



Korowai Ecology



The Pocket Wetland Planting Plan

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The Pocket Wetland Indigenous Planting Plan

Vision:

- To conserve the large wetland area in the centre of The Pocket (hereafter known as “the wetland”) and separate this fragile area from proposed agricultural and horticultural activities (Figure 1).
- To enhance the ecological values of the wetland by removing animal pests and exotic plants.
- To improve the ecological value of existing habitat in the wetland for native fauna and flora.
- To restore the wetland to the pre-1970 (pre lake) condition.

A: Brief Outline

The Client, Organic Farm New Zealand (OFNZ), wishes to erect a predator proof fence along the western boundary of The Pocket to conserve the large wetland area in the centre of The Pocket (hereafter known as “the wetland”) and separate this fragile area from proposed agricultural and horticultural activities (Figure 1).

OFNZ propose to install a predator proof fence along the western side of The Pocket along the Tarora Property boundary with Public Conservation Land (PCL), managed by the Department of Conservation (DOC) as part of the Snowdon Conservation Area. This will prevent large introduced wild animals from entering the wetland. Currently these animals pests cause damage to the wetland through browsing, rooting, and trampling (Figure 2).

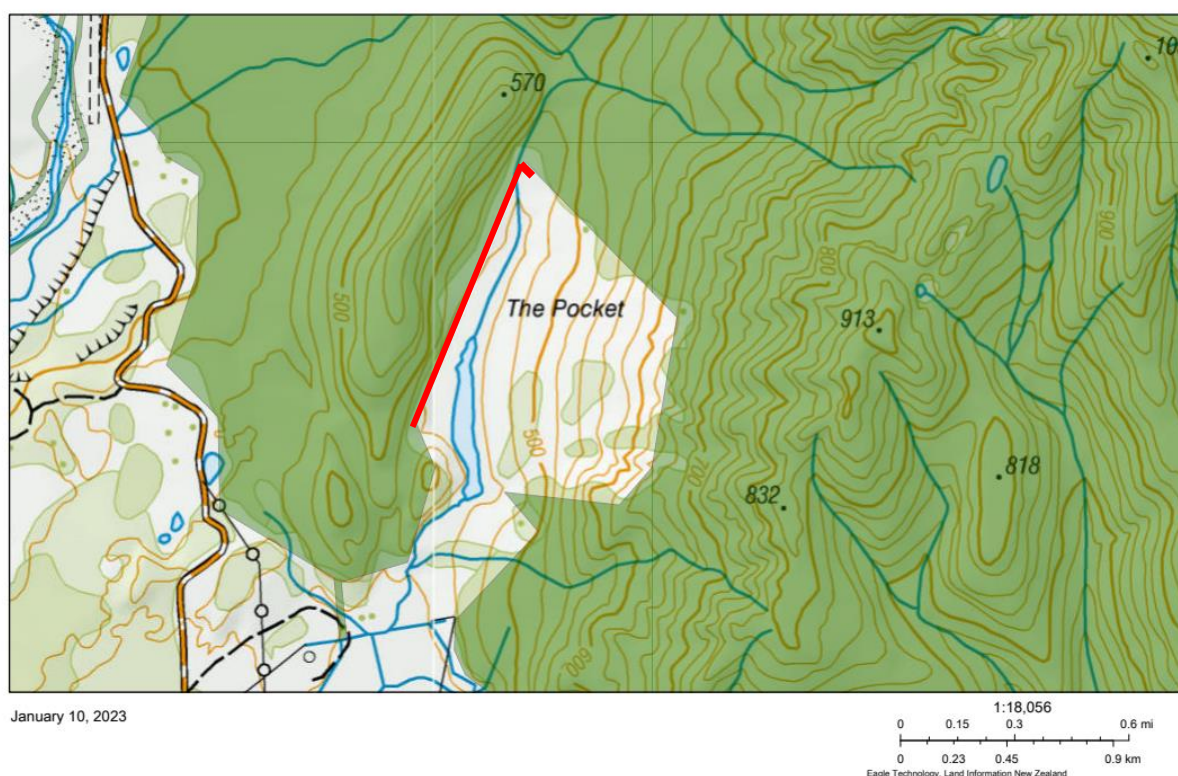


Figure 1. Topographic map showing the location and topography of The Pocket. The Upukerora River and the road through the Tarora property are located to the west of The Pocket. Public Conservation Land is shaded in dark green. The section of fence line requiring resource consent, through or adjacent to the wetland, is shown by the red lines.



