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The CEO
Kapiti Coast District Council
175 Rimu Road
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Attention Mr Matt Aitchison

Erosion Hazard Reassessment: northern shoreline of Waimeha Inlet

1.0 INTRODUCTION

As part of the Kapiti Coast District Council (KCDC) District Plan Review (DPR) process, Coastal Systems Ltd (CSL) have been instructed to carry out a more detailed erosion hazard assessment of the northern side of the Waimeha Inlet than that included in the previous district-wide erosion hazard assessments carried out by CSL in 2008 and 2012. This reassessment addresses matters raised in public consultation including the Question and Answer Session on 1 November, 2012, various written correspondences and the DPR submission from Mr John Harding who owns the property at 21 Field Way, Waikanae Beach which lies at the back of the inlet.

In particular I have been instructed to address the following matters:

1) The coincidence of the managed and unmanaged erosion prediction lines at the rear of the inlet;
2) Incorporation of the effect of a storm water outlet that enters the inlet next to the impermeable groyne located at the rear of the inlet just seaward of the Field Way car park, henceforth referred to as the *car park groyne* (see Figure 1).
3) Reconsider the 1966/1973 partition of shorelines into managed and unmanaged subsets, and
4) Incorporate any other material that has come to hand which could influence the location of the erosion prediction lines.

The Waimeha Inlet is a particularly difficult inlet to predict future shoreline erosion. This inlet was formed in 1921 by an artificial diversion and has been subject to ongoing management, indeed it is subject to more frequent control than any other inlet on the Kapiti Coast. Some detail of the inlets history is provided in CSL (2008) part 2, p34-38, and CSL (2012), p40. Additional information incorporated into this present reassessment consists of more in depth consideration of the Wellington Regional Council (WRC) archive summary report by Easther (1991), consideration of a greater range of aerial photos (1948, 1968, 1973 (April and October), 1988, 2010 and 2013) to interpret the historical and contemporary inlet change, further detail on more recent management practices provided by the WRC, and LIDAR (2003 and 2010) analysis to help assess the effect of these practices on erosion prediction.

2.0 HISTORICAL INLET CHANGE

The Waimeha Stream was diverted from its previous outlet into the Waikanae River (via what is now the Waimeha Lagoon waterway system) in 1921 to permit subdivision and formation of Waimeha Township. Easther (1991) p19, notes that the diversion was aligned with Huiawa Street and entered the sea at a low point in the coastal dunes. Easther further notes that the development of a new estuarine area then commenced and was still occurring (at the time of his publication), and he provides a useful summary (Archive 13) of management practices (up to 1986) used to constrain channel migration (p54 to 55).

The diversion appears to have been carried out by the then county council and a groyne was constructed some time later apparently to control to the streamôs tendency to migrate southward ï this being the focus of property development at that time. In 1945, the newly formed Manawatu Catchment Board (MCB) was petitioned by residents to control the channels southerly movement as the groyne had fell into disrepair. In 1955 the Waikanae Town Board requested the MCB realign the mouth to prevent erosion of the southern sandhills. Further requests were made in 1961 and 1962, but without searching the actual archives it is unclear whether these realignments were carried out and if they were, which side of the inlet was the object of protection. Bracketing aerial photographs of 1957 and 1966 show the Field Way subdivision and property development occurred during this period, so it is possible realignment was for control on the northern side of the inlet. However, it seems more likely that managers were still preoccupied with preventing southerly channel migration and a closer inspection of the 1966 aerial photo confirmed this with evidence of an appropriately located and functioning groyne, this not having been detected in the earlier CSL assessments.

Between 1968 and 1973, Archive 13 describes extensive channel realignment, stream mouth stabilization, and upgrade of an existing permeable groyne. This groyne is likely the same structure as that evident in the 1966 aerial photo, and its effect on channel control is evident in the 1973 and 1980 aerial photographs. It is noted that the alignment of this 1960s/70s groyne is very similar to the bund evident in the 2007 aerial photo (see CSL, 2012, Figure 4.8). However, there is no mention in Archive 13 of which specific area the various 1968-1973 works were intended to control/protect. Nonetheless, the 1968 and 1973 aerial photos do throw some light on the matter with the control of southward channel migration (outflanking the groyne) being evident. The photos also indicate alignment, and possibly bank protection works were carried out between 1968 and 1973 on the north bank in the vicinity of the present car park groyne. In addition, a short impermeable car park groyne is indicated in the 1980 and 1988 aerial photos, with this structure being further developed in the 1993 aerial photo and having reached its present extent in the 1998 aerial photo.

