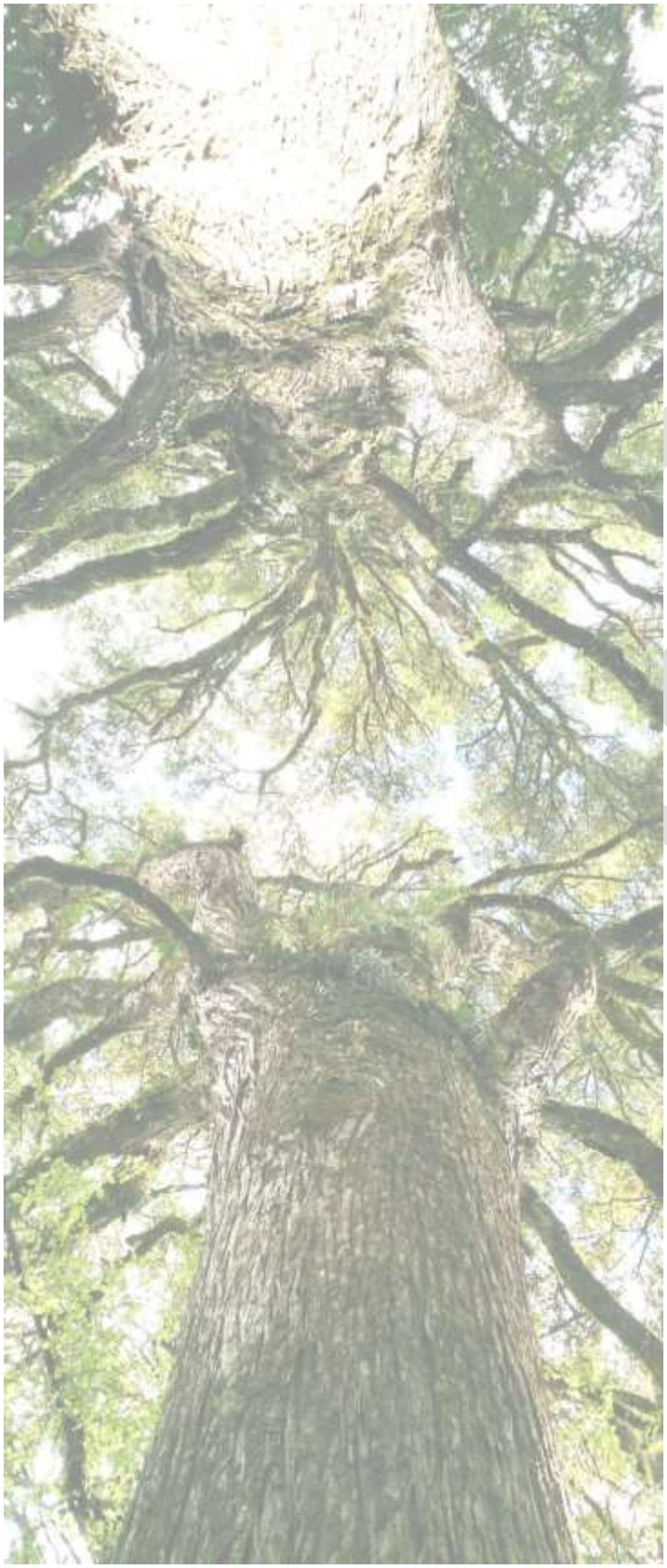

Mapping of Hawkes Bay Wetlands

Prepared for:
Hawkes Bay Regional Council

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1. Introduction

The Hawkes Bay Regional Council is in mediation with the environment court on Plan Change 5 to the Hawkes Bay Regional Council Regional Resource Management Plan (RRMP), with Fish and Game, Federated Farmers and Hort NZ parties to this.

The definition of a wetland in the proposed plan is identical to the definition described within the Resource Management Act 1991: Wetland includes *permanently or intermittently wet areas, shallow water, and land water margins that support a natural ecosystem of plants and animals that are adapted to wet conditions*'. However the plan proposes to exclude eight types of "wet-land" associated with highly developed land or specifically a result of human development including a.) wet pasture or cropping land.

Fish and Game are seeking changes to the way wetlands are defined in the RRMP by not expressly excluding wet pasture and cropping land. Federated Farmers and Hort NZ who are party to the appeal do not support the change sought by Fish and Game. The Hawkes Bay Regional Council are seeking to resolve this by mapping the extent of six identified wetlands within the region, to mediate and seek to avoid some of the issues in the definition. This report covers five of these wetlands; Lake Rotokare, Lake Poukawa, Lake Hatuma, Wanstead and Atua Road North and Atua Road South. All of these wetlands occur amongst agricultural land, with the predominant land use being sheep and beef pastoral agriculture. The sixth wetland identified is Ngamatea Swamp East. Discussions are ongoing with the landowners to gain access to this wetland complex. If these discussions are successful Ngamatea Swamp East will be appended as an addendum to this report.

1.1 The Hawkes Bay Environment

The Hawkes Bay has a semi-arid climate typically with an extended period of dry weather over the summer and autumn months. Rainfall is typically wettest in the winter and periodic heavy rainfall events can cause significant flooding. Hill-country soils are primarily derived from wind-blown loess and have formed heavy pallic soils over most of the hill country — these are often wet in winter and dry in summer. In depressions these clays have accumulated and as a result of extended periods of saturation have developed into gley soils. In some areas where wetlands have been present for long periods, such as Lake Poukawa, organic soils have developed. Both gley and organic soils are associated wetland ecosystems.

In Hawkes Bay wetland areas the combination of landform, soils and climate creates conditions of a highly fluctuating water table, and wetland areas frequently dry out or water tables drop to very low levels. Consequently in association with a long period of agricultural use, wetlands have been used especially for summer grazing. Some of these areas however still flood after significant rainfall and may be inundated or saturated for weeks or months. Ecologically, the result of this is that there has been a loss of native species composition and abundance and these areas are typically dominated by exotic or introduced plants. Seasonally, when inundated they still provide habitat for a range of wetland fauna.

1.2 Objectives

The objectives of this project were to provide the Hawkes Bay Regional Council and parties involved with environment court mediation, GIS mapped wetland boundaries identifying areas which are "intermittently or permanently wet" as defined by the definition with the RMA (1991).

A component of this was to map vegetation in broad structural classes including mapping areas of wet pasture or cropping land.

The report supporting this map outlines: the task, methodology, reasoning, survey results (boundary maps) and any constraints and/or assumptions used in the survey. It also makes some recommendations to potentially to resolve the conflict between the two opposing parties.

2. Methodology

Wetlands have several defining characteristics; a wet environment, a hydrologically influenced soil and flora and fauna adapted to a wet environment. Defining wetland boundaries involves detecting and mapping the distribution of plants which are adapted to wet conditions — consistent with the definition of wetlands with the Resource Management Act (1991). Using the USA wetland delineation approach Clarkson (2013) developed a methodology to map New Zealand wetlands. Fundamental to this methodology is the classification of plants occurring in New Zealand according to fidelity to wetland or non-wetland conditions.

The classes are:

- Obligate wetland (occurs almost always in wetlands)
- Facultative wetland (occurs usually in wetlands)
- Facultative (equally likely in wetlands or non-wetlands)
- Facultative upland (usually in non-wetlands)
- Obligate upland (almost always in non-wetlands).

