File PAC-08-02
Concessions
(Pourerere Baches)

IMPLICATIONS OF NATURAL HAZARDS ALONG POURERERE BEACH, CENTRAL HAWKE'S BAY DISTRICT, NORTH ISLAND EAST COAST

Report prepared for the Department of Conservation, East Coast Hawke's Bay Conservancy

C.R. 2007/2

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EXECUTIVE SUMMARY

Sections 1-23 at the south end of Pourerere Beach were first subdivided by the Crown in 1927 from a Landing Reserve with leases offered to the public from 1927-1929 by the District Lands & Survey Office. Since 1974-1975, the lessees have a right of renewal of 33 years in perpetuity. The present 33 year-term expires for the 23 properties between 31 December 2006 and 30 June 2008.

The 23 Sections face east-northeast and are located at the back of a narrow coastal plain of low sand dunes about 3.5-4.5m above MSL which overlie a wave cut shore platform cut by the sea over the last 7300 years from Late Tertiary Mudstone. In 2006, Sections 1-12 were about 35-44m landward of the seaward toe of the foredune (duneline) and Sections 13-23 about 13-37m landward of the duneline. All 23 Sections are backed by a 35-40^0 hillslope partly vegetated in slope stabilizing trees and shrubs.

Since survey records began in 1927, the duneline has advanced from accretion of sand by 29-34m by Sections 1-12, and 9-31m by Sections 13-23 up to 2006. The long-term trend of duneline advance has been punctuated by short-term duneline fluctuations of the order of 3-9m during episodes of storm erosion such as the 1970s. Following such episodes the duneline has continued to advance from a plentiful supply of sand to Pourerere Beach.

Because of their distance inland, Sections 1-23 are not subject to, or likely to be subject to short-term duneline erosion-accretion cycles this century. Sections 20-23 are likely to be subject to duneline erosion from a sea level rise of 0.8m by 2100 whereas Sections 1-19 are not subject to, or likely to be subject to, such erosion this century, owing to the effects of accretion.

We have not fully evaluated the risk to the 23 Sections of the potential hazard of sea flooding during severe wave storms or tsunami, or landslip from the hillslope behind the sections. We note, however, that a probable storm tide or tsunami of 4±0.5m above MSL would temporarily inundate the properties to a greater or lesser degree. There are cracks in the ground and slump scarps on the hillslope behind indicating a potential for slope failure during prolonged heavy rain accompanied by earthquakes.

Under the Proposed Hawke's Bay Regional Coastal Environment Plan (RCEP), proposed rules which have the statutory force of the RMA, are based on a framework of 3 coastal hazard risk zones; CHZ-1, CHZ-2 & CHZ-3. The former two cover sea erosion and the latter (CHZ-3) flooding from the sea. As Sections 1-23 are landward of CHZ-1 assessed in this study the Proposed RCEP rules as applied by Hawke's Bay Regional Council (HBRC) and Section 71 of the Building Act 2004 as applied by Central Hawke's Bay District Council (CHBDC), should not apply to these Sections. Although Sections 1-19 are also landward of CHZ-2 assessed in this study, Sections 20-23 at the south end of Pourerere Beach are located in CHZ-2 to a greater or lesser degree. The Proposed RCEP rules and Section 72 of the Building Act 2004 would apply to Sections 20-23 only.

For Sections 20-23 within CHZ-2, resource consents will be required from HBRC, to either replace a structure damaged or destroyed by the action of the sea (*Non-Complying Activity*), or construct a new building or perform external building work (*Restricted Discretionary Activity*). Under Section 72 of the Building Act 2004, CHBDC would issue building consents but in doing so would impose a Section 72 notice on the Certificate of Title for Sections 20-23. All or part of Sections 1-23 lie within CHZ-3 but the Proposed RCEP rules are less restrictive and resource consents are not required.

TABLE OF CONTENTS

FIGURES

TABLES

IMPLICATIONS OF NATURAL HAZARDS ALONG POURERERE BEACH, CENTRAL HAWKE'S BAY DISTRICT, NORTH ISLAND EAST COAST

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1. INTRODUCTION

On 7 March 2007, Coastal Management Consultancy Ltd (CMCL) were commissioned by the Director General of the Department of Conservation (DoC), through the East Coast Hawke's Bay Conservancy, to provide advice to Crown Counsel, Crown Law, to assist in proceedings before the Napier Land Valuation Tribunal, concerning the land value of 23 beachfront properties at Pourerere Beach (the study area) which are leased from the Department.

Crown Law are concerned that the likely value of the 23 properties could be affected by both exposure to natural coastal hazards and the Hawke's Bay Regional Council's (HBRC) Proposed Regional Coastal Environment Plan (RCEP), released by HBRC in August 2006 (HBRC 2006). Accordingly, Crown Counsel have requested specific advice from CMCL on:

1. The plan process and the likelihood of the Proposed RCEP being implemented.
2. The effect of the Proposed RCEP on the properties, especially the likelihood of their obtaining building consents.
3. The nature of hazards affecting each property.

The purpose of this report is to provide the advice requested on the above three points. Figure 1 shows the general location of the study area within the Hawke's Bay region and Figure 2 is a fully rectified orthophotomap showing Sections 13-23 at the southern end of Pourerere Beach and Sections 1-12 north of the Pourerere Caravan Park.

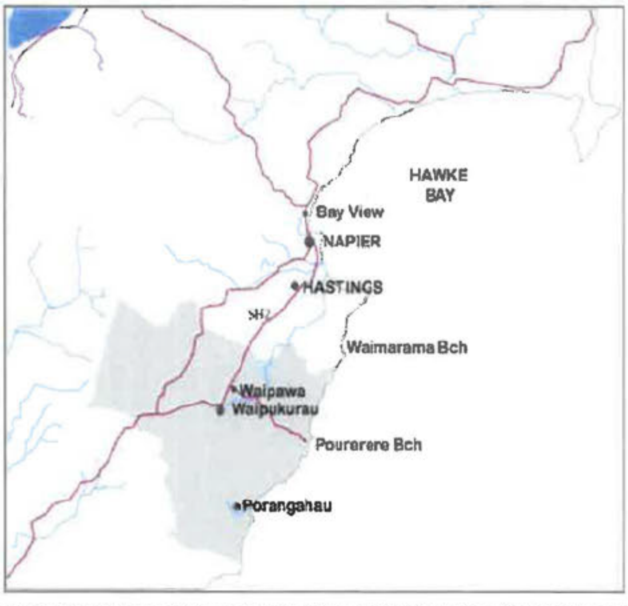

Figure 1: Sketch map of area showing the general location of Pourerere Beach and Central Hawke's Bay District.

