridges • control generally needed between bridge abutment and stream channel • culverts are more common and can be easily adapted to most site conditions • installation and removal of culverts can cause considerable damage to streambed, obstruct flood flows and present barriers to fish passage • culverts – sizing important as stormflows can cause erosion or overtop and destroy temporary structure • ensure culvert doesn't cause excessive safety issues in flood flows, including confirming that no increase in flood levels upstream (up to 1 per cent annual exceedance probability (AEP) in flood-prone areas)	• Place drum in drum with holes to minimise sucking sediment from bed – include fish screen. **Temporary watercourse diversions:** • excavate diversion channel leaving plug at each end so watercourse doesn't breach diversion • size diversion to convey 5 per cent annual exceedance probability (AEP), and consider implications of 1 per cent AEP (upstream effects, secondary flowpaths). • stabilise channel so it doesn't become a source of sediment with a suitable geotextile • once stabilised, open downstream plug to allow water to flow up channel, then open upstream plug • install non-erodible dam at upstream end of stream channel to divert into diversion channel (stabilise compacted earth dams) • relocate any fish in the isolated section of the watercourse • install non-erodible downstream dam to prevent backflow into stream channel	• What are the appropriate methods for stabilisation of the site on a daily basis? • No mention of appropriate colour of geotextile for stream diversion channels. • No guidance on how to stabilise beneath the upstream plug when it is removed from the temporary stream diversion method. Should guidance be given on an acceptable level of sediment generation? Or is there a suitable method for damming and over pumping during upstream plug removal? • The figure for upstream dam specification (Figure 123) is missing from guideline. • No effective control mechanism or methodology for trenching through a stream. • No mention of contingency stabilisation in the event that

Entity producing the guide	Guidance document	What does it cover?	Principles outlined	Methodology	Key gaps identified
			• ensure that fish passage isn't impacted by temporary culverts • structural stability, utility and safety are important considerations • remove temporary diversions when no longer needed and stabilise fully • keep machinery clear of watercourse during removal of structure • install structures in the dry • dam and pump can minimise disturbance when compared to diversion channel • diversion channels are sometimes the only option in high flow streams • dam and pump can be useful for small streams, and short durations or where site can be stabilised at the end of each day • not appropriate to use pumps where required to operate 24 hours due to noise and reliability • size pump for 1-year peak discharge from contributing catchment, assumes that full channel capacity is made overnight or when storms predicted • dam must be capable of holding back incoming flows.	• pump isolated channel into sediment retention pond (SRP) (or other appropriate device) for treatment then build structure • remove downstream dam to allow stream to flood back into original channel, then upstream dam. Backfill ends of diversion channel with non-erodible material • pump any dirty water to SRP or other device for treatment • backfill diversion channel and stabilise **Coffer dam diversions** • use non-erodible materials. Pump out retained water. Pump out dirty water within coffer dam to treatment device • Height of dam will be determined by potential height of water during works. • Fish relocation and fish passage – reader is referred to separate technical guidance	diversion method cannot cope with expected rain event. • Has the usefulness of coffer dams in a coastal or estuarine situation been considered? • There is no mention of what the implications of the maintenance items (specifically ripped geotextile, scour where flow re-enters channel and undercutting of diversion lining) mean, and what to do if they are noticed. • Only useful for Auckland streams, which are generally soft-bottomed first-, second- and third-order streams. • Are the diversion or crossing methods suitable or applicable in estuarine situations?

Entity producing the guide	Guidance document	What does it cover?	Principles outlined	Methodology	Key gaps identified
			• pump must be capable of conveying flows, as overtopping can cause environmental issues • work in the dry • temporary watercourse diversions are appropriate for ephemeral, intermittent and permanent watercourses and seek to divert all flows around site via stabilised system • coffer dams appropriate for outfall structures or stream bank retaining works • build coffer dams from non-erodible materials (eg, sandbags, sheet piles or similar) • ongoing maintenance needed. Watch for ripped geotextile, or scouring where flow re-enters channel and undercutting of diversion lining.		
	Best management practice: Works within watercourses. Auckland: Auckland Council. Auckland Council (2015)	Best practice guidance for all sites.	• Stormwater systems must only drain rain. • Protect receiving environments. • Forward planning by experienced personnel (including to identify if works are within or close to a watercourse). • Avoid working in water. • Minimise erosion and scour during temporary diversions.	• This is a quick guide, so no specific methodology provided.	• Doesn't mention faunal management.

Entity producing the guide	Guidance document	What does it cover?	Principles outlined	Methodology	Key gaps identified
			• Construct temporary dams from non-erodible materials (eg, sandbags) and remove after completion of works. • Don't leave any construction materials, waste, debris, structures in the watercourse after works are completed. • Minimise streamside vegetation removal. • Avoid contaminants entering watercourse (refuelling and storage outside of waterways). • Regularly assess performance of controls.		
Bay of Plenty Regional Council (Environment Bay of Plenty)	*Erosion and sediment control for forestry operations: Guidelines (Bay of Plenty Regional Council Guideline No. 2012/04).* Bay of Plenty Regional Council (2013)	Temporary stream crossings.	• Avoid working in streams, keep well clear. • Most crossings will need a resource consent. • Cross at right angles, on a straight section of stream. • Crossing approaches should be less than 10 degrees (18 per cent). Stabilise approaches as soon as construction is complete. • Stabilise abutments using rock protection, compacting, benching and revegetation. • Design stable batter slopes. • Design culvert length to achieve a stable batter slope.	• No methodologies provided for stream crossings.	• No minimum safe distance recommended to set-back from stream to avoid disturbance of the channel. • No mention of what fish spawning or migration seasons are. • What is "similar flexible material" when describing armouring of batters? • No mention of temporary stream diversions as a method. • No mention of what size streams the guideline

Entity producing the guide	Guidance document	What does it cover?	Principles outlined	Methodology	Key gaps identified
			• Ensure fish passage is not impeded. • Avoid constructing stream crossings in winter, prolonged wet weather or during fish spawning or migration periods. • Rock riprap (or similar flexible material) may be needed to prevent erosion of culverts. • Minimise use of temporary crossings. • Use lightweight culverts matched as close as possible to stream cross-section/channel size. • Log crossings generally discouraged but may be appropriate where streams are small. Avoid dragging soil across the crossing when the logs are pulled. • Construct major bridges and culverts in low flow conditions. • Ensure all machinery, materials and people on hand before building bridge. Use appropriate machinery. • Refuel and fuel storage should be done away from stream.		should be used for, despite forested areas potentially having a wide variety of stream types.
	River gravel management guidelines (Environment Bay of Plenty Guideline No. 2003/02).	Background of reasons for river gravel extraction, and the history in the district.	Principles cover typical topics: • minimising in-stream works • avoiding contaminant and sediment discharge	• Operational guidelines focused on considerations regarding rules of gravel extraction.	• Limited information regarding the potential impacts of gravel extraction. Focused on the reasons for

Entity producing the guide	Guidance document	What does it cover?	Principles outlined	Methodology	Key gaps identified
	Environment Bay of Plenty (2003)		• isolating work sites to prevent effects offsite • avoiding and mitigating effects on fauna (fish passage and bird nesting) • avoiding archaeological and historical sites • planning for emergencies (spills, bad weather) • adopting an adaptive approach to works.		undertaking gravel extraction. • No description of best practice methods for installing any required structures, specifics around nesting times/critical periods for fish. • All quite high-level guidance.
	Erosion and sediment control guidelines for land disturbing activities (Environment Bay of Plenty Guideline No. 2010/01). Environment Bay of Plenty (2010)	Describes the erosion process, including factors that lead to greater erosion and different erosion types. • ESC methods (silt fences, dams, geotextile etc) • Temporary watercourse crossings – bridges and culverts. • Temporary watercourse diversion.	Principles to guide methods that should minimise erosion and sediment discharge are outlined as: • minimising disturbance and time of exposure • staging construction • maintaining separation of clean and contaminated/dirty water • ensuring the ESC plan is adaptable to changing circumstances. When undertaking works and implementing ESC measures, the guideline has specific recommendations and guidance of where each method is most suitable: • loss of watercourse values and watercourses themselves can have permanent adverse environmental effects	Follows a similar structure to Leersnyder et al (2016). • Step-by-step methods for using ESC methods, including: Definition, purpose, conditions where a practice is suitable, construction specifications, maintenance needs and limitations of a method. • Temporary watercourse diversion method: As per GD05 Method 3 above. • Some “dos and don’ts” photos to further inform the guide.	• The methods and techniques are specific to temporary watercourse works only associated with crossings and diversions. • There is no step by step guide for the installation of temporary watercourse crossings. • There is no recommended time limit to guide when a temporary stream diversion requires damming and diverting by pipe, or by pump. • What treatment device should be used to treat dirty water that may accumulate between two

Entity producing the guide	Guidance document	What does it cover?	Principles outlined	Methodology	Key gaps identified
			• contact the regional council prior to undertaking stream works to check for consent requirements • avoid works in, or immediately adjacent to, watercourses • order of preference for crossing structures: bridges, arch culverts, box culverts, round culverts • all stages of works should avoid creating barriers to fish passage • ESC measures should not be constructed in permanent flowing water • install culverts (structures in stream) offline, away from stream flows. Watercourse diversions (ie, channel, or short-term pumping) will be necessary • after design, works method is the most important factor in minimising adverse effects • temporary watercourse crossings should have a maximum life of two years • select a location where the watercourse crossing effects are minimised • construct during periods of fine weather and construct as rapidly as possible and stabilise		dams if the upstream and downstream dams leak? • No mention of what the implications of the maintenance items (specifically ripped geotextile, scour where flow re-enters channel and undercutting of diversion lining) mean, and what to do if they are noticed.