The logic of this method was applied to delineate several Hawkes Bay wetlands and involved detecting and mapping plant species which are classified as either "Facultative wetland" species on the wetland side of the boundary, and "Facultative upland" and "Obligate upland" on the non-wetland side of the boundary. The permanently wet boundary is more difficult to locate because it is a seasonal characteristic and potentially changes yearly, in response to rainfall, water table height and the period of submergence. In some wetland types such as ephemeral wetlands, vegetation can be highly responsive and rapidly increase in abundance (Singers 1997). Accurately mapping the permanently wet boundary is only realistically possible at the lowest seasonal water level during late summer — autumn, though using aerial images during these periods is highly informative. Obligate wetland species however only occur in areas which are either permanently submerged or where the soil is saturated. Common obligate wetland species in the Hawkes Bay wetlands included raupo (*Typhae orientalis*), water milfoil (*Myriophyllum propinquum*). As these species were not always present this permanently wet boundary was mapped with the use of historic Google Earth images from summer images. It is however impossible to determine from Google Earth images the area of wetland which has a saturated soil, therefore this boundary perhaps best represents the lowest water table, not the permanently wet boundary.

The wetlands mapped were:

1. Lake Te Roto Kare
2. Lake Poukawa
3. Atua Road North
4. Lake Hatuma
5. Wanstead Swamp

Rotokare

The boundary of the intermittently wet margin of the wetland was mapped as a track using a hand-held Garmin Rino 650 GPS unit. In the field the boundary was delineated by mapping the distribution of several common indicator species which are described as being facultative wetland species and upland species (Clarkson 2013). The common indicator wetland species were; *Juncus amabilis*, jointed rush (*Juncus articulatus*), oval sedge (*Carex ovalis*), creeping bent (*Agrostis stolonifera*) and mercer grass (*Paspalum distichum*). All of these species are introduced species. Upland species used to exclude non-wetland areas included rye grass (*Lolium perenne*, rats tail (*Sporobolus aficanus*), brown top (*Agrostis capillaris*). Permanently wet areas were determined by ground truthing and mapping vegetation as well as examining historical Google Earth images. The boundary of this zone was mapped using the area of Lake visible on Google Earth (22/03/2013).

Rotokare is a shallow lake situated within a valley running WSW – ENE and is surrounded by moderately steep hillslopes in the west, south and north and gradually sloping land in the east. It appears the lake was formed by earthquake tilting of the shallow sloping land to the east, resulting in a depression of land with no natural stream outlet. The lake and associated wetlands hydrology is entirely dependent on rainfall, run-off from surrounding land and a few small seepages. In the north the lake is artificially drained by a deep drain which carries water towards Breckenridge Road, where another separate drain prevents water entering the lake. This drain only flows after high rainfall but now limits the height that the lake can obtain and thus the duration which the intermittently wet wetland vegetation is submerged for. Consequently the area of lake and the associated wetland areas are considerably smaller than what was historically present under natural conditions. It is likely that the ecological condition of the intermittently wet areas would be improved if submerged for a longer period as this would likely result in death of exotic species such as Mercer grass and celery-leaved buttercup — the native species present are highly tolerant of long periods of submergence. The historical wetland areas which are no longer intermittently flooded are now developed into high producing pasture.

The wetland margin was concisely mapped where the surrounding slope was steep (Figure 1) but was more difficult to accurately map where the slope is shallow and because of the effects on vegetation from the recent drainage works (Figure 2). These shallow sloping areas are only intermittently wet wetland habitat, best described as an ephemeral wetland (Johnson & Rogers 2003), much of which was above the lake level when surveyed. Most common in intermittently wet areas is tape measure plant (*Lilaeopsis novae-zelandiae*) (Figure 3) which occupies 30—40% cover while purple wind grass (*Lachnagrostis striata*) and batchelor's button (*Cotula coronopifolia*), are also common. Other native species include *Limosella lineata*, *Ranunculus limosella*, and poniu (*Rorippa palustris*). In lower areas which are inundated for longer water milfoil (*Myriophyllum propinquum*) becomes abundant, though this was mostly below the water level during the survey. Exotic species are also present and include Mercer grass (*Paspalum distichum*), celery-leaved buttercup (*Ranunculus sceleratus*), jointed rush (*Juncus articulatus*), creeping bent (*Agrostis stolonifera*) and water forget-me-not (*Myosotis laxa* subsp. *caespitose*) which appear to be increasing as a result of the recent drainage works. This intermittently wet wetland is fenced into multiple paddocks and could be regarded as a wet pasture.

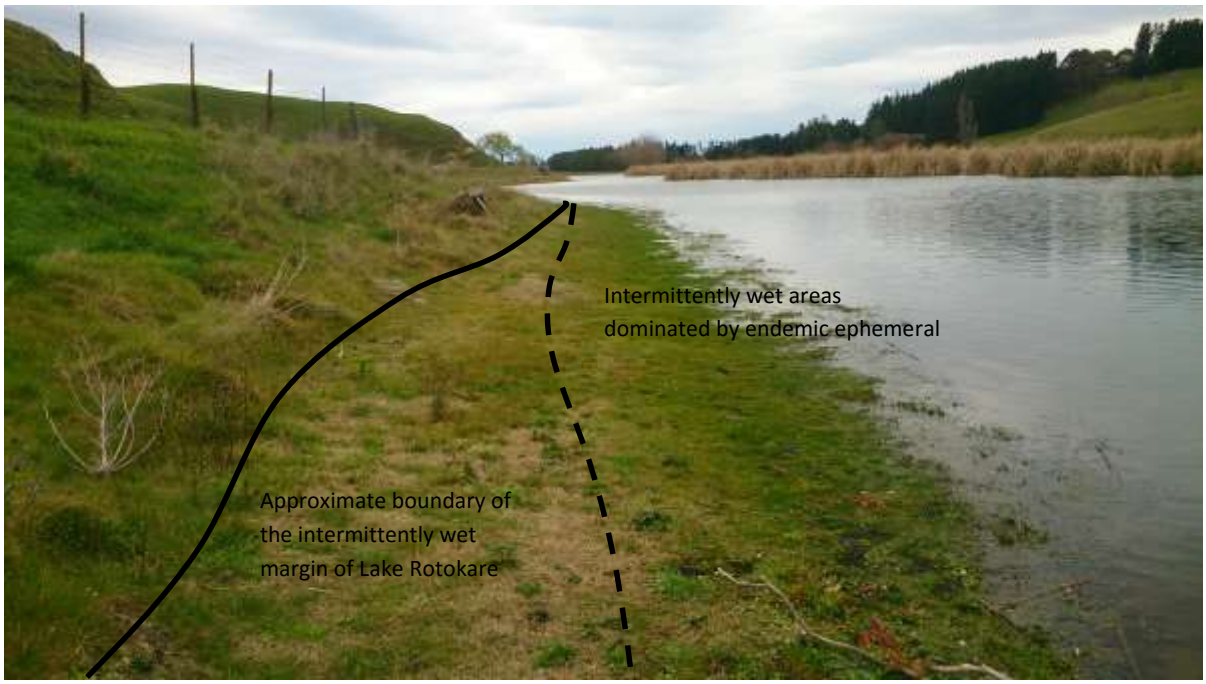

Figure 1: Very defined margin of the intermittently wet area of Lake Rotokare where land is steep (bold line). Exotic species including Mercer grass dominate the upper zone while endemic species dominate much of the water's edge (right of dotted line).

