Proposed Golf Links:

Muhunoa Road West, Ohau:

Coastal Processes and Vegetation – Opportunities & Constraints

Prepared for Grenadier Limited

December 2020

709 Muhunoa Road West: Coastal Processes and Vegetation

Report prepared for:

Grenadier Limited

C/- Land Matters
20 Addington Road
RD 1
Otaki 5581

Report prepared by:

Jim Dahm
Eco Nomos Ltd
jdahm@xtra.co.nz

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Executive Summary

Grenadier Limited proposes to establish a new Links Golf Course (Douglas Links) on the Horowhenua Coast near Ohau; located at the seaward end of Muhunoa Road West, on the northern side of the Ohau River entrance. This report provides comment and recommendations for the proposed course in respect to coastal processes and dune vegetation.

This coastline is vulnerable to wind erosion and the development of inland migrating dunes; due to the abundant sediment supply from rivers to the north, the fine-grained nature of the sediments, and the strong onshore winds. However, with appropriate procedures, the threat from wind erosion can be readily managed and is unlikely to present significant issues for the proposed course. The proposed course does not affect the sensitive frontal dune area in which most serious wind erosion issues develop.

In terms of coastal erosion, the ocean shoreline is subject to periods of storm erosion, but, when averaged over time, the shoreline is building seaward (due to the large volumes of sand moved southwards alongshore from rivers to the north). The average seaward advance rate over time will be assessed in more detail but appears to be at least 0.5-1m per year. In the longer term, projected sea-level rise may slow the seaward advance rate, depending on the rate and scale of sea-level rise and other factors. However, even with up to 1m sea level rise over the next 100 years, the shoreline seaward of the course is likely to advance by over 100m. Accordingly, coastal erosion does not pose any significant risk to the proposed development.

The western margin of the property borders the Ohau River, and has been subject to significant erosion over the last 100 years. Available data suggests that, over long periods of time, the rate of bank erosion averages about 1-2 m/yr. The erosion is probably episodic, with significant erosion possible during major flood events, with periods of much lesser erosion between such events. Any parts of the golf course (fairways, tees etc.) located close to the river margin may periodically need to be moved due to erosion. The areas likely to be at highest risk from erosion with existing channel geometry are identified.

The area contains some natural dune and (to a lesser extent) estuarine ecosystems which are presently in a degraded condition, often dominated by exotic vegetation. Nonetheless, these areas include rare, threatened and at-risk habitats. Care is required to balance golf course development with maintenance and restoration of these habitats. In general, the areas affected by the Links course are dominated by exotic vegetation with little to no native vegetation. Patches of kanuka scrubland within the course will largely be preserved. However, the seaward edge of the course does intrude into dune habitat with a significant native vegetation component. It is recommended that offset restoration focus on the dune habitat seaward of the course where, in my opinion, the greatest ecological gains can be obtained. The small area of estuarine wetland along the river margin of the property is not affected by the proposed course but also offers useful restoration opportunities.

Contents

1 Purpose of Report

Grenadier Limited propose to establish a new Links Golf Course (Douglas Links) on the Horowhenua Coast near Ohau; located at the seaward end of Muhunoa Road West, on the northern side of the Ohau River entrance .

Figure 1: Location of proposed Douglas Links (Google Earth photo dated July 2020).

The site is located on the Horowhenua coast at the seaward end of Muhunoa Road West near Ohau.

The property is composed of sand dunes, largely stabilised parabolic and transgressive dunes which originally migrated inland from the coast. The seaward edge of the property is bounded by a wide esplanade reserve, comprised of vegetated dunes which extend approximately 125m seaward of the boundary. The proposed course extends seaward into the landward edge of this reserve. The southern margin of the property is bordered by the Ohau River.

Eco Nomos has been engaged to provide comment and to identify opportunities and constraints in relation to coastal processes and dune vegetation. Eco Nomos have also had input to the RBT Management Plan for the project.

Figure 2: View of area of proposed course (Photo from Horowhenua District Council online GIS maps). .