The 2008 and 2012 erosion prediction analysis method partitioned the shoreline data set into 1942 to 1966 for the unmanaged scenario and 1973 to 2007 for the managed scenario. Given the additional information being considered in this reassessment, is this division still appropriate? Considerable management work occurred between 1966 and 1973 and there is some evidence of these works affecting the northern shoreline - at least that area toward the rear of the inlet. The 1966-1973 partition is thus still considered appropriate.

3.0 Stormwater pipe outlet

A storm water pipe outlet adjacent to, and on the north side of, the Field Way car park groyne was not detected during the initial erosion hazard assessments due to accumulated debris obscuring this structure. On the northern side of the groyne the vegetation recedes several metres landward of the groyne terminus and this was interpreted as a result of turbulence associated with tide, stream flow and waves interacting with the structure during higher energy conditions.

The location of the vegetation front is critical as this is the shoreline indicator typically used in coastal erosion hazard assessments. As storm water outlets also result in interactions which reduce vegetation, allowance for this effect is required within the assessment process. Accordingly the seaward terminus of the groyne has now been incorporated into the *inlet migration curve*[1] located along the northern side of the inlet by fitting a parabolic curve between the groyne end and (merged with) the inlet shoreline further seaward. It is noted that this type of function is typically used to model the interface between both natural and artificial structures and an adjacent unconsolidated shoreline.

4.0 Regional Council management

Wellington Regional Council erosion control management policy for the Waimea Inlet is set out in the Wellington Regional Plan and calls for mouth cuts the following situations:

- When the channel crosses trigger lines located 150 m north of the Field Way car park groyne and 250 m south of the groyne (see Figure 1). It was noted by Mr Graham Winterburn, WRC Field Supervisor, Kapiti Area, that some pre-emptive channelization is occasionally carried out to lessen the chance of the trigger lines being reached.

1. The *Inlet Migration Curve* is the reference line from which the erosion prediction line is measured. For further detail see the CSL (2008) assessment, Part 2, Section 2.4, and the CSL (2012) Update assessment, Section 4.1.

- When the channel creates a vertical scarp in the inlet margin sand dunes in excess of 2 m, or
- When the water level increases 300 mm or more above normal at the Field Way road bridge.

The WRC record since 2000 show 24 mouth cuts have been made at the Waimeha Inlet (see Table 1). This compares with 11 cuts at the Waitohu Inlet, 10 at the Mangaone, seven at the Otaki and one at the Waikanae. Furthermore, Mr Winterburn says that in the majority of cases at the Waimeha such management operations applied to the northern side of the inlet due to either the channel broaching the northern trigger line, or channel migration resulting in 2^{+} m scarp in the inlet-margin sand dunes. It is evident that the Waimeha Inlet is subject to considerable management intervention and that over time the focus has shifted from erosion protection on the southern side of the inlet to erosion protection on the northern side. Such a systematic change in erosion focus and control could be expected given the history of constraining channel migration as this gives less opportunity to migrate southward, increased occurrence of erosive flows against the northern side of the inlet will occur.

Table1 Waimeha Inlet mouth cut record: 2000 to2013

Mar-00	Jan-02	Jun-02	Oct-03	Jul-04
Sep-04	Aug-05	Aug-06	Nov-06	Jul-07
Nov-07	Jul-08	Oct-08	Mar-09	Apr-09
Oct-09	Dec-09	Sep-10	Apr-11	Jul-11
Jan-12	Feb-12	Sep-12	Mar-13	

Source: Wellington Regional Council

The current management practice of constraining channel migration is reducing the inletǿs dynamic area and this will result in sand dune infill around the inlet margins. While such practice may reduce inlet erosion hazard potential (from wave, storm tide and stream flow), the practices will need to be ongoing and could result in an increase in dune instability potential (from wind) as the dunes systematically grow higher.