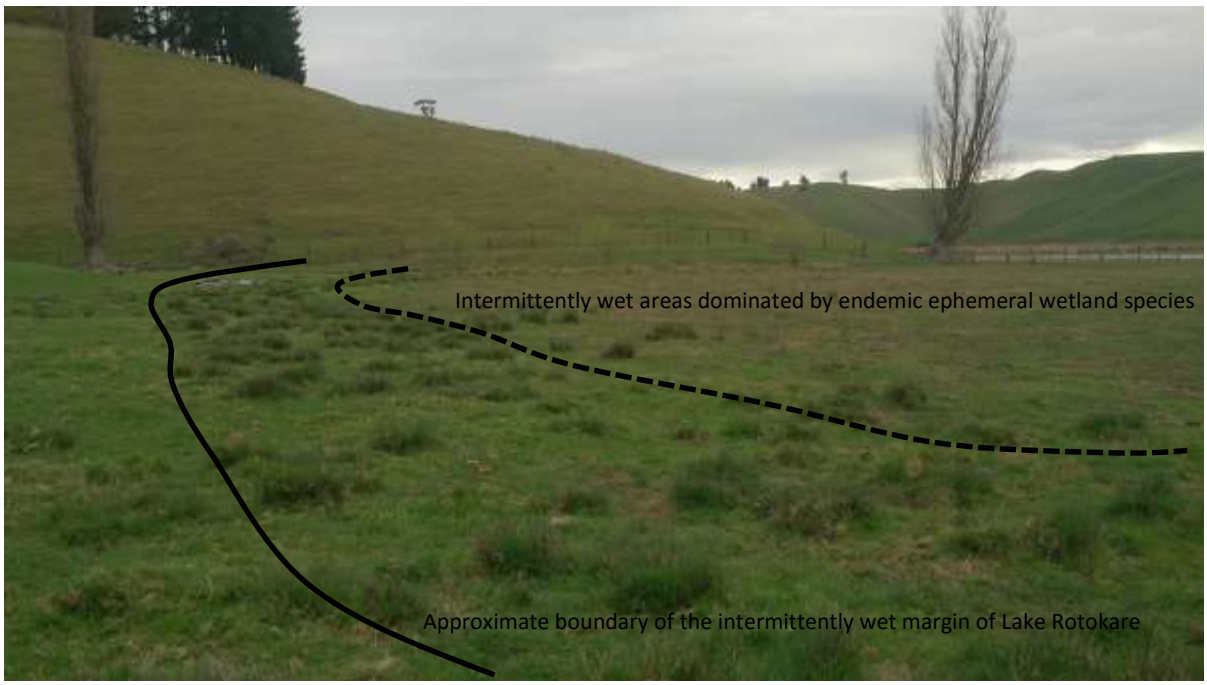

Figure 2: The intermittently wet area of Lake Rotokare is less easily defined where the slope is gradual (bold line). Exotic species dominate the margin though endemic species are common further into the wetland.

Figure 3: Endemic purple wind grass (*Lachnagrostis striata*) and tape-measure plant (*Lilaeopsis novae-zelandiae*) are both abundant in the ephemerally wet zone of Lake Rotokare.

Native species are generally of greater abundance than exotic species and appear to be resilient and perhaps maintained by grazing (by both sheep and water fowl) — where the lake was recently been fenced Mercer grass, celery-leaved buttercup and other weeds now dominate. Consequently within the proposed current definition of wetlands, which specifically excludes "wet pasture", these areas dominated by endemic and nationally uncommon biodiversity associated with ephemeral wetlands would be excluded. Ephemeral wetlands are rare ecosystems (Williams et al. 2007) which are regarded as a national priority for protection (MFE 2007).

Obligate wetland vegetation associated with permanently saturated areas includes areas of raupo reedland and aquatic vegetation (which was not sampled). In the northern part an area of willow forest and an area of planted vegetation are present that contains pukio (*Carex* secta) flax (*Phormium tenax*), cabbage tree (*Cordyline australis*), manuka (*Leptospermum scoparium*) and kahikatea (*Dacrycarpus dacrydioides*).

Waterfowl seen while surveying were concentrated to these intermittently wet areas and included 39 pied stilts, 46 black swans, 27 paradise shell ducks and 1 banded dotterel. An Australasian bittern was heard booming amongst the raupo reedland.

Recent change in the water table at Lake Rotokare

Recent drainage excavation, which occurred in August 2013 (Mr Gary Williams, landowner pers.com) appears to have significantly reduced the maximum water height of Lake Rotokare, which in turn has had a detrimental effect on wetland vegetation around the margin of the lake. An example of this was the impact on several obligate wetland species such as lake club rush (*Schoenoplentus tabermontani*). At the time of survey this species was positioned growing above the lake level while it typically should be growing on the lakes edge and into the lake to a depth of approximately 0.3–0.5m. Plants of this species and other obligate wetland plants, such as water milfoil had also recently died and areas of ephemeral turf were being invaded by aggressive fast colonising weeds such as water celery, water speedwell and Mercer grass.

Figure 4: Hydrology of Lake Rotokare showing intermittently and permanently wet areas.