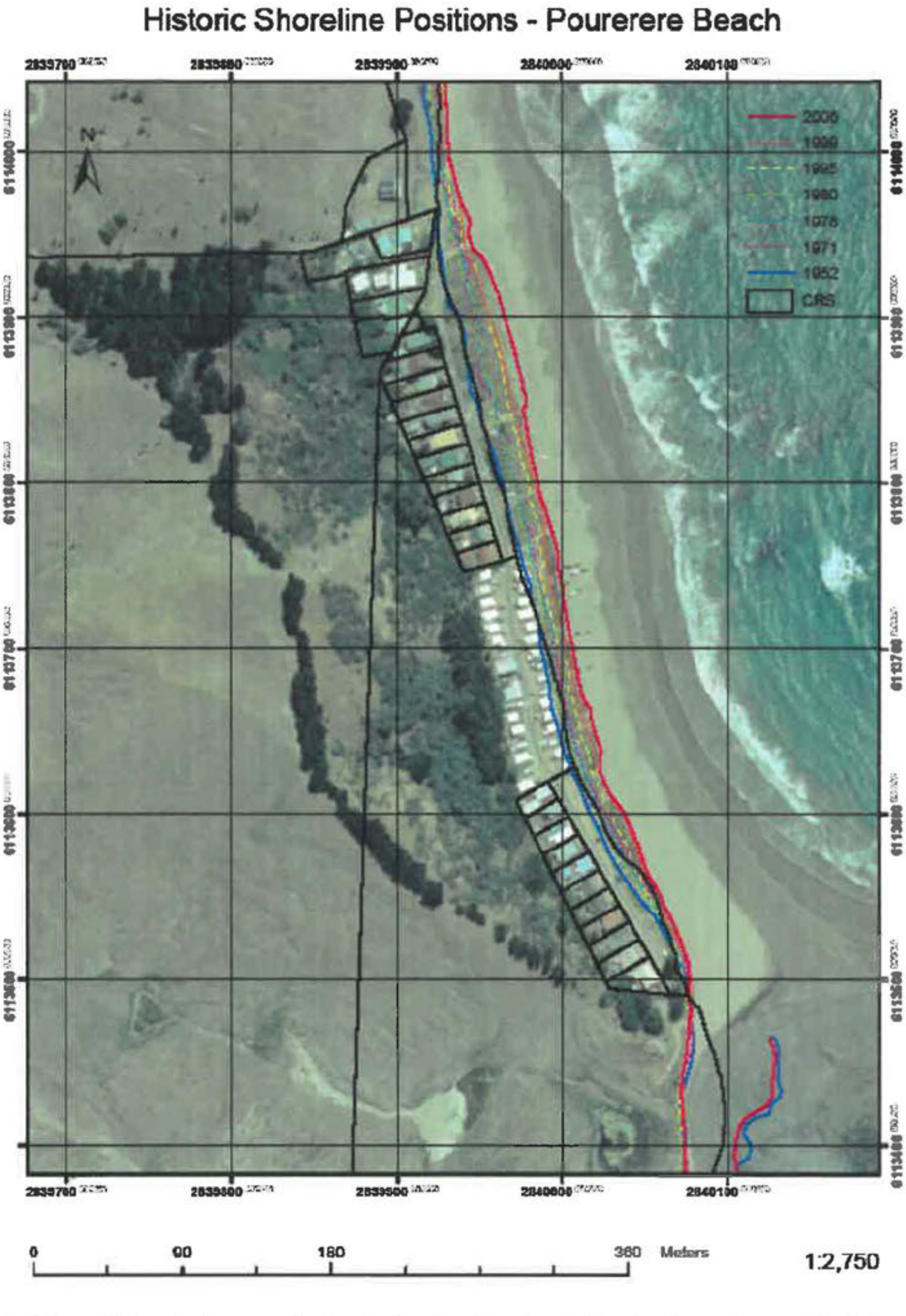

Figure 2: Fully rectified orthophotomap showing the location of Sections 1-23 within the study area. NZAM photomap at 1:2750 Scale from 2006 Aerial Survey.

2. METHODS

On 1 & 2 May 2007, CMCL based at Aramoana, made a detailed field inspection of the study area both on foot and with a 4WD vehicle at low tide. Because of favourable weather and sea conditions, the inspection was extended south of the study area along the beach to Aramoana and south of Aramoana to Blackhead. These extended observations helped provide a context for understanding coastal processes and natural hazards along Pourerere Beach.

On 3 May 2007, CMCL assisted NZ Aerial Mapping Ltd (NZAM) in Hastings with identifying and mapping the seaward toe of the foredune (duneline) and seacliff (cliffline) from historical aerial photographic surveys of Pourerere Beach from 1952-2006 listed in Table 1.

Table 1: Aerial surveys (SN etc.) and cadastral plans (SO etc.) covering Pourerere Beach utilised in this study to quantify the extent and rate of historical shoreline movements. Note MHW is the line of Mean High Water Mark along the beach and is generally seaward of the duneline and cliffline (seaward toes of foredune and seacliffs, respectively). Although both the 1927 & 1975 cadastral surveys record the seaward "*limit*" or "*edge*" of vegetation, we interpret that to closely approximate the duneline mapped by photogrammetry.

SURVEY NUMBER	SURVEY DATE	NOMINAL SCALE	SURVEY COVERAGE
SO1591	May 1927	2 chains/1 inch	Duneline & MHW
SO 1603	September 1927	1 chain/1 inch	Sections 1-23 & MHW
SN 230	12 May 1952	1:16,000	Duneline & cliffline
SN 3483	9 September 1971	1:24,000	Duneline & cliffline
SO 6741	January 1975	1:400	Sections 1-12 & duneline
SO 6751	January 1975	1:400	Sections 13-23 & duneline
SN 2992	28 October 1976	1:47,000	Duneline & cliffline
SN 5761	25 October 1980	1:25,000	Duneline & cliffline
SN 9410	18 March 1995	1:25,000	Duneline & cliffline
SN 12541	27 January 1999	1:50,000	Duneline & cliffline
SN 50529C	17 January 2006	1:40,000	Duneline & cliffline

Prior to the photogrammetric mapping of cliffline and duneline positions by NZAM, CMCL studied contact prints from the 7 aerial surveys at the nominal scales given in Table 1.NZAM used the 1976 Aerial Survey to provide accurate survey control for all 7 aerial surveys (Table 1) from 1952 (SN 230) to 2006 (SN 50529C). A fully orthorectified photomap was produced from the 2006 Aerial Survey as a base map to precisely layer historical shoreline positions on. A photogrammetry Project Report by NZAM describing the methods used by them is provided in Appendix A (Lorraine Claydon, Photogrammetry Production Manager, NZAM Ltd).