2 Methods

The assessment considered various information including:

- The layout plan and topographical survey prepared by Land Matters
- The preliminary Landscape Assessment prepared by Frank Boffa and associated plans dated 28 September 2020
- Historical surveys of the site dating from 1890 and historical vertical and oblique aerial photographs dating from 1940s to the present
- A wide variety of past reports and published papers related to coastal processes, dunes, and sand dune ecology along this coast
- Site visit report on indigenous vegetation prepared by Elizabeth Daly, ecologist of Horizons Regional Council
- The RBT Management Plan

A detailed field inspection of the site was also conducted on Tuesday 2 December.

3 Coastal Processes and Hazards

3.1 Coastal Processes

The coastal lowlands of western Manawatu are one of the driest areas of the North Island, typically receiving less than 900mm of rainfall per year (Chappell, 2015). The coast is subject to strong onshore winds, particularly from the west-northwest, with winds capable of initiating sand transport (>16 kph) blowing for approximately 33% of the time (Clement et al., 2010).

Sediment transport on the Manawatu coast is strongly wave-dominated, with waves from the west-northwest predominating; giving rise to a net southwards longshore drift along the coast. (Clement et al., 2010) This longshore drift supplies large volumes of sediment derived from areas further north; including rivers (particularly the Whanganui, Whangaehu, Rangitikei and Manawatu Rivers) and cliff erosion (particularly from areas north of Whanganui) (Gibb, 1978; Lithgow, 1986; Hicks and Shankar, 2003). In the period shortly after sea level reached existing elevations around 7500 years ago, onshore movement from the adjacent continental shelf was also likely a significant sediment source (Gibb, 1986; Shepherd, 1987; Clement et al., 2010).

Conditions on this coast favour the development of transgressive (i.e. inland migrating) dunes due to the abundant sediment supply, the fine grained nature of the sediments, the dominant and strong onshore winds, and the flat low gradient of the beaches (the latter factor exposing large surface areas to drying out and wind transport during lower tidal stages) (Muckersie and Shepherd, 1995, Hesp, 2001; Clement et al., 2010).

Historically, the Manawatu coast has experienced significant periods of wind erosion and inland migrating sands over the Holocene, associated with both natural and (over the last 1000 years) human disturbance of stabilising dune vegetation (Cowie, 1963; Muckersie and Shepherd, 1995, Hesp, 2001). The WNW alignment of the transgressive dunes is similar to the wind resultant vector for sand-moving winds calculated for the Manawatu coast by Clement et al. (2010).

The coastal dunes comprising the Muhunoa West Road property are part of an extensive transgressive dune field that extends from near Patea in the north to Paekakariki in the south, a distance of approximately 190km (Cowie, 1963; Muckersie and Shepherd, 1995). The dune field extends up to 19 km inland and covers an area of approximately 900 km^2 (Muckersie and Shepherd, 1995).

2.2 Wind Erosion

The Manawatu coast is extremely vulnerable to the development of wind erosion and transgressive dunes.

Cowie (1963) identified three periods of transgressive dunes in the Manawatu in the period since sea level stabilised at or about present elevations (about 7500 years ago), with a fourth period earlier while sea level was still rising.

Later work (Shepherd et al., 1986; Muckersie and Shepherd, 1995) suggested that the oldest period since present sea level was attained (Cowie's "Foxton" phase) commenced about 6500 years ago and continued through to 4500 years ago; though the dunes continued to migrate inland and were only stabilised by about 1600 years ago (Shepherd, 1987). A second phase began at the coast approximately 3500 years ago and ended about 1300 years ago (Muckersie and Shepherd, 1995), possibly even later (Hesp, 2001). A third phase (Cowie's "Waitarere" phase) commenced no more than 1000 years ago and may have consisted of two separate phases; one initiated by Maori and another initiated since European settlement (Muckersie and Shepherd, 1995).

Hesp (2001) noted that the entire Manawatu dune field is totally dominated by transgressive (largely parabolic) dunes, with foredunes occurring only along the seaward margin. It appears that the natural and (in more recent centuries) human factors responsible for the periods of dune destabilisation and inland migrating dunes commenced along the coast. The factors possibly responsible for the various phases of transgressive dunes are discussed by Hesp (2001).