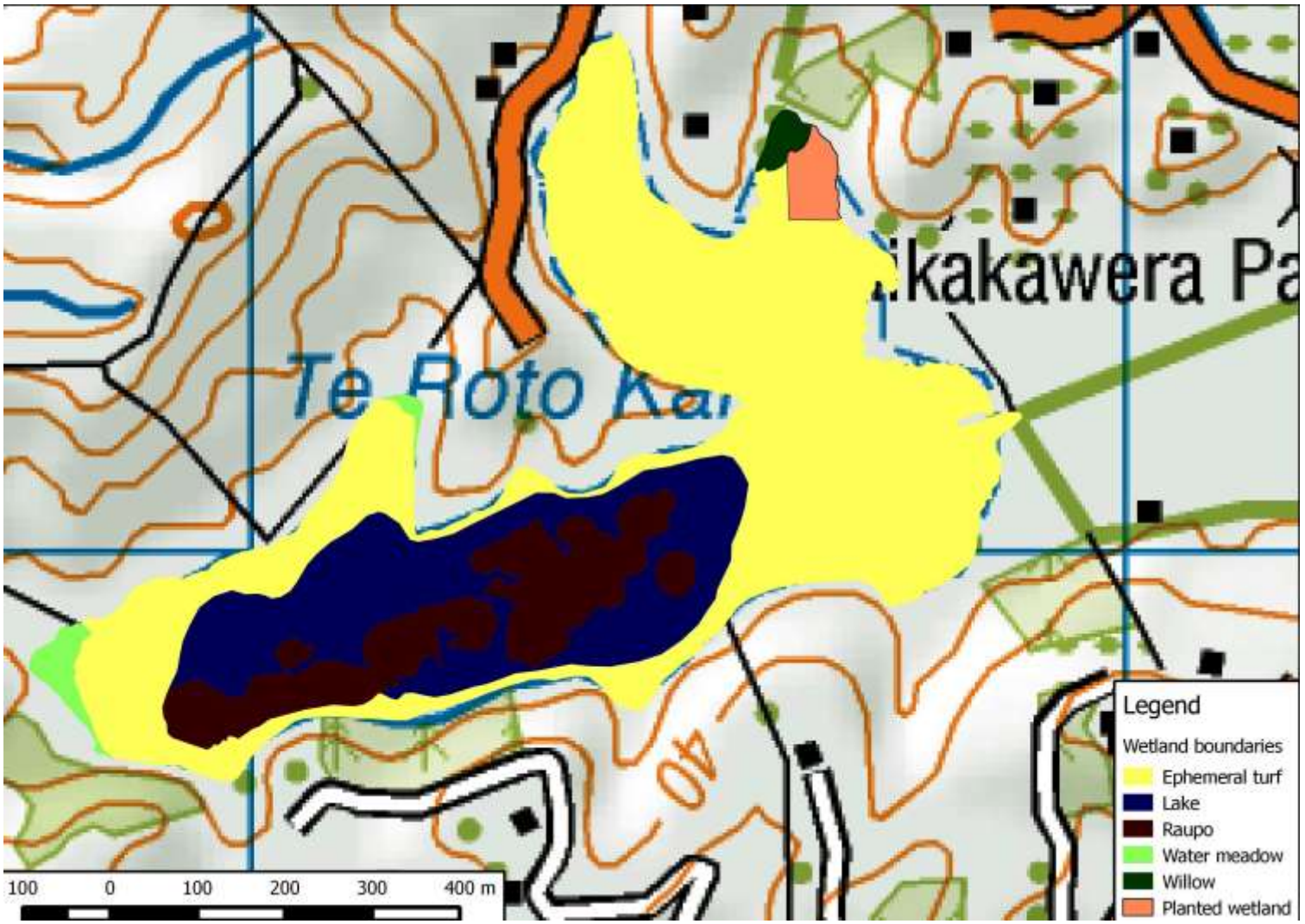

Figure 5: Broad vegetation types of Lake Rotokare. Note: Lake = intermittently and permanently wet area dominated by obligate wetland species.

Consequently mapping the boundary of the intermittently wet margin was confounded by the recent change to the Lake's hydrology. While the margin of facultative wetland and upland species was still generally present, because some obligate wetland species were dead or dying and there appeared to invasion occurring of intermittently wet areas by a number of exotic species, physically locating this boundary was at times difficult. This boundary is now probably receding and upland species will probably invade further into the now drier marginal areas. Temporary flooding in this intermittently wet area is an important ecosystem driver for the maintenance of ephemeral wetland habitats (Johnson and Rogers 2003). Given the recent change in hydrology only regular monitoring of the lakes water table in association with vegetation monitoring will truly inform whether this boundary is stable or receding.

Lake Poukawa

Lake Poukawa is situated in the Poukawa basin, approximately 17km south of Hastings. The hydrology is predominantly fed from inflows from surrounding hill country, including land approximately 8km to the south. It rapidly fills after rainfall as it is the lowest lying area in the basin and because it has a reasonably large catchment area. Intermittently wet areas were surveyed on the ground by mapping the distribution of creeping bent, jointed rush and other facultative wetland plants as indicators, as well as investigating water levels on recent aerial images from Google Earth. This boundary was also discussed with Jonathan Brownrigg following site investigation. Permanently wet areas were determined by examining historical Google Earth images and the boundary of this zone was mapped using the visible edge of the lake from a recent georeferenced Google Earth image (22/03/2013). As stated in the methodology this boundary is likely to be the minimum edge of the permanently wet boundary, as areas where the soil would still be saturated at the lowest lake level could require field surveying. That said the hydrological map of Lake Poukawa shows that most of the wetland is intermittently wet wetland habitat (Figure 8).

Figure 7: Water meadow of predominantly creeping bent (*Agrostis stolonifera*) grassland left of ponded area. Pied stilts, black swans and other wetland birds were feeding here.

Historically, Lake Poukawa and the associated adjoining area of wetland were much larger than today (NZMS1: N141 Waipawa). The land surrounding the lake was developed through construction of an extensive network of drains and pumps to manage the water table (Jonathan Brownrigg pers.com). Some of this developed land is now used for seasonal cropping and or grazing however a large area (291Ha) surrounding Lake Poukawa of intermittently wet pasture is now only used for summer grazing. This area is referred to by Jonathan Brownrigg as the "water grass" area and is dominated by creeping bent (*Agrostis stolonifera*), with a lesser component of jointed rush (*Juncus articulatus*), floating sweet grass (*Glyceria fluitans*), celery-leaved buttercup (*Ranunculus scleratus*), water speedwell (*Veronica anagallis-aquatica*), curled dock (*Rumex crispus*) and batchelor's button (*Cotula coronopifolia*). Locally this area includes small ponded areas with limited vegetation and also patches of grazed raupo, purua grass (*Bulboschoenus* sp.) and *Carex flacca*. This land readily floods after rain and is habitat for a large number of waterfowl and wetland birds (Figure 7).

The lake and remaining area of predominantly indigenous wetland is fenced from stock and occupies approximately 84 and 89 hectares respectively. Inside the fence the wetland is dominated by raupo, with patches of willow forest and scattered willow trees. Sedges are also common especially *Carex secta* and *C. virgata*. Two threatened plant species were seen during the survey; swamp nettle (*Urtica linearifolia*) an At risk declining species and an acutely threatened aquatic liverwort (*Ricciocarpos natans*) which is nationally endangered.

Lake Poukawa perhaps epitomises the conflicting views with respect to what is and isn't wetland within policy greatest because it has the largest area of land (approximately 291 Ha) which conforms to the definition of a wetland within the Resource Management Act (1991) and Clarkson et al. (2014). However under the existing regional plan clearly sits in the exception of "wet pasture or cropping land" and would not be considered as a wetland.

Jonathan Brownrigg who farms this area around Lake Poukawa calls this area the "water grass'' area and stated its primary benefit is for summer grazing of lambs. This low lying land is situated within the original footprint of the historic wetland area around Lake Poukawa and readily floods in all seasons after significant rain. Agricultural use, especially cropping of the historic Lake Poukawa wetland foot print relies on a sophisticated network of drains and pumps to manage water levels, however the "water grass" area is not economically viable for cropping because the water table is often high or too variable and readily floods after rain. Consequently it has been left to naturally develop into creeping bent grassland and its primary use is for summer grazing. This pasture has little indigenous flora values but has significant wildlife values for a range of water fowl and wetland birds, and is a regionally if not nationally significant winter foraging habitat for many species, some of which are Threatened or At Risk species. Species seen include;

- Mallard duck
- Mallard x grey duck
- Australasian shoveler
- Grey teal
- Black swan
- Canadian geese
- Paradise shelduck
- Pied stilt (At risk-declining)

- Black billed gull (Nationally critical)
- Banded dotterel (Nationally vulnerable)
- Black fronted dotterel

These “water grass” areas provide ideal winter and spring feeding areas, however it is novel habitat in that the management regime of drainage channels and grazing has created and maintains the habitat for these birds. Prior to development it didn’t exist as these areas were likely dominated by raupo, flax and pre-Maori kahikatea swamp forest (McGlone 2002). During the survey thousands of water fowl and wetland birds were present grazing and feeding on the water meadow including approximately 120 black-billed gulls which is a substantial proportion of the estimated regional population of approximately 1000 birds (Keiko Hashiba pers.com.)