On 4 May 2007, CMCL researched and obtained copies of early cadastral survey plans from 1927 (SO 1591) to 1975 (SO 6741) listed in Table 1 of Pourerere Beach at Surveying The Bay Ltd, Hastings. These plans fixed the position of the duneline at the time of survey with respect to the property boundaries along Pourerere Beach and provided useful historical information. For scaling purposes, all the plans were enlarged to 1:500 at Surveying the Bay Ltd. A reduced copy of the 1927 plan (SO 1591) is shown in Figure 3.

The pattern and rate of shoreline movements was quantified along the study area coast from the photogrammetry. The Tatuk GIS Viewer programme was downloaded from www.tatukgis.com and used to precisely quantify erosion or accretion amounts for various survey intervals (e.g. 1952-1971) and for the entire survey period from 1952-2006 at various stations along the study area coast. The results are recorded in Tables B-1 & B-2 in Appendix B.

Relevant reports and published papers referred to in this study, are listed in the References at the back of this report. In the process of gathering the data CMCL consulted with staff from DoC Napier and Gisborne, HBRC in Napier, Central Hawke's Bay District Council (CHBDC) in Waipawa, and Crown Law in Wellington.

3. HISTORY OF DEVELOPMENT

The following chronological summary of the history of subdivision and development of the 23 Sections at Pourerere Beach was derived from the plans and photographs listed in Table 1, from information provided by Quotable Value Ltd, Napier, DoC, Gisborne (Jessica Hogan, Community Relations Officer), and from Central Hawke's Bay District Council (John Glengarry, Regulatory Services Manager)..

1888: A block of coastal land was designated and gazetted a 24 acre 3 rood zero perches (10.016ha) "*Landing Reserve*" as a landing place from the sea on Section 32, Block XII, Pourerere Survey District, Patangata County, including land eventually covered by Sections 1-23 and the Pourerere Caravan Park.

1927: Sections 1-12 and 13-23 within the Landing Reserve were first surveyed by A.J. Watttie, Staff Surveyor, providing a total land area of 2 acres, zero roods, & 14.38 perches (0.8457ha).

Both Pourerere Domain and Recreation Reserve within the 10.016ha Landing Reserve were also gazetted that same year.

The 1927 survey plan (SO 1591) shows buildings (cottages) on Sections 1, 6, 7, 9, 10 and 16 prior to the offering of leases, as well as 4 buildings on Sections North and adjacent to Section 1 (Figure 3).

1927-29 Leases first offered (22 November 1927) by public auction by the District Lands & Survey Office for Sections 1-23 for 21 years with right of renewal for a further period of 21 years, the leases commencing between 15 December 1927 and 10 January 1929.

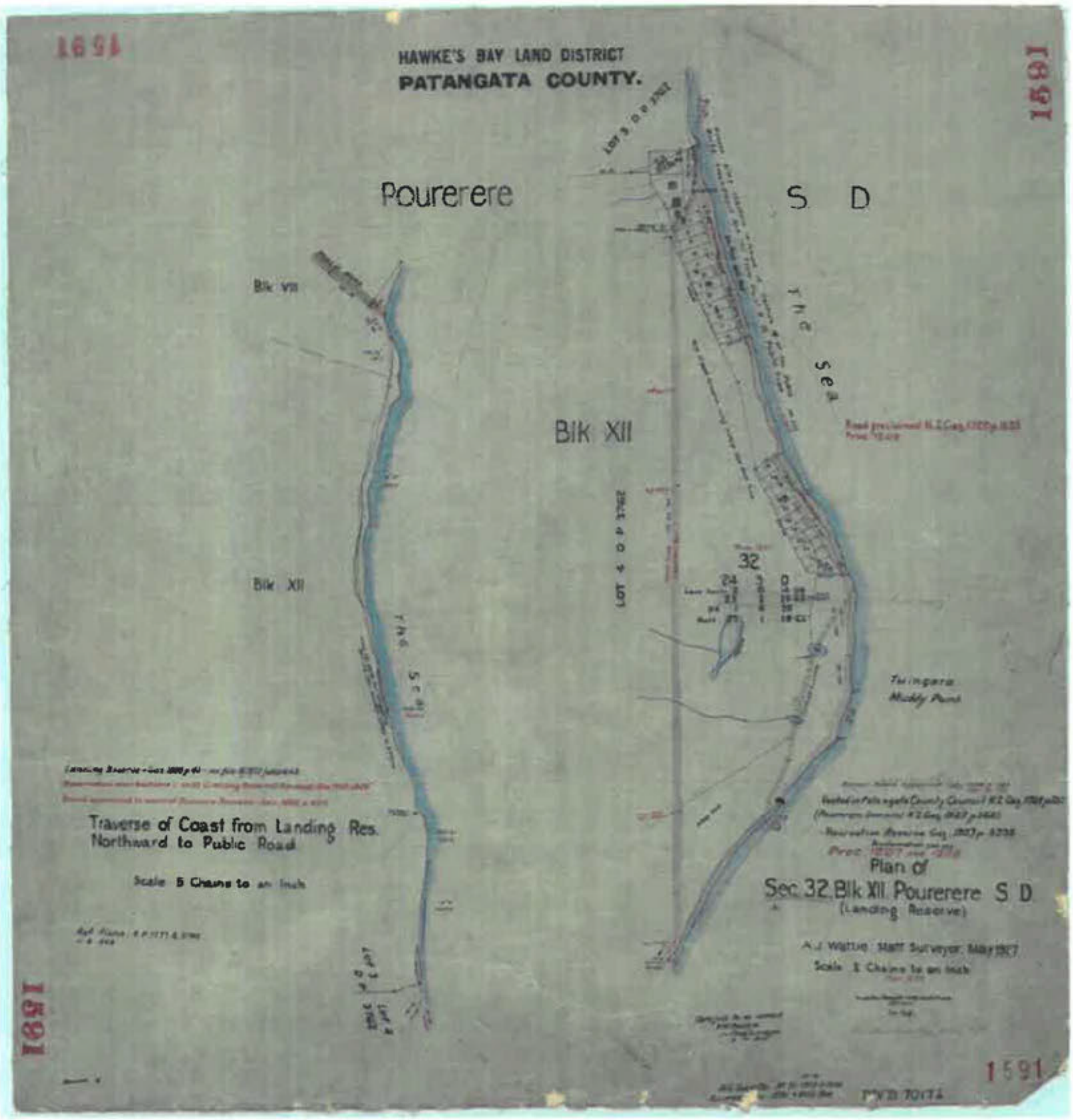

Figure 3: The 1927 Survey Plan (SO 1591) showing buildings on Sections 1, 6, 7, 9, 10 and 16.

