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Attention
Mr Wayne Spencer
Area Engineer – Northern
Horizons Regional Council

Responses to Whanganui Rivermouth Mole deterioration

1.0 Introduction

Coastal Systems Ltd (CSL) have been instructed by Horizons Regional Council to prepare a brief report on the environmental responses to mole deterioration and failure (under a deliberate lack of maintenance scenario) based on my experience. "The purpose of this short report is to provide a project establishment benchmark from which a decision-making process can develop to determine what is the best option for the future of the moles. The target audience is to be largely internal with the contents used to provide some knowledge and context when discussing the moles with iwi and the Port Revitalisation Partners Group".

I have been a practicing coastal geomorphologist for some 30 years, having undertaken applied projects throughout New Zealand and along the southwest coast of the North Island in particular. I have also undertaken extensive research on the Wanganui Coast and rivermouth. In 2016 CSL prepared the Geomorphological Baseline Assessment in the vicinity of the Whanganui Rivermouth (The Baseline Study), a report prepared as part of the Wanganui District Council's Lower Whanganui River Management Strategy and which is available on the District Council web site. That report describes the morphological changes about the rivermouth between 1842 to 2015 based on available literature. archive materials, some contemporary data, and a range of time-series analyses.

The Baseline Study, together with my own unpublished data and investigations, underpins the present report. The required brevity precludes a quantitative assessment (analysis/modelling) so the responses are necessarily conceptual in nature and without a timeline.

As detailed in the Baseline Study, the Whanganui River estuary, rivermouth and adjacent coasts are extensively controlled by hard structures established, in the main, between the 1880s and the 1920s to assist navigation. These structures, along with sand dune stabilization works, resulted in:

- the northern (Castlecliff) coastline migrating several hundred metres seaward and becoming capped with sand dune;

- the South Spit shoreline location stabilizing and being capped with sand dune. This followed narrowing and breaching of the spit in the 1940s when the south coast was starved of littoral sediment by accretion occurring along the northern coast, and
- the river channel seaward of Landguard Bluff being reformed and fixed against the left (South Spit) bank, a non-natural location that has required considerable maintenance at times.

The Castlecliff coast and the south coast both are systematically progradating (building seaward), and the river channel along the South Spit (the navigational channel) is in the process of attaining a more centralised alignment. Once again details are provided in the Baseline Study.

The following summary of environmental responses is divided into a mole subsidence section and a mole shortening section. For each response, likely impacts and alternative mitigation measures, **i.e. other than mole maintenance**, are also listed.

2.0 Morphological response to mole subsidence

Mole lowering will be accompanied by voids developing, sections collapsing and waves breaking through into the river. The onset of his type of behaviour is currently evident along seaward parts of the South Mole. The following responses may occur:

2.1 Jetting effectiveness at scouring the rivermouth bar system is reduced as outflow escapes through the compromised structure. Such scour maximises during fresh/flood river flows coupled with ebbing tides, especially under higher (spring) range.

Impact: navigation.

Alternative mitigation: dredging.

2.2 Waves washing littoral sand into the river resulting in localised shallowing. This occurred along both moles during the 1920s when the superstructure was in place but had only been raised to half tide level (Figure 1). It also occurred on the South Mole adjacent to the beach during the 1950s, a situation occurring again at present. In these cases the structures were raised to at least high tide level or individual voids were infilled.

Impact: navigation.

Alternative mitigation: dredging.

2.3 Wave penetration and sediment transport patterns in the vicinity of the Port may change as may surge patterns within the Basin.

Impact: navigation and port operations.

Alternative mitigation: usage restrictions.

2.4 Ongoing subsidence of the South Mole (submerged reefs are considered further in Section 4) may allow the river to outflank the structure and river flow to enter the sea along its seaward side.

Impact: navigation and port operations, hazards

Alternative mitigation: usage restrictions.

2.5 Increasing extent and frequency of inundation to low-lying infrastructure and properties at the river end of Tregenna Street.

Impact: river flow inundation.

Alternative mitigation: raising property and infrastructure or removal.

3.0 Morphological responses of mole shortening

Reducing the length of the Moles will release a potentially significant sediment source as sand trapped updrift by the North Mole (*trapped littoral sand*) is released by wave/current action and wind-driven processes. This sediment is presently held in a terrestrial compartment (above mean high water), a broadly triangular shape some 600 m wide at the river and 6 km along the coast, and a tidal/marine compartment (below high water and pinching out at the seaward limit of sediment transport up to 2 km offshore and at a depth of up to 20 m. While this *trapped littoral sand* will likely be released episodically as the moles shorten, the volume and frequency of erosion episodes may, at times, lead to significant environmental responses and impacts.