I was most impressed by Jonathan Brownrigg’s perspective on this issue, recognising the natural limitations of the land and the primary economic use for summer grazing of sheep. Occurring on gley and organic soil types adjacent to Lake Poukawa, it maintains pasture growth well into dry conditions but he also recognises that the natural limitation of the land for other uses such as cropping. Jonathan also recognises that the land in winter and spring provides habitat for abundant waterfowl and Brownrigg Agriculture in the last couple of years have deliberately left some areas of “water grass” wet during these periods specifically as waterfowl habitat. This management approach appears to be a win: win scenario providing an economic use within the capability of the land and also wild life habitat. Potential conflict here appears to be entirely resolvable by recognising in policy the use of the land for summer grazing of sheep and value of spring and winter flooding to provide habitat for wetland birds during the winter and spring months.

Figure 8: Hydrology of Lake Poukawa showing intermittently and permanently wet areas.

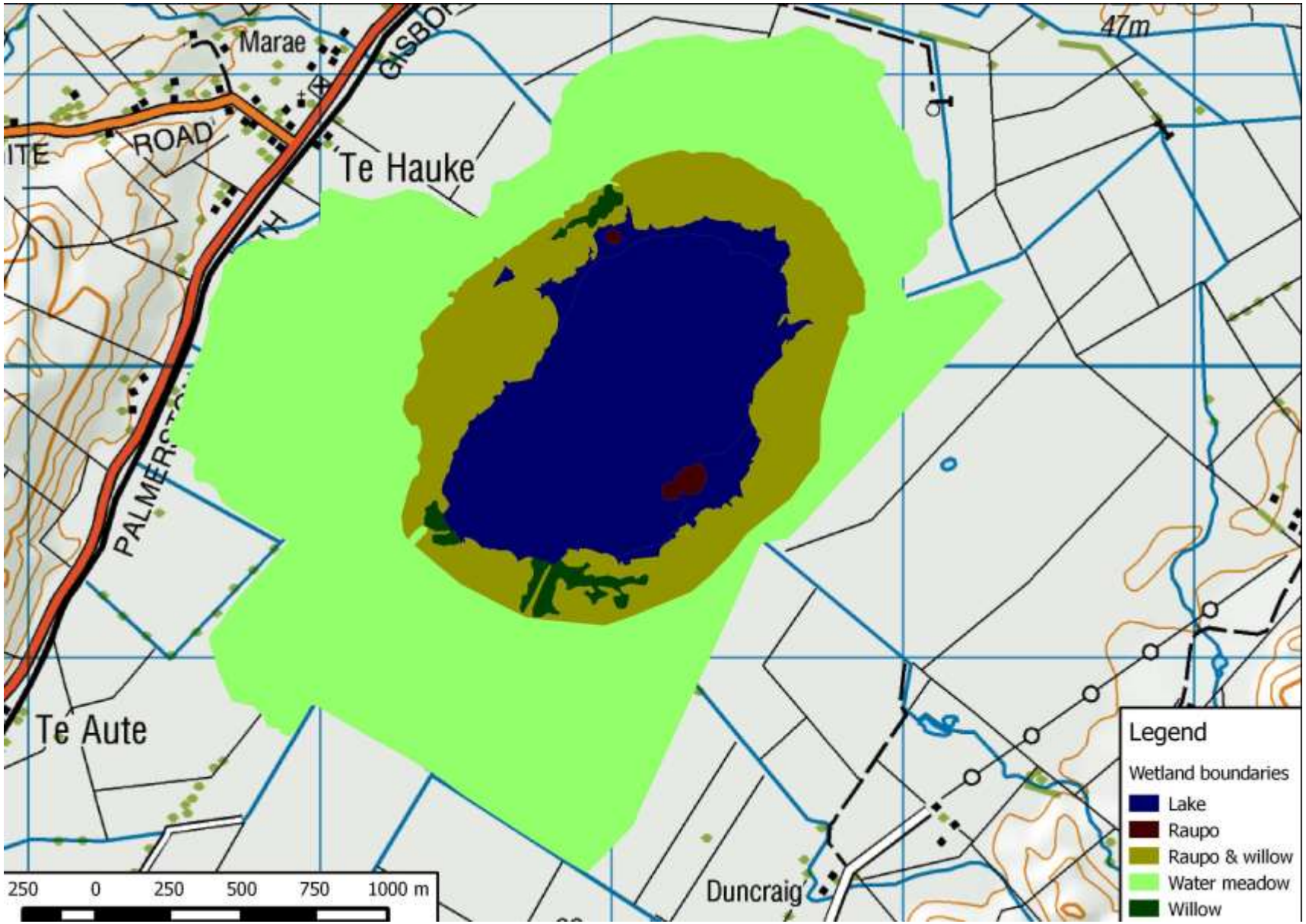

Figure 9: Broad vegetation types of Lake Poukawa. Note: Lake = intermittently and permanently wet area dominated by obligate wetland species.

Atua Road

Two wetland areas were identified for surveying at Atua Road; Atua Road South and Atua Road North. Based on historical Google Earth images and surveying from a nearby high point, Atua Road south wetland was not surveyed as recent drainage works and pasture development appears to have removed any readily discernible indigenous wetland vegetation (Appendix 2). While this area probably still seasonally floods it was considered to be too modified to qualify as a contemporary wetland.

Figure 10: Overview of Atua Road North wetland.

Atua Road North wetland is situated within a valley floor depression which until modern human drainage would not have had an outlet (Figure 10). Consequently it would have had a large fluctuating water table, with the water filling up seasonally and after periods of heavy rain and lowering over the summer dry period. Numerous small seepages are present on the surrounding hillslopes which also enter the wetland. Drainage is presently feeding both into and out of the wetland. A recent drain has been dug which enters the lagoon which likely will result in the south-eastern end of the wetland drying out. The existing outlet drain limits the maximum height of the wetland and probably also the area of land which is flooded. Consequently, because the height is regulated the periods of submergence the wetland experiences have also probably been reduced. This modification has likely reduced the area of wetland around the lagoon and resulted in it being more ephemeral.

Figure 11: Hydrology of Atua Road North Wetland.