1928: Public road proclaimed between the seaward boundary of the 23 sections and MHW occupying an area of 1 acre, zero roods & 26 perches (0.471ha) and vested in Patangata County Council.

Access to the 23 Sections and Landing Reserve was by way of the sandy beach along the coast at low tide.

1952: Aerial survey (Table 1) shows baches on all 23 Sections and no buildings or caravans on the Recreation Reserve separating Sections 1-12 to the North and Sections 13-23 to the

South.

1954: Domain Board appointed to control Pourerere Domain.

1969: Minister of Lands revokes the Landing Reserve over both Sections 1-23 and the public road area seaward of the sections.

1974-75: Renewable leases granted under the Land Act 1948 by the Commissioner of Crown Lands, on behalf of the Lessor, Her Majesty the Queen, to the Lessees of Sections 1-23 for a new renewable term of 33 years commencing between 1 January 1974 and 1 July 1975.

1975: Detailed plan of Sections 1-12 (SO 6741) and 13-23 (SO 6751) surveyed by J. Woodhall showing all dimensions and locations of baches on all 23 Sections including their relative distances from property boundaries and whether some were over various boundaries (Sections 12, 18, 23) or Sections were unoccupied (Section 7).

1971-76: Aerial surveys (Table 1) show that Pourerere Beach Road was extended along narrow coastal strip above the beach from 1971-1976 to Pourerere Beach settlement and Pourerere Caravan Park.

1987: The Director General of Conservation replaced the role of the Commissioner of Crown Lands as the representative of the Lessor regarding the administration of renewable leases over Sections 1-23.

1989: DoC appointed Central Hawke's Bay District Council to manage and control the Recreation Reserve including Pourerere Caravan Park.

2006: Aerial Survey (Table 1) shows baches on all 23 Sections and many caravans and a building on the Pourerere Caravan Park.

2006-08: The term of 33 years for the leases on the 23 properties expires between 31 December 2006 and 30 June 2008.

Under the terms of the leases, the lessees have a right of renewal of 33 years in perpetuity.

4. PROPOSED RCEP

In August 2006, the Proposed RCEP was publicly notified by HBRC and submissions were invited. HBRC received 200 submissions and 33 further submissions on the Proposed RCEP. The submission period has now closed and Hearings will commence on Monday 30 July 2007, continuing through August. As Local Body elections are planned for October 2007, it is intended that HBRC's decisions on those submissions will be issued prior (Gavin Ide, Senior Planner, HBRC, pers. comm. May 2007).

4.1. COASTAL HAZARD ZONES (CHZ)

An information sheet issued by HBRC in relation to the understanding of coastal hazards within the RCEP is provided in Appendix C. The Proposed RCEP's rules are based on a framework of 3 coastal hazard risk zones defined in the 2004 Hawke's Bay Regional Coastal Hazard Assessment for HBRC by Tonkin & Taylor Ltd, Auckland (T&TL 2004) and revised in subsequent reports (T&TL 2005a; 2006a; 2006b). The 3 risk zones are defined in the Proposed RCEP (HBRC 2006, pg 211), as:

CHZ-1 (Coastal Hazard Zone 1)

"Means an area within which land is assessed as being subject to storm erosion, short-term fluctuations and dune instability".

CHZ-2 (Coastal Hazard Zone 2)

"Means an area of land assessed as being potentially at risk up to 2100 due to long term rates of coastal erosion and at some locations, may also include areas assessed as being potentially at risk of sea water inundation in a 1-in-50 year combined tide and storm surge event. It includes allowance for sea level rise, but does not include land within Coastal Hazard Zone 1 or Coastal Hazard Zone 3".

CHZ-3 (Coastal Hazard Zone 3)

"Means an area of land assessed as being potentially at risk of sea water inundation in a 1-in-50 year combined tide and storm surge event, and includes allowance for sea level rise, but does not include land within Coastal Hazard Zone 1 or Coastal Hazard Zone 2".

4.2. PROPOSED RCEP RULES

Rules within the Proposed RCEP (August 2006) either allow, restrict or prohibit activities located in CHZs. Relatively stricter controls apply in CHZ-1 which lies adjacent to the beach and is exposed to greater hazard impacts compared to CHZ-2 which lies landward and adjacent to CHZ-1 and has lesser restrictions. Dwellings and other habitable buildings in CHZ-3 are not controlled by rules in the RCEP as the 2004 Building Code already requires those buildings to be built above predicted flood levels. In summary from Appendix C, the applicable rules to Sections 1-23 at Pourerere Beach are:

CHZ-1

It is a *Permitted Activity* (ie: not requiring a resource consent from HBRC), to replace, maintain, repair, remove or demolish a lawfully established building or structure, damaged or destroyed by something other than the sea. However, effects of such building work must be of a similar scale, character and intensity to effects of the existing structure(s).

It is a *Non-Complying Activity* (ie: requiring a resource consent from HBRC) to construct a new building or perform any external building work, and replace a structure (including buildings) damaged or destroyed by the action of the sea.

CHZ-2

It is a *Permitted Activity* (ie: not requiring a resource consent from HBRC) to replace, maintain, repair, remove or demolish a lawfully established building or structure, damaged and destroyed by something other than the sea. However, effects of such building work must be of a similar scale, character and intensity to effects of the existing structure(s).

It is a *Non-Complying Activity* (i.e.: requiring a resource consent from HBRC), to replace a structure damaged or destroyed by the action of the sea.

It is a *Restricted Discretionary Activity* (ie: requiring a resource consent from HBRC) to construct a new building or perform any external building work.

CHZ-3

It is a *Permitted Activity* (ie: not requiring a resource consent from HBRC) to replace, maintain, repair, remove or demolish a lawfully established building or structure, damaged or destroyed by something other than the sea. However, effects of such building work must be of a similar scale, character and intensity to effects of the existing structure(s).

The 2004 Building Code specifically requires floor levels of habitable buildings to be constructed above flood levels resulting from a 1-in-50 year storm event having a 2% annual exceedance probability (2% AEP).

Although the above proposed rules apply now in the Hawke's Bay region, including the study area, it is important to emphasize that the rules may either remain the same or be revised, over the next few years, as a result of deliberations by both HBRC's Hearing Committee and the Environment Court.

4.3. GRANTING BUILDING CONSENTS

Under the Building Act 2004, Central Hawke's Bay District Council (CHBDC) has the responsibility to issue building consents throughout its District including the Pourerere Beach area. CHBDC's District Plan makes no reference to the CHZ-1, CHZ-2 and CHZ-3 framework in HBRC's Proposed RCEP as the coastal hazard risk zones were implemented after their District Plan became operative. Under the circumstances, CHBDC control building consents through Sections 71 & 72 of the Building Act 2004 (John Glengarry, Regulatory Services Manager, CHBDC, pers. comm. May 2007).

