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Restoration Plan

Waikākahi Stream

Prepared for:

Ngā Wairiki Ngāti Apa

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Executive Summary

Ngā Wairiki Ngāti Apa have commissioned a report outlining the steps needed to restore the Waikākahi Stream. The Waikākahi is a small coastal stream within the Ngāti Apa rohe, and was chosen as it is deemed to be a discrete and manageable catchment within which to make an ecological improvement.

The aim of this restoration plan is to provide information on the current state of the Waikākahi Stream, including its values, and to give guidance on what actions are needed to improve on this current state. The Waikākahi has been subjected to considerable change and pressure, and full ecological restoration would be difficult indeed. However, this report provides practical actions that are achievable, and will help bring substantial improvements that move towards a healthier ecosystem for the stream.

In October and November of 2016, Morgan Cox (Kiwis for Kiwi), Logan Brown (Horizons Regional Council) and Hannah Rainforth (Perception Planning Ltd) undertook field examinations of the stream, sampling the aquatic biota and walking the catchment to identify fish passage issues, plant biodiversity, weed problems, fencing needs and other challenges facing the catchment. Those findings form the basis for this report, produced by Morgan Cox and Hannah Rainforth. Morgan has extensive weed and plant knowledge, and Hannah has a Masters in Ecological Restoration, focusing on freshwater.

Part One of the report provides an overview of the Waikākahi Catchment, including its values and issues, and general approaches to solving those issues. Part Two gives detailed information on individual sections within the catchment, with suggestions as to how to solve particular issues in each section. Following this is a table summarising the suggested actions, as a quick reference guide. We intend for these suggestions to be a helpful guide to Ngā Wairiki Ngāti Apa in prioritising remedial actions for the catchment.

The greatest issues facing the catchment are fish passage barriers blocking access to the majority of upstream fish habitat, lack of native streamside vegetation, an over-abundance of the aquatic weed water celery (*Apium nodiflorum*), and the need for fencing in some places. Terrestrial weeds are also an issue in some spots. Lastly, commercial eeling appears to be removing the larger eels from the catchment, and there is a lack of instream habitat.

We recommend replacing or removing problem culverts and instream structures to allow for fish passage, in particular the 'Earnslaw Culvert', the 'Farm Crossing Culvert' and the weir. Details of these are in the main document. We suggest three sites for intensive native planting, with an aim of both providing greater biodiversity and competing with the water celery to exclude it from the planting area. We also suggest planting the ponds in Section 2 (see Figures 3 and 4) to create bird habitat, and doing an aerial 'seed bomb' for kāhikatea in the wetland. Fencing needs have been outlined in the document and in Figures 7and 8. Weed control is needed at the three suggested planting sites, at the coast for white poplar, in Sections 2, 3, 4 and 6 for willow, and adjacent to the wetland for horsetail. We suggest working to effect a ban on commercial eeling throughout the catchment, and adding boulders and logs for instream habitat. We have also recommended considering kākahi translocations in the long-term.

1 Part One

1.1 Description of the Waikākahi catchment

The Waikākahi Stream is a small, second order coastal stream located around seven kilometres west of Bulls, in the Ngāti Apa rohe. The area is flat sand country with an occasional sand dune. Most of the catchment was originally in wetlands and has now been drained and converted to dairy farming, with a small amount of forestry in the remaining areas. There is very little native vegetation remaining, bar one wetland in the upper reaches. The area was a Ngāti Apa mahinga kai, with good shell fish presence at the coast, and was formerly the mouth of the Rangitīkei River (*pers. comm.* Chris Shenton, 2016).

1.1.1 Overview of values present in the Waikākahi catchment

We have divided the catchment into 8 sections, beginning at the mouth and working inland (see Figures 3 and 4). These sections are based on land use and landowners and are discussed in more detail in Part Two of this document.

EELS AND ĪNANGA FROM A TRAPPING SITE ON THE WAIKĀKAHI

1.1.1.1 Fish

In October 2016, Logan Brown (Horizons Regional Council) and Hannah Rainforth (Perception Planning) undertook electrofishing and trapping using fyke nets and gee minnows to determine fish species present in the stream. We were assisted by Chris Shenton (Ngā Wairiki Ngāti Apa). We found both long-fin eels (*Anguilla australis*) and short-fin eels (*Anguilla dieffenbachii*), as well as īnanga (*Galaxias maculatus*). There were also unidentified whitebait species that could perhaps be one of the other four galaxiid species, however given that we found no adults of these other species these unidentified individuals are more likely to be juvenile īnanga.

Īnanga were abundant in the trapped section, which was just below the most significant downstream fish barrier (see Figures 5 and 6 – 'Farm Crossing Culvert'). This barrier may be corralling the īnanga in this section, although there were īnanga spotted in other sections downstream too and the numbers may be similar in other sections.

Elvers were seen gathering below the most downstream fish barrier, located in the Earnslaw Forest in Section 1 (see Figures 5 and 6 – 'Earnslaw Culvert'). Their efforts to move upstream were being thwarted by the swift water in the culvert, and it was obvious the culvert was acting as a velocity barrier for these elvers. Some eels and īnanga must manage to get through, given the fish found upstream. Nevertheless, numbers upstream would likely increase should this barrier be removed.

1.1.1.2 Stream insects (macroinvertebrates)

The stream is sandy-bottomed with a reasonable flow, which is not very suitable for stream insects. Most stream insects need stones or sticks and logs to live on, or for the flow to be slow enough that leaves and other organic material can linger on the stream bottom. Sand is a difficult medium for stream insects to inhabit. We did not observe any stream insects on the stream bottom. The sandy-bottom also means the stream is not suitable for assessment using the Macroinvertebrate Community Index, so no sampling or scoring was applied.

However, given the reasonable number of fish present in the stream, there must be some number of insects available in the stream, as insects are a major part of the diet of native fish. Any insects present are likely to use the water celery as habitat, or to drop in from overhanging vegetation (including the water celery).

1.1.1.3 Kākahi

Given the stream's name, Waikākahi, we expected to find kākahi (freshwater mussel) populations. However, very little of the stream looked to be suitable kākahi habitat, with the majority being sandy-bottomed with a reasonable flow, as mentioned above. Neither did we find any evidence of kākahi in the form of empty shells – a tell-tale sign in areas where kākahi are present. We kept an eye out for kākahi in the water and conducted a cursory hand-search in one section, but did not complete an extensive search. Given that the wetland areas have been drained (see below), one might expect that flow velocity in the stream has increased. This may have affected the suitability of the streambed for kākahi, removing the slow-flowing areas that kākahi generally gravitate to. The velocity of the flow itself is unlikely to be an issue, but the abrasive movement of the sand and the lack of organic particles building up as food for the kākahi probably would be. If there

were any remnant populations of kākahi, they are likely to be in the upper reaches of the catchment, where the stream bottom has more fine sediment and less sand. It would be useful to keep an eye out in these areas while undertaking stream restoration work.

1.1.1.4 Native vegetation

Drainage, historic land clearance and conversion to pasture and forestry means that very little native vegetation remains in Waikākahi catchment. Grazing pressure, competition from pasture grasses and invasive weed species, coupled with limited native seed means that natural regeneration will be slow. Restoration planting to create seed sources and islands of biodiversity is required for native vegetation to return.

Assessing the original pre-clearance vegetation in the Waikākahi Stream catchment is difficult because of the very limited amount of original native vegetation left in the wider area. Esler (1978) mapped historic vegetation using records back to the 1860s and surveys of native remnants, many of which are now further degraded or missing. Esler's survey was between the Manawatū and Rangitīkei Rivers, however, the Waikākahi catchment 12 km to the north of the Rangitīkei is likely to have been botanically similar (*pers. comm*. Graeme LaCock, Department of Conservation).

In the 1860s, travel inland from the coast beyond the coastal dunes would pass over barren sandhills with patches of rushes and toetoe before moving into a mosaic of dune forest, semi-swamp forest, wetlands and open fern country. Dune forest was composed chiefly of māhoe, tītoki, akeake and ngaio, with tawa prominent in parts and tōtara also likely present. Semi-swamp forest was dominated by kāhikatea and pukatea and was a conspicuous feature of the lowlands on both the flood plains and some of the wet sand plains (Esler, 1978). Wetlands were likely to be surrounded by scrub dominated by tī kōuka, karamu, *Coprosma propinqua*, kōhūhū and pōhuehue, with harakeke, toetoe, raupō and pūrei (*Carex secta*) dominant as conditions became wetter.

The most diverse riparian vegetation is found in Section 1 where pine setbacks have left space for native vegetation. Mature tī kōuka is found close to small stands of harakeke with toetoe, upoko tangata (*Cyperus ustulatus*), raupō, *Carex secta*, *Tetragonia trigyna* (native spinach), wīwī (*Juncus australis*), and rauparaha (shore bindweed, *Calystegia soldanella*) also present. Recent plantings of ngaio, akeake, karamu and harakeke have added to the native flora and will provide a future seed source. Throughout the riparian edge of the main stem occasional mature *Carex secta* are found and once would have been common throughout the catchment.

Remnant tī kōuka dot paddocks in lower lying areas between dunes, but have little opportunity to regenerate due to browse pressure and competition from rank pasture grass. Small stands of raupō and harakeke are found in low lying areas between dunes and in ponds north of Raumai Road near the gas valve. These areas have potential to provide important areas of biodiversity, especially for native birds.

MATURE TĪ KŌUKA DOT LOWER LYING AREAS BETWEEN LOW VEGETATED DUNES

Approximately 5.5 km from the coast is a 4.3 ha wetland which is fed from the main stem. This wetland contains the strongest area of native vegetation. Under a dominant canopy of grey willow (*Salix cinerea*) and crack willow (*Salix fragalis*) are mature māhoe, karamu, mamaku and whekī. A range of ferns are present including titipo (*Pteris macilenta*), piupiu (gully fern, *Pneumatopteris pennigera*), mouku (hen and chicken fern, *Asplenium bulbiferum*), shining spleenwort (*Asplenium oblongifolium*), hanging spleenwort (*Asplenium flaccidum*) and leather-leaf fern (*Pyrrosia eleagnifolia*). In wetter areas where grey willow struggles to colonise, *C. secta*, raupō and harakeke are common with *Coprosma propinqua* and hybrids between *C. propinqua* and karamu also common. Occasional adult tī kōuka are found at the edges of the wetland as well as pōhuehue (*Muehlenbeckia complexa*) and the larger leaved *M. australis*.

1.1.1.5 Wetlands

Extensive wetlands were created along the Manawatū coast when sand dunes moving inland formed a barrier to water from the gently sloping hinterland. This formed a string of lagoons with extensive associated swamps. Only a small fraction of these wetlands and areas of open water now remain (see Figures 1 and 2). Even natural-looking wetlands have likely undergone significant change in vegetation composition due to lowering of the water table. For example, increases in raupō in Pukekpuke lagoon have been

attributed to lower water levels, and harakeke habitat can also increase as water levels drop (Esler, 1978).

The remaining 4.3 ha wetland on the Waikākahi Stream is a priority for restoration. Control of grey willow and crack willow is vital. The canopy of grey and crack willow creates a heavy shade that suppresses many native species. With the willow canopy removed it can be expected that seed from mature māhoe, karamu and *C. propinqua* would germinate. Establishing a native tree cover in the drier areas of the wetland is important for the long-term protection of the wetland. Low stature wetlands are vulnerable to reinvasion from weed species, especially grey willow whose wind dispersed seed can travel a long distance. This area was likely to have contained semi-swamp forest in the past and restoration of tall stature kāhikatea forest would make the wetland more resistant to further weed invasion. The Department of Conservation is interested in researching the potential of re-establishing kāhikatea forest by aerially dropping large amounts of kāhikatea seed into willow dominated wetlands. Once seed has germinated and reached small sapling size the willow would be sprayed, releasing the kāhikatea by providing more light. (*pers. comm*. James Griffiths, Department of Conservation).

There are three areas of open water close to the gas valve on Raumai Road and Sandbridge Road covering 0.4, 1.37 and 3.6 ha. The smallest of these is connected to the Waikākahi true left tributary in Section 2 by a shallow roadside drain. The other two ponds are not connected to Waikākahi Stream. All three of the ponds are artificial to a degree, having been excavated. Currently cattle have access to these ponds with negative effects on water quality and riparian vegetation. However, with fencing and planting these could provide valuable habitat for water birds. Pūkeko, black swan and kawau (black shag) were seen at the smallest pond, which has an area of established raupō as well as the nuisance species water celery (*Apium nodiflorum*). Australian coot, as well as black swan, mallard and Canadian geese were seen on the larger ponds. With native water-edge planting and raupō established, pūweto (spotless crake) are likely to naturally reintroduce themselves, with a possibility that koitareke (marsh crake) may also reintroduce. Pāpango (NZ scaup) and weweia (NZ dabchick) would likely make use of areas of deeper water and white faced heron are also likely to visit (*pers. comm.* Hugh Robertson, Department of Conservation).