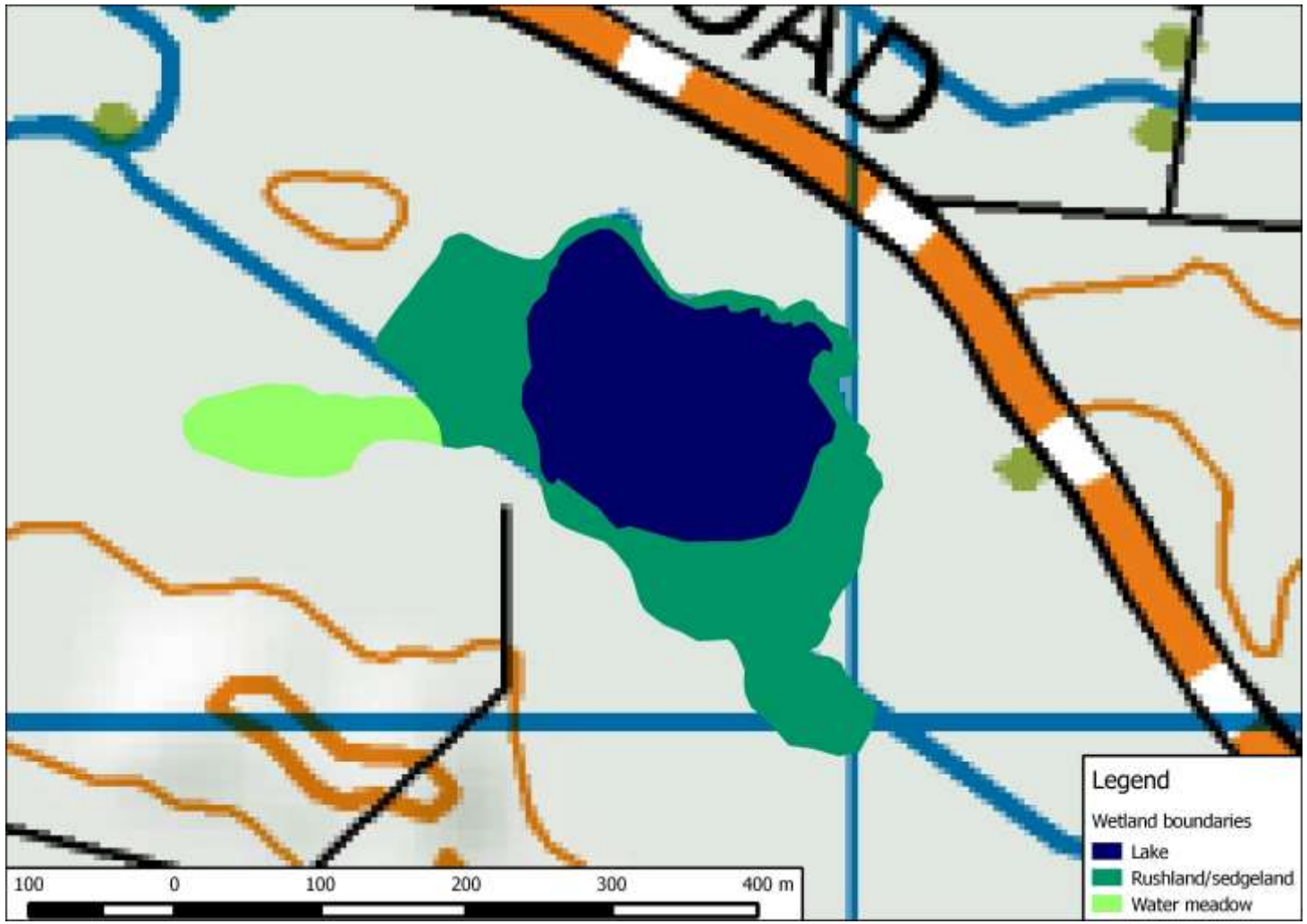

Figure 12: Broad vegetation types of Atua Road North Wetland. Note: Lake = intermittently wet area dominated by obligate wetland species.

Intermittently wet areas were surveyed on the ground by mapping the distribution of creeping bent, jointed rush and other facultative wetland plants as indicators as well as investigating water levels on recent aerial images from Google Earth. On examination of historical Google Earth images at times the lagoon has been completely dry (Google Earth 22/03/2013) so has been entirely mapped as intermittently wet.

The vegetation of Atua Road North wetland is dominated by sedge and rush species of which *Carex virgata*, *Juncus edgariae*, creeping bent, jointed rush and *Eleocharis acuta* were most common. Approximately 60–80 Australasian shoveler duck, 10 black swans and 11 pied stilts were seen.

Lake Hatuma

Lake Hatuma is situated in a valley floor depression south of Waipukurau. The hydrology is largely fed by many small streams, of which Ngahape Stream in the south has the largest catchment. The lake's hydrology appears to have had minimal human interference from drainage or water diversion, though drains from farm land have been cut into the lake to transport water off farmland faster. Additionally, at the outlet in the Kiorerau Stream a small concrete bund is present. This was likely built to retain water in the lake and prevent down-cutting of the stream, which would reduce the height and extent of the lake. Consequently, the hydrology of the lake and the associated wetland areas are generally intact.

Intermittently wet areas were surveyed on the ground by mapping the distribution of creeping bent, jointed rush and other facultative wetland plants as indicators. Permanently wet areas were determined by examining historical Google Earth images and the boundary of this zone was mapped using the visible edge of the lake from a recent georeferenced Google Earth image (22/03/2013). At its maximum extent Lake Hatuma is approximately 143 hectares in size, though occupied only 81 hectares on 22/03/2013.

The vegetation of Lake Hatuma and the surrounding wetlands is highly modified. It has previously been mapped and sampled by Geoff Walls (cited in Cameron 2008) and is largely similar today. The most intermittently wet part of the wetland is dominated by water meadow of creeping bent which occupies approximately 31 hectares around the outer perimeter. This wetland type is mostly grazed, even on conservation land where cattle have caused heavy pugging and soil damage (Fig.13). Closer to the lake this then grades into a mixed grey willow, crack willow forest which occupies approximately 47 hectares. Around the lake is a band of raupo and scattered willow which occupies approximately 21 hectares.

Figure 13: Heavily pugged water meadow and willow forest on public conservation land on the western side of Lake Hatuma.

Figure 14: Hydrology of Lake Hatuma.