Figure 1 Partially completed moles in the early 1920s raised to high tide level in the foreground and half tide in distance. Sand is washing into the river from the intertidal beach (located by the asterisk) and evidenced by the breaking waves on the river side of the North Mole – this being an indication of lesser depth. At this time the entire South Mole had been only raised to half tide level.

3.1 Shoreline change on the Castlecliff side of the rivermouth

3.1.1 Sand eroded by waves and currents will be transported alongshore to the rivermouth where it will cross to the south coast via the rivermouth bar (bar bypassing), or be swept into the river by flood tides and subsequently flushed seaward to rejoin the southward littoral stream under high river flow and ebb tide conditions (inlet bypassing). There are considerable uncertainties associated with these processes. At times the volume of released sediment could be considerable and extensive shoaling could occur which in turn would exacerbate upstream flooding.
Impacts: navigation, safety, inundation.

Alternative mitigation: extensive dredging and reduced commercial and recreational activity.

3.1.2 The Wanganui coast is subject to episodes of foredune erosion and this process can be expected to increase in frequency and extent under the shoreline retreat that will accompany mole shortening. If the resulting foredune scarp (sand cliff) is at least 2 m high, wind erodes the bare face and sand funnels through topographic lows where guts (blowouts) can form which rapidly increase in size and bury landward vegetation and property. For example, in 1989 storm waves eroded a 300 m length of foredune immediately NW of the rivermouth car park with a scarp some 2 to 3 m high (Figure 2, lower photo). The resulting unstable dune field now has 34,000 m^2 of bare sand (Figure 2, upper photo).

Impacts: Burial of property and infrastructure, loss of natural area, nuisance from wind-blown sand.
Alternative mitigation: soil conservation measures focusing on contouring and planting.

3.1.3 The matter of whether the shoreline could ever recede to its pre-mole location, thereby having affected considerable property and infrastructure, would require a very long time-scale, especially given the potential protection afforded by the remnant submerged moles (see Section 4). And such retreat would only occur after many other effects (that are now being described) had been experienced and dealt with, some at considerable cost. Climate change (Section 5) could also affect some processes thereby increasing uncertainty.

Impact: loss of property and infrastructure.

Mitigation: sand dune conservation works

Figure 2 Lower photo: wave cut foredune scarp in 1989. Upper photo: resulting unstable dune field some 30 years later.

3.2 Shoreline change on the South Beach side of the rivermouth

Sand from the Castlecliff side will likely reach the south coast within sand bars than will migrate landward and join the beach. Once above high tide level the bare sand is subject to wind erosion with sand desiccating and burying dune vegetation, and wind drifts migrating inland. Such processes create a barren landscape with subdued relief. Figure 3 illustrates the process of wind acting on a seaward sand source to eventually destabilize exiting vegetated sand dunes. This example is from south of the Turakina Rivermouth.

The South Spit could thus become somewhat featureless with wind blown-sand able to reach the river, potentially compromising the navigation channel. Wind drifts could also reach the airport.

Impacts: ecology, natural and recreational values, navigation and airport operations.

Alternative mitigation: conservation works for sand stabilization, dredging.

4.0 Submerged reefs

Mole remnants are likely to persist under both the mole subsidence and mole shortening scenarios. These remnants would create subtidal reefs which may persist for a considerable time. These structures will prevent complete loss of updrift *trapped littoral sand* (on the Castlecliff side) and potentially result in a very wide beach that will dissipate wave energy and provide some shoreline protection thereby limiting shoreline erosion. Figure 1 illustrates how the mole's rock level control the adjacent beach level.

Impacts: extreme navigation and safety hazards for river traffic, widened beach could facilitate wind erosion burying the existing dunes and cause landward sand drifts (the South Beach scenario).

Alternative mitigation: navigation markers, sand conservation works, and usage restriction.