To appreciate the effect of the 2 m escarpment trigger condition on the northern inlet, the 4 metre contour was defined from 2003 and 2010 LIDAR and these are plotted in Figure 1. The 4 metre contour was selected as the typical scarp base associated with channel scour is approximately 2 metres above MSL. These results show that only about 10 % of the 2003 and 2010 four metre contours actually correspond, i.e. no change. Along the outer inlet the 4 metre contour moved landward by up to 10 m during the 2003 to 2010 period, along the mid inlet the contour moved seaward by up to 10 m, and within the inner inlet the contour moved seaward up to 30 m.

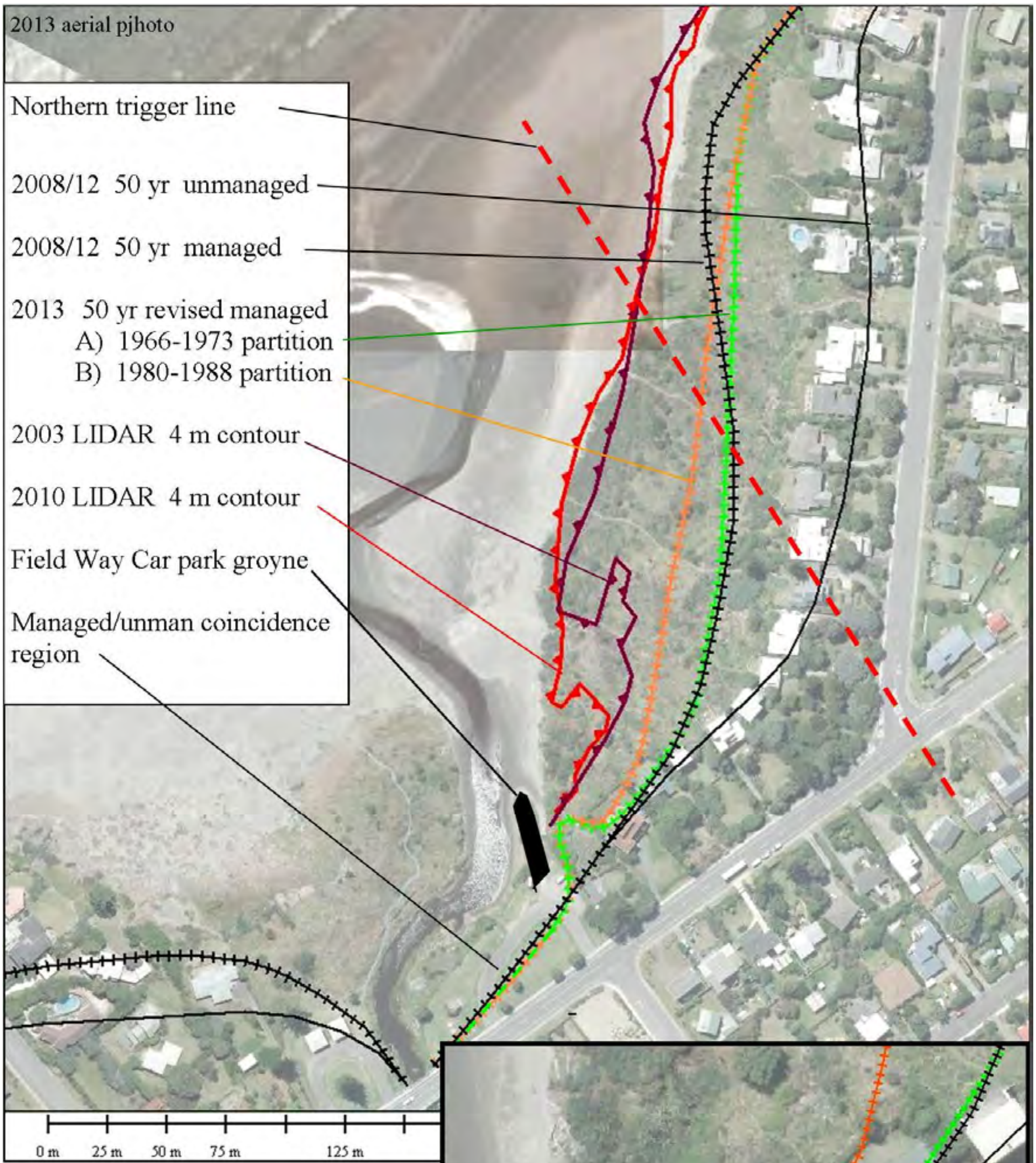

Figure 1 Revised inlet erosion prediction lines incorporating the various sources of additional information described above. Previous (2008 and 2012) prediction lines also shown along with the 2003 and 2010 four metre contours (an approximation for channel management triggered by a 2 m scarp height).

4.0 Additional aerial photo shorelines

The 1973 and 1988 aerial photo-based inlet shorelines used for the previous assessments were of poor quality so improved imagery was acquired, processed and shorelines abstracted. In addition, as the 2010 and 2013 aerial images are now available, these samples were also processed and shorelines defined. Figure 2 depicts the revised set of shorelines which were then incorporated within the inlet erosion remodelling.

