WHAKAKI 2N INCORPORATION RESOURCE CONSENT APPLICATION AT IWITEA ROAD, WAIROA, HAWKES BAY:

INVESTIGATION OF ALTERNATIVE OPTIONS FOR INCREASING THE AREA AVAILABLE FOR FARMING

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Whakaki 2N Incorporation Resource Consent at Iwitea Road, Wairoa, Hawkes Bay: Investigation of Alternative Options for Increasing the Area Available for Farming

Contract Report No. 2856

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1. INTRODUCTION

Whakaki 2N Incorporation (Whakaki 2N) has applied for resource consent to undertake the following activities on its land at Iwitea Road, Wairoa:

- Construct a low level embankment, to prevent the flow of floodwater from the Whakaki Lake, onto the Whakaki 2N property.
- Construct twin 1.0 m high × 1.5 m concrete box culverts, to enable the discharge of water through the embankment.
- Repair the breaches or excavations in the Tuhara Stream flood bank to prevent floodwaters in the Tuhara Stream flowing directly onto the Whakaki 2N property.
- Install a dewatering pump, with a maximum discharge capacity of 1,100 litres/second.

(Howatson 2009)

The purpose of these works is to alleviate inundation issues, the extent and duration of which have become more severe over the past 8-9 years (Tom Te Kahu, Chairman Whakaki 2N, pers. comm.). The application was lodged with the Hawke's Bay Regional Council (HBRC) in September 2009, and additional information was provided to HBRC on 30 October 2009. Subsequent processing of the application was put on hold however, in response to concerns raised by HBRC of potential effects on habitats of birds, and ecological values. In mid 2010, Whakaki 2N commissioned an ecologist to prepare an assessment of ecological effects and this highlighted a number of issues (Walls 2010). A further assessment was undertaken by John Cheyne (Fish and Game NZ) in September 2010, and this too indicated there would be significant ecological effects arising from the proposal as it currently stands (Cheyne 2010). John Cheyne's report did, however, present other options, one being an alternative embankment location, the other being the ecological restoration and protection of the wetlands within the area affected by the proposal.

John Cheyne's compromise proposal was rejected by Whakaki 2N (Bryan Welch, Department of Conservation, pers. comm.).

In response to the concerns expressed and escalating interest of other parties, HBRC decided the application would need to be publicly notified.

As an affected party, the Department of Conservation (DOC) recognises that the ecological effects of the application in its current form are significant, but is keen to explore whether there are other options available that would increase the area of land available to Whakaki 2N for farming without adversely impacting on the ecological values of the area. Wildlands has been engaged to undertake this investigation.

2. BACKGROUND

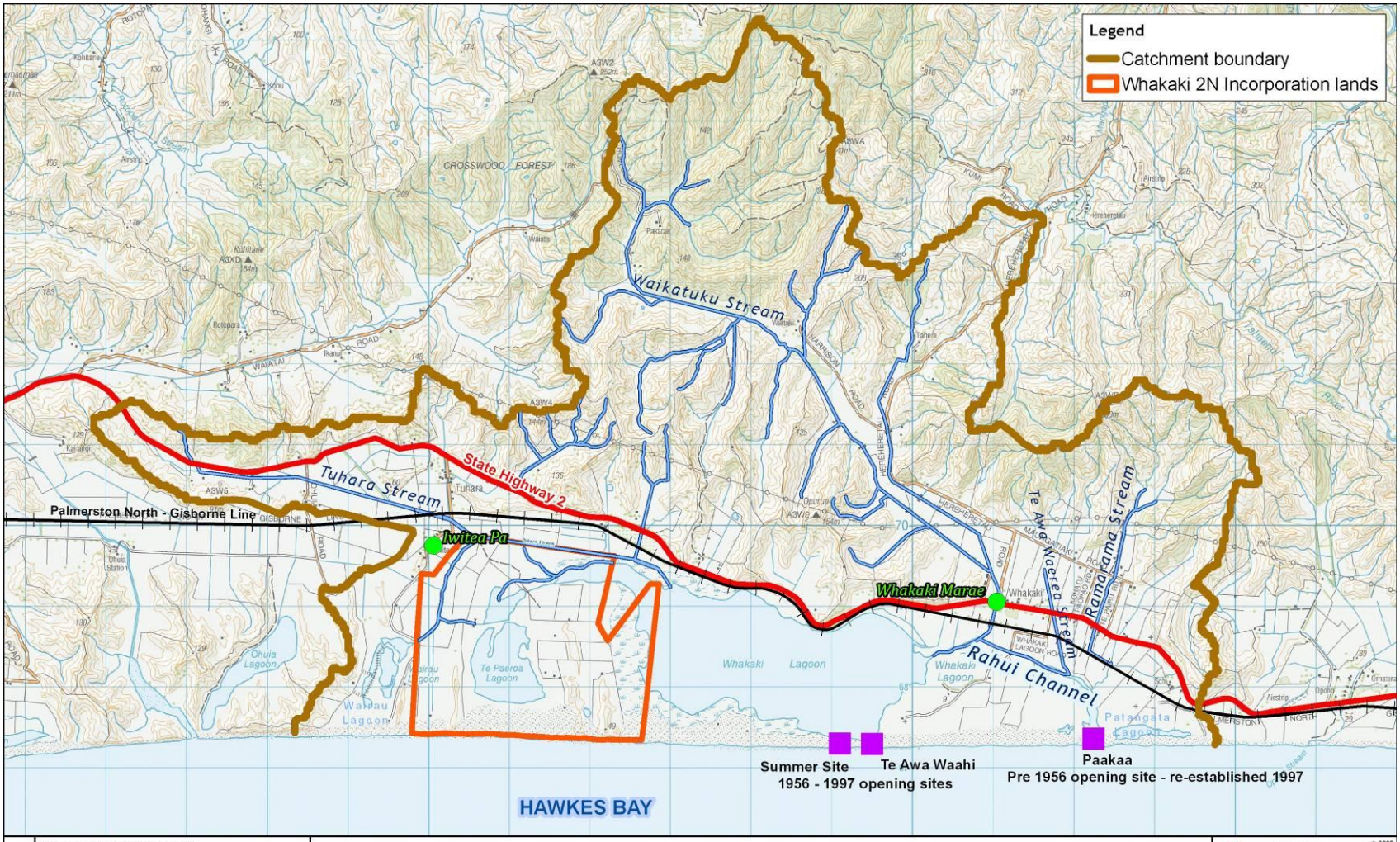
> "Whakaki 2N Incorporation farms a land area of 498 hectares adjacent to the Whakaki Lakes. Flooding of up to 230 hectares of this farm land can occur up to 4 times per year, which detrimentally affects pasture production, pasture utilisation, farm access and general farm management.
>
> Flooding, which can occur for up to a month at a time, has a devastating effect on farm profitability, and the ability to operate the farm as a profitable and sustainable farming operation".
>
> (Howatson 2009a)

The location of Whakaki 2N's property is shown in Figure 1. A significant proportion of the property occupies former lake bed. The area subject to periodic flooding/inundation, as indicated in the consent application, is shown in Figure 2.

Inundation has become more of an issue since 1997, when the site at which Whakaki Lagoon was manually opened to the sea for the previous 41 years, was relocated to its "traditional spot" at Paakaa (shown in Figure 1) which had prevailed since artificial openings to facilitate drainage (other than those that might have been undertaken by tangata whenua), commenced in 1899. During the period July 1956 to March 1997, the Whakaki Lagoon catchment, which includes Wairau Lagoon, Te Paeroa Lagoon (Korito), and all of Whakaki 2N's farming operation at Iwitea Road, was drained to the sea via breaches made in the south-eastern corner of the lagoon. These openings enabled more rapid, and at times complete dewatering of the lagoon (Koutsos 1984), and increased sedimentation rates. Salinity levels were also increased through the periodic intrusion of saltwater when tides were high and lagoon levels low, and these factors combined lead to a significant deterioration in ecological values across the wider Whakaki wetland complex (HBRC 2001). However, generally lower Whakaki Lagoon levels reduced the frequency and duration of inundation on Whakaki 2N and other low lying land upstream of the lagoon, and were more favourable to farming within these areas.

In 1983, minimum and maximum water levels (RL 10.5 and RL 11.8 respectively) were set for Whakaki Lagoon by the National Water and Soil Conservation Authority, and a water right was issued to allow the discharge of water through the former outlet at Paakaa. The works required to implement this were completed 14 years later, in March 1997. A drought during the following summer of 1997/98 resulted in low water levels for a prolonged period, but higher summer levels were maintained in the years immediately following that (HBRC 2001). HBRC's current operating guidelines for Whakaki allow for the lake outlet to be opened when levels are approaching RL 11.8 and likely to exceed that, and a summer minimum of RL 10.8 (Peter Manson, HBRC pers. comm.).

The post 1997 regime, coupled with other restoration initiatives, is likely to have been ecologically beneficial and slowed, if not halted, the ongoing degradation of values arising from four decades of draining the lagoon directly to the sea. However, Whakaki Lagoon levels have since generally been higher and more enduring than was the case during that *c.*40 year period, and the consequence of this has been that the



Data Acknowledgment

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Figure 1. Location of Whakaki 2N Incorporation land and present day Whakaki Lagoon catchment

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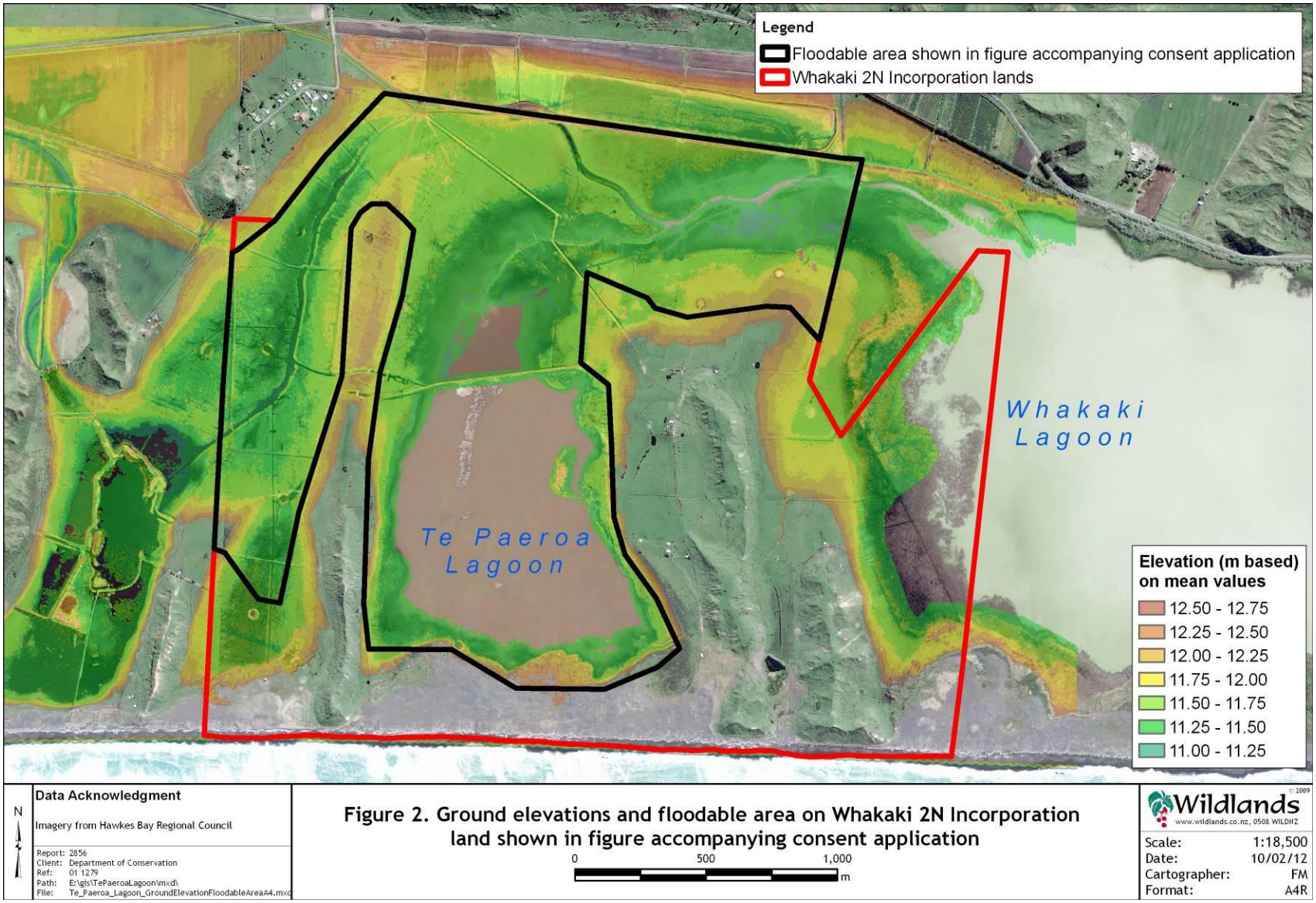

Figure 2. Ground elevations and floodable area on Whakaki 2N Incorporation land shown in figure accompanying consent application

lagoon has more often been backed up onto Whakaki 2N farmland, a significant part of which lies well below RL 11.8, (see Figure 2) than occurred during that timeframe. The level of the lagoon tends to reside much closer to (i.e. just below) the trigger point at which the lagoon is opened than it previously did, and consequently farmland is inundated for longer periods of time (Tom Te Kahu pers. comm.).

The engineering concept underlying the consent application, and desire to increase the productivity of the area affected by higher water levels on the Whakaki 2N property, is not a new one. Twenty nine years ago, shortly after the water right to enable the reinstatement of the former outlet at Paakaa was granted, Whakaki 2N and two other adjoining landowners (J. Robinson and C.J. Owen), in anticipation of the likelihood of higher water levels, lodged a water right application (Robinson and Owen 1983) very similar to the current application, the principal difference being the location of the main embankment (further to the east within the lagoon itself). This proceeded to a formal hearing before the Hawkes Bay Catchment Board and Regional Water Board, and attracted strong opposition from the former NZ Wildlife Service (cf. Stack 1983, Richmond 1983, Hawkins 1983).

Issues and actions associated with the management of Whakaki Lagoon and its surrounds have been long running, and a more detailed overview of these can be gleaned from Koutsos (1991), Parliamentary Commissioner for the Environment (1993), and HBRC (2001).

3. APPROACH

Relevant literature was reviewed, and unpublished reports and file notes were obtained from DOC, HBRC, and the Hawke's Bay Region of Fish and Game NZ (F&G). LiDAR data and Whakaki Lagoon opening records were provided on request from HBRC. Two field inspections were made of the site in conjunction with visits to the adjacent Otoki Wildlife Management Reserve (Otoki Reserve) to undertake field surveys for the preparation of a management plan for that area.

The first field visit, in December 2011, included a meeting on site with Dave Carlton, Helen Jonas, and Hans Rook (DOC), John Cheyne (F&G), and Peter Manson (HBRC); another with Tom Te Kahu, Ruka Niania (Whakaki 2N), Hilton Collier (AgFirst), Richard Robinson (adjoining landowner), and Rangi Ataria (Iwitea resident); and a separate meeting with Richard Robinson to review what's been happening at Wairau Lagoon. During the course of these meetings, background to the project was discussed with Andy Garrick, concerns of each party raised, and local hydrology investigated. A perimeter survey of Te Paeroa Lagoon was undertaken by Sarah Beadel and Fiona Wilcox to identify plant species, and to map and describe vegetation types.