Figure 2. Pig rooting in the wetland ground surface disturbs the wetland plant communities, alters natural drainage patterns and can lead to changes in plant community composition, including invasion of introduced weedy species.

This Plan outlines the restoration project to mitigate the impacts of building a maintenance road and predator proof fence along the western boundary of the wetland through and adjacent to wetland communities.

The Tarora Property is in the Upukerora Ecological District within the Mavora Ecological Region of inland Southland. The Upukerora Ecological District (ED) includes the gentle hills and rolling country east of Lakes Te Anau and Manapouri.

The Property owners are fully committed to mitigating the impacts of this development. This planting plan provides details of the mitigation measures to enhance the conservation values of the wetland. Briefly mitigation will:

- Enhance the existing wetland by removing weeds associated with the unnamed stream which flows out of the wetland in The Pocket:
 - willow trees along the stream banks,
 - the weed ragwort from a flood zone of the unnamed stream,
- Enhance and expand habitat for the fauna and flora inhabiting the wetland by undertaking:
 - restoration and enhancement planting within and along the margin of the area previously underneath the shallow lake and now inhabited mostly by introduced rush (*Juncus*) species,
- Restore the wetland to pre-1970 (pre lake) conditions.

The mitigation activities will mostly take place within the wetland in The Pocket and along the unnamed stream that flows out of the wetland (Figure 3).



Figure 3. Position of the mitigation measures for the proposed scope of works. Weed removal will take place south of the wetland for ragwort (location shown by the orange circle) and willows (red polygon). Enhancement plantings of pukio (*Carex secta*) will occur around the edge of the old lakebed (blue polygon) and along the banks of watercourses within the lakebed.



Figure 4. The wetland in The Pocket looking north from hill 500 m. The olive-green central area shows the position of the old lakebed. Large pukio (*Carex secta*) patches are present in some places along the old lakebed margin (within the red polygons). See Figure 7 for closeup view of pukio within the largest red polygon.

B: General Description of Wetland Vegetation in The Pocket

B.1: Topography and Wetland Definitions

The centre area of The Pocket is inhabited by a wetland, approximately 1.5 kms long and roughly 0.4 km wide as its broadest point (Figures 1, 3 & 4).

The wetland area in The Pocket is defined as a “natural inland wetland” under the NPS-FM 2020 framework, and as a “natural wetland” under the Southland Water and Land Plan (Environment Southland 2018).

The wetlands in The Pocket are “palustrine wetlands”. These are freshwater wetlands fed by rain, groundwater or surface water, but not directly from a lake or river (Johnson & Gerbeaux 2004).

The wetland in The Pocket is broad. Gentle slopes rise up on either side of the wide, central valley floor (Figure 1). Subtle changes in topography are reflected in the vegetation, with wetland communities in the hollows and some concave seepage slopes, and predominantly short and taller red tussock communities on the drier slopes and small ridges.

Wetland vegetation extends south of the main areas of The Pocket along the unmarked stream (Figure 1). This area is also inhabited by exotic willow trees.

B.2: Historic Vegetation Distribution

Based on the topography of the area and historical aerial photography, it seems likely that a natural wetland, inhabited by vegetation rather than open water existed in the centre of the lower valley of The Pocket prior to the late 1960's (Figure 5). Historical aerial photography suggests that large pukio (*Carex secta*) dominated the edge of the unnamed creek in the centre of the wetland.