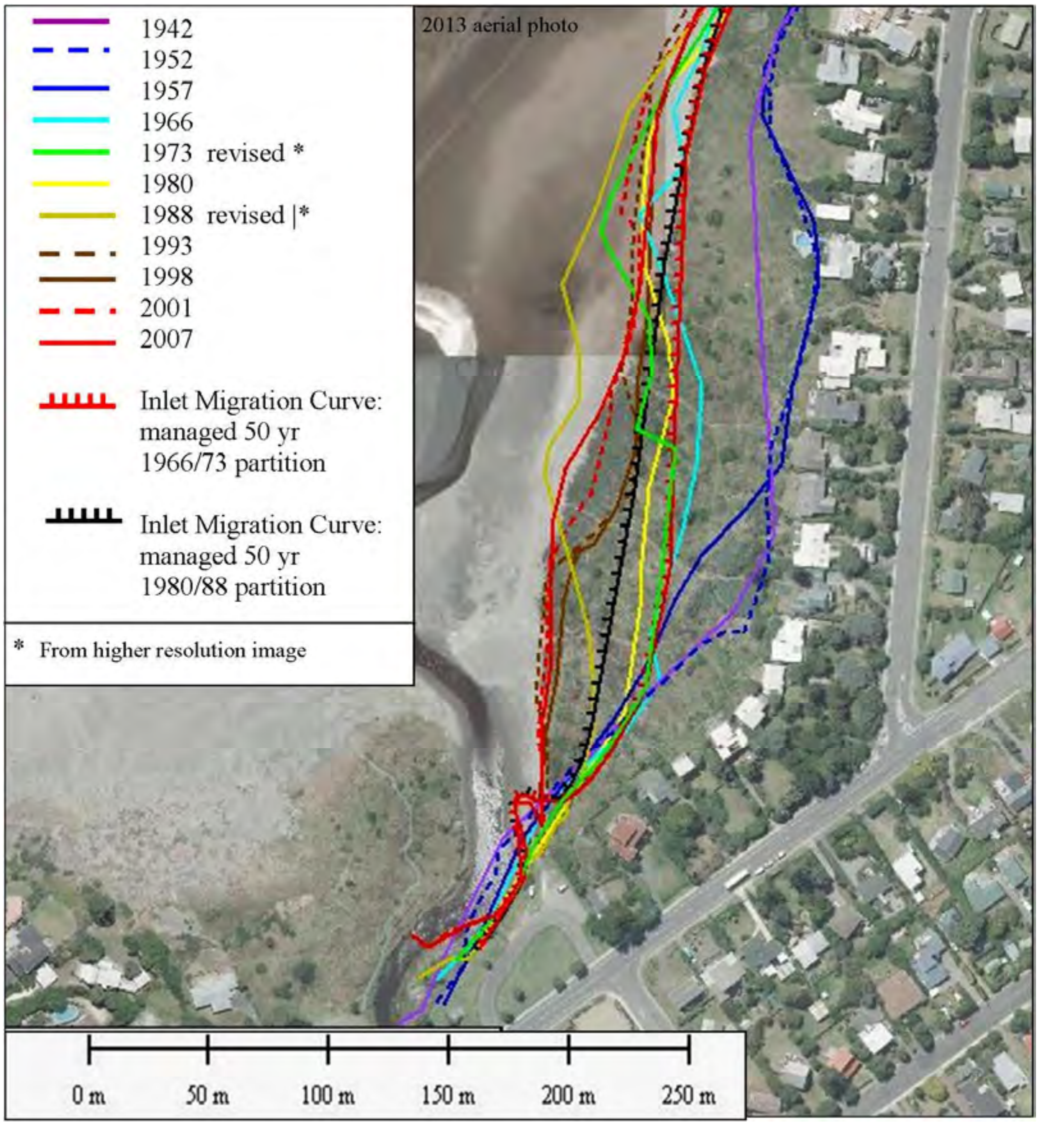

Figure 2 Northern Waimeha Inlet revised shorelines and inlet migration curves for 50 yr managed assessments based on 1973 to 2013, and also 1988 to 2013, shoreline analyses.

5.0 Revised prediction lines

The revised 50 yr managed inlet erosion prediction line based on 1973 to 2013 shoreline analysis and incorporating the various sources of additional information described above is shown by the green crossed line in Figure 1. Note that the associated inlet migration curve is depicted in Figure 2 (red racked line). For comparison the 2008 and 2012 managed 50 yr erosion prediction line is also depicted in Figure 1 (black crossed line). There are several differences between the revised and earlier erosion prediction lines and these are now described.

The inclusion of revised 1973, 1988 shorelines resulted in the prediction line moving seaward (at right angels to the inlet shoreline) up to 21 m in the vicinity of the car park groyne and landward by up to 13 m along the outer inlet. The prediction line along the central section has moved seaward by up to 4 m.

The LIDAR analysis shows the 4 m contour to be temporally dynamic which infers that the trigger-based management may reduce but not necessarily prevent landward erosion. To provide an indication of such management-constrained erosion prediction, analysis was carried out using only the 1988 to 2013 shorelines. This result is shown by the orange crossed line in Figure 1, with the associated inlet migration curve depicted by the black racked in Figure 2. The 1988-2013 based prediction line is up to 20 m seaward of the revised 1973-2013 based prediction line within the central section, but is similarly located toward the landward and seaward ends of the inlet.