Sarah Beadel visited the site again in late February 2012 after water levels had receded from the ephemeral wetland area linking Whakaki and Te Paeroa Lagoons, and conducted a walk-through survey of this area to identify and assess botanical features that were submerged during the earlier visit.

LiDAR data was interpreted and used to generate figures and assess implications of different scenarios using ARCGIS 9.3 software.

4. RESOURCE DESCRIPTIONS

4.1 Landform

Much of Whakaki 2N's land at Iwitea is low lying having formerly been part of a once far more substantial wetland complex that extended more or less uninterrupted from the lower Waiatai Valley in the west to Opoho River in the east. Two large ridge systems run due north from the coast as can be seen in Figure 2. The narrower western ridge extends almost right across the property, while the wider eastern ridge system extends approximately three quarters of the way. Te Paeroa Lagoon, or that part of it contained on the southern side of an embankment constructed across it in 1987, occupies an area of approximately 100 ha. The remainder of the property comprises lake bed, former lake bed, or ephemeral wetland, the elevation of which predominantly lies between RL 11.0 and RL 11.75. An area of approximately 60 ha at the very eastern end of the property incorporates a portion of the bed of Whakaki Lagoon, and a portion of its western shoreline.

4.2 Hydrology

There have been substantial changes to hydrological patterns within the Whakaki wetland complex since 1874 (see Figure 1 in Parliamentary Commissioner for the Environment 1993). In addition to direct precipitation, the Whakaki 2N property receives water from the Whakaki Lagoon catchment which today, is considerably smaller than it once was. Figure 1 (this report) indicates the extent of the present day catchment. Western parts of the Whakaki 2N property (Area 1 in Figure 3) receive water discharged from the Wairau Lagoon, or water backed up from the Whakaki Lagoon via the Tuhara Stream when water levels are in the range of about RL 11.25 to RL 11.35 upwards. Areas 1 and 2 appear to be hydrologically isolated by a ridge of slightly higher ground which bisects the two areas, unless the artificial interconnecting channel referred to below, or another drainage channel is present, which would allow water to move between the two when levels are higher. Te Paeroa Lagoon (Area 3), and the low lying land (Area 2) connecting it with Whakaki Lagoon via the Otoki Reserve, also receive water backed up from Whakaki Lagoon after periods of heavy rainfall. If the embankment constructed across Te Paeroa Lagoon did not have a breach in it at its western end as it currently does, Whakaki Lagoon water levels would need to exceed approximately RL 11.75 to top the embankment, but water levels in the vicinity of RL 11.50 are probably sufficient to do so now. There is also a flap-gated culvert in the embankment which allows water to flow into the lagoon when levels are higher in Area 2 than in the lagoon itself. As water levels recede, water from Te Paeroa Lagoon is discharged into Area 2 until the level of the breach is reached.

The Tuhara Stream, which discharges water into Whakaki Lagoon from the westernmost parts of its catchment, is a channelized water course stopbanked along sections of its southern side. In its lower reaches it has a series of breaches in it (see Figure 4) which allow water to spill into Area 2 when levels reach a certain (undetermined) threshold. This water could be from the upper catchment, or water

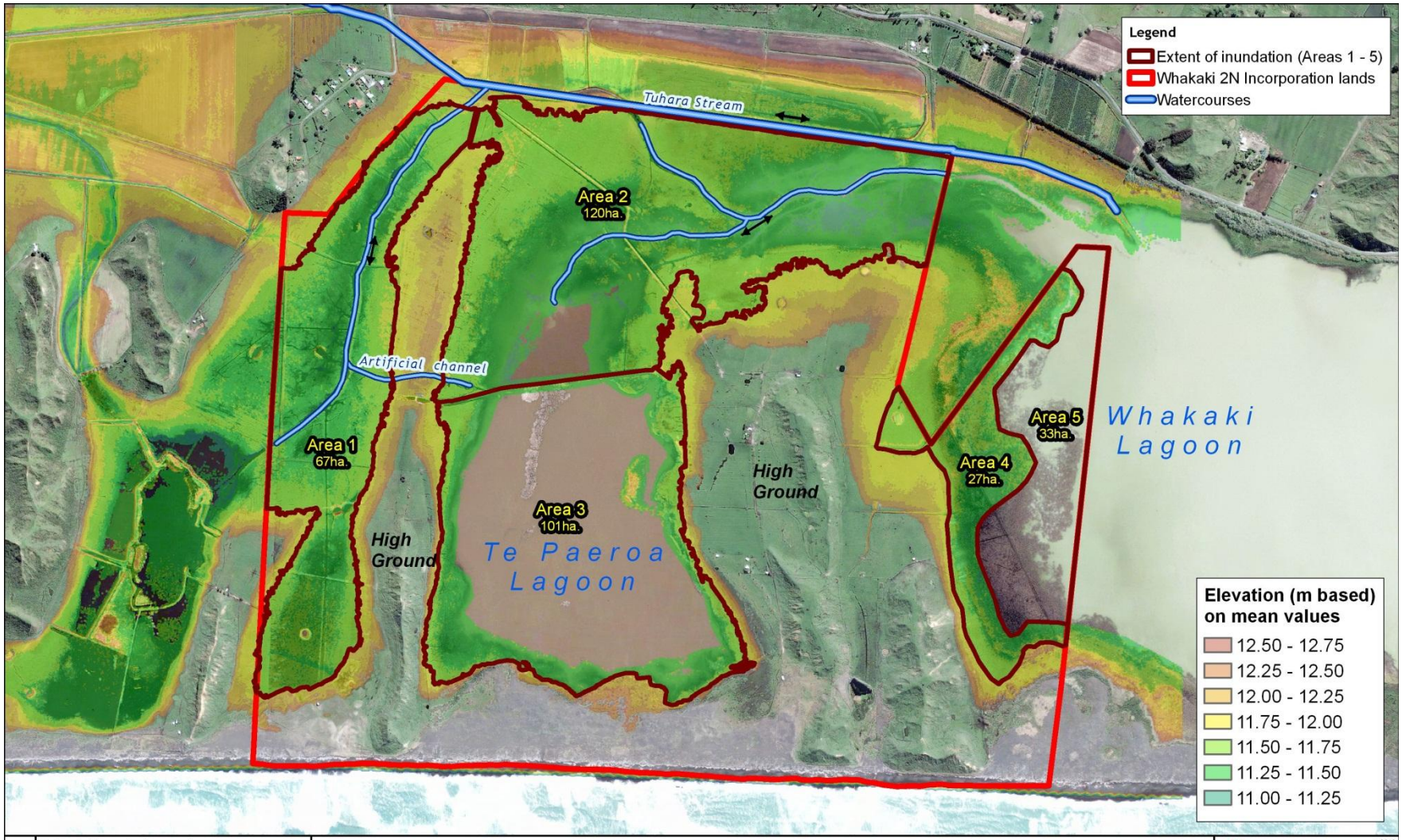

Figure 3. Ground elevations and extent of inundation on Whakaki 2N Incorporation land when water level reaches RL 11.75

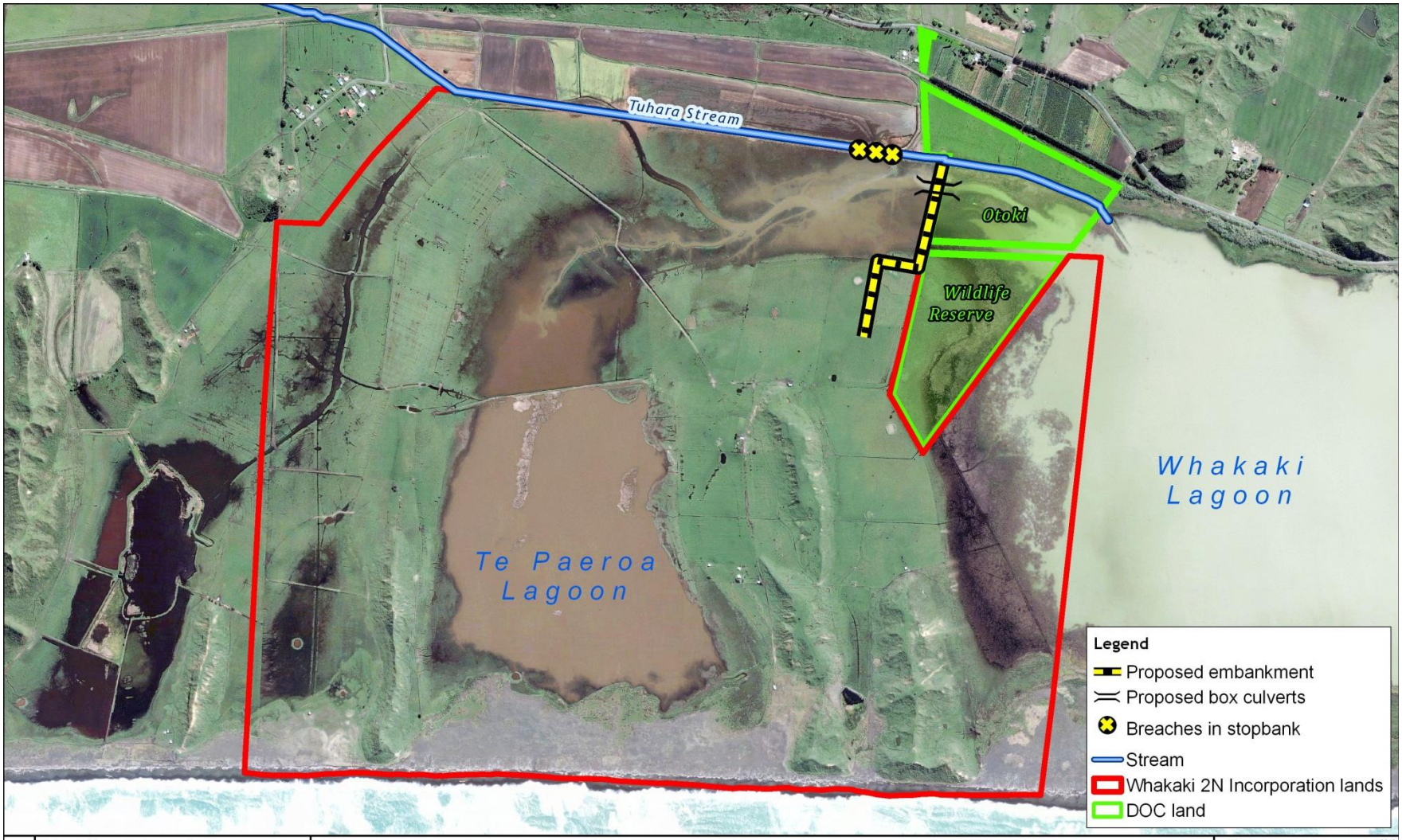

Figure 4. Location of Whakaki 2N Incorporation proposed embankment as shown in consent application

backed up from the Whakaki Lagoon, or a combination of both, and water could theoretically, move in either direction.

Wairau Lagoon, and the ephemeral wetland to the north of it which incorporates Area 1, currently discharge to the Tuhara Stream when levels in the lower catchment enable this to occur. However, there is also an interconnecting channel which has been constructed between the Wairau Lagoon outlet channel in Area 1 and Te Paeroa Lagoon north of the embankment in Area 2, which, if levels were higher in Area 1 than in Area 2 and the drain was in operational order, would enable water to discharge to Area 2 (or vice versa).

Water levels in low lying Areas 4 and 5 are primarily influenced by Whakaki Lagoon levels.

Water levels are not routinely monitored or recorded within Whakaki Lagoon (Peter Manson, HBRC pers. comm), nor is the extent and duration of water held back on Whakaki 2N land. The dates on which the lagoon has been opened to the sea have generally been recorded however, and these provide an insight into the minimum number of times each year that water levels have attained RL 11.8 and significant inundation would have been experienced on Whakaki 2N land, and the relative timing of these events. During the period July 2001 to November 2009, there were approximately 38 openings of the Paakaa outlet or about 4.4 times per year (Goodier 2012).

> "There have been periods when the time between openings has been over 1 year, as well as times when there have only been days between openings. The short times between openings were probably attributable to rough seas causing the mouth to close quickly after it had been opened. For the cases where the period between openings was up to 1 year, it is anticipated that evaporation from the lake surface would have become significant, and reduced the need for the mouth to be opened, since some equilibrium water level would have been reached".
>
> (Goodier 2012)

Appendix 1 lists the dates on which the outlet was opened over the past four years. In 2009, the lagoon was opened five times between June and October, and in 2011, five times during the period March to August. In 2010 there were six openings, one of which was at the beginning of February, the remainder between June and October. Water levels again reached RL 11.8 over the past summer, with openings required in both January and March.

Once the outlet at Paakaa has been opened, water levels generally recede quite rapidly within the catchment (Mike Perry, HBRC pers. comm.), and from the Whakaki 2N property (Helen Jonas, DOC pers. comm.).

4.3 Vegetation

A brief survey of the vegetation and flora of the Whakaki 2N ephemeral wetland within Area 2 (Figure 3) was undertaken on 24 February 2012. The area traversed during the survey is shown in Appendix 4 (Figure A). The vegetation comprises a gradation of mudfields, turfs, and grassland, the distribution of which are largely

related to relative ground level. Other contributing factors are domestic stock grazing pressure, drains, and farm management, including pasture improvement.

The extent of each of these vegetation types is likely to vary from year to year, and was not able to be closely correlated to the aerial photographs available or the 2009 LiDAR dataset. Actual vegetation cover present was described at 44 points during the field survey, and these points are mapped and described in Appendix 4). The vegetation types noted at each point were grouped into five broad classes:

1. Indigenous turfs;
2. Mercer grass dominant (or other exotic grasses);
3. Mercer grass-*Eleocharis acuta*-Indian doab-creeping bent grassland;
4. Mixture of exotic grasslands and indigenous turfs;
5. *Juncus sarophorus-Mentha pulegium*-creeping bent herbfield.

Locations at which these vegetation and habitat classes were recorded are shown in Figure 5.

The extensive mudfields and turfs (Class 1: Indigenous turfs) are dominated by species such as *Centipeda cunninghamii*, *Lilaeopsis novae-zelandiae,* and bachelor's button (*Cotula coronopifolia*). *Chenopodium ambiguum* is locally common, as is mudwort (*Limosella lineata*). Arrow grass (*Triglochin striata*) and *Myriophyllum propinquum* occur locally. Other species present locally include Mercer grass (*Paspalum distichum*), creeping bent (*Agrostis stolonifera*), and *Schoenoplectus pungens.* A few scattered searush (*Juncus kraussii* var. *australiensis*) occur in places. Species that were seen but were not common include *Elatine gratioloides* and *Rorippa palustris. Schoenoplectus pungens* and *Bolboschoenus* seedlings were observed in one place.