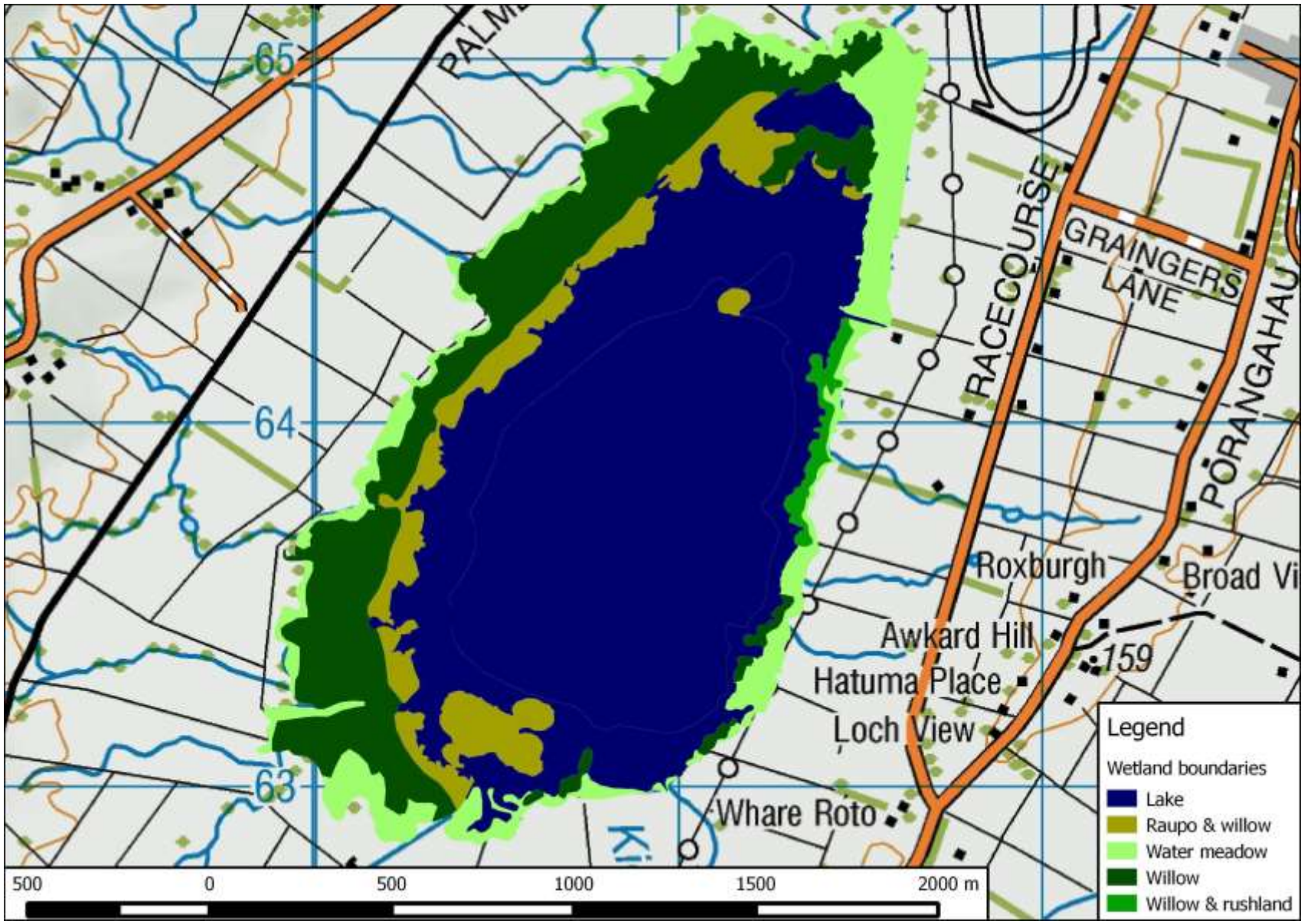

Figure 15: Broad vegetation types of Lake Hatuma. Note: Lake = intermittently and permanently wet area dominated by obligate wetland species.

Wanstead

Wanstead Lagoon and wetland occupies an area where water flow from the Mangaongaonga Stream is restricted through a narrow passage in the surrounding hills, which in effect has created a dam which the lagoon and associated wetlands sit behind. In the 1950's–1960's the area was dominated by native wetland vegetation including flax, sedges, cabbage trees and kahikatea (Peter Coleman; local farmer pers.com). The native vegetation has been almost entirely been replaced by tall crack willow forest. It appears this change was caused by invasion of the wetland by crack willow which accumulated silt around it roots, thereby raising the dam height and the lagoon's water table height. This probably resulted in much of the native wetland vegetation being excessively flooded. The Wanstead lagoon is drained by a large man made drain which penetrates well into the wetland. Historical imagery shows that this drain is at least 10 years old however approximately 5 years ago significant works were undertaken on it (Peter Coleman local farmer, pers.com), deepening this drain, removing willow debris and constructing a further drain in the south west. This appears to have resulted in the land either side of these drains significantly drying out and reducing the area of wetland.

Intermittently wet areas were surveyed in two ways. In the eastern end of the wetland beneath the tall crack willow forest the wetland boundary was mapped on the ground by physically mapping the distribution of creeping bent, *Carex virgata* and other wetland plants as indicators. Wanstead wetland is highly accessible from adjoining roads and much of the wetland was mapped from the road and using aerial imagery. Permanently wet areas were determined by examining historical Google Earth images (22/03/2013).

Figure 16: Crack willow forest with creeping bent and scattered *Carex* virgata.

The vegetation of Wanstead Swamp is dominated by very large crack willow trees with very little understory, especially where inundated. Between the drainage channel and open water, creeping bent pasture with scattered *Carex virgata* is present. Open water was covered in ferny azolla and duck weed.

Intermittently wet wetland areas also occur at the western end of the wetland, adjoining the Mangaongaonga Stream where it meanders across a flood plain. These wetlands occur within old oxbows and depressions are dominated by rushes both native and introduced.

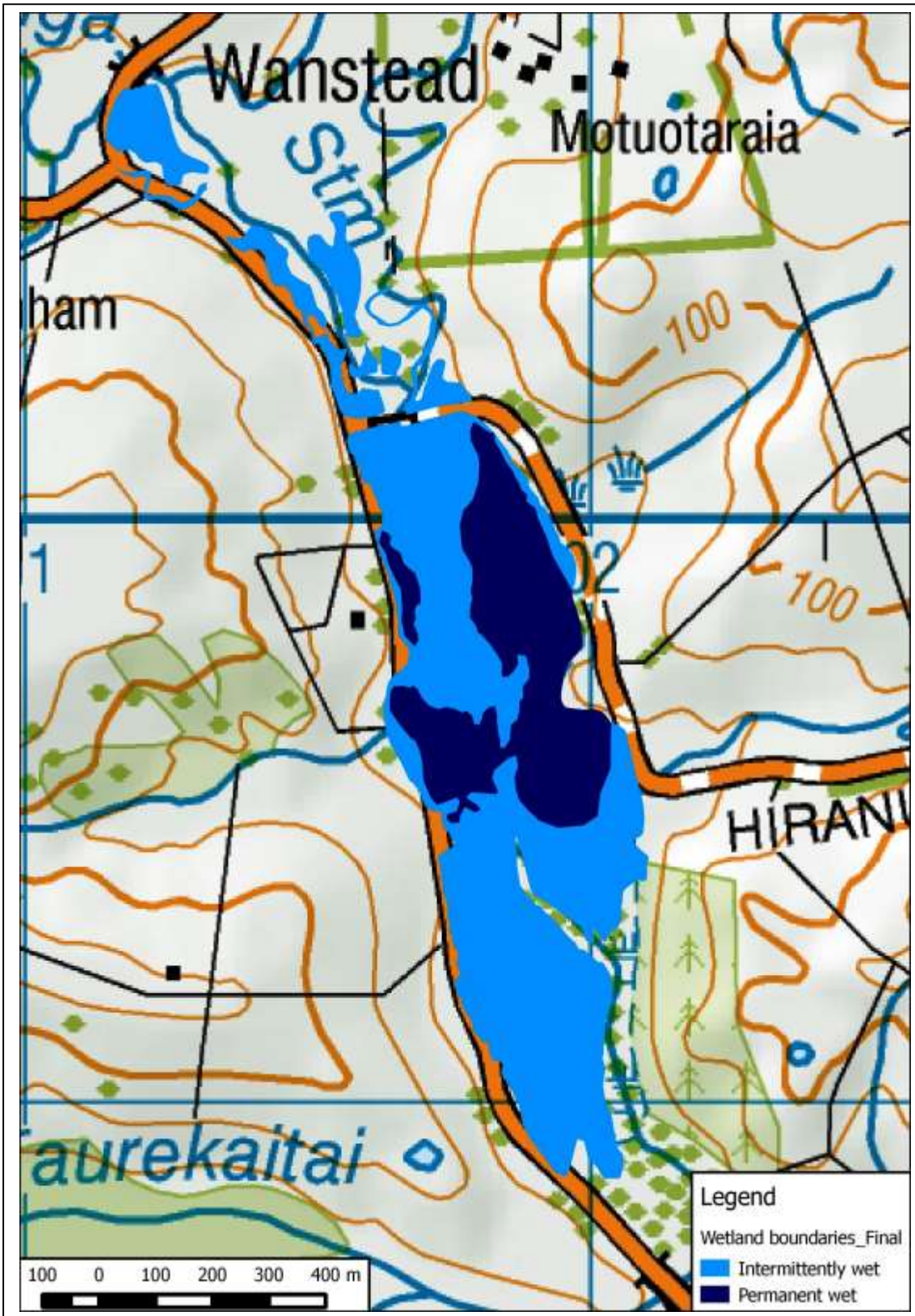

Figure 17: Hydrology of Wanstead Swamp.