Overall, transgressive dunefields have tended to characterise the Manawatu dunefields over the last 7500 years, with periods of stability during which the dunes are vegetated, including forests (Adkin, 1948; McGlone 1989; McGlone et al., 1997; McFadgen, 1997).

Available aerial photography for the property indicates widespread dune destabilisation in the 1940's, the site characterised by extensive areas of migrating sands with only pockets of vegetation (Figure 3). Over following decades, the more seaward dune areas gradually became more vegetated (Figure 4). However, the transgressive dunes (migrating sand sheets) persisted until at least the early 1980's (Figure 4). These areas were later stabilised and established in pines, probably involving marram planting (to stabilise the dunes), planting of wind and salt protection (in this case macrocarpa), and the use of exotic nitrogen fixers (e.g. yellow tree lupin) followed pine planting. The pines were removed and replaced by pasture circa 2013-14.

However, while the site is clearly prone to wind erosion, techniques for stabilising sands are now well established. No significant problems with wind erosion should be experienced provided planting is undertaken soon after earthworks, and any blow-outs that do develop are attended to rapidly.

It is also particularly important to ensure that the coastal margin dunes seaward of the property remain well vegetated to provide a natural buffer, as this is the area where serious wind erosion and transgressive dunes have typically commenced in the past.

Figure 3: Aerial view of the site taken somewhere between 1942 and 1948. (Source: Figure 4.17 of Smith, 2007).

2.3 Coastal Erosion

Over the period since sea level stabilised at or about existing elevations, the shoreline has consistently prograded seaward (Hesp, 2001).

Existing rates of seaward advance were estimated for the period since 1975, the year that the property and the reserve to seaward were surveyed. These estimates indicate that the shoreline has typically built seaward (i.e. prograded) by 65-75m over this period, suggesting the average rate of shoreline advance is 1.5-1.6 m/yr. These rates were also cross-checked using aerial photography covering the periods 2005-2010 and 2010-2020, with similar results (1.6 m/yr) obtained.

These estimates are virtually identical to those obtained at other beaches on this coast by Tonkin and Taylor (2013) and Bell (2015).

In the longer term, projected future sea level rise may exacerbate erosion and slow the rate of shoreline advance. It is difficult to reliably estimate this effect with existing techniques. However, approximate calculations using various standard techniques suggest 20-50m erosion could occur for every 1m of sea level rise. Work at Himatangi Beach by Bell (2017) estimated values towards the lower end of this range, assessing potential for 20m erosion for each 1m of sea level rise.

Present national guidelines (MfE, 2017) suggest adopting a planning period of 100 years and a sea level rise of about 1m (RCP 8.5M) to estimate coastal hazards for developments of this nature. At this site, these parameters would suggest that accretion will continue over the next 100 years, but seaward advance may be reduced (averaging 1-1.3 m/yr over the 100 years period). In other words, even with 1m sea level rise, significant shoreline advance (100-130m) is likely to occur over the next century.