On higher ground, Mercer grass is often the dominant cover, and covers extensive areas, often in association with creeping bent, Indian doab (*Cynodon dactylon*), and *Eleocharis acuta*. *Juncus sarophorus* and various other *Juncus* species also occur in this type (Classes 2 and 3: Mercer grass dominant (or other exotic grasses) and Mercer grass-*Eleocharis acuta*-Indian doab-creeping bent grassland respectively).

In places the vegetation on higher ground varies from the above, with exotic herbs more common, such as redroot (*Amaranthus powellii*) and *Persicaria maculosa*. Smooth witchgrass (*Panicum dichotomiflorum*) is locally common on the southern side near the two small ponds.

Other species present in these areas include *Echinochloa crus-galli*, *Mentha spicata*, *Centipeda cunninghamii*, annual poa (*Poa annua*), ryegrass (*Lolium perenne*), white clover (*Trifolium repens*), *Rumex*, and sea aster (*Aster subulatus*). Exact composition will vary from season to season, and be dependent on water levels (an example of this is Class 4: Mixture of exotic grasslands and indigenous turfs).

There is one small area within the area surveyed from which domestic stock have been excluded for a number of years. This is covered in dense *Bolboschoenus*, which indicates that if stock is excluded, *Bolboschoenus* may rapidly expand across a large portion of the ephemeral wetland subject to water regimes being favourable for it to

do so. Turfs would not be excluded altogether, but would probably be greatly reduced in extent, and confined to deeper water areas that are inundated for extended periods of time.

4.4 Flora

Sixty-three vascular plant species were recorded within the Whakaki 2N ephemeral wetland within Area 2, 26 of which are indigenous species, and 37 are naturalised. No threatened species as per de Lange *et al*. (2009) were located within the area.

Thirteen indigenous species (identified in Appendix 3) recorded during the field surveys of Otoki Reserve, Te Paeroa Lagoon, and the ephemeral wetland area between Te Paeroa and Whakaki Lagoons have not previously been recorded from the Waihua Ecological District (c.f. Whaley *et al*. 2001). Two of these species (*Persicaria decipiens* and *Euchiton involucratus*) were only recorded from the ephemeral wetland. A further eight (*Centipeda cunninghamii, Alternanthera nahui, Centella uniflora, Chenopodium ambiguum, Elatine gratioloides, Limosella lineata, Ranunculus glabrifolius,* and *Rorippa palustris*) of the 13 species were also recorded in this area. Some or all of the remaining species not previously recorded in the Ecological District are also likely to be present.

Many of the adventive species observed during the current survey have not previously been recorded within the Waihua Ecological District. This does not imply that they are not present at other sites however. Some of the adventive species not previously recorded from the Ecological District are *Carex otrubae, Sisyrinchium iridifolium*, and *Lythrum hyssopifolia*.

4.5 Fauna

Accounts of fauna are provided in HBRC (2001, 2005, 2007), Walls (2000), and NZ Wildlife Service and Department of Conservation file notes and unpublished reports held by DOC.

No comprehensive or systematic surveys or counts of birds have been undertaken on Te Paeroa Lagoon or Whakaki 2N lands within recent years, and little information, other than of an anecdotal nature, is available on seasonal patterns or spatial utilisation. Hawkins (1983) provides however, a useful insight into the manner in which individual species utilise the ephemeral wetland area, where, when, what for, and in what numbers, and the complementary and critical role this habitat plays within the wider Whakaki and Te Paeroa Lagoon wetland complex. Although dated, his observations of how and when species utilise various parts of the system in relation to prescribed water levels, is likely to be no less applicable today than it was then.

HBRC instigated a biennial ecological monitoring programme on Whakaki Lagoon in 1999 which includes bird observations, and fish sampling. These bird observations, coupled with a checklist provided in HBRC (2001), have been used to generate an updated list of birds recorded within the wider Whakaki wetland complex, and identify species likely to utilise the Whakaki 2N ephemeral wetland areas (see Appendix 3).

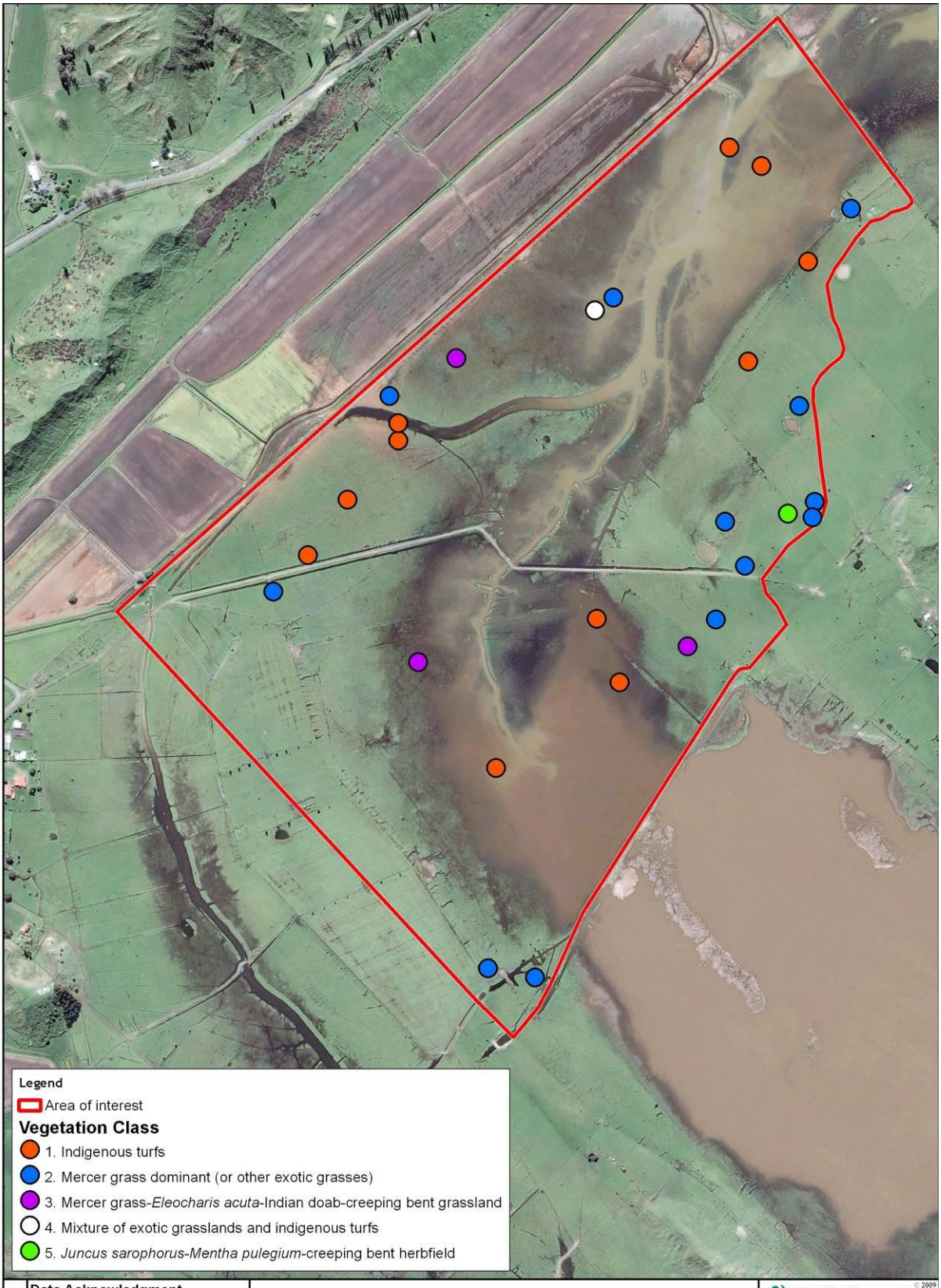

Figure 5. Spot locations of vegetation classes

Of the 44 wetland bird species (42 indigenous, two introduced) recorded from the area, all but four could be expected to take advantage of opportunities provided within the ephemeral wetland areas from time to time. Twelve of the 'ephemeral wetland' species are birds that exploit shallow and/or deeper open water habitats (waterfowl and shags), and 18 are species that typically forage by wading in shallow water habitat, of which, 10 are migratory waders. Three of the 'ephemeral wetland' species, wrybill (*Anarhynchus frontalis*), black-billed gull (*Larus bulleri*), and dabchick (*Poliocephalus rufopectus*) are classified as "Threatened-Nationally Vulnerable" by Miskelly *et al* (2008), while another, grey duck (*Anas superciliosa*), is classified as "Threatened-Nationally Critical". Bittern (*Botaurus poiciloptilus*), classified as "Threatened-Nationally Endangered" may also occasionally exploit the opportunities available. Seven "At Risk" species also utilise the area, these being variable oystercatcher (*Haematopus unicolor*), pied stilt (*Himantopus himantopus leucocephalus*), white-fronted tern (*Sterna striata striata*), the three shag species (*Phalacrocorax carbo, P. melanoleucos and P. sulcirostris*), and royal spoonbill (*Platalea regia*).

In 1999, Walls (2000) caught shortfin eel (*Anguilla australis*), inanga (*Galaxias maculatus*), common bully (*Gobiomorphus cotidianus*), and introduced goldfish (*Carassius auratus*) in Whakaki Lagoon, and these species have periodically been recorded in subsequent monitoring exercises conducted by HBRC (cf HBRC 2005, 2007). A large number of shortfin eels were salvaged from Te Paeroa when water levels were reduced to very low levels in the summer of 1994/95 due to drought (Malcolm Smith, DOC pers. comm.), and shortfin eels are well known to utilise the Whakaki 2N ephemeral wetlands (a disused eel weir and trap is located just north of Te Paeroa Lagoon (Cheyne 2010)).

5. ECOLOGICAL VALUES

The Whakaki 2N ephemeral wetlands are a very significant component of an extensive (*c.*1,060 ha) coastal wetland complex (Whakaki Lagoon, Te Paeroa Lagoon, and Patangata Lagoon) which was identified as a Recommended Area for Protection (RAP) in the Waihua Ecological District Protected Natural Areas Programme (PNAP) report (Whaley *et al*. 2001). Coastal wetlands, as a habitat type, are under-represented in the existing reserve system within the ecological district. The justification for the incorporation of these lagoons into a RAP was because:

> "they contain extensive areas of wetland vegetation, of a wide range of types. Whakaki Lagoon is also significant as the largest freshwater lagoon on the east coast of the North Island. All of the lagoons are also significant as wildlife habitats; Whakaki Lagoon has an SSWI ranking of 'high', while Te Paeroa and Patangata Lagoons have SSWI rankings of 'moderate-high'.
>
> (Whaley *et al.* 2001)

The ephemeral wetlands within Area 2 hydrologically link Whakaki Lagoon with Te Paeroa Lagoon, and ecologically, are an integral part of the functioning of the wider wetland complex. Walls (2010) and Cheyne (2010), and various other

observers, provide an overview of the habitat values of the ephemeral area for birds and eels, and Hawkins (1983) details when and how birds use it in addition to describing the complementary role it plays, and its importance within the context of the wider area.

The indigenous turfs present are of relatively good quality, and their composition and species diversity, which includes eight indigenous plant species not known from outside of the RAP, adds significance to the area.

Adams (1995) identified the Whakaki coastal lagoon complex (Whakaki, Wairau, Te Paeroa, Ohuia and Patangata Lagoons) as being the wetland of highest priority for restoration within the Hawke's Bay Region. Section 3.4 of the Hawke's Bay Regional Resource Management Plan acknowledges this ranking, and its policies are are very supportive of protecting this wetland and nine others generally recognised as being the top ten wetlands within the region, anticipating there will be "no further loss of ecologically significant wetlands" (HBRC 2006).

A revegetation programme instigated and managed by the Whakaki Lake Trust has planted many tens of thousands of plants around the margins of the Whakaki Lagoon over the past decade, and Whakaki 2N has contributed to other environmental initiatives the Trust or DOC has implemented there. There remains considerable opportunity and potential for restoration of habitats and enhancement of ecological values on Whakaki 2N land, which would complement those being undertaken on Whakaki Lagoon by the Whakaki Lake Trust.

6. ECOLOGICAL EFFECTS OF WHAKAKI 2N INCORPORATED PROPOSAL

6.1 Overview

The Whakaki 2N proposal involves the construction of a low level embankment along a section of the north-eastern boundary of the property and the Otoki Reserve in the north-western inlet arm of Whakaki Lagoon (see Figure 4). The purpose of the embankment is to prevent the Whakaki Lagoon from progressively inundating Whakaki 2N land as lagoon levels rise from *c.*RL 11.25-11.35 to the permitted maximum of RL 11.80. The embankment will have two box culverts installed into it, each of which will be fitted with a hinged floodgate on the eastern side of the embankment. Water will flow eastwards when levels are higher on the Whakaki 2N property side than in the lagoon and there is sufficient head to force the gates open. When water levels are higher in the lagoon than on Whakaki 2N land, the gates will automatically close. One culvert will be positioned so its invert is 20% below the bed of the existing channel to ensure there is a minimum water depth of 200 mm within the culvert (Howatson 2009b).

The three artificially formed breaches in the Tuhara Stream embankment shown in Figure 4 will be repaired to prevent high water levels in the Tuhara Stream from flowing directly into the Whakaki 2N property.

A dewatering pump will be installed to pump water contained behind (west of) the embankment, over the embankment and into Whakaki Lagoon when levels in the lagoon are higher than those on Whakaki 2N land and the culverts are closed. The consent application details the maximum capacity of the pump (1100 litres/second), but provides no insight into Whakaki 2N's objectives in terms of how low they wish to reduce water levels to, or what their optimal farming regime might look like.

6.2 Effects

If implemented in isolation, repairing the breaches in the Tuhara Stream embankment would have little if any effect on ecological features within Areas 2 or 3 (Figure 3). When water levels within the stream are of sufficient height to overflow the stream and spill onto Whakaki 2N land due to rainfall within the catchment, levels within the Whakaki Lagoon itself are likely to be sufficiently elevated for the lagoon to expand westwards and achieve the same result. It is possible there are differences in the quality of water derived from the Tuhara Stream catchment as opposed to the wider Whakaki catchment, but any influence this might have on ecological features within the Whakaki 2N ephemeral wetland area is likely to be negligible given the extent to which mixing is likely to occur.

If implemented in isolation, repairing the breaches in the Tuhara Stream embankment might be ecologically beneficial to the ephemeral wetland area in Area 1 by enabling water levels to back up into the area more rapidly or persist there for longer.

Implementation of the entire proposal as it stands, would have significant impacts on ecological values within the Whakaki 2N property. Walls (2010) and Cheyne (2010) provide an insight into these. If the floodgates are managed entirely passively and left to open and close automatically, the frequency and timing of when the gates are open could impede fish passage, and in addition to restricting foraging opportunities for eels resident in Whakaki Lagoon, and placing them at risk of asphyxiation if they become stranded[1] behind (west of) the embankment with diminishing water levels from pumping, could have an effect on juvenile recruitment into Te Paeroa Lagoon. Drainage of the ephemeral wetland (Area 2) to very low levels, which is presumably Whakaki 2N's intention, would have more significant consequences still. Botanically it would lead to the demise of the turf communities and indigenous turf forming species present, a vegetation type which is under represented in the protected natural areas network within the Waihua Ecological District, and substantially reduced in extent regionally as a consequence of land development. A reduction in the extent of the mudfields and turfs and these biologically highly productive ephemeral habitats, would have a significant local, if not regional impact on opportunities for a wide variety of wading bird species, and waterfowl, and potentially, the productivity of some of these species. It would also significantly reduce, if not remove, a periodically extensive area of 80 ha or more of what is probably highly productive foraging habitat for eels. The full implications of this would require further investigation, but it is conceivable that loss of this opportunity could impact on local

[1] This can occur presently, e.g. Cheyne (2010) reported seeing a number of dead eels in September 2010 that had been stranded in this area after recent high water levels had subsided, but could happen on a much greater scale if the *c.*400 m wide 'main' channel between the ephemeral habitat and the Whakaki Lagoon was blocked off as it would be with the proposed embankment in place.

carrying capacity for eels and hence eel biomass, and could potentially, affect growth rates.