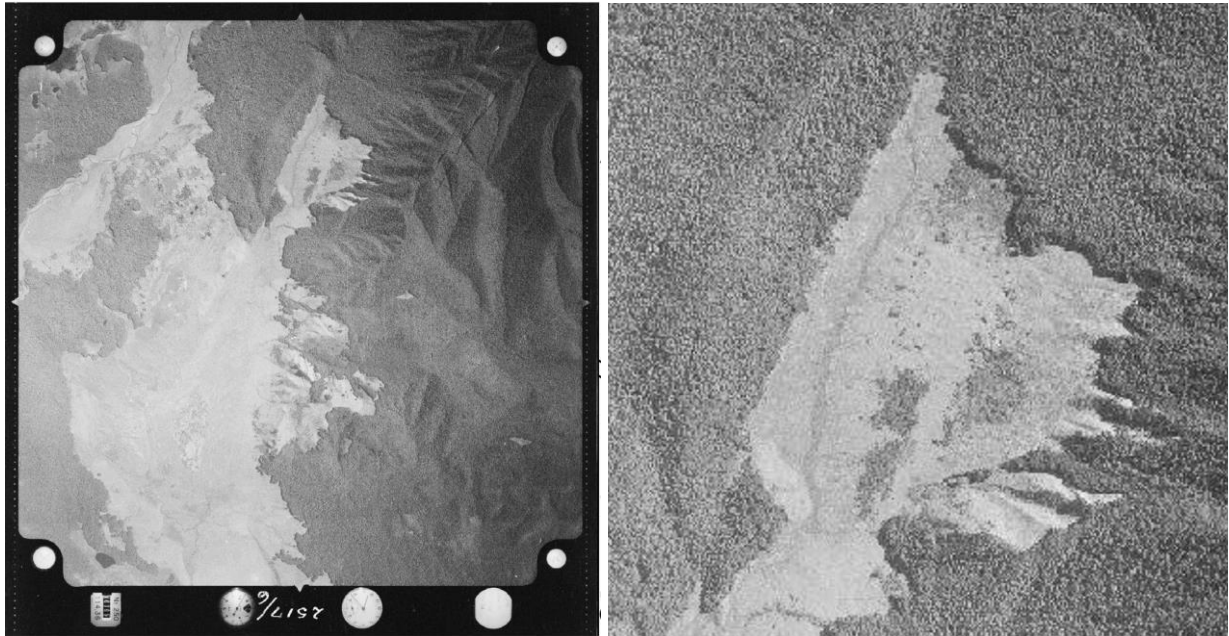


Figure 5. Historic aerial photo of The Pocket from **February 15 1957**, and enlargement of this photo on the right, showing the wetland down the centre of The Pocket (sourced from <https://retrolens.nz> and licensed by LINZ CC-BY 3.0).