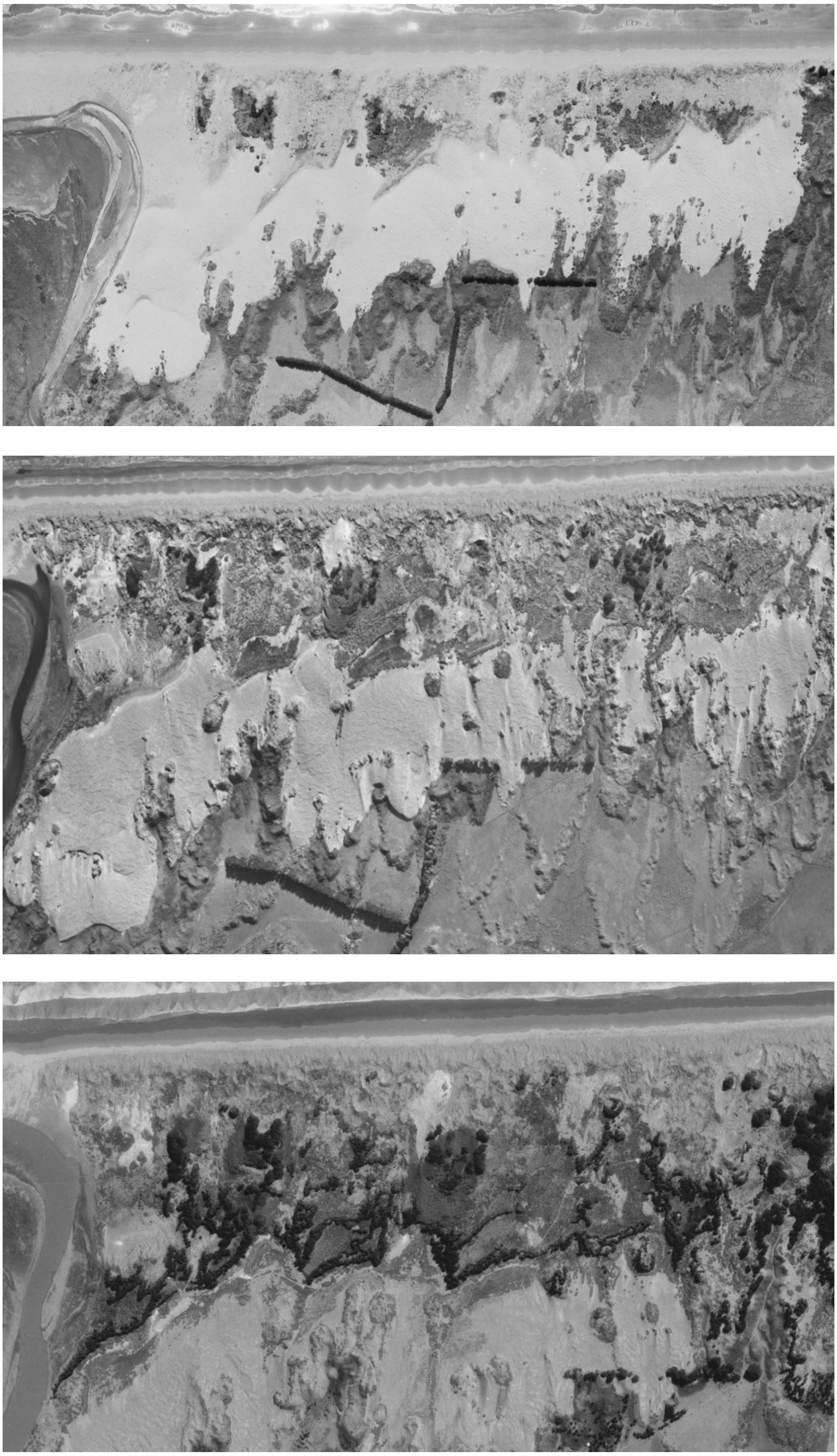

Figure 4: Views of property and adjacent areas from 1957 (top), 1972 (middle) and 1983 (bottom). (Source: Retrolens)

Accordingly, coastal erosion is not likely to pose a threat to the proposed Links course over the next 100 years, based on best present information on projected future sea level rise over that period.

2.4 River Erosion

The western margin of the property borders the Ohau River, and essentially lies on the outer bank of a large meander loop in the river. Over the 120 years since the first survey in 1900, this river bank has been subject to considerable erosion, with the river channel having moved significantly (in places >200-300m) northwards over the period.

In recent decades, the erosion appears to be continuing, with the highest erosion (as expected) near the apex of meander bends. For instance, in the period since 1975 (when the current property boundaries were surveyed), there has been moderate erosion on the outside of the two river bends adjacent to the property (Figure 5); with average erosion of about 80m (over 235m length) on the upstream bend and about 50m (over 375m length) over the length of the downstream bend.

This indicates, average erosion in the order of 2m/yr (approximately) on the outside of the upstream bend, and about 1.1-1.2 m/yr along the outside bank of the downstream bend; when averaged over long periods of time. However, it is important to appreciate that river erosion is episodic, occurring primarily during river floods. Accordingly, the erosion is likely to be very irregularly distributed in time; with potential for significant bank erosion (possibly 5-10m) in major floods, interspersed with long intervals in which there is little erosion. Similarly, the erosion will not be regularly distributed spatially, tending to be most serious near the apex of the meander bend and areas just downstream.