The implications for Te Paeroa Lagoon of the application in its current form, would be to significantly reduce, if not exclude, recharging of the lagoon with water backed up from the Whakaki Lagoon, particularly if or when the *c.*0.3m breach at the western end of the Te Paeroa embankment is repaired (which it needs to be to enhance ecological values within the lagoon itself). Te Paeroa Lagoon is relatively shallow[1] and has only a very limited catchment, and without the periodic buffer provided with top-ups from Whakaki Lagoon, is very likely to dry out more frequently, and drop to much lower water levels than it currently, or previously has done in summer[2]. Low summer water levels within a closed water body such as this impact on water quality, particularly water temperature and dissolved oxygen levels, and can adversely affect ecological values by detrimentally affecting habitat for a wide range of species. Low water levels can also greatly enhance the possibility of botulism outbreaks, and exacerbate issues such as lead poisoning. While it is no longer legal to use lead shot when hunting waterfowl over water, a significant reservoir of lead shot, a highly toxic substance, is likely to be present in the sediments lining the bed of Te Paeroa Lagoon given the long history and intensity of game bird hunting that has taken place there (Hawkins (1983) reported 14 stands supporting 28-36 hunters). High incidences of elevated (and debilitating) lead levels arising from the ingestion of lead shot, have been recorded in dabbling ducks and a wide variety of waders and other wetland birds, both in New Zealand and overseas. A sample of mallard and grey ducks from nearby Ohuia Lagoon in the summer of 1998/99, a drier summer than normal, revealed a large proportion of these had ingested lead shot and had elevated blood lead levels (Garrick 2000). Low water levels in shallow water systems with sandy, or predominantly hard bottom substrates such as Te Paeroa Lagoon can make lead shot far more accessible to birds feeding within these environments.

Compromising the hydrological connection between Whakaki Lagoon and Te Paeroa Lagoon during the spring/summer period could also significantly impact on elver recruitment into Paeroa Lagoon (and possibly, other indigenous freshwater fish species), and impact on the migration of adult eels to the sea during the late summer to early winter.

In recognition of some of these concerns, Tom Te Kahu (pers. comm.) has suggested Whakaki 2N may be amenable to the construction of a channel running north-south along the ridge dividing Area 1 from Area 2, which would directly link Tuhara Stream to Te Paeroa Lagoon and ensure the lagoon continues to periodically receive inflows from Whakaki Lagoon and/or the Tuhara Stream catchment.

If Areas 1 and 2 are hydrologically isolated as they appear to be, drainage of Area 2 would not affect Area 1. However, the artificial channel between the two shown in

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1 Cheyne (2010) reported an average depth of *c.*0.5m and a maximum depth of *c.*0.7 m when the water level was approximately RL 11.50, and noted that if the breach was not repaired, water depth would be reduced by another *c.*0.3 m which would reduce average water depth to *c.*0.2 m.

2 The lagoon rarely entirely dries out, but it did in 1985 (NZ Wildlife Service undated file note) and in 1988 (Tom Te Kahu pers. comm.), and in 1995 was reduced to such a low level that a fish salvage operation was organised to avoid a large number of eels dying (Malcolm Smith, DOC pers. comm.).

Figure 3, and low relief of the land that separates the two systems more generally, suggests it would be a very simple matter to link Area 1 to Area 2 and drain the ephemeral wetlands associated with Area 1 be that with or without the aid of a pump. Although the ecological values of Area 1 have only been very superficially investigated, it is very likely that loss of the ephemeral wetland system immediately north of the Wairau Lagoon would compound the effects of draining Area 2.

7. ALTERNATIVE OPTIONS

7.1 John Cheyne proposal

7.1.1 Overview

This proposal involves the construction of two low level bunds as shown in Figure 6. The southern, and more substantial embankment, follows an existing fence line running from the Otoki Reserve boundary westwards to the access road from Iwitea, then turns south and follows another existing fence line before keying into high ground. The eastern arm of the bund follows the Otoki Reserve boundary southwards until it too is keyed into higher land. The rationale for this embankment would be to isolate and protect an area of better quality pasture south of the structure from water backed up from the lower Tuhara Stream and Whakaki Lagoon. Drainage of water that is impounded to the south would be by gravity fed culverts with a flap-gate on the north side of the embankment to prevent water from backing into the protected pasture. A pump could be installed to increase the rate at which this area was drained if more rapid relief was required.

The smaller embankment located further north bridges the area between the Tuhara Stream and the access road from Iwitea. This bund, together with the Tuhara Stream stopbank and the raised causeway along which the access road runs, would protect a triangle of pasture as indicated in the figure. Installation of a flap-gated culvert through the embankment would again be required to drain impounded water derived from rainfall within the triangular area.

Seasonal grazing to maintain the present vegetation classes would be retained within the area presently grazed, the exception being parts of Te Paeroa Lagoon margin where stock should be excluded to enable the re-establishment of raupo and other lake edge vegetation for the benefit of species such as matuku, matata, and puweto.

7.1.2 Effects

This proposal would have negligible, if any effect on current ecological values, as it retains the full hydrological connectivity between Te Paeroa Lagoon and Whakaki Lagoon that presently exists, and preserves all but a small portion of the ephemeral wetland present within Areas 1 and 2. The northern triangular area protected from inundation via water backed up from Whakaki Lagoon and the lower Tuhara Stream supports some indigenous turfs, but also wi (*Juncus sarophorus*) and introduced Mercer grass, and is probably of lesser habitat value for birds and fish than the slightly lower lying areas which support more extensive areas of indigenous herbfield, mudflats and turfs.

The northern embankment would prevent an area of *c.*10 ha from being inundated by water backed up to RL 11.80. The southern embankment would protect *c.*5 ha vulnerable to flooding if water levels were to attain RL 12.00, but less than one hectare if water levels peaked at RL 11.80. The net effect of this proposal would be to retain *c.*91% of the area periodically inundated within Area 2.

Retaining light seasonal grazing within Area 2 would ensure the area retains its current habitat values for waders and waterfowl for longer than would be the case if natural regeneration was able to proceed undisturbed.

7.2 Wildlands alternative embankment

7.2.1 Overview

An alternative option to John Cheyne's proposal is to construct a single embankment at the location shown in Figure 7. This follows, more or less, the RL 11.55 contour on the northern side of the outlet channel from Te Paeroa Lagoon. A flap-gated culvert and pumping facility would need to be installed to remove rainfall derived water impounded on the northern side of the embankment.

Periodic light grazing would again be promoted within the ephemeral wetland area.

7.2.2 Effects

The impacts on current ecologically significant features within Area 2 (indigenous turfs and other indigenous flora, and habitat values for birds and eels) are most probably quite minor, though it would be useful to have some contemporary observations, and a greater understanding of habitat usage by birds in particular, to confirm this. A similar conclusion to that drawn in relation to the effects of John Cheyne's northern embankment is likely. Extensive parts of the area that would be excluded from periodic inundation when the lower Tuhara Stream and Whakaki Lagoon backs up, support Mercer grass dominant grassland, with creeping bent and exotic herbs a common feature in some areas. Some indigenous turf is also present, but the loss of this habitat is likely to be insignificant in the context of what is present elsewhere within Areas 1 and 2. The hydrological connectivity between Te Paeroa Lagoon and Whakaki Lagoon would be unaffected by this proposal, as would water level fluctuations and ecological processes within the more substantial, and ecologically significant portion of the ephemeral wetland present with Area 2.

The proposed embankment would exclude *c.*25 ha that would otherwise be inundated when water is backed up to RL 11.80. This represents approximately 21% of the area periodically inundated within Area 2, and would leave *c.*95 ha of ephemeral wetland intact including a full range of bottom profiles and ground elevations. The *c.*67 ha ephemeral wetland within Area 1, and other contiguous ephemeral wetland north of Wairau Lagoon, would be unaffected by this undertaking, provided there was no attempt to gravity feed or pump water from this area into the area protected from inundation by the proposed embankment, and thence into the Area 2 ephemeral wetland.

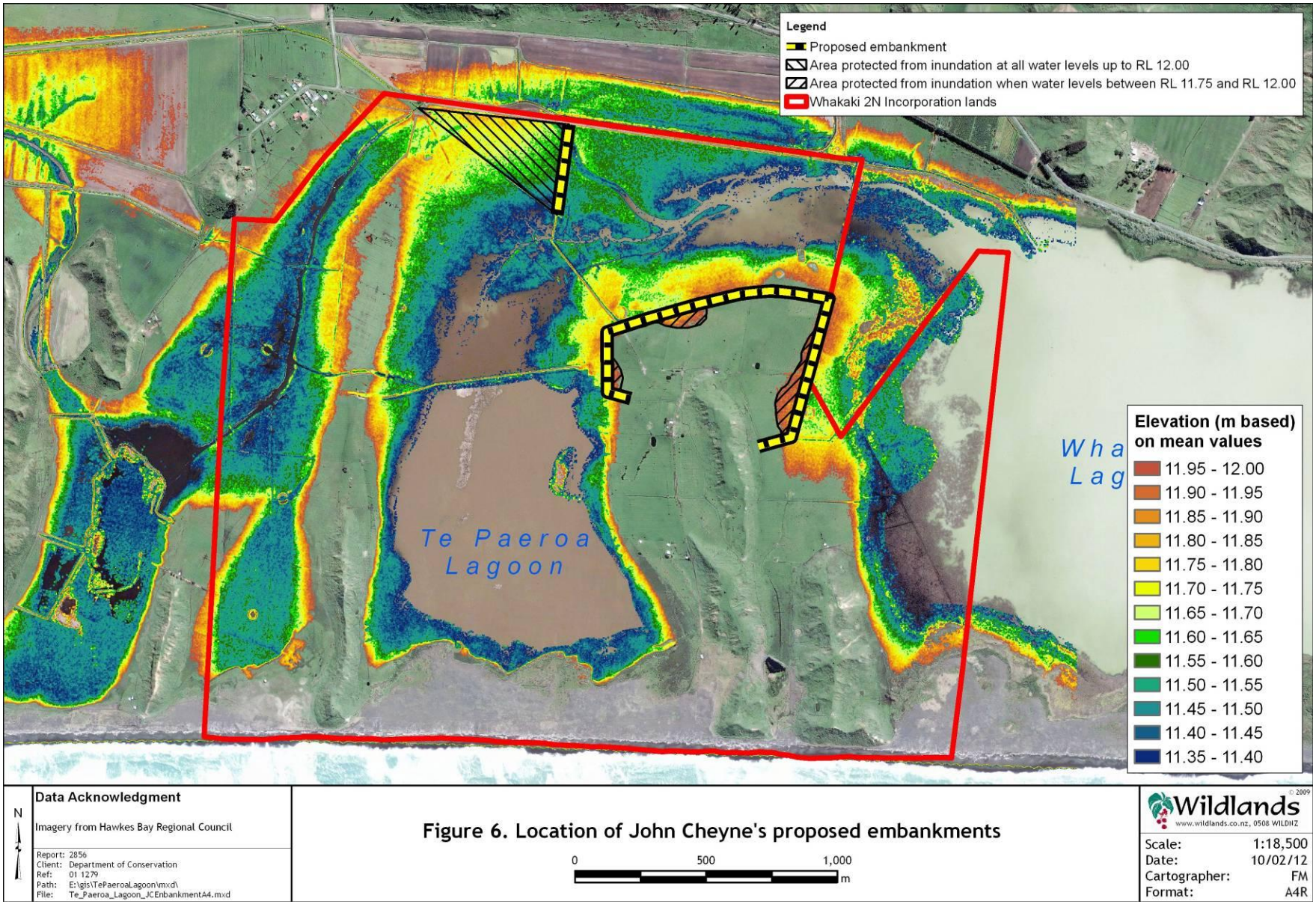

Figure 6. Location of John Cheyne's proposed embankments

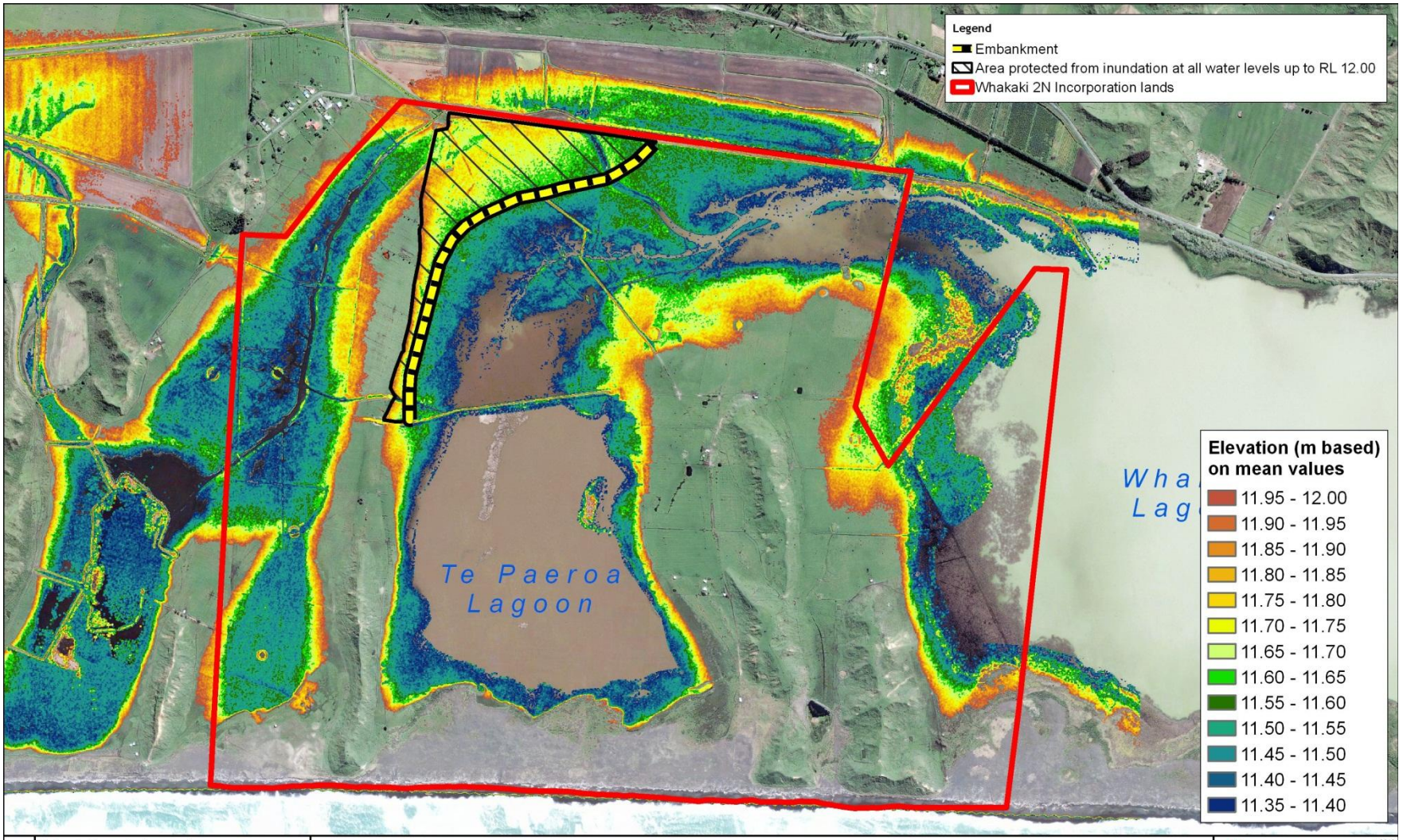

Figure 7. Location of Wildlands alternative embankment option

7.3 Whakaki 2N proposal with pumping restrictions

7.3.1 Overview

A further option is available that might provide relief to Whakaki 2N while largely preserving existing ecological values. This entails the construction of Whakaki 2N's embankment as described in the consent application, the installation and operation of fish friendly culverts through the embankment, the repair of the breaches in the Tuhara Stream stopbank, and the installation and/or operation of a pump to remove water impounded on the western side of the embankment. The critical difference between this option and Whakaki 2N's proposal however, is that a minimum water level to which levels could be reduced by pumping would apply. A provisional level of RL 11.60 is proposed, conditional upon further field observations being undertaken to ensure this is ecologically appropriate. Figure 8 provides an indicative picture, based on computer generated contours, of the implications of a level of RL 11.60 in terms of the areas that would no longer be inundated, and the location and extent of ephemeral wetland within Area 2 if water levels no longer exceeded this level.