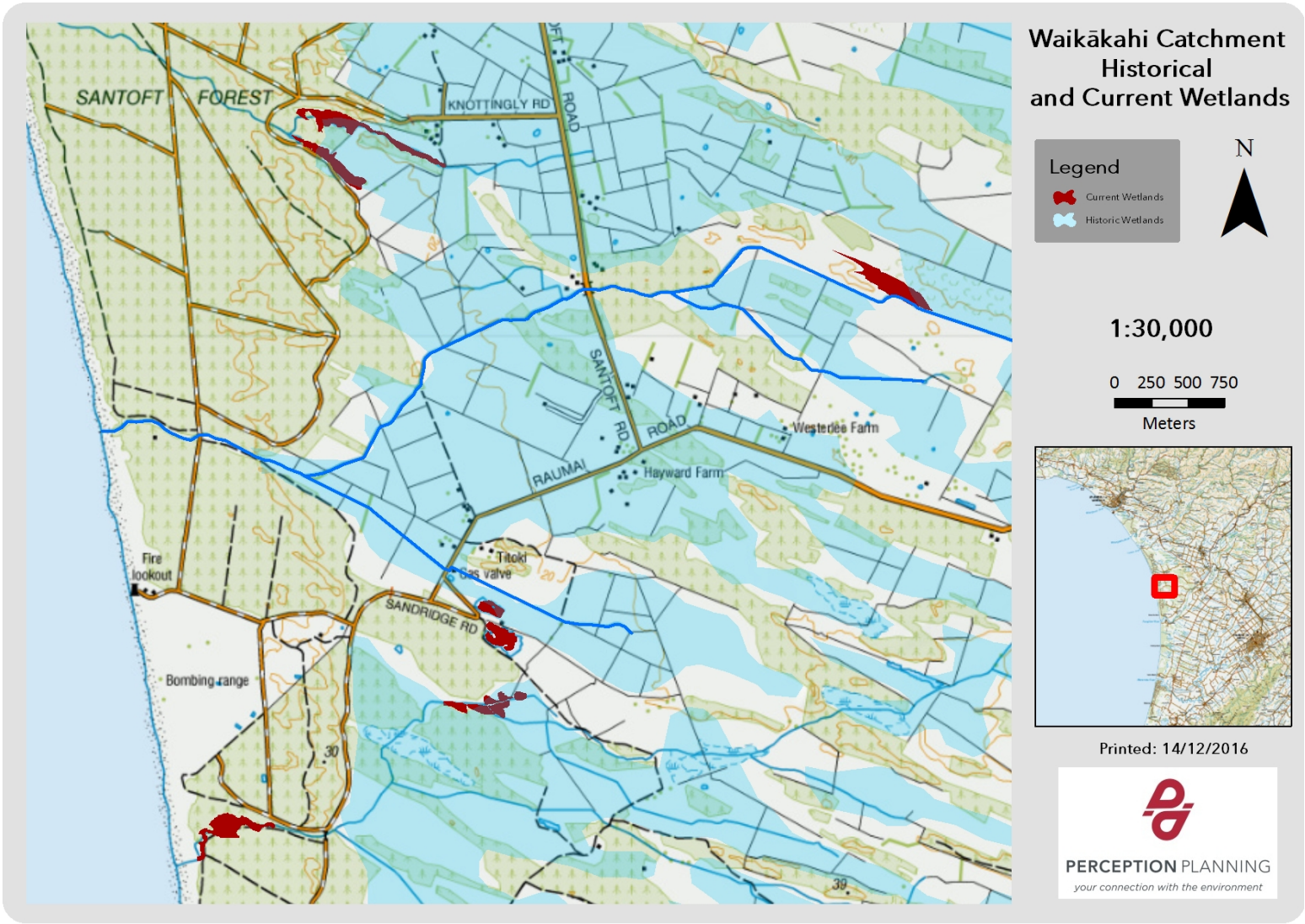

FIGURE 1: TOPOGRAPHICAL MAP OF WAIKĀKAHI CATCHMENT HISTORICAL AND CURRENT WETLANDS

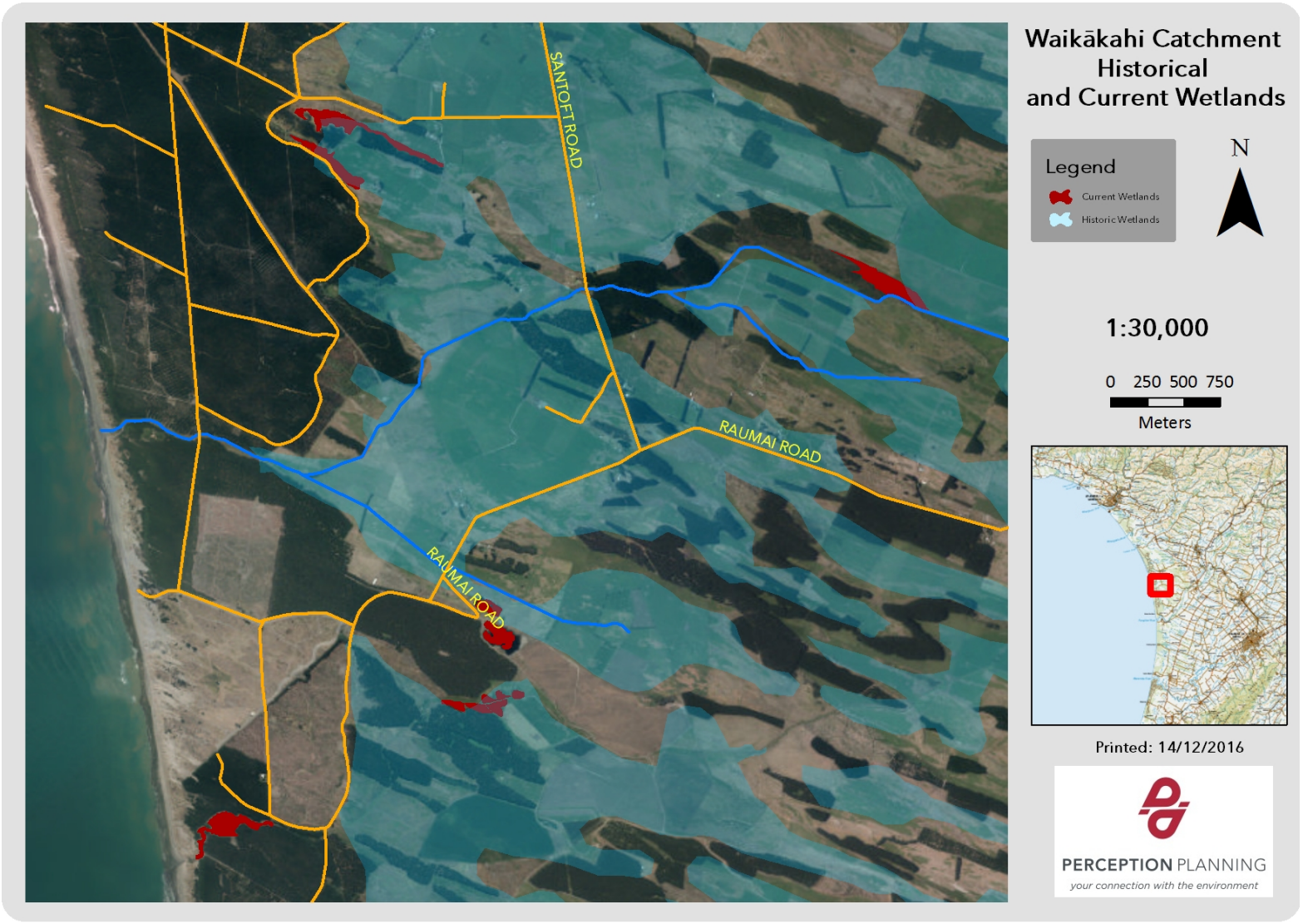

FIGURE 2: AERIAL MAP OF WAIKĀKAHI CATCHMENT HISTORICAL AND CURRENT WETLANDS

1.1.2 Overview of issues in the Waikākahi Catchment

1.1.2.1 Fish passage

Most New Zealand native fish are diadromous, meaning they spend part of their life at sea. Some species, for example eels, travel thousands of kilometres to breed in the ocean, while others such as īnanga and kōkopu spawn in freshwater, spend their larval stage in the coastal zone, then return to freshwater to mature. All these sea-going species rely on free access to and from freshwater in order to complete their life cycles.

Our native fish are good climbers, but poor jumpers. Unlike salmon, which are renowned for their ability to jump up obstacles and fast-flowing rapids, New Zealand's native fish get flummoxed by small perches or rapid flows. Most of them can, however, wriggle their way up some incredibly steep faces, as long as there is something for them to cling to and a damp surface. Īnanga fare the worst in all of this – they are neither good jumpers nor good climbers, and need low-gradient, smooth passage in order to access upstream habitat in which to grow and develop.

When restoring a stream, one the first issues to look to is fish passage. There is little value in having wonderful habitat upstream if no fish can reach it. Similarly, you can drastically increase the amount of habitat available simply by remedying a fish barrier in the lower reaches.

The general principles in correcting a fish barrier are that:

- the culvert should be wider than the stream width
- the culvert size should allow for large floods to pass through easily, without the waterbody backing up or overtopping the culvert; and
- the base of the culvert should be below the stream bed, to allow it to become covered with natural streambed material (eg rocks and stones).

Alternatively, constructing a bridge often avoids passage issues. Particular fish barriers found in the Waikākahi are discussed under the relevant stream section headings in Part Two, however the key ones to note are the Earnslaw Culvert, the Farm Crossing Culvert, and the weir (see Figures 5 and 6).

1.1.2.2 Commercial eeling

Most of the eels we caught during trapping and electrofishing were of a small to medium size, and appeared to be below the minimum size required for a legal commercial harvest. This suggests commercial eelers had been through the catchment fairly recently.

One option for protecting the catchment would be to place a moratorium on commercial eeling. This would ensure eels in the Waikākahi are allowed to reach breeding size, contributing much-needed stock to the eel breeding cycle and protecting tuna for the future.

1.1.2.3 Lack of in-stream habitat

As noted above, the Waikākahi area was once almost entirely wetland. This would have meant the stream should have had plenty of woody debris from the surrounding vegetation. Such woody debris provides excellent habitat for fish and stream insects. This woody debris is now completely absent. One straightforward option for increasing habitat in the stream would be to add large logs (these will need to be large enough that they stay in place during floods) and/or boulders.

The addition of these items will change the stream shape over time as the water moves around them. They will need to be placed in areas where the fences are far enough back from the stream to allow for meanders and movement. The areas that would benefit most from this are those outside of the proposed planting areas, as the planting areas will have increased habitat from the vegetation that the non-planted areas will lack.

1.1.2.4 Stock access to waterways

Stock access to waterways creates several issues. Firstly, direct defecation and urination in the waterbody adds pathogens and nutrients that are unhelpful to stream health. Secondly, stock eat the streamside vegetation that provides shade, cover and food supply (when insects drop from it) for native fish. Thirdly, stock can destroy spawning areas by eating spawning vegetation and trampling the banks. The bank trampling also adds sediment to the stream. Removing stock from waterways is one of the key methods for improving stream health.

STOCK ACCESS TO THE STREAM HAS REDUCED STREAM-EDGE VEGETATION AND COLLAPSED THE BANK

1.1.2.5 Fencing

Fencing along Waikākahi Stream, where present, consists of either two-wire electric, some with an additional two high tensile wires, or eight wire fence with either barbed wire or a single electric outrigger. Price per metre for these fences would range between approximately $3.50 p/m to $16 p/m. Eight wire fences are more secure but considerably more expensive.

Fencing streams needs to allow enough room for the stream to meander, especially where the stream has been straightened. Meanders are important to slow stream velocity and create diverse habitat. Some sections of the Waikākahi have been fenced very close to the stream and have become undercut by stream movement, which has allowed stock access to the stream. Fencing further back from the stream will also provide room for riparian planting to compete with water celery, provide diverse habitat and protect stream banks.

Where stock are currently reliant on the stream for drinking water, troughs and water reticulation will need to be put in place. Troughs cost $250 for 455 L and $600 for 1820 L, plus connection fittings and 50 mm pipe to connect to a water source. Fortunately, water

reticulation schemes are present on most of the farmland. This should reduce costs of adding additional troughs, providing there is enough capacity in the existing schemes.

For dairy farmers and land uses classed as 'intensive' under the Horizons One Plan, there are regulations and requirements for stock exclusion (see Appendix One). Farmers in this area are on the way to meeting these requirements, and where fences are still needed, in many places plans are in place to erect them. Details of where fencing is required are listed in the detailed sections in Part Two of this report.

1.1.2.6 Wetland drainage

Wetlands act to regulate flood flows by absorbing water and releasing it at a slower rate. Draining wetlands often results in more extreme flood flows. The entire Waikākahi Stream catchment is a very wet area, with most paddocks having surface water after rain events and/or deep drainage channels. An analysis of the historical extent of wetlands in the area (using Freshwater Environments NZ GIS data) suggests that almost the entire catchment was once wetland. Anecdotal evidence from one local farmer (A. Third) supports this, with comments that a large number of wetlands in the area have been drained, leading to an increase in flooding intensity and a resulting impact on instream structures.

1.1.2.7 Weeds

1.1.2.7.1 Overview of weed issues

There are two main types of weeds in relation to stream restoration efforts: those that cause an ecological issue, and those that are unwanted for aesthetic reasons. Of the former, there are terrestrial weeds and aquatic weeds. Terrestrial weeds such as willows can clog streams, knock out culverts and bridges when washed downstream in floods, and also reduce habitat for fish when their roots enter the water and eliminate undercut banks. Other species such as white poplar, boxthorn and pampas compete with native vegetation and can make it difficult to undertake riparian planting. Aquatic weeds can be an issue for a number of reasons: they can affect dissolved oxygen levels and pH in the water, exclude native aquatic plant species, and can affect spawning sites by excluding species better suited to egg survival. There are some positives associated with some non-native species, in that they can provide shade, cover for fish and substrate for juvenile kākahi (*pers. obs.* H. Rainforth). However, the negatives often outweigh the positives. Substantial growth of aquatic weeds can also cause issues for downstream structures, if large amounts of weeds break off in floods and knock out culverts or other structures.

1.1.2.7.2 Terrestrial weeds

The main terrestrial weed species present are sand acacia, white poplar, grey willow, crack willow, boxthorn, pampas, tree lupin, elderberry and gorse. Horsetail was found adjacent to the wetland in Section 6. Sand acacia, grey willow and white poplar are forming the densest infestations. Sand acacia is very common along the coast, with infestation reaching 300 m upstream from the coast in Section 1. White poplar is present in two expanding infestations in Sections 1 and 2, spreading from planted sites on the stream edge. White poplar forms dense stands from suckers that come off the roots of adult plants.

Grey willow is present in the main wetland with crack willow, and is found at the ponds in the gas valve area at Raumai Road. Grey willow produces vast amounts of wind dispersed seed and is very capable of colonising wetland areas. Control of grey willow in the wider area is important to protect wetland habitats. Crack willow can also have significant negative impacts but is less mobile as it only spreads vegetatively rather than producing seed. Boxthorn and pampas are common throughout the catchment and are too widespread to make control a priority except at restoration sites where they will compete with plantings. Tree lupin is also very widespread but is less problematic for restoration sites as it is easily over topped by native species. Elderberry is common in riparian areas and could provide useful protection while native plantings establish. Gorse is also common in fenced riparian areas and provides good protection for woody native plants to establish in. A small patch of field horsetail (*Equisetum arvense*) was seen in a paddock on the edge of the wetland. Field horsetail is difficult to control due to herbicide resistance and extensive underground rhizomes. Control options are discussed in Section 6.

1.1.2.7.3 Aquatic weeds

The dominant aquatic vegetation in Waikākahi Stream is the common emergent weed water celery (*Apium nodiflorum*), also known as cow parsley. Water celery is abundant throughout most of the stream and has all but displaced the introduced water cress, which is a species desired for use as a food plant. It is a fast growing perennial species that dies back in winter, regrowing the following spring. Relatively warm winter temperatures in area may, however, limit winter die-back compared to colder climates. Water celery favours disturbed, nutrient-rich habitats and is intolerant of dense shade. It has hollow stems up to 1 m in length that spread into the waterway, impeding flows and reducing stream capacity. Stems can be easily broken in fast flows potentially blocking instream infrastructure. It spreads from both seed and broken stems, which quickly take

root. Cattle graze water celery, reducing the amount of plant material, but do not eradicate it. As water celery favours nutrient-rich habitat, cattle access to streams may also benefit water celery growth.

CATTLE BROWSE WATER CELERY BUT DO NOT ERADICATE IT, AS EVIDENCED HERE BY THE GRAZED (RIGHT) AND UNGRAZED (LEFT) AREAS.

1.1.2.7.4 Water Celery: impacts and benefits

Macrophytes (stream plants) like water celery can impact on the level of dissolved oxygen (DO) in the stream. During the day macrophytes produce oxygen and at night they consume it through respiration. This leads to a diurnal (day-night) DO fluctuation pattern with high levels during the day and low levels during the night. These low levels at night can be harmful to fish (James, 2013). At the time of the survey, native fish were seen in the small left tributary as high up as Raumai Road, demonstrating that DO levels are adequate for their survival. However, the survey was undertaken in October and November, when temperatures were still relatively cool and flow reasonable. In times of lower flows and higher temperatures, DO levels may drop in small tributaries making conditions stressful for native fish. In order to test this, DO monitoring would need to be undertaken at different times of the year. DO levels may also be negatively affected by water celery

decomposing in the water during die back events either following flooding or winter die-back (Wilcock, McBride, Nagels, & Northcott, 1995). Dissolved oxygen testing during this period is also recommended.