Entity producing the guide	Guidance document	What does it cover?	Principles outlined	Methodology	Key gaps identified
			• plan where crossings will be needed • do not build crossings during fish migration periods • bridges are the preferred temporary crossing technique, but make sure they don't create an impediment to flood flow paths and that approaches don't create a source of sediment • installing and removing culverts can cause considerable damage to watercourses, and can obstruct flood flows • culverts should be capable of conveying flows associated with 20 per cent AEP, with a stabilised overland flow paths (OLFP) for larger storm events • inspections of temporary watercourse crossings should be done after rain. Check for: blockages, erosion, channel scour, instability. Repair immediately • remove structures that are no longer needed. Stabilise appropriately and keep machinery clear of watercourse during removal.		
	Earthworks fact sheet 3: Overall site management: Planning	Brief factsheet focused on ESC for earthworks projects.	Erosion control should be implemented as a primary measure to ensure that sediment control is effective.	Provides some information for implementation but not specific.	Does not cover ecological and environmental reasons for undertaking ESC.

Entity producing the guide	Guidance document	What does it cover?	Principles outlined	Methodology	Key gaps identified
	erosion and sediment control measures. Environment Bay of Plenty (2006)	Breaks ESC down into runoff control, surface stabilisation and sediment control.	Clean runoff should be separated from sediment laden runoff, and have a separate flow path around the disturbed site. All sediment laden runoff should pass through a sediment treatment system prior to discharge offsite. Runoff control channels should be of sufficient capacity to carry 20 per cent AEP (annual exceedance probability event) flows.		
Civil Contractors New Zealand	*Environmental guide: Providing information and advice to prevent environmental harm and legal consequences. Civil Contractors New Zealand.* Civil Contractors New Zealand (no date)	Environmental advice for small to medium-sized contractors regarding effects and considerations around land, air and water. Water-related guidance covers: • erosion and sediment control • dewatering • works in waterways (eg, dams and diversions) • hazardous substances • concrete runoff • wastewater.	• Briefly describes the environmental risks of each activity to waterways. • Outlines the considerations needed (land gradient, receiving environment) to determine ESC control options. • Description of typical "site preparation" practices for ESC, including sump protection and stockpile protection. • Outlines considerations needed in planning for activities, what preparation may be needed at a site and main considerations during works. • Identifies situations where fish salvage may be necessary (diversions, works in waterways). • Lists controls available to ensure water is clean for discharging or to	• Sump protection: filter socks, 'witches hats' or similar, should be used to prevent runoff and sediment generation. • Stockpile management: Stockpiles should be isolated, and measures taken to prevent water accumulating. • Dewatering: Check the local rules around dewatering, and have the appropriate treatment/controls available. • Controls should be monitored to ensure they continue to be effective and compliant. • Dams and diversions: Dams and diversions require over-pumping. Scour protection should be used if water flows are likely to cause erosion.	• No/little guidance about which control methods are most appropriate in each situation, and best practice methods to install them. • Brief information about control options. No referral to more detailed ESC documents that may hold more detail.

Entity producing the guide	Guidance document	What does it cover?	Principles outlined	Methodology	Key gaps identified
			prevent sediment discharge to a waterway. • Identifies that ESC plans may be required depending on the scale of the project. • Outlines possible consequences (eg, fines and legal action)	• Coffer dams: filtration of removed water may be needed. Fish salvage will be required. • Dredging/widening: install sediment gates in a series to catch sediment downstream. • Conduct works in clear weather where possible, or prepare to install additional controls if rain is forecast. • Hazardous substances: Appropriate spill kits should be available. Fuel should be stored in an appropriate location. Refuelling near waterways should be avoided. Follow the spill response plan. • Concrete runoff: Areas where concrete is being poured should be isolated from waterways, and waterways monitored for pH changes. Any washing should be into a lined skip or pit. A sucker truck or WetVac should be used to remove all concrete slurry when cutting concrete.	
Christchurch City Council	*Waterways, Wetlands and Drainage Guide.* Christchurch City Council (2003a, b)	• Channel bed stabilisation • Waterway bank protection, including bank regrading and waterway structural lining.	• Describes natural erosion processes and the relationship between flow and erodibility on stream channel form.	Channel bed stabilisation: • look to local existing natural streams for guidance on appropriate form. • bring erosion under control by introducing coarser substrates	• An informative guide, however, there is no information on how to physically undertake stream works while

Entity producing the guide	Guidance document	What does it cover?	Principles outlined	Methodology	Key gaps identified
			• Good background to causes and types of erosion, both natural and human influenced. • Description of considerations when determining suitable erosion protection methods. • Natural or naturalised waterways are the appropriate design and management option expect in special circumstances. Waterway lining (concrete, timber, etc.) commits future generations to expensive replacement, and encourages inappropriate development and filling too close to the edge of the waterway, and cannot support an ecologically diverse environment. • Bank protection works should only cater for the stability of the waterway perimeter, and not be used for structural support of adjacent buildings – they must be self-supporting.	than occur naturally, or geotextiles on exceptionally soft substrates. • principles applying to bank stabilisation may also apply to bed stabilisation. Waterway bank protection: • bank works design should incorporate the full range of values (ie, ecology, landscape, recreation, heritage, culture, drainage), not just structural integrity. • bank regrading is preferable to waterway structural lining. Bank work treatments should use minimum amount of engineering intervention necessary. • waterway structural lining includes retaining walls (bank terracing, stonework, gabions, reinforced earth, timber, shotcrete and structural concrete.	managing potential effects. • More relevant to designers than contractors undertaking the physical work. • No description of methods to separate work area from stream when undertaking bank stabilisation works, despite outlining protection measures that will inevitably involve work in the stream channel.
Environment Canterbury	*Erosion and sediment control guidelines for small sites.* Environment Canterbury (no date)		• No principles or information on works in waterways.	• No methodologies.	• No information at all on works in waterways. Is a guide aimed at managing effects of building sites; inclusion of works in waterways practices is inappropriate.

Entity producing the guide	Guidance document	What does it cover?	Principles outlined	Methodology	Key gaps identified
	Fish salvage guidance for works in waterways. Burrell & Gray (2017)	• Guidance on fish salvage. • Identifies where fish salvage may be necessary. • Identifies what activities may require fish salvage. • Applicable to all works in waterways, regardless of scale or size of project.	Doesn't specifically provide principles. • No killing of indigenous fish (Section 70 of Freshwater Fisheries Regulations 1983). • Fish salvage should always be considered. • Activities that result in fish being stranded on the bank will require fish to be returned to suitable habitat. • Monitoring of water quality downstream to avoid adverse effects on freshwater fish.	Recommended methodology: • initial survey to establish species and population sizes • timing of the works to avoid sensitive periods • isolate the work site to avoid effects where possible • provides high-level information on the techniques available for catching and relocating freshwater fish • ensure all permits and approvals are in place and fish salvage is overseen by a suitably qualified and experienced freshwater ecologist.	• • Only refers to freshwater fish, but current legislation includes kēkēwai and kākahi in the definition of freshwater fish.
	Canterbury regional code of practice for defences against water and drainage schemes Canterbury Regional Council (2019)	The document covers works in waterways related to 'defences against water', such as flood protection works. Activities covered include: • drain works (weed control, culvert and floodgate installation, bank/edge maintenance) • river works (works and maintenance to protect banks such as groynes, clearing flood debris)	Follows Resource Management Act 1991 (RMA) hierarchy of mitigating effects. • Recognises that in-stream environmental and ecological values should be identified and effects avoided. • Activities should minimise in-stream works, avoid sediment deposition and discharge, and avoid or mitigate effects on fish passage. • Flood protection works should not negatively impact on berm and riparian values where possible	General methods and requirements for each activity group are outlined. • Includes general recommendations and considerations such as timing, planning for minimal disturbance and having contingency plans for spills and bad weather. • Describes rules and requirements for timing of works • Accidental discovery protocol outlined.	• ESC guidelines state the desired outcomes and requirements (ie, no erosion or sediment discharge), but do not cover the options for appropriate control methods and how to implement them. • Requirements to minimise and prevent environmental impacts are described. • Is primarily aimed at informing requirements for planning for gaining

Entity producing the guide	Guidance document	What does it cover?	Principles outlined	Methodology	Key gaps identified
		• tree works (planting, removal) • vegetation clearance • other control and maintenance (pest control, flood pumping).	including effects on native vegetation and the habitats of indigenous species. • Opportunity to enhance the environment and incorporate into work where possible (such as restoring or enhancing fish passage or planting). • Cultural matters should be considered and provided for, including sites of significance, and using appropriate construction and accidental discovery procedures adopted to avoid, remedy or mitigate adverse effects. Engagement with tangata whenua should be included. • Waterways shall not be narrowed, restricted, or realigned to a degree that reduces flood capacity, increases erosion risk, or destabilises river alignment. • Minimise changes to riverbed levels. • Existing flood and erosion protection infrastructure shall not be weakened. • Performance of other infrastructure such as bridges, water intakes and power pylons shall not be adversely affected.	• Requirements for fuel and hazardous materials management outlined – including not refuelling over a waterway or storing contaminants within 20 metres of a watercourse. • ESC is required, and states that works shall not cause erosion, nor impede fish passage. • Outlines measures required to be taken to undertake an activity while minimising environmental impact. • Includes a checklist of requirements pre-, during and post-works for each activity type.	consent, and requirements while undertaking works for an activity to remain compliant.

Entity producing the guide	Guidance document	What does it cover?	Principles outlined	Methodology	Key gaps identified
			• New flood protection infrastructure shall be maintained on an ongoing basis by the local authority or network utility operator. • Location, timing, duration and scale of works shall be considered. • Work within significant natural areas (SNAs) is minimised. • Outlines erosion and sediment control principles that should be followed. Directs to ESC Toolbox website. • Guiding principles for gravel extraction: minimising effects (including sedimentation, on fauna, pests, flood and erosion risk, cultural values).		
	Canterbury Regional Council river gravel extraction code of practice Environment Canterbury (2017)	A guide for gravel extraction rules and standards in Canterbury. Includes: • work in flowing water • temporary culverts and bridges • refuelling • equipment and machinery storage • dust.	Briefly describes the benefits and negative impacts gravel extraction may have. Includes cultural considerations. Guiding principles for achieving good practice include ecological considerations, such as maintaining habitat for birds and fish, avoiding critical periods for fish, minimising works in flowing water and minimising sediment and contaminant discharge.	Standards and rules described.	• A focus on flood management. • Standard rules and consent conditions are outlined (eg, temporary structures and diversions are allowed) but does not have guidance regarding implementation of installing these structures. • Preferred/best practice methods of extraction (eg, excavator type/size, etc) are not described.