The Ohau River was straightened and stop-banked further upstream in the early 1970's to facilitate improved flood release and drainage. These works probably increased flood velocities on the outside of the river bends. Accordingly, it is not clear whether the erosion rates since 1975 are typical or reflect a period of accelerated river channel change following the diversion.

The areas assessed as being most likely to be affected by river bank erosion on the basis of existing channel morphology are shown approximately in Figure 6.

Obviously, any parts of the Links course (fairways, tees etc.) located close to the river margin (particularly the areas shown in Figure 6), may periodically need to be moved due to erosion. However, given the relatively simple nature of such action, this does not preclude location of parts of the course in these areas.

The river entrance is also subject to significant longshore movement. With the dominant southwards net littoral drift, this periodic longshore migration primarily affects land to the south. The respected amateur geologist, historian and photographer, George Leslie Adkin produced a map in 1935 indicating that the Ohau River entrance has in the past extended as far south as the entrance of the Waikawa River.

However, while such longshore migration primarily affects areas to the south, there is potential for the river to break out more directly during major floods, which might potentially affect near entrance areas of the property (Figure 6). The river has broken directly seaward in the past, temporarily turning the spit into an island (e.g. evident in surveys from 1903 and 1925) (Figure 7). Over time, the flood-formed entrance is closed off by longshore drift and the spit re-forms.

Figure 5: View of river margin of property showing (light green shading) the location and approximate area of bank erosion since 1975.

Figure 6: Diagram showing (approximately) the areas assessed as most likely to be affected by river erosion with present river morphology