Water celery is likely to affect native fish spawning success. Īnanga lay their eggs in the tidal wedge – the area in a stream where fresh- and saltwater meet. They lay on a spring tide when the water is especially high, amongst the streamside vegetation. When the tide recedes, the eggs are left out of water for two to six weeks, and will hatch on the next spring tide when they become immersed again. Because the eggs spend so long out of water, they rely on the surrounding vegetation to keep them moist. Species like *Carex secta* and harakeke provide better protection from desiccation, as their dense stems keep humidity and temperature even. Water celery, on the other hand, does not provide good quality spawning vegetation for īnanga, as the thick stems are wide apart and don't retain the moisture as well. The abundance of water celery in the Waikākahi Stream is, therefore, likely to be an issue for īnanga reproduction.

The dominance of water celery over native riparian vegetation reduces biodiversity, and insect numbers are likely to be lower than in diverse native vegetation. As mentioned above, water celery is also prone to breaking off during floods, blocking culverts and damaging instream infrastructure.

Water celery does however play some useful ecological functions, creating shade over waterways that should lower water temperature, and also providing cover for native fish. Therefore, when water celery is removed from a stream it should be replaced by other desired vegetation.

1.1.2.7.5 Water celery control and planting competition:

Removal of water celery from the entire catchment is a difficult task due to the ability of water celery to recolonise cleared areas via seed and broken stems. However, sections of Waikākahi stream can be restored to native vegetation by removing water celery and replacing it with dense stream-edge planting of native species. Dense planting of suitable native species such as *C. secta* will create both shade and site competition pressure. The CAREX Freshwater Ecological Research Group at Canterbury University is currently researching environmentally friendly ways of managing small waterways on farms. The main introduced stream weed species they are studying are monkey musk and watercress, which have similar growth habits to water celery. They found the only successful long-term way to control monkey musk and watercress was removal of the plants followed by dense native planting to create site competition and shade (*pers. comm.* Katie Collins, CAREX PhD student).

LARGE *CAREX SECTA* CLOSE TO WAIKĀKAHI STREAM. *CAREX SECTA* WOULD HAVE BEEN COMMON ALONG THE STREAM AND COULD PLAY A VALUABLE ROLE IN RESTORING NATIVE RIPARIAN VEGETATION. DENSE PLANTING OF *C. SECTA* AT THE WATER EDGE WITH TOETOE, HARAKEKE AND NATIVE TREES BEHIND WILL CREATE STRONG SITE COMPETITION AND SHADE TO EXCLUDE WATER CELERY.

Sections of stream to be restored must be fenced to prevent stock access, and will ideally have pre-existing meanders. Fencing needs to be well set back from the stream edge to allow room for an adequate depth of planting. Fencing and planting will reduce nutrient input to waterways which will further disadvantage water celery.

The location of planting areas, weed control methods, the timing of planting, individual plant location and follow-up maintenance are all key to restoration being successful (*pers. comm*. Katie Collins). It is recommended that restoration planting starts on small sections so that techniques can be refined for the local conditions at Waikākahi Stream. We have identified three suggested sites for this purpose – these are discussed in Part Two.

Water celery grows differently in different parts of the stream, and some sites are more likely to be successfully planted than others. In sections of the main stem and larger tributaries, the greater water depth, width, and speed of flow means that areas of open, flowing water were maintained at the time of survey in mid to late November. In these sections water celery typically roots into the stream bank, starting at or just below the waterline, with floating stems reaching out into the stream. Stems in the waterway form roots but these are free floating, making water celery easier to remove without disturbing

stream sediment. Occasional small water celery plants were also rooted in the sandy stream bed at a water depth of up to 30 cm. Native plants could occupy these areas on the stream bank where water celery takes root and replace the weed.

WATER CELERY SHOWING FREE FLOATING ROOTS THAT HAVE NOT ROOTED INTO THE STREAM BED

Water celery can be successfully controlled in the short-term by both physical removal and by herbicide (Garlon® 360 and Glysophate products). Reinvasion from seed is very likely to occur within 12 months. A trial at the Waikato River Mouth using Garlon® 360 was successful in controlling 100% of the plants but within 11 months seedlings were common (Champion, James, Singers, & Bodmin, 2011). Decomposition of plant material left in the stream to rot following herbicide control can deplete DO levels (James, 2013). The CAREX Research Group will further study DO levels pre- and post-herbicide use in Canterbury farm streams in summer 2017. Katie Collins can be contacted to discuss these results. At Waikākahi Stream water celery left in stream can also block culverts. Because of these factors physical removal of water celery is the suggested method of control, at least for the initial trial planting sites (Champion, James, Singers, & Bodmin, 2011).

SECTIONS OF STREAM WITH OPEN WATER WHERE WATER CELERY IS ROOTED INTO THE BANKS BUT NOT THE STREAM BED OFFER GOOD OPPORTUNITIES TO EXCLUDE THE WEED WITH DENSE NATIVE PLANTING.

After weed removal, dense planting of the stream edge using *C. secta* followed by toetoe, harakeke, and tree species like ngaio, karamu, kōhūhū, tī kōuka, māhoe and akeake should be undertaken. The placement of *C. secta* is very important to exclude water celery from the stream edge environment. *Carex secta* should be planted at 1 m spacings close to the waterline at low stream flows. There is a risk of losing

plants in flood events before they have developed strong roots, but *C. secta* must be dominant at the water's edge to displace water celery (*pers. comm.* Katie Collins 2016), so this is a risk that needs to be borne. At 1.5 m distance behind the *C. secta* plant toetoe and harakeke at 2 m spacing, followed by tree species at 3 m spacing to create a solid band of native vegetation back from the stream edge that covers habitat occupied by water celery. Several rows of *C. secta* would be required on shallow-angle banks that have a wider area of saturated ground.

Once plantings are established, the permanently wet margin on the stream-side of the *C. secta* may be colonised by raupō. Raupō is already present in stream margins in Section 1 and would add to the competition pressure on water celery at the wetter extent of water celery habitat.

Plantings will need to be released from weed pressure until they become established. CAREX experimented with weed mat using wool mulch, coconut fibre and black plastic weed mat. Wool mulch broke down too quickly in the wet environment. Coconut fibre matting lasted longer although some grasses and other weeds grew through it. Black plastic weed mat was also successful but is not biodegradable. Alternatively, plantings can be released in spring and late summer. It will take several years before native plantings are able to start competing with the fast-growing water celery.

Restoration planting can be expensive, depending on plant and labour costs. This is especially the case where dense planting is required to suppress weed growth. A 100 m section of stream planted on both sides with one line of *C. secta*, two lines of toetoe and harakeke and one line of trees would require 466 plants (200 *C. secta,* 200 toetoe/harakeke and 66 trees). Prior to planting, the site needs to be prepared and plants need to be managed for several years until they are large enough to withstand weed competition. Purchase of weed mat may be required. Indicative costs for 100 m of planting on both sides of a stream are given below. Volunteer labour would of course reduce costs. Weed mat, if used, would reduce labour required for releasing plants.

Site preparation 8 hours @ $40	$320
Plant purchase 466 plants @ $4 each	$1,864
Planting @ $1.85 per plant	$862
Weed mat (BioCoir coconut matting) 4 x 50 x 2.5 m rolls @ $283 each (http://www.cirtex.co.nz/product/biocoir-coconut-matting/)	$1,132

Or Releasing plants 8 hours @ $40 x spring and summer x 2 years	$1,280

1.1.2.8 Variation in streambed location

There are sections of the stream that have been artificially shifted and no longer align with the topographical map. The first straightened section on the main stem (as you head upstream) is one such example. It also appears to alter depending on whether the duck-shooting season is open or closed, with possible diversions to an artificial wetland area. When viewing maps, the reader should be aware that the points discussed are where the stream was physically located as at October 2016.

2 Part Two

2.1 Issues in the Waikākahi catchment by section

We have divided the catchment into 8 sections, beginning at the mouth and working inland (see Figures 3 and 4). These sections are based on land use and landowners. Culverts, fences required, and suggested planting areas are also mapped on the following pages.

2.1.1 Section 1: Coastal forestry section

2.1.1.1 Section description

Section 1 is the most downstream section, starting where the stream enters the Santoft Forest. Pines are planted close to the true right of the stream, but there is a large grassy area to the left. Nearer the coast there are some native species including tī kōuka, harakeke, *C. secta*, toetoe upoko tangata, raupō, native spinach, shore bindweed and wīwī. Ngāti Apa have undertaken restoration planting in this area, with ngaio, harakeke, karamu, tī kōuka and other species planted on the true left. This will provide shading and bank stability once the plants establish and grow. There is space between the plantings and the stream edge to add riparian species that will provide fish spawning habitat, insect falls, and competition of the water celery.

2.1.1.2 Issues and actions in this section

2.1.1.2.1 Weeds

Water celery is abundant in this section, reducing the availability of quality spawning sites for īnanga and lowering streamside biodiversity. Experimental control and planting of the streamside to displace water celery is recommended for this site. Planting should extend on the planting currently being undertaken by Ngāti Apa and incorporate small stands of streamside harakeke. Pine set-backs allow more space for planting than is typically found on the farm land so there is the opportunity to establish a diverse riparian corridor. Currently pines are providing shelter from coastal winds but the site will become more exposed in the future post-harvest. Ideally plantings will be established before harvest takes place. Large crack willow growing close to the coast could be retained to help provide shelter when pine is felled.