Entity producing the guide	Guidance document	What does it cover?	Principles outlined	Methodology	Key gaps identified
	Good drain management practices. Environment Canterbury (2018)	Brochure. Addresses physical and chemical methods of drain clearance. Also briefly talks about planting and fencing to reduce impacts on streams.	Briefly outlines the importance of drains as habitats for aquatic flora and fauna. Describes the problems that occur with excessive macrophyte growth, but recognises the need to minimise ecological impacts when undertaking drain clearance. Addresses several issues with drain clearance, including: • the need to avoid undertaking works during critical periods for fish • avoiding damage to habitat in stream and on the banks • using methods that minimise fish stranding/kill.	Promotes a preventative approach. For physical clearance of weeds: • recommends staging works (ie, not clearing an entire waterway all in one go). • avoiding mechanical removal if possible, and instead using hand-cutting methods. • using a weed rake or weed bucket to reduce chance of fish by-catch and minimise disturbance to the streambed. • undertaking fish salvage. • using filters to prevent sediment moving downstream. For chemical clearance of weeds (ie, spraying): • engaging rūnanga before spraying • ensuring only approved chemicals are used • avoiding spraying in known habitat for fauna (in particular, whitebait) and during critical periods for fish • using other mitigation methods, such as planting and fencing to prevent further macrophyte growth.	Focused on "drains", though is probably applicable to a wider range of watercourses. A lack of regard to possible disturbance of sediments or additional sediment discharge caused by the activity, and mitigation measures for this.

Entity producing the guide	Guidance document	What does it cover?	Principles outlined	Methodology	Key gaps identified
Department of Conservation	*River erosion protection works: Technical guidance for RMA and concessions applications.* Burrell (2019)	• Erosion protection structures: rock groynes, bridge pile protection, concrete blocks and banks, gabions and reno mattresses, rock lining and riprap, rock bank footing, geotextile bags, debris fences. • In-stream works: channel realignment, channel 'training'. • Sheet piling or plastic lined Geodesign Barrier.	• Soft engineering preferable to hard engineering. • Working outside of flowing water greatly reduces construction-related issues associated with erosion and sedimentation, and should be encouraged. • Avoid nesting and migration periods of threatened or at-risk birds and fish. • Regional and district rules need to be complied with. • In-stream works and crossing should be limited. • Fish passage should be maintained past all works. • Salvage and relocation of lizards, fish, kōura and kākahi should be undertaken before (and during) any works. • Table in Section 4 contains a very good description of potential effects on values and means to address them. • Section 5 describes types of erosion protection measures and in-stream works undertaken in waterways and their associated effects on waterways. • Promote ecologically sensitive methods for erosion protection from most sensitive to least:	• Coffer dams • Bank works: bidim cloth should be used for short-term protection to limit erosion and runoff. Coconut matting should be used at the end of works, before planting. • Gravel extraction should be a minimum of 5 metres back from the water's edge. • Gravel shouldn't be excavated deeper than 30 centimetres above the water level. • Recommend haybales, pontoons and silt screens to minimise sediment discharge. • Avoid works in flowing water. • Use fish screens on any pumps. • Maintain fish passage. • Machinery and equipment should be cleaned and dried before commencing works. • "Best practice" should be followed for •	• This publication lacks guidance on how to understand/assess the physical aspects or methodology of how the work could be undertaken. • Recommended to isolate works site from water, using sheet piling, Geodesign Barriers or similar, but provides no advice on set-up or installation. • Mentions screening at inlet of pump to avoid fish being drawn into the pump and killed, but provides no guidance on what a suitable screen size is. • The publication is a tool to assist the understanding and assessment of effects as they relate to erosion control practices for use by consent application assessments. To that end, there is no specific guidance on how to physically undertake in-

Entity producing the guide	Guidance document	What does it cover?	Principles outlined	Methodology	Key gaps identified
			provide space for river, native vegetation for erosion protection, 'softer' engineering options. • Key matters to address effects during construction: minimise extent and duration of disturbance; avoid sensitive periods for at risk and threatened species; work in the dry where possible; use appropriately trained and informed contractors. • Fish salvage and relocation before works start and fish exclusion nets upstream and downstream of works area. Fish screen at inlet of pump, stabilise at outlet of pump to prevent scour. • Create dry works site by coffer dam (sheet piles or Geodesign barrier). • Silt fences or silt curtains as a last resort – erosion control should predominate. • Avoid coconut matting with plastic mesh, or long-term stabilisation of soft landscaping with artificial fibre geotextiles. • Mitigate adverse ecological effects in the long term.		stream works to minimise effects.
Greater Wellington Regional Council	*Erosion and sediment control guidelines for the Wellington Region.*	• Temporary water body diversions.	• Plan to minimise the need for temporary water body crossings, avoid if possible.	• As per GD05 Method 3 for temporary watercourse diversions.	• Section 6.1 d. Step 2 – Dam construction for plugging stream channel is recommended to be

Entity producing the guide	Guidance document	What does it cover?	Principles outlined	Methodology	Key gaps identified
	Greater Wellington Regional Council (2002)	• Temporary water body crossings: bridges, culverts, fords.	• Plan to build them in periods of dry weather. Construct rapidly and stabilise as soon as possible. • Bridges are preferred for all the usual reasons, but they can present a safety hazard if not installed and maintained appropriately. • Fords are used in steep catchments subject to flooding but where normal flows are shallow. Only use them where crossing requirements are infrequent. They can offer little or no obstruction to flows, are relatively easy to install and maintain and in most cases can be left in place at the end of the construction activity. • Usual maintenance items to check for with temporary watercourse crossings. • Remove crossing on completion.		shotcrete/concrete covered. Use of concrete in close proximity to the stream may cause issues with pH control/runoff? • Should fords really be left in place post-construction?
	Guide for landowners & excavator operators: Good practices for the mechanical management of highly modified waterways. Greater Wellington Regional Council (2020)	Activities are predominantly concerned with farm-drain type management practices – clearing macrophytes and silt from waterways mechanically.	Outlines environmental/ecological value of modified waterways. Best practice shaped around the principles: • maintain the streambed profile • retain bank vegetation • reduce the effects of fish stranding • preserve or create aquatic habitat • minimise sediment release	**Maintain the streambed profile** Only remove unconsolidated fine sediment. **Retain bank vegetation** Stabilise exposed soil **Reseed/replant bare earth** Reduce the effects of fish stranding • Undertake fish recovery:	Generally well covered for the activities included.

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			• time works to avoid critical periods for fish migration and spawning • reduce the frequency of waterway clearance.	• search thinly spread spoil for fish • return fauna upstream of the works immediately (if possible); if fish must be held, aeration of water must be maintained (manually or with aeration device) • fauna should not be held out of the waterway for longer than 1 hour • periodically re-check spoil for fish, including a check the following morning. • use a weed rake in hard-bottomed waterways • leave the bucket submerged at the end of each scoop. **Preserve or create aquatic habitat** • avoid clearing all waterways at once • preserve specific habitats (eg, pools, riffles, woody debris) that may provide important habitat for refuge and breeding • avoid removing gravel • maintain variability in the streambed profile. **Minimise sediment release** • Install permanent sediment traps.	

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				• Install temporary sediment retention devices (eg, cloth) across the channel. • Maintain an uncleared section downstream of the excavator. • Use a conventional bucket in heavily silted waterways. • Recover distressed fish from the waterway. **Time works to avoid critical periods for fish migration and spawning** • Delay works if large numbers of īnanga during the spawning season. **Reduce the frequency of waterway clearance** • Only undertake when necessary. • Use preventative measures (eg, planting to provide shading).	
	Small earthworks. Erosion and sediment control for small sites. Greater Wellington Regional Council (2006)	Outlines reasons for undertaking ESC (environmental risks) very briefly.	• Undertake works in spring/summer months to avoid rainy periods. • Check rainfall, slopes, soil types, vegetation cover, and nearby watercourses. • Check for overland flow paths and existing waterways in the site, or neighbouring. • Assess site for what may be the most appropriate ESC measures. • Minimise area of exposed soil.	No specific methods provided – options for ESC methods are suggested. **Sediment control:** • Hay bales, sumps and vegetated buffer strips and basecourse bunds can be effective for minor flows and low sediment loads. • Silt fences or earth bunds can be used to interrupt overland flow down gentle slopes.	Direction on what may be the "best" option for different situations is not provided. No specific installation methods provided. Suggestive for good practice, but actual implementation isn't covered. No mention of effects on fauna, or provisions that may

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			• Stage works. • Consider temporary crossings. • Plan for stabilising, revegetating sites as soon as possible. • Keep vehicles off site as much as possible. • Prevent clean water running onto site to prevent treating sediment-loaded water. • Stockpiles should be kept away from surface-water flow paths and paved surfaces. • Cement/concrete wash shouldn't be allowed to enter a waterway. • Hazardous substances (fuel, oils etc) should be used and stored in such a way that they do not contaminate water or soil.	• For silt fences, install posts at 2-metre intervals and firmly anchor filter cloth to the slope by burying it or using large rocks to secure it, plastic or wire mesh or similar can be used to reinforce silt fence cloth. Shade cloth does not make an acceptable silt fence. • Sediment ponds are recommended for larger sites. **Replacing veg:** • A straw or mulch layer 100-millimetres deep can be can provide short-term protection until the new growth is established.	be required where fauna may be affected.
Hawke's Bay Regional Council	*Hawke's Bay waterway guidelines: Erosion & sediment control.* Hawke's Bay Regional Council (2009a)		• Avoid works in a watercourse where possible. Consider alternatives. • Install a stabilised diversion so works can be undertaken in the dry. • Carry out works during dry time of year when streams are low and storm likelihood is low. • Keep duration of works short. • Avoid fish spawning periods.	• • No methodologies.	• The publication recommends avoiding periods of fish spawning. Should this be extended to include fish migration periods too, or just spawning? • There is no mention of what fish passage provisions are, or where to seek advice. • Publication recommends notifying downstream