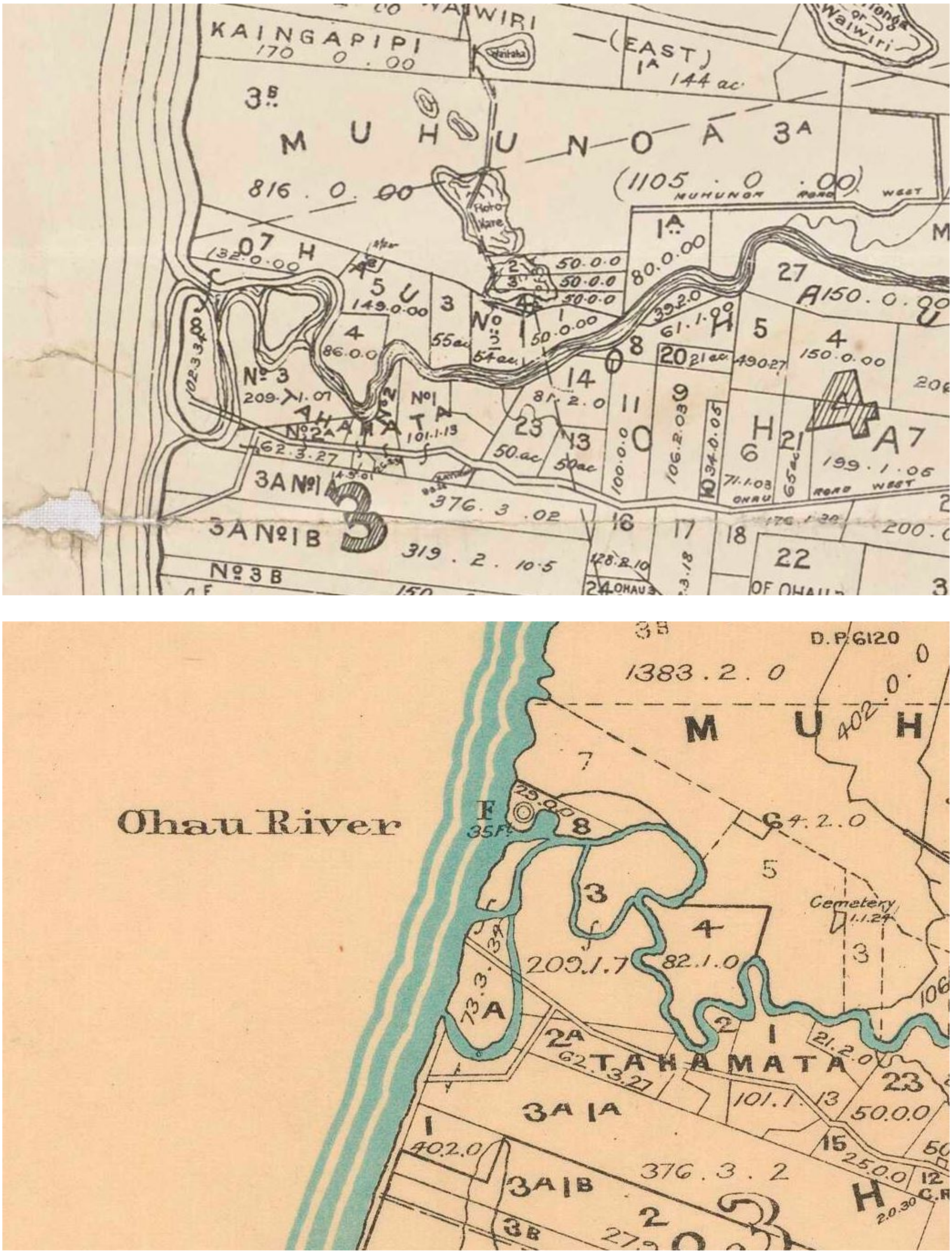

Figure 7: Excerpts from historic Lands and Survey Department maps of 1903 (top) and 1925 (bottom) showing Ohau River entrance area. (Source: Alexander Turnbull Library).

3 Natural Ecosystems

As noted in Section 2, the property was largely characterised by severe wind erosion and migrating dunes/sand sheets in the 1940's (Figure 3). This advancing coast has been characterised by intermittent periods of natural transgressive dunes over the Holocene, with intervening periods of stabilisation and vegetation (see Section 2.2 above). However, it appears likely that the destabilisation evident in the 1940's was largely human-induced; associated with over-stocking and burning of previously stabilised dunes, which caused widespread issues with migrating sands along this coast (McKelvey, 1999). In particular, this is suggested by the natural re-vegetation and stabilisation of the coastal margin in the following decades; even though transgressive dunes remained active further inland (Figure 4) until stabilised by exotic forest.

Given the recent land use history of pines followed by pastoral faming, the remnant areas of native ecosystems which have developed in recent decades largely occur on the reserve to seaward and in isolated areas along the river margin. However, there are also small but significant areas of kanuka shrubland on the property itself (Dayly, 2020). The majority of the remnant native ecosystems are dune ecosystems, but there are also small areas of estuarine and other wetlands (Dayly, 2020).

3.1 Native Dune Vegetation

Existing Native Dune Vegetation

I conducted a field inspection of the dunes in December 2020, and have also previously inspected the dunes in this area in 2010. This section is also based on the useful site inspection and observations reported by Dayly (2020).

Field inspection indicates the dunes along the seaward margin of the property show a general shore-normal vegetation sequence (i.e. zonation) from spinifex to more complex backdune communities.

The most seaward dune area is characterised by a spinifex-dominated frontal dune, which can be broadly subdivided into two zones.

In the more seaward areas (typically varying in width from 12-20m), the vegetation on this frontal dune is dominated by vigorous spinifex (*Spinifex sericeus*) (Figure 8). This is a critically important zone on this coast, as disruption of this vegetation can lead to serious wind erosion and migrating sand issues over time. Notably, only very limited areas of pingao (*Ficinia spiralis*) occur in this area, though it was very likely a significant (possibly up to 10-20%) component of the spinifex zone prior to human settlement. The present absence likely reflects historic degradation by human activities, including grazing by stock and introduced animal pests (pingao is very palatable species). There are also isolated patches of the exotic marram grass (*Ammophila arenaria*), which is widespread on the Manawatu coast from earlier dune stabilisation work. Any restoration of this area should focus on spraying out the remnant areas of marram and expanding the pingao component (ideally to at least 10% of the dune cover on the most seaward 10-15m of the dune). It is also important to manage any beach access to prevent damage to this vegetation which is very vulnerable to trampling and vehicle damage.