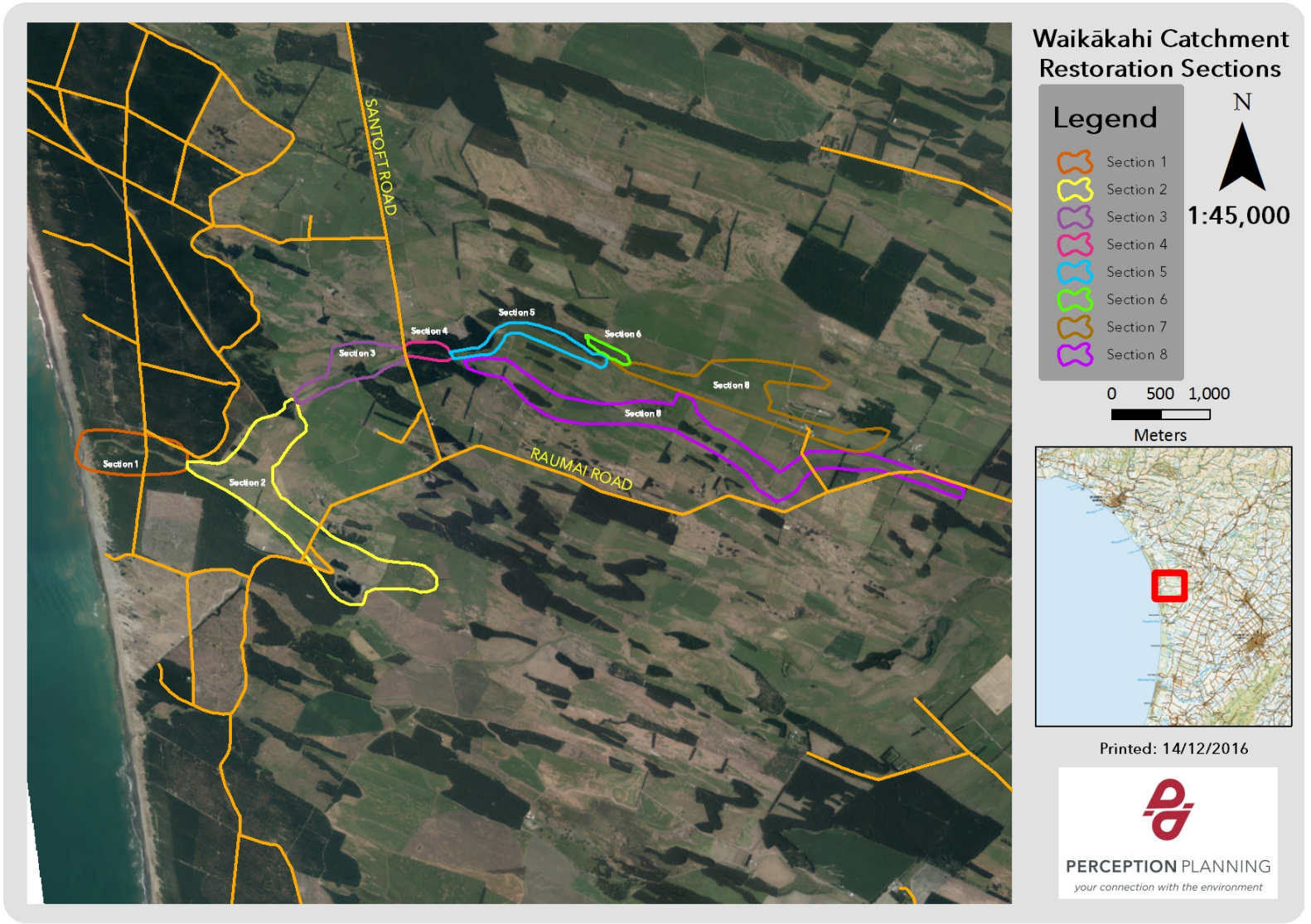

FIGURE 3: AERIAL MAP OF THE STREAM SECTIONS IN THE WAIKĀKAHI CATCHMENT

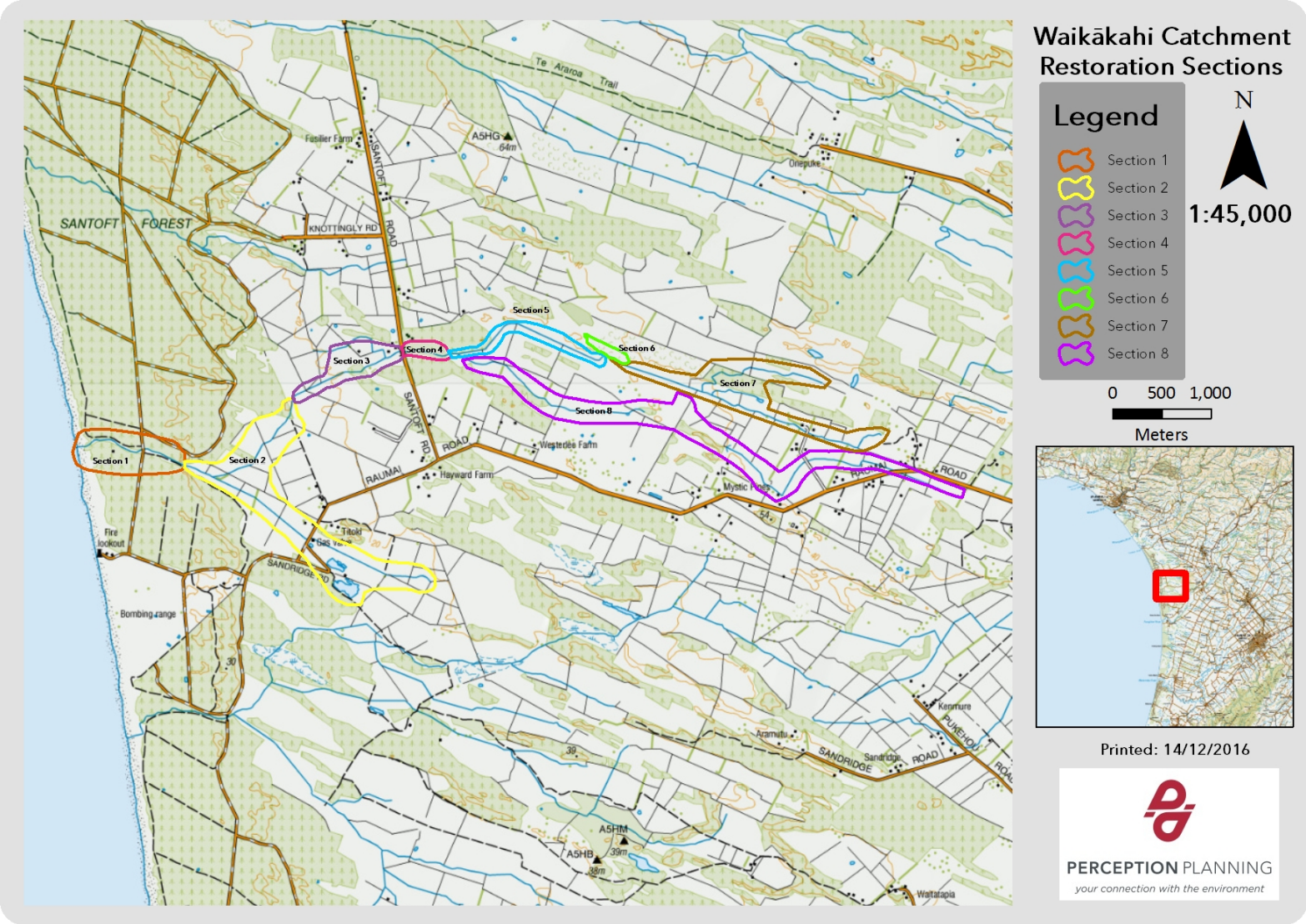

FIGURE 4: TOPOGRAPHICAL MAP OF THE STREAM SECTIONS IN THE WAIKĀKAHI CATCHMENT

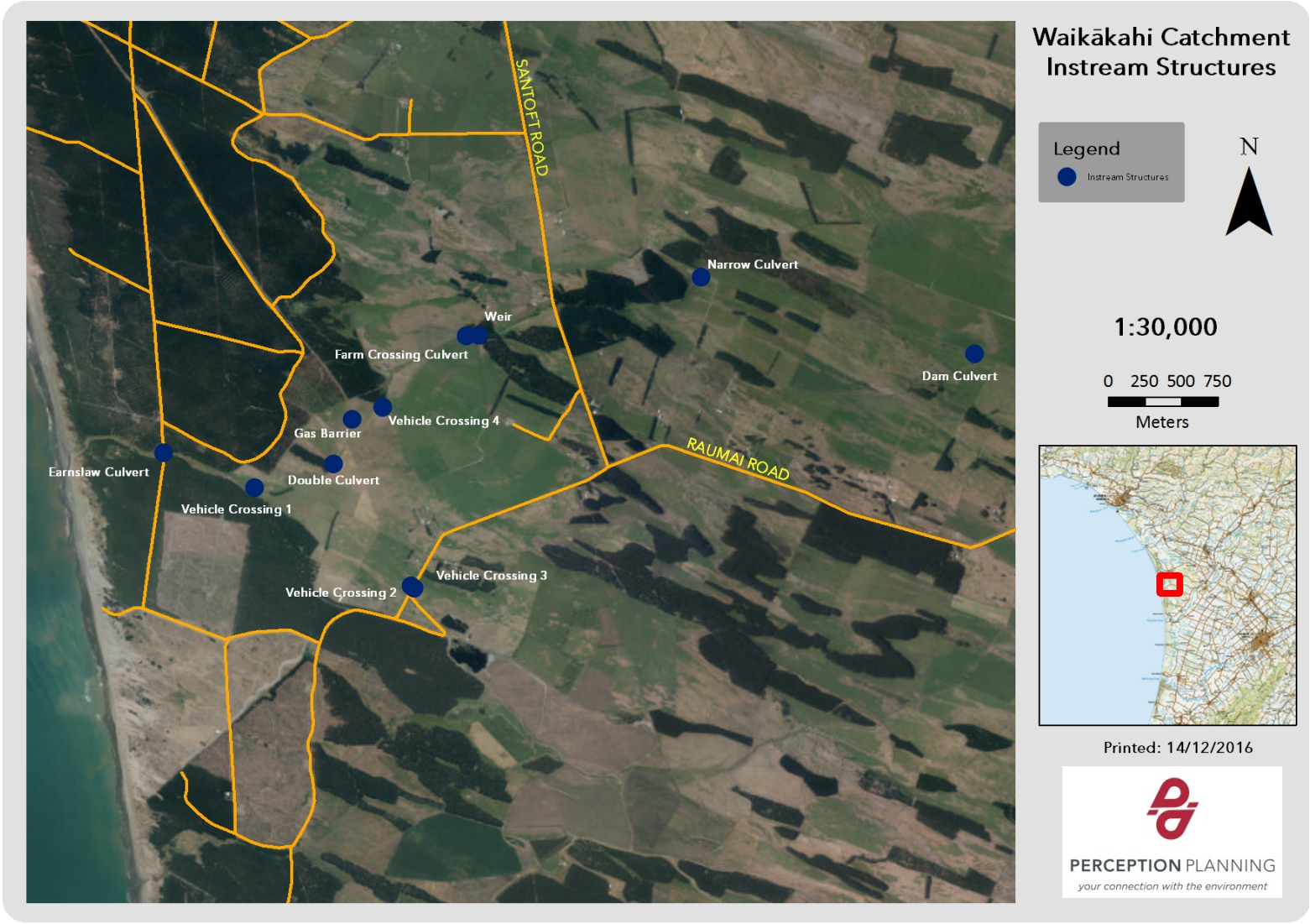

FIGURE 5: AERIAL MAP OF INSTREAM STRUCTURES AND VEHICLE CROSSINGS IN THE WAIKĀKAHI CATCHMENT

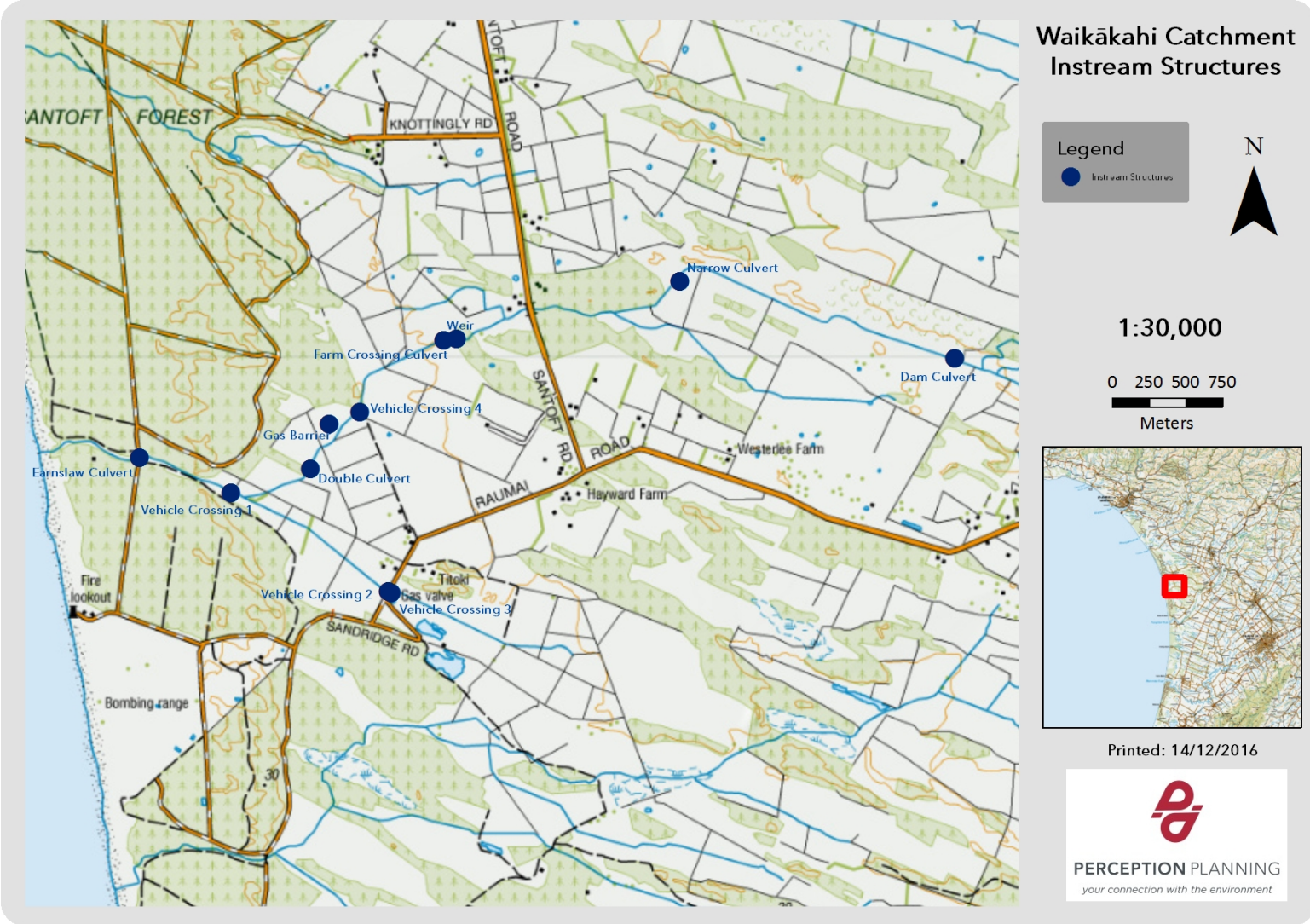

FIGURE 6: TOPOGRAPHICAL MAP OF INSTREAM STRUCTURES AND VEHICLE CROSSINGS IN THE WAIKĀKAHI CATCHMENT

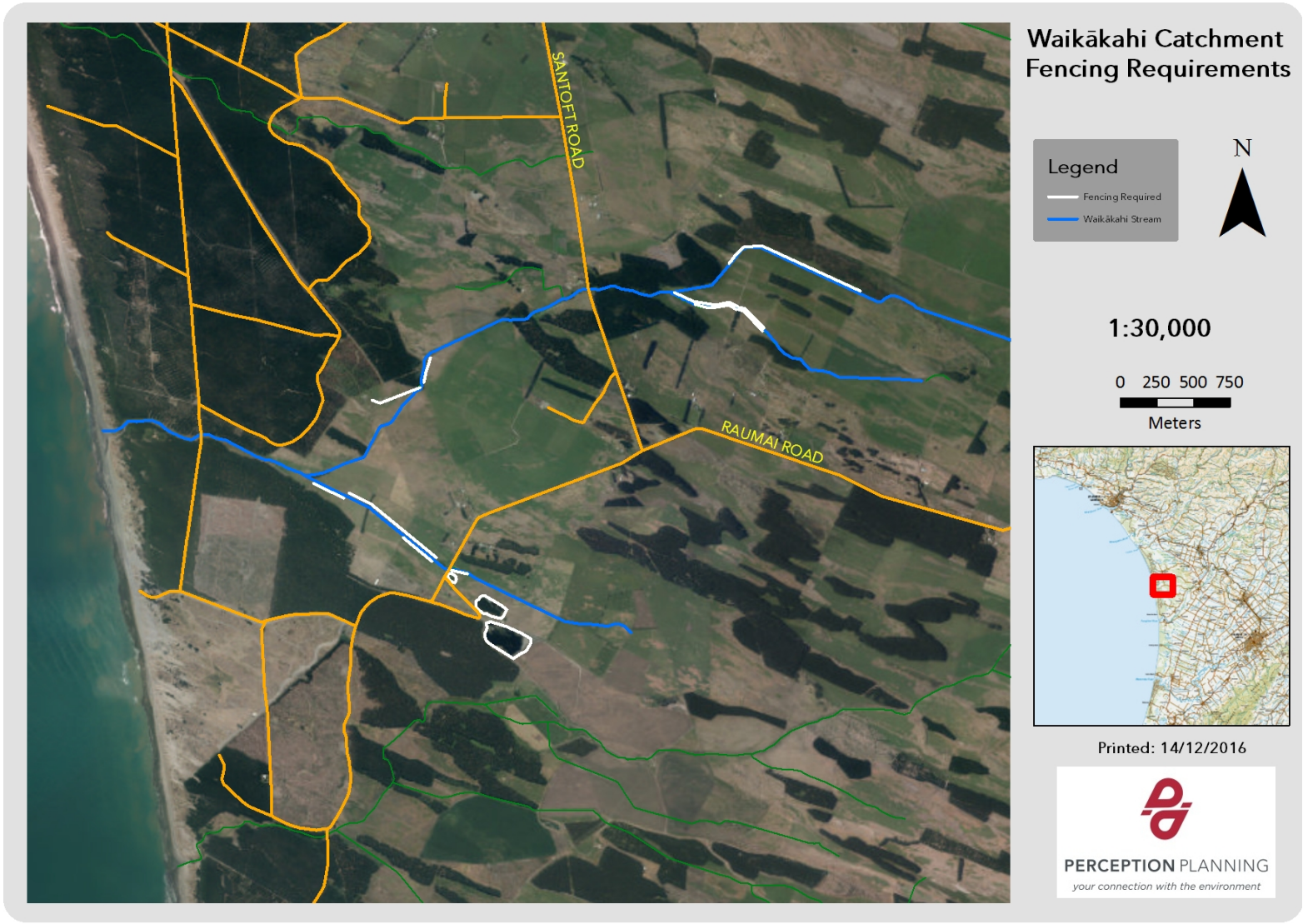

FIGURE 7: AERIAL MAP OF FENCING REQUIREMENTS IN THE WAIKĀKAHI CATCHMENT

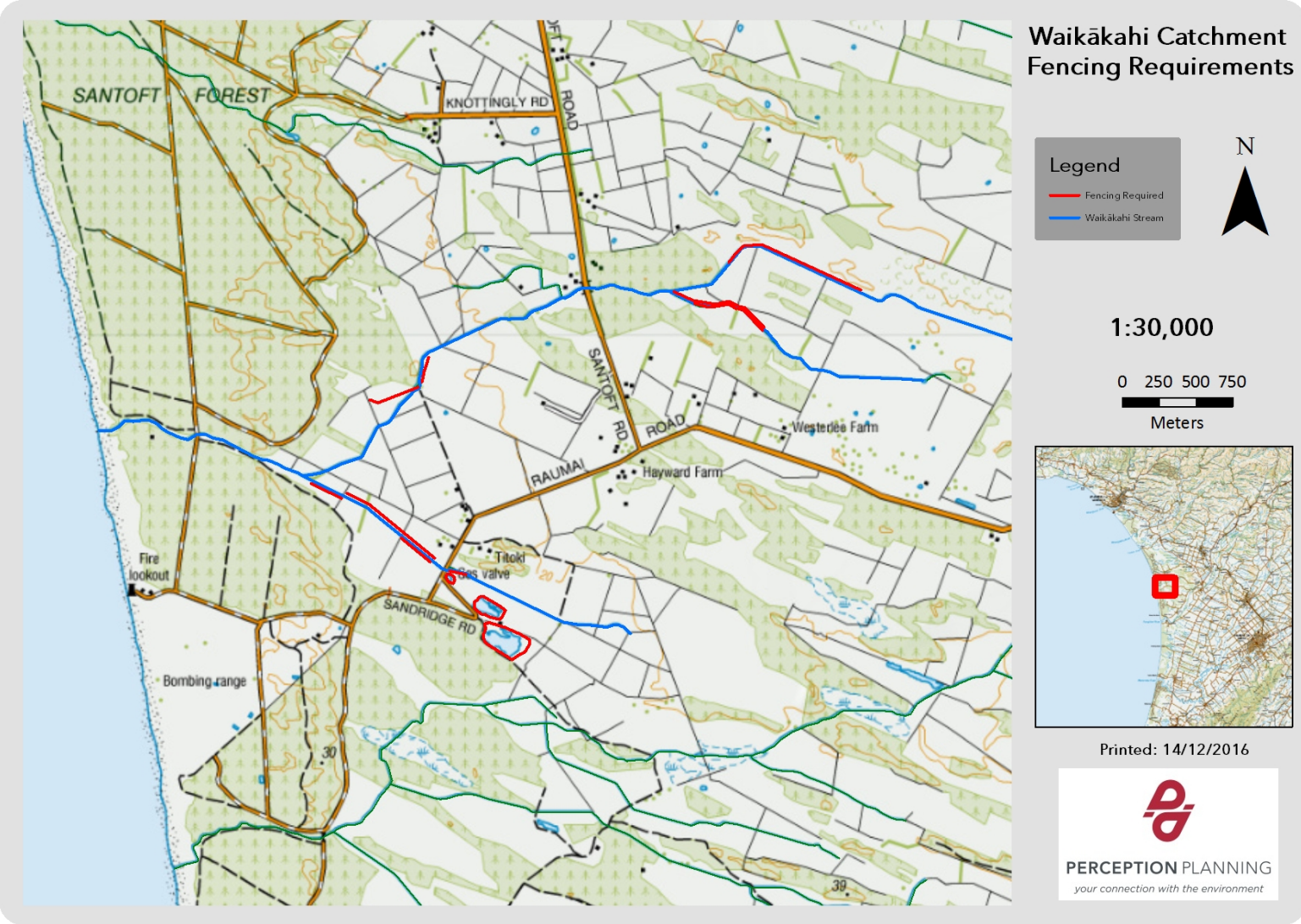

FIGURE 8: TOPOGRAPHICAL MAP OF FENCING REQUIREMENTS IN THE WAIKĀKAHI CATCHMENT

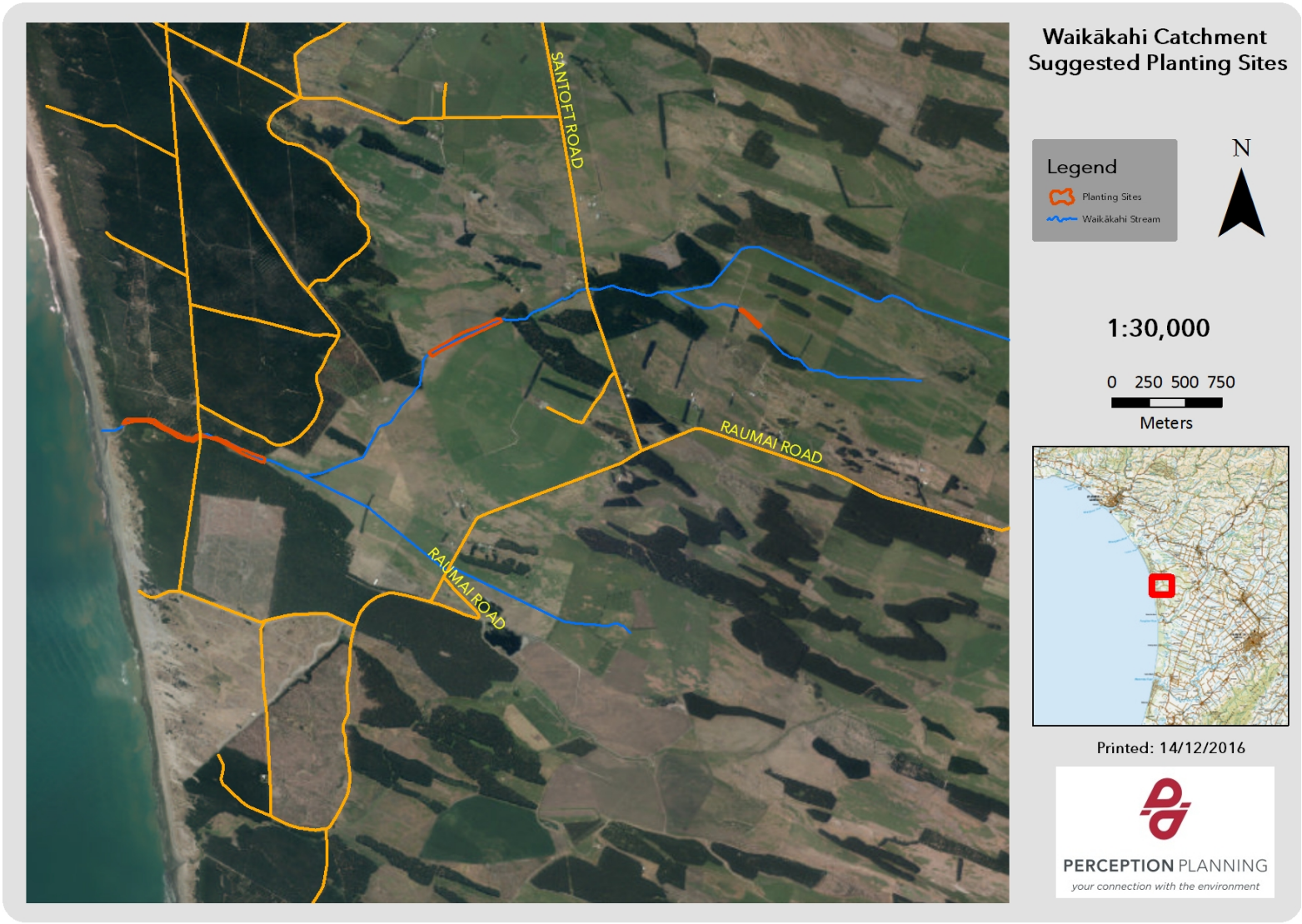

FIGURE 9: AERIAL MAP OF SUGGESTED PLANTING SITES IN THE WAIKĀKAHI CATCHMENT

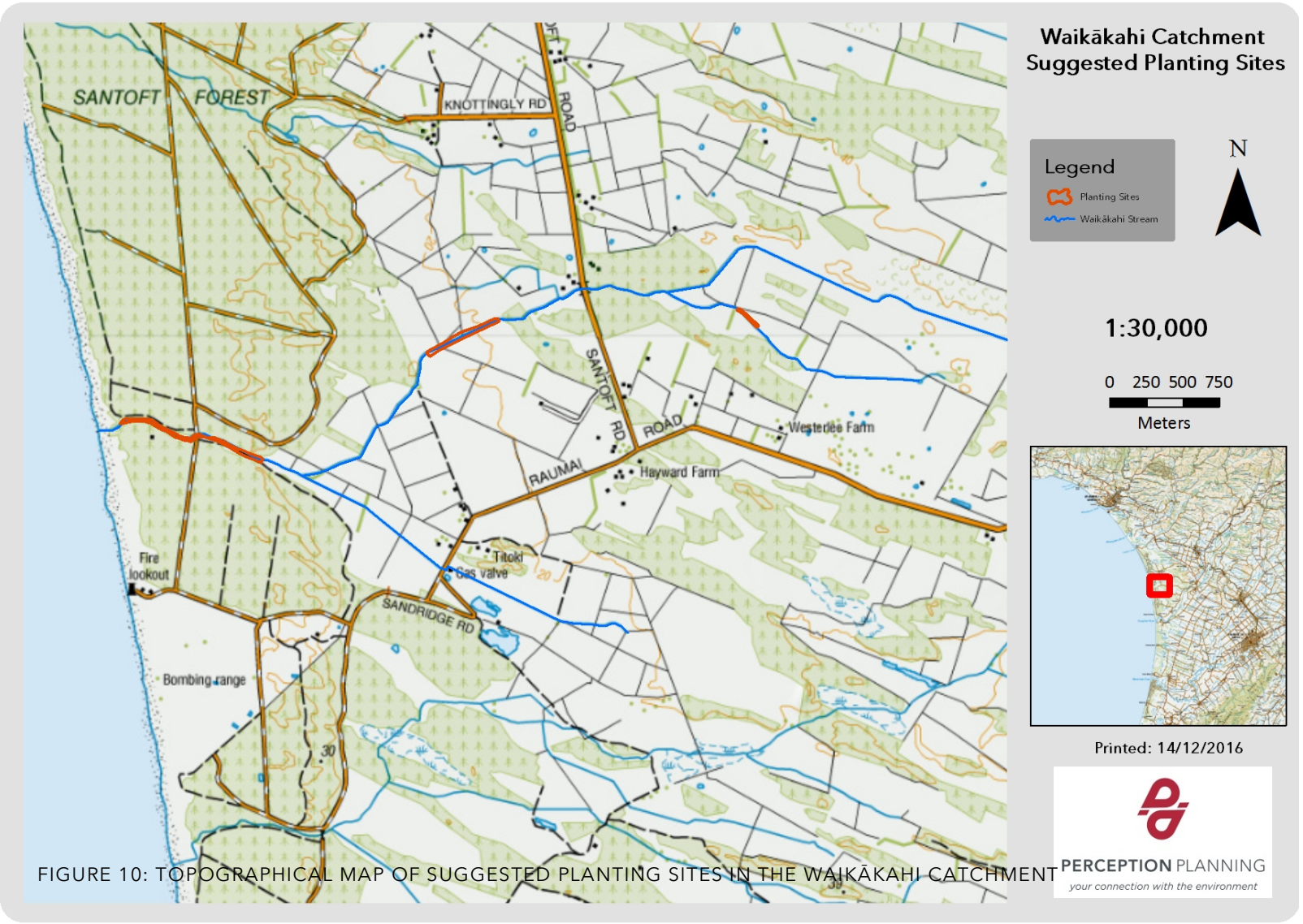

FIGURE 10: TOPOGRAPHICAL MAP OF SUGGESTED PLANTING SITES IN THE WAIKĀKAHI CATCHMENT

There are significant terrestrial weed issues in this section with sand acacia (*Acacia sophorae*) forming dense infestations at the coast and white poplar spreading from plantings which were put in place to protect the forestry road from stream erosion. Other weed species of note are crack willow near the coast, occasional boxthorn, gorse, elderberry, pampas, South African ice plant and montbretia in the forestry area.

Sand acacia is too widespread to make eradication a priority as part of a riparian restoration project. However, local control should be undertaken to protect future plantings. Control can be achieved by spraying with Versatill at a rate of 500 ml/100 L plus pulse at 100 ml per 100 L (DoC weed database). White poplar should be eradicated to prevent further spread via suckering. Streamside white poplar can be cut and stump treated with glysophate while plants further from the stream could be sprayed with glysophate when in full leaf (DoC weed database). Basal spraying may also be an acceptable method of control that would reduce the risk of spray drift: (see Appendix Two). Streamside planting to protect the road should be replaced either with draping vegetation like *C. secta* and harakeke, or sterile male Matsundana shrubby willow (Denyer, 2015). White poplar roots will remain in the soil and provide erosion protection while planted species establish. Boxthorn, elderberry and pampas should be controlled close to planting sites. Gorse should be retained to provide protection for plantings as it will be eventually shaded out. South African ice plant and montbretia are not threatening biodiversity values at this pine dominated site and are not an issue for riparian planting.

2.1.1.2.2 Fish passage

As mentioned in the overview section, there is a culvert in this section that is acting as a velocity barrier for elvers, and possibly īnanga too (see Figures 5 and 6 – 'Earnslaw Culvert'). This is a high priority to remedy, and will help open up the rest of the catchment to these juvenile eels.