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			• Install appropriately designed fish passage provisions.		users of your in-stream actions. How far downstream do you go with notification of downstream users? • There are no methods or pictures provided for appropriate watercourse crossings or stream works.
	Hawke's Bay waterway guidelines: Works in waterways. Hawke's Bay Regional Council (2009b)	Outlines the high potential for erosion and sediment discharge when works take place around watercourses. Covers the purpose, application, design and maintenance of the following structures/activities: • temporary watercourse crossings (bridges, culverts, fords) • dam and pumping/dam and divert • temporary diversions • rock outlet protection.	• Preference for temporary crossings: bridge, then culvert, and fords only where crossing frequency is low. • Do not build a watercourse crossing during the fish migration period for the watercourse.	Some design features provided for structures: • some bridge design suggestions • culvert to be sized for approximately 85 per cent of the channel if in place for less than a year • provides step-by-step for installing/livening stream diversions (as in GD05).	• Little to no detail on probable needs for ESC during construction. • Discusses ESC factors of a feature in terms of the end-product, and less in terms of the effect of construction of the structure. • Little mention of fish passage (only in the bridge section) and need to maintain with any of the structures. • No discussion of possible fish salvage requirements for diversion. • No provision for culverts to be in place for longer than a year.

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	Environmental code of practice for river control and waterway works. Hawke's Bay Regional Council (2017)	Aimed to outline best-practice standards for river control and drainage works. Identifies region's river values. Activities that may involve in stream works: • channel diversions • drain maintenance • crossings • gravel extraction • rock revetments • weed cutting.	• Machinery should be kept out of waterways as far as practicable. • Refuelling and fuel, contaminant and chemical storage should be kept clear of waterways. • Fish passage must always be maintained during in-stream works. • Concrete pouring should take place in a contained area to prevent uncured material entering a waterway. • Crossing of the active river channel by machinery should be avoided where practicable during the fish spawning months of May to September.	Very brief methodologies are outlined. Weed spraying: • mix sprays away from a watercourse • use spot-spraying techniques and avoid discharge of herbicide to the water's surface. Channel diversion: • Diversion sided should not have steeper banks than 1:1. • Diversion works should avoid fish spawning period of May to September, unless suitable fish passage is provided. General: • No refuelling of machinery should occur within 20 metres of the active river channel.	• Diversions: discusses avoiding fish spawning periods unless passage is possible. These issues should probably be considered separately. • Very brief descriptions of each activity. • Not much (if any in places) reference to ESC measures that need to be considered.
Horizons Regional Council	*Working in beds of rivers and lakes – General conditions* Horizons Regional Council (2016c)	General conditions for working in waterways, in relation to protecting values – high-level overview, typically refers reader to consult the regional plan. Considers sediment, contaminants and hazards, protecting aquatic fauna, and considering terrestrial fauna in riparian areas.	• General conditions or works in streams and rivers – keep out of flowing water, avoid working when rain is expected, don't reduce capacity of river for longer than 12 consecutive hours, use only materials you need and don't leave anything after you've finished, don't let toxic material get into the water, refuel where spills can't enter water, bank modifications	• No methodologies.	• The condition requiring a temporary diversion channel to have the same capacity of the original channel may be unworkable in rivers, or large streams. • The publication ought to stipulate a design storm to convey, otherwise it could be interpreted as

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			should have a natural shape and be revegetated when you finish. • Outlines conditions associated with temporary diversion of water (ie, restricting the length of diversion to no more than 100 metres and still within the bed of the river). No diversion between catchments. Diversions can't involve a lake, must be able to carry the same flow as the original channel, and must be removed on completion. • Restrictions on various activities at various times of the year to protect values of rivers and streams: Avoid times when native birds may be nesting; fish spawning and whitebait migration; weekends and public holidays in summer for recreational users.		needing to convey the 1 per cent AEP. • Seems to apply only to river systems and no guidance is given on how to physically undertake works in water ways.
	Environmental code of practice for river works. Horizons Regional Council (2010)	Activities covered are considered for the purpose of river management, flood protection, erosion control and drainage management. **River management activities:** • bank shaping; including bank battering and slump reinstatement • beach raking • gravel extraction	Outlines environmental principles briefly. Standards for good practice for all activities include: • Having consideration for habitat and morphological diversity, including maintaining fish passage during works in waterways. • Minimising in-stream works, including keeping machinery out of flowing water.	• No specific methodology for each activity is provided, with the exception of some directions given in the "standards for good practice" for each activity.	• Ecosystem values only considered to be significant for a number of factors (eg, īnanga spawning, whitebait migration) for "specified sites/reaches". • The "natural state" of rivers only required to be maintained on public conservation land (PCL). • Consideration of environmental values

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		• gravel management, including channel realignment, diversions and gravel relocation • channel clearance. **Hard engineering activities include:** • lateral walls – concrete block, timber, sheet piling, gabions • concrete riprap • culverts • detention dam maintenance • drainage channels/modified streams – mechanical cleaning • drainage channels/modified streams – weed control by herbicide application • grade controls/bed control structures/weirs • groynes – impermeable and permeable • permeable mesh units • rock linings	• Avoiding discharges of sediment or contaminants into water. • Avoiding or mitigating effects of activities on fish passage. • Isolating the works site to avoid adverse offsite effects, including undertaking refuelling of machinery away from a water body. • Taking an adaptive approach to methods. • Planning riparian planting carefully. • Avoiding archaeological or historic sites. • Maintaining ecological values. • Maintaining works to an appropriate standard. • Considering emergency contingencies. • Avoiding the transfer of aquatic pests. • Minimise the extent, duration and frequency of the activity, including the possible need to stage works.		limited (eg, no timing considerations for fish species beyond trout, whitebait and īnanga). • Direction on how to achieve things such as maintaining fish passage are not covered.
	Clearing streams and drains.	Information sheet outlines rules for clearing macrophytes and sediment from streams	• Can remove and destroy weeds from streams and farm drains except when water is flowing	• Spot spraying should take place following the manufacturer's instructions.	• Mentions being able to spray weeds in "rare, threatened and at-risk

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	Horizons Regional Council (2016a)	and drains mechanically, and small-scale gravel extraction.	through wetlands, lakes, lagoons or indigenous vegetation that is rare, threatened and at-risk habitat. • Spraying of weeds should be using spot-spraying. • Manage sediment discharge when digging out waterways by undertaking work when the waterway is dry, or dig only once a year for no longer than 24 hours. • Cleared material should be checked within 5 minutes of removal from the waterway for stranded fish, which should be returned to the stream immediately. • Look to other documents for specific rules/conditions.	• Spray should be kept out of the water. • No methods provided for digging out the stream.	habitats" though does not seek to define these or how to determine such habitats beyond "seeking advice". • Does not suggest further sediment control measures beyond only undertaking the work once a year. • No best practice methods such as using a weed rake rather than bucket mentioned.
	Structures in the beds of rivers and lakes. Horizons Regional Council (2016b)	Factsheet regarding rules and provisions required when installing structures (small scale bridges, fords, pipelines).	• Structures must be constructed and maintained to avoid changes to the riverbed that may affect fish passage. • Structures such as pipes and cables should be installed so that they do not disrupt flow or cause scouring.	• Refers to other documents for methods. • Size limits for structures (without consent) provided: 40m2 for fords, other structures such as bridges is 20m2.	• • Environmental impacts/considerations beyond avoiding impacts on fish passage aren't covered.
Tasman District Council / Nelson City Council	*Erosion and sediment control practices in New Zealand: Information gaps.* Basher et al (2016a)		• No discussion on works in waterways.	• No methodologies.	• Doesn't pertain to works in watercourses.
	Scientific basis for erosion and sediment		• Table on page 10 (page 22 of PDF) briefly outlines various practices:	• No methodologies.	• Doesn't pertain to works in watercourses.

Entity producing the guide	Guidance document	What does it cover?	Principles outlined	Methodology	Key gaps identified
	control practices in New Zealand Basher et al (2016b)		• temporary watercourse crossings • permanent watercourse crossings • dam (with pumping or diverting) • temporary waterway diversions • in-stream and near stream works.		
	Best practice guidelines for waterway crossings. James (2009)	Guide for different types of permanent crossing structures and where they are best suited. Similar to Environment Waikato stream crossing guide.	• Preferred hierarchy of crossing types is: single span bridge, single-barrel arch culvert, single barrel circular culvert, multi-barrel circular culvert, box culvert, ford. • Maintaining and restoring ecological values briefly discussed, with focus on fish passage. Includes considerations regarding lighting, water velocity, whether passage is perched, substrate (ie, too smooth), and angle.	• Design and retrofitting of crossings (particularly culverts) to allow for fish passage (including improving lighting) is described. • Methods for installing crossings not included.	• Does not cover multiple-span bridges. • Provides design standards to provide for fish passage and best environmental outcomes of the final product, but does not provide consideration for other environmental concerns that may arise during the construction of the structure (eg ESC).
	Nelson Tasman erosion and sediment control guidelines. Nelson City Council & Tasman District Council (2019)	• Temporary waterway crossings – bridges, culverts, fords. • Diversion by coffer dam. • Temporary diversion by damming and piping. • Temporary diversion channel. • Outlet protection.	• Works in watercourses – direct effects: direct removal and destruction of substrate by digging out bed; removing wildlife spawning areas (in-stream and along banks); removing cover used for refuge; removal of vegetation that provides food (eg, leaf and insect fall); removing vegetation that provides shading. • Far-reaching impacts: destroying aquatic habitat by filling pools; deposition reduces carrying capacity of channel; smothering of	**Temporary watercourse crossings** • Select an area where effects are minimised (eg, old or existing crossings, or where bed is firm aggregate rather than muds). • Install during low dry and dry weather, install quickly and stabilise all areas. • Bridges are preferred temporary crossing. • Culverts – sizing detail is provided in appendix and table of document. For duration less	• No aperture size for pump screen, only flow rate maximum velocity over screen. • No mention of where to dewater work area to during dam and pump diversion method.