CHZ-1

Under Section 71 of the 2004 Act, CHBDC refuses to issue a consent for building work in this risk zone. Section 71 states that Council must refuse to grant a consent for building work where the land is subject to natural hazards such as erosion and flooding from the sea, unless it considers the building work or land can be adequately protected from these natural hazards. By preventing owners building in CHZ-1, Council is of the opinion that they and any insurer are avoiding liability issues. (John Glengarry, pers. comm. May 2007).

CHZ-2

Under Section 72 of the 2004 Act CHBDC would issue building consents but in doing so would impose a Section 72 notice on the Certificate of Title, thereby exempting Council from any future liability for damage or destruction of buildings by the action of the sea. (John Glengarry, pers. comm. May 2007).

CHZ-3

It is Council's opinion that buildings within this risk zone are not subject to substantive risk so that as for CHZ-2, Section 72 of the Building Act 2004 is applied when granting a building consent (John Glengarry, pers. comm. May 2007).

4.4. 2006 POURERERE (SOUTH) CHZ

In 2004 Tonkin & Taylor Ltd assessed both a Coastal Erosion Hazard Zone (CEHZ) and Coastal Flood Hazard Zone (CFHZ) for the study area, described as Pourerere (South) (T&TL 2004). In 2005 and 2006, T&TL revised the 2004 Pourerere South CEHZ and assessed a "*Cliff Hazard Zone*" as well (T&TL 2005; 2006a; 2006b). Based on this work it is possible to define widths below for both CHZ-1 and CHZ-2 for erosion hazard, plus inundation levels for CHZ-3 for the study area. According to HBRC the CHZs within the Proposed RCEP are based on the most recent assessments by T&TL (Gavin Ide, pers. comm. May 2007).

4.4.1. Sea Erosion Hazard

T&TL (2004, 2006a) have used the following empirical equation to determine the width of a CEHZ, where:

$$\textbf{CEHZ} = \textbf{ST} + \textbf{SE} + \textbf{LT}_{10} + \textbf{DS} + \textbf{SL} + \textbf{LT}_{100} \qquad \text{Eqn [1]}$$

Where; **ST** = Horizontal fluctuation of the 1.0m MSL beach contour approximating the level of MHWS, of 28m equal to two standard deviations of annual shoreline movements as measured from 5 years of beach profile data comprising 6-7 surveys, surveyed at Waimarama beach between 22 December 1997 and 19 December 2002.

SE = Horizontal fluctuation of the 1.0m MSL beach contour (MHWS) of 14m equal to one standard deviation of annual shoreline movements from the same profile data source at Waimarama.

DS = Horizontal distance from the 1.0m beach contour to the duneline at Pourerere Beach of 41.5m.

SL = Potential erosion from sea level rise (SLR) for a SLR of 0.5m above 1990 levels by 2100, using the Bruun Rule.

LT = Long-term rate of shoreline retreat of -0.18m/year quantified by dividing nearby shore platform widths by an assumed formation age of 6,500 years and multiplying the rate by either 10 or 100 years.

Table 2 summarises the CEHZ assessment according to the parameters used by T&TL in 2004 and 2006. For the 2004 assessment the CEHZ width is measured landward from the duneline whereas for the 2006 assessment the width is measured landward from the 1.0 MSL beach contour approximating MHWS which adds a further 41.5m of upper beach on to the overall width.

Table 2: Parameters used by T&TL (2004; 2006a) to assess the width of a CEHZ at "*Pourerere South*" which comprises both CHZ-1 & CHZ-2 risk zones. The 2006 CEHZ assessment applies to HBRCs Proposed RCEP.

FACTORS	LT_{10} (m)	SE (m)	ST (m)	DS (m)	CHZ-1	LT_{100} (m)	SL (m)	CHZ-2	CEHZ
T&TL 2004	1.8	14	28	N/D	43.8m	18	20.5	38.5	82.3m
T&TL 2006	1.8	14	28	41.5	85.3m	18	33.3	51.3	136.6m

NOTE: Normalising both the above CEHZ assessments to the same reference shoreline (duneline) would reduce CHZ-1 in 2006 to 43.8m and the CEHZ width to 95.1m. In 2006, T&TL (2006a) and HBRC used the 2003 duneline as a reference shoreline to offset CHZ-1 & CHZ-2 distances.

In Table 3, Factor SL, the estimated amount of erosion from SLR by 2100, was calculated by T&TL (2004; 2006) using the widely accepted Bruun Rule (1962; 1983; 1988), where;

$$SL = \frac{\ell . a}{h+d} \qquad \text{Eqn [2]}$$

Where; **a** = Amount of sea level rise up to 2100 0f 0.5m.

ℓ = Horizontal distance from the crest of the foredune to the contour representing the offshore beach closure depth from 555m (2004) to 911m (2006).

h = Average height of the foredune above MSL from 3.2m (2004) to 3.7m (2006).

d = Average closure depth below MSL approximately -10.0m.

Table 3 summarises the assessment of Factor **SL** [Eqn 1] using Equation [2].

Table 3: Parameters used by T&TL (2004; 2006a) to quantify Factor **SL** using the Bruun Rule [Eqn2]. The 2006 assessment applies to the Proposed RCEP.

FACTORS	a (m)	ℓ (m)	h (m)	d (m)	SL
T&TL 2004	0.5	555	3.2	10.0	21m
T&TL 2006	0.5	911	3.7	10.0	33m

4.4.2. Sea Flood Hazard

T&TL (2004) estimated inundation levels for land in CHZ-3 at Pourerere Beach using the following factors and adding the estimated component values in Table 4 to determine the CFHZ as follows:

Table 4: Values used by T&TL (2004) to assess inundation hazard at Pourerere Beach. The 2004 CFHZ applies to the Proposed RCEP and is defined as CHZ-3.

FACTORS	VALUES (m)	CUMULATIVE HEIGHTS ABOVE MSL
Mean Sea Level Napier Datum	0.0	
Assumed Mean High Water Springs	1.0	1.0
Assumed Sea Level Fluctuations over periods greater than 6 months	0.2	1.2
Estimated Storm Surge from 1-in-80 to 100 year frequency wave storm	0.9	2.1
Global Sea Level Rise by 2100 recommended by MfE	0.5	2.6
Estimated Maximum wave setup	1.4	4.0
Estimated Maximum wave runup	2.2	6.2

For Pourerere Beach, the maximum estimated inundation level by the end of this century of 6.2m MSL (Table 4) is restricted to CHZ-1 and includes storm wave runup. In contrast, the maximum level applying to CHZ-2 is 4.0m MSL (Table 4) as the effects of wave runup of 2.2m are assumed by T&TL to not extend landward of the area encompassed by CHZ-1. Land below these elevations is expected to be temporarily inundated by the sea during wave storms with an annual exceedance probability of approximately 1-2% (1-2%AEP). T&TL did not review these estimates in 2006.