EARNSLAW CULVERT – VELOCITY BARRIER UNDER EARNSLAW ROAD

2.1.2 Section 2: Lower true left trib and lower main stem

2.1.2.1 Section description

This section is comprised of dairy farm run by Alan Third and contains a section of the main stem and a straightened tributary that originates east of Raumai Road. Three open water ponds near the gas valve are also included in this section. Some fencing has been completed, but more is required. Where fences are in place, they are often situated quite close to the stream; this results in fences being eroded or ineffective. Narrow fencing also limits planting options and restricts the ability of the stream to meander, an important feature in creating habitat heterogeneity and slowing stream velocity.

There are issues with effluent management in this section, with effluent being directly discharged into the true left tributary via a disconnected irrigation pipe. At the time the discharge was observed, the paddocks were saturated after recent wet weather and probably unable to accommodate effluent irrigation. It seems more effluent storage is required on this property to allow for wet periods.

As with the rest of the catchment, prolific growth of water celery is an issue.

The true left tributary has been straightened at some stage, and is not being treated as a stream. Cows have access to the water. However, it does meet the Sustainable Dairy: Water Accord requirements that "animals are to be excluded from waterways and drains that are at any point within the boundary of the dairy farm wider than one metre and deeper than 30 cm" (Dairy Environment Leadership Group) and also One Plan requirements that waterbodies in areas of intensive land use wider than a metre must be fenced (Horizons Regional Council, 2014). As such it needs fencing. Given that there is a weir in Section 3 blocking upstream fish passage, this true left tributary currently amounts to around 30% of all available fish habitat in the stream (particularly for īnanga). It is, therefore, an important section.

COWS WITH STREAM ACCESS ON THE LOWER TRUE LEFT TRIBUTARY

There are three vehicle and stock crossings in Section 2; these need to be culverted or bridged to prevent both contaminants from the vehicles

and the impacts of stock access, ie, eroded banks and faecal and urine inputs. In general, culverts in this section are not large enough to accommodate flood flows. This is resulting in erosion and washed out culverts, creating extra work and costs for the farmer. Details of particular culverts and vehicle crossings are described below.

Near the gas valve on Raumai Road there is a small pond, and on Sandridge Road there are two small lakes that are not connected to the stream. These could be planted to provide bird habitat.