With increasing distance landward, the spinifex generally becomes less vigorous (except in areas subject to disturbance) and there is increased native diversity, reflecting early successional replacement of the spinifex (a pioneer stabiliser) (Figure 9). While spinifex often remains the dominant cover in this area (which commonly extends up to 30m inland from the seaward toe of

Figure 8: View of spinifex-dominated zone at seaward edge of dunes

Figure 9: View of more landward areas of the spinifex zone, where spinifex is less vigorous and gradually being replaced by other species.

dune), it is markedly less vigorous than in the more seaward areas. Other native dune species occurring in this area are most commonly tauhinu (*Ozothamnus leptophyllus*) and knobby clubrush (*Ficinia nodosa*), though both species are typically sparse. Patches of sand daphne (*Pimelea villosa*) also occur in this area, an "At Risk – Declining' species. In a previous inspection of this area in 2010,

I also noted occasional occurrence of *Carex testacea.* Other native species also likely occurred historically.

Unfortunately, this latter zone is now increasingly being invaded by exotic species, most notably yellow tree lupin (*Lupinus aboreus*), a serious dune weed species derived from earlier dune stabilisation and forestry practices. Marram is also common.

Any restoration in this area should focus on elimination of the lupin and marram, and on expanding the existing native vegetation, as well as introducing other native dune vegetation that may occur in this zone naturally (using existing dune vegetation planting guides for this area such as WFT, undated). While difficult to establish and maintain, particular emphasis should be given to protecting and expanding the existing areas of sand pimelea, as this species is declining (in my experience, relatively rapidly) in most areas of NZ in which it occurs. The reasons for the decline are not yet well understood despite some investigation and so it is presently difficult to address he fundamental causes. However, expansion of existing populations has been successful in some restoration work and this is a useful approach until the cause of the decline can be more fundamentally addressed.

Further landward, the knobby clubrush gradually becomes the dominant native plant community and extends back to the seaward edge of the macrocarpa shelter belt (Figure 10). This native plant community is now very extensively invaded by yellow tree lupin. The invasion by the lupin is markedly more widespread than observed in my earlier October 2010 site inspection.

Within and landward of the macrocarpa shelter belt, patches of native dune vegetation (largely knobby clubrush) also occur. However, in these areas, the vegetation is generally dominated by exotic species; predominantly yellow tree lupin and exotic perennial grasses.

However, further landward, in isolated, low-lying areas there are notable patches of kanuka (*Kunzea ericoides*) shrubland, discussed also by Dayly (2020). Limited flax (*Phormium tenax*) and cabbage tree (*Cordyline australis*) also occur in association, reflecting the relatively damp environment (at the time of the field inspection, the ground was generally quite wet in the areas of kanuka). This shrubland has been significantly modified by historic stock access but can be readily restored over time. Areas of native dune shrubland such as this are now very rare on this coast and it is desirable to maintain and enhance these areas and minimise disturbance.

Effect of the Proposed Golf Links

The proposed Links course extends to just seaward of the existing macrocarpa shelter belt (which will be removed). It therefore extends into the landward edge of the dense knobby clubrush and lupin community Figure 10). It will also result in loss of the small patches of native vegetation (largely knobby clubrush) that occur within and landward of the macrocarpa. However, as noted above, most of the latter areas are extensively dominated by exotic species.

In my opinion, restoration work to offset these losses should focus on the dune vegetation seaward of the proposed course. This work will have much higher ecological value than planting small patches of native vegetation within the course itself. The ecological benefits will also increase over time as the shoreline continues to extend seaward, widening the area of native dune vegetation and habitat by around 15-16m every decade. As noted above, at present, native-dominated communities are limited to the nearshore areas with serious (and, over time, increasing) weed invasion in the more landward areas.

The native dune vegetation sequence seaward of the proposed Links course is a sequence typical of stabilised dunes as opposed to the narrow frontal dune backed by transgressive dunes that have historically been more typical on this coast (e.g. the “Foxtangi” remnant area near Foxton discussed by Ravine (1992) and Rapson et al., (2016)). Nonetheless, this wide seaward dune area appears to have naturally stabilised naturally and similar periods of natural stabilisation have occurred on this coast in the past between phases of transgressive dunes. Establishment of a native-dominated dune sequence in this area would in my opinion be a very valuable outcome on a coast where the existing dune vegetation is now extensively dominated by exotic vegetation; particularly weed species (e.g. marram, lupin and *Acacia sophorae*) derived from historic dune stabilisation and forestry practices.