4.4.3. Cliff Zone Hazard

T&TL (2006b) assessed a general "*Cliff Shore Hazard Zone*" for the coastal hillslopes adjacent to the study area which extended inland some 330-350m from the cliff toe (cliffline) behind Sections 1-23. Although T&TL (2006b) acknowledged that cliff slopes were at risk from the hazard of landslip, the potential risks from this hazard were not considered by them.

4.5. IMPACTS OF PROPOSED RCEP ON SECTIONS 1-23

HBRC provided CMCL with a CHZ map for "*Pourerere (South)*" at 1:3000 Scale showing CHZ-1, CHZ-2, and the 4.0m and 6.2m contours above MSL (CHZ-3) in relation to Section 1-23, so that the impacts of these CHZs on the 23 Sections could be assessed by CMCL. The results are summarized in Table 5.

Table 5: Effects of CHZ-1 & CHZ-2 assessed by T&TL (2006a) on Sections 1-12 and 13-23 at Pourerere Beach, including the 23 baches, where CHZ-1 is offset 43.8m from the 2003 duneline and CHZ-2, 95.1m.

SECTIONS	CHZ-1	CHZ-2
1	Extends 14m into property & includes seaward part of bach	Includes remainder of section plus all buildings
2	Extends 14m into property & includes seaward part of bach	Includes remainder of section plus all buildings
3	Extends 14m into property & includes seaward part of bach	Includes remainder of section plus all buildings
4	Extends 16m into property & includes seaward part of bach	Includes remainder of section plus all buildings
5	Extends 16m into property & includes seaward part of bach	Includes remainder of section plus all buildings
6	Extends 16m into property & includes seaward part of bach	Includes remainder of section plus all buildings
7	Extends 16m into property & includes seaward part of bach	Includes remainder of section plus all buildings
8	Extends 16m into property & includes seaward part of bach	Includes remainder of section plus all buildings
9	Extends 18m into property & includes all of bach	Includes remainder of section plus all buildings
10	Extends 18m into property & includes all of bach	Includes remainder of section plus all buildings
11	Extends 18m into property & includes all of bach	Includes remainder of section plus all buildings
12	Extends 18m into property & includes all of bach	Includes remainder of section plus all buildings
13	Extends 22m into property & includes all buildings	Includes remainder of section
14	Extends 22m into property & includes all buildings	Includes remainder of section
15	Extends 22m into property & includes all buildings	Includes remainder of section
16	Extends 23m into property & includes all buildings	Includes remainder of section
17	Extends 24m into property & includes all buildings	Includes remainder of section
18	Extends 25m into property & includes all buildings	Includes remainder of section
19	Extends 25m into property & includes all buildings	Includes remainder of section

20	Extends 30m into property & includes all buildings	Includes remainder of section
21	Extends 30m into property & includes all buildings	Includes remainder of section
22	Extends 30m into property & includes all buildings	Includes remainder of section
23	Extends 33m into property & includes all buildings	Landward of section

Table 5 reveals that part or all of Sections 1-23 lie within the area of CHZ-1 which extends 14-23m into the properties, generally increasing area southwards within CHZ-1. All buildings on Sections 1-23 have part or all of them within CHZ-1 (Table 5) with the remainder being located in CHZ-2.

In terms of the Proposed RCEP, the rules applying to CHZ-1 impinge on all 23 Sections, and to part or all of the existing buildings on Sections 1-23. The applicable rules are set out in section 4.2 of this report including the firm stance of CHBDC in Section 4.3 regarding building consents.

For CHZ-3, levels determined in this study by photogrammetric techniques reveal that the height of the foredune generally ranges from 2.59m MSL up to 3.31m MSL, generally averaging about 2.9m MSL. Mapping by HBRC reveals that part or all of Sections 1-23 are below 4m MSL, and all are below 6.2m MSL. We conclude from this that the 23 Sections are expected to be inundated by the sea from time to time this century during a 1-2%AEP wave storm event coupled with a progressive rise in sea level up to 0.5m above 1990 levels by the end of the 21st century.

5. FACTS FOUND

The following is a summary of facts found in this study from observations and previous work.

5.1. GEOLOGIC EVOLUTION

i. In the Pourerere Beach area the coast has been sculptured by the sea out of massive light blue-grey calcareous mudstone of Late Tertiary age with relatively hard, erosion resistant calcareous concretions (Kingma 1962).

ii. From about 14000 to 7300 years ago, rapidly rising sea levels at 10-15mm/year as a result of the global postglacial marine transgression following the Last Glacial Period caused widespread coastal retreat everywhere around New Zealand (Gibb 1980), including the study area.

iii. Following the culmination of the global transgression about 7300 calendar years ago (6500 radiocarbon years), sea level fluctuations have not deviated from the present sea level in New Zealand by more than about ±0.5m (Gibb 1986) and the coastline has evolved at this level.

iv. At Pourerere, the sea first transgressed about 1km inland within the Pourerere Stream valley about 7330 radiocarbon years ago (Ota *et al.* 1990) and has cut shore platforms from the Late Tertiary mudstone ranging in width from about 195m south of Tuingara Point up to 510m at the Point adjacent to Section 23 (Figure 4) during the 7300-year period of relatively stable sea level.