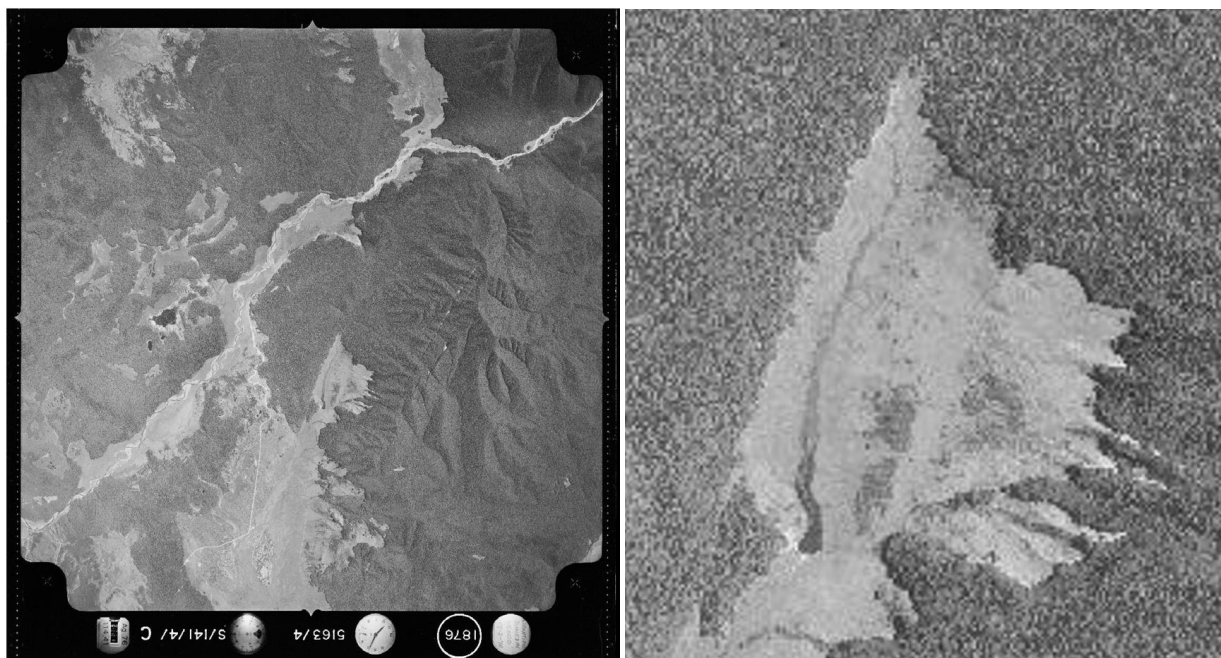


Figure 6. Historic aerial photo of The Pocket from **February 17 1970**, and enlargement of this photo on the right, showing a small area of open water at the southern end of The Pocket (sourced from <https://retrolens.nz> and licensed by LINZ CC-BY 3.0).

B.3: Shallow Lakebed

The wetland was partially dammed with a shallow lakebed present in the southern part of The Pocket prior to 1970 (see Figures 1, 3, 6). The full extent of the lake outlined on the topographic map in Figure 1 was present from at least 1978 to the breach four or five years ago (*Historic aerial photos are sourced from <https://retrolens.nz> and licensed by LINZ CC-BY 3.0*).

The dam opened four or five years ago after a heavy storm event. Since that time, the area previously under water has been maintained as a wetland, dominated by several, mostly introduced, *Juncus* rush species (Figure 4). Water levels have mostly been just below the ground surface with a few small areas of standing water (Organic Farm New Zealand Staff *pers. comm.*).

B.4: Current Vegetation Communities

A brief assessment of the wetland communities present in The Pocket was made during the April 2022 visit. There is a complex range of wetland communities present. The distribution of these communities relates to variation in microtopography and underlying drainage patterns.

There are several different wetland types in The Pocket which blend into each other, with their distribution varying with slope position, terrain shape and water source.

Based on my brief visit, there are three main wetland types present in The Pocket (see Johnson & Gerbeaux 2004 for the wetland classification).

Bogs (water sourced from precipitation only) and **fens** (water and nutrients sourced from adjacent ground) are present on sloping ground either side of the main valley floor. The central valley floor of The Pocket is dominated by **swamp wetland**. This wetland type includes areas of standing water or surface channels which have a gentle permanent or periodic flow. The water table is usually permanently above some of the ground surface. This wetland type is inhabited by large sedges such as pukio (*Carex secta*) with some rushes (*Juncus* species; Figure 7).

The most poorly drained wetland communities occur in the central valley floor of The Pocket. The composition of the swamp wetland communities in this zone vary across the wetland. The northern section of the valley floor is inhabited by seepage communities dominated by short sedges and grasses. The mid and southern sections of the wetland are inhabited by taller wetland species. A creek emerges in the southern part of the valley floor, with tall sedges (pukio) scattered along the creek margin. The area previously inhabited by the shallow lakebed, is now densely covered by a range of mostly introduced rush (*Juncus*) species, including *Juncus effusus*, with scattered pukio defining the margin of the old lakebed (Figure 7).