2.1.2.2 Issues and actions in this section

2.1.2.2.1 Culverts and vehicle crossings

In the lowest, most downstream paddock in this section below the confluence of the true left tributary and the main stem, there is a vehicle and stock crossing that needs to be bridged (see Figures 5 and 6 – 'Vehicle Crossing 1'). Stock crossings are addressed in the Sustainable Dairy: Water Accord, with an undertaking by the dairy industry to "Implement measures to ensure 100% of regular stock crossing points are either bridged or culverted by 31 May 2018." (Dairy Environment Leadership Group). It is also a requirement under the One Plan Policy 14-5 (Horizons Regional Council, 2014).

VEHICLE CROSSING 1, IN MOST DOWNSTREAM PADDOCK

Upstream of here on the lower true left tributary there is an undersized culvert that ought to be replaced as it is at risk of blowing out. However, it is not a fish barrier.

Further up where the true left tributary meets Raumai Road, there are two more vehicle and stock crossings which need to be bridged (one upstream and one downstream of the road – see Figures 5 and 6 – Vehicle Crossings 2 and 3).

Moving across to the main stem, there is a culvert comprising two different sized pipes that had washed out around the join (see Figures 5 and 6 – 'Double Culvert'). Again this does not appear to be a fish barrier as fish were found upstream, but will be causing ongoing work for the farmer. It would be better replaced with a single, larger culvert.

There is a gas pipe crossing at E1789290, N5549544 (see Figures 5 and 6 – 'Gas Barrier'). Logan Brown at Horizons Regional Council has alerted the owners to the need for remedial work on this issue, and this will be actioned shortly. Some fish must be getting past this point intermittently as there are fish upstream, so it can be considered a minor fish barrier issue.

GAS BARRIER

There is a crossing at the upstream extent of Alan Third's land that needs proper bridging to keep both stock and vehicles out of the water (see Figures 5 and 6 – 'Vehicle Crossing 4'). At this point, there is flow joining the main stem from the true left. This small tributary has a perched culvert on it about 20 m upstream. Eventually this could be replaced, but is of a lower priority currently as there is little habitat upstream.

2.1.2.2.2 Fencing and water reticulation

The main stem has three sections that are yet to be fenced. At the upstream end of this section, 190 m of fencing is required on the true left of the stream adjacent to a stand of white poplar in forestry cutover. The true right of this section is not fenced but is not currently grazed. This section of stream has natural meanders and could be a candidate for riparian planting in the future if the fencing allows enough room. White poplar would also need to be controlled before riparian planting was undertaken. Immediately downstream from here the true right of the main stem requires 310 m of fencing. This section of stream, which contains the gas pipe crossing, has been straightened in the past and differs from where the stream channel is marked on the topographical map. The final section of the main stem that is not fenced is the small paddock adjacent to the forestry, however it is not clear whether this field is grazed.

ERODED CULVERT

The straightened true left tributary is partially fenced between Raumai Road and the confluence with the main stem. However, stock are not excluded from the waterway except immediately above the confluence, the small paddock downstream of Raumai Road, and a fenced section above the gas valve. In total 1250 m of fencing is required. When stock are excluded from the true left tributary a total of five troughs would need to be put in place. Some paddocks already have troughs which should make the installation of further troughs easier providing there is enough water capacity to supply them.

Upstream of Raumai Road there is a short stretch that is not fenced adjacent to the gas valve requiring 280 m of fencing. This section contains a vehicle crossing, discussed above. From 140 m upstream of the gas valve the tributary is fenced on both sides and planted with harakeke and tī kōuka.

SMALL POND WITH STOCK DAMAGE. RAUPŌ IS VISIBLE TO THE RIGHT OF THE PICTURE.

The three ponds to the east of Raumai Road are not fenced. The two ponds on Alan Third's property would require approximately 190 m and 580 m of fencing. Two stock troughs would also be required. The larger pond on Waitatapia Station would require 640 m of fencing. This property was not visited and it is not clear what stock water would be required.

2.1.2.2.3 Weed control

The main area of terrestrial weeds is found in the expanding white poplar infestation. White poplar is expanding through pine slash and into the pine plantation from mature plants on the stream edge. In this area, elderberry, gorse and lupin are common, and the occasional boxthorn is present. Boxthorn are also present close to the junction of the main stem and the true left tributary. The presence of these weeds increases the difficulty and expense of establishing native riparian planting in this section.

WHITE POPLAR INFESTATION EXPANDING FROM MATURE PLANTS NEAR THE STREAM

A shelter belt of grey willow runs beside Raumai Road south of the gas valve and adjacent to the smallest of the ponds. Grey willow appears to have established on islands in the two larger ponds. Grey willow is a priority to control due to the wide dispersal of wind-blown seed and ability to invade wetlands such as the one in Section 6. A large crack willow is also present but does not appear to have spread.

Water celery is abundant throughout this section. Currently, however, there are few areas suitable for riparian planting to exclude water celery. Fencing is often too close to the stream edge to allow for enough depth of planting, and straightened sections of stream are likely to form meanders that could erode new plantings.

If the weir in section 3 is not able to be addressed, however, the priority to undertake water celery control and establish riparian planting in both the main stem and left tributary would increase.

2.1.2.2.4 Planting

The ponds above Raumai Road could be planted to provide habitat for native birds if fenced and weed control is undertaken. Planting would follow the same pattern as riparian planting in Section 1, with *C. secta*, toetoe, harakeke and tree species. This would be relatively straight forward and publically visible.

2.1.3 Section 3: Top boundary of Alan Third's land to Santoft Rd

2.1.3.1 Section description

This farm is run by Joe Skerman and is again a dairy farm. The entire stream in this section is fenced, with generous setbacks that create ample room for riparian planting.

There is a culvert under a farm road crossing (Figures 5 and 6 – 'Farm Crossing Barrier') that is likely to be a velocity barrier for fish, and a tall weir of over a metre high upstream from this that would prevent īnanga from migrating upstream. Elvers, however, would probably manage to negotiate the weir by climbing up the damp vegetation on its face and sides, if they manage to pass through the downstream velocity barrier.

The stream bottom is still sandy in this section. The topographical map indicates that there is a tributary flowing in an easterly direction on the true right; however this was little more than a damp area in the paddock in reality. There is, however, a small raupō wetland that is not marked on the topographical map, located at the point where the tributary is marked to begin.

SMALL RAUPŌ WETLAND

The weeds in this area include crack willow, boxthorn, elderberry and gorse. Water celery is, again, present throughout this section.

2.1.3.2 Issues and actions in this section

2.1.3.2.1 Culvert and weir

FARM CROSSING BARRIER

This section contains two considerable fish barriers. The first, as described above, is a velocity barrier created by a small culvert underneath a farm vehicle crossing. Rocks have been placed beneath the outlet, which will assist fish passage somewhat, but in general this culvert (and the small one beside it that is designed for higher flows) needs to be replaced with a much larger capacity culvert. A box culvert would probably be best. Once replaced, the streambed will even out, with sediment currently trapped upstream moving downstream. It would be wise to allow this to happen before undertaking downstream planting.

About 50 m upstream of here is an old weir (Figures 5 and 6 – 'Weir'); locals say it was made with discarded telephone poles, but it is so overgrown with water celery that it is impossible to tell. As stated above, elvers are likely to be able to climb the damp vegetation to get past this barrier, but īnanga will find it an impasse. Given the large amount of potential īnanga habitat upstream, removal of this weir is a crucial factor in restoring the Waikākahi Stream. We would also note at this point that kākahi rely on fish hosts in order to complete their life cycle, so opening up the stream to īnanga will help with any long-term goals of returning kākahi to the area.

Removing this weir will result in substantial realignment of the streambed, with a channel likely to form in the upstream area that is currently a wide wet swathe. Again, the streambed will even out, with sediment upstream moving to fill in areas downstream. Planting in this area should be delayed until the streambed has realigned.

OLD WEIR AND SURROUNDING AREA

2.1.3.2.2 Weeds and planting

Below the weir and vehicle crossing are good sites for native riparian planting to increase biodiversity and compete with water celery. The stream has natural meanders and fences are set far enough back from the stream on both sides to allow for a full range of planting, from *C. secta* at the stream edge to toetoe and harakeke and tree species further back. Water celery is abundant but the stream still has areas of open water. Water celery is predominantly rooted at the stream edge, with plant material in the stream free-floating rather than rooted into the stream bed itself. This makes removal easier and competition planting more likely to be successful. There is the potential to plant 600 metres of stream below the vehicle crossing. However, before planting can be undertaken the fish barriers created by the vehicle crossing and the weir ought to be remedied.

LOOKING DOWNSTREAM FROM THE VEHICLE CROSSING AT POTENTIAL RIPARIAN PLANTING AREA. WIDE FENCING SET-BACKS AND NATURAL MEANDERS MAKE THIS A GOOD SECTION OF STREAM TO PLANT.

Below the vehicle crossing, boxthorn, elderberry and establishing crack willow are growing together in thickets mainly on the true left, and these should be controlled prior to planting. There is easy access for a gun and hose unit and spraying would be straight forward. Weeds should be left standing to provide shelter for native plantings. Gorse is also common but does not need to be controlled away from the fence line as it will

provide valuable shelter to native plantings and will be shaded out when native trees mature.

At and above the weir is a stand of mature crack willow with some elderberry. Crack willow can be killed standing by drilling and poisoning in autumn. This prevents large amounts of live branches falling into the stream where they can root and start new infestations. Once dead, crack willow can either be left standing to eventually decay, or else felled and dragged to the side with a digger to rot or be burnt. If trees are left standing there is the risk that falling branches will block or blow out downstream culverts. However, some woody debris in the stream would benefit stream insect life, so leaving a few larger trunks that could withstand floods may be an option. We suggest discussing this with local farmers, who will know how severe floods in the stream can be and can help gauge what wood might safely be left. Certainly if the weir is removed, which we strongly recommend, dead standing willow ought to also be removed.

Drilling of willow and spraying boxthorn, elderberry and willow in the planting site could be completed in two person days at a cost of approximately $760.

There are mature crack willow above this section so reinvasion of the site is possible until the upstream crack willow are controlled.

2.1.4 Section 4: Main stem in forestry/willow

2.1.4.1 Section description

This 430 m section of Waikākahi Stream runs through forestry before going under a wide culvert at Santoft Road. Pine on the true left has been harvested and replanted in the last few years while pine on the true right is nearing maturity. Large crack willow are found close to the stream creating a solid canopy over the stream in places. Pampas is found along the edge of the young pine and may be an invasion threat to the wetland in Section 6. The stream bed is wide for a lot of this section, especially close to Santoft Road. Water celery is abundant, especially in the lower wide section and the pest species *Tradescantia fluminensis* (also known as wandering willie) is present on the upstream side of the road edge.

MATURE CRACK WILLOW AT THE UPSTREAM END OF SECTION 4

2.1.4.2 Issues and actions in this section

2.1.4.2.1 Weeds

Crack willow is likely to invade lower sections of Waikākahi Stream from broken branches moving down stream and it should be controlled if willow control is undertaken in Section 3. Drilling and poisoning could be easily achieved as there is reasonable access to the trees. If dead standing trees are to be removed from the stream to prevent material possibly damming on the road culvert this would need to be completed when the pines on the true right are harvested. Because of the wide stream bed water celery will be hard to displace by planting of native species and this site is not recommended for restoration planting in the short term. Wandering willie is also likely to be transported downstream where it could establish new infestations. If riparian planting and weed control is undertaken in section 3 and further down stream wandering willie should also be controlled. Control could be undertaken by spraying in summer low flows using glyphosate (20 ml/L + penetrant), however, areas close the the stream should be removed by hand.

2.1.5 Section 5: Main channel above willow and pine to wetland

2.1.5.1 Section description

STOCK ACCESS TO THE UNFENCED PART OF SECTION 5

This 1.8 km section of Waikākahi Stream runs through grazing on the true left on Knottingly Farm Limited and a narrow strip of grazing and forestry on the true right owned by Lissington and Fordyce. The majority of this section has been straightened at some time. The true left is fenced with an eight wire fence with an electric outrigger, leaving enough space for *C. secta*, toetoe and harakeke to be planted. The true right is not fenced and cattle have caused damage to the stream bank in places. Water celery is abundant throughout the section, although eaten down somewhat by cattle. There are a few remnant tī kōuka and occassional gorse. On the true right there is a small raupō and harakeke wetland that is not directly connected to the stream.

2.1.5.2 Issues and actions in this section

2.1.5.2.1 Fencing and planting

Fencing the true right to exclude stock from the stream is a high priority for this section, with 1025 m of fencing required. There is no stock water on the true right, and as the narrow strip of grazing is seperated from other paddocks by forested sand dunes it may prove difficult to put stock water in place. Ideally fencing will allow room for the stream to form meanders and allow for future planting. Water celery could be excluded by native planting. Fencing and planting would also have the benefit of reducing nutrient levels in the stream. If the weir in Section 3 is removed this section of stream would create good native fish habitat which would also benefit from native planting.

2.1.5.2.2 Culverts

There is a small culvert in this section that is much narrower than the stream bed (Figures 5 and 6 – 'Narrow Culvert'). Given the current downstream blockages, replacing this culvert is a low priority. We recommend replacing the downstream fish barriers then assessing this culvert 1 to 2 years following that, to determine whether it is a velocity barrier for īnanga. It is not currently perched but may erode out over time.

NARROW CULVERT

2.1.6 Section 6: The last wetland

2.1.6.1 Section description

This section on the Killarney Farms Ltd property contains the only large wetland left in the Waikākahi catchment. The 4.3 ha wetland is 5.5 km from the coast and bounded at the western edge by a pine-covered sand dune. The wetland is off the main stem which skirts the southern edge of the wetland. Grey and crack willow have become the dominant canopy but mature māhoe, karamu, mamaku and whekī are present underneath. Open areas are dominated by *C. secta*, raupō and harakeke with mature tī kōuka at the outer edges of the wetland. The wetland is likely to have formerly contained swamp forest and could potentially be returned to kāhikatea forest. Korimako were seen feeding on harakeke flowers and riroriro and tīwaiwaka were seen catching insects in the wetland.

The wetland is fenced except for the border with the pine-forested dune, which is not grazed. There was some evidence of past pugging indicating stock had been in to the wetland but no signs of damage to vegetation. In drier parts of the wetland grey willow forms the bulk of the canopy with smaller areas of taller crack willow. In wetter areas grey willow are common but are not currently out-competing *C. secta*, harakeke and raupō.

ONE OF THE WETTER AREAS IN THE CENTRE OF THE WETLAND WITH HARAKEKE, TĪ KŌUKA, RAUPŌ, *C. SECTA, COPROSMA PROPINQUA* AND SAPLING GREY WILLOW. MATURE GREY WILLOW FORM A CANOPY IN THE BACKGROUND

2.1.6.2 Issues and actions in this section

2.1.6.2.1 Weed control and re-establishing a kāhikatea canopy

An extensive grey and crack willow canopy has replaced the former native swamp forest and is causing the further decline of biodiversity values. Grey and crack willow have been successfully controlled in wetlands by aerial spraying and follow-up ground control. The closed canopy of the willow will partially protect the native vegetation underneath from spray, although native species in the canopy and those in open areas can be affected. At Kopuatai Wetland aerial spraying of willows with glyphosate in 2002 resulted in excellent control of willows with very little damage to non-target species, such as indigenous sedges in the understory (Reeves & Champion, 2003). At Lake Hatuma, aerial spraying of willows in 2002 resulted in raupō and *C. secta* being initially "knocked back", but then expanding in range by 2005 (Walls, 2005). At Opuatia Wetland, aerial spraying of willows in 2006 resulted in high willow mortality, although some tī kōuka in the canopy died and

sedges and rushes in canopy gaps also suffered high mortality. However, sedges and rushes under a denser canopy appeared unaffected and harakeke and Coprosma shrubs were generally unaffected (Golder Associates, 2009).