Periodic light grazing would be desirable within the ephemeral wetland area.

7.3.2 Effects

Subject to further field evaluation, the overall impact on ecological values of this proposal is conceivably very similar to that of Wildlands alternative embankment option despite a larger area in total being excluded from periodic inundation. In the north-western corner of Area 2, *c.*20 ha would no longer be subject to water backing up from Whakaki Lagoon when levels attain RL 11.80, while *c.*15 ha in the south-eastern corner would no longer support surface water as it currently does from time to time (refer Figure 8). Approximately 85 ha or 71% of Area 2 would continue to function as an ephemeral wetland, water levels passively dropping from a peak level of RL 11.60 via gravity flows when water levels in Whakaki Lagoon permit, and via evaporation as conditions dictate. Levels greater than RL 11.60 would prevail for shorter periods than is currently the case, if at all.

For some decades prior to relocation of the Whakaki outlet in 1997, higher water levels on Whakaki 2N lands were experienced less frequently, and for shorter durations. In a submission supporting an objection by the Conservator of Wildlife to an earlier water right application, Hawkins (1983) outlined the habitat values of this wetland as they were then, and described how, and under what conditions the wetland area was utilised by various bird species. Hawkins noted that while some species (black swan and shags) exploited the wetland when levels approached RL 11.80, species such as mallard and grey duck were disadvantaged when levels exceeded RL 11.50 to RL 11.60[1].

[1] Hawkins (1983) also observed that levels in excess of RL 11.70 were less productive for waterfowl hunting.

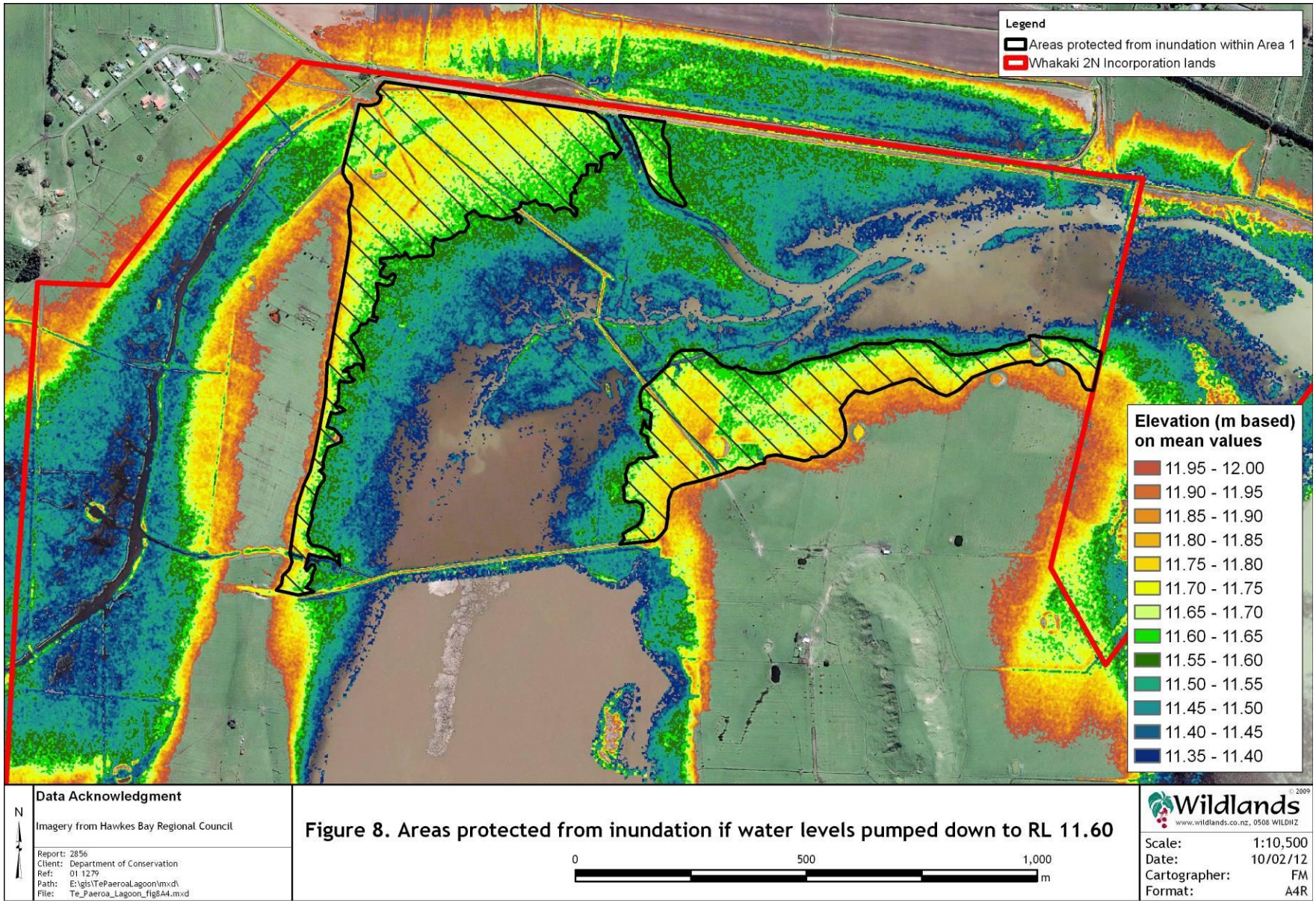

Figure 8. Areas protected from inundation if water levels pumped down to RL 11.60

When water levels are at RL 11.60, approximately one third of the ephemeral wetland in Area 2 is covered in water to a depth of 0-15 cm. A further third supports water in the range of 15-25 cm, while water depths in the remaining third exceed 25 cm. This range of depths provides extensive and diverse opportunity for waders and waterfowl, and birds that forage over, and loaf in or adjacent to open water habitats. This diversity of opportunity continues to be available as water levels drop to RL 11.40 and the bed of much of the wetland starts to be exposed.

Water levels are only one of the factors contributing to the significance and ecological values of this area. As important, is the extent to which levels fluctuate, because it is the wetting and drying, and ephemeral nature of the wetlands that plays a big part in driving their productivity. Provided the culverts allow water to drain freely from Area 2 as water levels drop within Whakaki Lagoon, and provided they allow water to back up into the area until a level of RL 11.60[1] is reached, productivity should largely be unaffected. The embankment will however, present some obstacle to the currently unimpeded access eels have into Area 2 from Whakaki Lagoon, and this might prevent some of these eels from being able to take advantage of the foraging opportunity available within Area 2.

This option presents significantly greater operational risks than the other two options described. Whereas the Cheyne and Wildlands embankment proposals involve the installation of simple structures only, and no ongoing intervention, this option requires the design, installation, and management of culverts or some other fish passage device that facilitates the movement of eels between Whakaki Lagoon, the Whakaki 2N ephemeral wetland, and Te Paeroa Lagoon. This option also requires active management of whatever gate facility is attached to the culverts to ensure water can move freely upstream and downstream when water levels are less than RL 11.60, and it requires a facility or protocol to ensure pumping ceases when water levels are reduced to RL 11.60.

8. SUMMARY

1. Whakaki 2N Incorporation (Whakaki 2N) has applied for resource consent to install a low level embankment and pumping facility on its property at Iwitea Road, Wairoa to reduce the extent to which the land it farms is inundated when water levels on Whakaki Lagoon rise beyond a certain point.

2. The area potentially affected by the proposal supports a permanent wetland, Te Paeroa Lagoon, a portion of the Whakaki Lagoon lake bed, and an ecologically very significant area of ephemeral wetland linking the two. These wetlands provide habitat for a wide variety of waterfowl and waders, eels, and indigenous turf communities. The Whakaki wetland complex has been identified as a Recommended Area for Protection, and has been ranked as the wetland of highest priority for restoration within the Hawke's Bay Region. The regional significance

[1] The twin box culverts prescribed in the consent application, will provide frictional resistance to the movement of water between Area 2 and Whakaki Lagoon, and water is likely to take longer to back up into Areas 2 and 3 and attain a level of RL 11.60 than it currently does. It is unclear what the ecological implications of this might be.

of the wetland is recognised in the Operative Hawkes' Bay Regional Resource Management Plan.

3. The proposal as presented will have major impacts on ecological values by directly affecting habitats on Whakaki 2N lands, and by indirectly affecting the species that utilise these habitats. The proposal, if implemented, could have regional, as well as local consequences.

4. The Department of Conservation wishes to establish whether there are alternative means of reducing the extent to which Whakaki 2N's farming aspirations are compromised by water backed up from Whakaki Lagoon, while at the same time preserving present day ecological values.

5. John Cheyne has proposed an alternative option involving the construction of two embankments at other locations. This proposal would have negligible, if any effect on current ecological values, but would exclude 10-11 ha of land from being inundated when water levels attain RL 11.80.

6. An alternative embankment option is available that is also likely to have very little impact on ecological values. This option would exclude approximately 25 ha from inundation when water is backed up to a level of RL 11.80. As with the Cheyne proposal, no active or ongoing intervention would be required to maintain current ecological values other than periodic light grazing of the ephemeral wetland between the Whakaki and Te Paeroa Lagoons.

7. Subject to further evaluation, one other approach could be considered, and that would be to install the structures and facilities for which Whakaki 2N has lodged its consent application (more or less), but impose a minimum level (RL 11.60) to which water could be pumped down to. This option would prevent approximately 35 ha of land being inundated when water backs up from Whakaki Lagoon and levels reach RL 11.80. This approach however, imposes significantly greater ecological risks than the other two options proposed, as it requires active intervention at critical points in time, and a much greater level of management input to ensure ecological values are not adversely affected. This is not a recommended option from an ecological perspective.

8. Periodic light grazing within currently grazed ephemeral wetland areas will be required to maintain existing herbaceous communities and turfs.

9. There is considerable opportunity and potential for ecological restoration and enhancement on Whakaki 2N's property without compromising existing farming operations.

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John Sawyer and Bryan Welch (DOC) instigated the project which was subsequently taken over by Dave Carlton of the Hawke's Bay and Wairarapa Offices of DOC. John Cheyne (F&G), Peter Manson (HBRC), Dave Carlton, Helen Jonas, and Hans Rook (DOC) participated in a very useful on site discussion of ecological and hydrological features, and

facilitated access to documents and other records held by agencies. Tom Te Kahu and Ruku Niania (Whakaki 2N), and Hilton Collier (AgFirst) contributed a valuable insight into Whakaki 2N's issues and concerns, and the rationale underlying the consent application, and Richard Robinson (Wairau Lagoon owner) provided his perspective in addition to an on site overview of his property. Helen Jonas helped with logistics, and provided assistance in the field with the vegetation surveys.

REFERENCES

Adams J. 1995: Priority wetlands for restoration in the Hawke's Bay Region. 9 pp.

Boffa Miskell 2002: Lake Whakaki Management Plan. Prepared for Pt Hereheretau B2L2 Trust. 46 pp.

Cheyne J. 2010: Draft report on Whakaki 2N Incorporation resource consent application to drain part of Lake Whakaki and associated wetlands. Fish and Game Hawke's Bay Region. 3 pp.

Garrick A.S. 2000: Results of an investigation into the incidence of ingested lead shot and elevated blood lead levels in mallard and grey duck populations in the Bay of Plenty and East Coast Regions of the North Island. *Fish and Game New Zealand Technical Report*. Fish and Game New Zealand. 25 pp.

Goodier C. 2010: Whakaki Lake Hydrodynamic Model. *Hawke's Bay Regional Council 5/212000*. 3 pp.

Hawke's Bay Regional Council 2001: Whakaki Lake: Management requirements to protect and enhance, 1999-2004. *Environmental Management Group Internal Report EMI 0116, HBRC Plan Number 3074*. 28 pp.

Hawke's Bay Regional Council 2006: Hawke's Bay Regional Resource Management Plan. Operative 28 August 2006. *HBRC Plan Number 3881*. 235 pp.

Hawke's Bay Regional Council 2006a: Whakaki Lagoon ecological monitoring 2005. *Environmental Management Group Technical Report EMI 06/11, BBRC Plan Number 3861*. 54 pp.

Hawke's Bay Regional Council 2008: Whakaki Lagoon ecological monitoring 2007. *Environmental Management Group Technical Report EMI 0809, HBRC Plan Number 4022*. 50 pp.

Hawkins K. 1983: Statement by K.C. Hawkins in support of the objection by the Conservator of Wildlife of Water Right Application 830460/1. 7pp.

Howatson I. 2009a: Resource consent application to Hawke's Bay Regional Council for use and develop the bed of a lake/river/sea discharge of pumped floodwater for Whakaki 2N Incorporated. 45 pp plus drawings and plans.

Howatson I. 2009b: Request for further information, LU090530/31/32C, DP090533W. Letter to Consents Office, Hawke's Bay Regional Council. 7 pp.

Koutsos T. 1991: Whakaki Lagoon outlet. Briefing paper to Operations Committee Meeting, Agenda Item No. 4. Hawke's Bay Regional Council. 5 pp.

Miskelly C.M., Dowding J.E., Elliott G.P., Hitchmough R.A., Powlesland R.G., Robertson H.A., Sagar P.M., Scofield R.P., Taylor G.A. 2008: Conservation status of New Zealand birds, 2008. *Notornis 55*: 117-135.