Bog and fen wetland communities inhabit the gentle slopes on both sides of the central valley floor wetland zone. At the northern end of the wetland, the slopes are dominated by short sedges and rushes. Slopes to the east and west of the valley floor contain a mosaic of wetland communities reflecting subtle changes in drainage and topography. On the east side, for example, there are raised patches of comb sedge (*Oreobolus pectinatus*) on slight rises and areas of dense sedges in shallow depressions.

Slopes in the south-east of the wetland are inhabited by tall red tussock (*Chionochloa rubra*) in places.

There are scattered patches of the regionally rare bog pine (*Halocarpus bidwillii*) shrubland community adjacent to the forest edge along the southern half of the western wetland margin.

Currently introduced animal pests have unrestricted access to most of The Pocket. Both pigs and red deer were observed roaming through the wetland during the site visits. Evidence of deer browse on native vegetation is widespread.

Recent and historic pig rooting was also observed in several locations throughout the wetland (Figure 2). Rooting permanently damages wetland communities, sometimes changing the composition of plant species present and drainage patterns. Altered conditions are often susceptible to invasion by introduced weedy species.



Figure 7. Patches of tussock-like pukio sedges are scattered along the edge of the old lakebed which is dominated by mostly introduced rush (*Juncus*) species (olive green colour). This photo shows a closeup view of the vegetation in the largest red polygon in Figure 4.

C: Mitigation Measures

C.1: Proposed Areas for Mitigation

All mitigation activities will take place within and immediately south of the main wetland in The Pocket (Figure 3) along the unnamed stream which flows out of the main wetland in The Pocket.

C.2: Two Types of Mitigation

The two main types of mitigation are described in detail in the sections below. The mitigation plan includes:

- 1) **Weed removal.** Enhance the existing wetland by removing weeds:
 - a. willow trees along the banks of the unnamed stream (Figures 3 & 8).
 - b. the weed ragwort from a large flood zone of the unnamed stream (Figure 3).
- 2) **Enhancement planting.** Enhance and expand the habitat for the fauna and flora inhabiting the wetland by undertaking:
 - a. restoration and enhancement planting within and along the margin of the area previously underneath the shallow lake and now inhabited mostly by introduced rush (*Juncus*) species. The old lakebed is approximately 6000m² in size (roughly 120 m wide x 600m long). Enhancement plantings will be positioned as patches around the margin of the old lakebed and along the banks of small creeks within the lakebed.
 - b. restoration and enhancement planting along the bank of the unnamed stream where willows have been removed.



Figure 8. Willow trees along the banks of the unnamed stream that flows south from the southern end of the main wetland in The Pocket.

D: Weed Removal

The removal of weeds will take place south of the main wetland along the banks of the unnamed stream which runs out of The Pocket and in the flood zone of this stream (Figure 3).

D.1: Removal of Willows

Willow trees will be physically removed from the banks along the unnamed stream (Figures 3 & 8).

- Dig the entire root system of each tree to ensure the trees do not resprout.
- Remove all trees and roots from the area.
- Ensure damage to any existing native species is minimised during tree and root removal.
- Cut willow trunks can resprout, so ongoing surveillance will be necessary to remove any resprouts.

Enhancement plantings of pukio will be undertaken once it is certain that the willows are not resprouting (see Section E).

D2: Removal of Ragwort



Figure 9. Ragwort on the flood zone of the unnamed stream south of the main wetland in The Pocket.

There are two possible options for ragwort control. Control by herbicide has not been considered due to OFNZ's desire to maintain organic farming practices.

- 1) Physically remove ragwort plants. Hand pulling or grubbing works best with rosettes and early flowering plants. Remove at least 5 cm of the root system to prevent regrowth. Ensure gloves are worn as ragwort is poisonous to humans. It may take up to six years to control ragwort even with hand pulling or grubbing. Note that dormant seeds can germinate in newly disturbed soil.