It is suggested that restoration include:

- Clearance of exotic species (particularly yellow tree lupin, marram and gorse) from the area seaward of the course
- Planting of appropriate native dune species in each of the various dune sub-environments noted earlier.

The work will involve a range of activities (e.g. plant and possibly animal pest control, planting, ongoing maintenance, management of human use and disturbance, etc). It will require preparation of a detailed restoration plan as a strategic approach is critical to success in difficult sites like this. An experimental approach will also be required to some elements given the limited experience with successful restoration of native dune communities to date on the Manawatu coast. This coast has unique characteristics which mean that lessons from dune restoration elsewhere, while valuable, will not likely be adequate to address all issues likely to be faced.

The elimination of the yellow tree lupin seaward of the course is likely to be particularly difficult and require a sustained effort over time. Fortunately, the lupin suffers from Lupin blight (*Colletotrichum gloeosporioides*) and is also a relatively short-lived species, both of which factors will aid a well-planned elimination strategy. However, the species also produces large numbers of long-lasting seeds and is a rapidly growing species. It is also taller than the native species it is competing with in this area, and so tends to shade out the knobby clubrush and other natives over time. To prevent

Figure 10: View of knobby clubrush zone, now increasingly dominated by yellow tree lupin.

Figure 11: View of part of the area of Kanuka shrubland.

re-invasion from alongshore areas to the south will also be a challenge. It will likely require the establishment of a dense native vegetation community in the area currently dominated by knobby clubrush and lupin. The elimination of the lupin and replacement with natives will therefore require a well-planned and executed strategy, and persistence over a number of years. In more landward areas of the sequence immediately seaward of the proposed Links course, it may also be possible to establish hardy native shrubland communities over time; though planting losses will likely be significant (requiring very careful species selection and some experimentation) and growth rates are likely to be slow.

The kanuka shrubland within the property was identified as a constraint in the original design, with the course designed to minimise damage to this vegetation to the maximum possible extent. Most of the existing areas of kanuka shrubland have been retained and incorporated into the design of the course. Where small areas of the kanuka are removed, it is recommended that these be balanced by further planting, ideally adopting a 2 for 1 ration between the area replanted and the area lost.

3.2 Estuarine Vegetation

The majority of the original saltmarsh and estuarine wetlands in the Ohau River originally occurred on the southern side of the river, as the northern side has tended to be characterised by dunelands.

However, a small but useful area of saltmarsh wetland occurs along the Ohau River margin of the property as discussed mapped by Dayly (2020). This small area occurs in a small embayment formed by an historic meander bend. Over time, the slow ongoing erosion along the northern side of the Ohau River (see Section 2.4) will gradually diminish this area of wetland. However, it is nonetheless likely to persist for many more decades and is also worthy of restoration; particularly as most of the original natural areas of estuarine wetland in this river have been lost due to human activities (e.g. drainage and pastoral use) (Smith, 20??).

In addition to the slow river erosion along the seaward margin, the wetland is slowly building up due to ingress of windblown sand from the seaward side. This gradual build-up is largely responsible for the vegetation gradient (shrubland to rushland to herbfield) with distance downstream noted by Daly (2020).While this slow ingress of windblown sand is partly natural, it appears from field inspection to be exacerbated by human activity in this area, particularly vehicle use.

The area of saltmarsh and surrounding native and exotic vegetation is not impacted by the proposed Links course but offers a useful restoration opportunity.

It is suggested that any restoration in this area focus on:

- Improved management of existing vehicle use, ideally containing any use to a narrow defined track landward of the estuarine area and associated riparian vegetation
- Restoration of a native riparian vegetation sequence around the landward margins of the saltmarsh, using such species as oioi, saltmarsh ribbonwood, and flax
- Removal of exotic vegetation (particularly around the riparian margin and also the grass invasion of some parts of the saltmarsh).

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