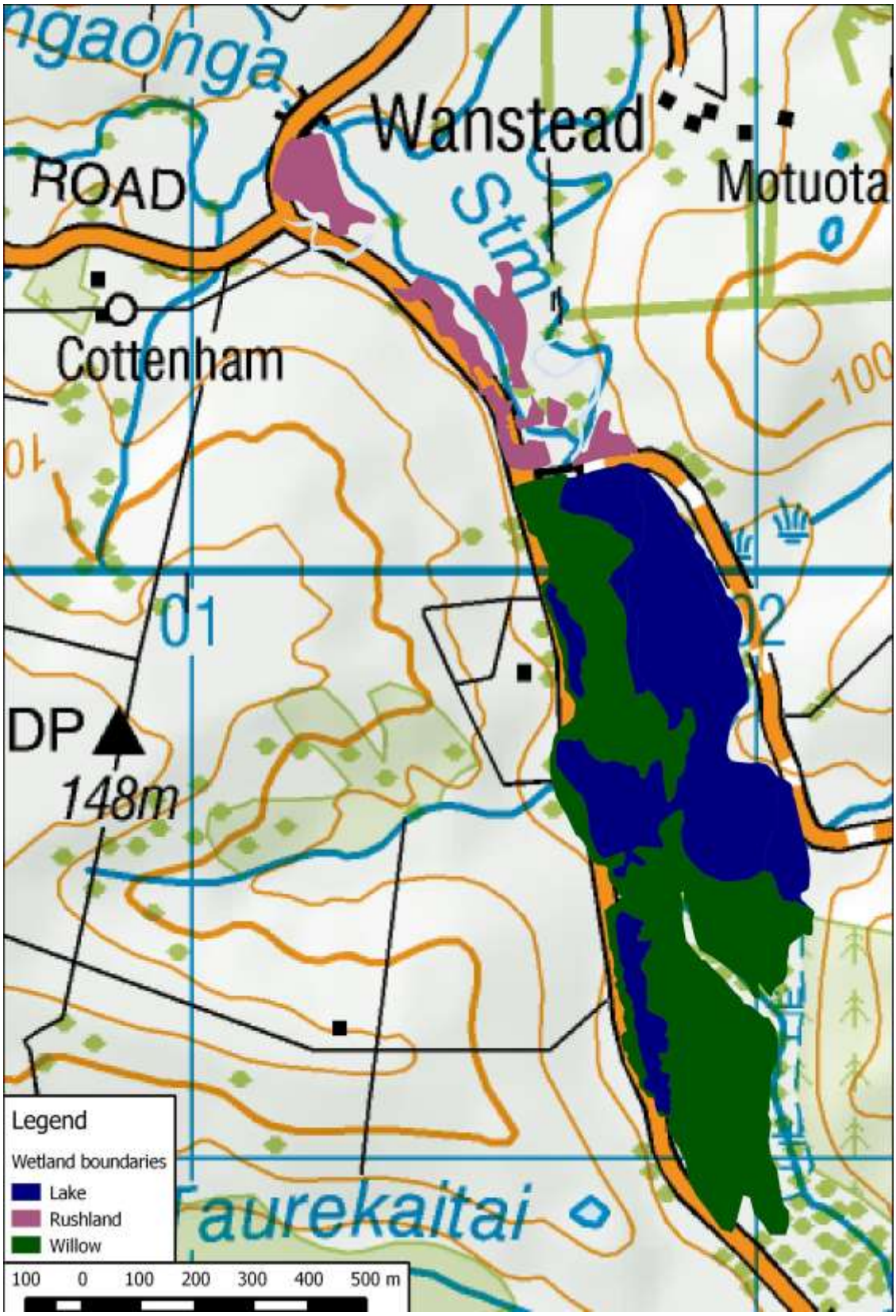

Figure 18: Broad vegetation types of Wanstead.

Conclusion

Hawkes Bay has a semi-arid climate and the wetlands surveyed have a large area of intermittently wet habitat. Land modification through the development of drainage around these wetlands has exacerbated this situation resulting in lower water tables. Grazing stock and agricultural land management in these intermittently wet areas has typically resulted in a replacement of native wetland plant species by exotic ones. Consequently most intermittently wet areas are dominated by exotic plants and from a flora perspective are generally of low ecological value. The exception to this is Lake Rotokare where areas still have significant flora values and is an example of the nationally rare ecosystem type "ephemeral wetland" (Williams et al 2007). While somewhat speculative grazing by water fowl and possibly sheep may be beneficial in these areas through controlling specific aggressive exotic plant species such as Mercer grass. At the other wetlands surveyed these same intermittently wet areas with low floristic value appear to be a significant habitat when wet for a wide range of wetland birds and waterfowl.

This habitat is similar to the northern hemisphere ecosystem types "wet meadow" (https://en.wikipedia.org/wiki/Wet_meadow) and "water meadow" (https://en.wikipedia.org/wiki/Water-meadow) both of which are ephemerally wet areas of grassland which typically provide significant wildlife habitat though are often also used for pastoral grazing. In Britain since 2005 with the help of changes to the Common Agricultural Policy- British farmers have been given subsidies to help restore many of Britain's' important water meadows (http://www.bury-watermeadowsgroup.com/water-meadows-important/). Rather than excluding these intermittently wet areas as wetlands I propose that either the northern hemisphere terms "wet meadow" or "water meadow" be adopted in policy to describe this specific wetland type. For example sheep grazing would be a permitted activity while drainage which would result in a loss of intermittently wet wetland (compared to a benchmark e.g. 2015) would be a discretionary activity requiring resource consent.

In conclusion, the ephemerally wet areas identified by a predominance of obligate and facultative wetland species have been mapped for the five wetlands able to have been accessed. This is in accordance with the Clarkson (2013) wetland delineation approach.

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Appendix 1: Resource Management Act (1991) Wetland Definition

The Resource Management Act 1991 – this defines wetlands as: '*includes permanently or intermittently wet areas, shallow water, and land water margins that support a natural ecosystem of plants and animals that are adapted to wet conditions*'.

The key components of this definition are the key words "permanently" or "intermittently" and "natural ecosystem of plants and animals adapted to wet conditions"

Hydrologically it includes the words "permanently" or "intermittently" encompassing the full extent of wetland ecosystems.

Within the definitions of the Act *natural and physical resources* includes land, water, air, soil, minerals, and energy, all forms of plants and animals (whether native to New Zealand or introduced), and all structures. Therefore natural should be interpreted as not man-made and includes both wetlands composed of native and introduced species.

Appendix 2: Atua Road South Wetland

Figure 19: Atua Road South. Google Earth Image July 2015