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			wildlife; reduction of light for plantings and animals to see for feeding; damage to aquatic food supplies; damage to gills of fish and inverts; impact on reproduction of fish; amenity and natural character loss. • Activities in watercourses mean within the water or riverbed, while works around watercourses mean those in close proximity (eg, within 15 metres). • Includes aspects considered by Tasman Resources Management Plan & Nelson Resources Management Plan for works around watercourses and definitions of watercourses. • Don't install ESC measures in channels with permanent flow. • Fish and eel recovery may be required for stream and river works. Guidance provided on who can undertake fish capture and how to undertake for two scenarios. • Don't build watercourse crossings during spawning or migration.	than two weeks, culvert should be 85 per cent of channel at bank full width, with appropriate provision for overtopping. • Contingency for temporary crossings needed – removal of structure and stabilise, understanding flow paths around site, scour protection, machinery and materials are out of channel prior to storm. • Provide fish passage for temp culverts – invert below bed, velocity dissipation structures, multiple barrel culverts – one should be lower than others, sloped base to box culverts to keep flow to one side. • Fords – as per Waka Kotahi NZTA guide. • Remove all temporary structures on completion. **Coffer dams** • Allows isolation of work area in stream or lake. Water can continually flow past and no barrier to fish passage. Not suitable in high velocities, may require ongoing dewatering due to groundwater or leakage, how to dispose of sediment-laden	

Entity producing the guide	Guidance document	What does it cover?	Principles outlined	Methodology	Key gaps identified
				water within dam, can create small, confined area. • Install from upstream to down. • Contingency planning could be to remove dam, temporarily stabilise work area, remove materials and machines. • Remove from downstream to up. **Diversions by damming and piping/pumping** • Less disturbance than diversion channel. Generally suitable for small streams with low flow. Limitation with using a pump is the pump rate, runout of fuel, or breakdown. There are fish passage issues with using a pump. Dam across watercourse, upstream and downstream. Install pump and sit intake in drum with a screen placed on the inlet to ensure velocity over screen is less than 0.3m/sec to prevent sucking up aquatic life and minimise sediment being sucked up from bed. Discharge pump to stabilised area. • Carry out fish capture as works area is dewatered. • Five-day time limit on over pump method due to fish	

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				passage barrier requirements (no more than five days in a 20-day period). • Contingency planning could be to remove dam, temporarily stabilise work area, remove materials and machines. • Reinstate bed in the works area by matching upstream and downstream stream profile and cross-section. Reinstate similar bed substrate. • To decommission, retain fish barrier nets; while still pumping past, remove downstream dam; remove upstream dam and reduce rate of pumping to achieve low flow through works area; once water is flowing, turn off pump and remove all equipment and fish barrier nets. • • Diversion by temporary channel • Useful for longer duration, if base flows exceed pump capacity, or fish passage needs to be maintained. • Method as per GD05 but includes fish exclusion nets for fish recovery. • Contingency as per other methods.	

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				• Decommissioning should match cross section and substrate of the stream.	
Northland Regional Council	*Gravel management in our rivers.* Northland Regional Council (no date)	• Factsheet regarding gravel management. Outlines the reasoning for undertaking gravel management and some rules around gravel extraction.	• None provided	• No methodologies provided	Alludes to standards (to be found elsewhere), however, does not outline any potential negative environmental impacts of gravel management activities.
Waka Kotahi NZTA	*Erosion and sediment control guidelines for State Highway infrastructure: Construction stormwater management.* New Zealand Transport Agency (2014)	• Temporary watercourse crossings – bridge, culvert, ford. • Dam and pump, or dam and divert. • Temporary waterway diversions. • In-stream and near stream works.	• High potential for erosion and discharge of sediment. • Methods and techniques are specific to temporary watercourse works only. • Temporary watercourse crossings should be installation in the dry, as quickly as possible and stabilised all round on completion. • Don't install during fish migration periods. • Bridges are preferred method of temporary crossing. • Culverts are adaptable, but destructive. • Culverts should be 85 per cent of the channel cross-section if the duration of the crossing is less than 1 year. For durations >1 year, specific hydrological design is needed. Scour protection is needed.	• **Temporary watercourse crossings** – no real method, but considerations given. • **Dam and pump, or dam and divert** – as per GD05. • Also includes: if duration of temporary channel is: <30 days, size for 2-year peak discharge; 30–60 days, 10-year peak discharge; >60 days, 20-year peak discharge. • Dam must be capable of holding back incoming flows. • Pump should be capable of conveying all flows beyond downstream dam and discharge in a way that doesn't cause scour. • **Temporary waterway Diversions** – for use in permanent and ephemeral watercourses.	• Methods and techniques are specific to temporary watercourse works only. • Perhaps a bit light in terms of applicability especially when you consider the variation in types of waterways that could be encountered by NZTA works.

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			• Ensure maintenance of fish passage. • Consent may be required. • Fords for steep catchments with shallow normal flows. • Remove all temporary structures on completion and stabilise fully. Keep machinery away from watercourses during removal. • Standard maintenance items for temporary watercourse crossings.	• Size for 5 per cent AEP rain event. • Method is same as GD05, but includes statement about shot-creting dam. • **Coffer dams** – no text method, but good diagrams of how various coffer dams can be built, including a structure to dewater to, but no mention of what that dewatering structure should be. • Maintenance: inspection daily with more frequent check during storms, repair gaps, holes and scour, remove any captured sediment on completion, remove structure, stabilise.	
	Fish recovery and rescue protocols: Draft. River Lake Ltd (2018)	A guide for undertaking fish salvage. (Note this guide was drafted for a specific project.)	• Fish rescue applies for installation of culverts and stream diversions. • Prioritises rescue of native species over introduced fish species. • More intensive efforts for fish rescue planned for waterways where more native fish are expected.	**Overnight trapping:** Fyke nets require sufficient water depth (about 35–40 centimetre) and sufficient stream width (about >55 centimetre) free of snags. Gee minnow traps (GMTs) require about 15 centimetre water depth, though they can be dug into the sediment in shallower water (Ling et al, 2013). • Nets should be set overnight, with nets put out in the late afternoon/evening and retrieved early the following morning.	• Protocol where fish are "allowed to voluntarily leave" the area is not best practice. Active salvage/recovery should be prioritised to maximise likelihood of successful rescue and numbers of fish rescued/salvaged. This also would likely be hard to achieve while dewatering where site isolation is required.

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				• Traps and nets may need to be set for several nights in a row, depending on the number of fish caught, species present and size of the site. • If native fish with a conservation status of threatened or at risk – declining are found in densities greater than 0.5 fish per trap/net then netting/trapping should be carried out until catch rates fall below an average of 0.5 fish per trap/net (excluding juveniles). • Up to three nights of netting in total may be necessary, checking the traps for fish each morning. Document notes that additional nights of trapping increase the risk of site isolation failure during rain events and blocking fish passage. • Overnight trapping after partial dewatering may also be an effective fish recovery method. It has been found to be a very effective method for fish recovery in macrophyte dominated streams if fyke nets/traps can be placed in confined channels where the water is draining.	• A single pass of EF is not likely to be sufficient, especially in a large area. • Fish relocation protocol do not stipulate the need to place fish in water clear of active sedimentation/high turbidity.

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				• Fyke nets will be set at a density of 6 per 100 metres of stream if the channel is deep enough. • There should be two GMTs placed within 5 metres of each fyke net. **Electric fishing and voluntary leaving** Backpack electric fishing requires about 10 centimetres of water depth, but is ineffective and unsafe in deep water (eg, about 60 centimetres), or where there is soft deep sediment or dense aquatic vegetation. • Allow fish to swim downstream as water recedes during dewatering. • Electric fishing will be used where trapping and 'voluntary leaving' is not possible. • A single pass of electric fishing will be used. **Fish relocation** • Fish will be held in containers for as short a period as possible – less than 3 hours, with water changed every two hours and maintained at a temperature of under 20°C. • Oxygenators may be required.	

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				• Larger eels and kōura should be held separately to smaller fish. • Fish should be relocated to similar habitat as the source habitat, and over a similar length of stream as where they were caught. • Fish should be handled with wet hands or gloves. • Pest fish should be disposed of.	
Waikato Regional Council	*Erosion & sediment control guidelines for soil disturbing activities.* Environment Waikato Regional Council (2009)	• Temporary watercourse crossings: bridge, culvert or ford. • Temporary watercourse diversion. • Permanent watercourse crossings: bridge, culvert, ford. • Rock outlet protection.	• High potential for discharge of sediment. • Select a position that minimises effects of temporary watercourse crossings, and plan well before you need them. • Install in dry weather as rapidly as possible and stabilise afterwards. • Bridges are preferred, then culverts, then fords. • Typical maintenance items for temporary crossings recommended: blockages, erosion, scour, instability. • Size temporary watercourse diversions for 5 per cent AEP. • Includes guidance on permanent structures.	• No method for temporary water crossing installation. • Method for temporary watercourse diversion is the same as GWRC. • **Permanent bridges:** Bridge abutments/piles on stable ground. Lowest point of soffit must be minimum 0.5 metres above 1 per cent AEP flood level. Approach to bridges should be less than 10 per cent (1V:10H) and should avoid flood flow restriction. Engineering design needed. Keep in-channel support outside low flow channel. Spans >10 metres likely to need specialist design and in-channel support. Avoid/minimise restrictions to flood flow in channel or flood plain. Channel armouring may	• Temporary crossings need to comply with WRC requirements, but no mention of where these requirements can be found. • Temporary diversion channel needs compacted clay plug to seal off existing channel. Mentions shot-creting/concreting bund, but no discussion on pH effect, or measures to prevent discharge to stream. No direction provided on rock sizing for outlet protection. • Guide recommends use of "well graded rock riprap" for outlet protection but should say "poorly