Historic Shoreline Positions - Pourerere Beach

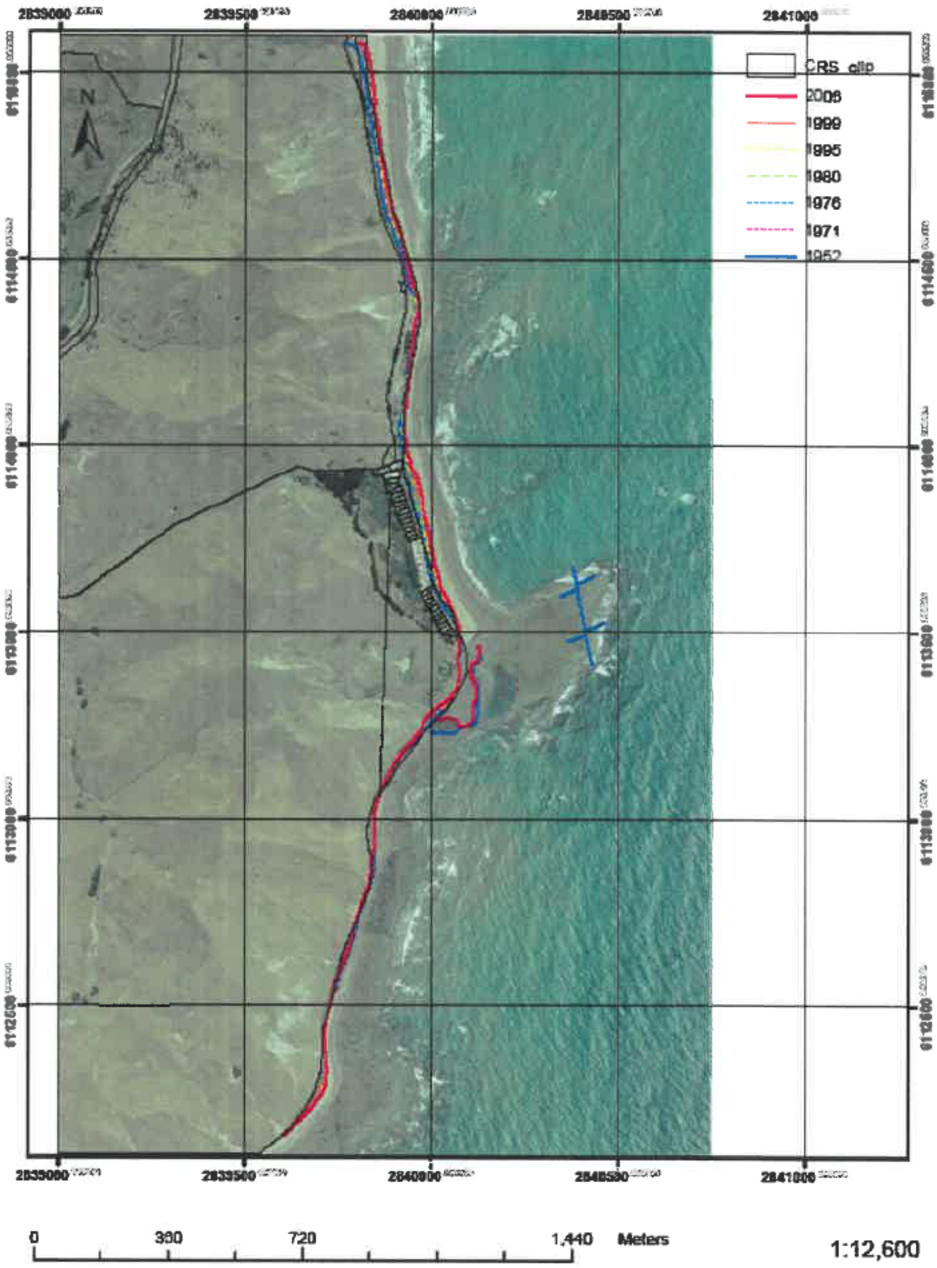

Figure 4: Fully rectified 2006 orthophotomap showing general state of the coast, the Tuingara landslide and historic toe positions, wide shore platforms including that at Tuingara Point with an offset transcurrent fault.

v. At Tuingara Point, the net geologic rate of cliffline retreat over the last 7300 years is -0.07m/year.

vi. As the shore platforms have increased in width, the process of seacliff retreat has steadily diminished and sand has accumulated at the back of the shore platforms to form beaches and narrow vegetated coastal plains. Stream valleys like Blackhead, Aramoana and Pourerere have progressively infilled resulting in a smoothing of the coastline.

vii. During the past 7200 calendar years, there have been at least 7 major earthquake-related displacements in southern Hawke's Bay at a frequency of 600-1600 years, the most recent event being the Magnitude 7.8 Napier Earthquake of 3 February 1931 (Hayward *et al.* 2006).

viii. At Pourerere, episodic uplift associated with moderate to large earthquakes has raised the coast some 10.6m over the last 7330 radiocarbon years at about 1.45m/1,000 years (Ota *et al.* 1990) with some earthquake events triggering relatively large coastal landslips especially where the hillslopes had been oversteepened and destabilized by sea erosion.

ix. Today, vegetated hillslopes with stable slopes of 35-40^0 fringed by narrow beaches or coastal dunes and relatively wide wave-cut shore platforms colonized by dense algal beds, indicates that the Pourerere coastline has steadily reached a state of geologic dynamic equilibrium (Figure 5) from the combination of tectonic uplift, adequate sand supply and a relatively stable sea level.

Figure 5: Photograph looking south toward Aramoana showing a coastline between Pourerere and Aramoana in geologic dynamic equilibrium with a stable hillslope of 37^0. Photo taken 2 May 2007 by [redacted]

5.2. COASTAL PROCESSES

i. For the entire length of North Island, east coast between Cape Palliser and Matakaoa Point there is a regional net northerly drift of beach sediments in response to a persistent southerly swell (Gibb 1980).

ii. Where the persistent southerly swell is refracted by shore platforms and nearshore reefs, there are local net southerly counter drifts or an oscillatory drift (Gibb 1980).

iii. Between Blackhead and Pourerere, the uniform sand beach, often perched on the back of shore platforms (Figure 6), is a yellow-brown Well Sorted Fine Sand, derived principally from backcutting of seacliffs and downcutting of shore platforms, the nearshore seabed to the south, with a small coastal supply from rivers and streams (Gibb 1980).

iv. Along the North Island east coast the nearshore sand transport zone extends offshore to depths of about 18-25m and the net rate of net northerly longshore transport is inferred to be of the order of 100,000-250,000m^3/year (Gibb 1980).

v. At Pourerere Beach south, the 510m-wide wave cut shore platform at Tuingara Point "*dries'* at low tide and creates a partial "*wave shadow*" on the north side by intercepting and reducing the energy of the persistent southerly swell.

vi. As a result, southerly approaching waves are refracted around the platform and a significant sand cuspate foreland has formed on the beach in the lee (Figure 7) which largely controls the relatively wide sand beach adjacent to Sections 13-23 and the Pourerere Caravan Park to the north.

vii. We observed breaking waves of 2-3m on the outer edge of the shore platforms being reduced in height by an order of magnitude to 0.2-0.5m on the north side of Tuingara platform as a result of wave refraction. At the back of the shore platforms at high tide the 2-3m high breakers were reduced further to 0.1-0.2m high waves on the sand beaches.

viii. North of the Caravan Park, the beach has formed shallow cuspates in the lee of nearshore reefs (see Figure 4) which extend several hundred metres from the beach, protecting the beach by reducing incident wave energy.

ix. There is likely an oscillatory to small net southerly drift adjacent to the settlement in response to the effects of the shore platform and nearshore reefs along Pourerere Beach on approaching waves.

x. The Tuingara shore platform is bisected at its seaward part by a shore-parallel strike-slip sinistral fault with evidence of 10-12m horizontal offsets of strata from past horizontal fault movements (Figure 4). Such movements may have caused a slight up-doming of the shore platform surface since its formation, increasing its effectiveness as a natural shore protection landform, reducing incident wave energy.

xi. Although Pourerere Beach is naturally protected from relatively severe wave storms from the S-SE quadrant it is relatively more exposed between the nearshore reefs and platforms to less frequent wave storms from the E-NE quadrant.