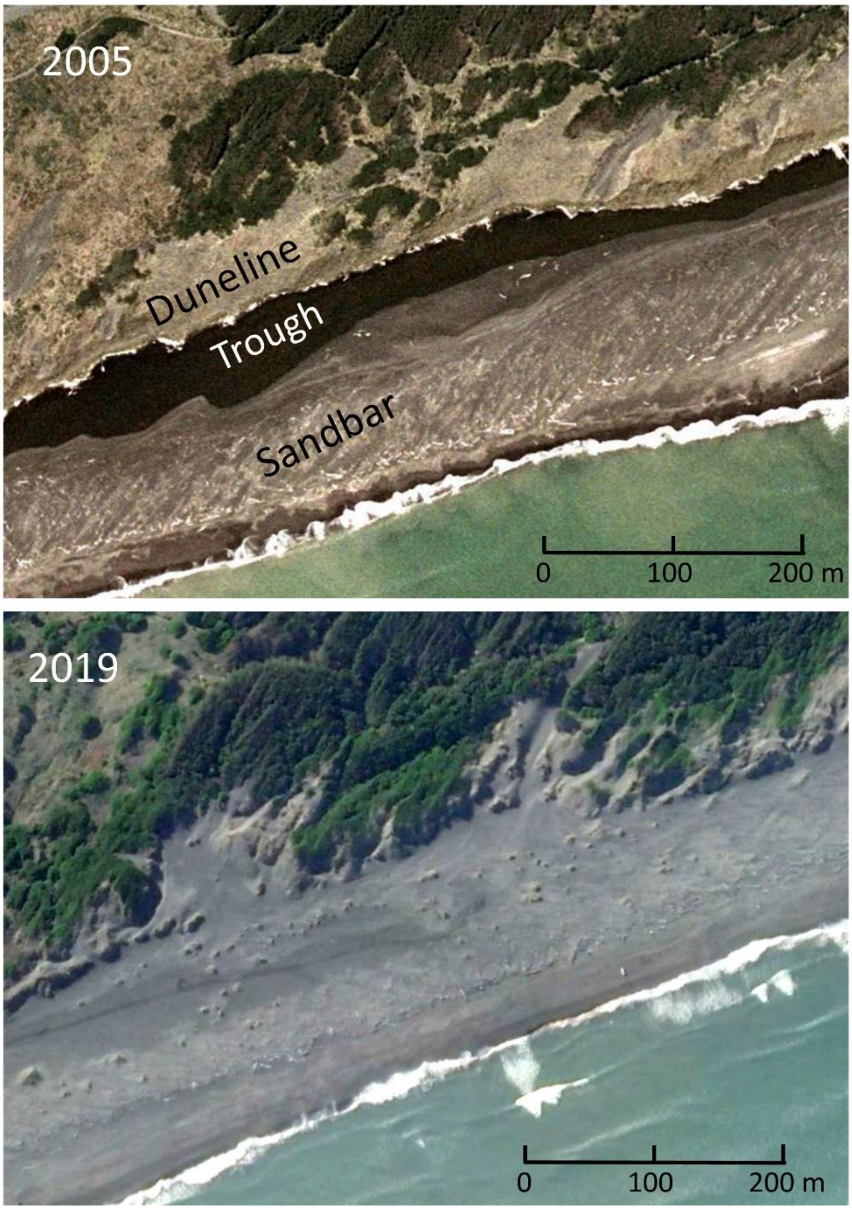

Figure 3 Example of wind-blown sand from a seaward source (sand bar) that infilled the landward trough then buried existing dune vegetation as sand drifts move inland. In this case (near the Turakina Rivermouth) the sand bar supplying the sediment is a spit remnant formed after the river had earlier cut a direct route to the sea.

5.0 Implications of climate change

Ministry for the Environment (MFE) guidelines predict climate change could modify coastal geomorphological processes as follows:

- Sea-levels to rise, perhaps by a 1 m or more over the next 100 years;
- Extreme wave heights and winds to increase, 10% is suggested;
- On this coast, rainfall will increase as will flood flows so fluvial sediment discharge to the coast could well increase.

Geomorphological responses include:

- erosion of both cliff and sandy/foredune-fronted shorelines would increase;
- a change in the background littoral sediment drift along the coast, and
- an increase in aeolian sediment transport potential.

These effects will further complicate the response to mole deterioration.

6.0 Summary

Mole deterioration from a deliberate lack of maintenance will result in systematic subsidence and shortening of these structures and this will have a range of gomorphological responses.

Sedimentation in and about the rivermouth and port will impact navigation and enhance flooding. Shoreline and dune erosion/sand drifting will occur on the Castlecliff side and impact property and infrastructure and compromise recreation and natural character. Shoreline accretion will occur along the South coast resulting in sand drifts potentially reaching the river channel and airport, as well as loss of natural character.

In the absence of mole maintenance, ongoing, and potentially expensive, sand stabilisation works, dredging and hazard management will be required.

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Dr Roger Shand
Principal Scientist