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				be needed. Bridge over straight reaches with stable invert is preferred. Unstable watercourses may require additional armouring that may extend for considerable distances upstream and downstream. • **Permanent culvert crossings**: suitable for use on most small modified watercourses (drains) and small, unmodified streams where there's little risk of blockage from trees or logs. Pipe size determined by upstream catchment. Fill over culvert up to 1.5 metres with clean graded aggregate free of debris and topsoil. Construct headwalls to prevent scour of fill batters. Check after storms. Lay pipes horizontal with bottom of culvert and set into streambed to maintain flooded invert. Culverts >1.5 metres diameter need special design considerations. Energy dissipation at outlet. Stable pathway needed for overflows. • **Rock outlet protection**: Do not use to protect pipe outlets at the top of cuts, or on slopes greater than 10 per cent without further	graded" (poorly graded = consistent size rock, well graded = many differing sizes from sand to boulder) 

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				armouring of receiving channel. Correct rock size needed so minimum movement in maximum flow, underlay with geotextile. Gabions and reno-mattresses are recommended with appropriate construction considerations.	
	Aquatic life recovery protocols for the management of native fish and large aquatic invertebrates during instream works. Bennett (2017)	Protocols for recovering native fish and large aquatic invertebrates (kākahi and kōura/kēwai) where regular in-stream maintenance activities have taken place.	Provides detailed key considerations and supporting principles that guide the protocols. Predominantly around sufficient planning and what resources may be needed to undertake fauna salvage safely and effectively. Includes: • timing works to avoid critical periods for fish • understanding the environment, including important habitats and likely species at the site. • Planning for returning fish to the waterway in a suitable location. • Having suitable equipment on site to capture fauna, store fauna if they need to remain out of the waterway and provisions for disposing of pest fish. • Handling biota; bankside vs in-stream. • Stresses importance of maintaining fish health if holding them out of the waterway is necessary.	Provides protocols for salvaging fish for four activities: drain clearance, gravel management, works requiring coffer dams and erosion protection works. Freshwater mussels should be pushed into the sand or sediments with the "hinged" end down for the best opportunity for survival. Pest fish should be disposed of humanely. Change the water in any holding buckets regularly using clean water. Water quality will deteriorate quickly if large numbers of fish are held or if water temperatures are high. **Drain clearance:** • Identify fish release sites upstream of works site. • Spoil should be placed in low mounds on stream banks for	• Does not provide for determining whether or not fish salvage is necessary. • Limited range of activities considered for this protocol. • Drain clearance: does not specify ideal timing of the further search at the end of the works. • Does not outline legal requirements, including laws for protecting fish, and the permits required to handle fauna, operate electric fishing machines and salvage fauna. • Does not suggest overnight trapping as an option for salvaging fish from an isolated site. • Does not have recommendation of mesh

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				searching and recovery of stranded animals. • Both in-stream and bank recovery may be required. • For bankside recovery, follow the machinery and watch for fish. Fish are easiest to spot immediately after being removed from the water. • Hold fish in water-filled buckets, and eels can be held temporarily in wet sacks. • Return fauna to the watercourse as soon as possible. • Undertake a further search of spoil/works area for any eels and crayfish that may still be stranded. • For in-stream recovery, only recover fish showing signs of distress. • Suggests prioritising the release of non-eel species, as they have the shortest life span out of water. **Gravel management:** • Electric fishing (EF) may be required if the site is suitable. • Site should be isolated the day before in-stream works begin.	size for fish screens on pumps.

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				• EF should be undertaken in multiple passes and continue until fish catch is rare. • Return fish upstream of the works. • No diversion: Leave stop nets/maintain site isolation overnight, but remove downstream barrier to allow fish to move downstream. • Begin gravel removal at the upstream extent of works, working downstream. Taking slow 'bites' of gravel by the machinery operator will allow fish to escape the area. • Diversion: Isolate site as above. • Use a seine net along the bed of the river if possible and use to rescue fish from the reach as it is dewatered. • Undertake EF, hand-netting and seine netting to retrieve fish from the works site. **Coffer dams:** • Follows in-stream and bankside protocols as largely outlined in drain maintenance section; bankside recovery to take place if sediment removal from within the coffer dam is required.	

Entity producing the guide	Guidance document	What does it cover?	Principles outlined	Methodology	Key gaps identified
				• Seine nets may be suitable for large waterways or pools. • Suggest retrieval of fish with excavator buckets if careful. • Use dipnets to retrieve fish from smaller pools.	
	Best practice guidelines for vegetation management and in stream works Environment Waikato (2007)	Guide document for works concerned primarily with flood management. Activities include: • vegetative protection measures • hard engineering protection • in-stream works: debris traps, gravel management and extraction, diversions, in-stream debris management and obstruction removal, battered banks, gradient control structures/weirs, silt removal, fish passage structures • erosion and sediment control. Opportunities for enhancement for a number of activities is also explored.		**Vegetative protective works (**including vegetation groynes, lopping and layering, brushing/tying in vegetation to the bank, mechanical vegetation removal): • Use brushing/tying in vegetation in small rivers where the bed is shallow and open. • Willow removal: No more than 1.5 kilometres of dense willows should be removed initially. **Hard engineering works** (including gabion baskets and rock riprap, and diversion bunds/detention dams): • Gabion baskets: rock used should be clean quarry spalls ex-face, or other suitable rock material free of soil, mud, clay or other soluble debris. **In-stream works** (including debris traps, gravel management and extraction, diversions, in-stream debris management and obstruction removal, battered banks, gradient	• No prescribed method for installing debris trap. • No method for installing diversions, nor mention of the need for possible fish salvage. • Talks about "fishery class" waterways and does not consider other waterways as habitat for fish, and the associated considerations. • No discussion of dewatering needs or pumping, and associated risks and considerations (eg, fish stranding, need for screens around pumps). • No design requirements for in-stream debris traps to allow for maintenance of fish passage. • Recommends the use of a large machine for extracting gravel to

Entity producing the guide	Guidance document	What does it cover?	Principles outlined	Methodology	Key gaps identified
				control structures/weirs, silt removal, fish passage structure). Debris trap installation: • Minimise time and duration of in stream works Gravel management: • When extracting gravel from a beach, leave a buffer strip (1–5 metres) around the river edge of the beach. • Use a large machine to limit excavation time. • Leave the streambed rough (rather than smooth) if excavating in stream. • Ensure at least one-third of the river width allows flowing water if some diversion is needed. Diversion/realignment: • Take water samples up and downstream of works to determine the duration and level of effect. • Avoid fish spawning periods as appropriate. • Undertake works in low flow conditions. In stream debris management:	reduce time, but does not consider the other risks involved with undertaking works with a larger machine. • No direction as to remediation for diversions if water quality samples returned from up/downstream of diversion works have had an adverse effect. • Discusses avoiding fish spawning periods, but not migration periods (for diversions), nor the potential need to undertake fish salvage. • Insufficient coverage of ESC methods that may be needed for activities. • For stream clearance (silt and debris) does not suggest staging of works or downstream sediment discharge control that may be necessary to prevent effects.

Entity producing the guide	Guidance document	What does it cover?	Principles outlined	Methodology	Key gaps identified
				• Cut and lift debris rather than pull and drag. Battered banks: • Do not cut below the waterline unless absolutely necessary. Gradient control/weirs: • 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. Silt removal: • Works should be designed, supervised and implemented to carry out the minimum amount of excavation necessary.	
	Environment Waikato Best Practice Guidelines for Waterway Crossings Spiers & Ryan (2006)	Guide to permanent waterway crossing options, generally targeted at the agricultural sector. Mainly concerned with the design of the crossing.	• Preferred hierarchy of crossing types is single span bridge, single-barrel arch culvert, multiple span bridge, single barrel circular culvert, multi-barrel circular culvert, box culvert, ford. • Maintaining and restoring ecological values briefly discussed, with focus on fish passage. Includes considerations regarding lighting, water velocity, whether passage is perched, substrate (ie, too smooth), and angle.	Design and retrofitting of crossings (particularly culverts) to allow for fish passage (including improving lighting) is described. Methods for installing crossings not included.	Provides design standards to provide for fish passage and best environmental outcomes of the final product, but does not provide consideration for other environmental concerns that may arise during the construction of the structure.

Entity producing the guide	Guidance document	What does it cover?	Principles outlined	Methodology	Key gaps identified
Environment Southland	*Environmental code of practice for river works.* Environment Southland Regional Council (2019a)	Best practice methods for activities including: Flood protection (including stopbanks, floodgates, spillways, dams, pump stations), erosion control, drainage management including bank shaping, gravel extraction, realignment, diversion, channel clearance (vegetation in and near waterway). Detailed descriptions of 'generic' good practice standards, then has specific guidance for each activity.	Standard principles to guide good practice: • consider habitat and morphological diversity • minimising in-stream works • avoiding contaminant and sediment discharge • isolating works sites to prevent effects offsite • avoiding and mitigating effects on fauna (fish passage and bird nesting) • avoiding archaeological and historical sites • planning for emergencies (spills, bad weather) • adopting an adaptive approach to works • avoiding spread of aquatic pests • all works will require some form of maintenance. • recreational values should be maintained. Includes generic, activity and special standards. Covers potential benefits and adverse effects of each activity.	Best practice for each activity is provided, though is not always prescriptive. • For example, bank grading to "a grade appropriate" to soil conditions. • Includes additional standards for "Sites of special environmental value", such as fish spawning sites. Specifies dates that certain activities should not take place for the relevant species.	• No detail regarding best design principles for structures – rather just covers requirements for works/a structure to be compliant. • Focus on riverbank works/edge management. • Provides standards, though no specific methodology to achieve these standards.
	Activities in waterways.	Factsheet with a very brief overview of environmental	Provides very brief overview of the environmental risks that are to be	No methodologies given – gives a high-level overview of rules and	• Little direction to further documents that may have more detailed instruction