- 2) Use of ragwort biocontrol agents. Ragwort populations have been successfully controlled by the ragwort flea beetle (*Longitarsus jacobaeae*) in some parts of the country. However, this beetle does not survive well in high rainfall areas of New Zealand, such as the West Coast and probably Fiordland. The ragwort plume moth (*Platyptilia isodactyla*) has been introduced to control ragwort in high rainfall areas. There have been no studies to determine the effectiveness of this biocontrol agent. For more details on this moth please see: https://www.landcareresearch.co.nz/assets/Discover-Our-Research/Biosecurity/Biocontrol-ecology-of-weeds/1-Control-of-weeds-book/Ragwort_Plume_Moth.pdf

E: Enhancement Planting

The aim of the enhancement planting is to ensure the composition of the wetland moves towards pre-1970 wetland (pre lake) conditions. Enhancement planting will also increase the conservation values of the wetland by enhancing and expanding the habitat for the fauna. The plantings will also provide more suitable conditions with a higher proportion of native vegetation cover for wetland flora to naturally reestablish.

E.1: Locations of Restoration Planting



Figure 10: Schematic showing the planned distribution of planted pukio (*Carex secta*: shown by red circles) using two types of planting, 1) around the edge and 2) within the old lakebed along small stream margins. Plantings around the margin would infill gaps in the existing pukio cover along the edge of the old lakebed and expand cover slightly into the old lakebed. Patchy plantings within the lakebed, concentrating mostly along water courses, would replicate the natural distribution on pukio and improve habitat for freshwater fish and aquatic invertebrate species.

Restoration and enhancement planting will be undertaken within and along the margin of the area previously submerged below the shallow lake. This is now inhabited by a dense sward of mostly introduced rush (*Juncus*) species.

The lakebed is approximately 6000m² in size. Restoration planting will take place within and along the edge of the old lakebed (Figure 3). Planting will be patchy, to mimic natural distributions, and will be carried out over approximately one-third (2000m²) of the lakebed.

There are two main types of plantings:

- **Margin of the old lakebed:** dense patches rather than continuous areas of planted seedlings positioned along the margin, infilling gaps in the existing pukio cover along the margin and expanding cover into the old lakebed. Patches of planted seedlings will be two to five plants deep.
- **Within the lakebed:** scattered clusters of planted pukio seedlings along the banks of small creeks in the old lakebed. Pukio would be planted as patches that are one plant, and occasionally two plants wide either side of the waterway.

Small-scale planting will also occur:

- **Along the banks of the unnamed stream:** plant pukio flowing out of the southern end of the wetland once it is certain have been completely removed and are not resprouting.

Figure 10 provides a schematic illustration of the proposed planting plan for the main wetland, with seedlings planted in patches along small watercourses and larger scattered patches of seedlings along the margin of the old lakebed. The aim is to infill the old lakebed partially and with time a range of native plants will infilling naturally by seed from elsewhere in the wetland.

The restoration plantings should mimic the natural distribution of pukio. This is illustrated in Figure 11, which shows pukio inhabiting the lake margin near the northern end of the old lakebed.

With time the planted pukio will grow to form dense but patchy cover, replicating the dense pukio naturally occurring in the centre of the valley north of the old lakebed (Figure 12).



Figure 11: Natural distribution of pukio (*Carex secta*) along the margin of the northern end of the old lakebed (within the red polygon).



Figure 12: Dense but patchy distribution of pukio present in the centre of the wetland further north of the old lakebed. Enhancement plants aim to replicate this distribution around the margin and along watercourses within the old lakebed.

E.2: Restoration Planting – Plant Selection

Approximately one-third (2000m²) of the old lakebed will be planted with pukio (*Carex secta*). Plantings will be concentrated around the lake margin and along creeks within the lakebed.

Pukio is a large “tussock” forming sedge which is common in swamp wetlands in Southland (Figure 12). These large sprawling plants grow in moist conditions along creek margins and in swamps. They provide shelter and habitat for other species such as freshwater fish and invertebrates.

Plant selection has been restricted to pukio as it naturally dominates the centre of the wetland further north of the lakebed. Additionally, pukio seedlings are easily propagated commercially in nurseries and it known to be a highly successful species for restoration because they establish easily and quickly provide a large area of native cover. Other dominant wetland species in The Pocket have not been used commercially in restorations projects, so their success for large-scale propagation and restoration planting is unknown.