The wetland has mature māhoe, karamu, *Coprosma propinqua* and tī kōuka and strong stands of *Carex secta*, raupō and harakeke, and can reasonably be expected to recover well after aerial control of willow. Control of willow will increase light to the wetland floor and enable native seed to germinate and seedlings to survive. The wetland would, however, remain vulnerable to reinvasion until a significant tall canopy is established (*pers. comm.* James Griffiths, Department of Conservation). Grey willow is present in the wider area and seed from this species is likely to reach the wetland in the future.

WHEKĪ, MĀHOE, DIVERSE FERNS AND *CAREX* SP. UNDER A GREY AND CRACK WILLOW CANOPY. KĀHIKATEA COULD BE RESEEDED UNDER THE WILLOW CANOPY BEFORE WILLOW IS CONTROLLED TO RELEASE KĀHIKATEA SAPLINGS.

A study on the impact that aerial control of willows using glyphosate has on kāhikatea found that it created favorable conditions for kāhikatea growth (Griffiths & McAlpine, In draft). The Department of Conservation is interested in researching the potential of re-establishing kāhikatea forest by aerially dropping large amounts of kāhikatea seed into willow-dominated wetlands. Once seed has germinated and reached small sapling size, the willow would be sprayed, releasing the kāhikatea by providing more light. The kāhikatea saplings should largely be protected from the herbicide by the willow canopy (*pers comm.* James Griffiths, Department of Conservation). It is recommended that James Griffiths at Department of Conservation Head Office is approached to see if the wetland could become part of a study on this method of re-establishing kāhikatea forest.

A patch of field horsetail (*Equisetum arvense*) is located in wet pasture on the northern edge of the wetland. Field horsetail was not seen in the wetland itself but would be very difficult to remove once established in the wetland. It is toxic to stock and should be controlled. Control can be achieved by digging out and incinerating all parts and contaminated soil, or spraying in summer with either metsulfuron-methyl 600 g/kg (5 g/10

L) or Tordon Brushkiller (25 ml/10 L) with penetrant in both cases. Follow-up control will be required.

Blackberry is present in the wetland at low densities and would increase if willow was controlled, before shade from native species suppressed it again.

VIEW LOOKING OVER THE GREY AND CRACK WILLOW CANOPY THAT CURRENTLY COVERS THE WETLAND. THIS COULD BE RETURNED TO TALL KĀHIKATEA FOREST THAT WOULD HELP PROTECT THE WETLAND FROM FUTURE WEED INVASION.

2.1.7 Section 7: Upper main stem

2.1.7.1 Section description

This section runs from the wetland in Section 6 to the top of the stream catchment. On the true right and upper true left is Kilarney Farms Ltd. The lower true left runs though Gurteen Farms Ltd and the property of Harold Cooper and Martin Field. The upper extent of this section was not surveyed as the flow became very low towards the top end. The stream has been straightened in the past. Parts of the stream bed are very open, indicating it has probably been

DAM CULVERT

mechanically cleared in the recent past. Water celery is common in parts of this section. At around about E1793619, N5549932, a small perched culvert (Figures 5 and 6 – 'Dam Culvert') has dammed the main flow redirecting some of the stream flow through a dug channel into the true left tributary discussed in Section 8. This results in a reduction to the flow in the main stem. The stream is fenced where it has stronger flows, although a two wire electric fence in a redeveloped paddock on the true right needs to be re-established. Fencing is very close to the stream and does not provide enough room for riparian planting.

A DUG CHANNEL CONNECTING THE MAIN STEM (IN FOREGROUND) TO THE TRUE LEFT TRIBUTARY (FLOWING AWAY UNDER THE FENCE)

2.1.7.2 *Issues and actions in this section*

As discussed above, the perched culvert needs to be replaced to allow the stream to return to its main course. This will become higher priority to complete once the downstream blockages have been remedied. Fencing on the true right will also need to be re-erected, especially before stock graze the crops.

LOWER FLOW BELOW THE CULVERT LOOKING DOWNSTREAM. THE FENCE ON THE TRUE RIGHT NEEDS TO BE REINSTATED. FENCING ON BOTH SIDES OF THE STREAM IS CLOSE TO THE STREAM MEANING RIPARIAN PLANTING CANNOT BE EASILY UNDERTAKEN.

2.1.8 Section 8: True left upper tributary.

2.1.8.1 Section description

This section contains a significant tributary to the Waikākahi Stream that runs over 5.5 km through Knottingly Farm Ltd, Gurteen Farms Ltd, the property of Harold Cooper and Martin Field, and Killarney Farms Ltd. The confluence with the Waikākahi is just above the block of pines in Section 4, immediatly east of Santoft Road. The tributary runs predominantly through grazing land but also passes beside some small blocks of forestry. On the topographical map the stream disappears underground for about 1 km, however, it was flowing strongly above ground for the entire length at the time of survey. In the mid to upper reaches of the tributary it is fed by multiple ditches that are draining paddocks in what would likely have been wetlands associated with small dunes. Water is also diverted from the main stem into the tributary by the Dam Culvert (see section 7); this has increased the flow in the middle reaches of the tributary. Sections of the downstream end of the tributary are fenced, however, there is no permanent fencing for the majority of its length. In the upper reaches temporary electric fences were being used to exclude cattle from the stream. There is little native vegetation on this tributary except for remant tī kōuka. Water celery is abundant throughout. The tributary could provide extra habitat for native fish if the weir below Santoft Road is remediated.

The streambed in this area is slightly less sandy and more silty than further down the catchment. It provides better potential habitat for kākahi than other sections.

2.1.8.2 Issues and actions in this section

2.1.8.2.1 Fencing

The lower part of this section of the stream is partially fenced and has two large culverts and vehicles crossings already in place. In total 1.2 km of fencing would be required to exclude stock for the lower 1 km of the tributary. Below the lower shelterbelt fencing of the tributary could be done by altering the boundaries of two paddocks to prevent small unusable areas of grazing being created.

Upgrading the culvert in the main stem in Section 7 would reduce the flow to the middle reaches of the tributary. This may lower the stream flow in the middle sections to below Accord and One Plan requirements for fencing, however, given the ecological benefits of excluding stock the farmer may wish to look at fencing this section in the future regardless. It is recommended that decisions on fencing in the middle reaches of the

tributary are made once the lower section is fenced and the culvert in the main stem remedied.

2.1.8.2.2 Planting

The lower section of the tributary is a good site for planting to compete with water celery. The stream has meanders and water celery is mainly rooted into the stream banks rather than across the entire bed of the stream. If the weir in Section 3 is removed this would be a priority site for restoration planting, once fenced.

2.1.8.2.3 Kākahi translocations

In the future, the possibility of translocating kākahi to this tributary could be investigated. A thorough hand-search of the stream for kākahi should be conducted first to ensure they are indeed absent from the Waikākahi.

LOOKING UPSTREAM FROM THE LOWER SHELTERBELT / VEHICLE CROSSING. A GOOD POTENTIAL RESTORATION SITE WITH FENCING AND NATIVE PLANTINGS TO COMPETE WITH WATER CELERY. THE SECTION HAS NATURAL MEANDERS, GOOD WATER FLOW AND GOOD POTENTIAL FISH HABITAT IF THE WEIR IN SECTION 3 IS REMOVED.

2.2 Summary of actions for restoration

Section of Stream	Matter	Summary of issue	Action	Priority	Who to action	When
Entire catchment	Commercial eeling	Commercial eeling removes the larger eels from a stream. These larger eels are closer to reaching breeding age and will also hold more eggs when mature than smaller mature individuals; consequently commercial eeling can undermine the long-term prospects of the eel population. Commercial eeling also takes an at risk species (long-fin eels) from the stream when these are already under pressure, and can potentially affect the ability of the haukāinga to undertake cultural harvest.	Work to effect a moratorium on commercial eeling.	High	Ngā Wairiki Ngāti Apa	Begin as soon as possible. May take some time to work through the legal requirements.

Entire catchment	Introduce instream habitat	Adding boulders or logs that are large enough to remain in place during floods will increase the diversity of habitat in the stream and provide cover for fish and substrate for stream insects.	Add boulders and/or large logs to the stream.	High	Ngā Wairiki Ngāti Apa, with landowner support	As soon as possible
1	Earnslaw Culvert	This culvert forms a velocity barrier, particularly for elvers. A number of elvers were observed in October 2016 congregating at the bottom edges of the culvert, attempting to make their way upstream.	Ask Earnslaw to replace with an appropriately sized culvert. A box culvert is probably best.	High	Ngā Wairiki Ngāti Apa to initiate discussions; Earnslaw to undertake and fund work.	As soon as possible
1	Water celery clogging stream	Water celery is not native, blocks the stream and can damage instream structures during floods, causes reductions in dissolved oxygen when it dies back in the cooler seasons, and is less than ideal as fish spawning habitat.	Trial dense planting of *Carex secta* to compete with water celery, below current native plantings.	High	Ngā Wairiki Ngāti Apa	As soon as possible

1	Weed control	White poplar is invasive and spreads easily.	Control infestation of white poplar and replace erosion planting - see details in relevant section	High	Qualified weed control contractor, commissioned by Ngā Wairiki Ngāti Apa and ideally in conjunction with Earnslaw.	As soon as funding is available
1	Weed control	Sand acacia, boxthorn, elderberry and pampas near the native planting site in this section may adversely affect the target native plants.	Control sand acacia, boxthorn, elderberry and pampas around planting site – see details in relevant section	Medium, as required to protect riparian planting	Qualified weed control contractor, commissioned by Ngā Wairiki Ngāti Apa	Medium term
1	Planting	Planting in this section will augment current native plantings, provide potential spawning habitat, increase	Plant close to the stream joining with Ngāti Apa	High – one of the best places to	Ngā Wairiki Ngāti Apa	As soon as possible

		biodiversity and should work to exclude water celery from the area.	planting and natural regeneration	plant in the catchment to increase biodiversity and trial exclusion of water celery (see above under water celery)		
2	Vehicle Crossing 1	Vehicle and stock crossings damage banks and introduce contaminants and nutrients into the water.	Install a proper crossing	High – Accord and One Plan requirement	Farmer	Immediately
2	Double Culvert	This culvert does not appear to be a fish passage issue, but is prone to erosion and would be better replaced with a single, wider culvert.	Replace with suitably-sized single culvert	Low-med – mostly affects farmer as opposed to the stream	Farmer	When convenient
2	Gas Barrier	The gas pipeline passes under the stream at this point. The streambed has eroded at the downstream end of the 'blanket' installed to protect the	Ensure gas company does replace this; keep in contact with	Low – action to remedy this is already underway.	Gas company	Immediately

		pipeline and is a moderate fish barrier. Some fish are still managing to navigate past this, as evidenced by the numbers upstream, but it is likely to erode further without remedial action.	Horizons Regional Council and check stream when in the area.			
2	Vehicle Crossing 2	Vehicle and stock crossings damage banks and introduce contaminants and nutrients into the water.	Install a proper crossing	High – Accord and One Plan requirement	Farmer	Immediately
2	Vehicle Crossing 3	Vehicle and stock crossings damage banks and introduce contaminants and nutrients into the water.	Install a proper crossing	High – Accord and One Plan requirement	Farmer	Immediately
2	Vehicle Crossing 4	Vehicle and stock crossings damage banks and introduce contaminants and nutrients into the water.	Install a proper crossing	High – Accord and One Plan requirement	Farmer	Immediately
2	Perched culvert in the small true left tributary joining the main stem at the top of	The perch on this culvert prevents fish from navigating their way upstream. However the channel upstream from here is very minimal and not great quality.	Replace with a larger culvert	Low – little habitat upstream	Farmer	When convenient

	Alan Third's land					
2	Fencing and water reticulation	Fencing is needed to exclude stock from parts of this section. Water reticulation will be necessary as currently stock access their water needs directly from the stream.	Main stem – 3 sections (190 m, 310 m and the small paddock adjacent the forest. True left tributary – 1250 m required, plus a further 280 m upstream of Raumai Road. Seven new water troughs in total. Ponds – 190 m, 580 m and 640 m of fencing required.	High – One Plan and Accord requirement (NB the ponds do not fall under the One Plan requirements, but would be included in the Accord requirements)	Farmer	Immediately
2	Weed control	Grey willow seeds are dispersed by wind. They are a pest species and	Control grey willow to prevent weed spread and	High	Qualified weed control contractor,	As soon as funding is available

		need to be controlled to prevent further infestations.	reinvasion of restoration sites.		commissioned by Ngā Wairiki Ngāti Apa and ideally in conjunction with farmer and/or Horizons	
2	Planting	The ponds on Raumai Road are one of the few places of open water in the catchment. Planting these will provide habitat for native birds.	Plant the Raumai Road ponds for bird habitat	Medium	Ngā Wairiki Ngāti Apa in conjunction with landowner, and possibly Fish and Game if they are interested.	Medium-term
2	Dissolved Oxygen Monitoring	The impact of water celery during its growing phase (as opposed to its die-back phase) on slow moving waters is still a little uncertain. It	Place DO loggers in the stream (both the main stem and the	High. Will provide valuable information	Ngā Wairiki Ngāti Apa in conjunction with Horizons	Feb-March 2017 for growth period; likely

		would be very useful to undertake dissolved oxygen monitoring for the period of a few days, at different points within the stream. It would also be helpful if possible to measure DO during the die-back phase to confirm impacts during this period.	lower true left tributary) for 24-48 hours each.	to guide further decisions.	Regional Council (if they are agreeable to assisting)	May-June for die-back period
3	Farm Crossing Culvert	This culvert is a velocity barrier. The stream bed below it has eroded out. It needs to be replaced to allow fish access to the upstream habitat, which constitutes a large percentage of the catchment.	Replace with an appropriately sized culvert. A box culvert is probably best.	High – blocks a substantial amount of upstream habitat	Farmer. If Ngā Wairiki Ngāti Apa can source funding to support this work that would expedite the action.	Immediately
3	Weir	This weir will be a barrier to īnanga migrating upstream. It needs to be removed to allow access to the upstream habitat.	Remove and allow streambed to return to pre-weir level.	High – blocks a substantial amount of upstream habitat	Farmer. They may appreciate support from Ngā Wairiki Ngāti Apa to	Immediately

					get the work done.	
3	Planting	The area below the Farm Crossing Culvert is highly suitable for native planting, as it has large set-backs and a meandering stream reach. Planting will increase the biodiversity in the area and, hopefully, out-compete the water celery.	Plant below the Farm Crossing Culvert, once culvert replaced	High – one of the best places to plant in the catchment to increase bio-diversity and trial exclusion of water celery	Ngā Wairiki Ngāti Apa, with assistance from the farmer if willing.	Medium term, once fish barriers removed and stream-bed resettled.
3	Weed control	Weed control will be needed in and around the planting area discussed above, to protect the target plants.	Control boxthorn, elderberry and crack willow in the proposed planting area, once culvert replaced and prior to planting. Crack willow above the weir, before the weir is removed.	High	Qualified weed control contractor, commissioned by Ngā Wairiki Ngāti Apa.	Before the weir removal for crack willow, and before planting for the remaining weeds.