Entity producing the guide	Guidance document	What does it cover?	Principles outlined	Methodology	Key gaps identified
	Environment Southland Regional Council (2018)	impacts. Provides a Q&A, with questions regarding structures in and over waterways, sediment traps, dams, ecological factors, flood protection and drain clearance.	avoided (eg, avoiding impeding fish passage, disturbing nesting sites). Directs the reader to consult the consents department to ensure compliance of an activity.	directs reader to rules in the regional plan that may impact their activity.	about methods for undertaking the mentioned activities. • Rules focused, rather than "best practice".
	Weed and sediment removal for drainage. Environment Southland Regional Council (2019b)	Factsheet primarily aimed at the rural sector. Concerned primarily with maintenance of artificial and modified watercourses.	• Brief overview of reasons for good practice (to avoid harm to ecosystems) and where consent may be required. • Outlines rules for works to be permitted. • Prevention of macrophyte and sediment build-up promoted as the foremost and preferred control method. This involves maintaining sufficient riparian buffers and preventing nutrient runoff. • Addresses undertaking works at a suitable time to prevent disturbing fauna. • Avoid doing works where native vegetation will be damaged. • Leave areas of vegetation to provide habitat for fauna and prevent stream-bed damage. • Culverts should be placed so as to provide for fish passage.	• Use a weed rake or bucket with holes to prevent fish stranding. • Install a sediment trap to prevent need for maintenance for long reaches.	Very brief overview of how to undertake drain maintenance. • Doesn't address staging of works/not clearing the entire waterway at once.
Otago Regional Council	*The Otago water quality rules: Sediment in water.*	Factsheet outlining rules for sediment discharge to waterways. Primarily aimed at the agricultural sector and	• Sediment control measures should be put in place when disturbing land that may result in sediment movement to waterways.	• • No methods provided.	Some suggested sediment retention methods, though

Entity producing the guide	Guidance document	What does it cover?	Principles outlined	Methodology	Key gaps identified
	Otago Regional Council (2015a)	reducing sediment runoff from the land or drains.	• Buffers of rank grass or low vegetation can act as buffers for sediment runoff. • Sediment traps can be effective to capture runoff. • Clean out drains or water races when they are dry, or use hay bales to trap sediment. • Outlines the environmental issues with excessive sedimentation.		no guidance on how to install/implement.
	The Otago water quality rules: Working in waterways. Otago Regional Council (2015b)	Factsheet outlining rules for working in waterways where bed disturbance will occur. Provides a table of activities and outlining where rules apply and, where those rules aren't in place, what is considered best practice for an activity. Activities include: • structures and defences against water • water intakes • clearing flood debris • reinstating banks following floods • controlling aquatic pest plants • drain maintenance in regionally significant wetlands	• Notify DOC and Fish and Game if works take place between 1 May and 30 September. • Disturbance shouldn't cause flooding or erosion. • Limit disturbance only to the extent required. • Time spent in the wetted bed does not exceed 10 hours. • Measures will be taken to minimise sediment discharge to the waterway. • No conspicuous change to colour or visual clarity will be obvious further than 200 metres downstream of an activity. • No damage to native flora or fauna in a regionally significant wetland. • No change to water levels of hydrological function in a regionally significant wetland.	• No methods provided	No methods provided – primarily concerned with outlining rules and where they apply versus where those rules as concepts are best practice.

Entity producing the guide	Guidance document	What does it cover?	Principles outlined	Methodology	Key gaps identified
		• gravel extraction.	• Sites will be left tidy.		
Taranaki Regional Council	*Stream crossings.* Taranaki Regional Council (2012)	Fact sheet for installing bridges and culverts in an agricultural setting. Addresses the need for consent, and considerations required for each structure type.	• Identifies the ideal location and physical attributes of a culvert (including size, materials, gradient) according to stream type, and to achieve good outcomes for stream stability, preventing scouring and maintaining fish passage. • Multi-barrel culverts aren't recommended as they are more prone to blockage and can create barriers to fish passage. • Well-designed and -installed crossings lead to less erosion, cleaner water and better habitat for fish, as well as fish passage. • A bridge should be longer than it is wide to prevent abutments encroaching on the stream and causing erosion. • De-watering or diversion may be required when installing a structure.	• Includes design suggestions, but no methods for installation for bridges. • Install culverts so that 20 per cent of the structure is beneath the streambed to allow for continued fish passage. • Armour the inlet and outlet of culverts with riprap or a headwall.	• No provision for additional work/considerations and actions that may be required if de-watering or diverting during works (fish salvage etc) • Little coverage of the installation/works period itself, including lack of information about erosion and sediment control needs.

Appendix 3: Example standard conditions

We undertook a desktop review of the 'standard conditions' regional and unitary authorities have applied to land use consents for works in waterways. This review was based on the standard conditions that we received, but not all councils were able to provide these. The conditions related to works in waterways generally, rather than to specific activities. While we observed some variability in condition style and content across the standard conditions received, generally the same outcomes were sought by the regional and unitary authorities.

While conditions are decided on a case-by-case basis and may differ between regions in writing style and content, the following 'recommended conditions' are provided as a starting point for developing best practice conditions.

Refer to **Best practice principles** for the rationale for these conditions and the cross references to the specific principles that the conditions give effect to.

1. Timing of works

a. Where the activity occurs in an ephemeral watercourse, or where there is the ability to cease flows, works must as far as practicable be undertaken when then there are no visible flows.

b. In all other instances, the activity must as far as practicable be undertaken outside the wetted bed of the watercourse.

2. Mitigation

When undertaking works:

a. ensure that sediment losses to natural water are avoided where practicable, and that silt control measures are in place

b. ensure that all machinery operates from the banks of the watercourse as far as reasonably practicable, only enter the bed of the watercourse when necessary to carry out required works, and use one corridor for entering and exiting

d. as far as practicable, avoid disturbing natural pools.

3. Fish and other fauna passage

The activity must be undertaken in a manner that provides for the:

a. passage of fish both upstream and downstream, including past any structure

b. free movement of other aquatic life along the stream corridor.

4. Fish recovery protocol

The activity must be undertaken in accordance with the fish recovery protocol.

Note: The fauna recovery protocol is provided in Appendix 5: Fauna capture, relocation and salvage.

5. Works during spawning seasons

The activity must as far as practicable be undertaken outside of aquatic fauna spawning seasons.

Note: Refer to the National Works in Waterways Hub[16] for the spawning seasons for each species.

6. Erosion and sediment control

Prior to any earthworks beginning, best practice erosion and sediment controls in line with the construction and environmental management plan, or relevant erosion and sediment control guidelines, must be put in place to avoid sediment loss to the water body.

7. Accidental discovery protocol

The accidental discovery protocol must be adhered to at all times.

The accidental discovery protocol is provided in **Appendix 4: Accidental discovery protocol**.

[16] https://works-in-waterways-boffa.hub.arcgis.com/

8. Biosecurity

All reasonable precautions must be taken to avoid the spread of pest plants and aquatic weeds, including, but not limited to:

a) Water blast all machinery to remove any visible dirt and/or vegetation prior to being brought onsite, to reduce the potential for pest species being introduced to the bed of the watercourse. Machinery and equipment that has worked in watercourses must, before entering the site, also be cleaned with suitable chemicals or agents to kill didymo.

b) Avoid working in areas where aquatic weeds are known to be present.

c) To avoid the spread of the Didymosphenia geminata or any other pest plant, not use machinery in the berm or bed of the river that has been used in any area where the pest plant(s) are known to be present in the previous 20 working days, unless the machinery has been thoroughly cleansed with a decontamination solution.

d) Remove any vegetation caught on the machinery at the completion of works.

e) After finishing the works and before leaving the site, waterblast all machinery, to reduce the potential for pest species being spread from the bed of the watercourse.

9. Contamination

All practicable measures must be undertaken to prevent the spill of fuel, hydraulic fluid, or other potential liquid contaminants, including, but not limited to:

a) no fuel may be stored, or vehicles or machinery refuelled, within 20 metres of the water body

b) where refuelling cannot be undertaken more than 20 metres from the water body, appropriate controls must be put in place to avoid potential spills while refuelling

c) fuel, hydraulic fluid and other potential liquid contaminants must be stored securely or are removed from site overnight.

10. Cement use

All practical measures must be taken to prevent cement and cement products entering flowing water, including but not limited to:

a) Avoiding flowing water coming into contact with the concrete until the concrete is firmly set.

b) Using boxing or other similar devices to contain wet cement during construction of the structure.

c) If any concrete is spilled beyond the boxing, pouring of concrete must stop immediately and all concrete must be removed from the watercourse.

d) No equipment used in the pouring of concrete may be washed out onsite.

10. Rehabilitation

Following the completion of works, the site must be restored as follows:

a) the banks and riparian margins left in a stable condition and revegetated with preference to native woody vegetation

b) all exposed earthworks rehabilitated with native plants

c) all rubbish, leftover materials and debris must be removed from the site and disposed of appropriately

d) all equipment and signs associated with the works must be removed.

10. Stream clearance works

Where works are associated with stream clearance or removal of vegetation and alluvium:

a) ensure that vegetation and alluvium from the bed of the watercourse is removed by progressively moving in one direction

b) limit the distance of continuous clearance to the extent practicable

c) maintain a distance proportionate to 30 per cent of any continuous length of clearance in flowing water, to provide refuge and recovery habitat for aquatic ecosystems

d) ensure there is no significant change to the cross-sectional area of the streambed.

Appendix 4: Accidental discovery protocol

In the event that taonga (Māori artefacts including pounamu), burial sites or kōiwi tangata (human remains), or Māori archaeological sites are accidentally discovered, the following procedure must be followed. Prior to commencement of any works, a copy of this accidental discovery protocol (ADP) should be made available to all contractors working on site.