Parliamentary Commissioner for the Environment 1993: Investigation into the management of Whakaki Lagoon. *ISBN 0-908804-40-7*. 52 pp.

Richmond C.J. 1983: Statement by C.J. Richmond in support of the objection by the Conservator of Wildlife; in the matter of the Water and Soil Conservation Act 1967. 9 pp.

Robinson J. and Owen C.J. 1983: Water Right Application (830460/1). Whakaki 2N Incorporation. 11 pp.

Smith M. 1997: Whakaki Wetland enhancement. Prepared for the Hawke's Bay Regional Council. Department of Conservation. 16 pp.

Smith M. and Adams J. 1995: Wetland restoration report for Hawke's Bay Regional Council. Department of Conservation. 6 pp.

Stack D.J. 1983: Water Right Applications (830460/1), Whakaki 2N Incorporation, J. Robinson and C.J. Owen: To dam Whakaki Lagoon and discharge water. Objection by Conservator of Wildlife. *Letter to Hawke's Bay Catchment Board*. 2 pp.

Walls G. 2000: Whakaki Lagoon ecological monitoring 1999. Prepared for Hawke's Bay Regional Council. 21 pp.

Walls G. 2010: Te Paeroa Lagoon and Whakaki Lake: Ecological effects of proposed flood control. Contract report prepared for Whakaki 2N Incorporation. 15 pp.

Whaley K.J., Clarkson B.D., Emmett D.K., Innes J.G., Leathwick J.R., Smale M.C., Whaley P.T. 2001: Tiniroto, Waihua, Mahia and Matawai Ecological Districts. Survey Report for the Protected Natural Areas Programme. Department of Conservation, Gisborne. 504 pp.

WHAKAKI LAGOON OPENINGS SINCE MID-2008

(provided by Mike Perry, HBRC)

Year	Date Opened
2008	30 May 2008 29 June 2008 2 August 2008
2009	10 June 2009 3 July 2009 20 July 2009 18 August 2009 12 October 2009
2010	1 February 2010 11 June 2010 7 July 2010 3 August 2010 2 September 2010 15 October 2010
2011	24 March 2011 28 April 2011 4 July 2011 11 August 2011 22 August 2011
2012	10 January 2012 22 March 2012

APPENDIX 2

VASCULAR PLANT SPECIES RECORDED WITHIN THE WHAKAKI 2N INCORPORATION EPHEMERAL WETLAND AREA BETWEEN WHAKAKI LAGOON AND TE PAEROA LAGOON, AT TE PAEROA LAGOON, AND WITHIN THE OTOKI WILDLIFE MANAGEMENT RESERVE DURING SITE VISITS IN DECEMBER 2011 AND FEBRUARY 2012

Key

* = Not known to occur at any other sites in Waihua Ecological District.

Species		Whakaki 2N Ephemeral	Te Paeroa Lagoon	Otoki Reserve	Whakaki 2N Sand Dunes[1]
INDIGENOUS SPECIES					
Dicot. trees and shrubs					
Coprosma robusta	karamu			✓	
Melicytus ramiflorus subsp. *ramiflorus*	mahoe			✓	
Pittosporum crassifolium	karo			✓	
Plagianthus divaricatus	marsh ribbonwood makaka			✓	
Dicot. lianes					
Calystegia soldanella	panahi, shore bindweed				✓
Calystegia sepium subsp. *roseata*	pohue			✓	
Muehlenbeckia complexa	pohuehue			✓	✓
Ferns					
Azolla filiculoides	retoretore		✓	✓	
Grasses					
Rytidosperma gracilis.		✓			✓
Spinifex sericeus	kowhangatara, spinifex				✓
Sedges					
Baumea articulata			✓	✓	
Bolboschoenus caldwellii	purua grass	✓	✓	✓	
Bolboschoenus fluviatilis	purua grass		✓	✓	
Bolboschoenus medianus	purua grass	✓		✓	
Carex geminata agg.	rautahi		✓		
Carex pumila					✓
Cyperus ustulatus f. *ustulatus*	toetoe, upokotangata	✓	✓	✓	
Eleocharis acuta	spike sedge	✓	✓	✓	
Eleocharis gracilis				✓	
Ficinia nodosa	wiwi				✓
Isolepis habra			✓		
Isolepis prolifera		✓	✓	✓	
Schoenoplectus pungens		✓	✓	✓	
Schoenoplectus tabernaemontani	kapungawha		✓	✓	
Rushes					
Juncus australis	wi	✓	✓	✓	
Juncus edgariae	wi	✓	✓	✓	
Juncus kraussii var. *australiensis*	wi searush	✓		✓	
Juncus pallidus	wi		✓		
Juncus sarophorus	wi	✓			
Monocot. herbs (other than orchids, grasses, sedges, and rushes)					
Lemna minor	karearea	✓	✓	✓	

[1] Incomplete list; only a few dominant/prominent species were recorded.

Species		Whakaki 2N Ephemeral	Te Paeroa Lagoon	Otoki Reserve	Whakaki 2N Sand Dunes[1]
**Ruppia* sp. (J. Cheyne pers. comm.)			✓		
Triglochin striata	arrow grass	✓	✓	✓	
Typha orientalis	raupo		✓	✓	
Composite herbs					
**Centipeda cunninghamii*		✓	✓	✓	
Cotula coronopifolia	bachelor's button	✓	✓	✓	
**Euchiton involucratus*		✓			
Raoulia aff. *hookeri*					✓
Senecio diaschides	fireweed				✓
Dicot. herbs (other than composites)					
**Alternanthera nahui*	nahui	✓	✓		
Callitriche stagnalis	starwort		✓	✓	
**Centella uniflora*		✓	✓	✓	
**Chenopodium ambiguum*		✓	✓		
**Elatine gratioloides*		✓	✓		
**Glossostigma elatinoides*			✓		
Lilaeopsis novae-zelandiae		✓	✓	✓	
**Limosella lineata*	mudwort	✓	✓		
Lobelia anceps	punakuru			✓	
Myriophyllum propinquum		✓	✓		
**Persicaria decipiens*		✓			
**Ranunculus glabrifolius*	kawariki	✓	✓		
**Ranunculus macropus*	raoriki		✓		
**Rorippa palustris*	hanea	✓	✓		
Selliera radicans	remuremu		✓	✓	
NATURALISED AND EXOTIC SPECIES					
Gymnosperms					
Pinus sp. (dead?)	pine				
Dicot. trees and shrubs					
Lupinus arboreus	lupin				✓
Populus alba 'Nivea'	silver poplar			✓	
Rubus sp. (*R. fruticosus* agg.)	blackberry		✓	✓	
Salix babylonica	weeping willow		✓?	✓	
Salix fragilis	crack willow			✓	
Grasses					
Agrostis capillar	browntop	✓		✓	
Agrostis stolonifera	creeping bent	✓	✓	✓	
Ammophila arenaria	marram				✓
Anthoxanthum odoratum	sweet vernal		✓	✓	
Avena barbata	slender oat		✓	✓	
Bromus diandrus	ripgut brome				✓
Bromus willdenowii	prairie grass		✓	✓	
Cynodon dactylon	Indian doab	✓	✓		✓
Cynosurus cristatus	crested dogstail	✓			
Dactylis glomerata	cocksfoot		✓	✓	
Echinochloa crus-galli	barnyard grass	✓			
Holcus lanatus	Yorkshire fog	✓	✓	✓	
Hordeum murinum	barley grass		✓		
Lolium perenne	ryegrass	✓	✓	✓	
Panicum dichotomiflorum	smooth witchgrass	✓			
Paspalum dilatatum	paspalum		✓	✓	
Paspalum distichum	Mercer grass	✓	✓	✓	
Poa annua	annual poa	✓			
Schedonorus arundinaceus	tall fescue	✓		✓	
Vulpia sp.					✓
Sedges					
Carex divulsa	grey sedge			✓	
**Carex otrubae*	false fox sedge	✓	✓	✓	
**Carex ovalis*	oval sedge			✓	
Cyperus eragrostis	umbrella sedge			✓	
**Isolepis sepulcralis*			✓	✓	

Species		Whakaki 2N Ephemeral	Te Paeroa Lagoon	Otoki Reserve	Whakaki 2N Sand Dunes[1]
Rushes					
Juncus acuminatus	sharp-fruited rush	✓			
Juncus articulatus	jointed rush	✓	✓	✓	
Juncus bufonius var. *bufonius*	toad rush		✓	✓	
Juncus conglomeratus	soft rush	✓	✓	✓	
Juncus effusus var. *effusus*	soft rush, leafless rush	✓	✓	✓	
Juncus tenuis var. *tenuis*	track rush	✓	✓	✓	
Monocot. herbs (other than orchids, grasses, sedges, and rushes)					
**Sisyrinchium iridifolium*	purple-eyed grass	✓			
Zantedeschia aethiopica				✓	
Composite herbs					
Achillea millefolium	yarrow			✓	
Anthemis cotula	stinking mayweed			✓	
Arctotheca calendula	cape weed		✓		
Aster subulatus	sea aster	✓	✓	✓	
Bidens frondosa	beggars' ticks		✓	✓	
Cirsium arvense	California thistle		✓		
Cirsium vulgare	Scotch thistle	✓		✓	
Conyza sumatrensis	broad-leaved fleabane				✓
Crepis capillaris	hawksbeard			✓	
Hypochaeris radicata	catsear				✓
Leontodon taraxacoides	hawkbit	✓			
Senecio bipinnatisectus	Australian fireweed			✓	
Sonchus asper	prickly puha			✓	
Dicot. herbs (other than composites)					
Anagallis arvensis	scarlet pimpernel		✓		
Amaranthus powellii	redroot	✓			
Atriplex prostrata	orache	✓	✓		
Chenopodium album	fathen			✓	
Galium aparine	cleavers			✓	
Galium palustre	marsh bedstraw		✓	✓	
Lotus pedunculatus	lotus			✓	
**Lythrum hyssopifolia*	hyssop loosestrife	✓	✓	✓	
Mentha pulegium	penny royal	✓	✓	✓	
Mentha spicata	spearmint	✓			
Myosotis sp.	forget-me-not			✓	
Oenothera stricta	evening primrose		✓	✓	
Parentucellia viscosa	tarweed		✓		
Persicaria hydropiper	water pepper		✓	✓	
Persicaria maculosa	willow weed	✓			
Phytolacca octondra	pokeweed			✓	
Plantago australis	swamp plantain	✓	✓	✓	
Plantago coronopus	buck's-horn plantain		✓		
Plantago lanceolata	narrow-leaved plantain	✓	✓		
Polycarpon tetraphyllum	allseed				✓
Polygonum aviculare	wireweed	✓	✓		
Ranunculus repens	creeping buttercup		✓	✓	
Ranunculus sardous	hairy buttercup	✓			
Ranunculus sceleratus	celery-leaved buttercup		✓	✓	
**Ranunculus trichophyllus*	water buttercup		✓		
Rumex acetosella	sheep's sorrel			✓	✓
Rumex conglomeratus	clustered dock	✓			
Rumex crispus	curled dock	✓			
Rumex obtusifolius	broad-leaved dock	✓		✓	
Silene gallica	catchfly				✓
Sisymbrium officinale	hedge mustard	✓			
Solanum nigrum	black nightshade	✓	✓		
Trifolium arvense	haresfoot trefoil				✓
Trifolium pratense	red clover			✓	
Trifolium repens	white clover	✓	✓	✓	
Vicia sativa	vetch			✓	

AVIFAUNA THAT HAVE BEEN RECORDED WITHIN THE WHAKAKI/TE PAEROA LAGOON/EPHEMERAL WETLAND COMPLEX

Key to threatened species status (as per Miskelly 2008):

T-NC = Threatened-Nationally Critical
T-NE = Threatened-Nationally Endangered
T-NV = Threatened-Nationally Vulnerable
AR-D = At Risk-Declining
AR-Rel = At Risk-Relict
AR-Rec = At Risk-Recovering
AR-NU = At Risk-Naturally Uncommon

Key:

1. Wetland species that uses, or is likely to utilise, the ephemeral wetlands.
2. Species recorded within the ephemeral wetland area during the field surveys in Dec 2011 and Feb 2012.

WETLAND BIRDS

Indigenous

Anarhynchus frontalis (T-NV)[1]	ngutuparore; wrybill
Anas gracilis[1,2]	tete; grey teal
Anas rhynchotis[1,2]	kuruwhengi; Australasian shoveler
Anas superciliosa (T-NC) [1]	parera; grey duck
Ardea ibis coromanda[1]	eastern cattle egret
Ardea modesta[1]	kotuku, white heron
Arenaria interpres[1]	ruddy turnstone
Botaurus poiciloptilus (T-NE)[1,2]	matuku; Australasian bittern
Bowdleria punctata vealeae (AR-D)[2]	matata; North Island fernbird
Calidris acuminata[1]	sharp-tailed sandpiper
Calidris canutus[1]	huahou, lesser knot
Calidris ferruginea[1]	curlew sandpiper
Calidris ruficollis[1]	red-necked stint
Charadrius bicinctus[1,2]	tuturiwhatu; banded dotterel
Circus approximans[1,2]	kahu; swamp harrier
Cygnus atratus[1,2]	black swan
Egretta novaehollandiae novaehollandiae[1,2]	white-faced heron
Elseyornis melanops[1]	black-fronted dotterel
Fulica atra australis[1]	Australian coot
Gallirallus philippensis assimilis (AR-NU)	moho-pereru; banded rail
Haematopus unicolor (AR-Rec)[1]	torea, toreapango, variable oystercatcher
Himantopus himantopus leucocephalus (AR-D)[1,2]	poaka; pied stilt
Hirundo neoxena neoxena[1,2]	welcome swallow
Larus bulleri (T-NV) [1]	black-billed gull
Larus dominicanus dominicanus[1,2]	karoro; southern black-backed gull
Larus novaehollandiae scopulinus (T-NV) [1]	tarapunga; red-billed gull
Limosa lapponica[1,2]	bar-tailed godwit
Numenius phaeopus[1]	whimbrel
Phalacrocorax carbo novaehollandiae (AR-NU)[1,2]	kawau; black shag

Phalacrocorax melanoleucos brevirostris (AR-NU)[1]	kawaupaka; little shag
Phalacrocorax sulcirostris (AR-NU)[1]	little black shag
Platalea regia (AR-NU)[1,2]	kotuku-ngutupapa; royal spoonbill
Plegadis falcinellus[1]	glossy ibis
Pluvialis fulva[1]	Pacific golden plover
Poliocephalus rufopectus (T-NV)[1]	weweia; New Zealand dabchick
Porphyrio melanotus melanotus[1,2]	pukeko
Porzana pusilla affinis (AR-Rel)	koitareke; marsh crake
Porzana tabuensis tabuensis (AR-Rel)	puweto; spotless crake;
Sterna striata striata (AR-D) [1]	tara; white-fronted tern
Tadorna variegata[1,2]	putangitangi; pari; paradise shelduck
Todiramphus sanctus vagan[1]	kotare; New Zealand kingfisher
Vanellus miles novaehollandiae[1,2]	spur-winged plover

Introduced

Anas platyrhynchos platyrhynchos[1,2]	mallard
Branta Canadensis maxima[1,2]	Canada goose

TERRESTRIAL BIRDS

Indigenous

Anthus novaeseelandiae novaeseelandiae (AR-D)	pihoihoi; New Zealand pipit
Gerygone igata	riroriro; grey warbler
Rhipidura fuliginosa placabilis	piwakawaka; North Island fantail
Zosterops lateralis lateralis	silvereye; tauhou

Introduced

Acridotheres tristis	common myna
Alauda arvensis	Eurasian skylark
Carduelis carduelis britannica	European goldfinch
Carduelis chloris	European greenfinch
Carduelis flammea	common redpoll
Emberiza citrinella	yellowhammer
Gymnorhina tibicen	Australian magpie
Phasianus colchicus	common pheasant
Prunella modularis	dunnock
Sturnus vulgaris vulgaris	common starling
Turdus merula merula	Eurasian blackbird
Turdus philomelos	song thrush

VEGETATION AND HABITATS AT SELECTED POINTS WITHIN THE WHAKAKI 2N INCORPORATION EPHEMERAL WETLAND AREA BETWEEN WHAKAKI LAGOON AND TE PAEROA LAGOON

Brief descriptions of the vegetation present on 24 February 2012 at 44 points spread through the site are presented below. The location of each point is shown in Figure A.