Once established, planted pukio should outcompete and breakup the dominance of *Juncus* in at least part of the lakebed and will provide a tall, broad canopy of shelter for other (often smaller) native wetland species to establish naturally from nearby within the wetland.

Table 4 provides a rough estimate of the number of pukio required for the restoration plantings. Note that it is difficult to accurately estimate the number of pukio seedlings required for this restoration planting, due to the patchy distribution of the plantings and the irregular distribution of naturally occurring pukio around the lake margin.

Table 4. A rough estimate of the number of indigenous pukio sedge plants (*Carex secta*) required for the restoration plantings for one-third (approximately 2000m²) of the old lakebed and along the bank of the unnamed stream. See Figures 7, 11 & 12 for photos of pukio and Figure 10 for the schematic of the proposed planting.

Latin Name:	Common Name:	Plant Type:	Top Height:	Spacing between plants:	Number of plants/ha (based on average 1.3 m spacing):	Estimate of plants required for 2ha area:
<i>Carex secta</i>	Pukio	Sedge	1.2 m	1.2 to 1.4 m	700	
Total plants:						1360

E.3: Restoration Planting – Timing

Ideally plant in late spring (late September to mid-November), once heavy frosts have passed. Summer may be too warm and potentially too dry. Avoid late autumn and winter planting as the roots and young shoots of seedlings are susceptible to winter frosts. This may impact seedling survival.

Planting in areas with standing water present in the months between late September to mid-November may need to be rescheduled to late summer when water levels are low.

E.4: Restoration Planting – Site Plan, Preparation and Planting

The ease of establishment and long-term survival of planted seedlings are significantly improved by good site preparation.

Position planted seedlings in patches to mimic their natural distribution, rather than a systematic grid.

- **Margin of the old lakebed:** dense but not continuous areas of planted seedlings positioned along the margin, infilling gaps in the existing pukio cover and extending it a little into the old lakebed by approximately 2 to 3 metres (the width of two to three mature pukio plants).
- **Within the lakebed:** scattered clustered of planted seedlings along the banks of small watercourses, approximately 1.5 to 3 metres (mostly one plant, sometimes 2 plants) in width each side of the creek.
- **Along the unnamed creek bank:** plant 2 rows of pukio along the stream bank where the willows have been removed.

Site preparation includes the following:

- Ensure the soil is moist prior to planting.
- Position planting holes so they are approximately 1.2m to 1.4 m apart. This distance should be used regardless of whether the plantings are in open spaces or infilling gaps between existing, naturally occurring pukio.
- Remove the dense sward of *Juncus* rushes approximately 50 cm diameter area around the planting location to allow planted seedlings to flourish with only minimal root competition.
- Hand-dig the planting hole so that it is bigger than the root ball. Break up the soil with a spade at the bottom and sides of the hole to provide a friable rooting medium for rapid growth and penetration of the roots.

Planting includes the following:

- Remove the plant from the container and tease out the roots if they are compacted or the plant is root bound.
- Place the plant in the hole, infill with relatively loose (not hard and compacted) topsoil around the plant so plant roots can disperse through the soil. Pack the soil firmly to secure the seedling and prevent air gaps. Ensure there is a shallow depression around the stem of the plant to capture a small amount of water.
- Ensure the general planting area has a rough surface. Rough surfaces provide small-scale variation in topography which provides shelter, a stable microclimate and variation in drainage to help plant establishment and resilience to climate extremes. Uneven surfaces also limit the movement of surface water until plants have established.
- Note that plant guards will not be required as the restoration enhancement planting is located within a predator-free area.
- Unless conditions are exceptionally dry, plants should not need to be watered after planting.

G: Timeline

G.1: Weed removal

- 1) Willow tree and ragwort removal should begin as soon as practicably possible.
- 2) Ongoing monitoring to ensure willow trees are not resprouting and ragwort is not re-establishing.
- 3) Ragwort monitoring should continue for at least six years after removal.
- 4) Plant pukio along the stream bank once it is certain that the willow trees are not sprouting.