When deciding whether or not to adopt a more constrained (1988 to 2013-based) erosion prediction line we should be mindful that (i) the LIDAR results in Figure 1 indicate management will reduce rather than prevent erosion, (ii) the matter of long-term stability of inlet sand dunes may result in a future council deciding that a more natural/dynamic inlet behavioural regime is appropriate, and (iii) erosion hazard assessments are required to be conservative. Each of these matters supports the adoption of the revised 1973-2013 based erosion prediction determination.

6.0 Managed/unmanaged coincidence

The coincidence of 50 yr managed and unmanaged erosion prediction lines in the 2008 and 2012 assessments occurred along the back of the inlet (indicated in Figure 1) due to there being minimal variation in landwardmost shoreline variation between the unmanaged shorelines (1942 to 1966) are the managed set (1973 to 2007). The associated inlet migration-curves for both unmanaged and managed are coincidental and thus the final erosion prediction lines also coincide. However, as can be seen in Figure 1, the revised 50 yr managed prediction line does show some variation to the unmanaged

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prediction line; this being due firstly to incorporation of the car park groyne influence which, downstream of the structure, offsets the managed prediction line seaward. And secondly, immediately upstream of the groyne, the managed line is a few metres landward, this latter modification being due to a more accurate determination of the 1988 shoreline.

7.0 Recommendations

1) That long-term environmental implications of the present inlet management (erosion) regime be assessed, and

2) That the 50 yr managed erosion inlet line be that based upon analysis of the revised 1966/1973 partitioned shoreline data set.

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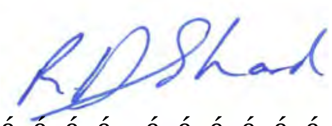

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