- Work must cease immediately at that place and within 20 metres around the site.
- All machinery must be shut down and the area must be secured. The relevant Heritage New Zealand Pouhere Taonga regional archaeologist and the consent authority must be notified.
- If the site is of Māori origin, the consent holder must also notify the appropriate iwi groups or kaitiaki representative (Te Kahui Mangai[17] can help you identify the appropriate iwi groups or kaitiaki representative), to ensure site access and enable appropriate cultural procedures and tikanga to be undertaken, as long as all statutory requirements under legislation are met (Heritage New Zealand Pouhere Taonga Act 2014, Protected Objects Act 1975).
- If human remains are uncovered, the consent holder must advise the New Zealand Police, the relevant Heritage New Zealand Pouhere Taonga regional archaeologist, the consent authority and the appropriate iwi groups or kaitiaki representative (as above). Remains are not to be disturbed or moved until such time as the New Zealand Police, Heritage New Zealand Pouhere Taonga and iwi have responded.
- Works affecting the archaeological site and any human remains must not resume until Heritage New Zealand Pouhere Taonga gives written approval for work to continue. Further assessment by an archaeologist may be required.
- Where iwi request, any information recorded as the result of the find (such as a description of location and content) must be provided for their records.

[17] http://www.tkm.govt.nz/

Appendix 5: Fauna capture, relocation and salvage

This section outlines the circumstances under which you need to capture, relocate and salvage freshwater fauna , and the permits and approvals you're required to have to undertake this. It provides high-level information on the best practice methods for fauna capture, relocation and salvage. See the National Works in Waterways Hub[18] for specific information and protocols on fauna capture, relocation and salvage.

When is fauna capture, relocation and salvage necessary?

Waterways that have surface water present most of the time may contain and support fish and/or other freshwater fauna (Burrell & Gray, 2017). Waterways that do not always have water present (ie, those that dry intermittently) may also provide habitat for freshwater fauna. Wet areas with very high groundwater tables, particularly when connected with waterways (even occasionally), may also support some freshwater life. For example, eels have been found in 'wet paddocks' where grass and topsoil has been removed and groundwater has been intercepted. A temporary absence of surface water does not indicate an absence of fish or other freshwater life.

As noted in **Legislative context**, it is an offence for any works in waterways to disturb or damage spawning grounds of any freshwater fish (section 26ZJ, Conservation Act 1987); and unless an authorisation to take (capture, handle) indigenous fish is in place, fish must not be taken in a manner that results in injury or death, and the fish must be returned (alive) to the water as soon as practicable after taking them (section 26ZHB(2), Conservation Act 1987).

Permits and approvals

A suitably qualified and experienced ecologist will be required to oversee any fauna salvage and relocation activities. The ecologist will need to hold the following permits and approvals:

- a special permit issued by the Ministry for Primary Industries (MPI) under section 97(1) of the Fisheries Act 1996, which permits the holder to take aquatic life
- approvals from the Department of Conservation (DOC) and/or Fish and Game to use an electric fishing machine under section 26ZR(2)(b) of the Conservation Act 1987
- A Native Fish Transfer authorisation, pursuant to section 26ZM(2)(a) of the Conservation Act 1987.

Depending on the scale of the activity, fauna relocation and salvage may be carried out by a suitably qualified and experienced ecologist, or by other suitably trained persons guided by an ecologist who has the above permits and approvals in place.

Steps for undertaking fauna relocation and salvage

1. Undertake an initial fauna survey to determine species abundance and composition (if required).
2. Identify suitable relocation and salvage methods for that site.
3. Identify a suitable release location.
4. Isolate the work area from fauna movement.
5. Undertake the fauna relocation and salvage.

[18] https://works-in-waterways-boffa.hub.arcgis.com/

6. Undertake post-activity monitoring of the community (if required).

Fauna relocation and salvage methods

A suitably qualified and experienced freshwater ecologist will assist you with determining the best practice methods for a fauna relocation and salvage operation. Several factors will determine the best practice method, or combination of methods.

Key considerations:

- Scale/area of waterway affected: Depth, length and width of the waterway.
- The fauna likely to be present in the waterway. Species respond differently to capture methods (ie, some fish species aren't effectively captured using electric-fishing methods; others are under-represented when using trapping).
- How long works are expected to take. If fish passage is to be obstructed for an extended period, a suitable diversion to provide passage and guidance from a suitably qualified and experienced freshwater ecologist may be required.
- How well the site can be isolated. If the site cannot be completely isolated following initial removal of fauna, an observer may be needed to search through spoil, macrophytes or other material removed/excavated from the waterway.
  - Spoil, macrophytes and other material should be laid out alongside the waterway initially to be searched.
  - These materials should be searched immediately after removing from the waterway and again the following day (in the morning) to rescue any remaining stranded fauna.

Choosing a suitable release site

Before beginning an activity that requires fauna relocation and salvage, a suitable release location needs to be identified. Ideally, fauna should be relocated to a safe location in the same waterway they are taken from. Where this is not possible, approvals from MPI and DOC may be required (under section 26ZM of the Conservation Act 1987 and section 59 of Freshwater Fisheries Regulations 1983 - **Legislative context)**.

Factors to consider when selecting a release site:

- habitat and water quality conditions at the release site
- releasing fauna upstream or downstream of the work site
  - if there is risk of sediments being discharged downstream, fauna should be released upstream; fauna should not be returned to highly turbid water
- populations and abundances of species found at the release site.

Isolating the work area

- Before starting fauna relocation and salvage, the section of waterway should be isolated to prevent fish from entering or returning by using fish barriers.
- The barrier should prevent fish re-entering, but should allow water flow through the site.
- It should extend well above the water surface in case of fluctuating water levels and to prevent overtopping or breaching of the exclusion area.

- Barriers can be constructed from fine mesh (approximately 4 millimetres) material (such as two layers of shade cloth). In larger waterways, other methods may be required, such as sheet piling or coffer dams.
- Fish barriers should be checked daily to identify any signs of barrier failure. Any failure should be fixed immediately.

Once the relocation site has been identified and the work area isolated, fauna relocation and salvage should commence. There are three main techniques available for fauna relocation and salvage, which can be used in isolation or in combination. Joy et al (2013) provides guidance on applicability of the various techniques in different habitat conditions.

Electric fishing

Electric fishing is most suited to wadeable streams, with water depth of typically between 10 and 60 centimetres, and with cobble or boulder (ie, hard-bottomed bed) substrates.

It is generally ineffective in deep water and in soft-bottomed waterways or areas with lots of soft, deep sediments and lots of macrophytes.

Electric fishing is ineffective in very high or low conductivity waterways (eg, saline water, water with a high load of suspended sediment or dissolved inorganic solids; or braided rivers draining limestone catchments).

Fauna should be transferred to a recovery bin with fresh stream water, or directly to the relocation area as soon as possible and within 1 hour of capturing.

Trapping and netting

Trapping and netting refers to the use of nets (fyke nets/hīnaki) and traps (Gee minnow traps and other traps) to catch fish and freshwater crayfish. Hīnaki are useful for capturing eels/tuna, particularly when baited.

Trapping and netting techniques are most suited to slow-moving and soft-bottomed waterways, either wadeable or non-wadeable.

Water depth is an important consideration when trapping and netting. Hīnaki require about 35–40 centimetres of water depth and at least 55 centimetres width (the width of a trap); Gee minnow traps require about 15 centimetres of water depth, though they can be dug into the sediment in shallower water.

Extra care and consideration should be taken in waterways with little flow, or with high levels of organic material as water can become anoxic (ie, depleted of dissolved oxygen) resulting in fauna mortality. Traps and nets should be only partially submerged, or floats placed in net compartments to keep sections above the water surface in order to maintain an ‘air gap’ (Joy et al, 2013).

Nets should be set later in the afternoon, left overnight, and retrieved early the following morning.

Traps and nets may need to be set for several nights in a row, depending on the number of fish caught, species present and size of the site.

Overnight trapping after partial dewatering may also be an effective fish recovery method, especially in waterways dominated by macrophytes as setting traps and nets among extensive plant growth can be difficult.

Traps and nets should be baited to actively attract fish and other fauna, using:

- a small tin or pouch of cat food in the central compartment of a hīnaki
- a 'diffusing' container with marmite and/or a small number of cat biscuits in Gee minnow traps.

Fauna should be transferred to a recovery bin with fresh stream water, or directly to the relocation area as soon as possible and within 1 hour of capturing.

Hand salvage

Hand salvage refers to active searching for and salvage of fauna from spoil, macrophyte or other materials removed from the waterway. This method can be particularly effective for eels, when used in combination with electric fishing and/or trapping and netting.

Hand salvage is a good technique during pumping and dewatering of waterways, especially when used in combination with electric fishing and/or trapping and netting. As water levels recede, the original channel and pools can be searched for any remaining fish or other freshwater fauna (eg, kēkēwai or kākahi).

Fauna should be salvaged using hand-held nets, or by hand, and should be transferred to a recovery bin with fresh stream water, or directly to the relocation area as soon as possible and within 1 hour of capturing.

Handling fauna

General handling techniques:

- ensure there are no residues on your hands that may be toxic to fish (ie, sunscreen, hand sanitiser, other lotions)
- ensure hands or gloves (if using) are wet
- be gentle – do not squeeze or hold too tightly
- transfer fish into a bucket of fresh, clean water as quickly as possible (ideally from the site from which fish are being salvaged from)
- fish should be kept in the shade; water temperature should not exceed 20°C
  - monitor fish behaviour for signs of distress (air gulping, upside down)
  - containers shall not be overstocked and larger eels (>500 millimetres) and kōura shall be kept in separate containers to other captured fish to avoid injury or predation
- if transferring fish to the release site is likely to take more than 20 minutes, frequently replenish the water to keep the temperature down and ensure oxygen levels stay sufficient
- if fish must remain in a bucket/out of a flowing waterway for an extended period of time, an oxygenation device may be needed in the holding bucket.

Procedures for dealing with pest fish

Any captured fish species managed as a pest must not be returned to the waterway and must be humanely euthanised. Pest fish vary across regions, but generally include brown bullhead catfish, koi carp, gambusia, wild goldfish, perch, tench and rudd.