G.2: Restoration Planting

- 1a) The restoration plantings in the main wetland should begin within two years of completing the predator proof fence.
- 1b) Restoration plantings to replace the willows on the bank of the unnamed stream should begin once it is certain that the willows have been completely removed and are not resprouting.
- 2) Ongoing post planting maintenance and monitoring is required to ensure planting success (see Sections H & I). This should continue for at least three years after the start of the restoration plantings.
- 3) All plantings will be maintained in good order, throughout the duration of the consent. Any dying or diseased plants will be replaced in the subsequent planting season.

H: Post Planting Site Maintenance

H.1: Restoration Planting

The effort put into post planting maintenance determines the success of the restoration planting. The following areas must be addressed:

- **Watering: soil moisture has a significant impact on seedling survival and growth. However, due to the wetland position of planted seedlings, watering should not be necessary.** Over the summer months, it will be important to regularly check plants to ensure the soil has not dried out. Fiordland spring weather and periodic rain events through the summer should be sufficient rainfall to keep plants well-watered.
- **Ongoing weed control** will be required until the end of year 2 or 3 after the planting. Weeds will use up much of the soil moisture reserves needed by the planted native seedlings. Control of woody weeds and rank grass will be required. This may require frequent hand weeding.
- **Mulching** should not be necessary due to the moist conditions of the site.
- **Fencing** should not be necessary with the predator proof fence, but plants should be checked periodically for any signs of excessive grazing. Hares are known to target newly planted restoration plantings.

- **Monitoring:** see Section I for monitoring requirements.

I: Monitoring of all Mitigation Sites

The planting programme may be outsourced/overseen by a professional company or undertaken by the client. Either way, a monitoring programme should be set up to oversee the progress, maintenance, and success of the mitigation measures. However, the small size of the mitigation areas means that monitoring could be less formal than for larger restoration areas.

For both weed removal and restoration planting sites:

- Monitoring will be set up by a plant specialist who has professional experience at caring for restoration planting programmes.
- The new plantings will be monitored for a minimum of three years after the completion of each stage of planting.
- The plant specialist will set up a regime for monthly checks. At the initial visit she/he can train OFNZ staff to undertake the monthly checks.
- The plant specialist will visit 9 months after the initial planting to check seedling survivorship and weed presence.
- The plant specialist will prepare a brief report, including photographs and provide these reports to Southland District Council within 1 month after inspecting each site.

I1: Weed Removal Monitoring Timeline

- **Step 1:** Post willow tree removal to check all trees and roots have been removed. *Check by plant specialist.*
- **Step 2:** 9-month check to check for ragwort existence and resprouting of willows - *plant specialist and OFNZ staff.*
- **Step 3:** Continue weed surveillance and control for at least six years - *OFNZ staff.*
- **Step 4:** undertake restoration planting where the willows have been removed once surveillance has assured that willow is not resprouting - *OFNZ staff.*

I2: Restoration Planting Monitoring Timeline

- **Step 1:** Two-weekly checks for the first month to check on soil moisture, seedling plant survival and health. Check soil moisture and predation. *Initial bi-weekly check by plant specialist with training for OFNZ staff to take over at week 4.*
- **Step 2:** Undertake bi-monthly checks to ensure weeds are not establishing in the restoration plantings, check for predation and plant survivorship- *OFNZ staff.*
- **Step 3:** 9-month check to monitor plant survival; check weed management and identify if any replacement seedlings are required - *plant specialist.*

- **Step 4:** Continued monthly checks for predation and plant survival - *OFNZ staff*.
- **Step 5:** Continue weed surveillance and control around plantings for at least three years - *OFNZ staff*.
- **Step 6:** Plantings along the unnamed stream should follow the same procedure but might occur 2 or 3 years later than the main planting.

J. Literature Cited

Johnson, P Gerbeaux P. 2004. Wetland Types in New Zealand. Department of Conservation. 184pp.