4	Weed control	The crack willow in this section will spread downstream unless controlled, impacting on the planting proposed downstream. These need to be poisoned.	Drill and poison crack willow; remove dead trees during pine harvest.	Medium	Qualified weed control contractor, commissioned by Ngā Wairiki Ngāti Apa, ideally in conjunction with the forestry managers or owners.	Medium-term
5	Fencing	Stock currently have access to the stream in this section; it requires a fence and water reticulation.	Fence true right; add water reticulation	High – One Plan and Accord requirement if dairy grazing occurs here.	Farmer	Immediately
5	Planting	Once fenced as recommended above, the area would benefit from	Plant native species to exclude water celery.	Medium-low – reliant on waiting for wide fencing	Ngā Wairiki Ngāti Apa, with assistance	Medium- to long-term

		planting to increase biodiversity and out-compete water celery.		on true right above and remediation of the Farm Crossing Culvert and Weir.	from the farmer if willing.	
5	Narrow Culvert	This narrow culvert does not appear to be a problem at present, but may erode out over time. We recommend reassessing it in 1-2 years' time, after the downstream fish barriers have been remedied.	Re-assess in 1-2 years, once downstream fish barriers have been remedied.	Low	Ngā Wairiki Ngāti Apa for reassessment; farmer for replacement	Medium- to long-term
6	Weed control	Willow have overrun the wetland in Section 6. This is the last remaining wetland in the catchment and is of substantial importance. Willow need to be controlled to allow native species to thrive.	Aerially spray willows	High – only proper wetland left in the catchment	Qualified weed control contractor, commissioned by Ngā Wairiki Ngāti Apa. Potential support from DoC in conjunction	As soon as funding is available

					with experimental seed bomb trial.	
6	Weed control	Horsetail is an extremely invasive weed that is difficult to control. It is also toxic to stock. Currently there is only one small patch in the catchment – this needs to be controlled quickly, before it spreads.	Control horsetail	High	Qualified weed control contractor. The farmer may wish to commission this work, given the risk to operations.	Immediately.
6	Kāhikatea canopy restoration	The wetland would benefit from support for native regeneration, especially as this will help prevent reinvasion by willow. One means of achieving this is to drop a large amount of native seeds aerially and allow these to germinate before undertaking willow control. The proposal is to drop a 'seed bomb' of kāhikatea seed from an aeroplane.	Seed bomb kāhikatea (with DoC) to establish kāhikatea saplings prior to aerial control of willow	Med-high – will substantial assist native regeneration and increase resistance of wetland to weed invasion	Department of Conservation and Ngā Wairiki Ngāti Apa, with support from the landowner.	As soon as possible. However this is dependent on securing funding for subsequent willow control.

7	Dam Culvert	The Dam Culvert is blocking the main stem and forcing the flow through an artificial channel back into the true left tributary. It ought to be replaced with a more appropriately-sized culvert.	Replace perched culvert	Med-low – dependent on fixing downstream blockages first	Farmer	Medium-term
8	Fencing	Stock currently have access to the stream in this section; it requires a fence and water reticulation. Fencing ought to be wide enough to allow for native plantings (see below).	Lower part	High – current stock access to stream	Farmer	Immediately
8	Fencing	Stock currently have access to the stream in this section. The stream would benefit from being fenced. However, if the main stem flow is returned to its natural course the amount of water in this area may mean fencing becomes a matter of goodwill on the part of the farmer.	Middle part	Medium – assess water flows once main stem culvert replaced	Farmer	Medium-term
8	Planting	In the lower part of this section, fencing has the potential to create an area very suitable for native planting.	Native plantings to compete with water celery and	Medium – undertake once the weir	Ngā Wairiki Ngāti Apa, with	Medium- to long-term

		Planting will increase biodiversity and, hopefully, out-compete the water celery.	increase riparian biodiversity	in Section 3 is removed	assistance from the farmer if willing.	
8	Kākahi translocations	Of all the sections in the stream, this area appears to have the best potential kākahi habitat. Given the stream name, it is reasonable to assume kākahi once inhabited this area. If so, re-introducing kākahi would reinstate a lost species, and increase the aquatic biodiversity of the stream. However, at this stage, reintroductions are dependent on other restoration actions and will need to wait for a later date.	Re-introduce kākahi to the stream in this section.	Low – dependant removing weir to allow host fish into the section and improving habitat first	Ngā Wairiki Ngāti Apa	Long-term

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4 Appendix One

4.1.1 One Plan requirements

Below are policies and rules in the One Plan in relation to stock management, willow removal, and the removal of the weir.

4.1.1.1 Stock management

Policy 14-5: Management of intensive farming land^ uses

In order to give effect to Policy 5-7 and Policy 5-8, intensive farming land^ use activities affecting groundwater and surface water^ quality must be managed in the following manner:

(a) The following land uses have been identified as intensive farming land^ uses:

(i) Dairy farming*
2. (ii) Commercial vegetable growing*
3. (iii) Cropping*
4. (iv) Intensive sheep and beef*

(b) The intensive farming land^ uses identified in (a) must be regulated where:

1. (i) They are existing intensive farming land^ uses, in the targeted Water Management Sub-zones* identified in Table 14.1.
2. (ii) They are new (ie., established after the Plan has legal effect) intensive farming land^ uses, in all Water Management Sub- zones* in the Region.

(c) Nitrogen leaching maximums have been established in Table 14.2.

4. (d) Existing intensive farming land^ uses regulated in accordance with (b)(i) must be managed to ensure that the leaching of nitrogen from those land^ uses does not exceed the cumulative nitrogen leaching maximum* values for each year contained in Table 14.2, unless the circumstances in Policy 14-6 apply.
5. (e) New intensive farming land^ uses regulated in accordance with (b)(ii) must be managed to ensure that the leaching of nitrogen from those land^ uses does not exceed the cumulative nitrogen leaching maximum* values for each year contained in Table 14.2.
6. (f) Intensive farming land^ uses regulated in accordance with (b) must exclude cattle from:

1. (i) A wetland^ or lake^ that is a rare habitat*, threatened habitat* or at-risk habitat*.
2. (ii) Any river^ that is permanently flowing or has an active bed* width greater than 1 metre.

(g) All places where cattle cross a river that is permanently flowing or has an active bed* width greater than 1 metre must be culverted or bridged and those culverts or bridges must be used by cattle whenever they cross the river.

4.1.1.2 Willow removal

Horizons have provided the following advice regarding willow removal in the Waikākahi Stream: "The removal of willows from the bed of a stream can be undertaken as a

permitted activity (no consent required) subject to the conditions in the attached rule and table being met [see below].

…[T]here are no riparian, Inanga, whitebait, trout spawning or trout fishery values associated with the stream. So the conditions relating to these values in table 17.2 do not apply" (*pers. comm.* Leana Shirley, Horizons Regional Council).

Rule	Activity	Classification	Conditions/Standards/Terms	Control/Discretion Non-Notification
17-19 **Plants**	Except as regulated by other *rules*^ in this chapter, the introduction, planting, removal or destruction of a plant in or on the *bed*^ of a *river*^ or *lake*^ pursuant to s13(1) or s13(2) RMA, and any ancillary: (a) excavation, drilling, tunnelling or other disturbance of the *bed*^ of a *river*^ or *lake*^ pursuant to s13(1) RMA (b) damming or diversion of *water*^ pursuant to s14(2) RMA (c) *discharge*^ of *water*^ or sediment into *water*^ or onto or into *land*^ pursuant to ss15(1) or 15(2A) RMA (d) deposition of substances in or on the *bed*^ of the *river*^ or *lake*^ pursuant to s13(1).	**Permitted**	(a) A pest plant, as listed in the Regional Pest Plant Management Strategy, must not be introduced or planted. (b) The activity must not involve the planting of a tree or shrub in a reach of a *river*^ with a Schedule B Value of Flood Control and Drainage, as regulated by Rule 17-15. (c) The activity must not involve the removal or destruction of plants in Lake Papaitonga, Pukepuke Lagoon or Lake Horowhenua except for a radius of 500 m from the Lake Horowhenua outlet weir (which is permitted by this *rule*^). (d) The activity must comply with the general *conditions*^ listed in Section 17.3. (e) The activity must not take place in any *rare habitat**, *threatened habitat** or *at-risk habitat**.	

Section 17.3 - Table 17.2

17.3 General Conditions for Permitted Activities and Controlled Activities involving the Beds of Rivers and Lakes

The table below sets out general conditions for activities involving the beds of rivers and lakes. These general conditions are referred to in a number of the permitted activity and controlled activity rules in this chapter. The table sets out general conditions for all rivers and lakes under the Value of Life-supporting Capacity (this Value applies to all rivers and lakes as shown in Schedule B). It then sets out additional conditions for other Values that apply to specific reaches of rivers, as listed in Schedule B. Schedule B must be referred to in order to identify the locations of the Water Management Sub-zones* to which these other Values apply, and whether they are therefore relevant to a particular activity.

Value	Condition
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. (g) Refuelling of machinery must not take place in any area where spills may enter surface *water*^. (h) The activity must be undertaken in a manner that provides for the safe passage of fish both upstream and downstream, including past any *structure*^. (i) 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. (j) Upon completion of any channel bank works, the banks must be reinstated to a natural contour and revegetated. (k) 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. (l) There must be no removal of instream woody debris less than 2 m^3 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)	(m) 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: (i) within 7 days following a flood of the area of beach that is the subject of the activity, or (ii) 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)	(n) 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).

Value	Condition
*Whitebait** Migration (applies to all reaches in *water bodies*^ and their *beds*^ with a Schedule B Value of *Whitebait** Migration)	(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 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)	(p) 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)	(q) 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)	(r) 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*^	(u) 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 20 m upstream or downstream of a high pressure gas transmission pipeline identified by a *district plan*^ or *regional plan*^ or by a marker[2] on the bank of the *river*^.

[1] Further information on the location of flow-recording sites can be obtained by either visiting the Regional Council's website (www.horizons.govt.nz) or by contacting the Regional Council's Hydrology Department.

[2] High pressure transmission gas pipelines are normally indicated by white triangle marker posts or yellow pipeline warning signs. If you are unsure about a pipeline being present, please contact your Territorial Authority.

4.1.1.3 Removal of the weir:

Weir removal is a permitted activity under Rule 17-6 (see below). Sediment would need to be managed to ensure compliance with Section 17.3 (above). Given the bed is comprised of sand, sediment issues are likely to be very minimal as the sand will settle quickly. Although advice from Horizons is that riparian, Inanga, whitebait, trout spawning or trout fishery values do not apply in this instance, it would not hurt to time the weir removal to be between either 2 May and 14 Aug or 1 Dec and 31 January, to comply with these values regardless.

17-6 Removal and demolition of structures^	Except as regulated by Rule 17-15, the removal or demolition of a structure^ located in, on, under or over the bed^ of a river^ or lake^ pursuant to s13(1) RMA, and any ancillary: 1. (a) excavation, drilling, tunnelling or other disturbance of the river^ or lake^ bed^ pursuant to s13(1) RMA 2. (b) damming or diversion of water^ pursuant to s14(2) RMA 3. (c) discharge^ of water^ or sediment into water^ or onto or into land^ pursuant to ss15(1) or 15(2A) RMA 4. (d) deposition of substances in or on the bed^ of the river^ or lake^ pursuant to s13(1).	Permitted	1. (a) The activity must comply with the general conditions^ listed in Section 17.3. 2. (b) The Regional Council must be informed in writing of the removal or demolition of any of the following structures^, at least 10 working days^ prior to the commencement of the removal or demolition: 1. (i) access structures^ in or on the bed^ of a river^ or lake^, including bridges (other than temporary bridges for military training purposes), culverts and fords, where the catchment above the structure^ is greater than 50 ha 2. (ii) structures^ occupying more than 5 m^2 of the bed^ of a river^ or lake^ 3. (iii) any device for the purpose of monitoring or recording river^ levels or quality. 3. (c) The activity must not take place in any rare habitat*, threatened habitat* or at-risk habitat*.	

5 Appendix Two

5.1.1 Herbicide use in wetlands

Only three types of herbicide that work on woody weeds can be used over or near water (and two of them will need a resource consent):

- Glyphosate (e.g. Round-up) – very effective, but kills every plant it touches (including natives), so is best used on dense, older willow or alder stands if spraying from the air. Consent is not required for ground-based use around waterways if you use the correct formulation, but might be needed for aerial application or to clear large areas.
- Triclopyr triethylamine (e.g. Garlon® 360) – kills mainly broadleaf trees (willows and alders, but also native shrubs and trees), best for scattered willows or alders where most of the natives are monocots (strappy-leaved plants like flax, cabbage tree, sedges and native grasses); ideal if spraying from the air on young invading grey willow. Requires a resource consent from the Regional Council to use around waterways.
- Metsulfuron-methyl (e.g. Escort) – as for triclopyr triethylamine. Also requires a resource consent. Other herbicides like Vigilant or Grazon can't be used around water as they can harm fish and other aquatic life (Denyer, 2015).

5.1.2 Basal spray herbicide application

Pines, sycamores and willows (and most other woody species) can be poisoned using low volume basal bark applications of Grazon (600 g/L triclopyrbutoxy ethyl ester) herbicide. The technique is only really effective on trees with a stem diameter of less than 15 cm and which have not yet developed a thick bark. Treatment should, however, ideally occur 6 weeks prior to leaf expansion until 2 months after to ensure the control of the root systems of targeted plants.

For best and reliable results, spray to saturate the entire circumference of the bottom 30 - 50 cm (up to 2 m for bigger trees) of trunk, including the root collar area, until just before the point of runoff using a knapsack (one dedicated for oil use only) and a solid cone or flat fan nozzle. Care must be taken to minimise the amount of spray drift and chemical/oil that runs into the soil, which could potentially damage adjacent non-target trees. This is only because there is the possibility of injury to plants whose roots may extend into areas treated with the herbicide. Particular care must be taken to ensure that the oil does not get into water in a wetland situation (you may want to apply the solution using a paint brush in these

instances). Although much quicker and efficient than cutting and pasting, frilling or drilling and filling, basal bark treatments are labour-intensive because each and every stem needs to be treated. For this reason it can reasonably be expected that some trees and saplings will be missed during a poisoning operation. Follow-up operations should therefore be planned for missed stems, new saplings and root suckers. Usually one or two follow-up spot treatments at 6 month intervals will provide a complete kill if the trees are susceptible. Re-treatment should include any living parts of treated stem(s) and re-sprouted stems.

http://www.wildingconifers.org.nz/index.php/research/control/using-herbicides/36-basal-bark-application