- Point 003 - Turfs dominated by *Centipeda cunninghamii* and clammy goosefoot (*Chenopodium ambiguum*), in association with *Lilaeopsis novae-zelandiae*, and bachelor's button. Mercer grass is often common alongside the canal, and *Schoenoplectus pungens* occurs locally. There are a few searush tussocks.

  To the south of Point 003, as the ground level rises, the vegetation cover changes to *Centipeda cunninghamii*-Mercer grassland-turf, and then to Mercer grassland (dominated by Mercer grass with scattered *Centipeda cunninghamii* and exotic herbs (including black nightshade (*Solanum nigrum*)) and scattered searush.

- Point 004 - (*Chenopodium ambiguum*)-(bachelor's button)-(*Lilaeopsis novae-zelandiae*) mudfield. A large area of mud is present with scattered seedlings of *Chenopodium ambiguum*, bachelor's button, *Lilaeopsis novae-zelandiae*, and creeping bent.

- Point 005 - Mercer grassland. Dominated by Mercer grass with very scattered rushes (*Juncus sarophorus*), a few exotic herbs (including *Rumex*, narrow-leaved plantain (*Plantago lanceolatum*), and black nightshade). Indigenous herb turf species occur around the margins, including *Centipeda cunninghamii*, *Chenopodium ambiguum*, and *Lilaeopsis novae-zelandiae*. *Eleocharis acuta* is also present.

- Points 005-006 - Mats of *Lilaeopsis novae-zelandiae* are common, with scattered bachelor's button and *Centipeda cunninghamii*. Mercer grass occurs locally throughout.

- Point 006 - *Lilaeopsis novae-zelandiae* mudfield. This area is mainly bare mud, with scattered *Lilaeopsis novae-zelandiae*, very small seedlings of indigenous herbaceous turf species, and exotic grass seedlings.

- Point 007 - Mudfield. Bare mud is the dominant feature here with scattered large *Centipeda cunninghamii* plants, scattered patches of *Lilaeopsis novae-zelandiae*, turf, exotic grasses (mainly Mercer grass), and a few exotic herbs. This area has been cultivated and sown with pasture species, but seed had not germinated at the time of this survey).

- Point 008 - Mudfield. Some patches of exotic grasses (including barnyard grass (*Echinochloa crus-galli*)) and *Persicaria maculosa*.

- Point 009 - Waterhole. Small human-made depression. Small area of open water with a narrow fringe of duckweed (*Lemma minor*) around the margin, surrounded by a swathe of

Isolepis prolifera sedgeland (2-3 m wide), with Mercer grass common. A bund (probably comprising the excavated material) occurs around the margin covered in exotic grasses and herbs (including ryegrass, Yorkshire fog (*Holcus lanatus*), redroot, black nightshade).

- Point 013 - *Chenopodium ambiguum*-redroot-annual poa-*Euchiton involucratus* herb-grassland. Variable vegetation composition, including patches of *Chenopodium ambiguum*, patches of redroot, and patches of *Persicaria maculosa*. *Euchiton involucratus* is locally common. Other species present include annual poa, *Mentha spicata*, barnyard grass, and black nightshade.

- Point 015[1] - *Juncus sarophorus*/penny royal (*Mentha pulegium*)-creeping bent herbfield. Other species present include *Centipeda cunninghamii*, Scotch thistle (*Cirsium vulgare*), narrow-leaved plantain, *Juncus tenuis*, white clover, crested dogstail (*Cynosurus cristatus*), purple-eyed grass (*Sisyrinchium iridifolium*), and local *Centella uniflora*.

- Point 017[1] - Creeping bent-Mercer grass-*Juncus sarophorus*-bachelor's button grassland. Creeping bent and Mercer grass are dominant, with local patches of bachelor's button and scattered *Juncus sarophorus*. Other species present include *Rumex*, *Eleocharis acuta*, hawkbit (*Leontodon taraxacoides*), sea aster, and *Centipeda cunninghamii*. Indian doab occurs locally. There are a few examples of *Rorippa palustris*.

- Point 019 - Creeping bent-Mercer grass-*Juncus sarophorus*-bachelor's button grassland. Creeping bent and Mercer grass are dominant, with local patches of bachelor's button and scattered *Juncus sarophorus*. Other species present include Indian doab, *Rumex*, *Eleocharis acuta*, hawkbit, sea aster, *Centipeda cunninghamii*, *Juncus tenuis*, cyperus (*Cyperus ustulatus*), and redroot.

  Pond B - *Myriophyllum propinquum* turf occurs around the margins of this pond. *Myriophyllum propinquum* is common in association with bachelor's button, *Eleocharis acuta*, Mercer grass, *Lilaeopsis novae-zelandiae*, duckweed, and local *Isolepis prolifer*.

- Point 020 - Browntop-Mercer grass-*Eleocharis acuta* grassland. Dominated by browntop (*Agrostis capillaris*), Mercer grass, and *Eleocharis acuta*. Other species are present but are very scattered. Mud patches near this point support the following species: bachelor's button, and very small seedlings of *Lilaeopsis novae-zelandiae*, *Eleocharis gracilis*, *Centipeda cunninghamii*, and exotic grasses.

- Point 021 - Bare substrate with scattered Mercer grass, *Lilaeopsis novae-zelandiae*, *Centipeda cunninghamii*, and bachelor's button.

- Point 022 - Turf comprising *Lilaeopsis novae-zelandiae*, *Centipeda cunninghamii*, arrow grass, bachelor's button, clammy goosefoot, exotic grasses, small plants of *Isolepis prolifer*, *Ranunculus sardous*, and *Myriophyllum propinquum*.

- Point 024 - *Bolboschoenus* is common along the fence here. On the seaward side of the fence there is a line of what appears to be *Bolboschoenus caldwellii*, whilst on the other

[1] The types described at Points 015 and 017 form a mosaic around and between these points.

side of the fence the species may be *B. medianus*, although no flowering or fruiting parts were present.

- Point 025 - Mercer grassland. Mercer grass forms a dense cover with local *Juncus australis, Eleocharis gracilis*, and bachelor's button.

- Point 026 - Mercer grass-creeping bent grassland. Mercer grass and creeping bent form the cover with scattered *Persicaria maculosa*.

- Point 028 - *Lilaeopsis* turf - *Lilaeopsis novae-zelandiae* is common, with local bachelor's button, *Centipeda cunninghamii*, *Myriophyllum propinquum*, arrow grass, clammy goosefoot, and exotic grasses.

- Point 029 - *Limosella lineata* herbfield. *Limosella lineata* is dominant, with scattered *Centipeda cunninghamii*, clammy goosefoot, and *Eleocharis acuta* seedlings. There are a few *Lythrum hyssopifolia* plants.

- Point 032 - Mercer grass- *Eleocharis acuta* grassland. This area is dominated by Mercer grass in association with *Eleocharis acuta*.

- Point 033 - Mercer grassland. Mercer grass is dominant here and continues to be out to the edge of the study area. Near the boundary, other species such as Indian doab and creeping bent are also common, with scattered *Polygonum aviculare* and *Persicaria maculosa*.

- Point 034 - Mercer grass-*Polygonum aviculare*-Indian doab grassland. Mercer grass, *Polygonum aviculare*, and Indian doab are common, with scattered *Juncus sarophorus* and *Persicaria maculosa*. There is local common witchgrass.

    - Point 034a *Juncus sarophorus* is a co-dominant species at this point.
    - Point 034b - *Juncus sarophorus* is locally common here whilst Mercer grass is reduced in dominance.

- Point 035 - This entire paddock comprises turf dominated by *Lilaeopsis novae-zelandiae*, *Isolepis prolifera*, and creeping bent. Other species present include bachelor's button, sea aster, barnyard grass, *Juncus articulatus*, *Centipeda cunninghamii*, *Juncus tenuis*, *Persicaria maculosa, Persicaria decipiens*, *Isolepis prolifer*, *Polygonum aviculare*, and Mercer grass.

- Point 036 - *Lilaeopsis novae-zelandiae* turf. *Lilaeopsis novae-zelandiae* is locally dominant with scattered sea aster, *Juncus articulatus*, and bachelor's button.

- Point 037 - "Cracked" mud mudfield. Seedlings are common in the cracks, including *Ranunculus sardous*, exotic grass seedlings, and local *Lilaeopsis novae-zelandiae* and bachelor's button.

- Point 038 - Dense Mercer grassland occurs alongside the edge of the channel.

- Point 039 - *Juncus effusus*/Mercer grass-creeping bent-*Cynodon dactylis* rush-grassland. This area is dominated by *Juncus effusus*, Mercer grass, creeping bent, and *Cynodon dactylis* with *Juncus australis*, *Carex otrubae*, and *Eleocharis acuta*.

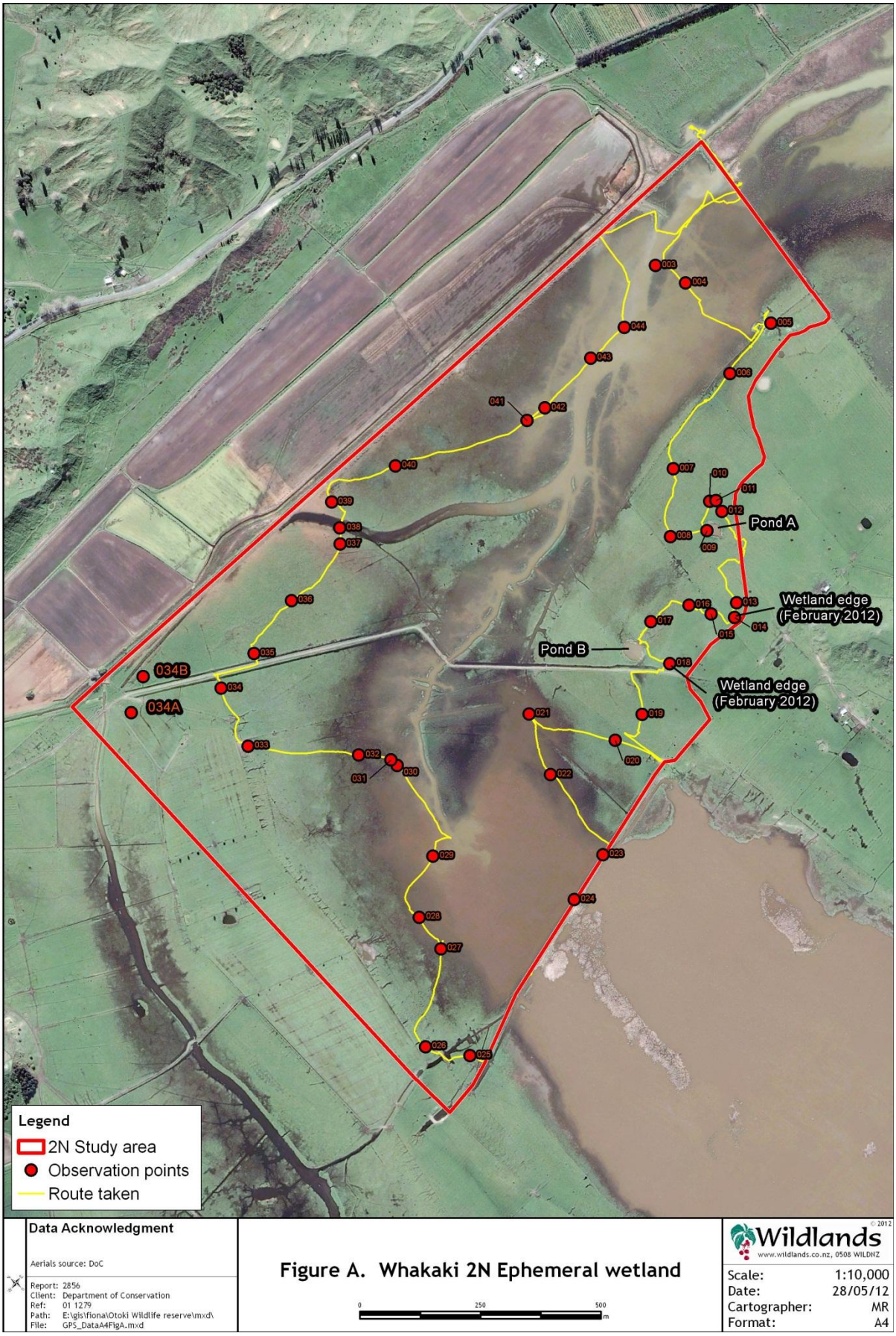
- Point 040 - Mercer grass- *Eleocharis acuta* grassland. Dense Mercer grass is present in association with *Eleocharis acuta*, *Juncus conglomeratus*, and *Juncus acuminatus*.

- Point 041 - Mercer grassland and bare mud. This area supports patches of bare ground and patches of Mercer grass. Also present are bachelor's button, *Ranunculus sardous*, *Lilaeopsis novae-zelandiae*, *Centipeda cunninghamii*, and creeping bent.

- Point 042 - Mudfield. At the time of the survey, this area was bare mud with no vegetation present.

- Point 043 - *Schoenoplectus pungens* sedgeland. This area is dominated by *Schoenoplectus pungens* with scattered small plants of clammy goosefoot, bachelor's button, *Centipeda cunninghamii*, *Ranunculus sardous*, and orache (*Atriplex prostrata*). There are also a few scattered searush, and local *Bolboschoenus* seedlings.

- Point 044 - *Bolboschoenus* growing within a small fenced area containing a maimai. This area is not grazed.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Wetland edge
(February 2012)
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Pond B
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Wetland edge
(February 2012)
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Figure A. Whakaki 2N Ephemeral wetland
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Plate 1: Overview of the Whakaki 2N ephemeral wetland between Whakaki Lagoon and Te Paeroa Lagoon, looking north. Note there is more water present in December than was present at the later site inspection in February 2012.
(Photograph 8 December 2011.)

Plate 2: Large areas of turfs and bare ground. (Photograph February 2012.)

Plate 3: Large expanses of turfs. (Photograph February 2012.)

Plate 4: Large expanses of bare mud and turfs. (Photograph February 2012.)

Plate 5: Turf species. White flowers are *Limosella lineata*, *Centipeda cunninghamii* (top right) and also *Lilaeopsis novae-zelandiae*. (Photograph February 2012.)

Plate 6: Small fenced area dominated by *Bolboschoenus*, surrounded by bare mud. (Photograph February 2012.)

Plate 7: Area that had been cultivated and planted, but where the crop had failed. (Photograph February 2012.)

Plate 8: Artificial pond in the southern part of the site. *Isolepis prolifera* dominates the vegetation. (Photograph February 2012).

Plate 9: Drain along northern margin (February 2012). *Bolboschoenus* growing on right hand side of the photograph.

APPENDIX 5

VEGETATION AND FLORA RECORDED AT TE PAEROA LAGOON, 8 DECEMBER 2011

Vegetation and Habitat Type Descriptions

Figure B maps the distribution of vegetation and habitat types, and descriptions of these are provided below.

1. Mercer grass-*Eleocharis acuta*-Indian doab grassland

   This vegetation type comprises Mercer grass and Indian doab (*Cynodon dactylon*) dominated grassland with common *Eleocharis acuta*, and local patches of water pepper (*Persicaria hydropiper*). Bachelor's button (*Cotula coronopifolia*), *Myriophyllum propinquum*, *Schoenoplectus pungens, Glossostigma elatinoides,* and *Centipeda cunninghamii* are scattered throughout pasture within *c.*1.5m of the lagoon edge.

   Areas of bare mud and damp depressions within this type support small herbfields dominated by *Lilaeopsis novae-zelandiae*, with *Myriophyllum propinquum*, bachelor's button, and arrow grass (*Triglochin striata*) locally common. There are also dense local patches of *Selliera radicans*.

2. *Eleocharis acuta*-Mercer grass reedland

   Eleocharis acuta forms patches amongst areas of open water. Mercer grass (*Paspalum distichum*) is locally common to co-dominant (forming 5-50% of the cover) within the patches of *Eleocharis* and there are scattered clumps of *Juncus australis*.

   Azolla filiculoides-Lemna minor-Glossostigma elatinoides herbfield (not mapped; too small)

   Patches of floating herbfield dominated by *Azolla filiculoides*, duckweed (*Lemna minor*), and *Glossostigma elatinoides*, with scattered *Eleocharis acuta*, are present in sheltered areas at the pasture-water interface. This type was not mapped as it was too small.

3. *Baumea articulata-Juncus articulatus*-blackberry-*Cyperus ustulatus*/rough pasture sedgeland and grassland

   Large clumps of *Cyperus ustulatus* and blackberry are present amongst *Baumea articulata-Juncus articulatus* sedgeland and rough pasture that is dominated by Yorkshire fog and Mercer grass. White clover, browntop, penny royal, and sweet vernal are common within the rough pasture. *Juncus tenuis* is common on the margins.

   The dominance of sedges to grasses follows a gradient reflecting the water table. In the northwest of this area, where the water table is higher, sedges are dominant. In areas of higher grazing intensity, grassland is dominant, similar in composition to Vegetation

Type 2 described above. *Isolepis prolifera* is locally common in the grassland areas with water logged soil. The soil is heavily pugged from stock trampling in some places.

4. *Isolepis prolifera*-mercer grass sedgeland

   A floating mat of *Isolepis prolifera* and mercer grass is present in a deep drain near the southeastern edge of the lagoon. There is scattered water pepper on the margins of this type where the water level is lower.

5. Blackberry-(*Calystegia sepium*)-(*Muehlenbeckia complexa*)/Mercer grass-*Juncus australis* shrubland

   A small area of dead and dying blackberry is present on a raised bank at the southeastern end of the lagoon. *Calystegia sepium*, and *Muehlenbeckia complexa* are entwined through the blackberry, and Mercer grass and *Juncus australis* are present where the blackberry is less dense, and also on the margins of this type. Annual ryegrass and *Bolboschoenus fluviatilis* are locally common.

6. Annual ryegrass-sweet vernal-Yorkshire fog grassland

   Rank grassland dominated by annual ryegrass occurs on the graded back dunes between Te Paeroa Lagoon and the Pacific Ocean. Sweet vernal and Yorkshire fog are common components of the grassland, with clumps of *Juncus pallidus*, blackberry, and *Cyperus ustulatus* particularly towards the northern edge of this type. Hairy birdsfoot trefoil (*Lotus suaveolens*) and catsear (*Hypochoeris radicata*) are locally common.

7. Blackberry-*Cyperus ustulatus*/*Juncus pallidus*/rough pasture shrubland

   Dense patches of blackberry are present on the slightly raised lagoon margin along the southern end of the lagoon where the habitat changes from wetland to back dunes. *Cyperus ustulatus* and *Juncus pallidus* are common amongst the blackberry. The rough pasture is dominated by Mercer grass, and annual ryegrass, with catsear, clustered dock (*Rumex conglomeratus*), white clover, lotus (*Lotus pedunculatus*), and *Juncus articulatus* locally common.

   Where this vegetation type meets the lagoon, water pepper, and *Juncus effusus* form a thin band between predominantly terrestrial and shallow water habitats. There are occasional patches of beggars' ticks (*Bidens frondosa*) within this band.

8. Mercer grass grassland and bachelor's button, *Myriophyllum propinquum*, and beggars' ticks herbfield

   Grassland dominated by Mercer grass with locally common *Isolepis rugosa, Juncus effusus,* and *Eleocharis acuta*. Scattered areas of herbfield dominated by bachelor's button, *Myriophyllum propinquum*, and beggars' tick are present close to the lake margin.

9. *Myriophyllum propinquum*-Mercer grass herbfield

   Myriophyllum propinquum dominated herbfield with locally common Mercer grass and scattered patches of *Eleocharis acuta* in the littoral zone of the southwest corner of the lake.

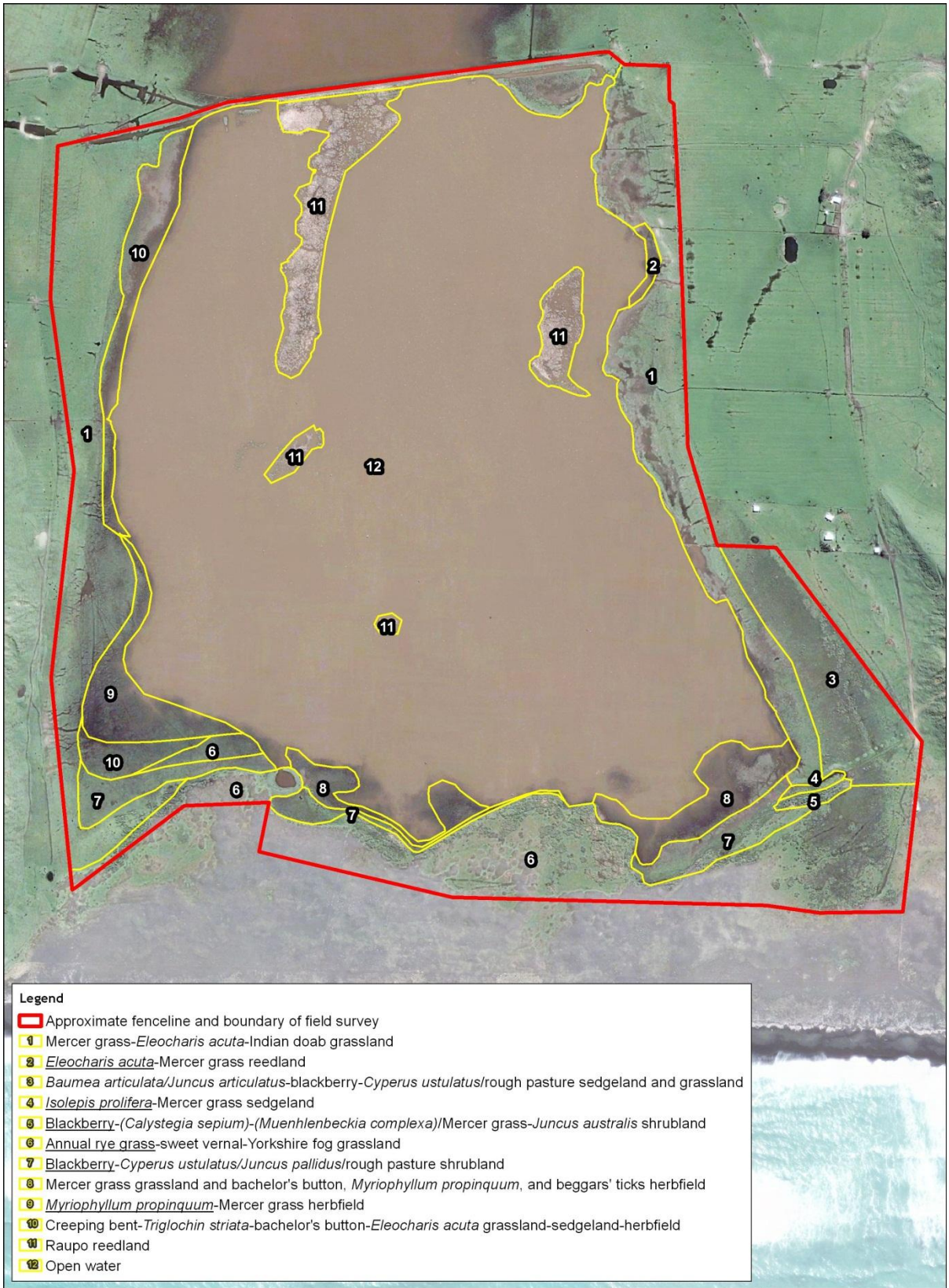
10. Creeping bent-arrow grass-bachelor's button-*Eleocharis acuta* grass-sedge-herbfield.

    A mosaic of grassland, herbfield and sedgeland with large patches of bare mud on the western margin of the lagoon. Creeping bent is the dominant grass species, arrow grass and *Eleocharis acuta* are co-dominant to dominant in the sedgeland areas, and bachelor's button dominates herbfield areas. The areas of bare mud appear to be heavily utilised by water fowl (large numbers of tracks in mud).

11. Raupo reedland

    Dense raupo (*Typha orientalis*) is located beside the causeway that separates Te Paeroa lagoon from a small, unnamed lake that links Wairau Lagoon with Whakaki Lagoon. Water pepper, annual ryegrass, Mercer grass and curled dock (*Rumex crispus*) are present in shallow water between the raupo and the causeway.

    Raupo reedland is also present in the middle of the lake but these areas were only viewed through binoculars so the presence and density of other species (if any) could not be determined.


Legend
Approximate fenceline and boundary of field survey
1 Mercer grass-Eleocharis acuta-Indian doab grassland
2 Eleocharis acuta-Mercer grass reedland
3 Baumea articulata/Juncus articulatus-blackberry-Cyperus ustulatus/rough pasture sedgeland and grassland
4 Isolepis prolifera-Mercer grass sedgeland
5 Blackberry-(Calystegia sepium)-(Muenhlenbeckia complexa)/Mercer grass-Juncus australis shrubland
6 Annual rye grass-sweet vernal-Yorkshire fog grassland
7 Blackberry-Cyperus ustulatus/Juncus pallidus/rough pasture shrubland
8 Mercer grass grassland and bachelor's button, Myriophyllum propinquum, and beggars' ticks herbfield
9 Myriophyllum propinquum-Mercer grass herbfield
10 Creeping bent-Triglochin striata-bachelor's button-Eleocharis acuta grassland-sedgeland-herbfield
11 Raupo reedland
12 Open water
N
Data Acknowledgment
Aerials source: DoC
Report: 2856
Client: Department of Conservation
Ref: 01 1279
Path: E:\gis\TePaeroaLagoon\mxd\
File: FigBA4.mxd
Figure B. Vegetation and habitat types at Te Paeroa Lagoon
0
190
380
m
© 2012 Wildlands
www.wildlands.co.nz, 0508 WILDNZ
Scale: 1:7,500
Date: 29/05/12
Cartographer: MR
Format: A4

Flora

Seventy-four vascular plant species were recorded within or along the margins of Te Paeroa Lagoon, of which 33 species are indigenous, and 41 naturalised. None of these species are classified as threatened by de Lange *et al*. (2009), but one species, *Ranunculus macropus*, is classed as 'Data Deficient'.

Thirteen indigenous species (identified in Appendix 2) recorded during the field surveys of Otoki Wildlife Management Reserve, Te Paeroa Lagoon, and the Whakaki 2N ephemeral wetland area between Te Paeroa and Whakaki Lagoons have not previously been recorded from the Waihua Ecological District (c.f. Whaley *et al*. 2001). Eleven of these species (*Ruppia* sp., *Centipeda cunninghamii, Alternanthera nahui, Centella uniflora, Chenopodium ambiguum, Elatine gratioloides, Glossostigma elatinoides, Limosella lineata, Ranunculus glabrifolius, Ranunculus macropus, Rorippa palustris*) were recorded at Te Paeroa Lagoon (or have recently been in the case of *Ruppia* sp.), and it is likely that the two other species (*Persicaria decipiens* and *Euchiton involucratus*) are also present. Two species (*Glossostigma elatinoides, Ruppia* sp.) were only found at Te Paeroa Lagoon during the current field surveys.

Two of the adventive species recorded at Te Paeroa Lagoon (crack willow and blackberry) are pest plants. The willow should be removed before it spreads further. Control of blackberry is advisable, but will ultimately depend on what the ongoing management objectives are for the wetland.

Many of the adventive species observed during the current survey have not previously been recorded within the Waihua Ecological District. This does not imply that they are not present at other sites however. Some of the adventive species not previously recorded from the Ecological District are *Carex otrubae*, *Carex ovalis*, *Isolepis sepulcralis*, *Sisyrinchium iridifolium*, *Lythrum hyssopifolia*, and *Ranunculus trichophyllus*.

Plate 1: Southern end of Te Paeroa Lagoon. Raupo reedland visible in lagoon on right hand side of photograph. (Photograph 2011.)

Plate 2: Te Paeroa Lagoon eastern margins. *Eleocharis acuta* and Mercer grass are common here. (Photograph December 2011).

Plate 3: Turf on western margins of Te Paeroa Lagoon. (Photograph December 2011.)

Plate 4: Bachelor's button on the western margin of Te Paeroa Lagoon.
(Photograph December 2011.)

Plate 5: Raupo reedland, Te Paeroa Lagoon. (Photograph December 2011.)

Plate 6: The lagoon margins are grazed. Mercer grass. (Photograph December 2011.)

Plate 7: Dense turfs occur locally in Vegetation Type 2. *Selliera radicans* is dominant here. (Photograph December 2011.)

Plate 8: Turf on margins of Te Paeroa dominated by *Lilaeopsis novae-zelandiae*. (Photograph 2011.)

Plate 9: *Glossostigma* in flower. (Photograph December 2011.)

Plate 10: *Elatine gratioloides* in centre of photograph. (Photograph December 2011.)

Plate 11: *Rorippa palustris* on the margins of Te Paeroa Lagoon. (Photograph December 2011.)

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