Figure 6: Photograph looking north at low tide south of Pourerere Beach showing a perched sand beach on the shore platform. Photo taken 2 May 2007 by [redacted]

Figure 7: Photograph looking east at low tide at Tuingara Point showing wide stable sand beach in lee of wave cut shore platform. Photo taken 2 May 2007 b[redacted]

5.3. LANDSLIDES

i. When waves erode the base of a seacliff, the cliff becomes unstable due to increases in slope angle and the slope stress caused by sea erosion at the toe. For coastal hillslopes in geologic dynamic equilibrium this trigger mechanism for slope failure has been eliminated as the coast has evolved.

ii. Of the 75km-long Central Hawke's Bay District coastline, landslip adversely affects, or may adversely affect 69%, the occurrence of which is influenced by the lithology, geologic structure such as faults and fractures, geotechnical properties such as bentonitic clays, and triggers such as large earthquakes and prolonged rain storms (CMCL 1995a).

iii. At Tuingara Point there is a large, still active, rotational failure termed her the "*Tuingara landslide*", where the backwall extends some 585m inland from the present toe and the remnant toe some 100 m out on to the shore platform (Figure 8).

iv. From 1952-2006 the Tuingara landslide toe has retreated at -0.07 to -0.28m/year which based on the 100m distance to the remnant toe from the present toe and assuming similar erosion rates, provides a likely formation age of the order 360-1430 years ago.

v. On the adjacent shore platform the retreating landslide toe has left behind a layer of soft grey pug or landslide colluvium, with large boulders of calcareous concretions which have been rolled back by the sea over time to form a low boulder ridge (Figure 9) which also helps to reduce wave erosion of the present landslide toe by breaking up incident wave energy.

vi. From 1952-2006, the remnant boulder ridge retreated landward by 5-13m, averaging 9.5m at -0.18m/year. Applying the average rate to determining the formation age of the Tuingara landslide, suggests it occurred about 550-600 years ago, and may therefore, have been triggered by a large land displacing earthquake in the Hawke's Bay region that occurred about 600 years ago (Hayward *et al.* 2006).

vii. The Tuingara landslide and its ponds, which are still evident today are recorded on the 1927 cadastral plan (SO 1591) and the toe may be alternating from very slowly moving seaward, under gravity, especially during periods of prolonged rainfall leading to ground saturation, to static during prolonged dry periods.

viii. Behind Sections 1-23 and the Pourerere Caravan Park there is some evidence from aerial photographs and field inspections of localized small scale slumping and low scarps and cracks in the ground especially at the south end by Sections 20-23. Extensive tree planting above the baches and Caravan Park has helped stabilize this slope.

ix. North of Sections 1-23 many gullies above the Pourerere Beach Road contain remnant slumps but the sea can no longer destabilize the toes as accretion of a narrow plain of well-vegetated dunes has occurred (see Figure 4), suggesting that these landslides which may also have been triggered 600 years ago by a large earthquake, have been inactive at least over the past century..

Figure 8: Photograph looking west at low tide at the Tuingara landslide. Photo taken 2 May 2007 b[redacted]

Figure 9: Photograph looking southeast of calcareous concretions rolled landward by the sea over Tuingara grey landslide colluvium to form a natural protective breakwater. Photo taken 2 May 2007 b[redacted]

5.4. SHORELINE MOVEMENTS

Over approximately the last 7300 years, the seacliffs at Tuingara Point have retreated about 510m at -0.07m/year and further south toward Aramoana about 195m at -0.03m/year. Over the same period the coastal plains at Pourerere and Aramoana have advanced about 1.4km and 1.3km at 0.19 and 0.18m/year, respectively, and are still advancing from a plentiful supply of sand.

5.4.1. HISTORICAL SHORELINE MOVEMENTS 1952-2006

i. In Appendix B, Table B-1 tabulates rates of erosion or accretion for 6 survey intervals from 1952-2006 at 14 Stations over a distance of about 3,000m, north and south of Sections 1-23. Net rates over the 54 year survey period are summarized in Figure 10.

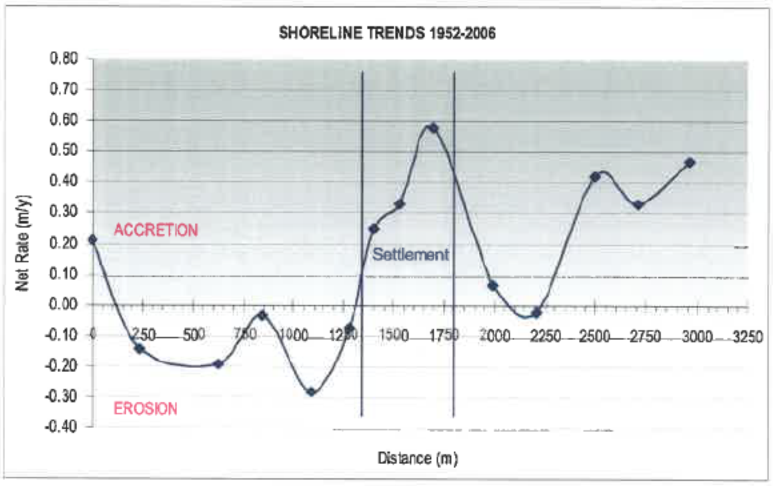

Figure 10: Net shoreline trends from 1952-2006 along Pourerere Beach both north and south of Sections 1-23. Data from Table B-1, Appendix B.

ii. South of Sections 1-23 field evidence indicates that much of the coast has reached geologic dynamic equilibrium but there are localized stretches (apart from the Tuingara landslide) usually associated with faults or old landslides which have retreated at -0.03 to -0.19m/year from 1952-2006 and one point that has locally advanced from sand accretion at 0.21m/year (Figure 11).

iii. The localized retreating sections of seacliff are adjacent to relatively narrower and lower shore platforms allowing erosive storm waves to reach clifflines more frequently. Conversely the advancing section is adjacent to a relatively wider and higher shore platform which reduces incident wave energy allowing waves to deposit and not erode sand at this point.

iv. Adjacent to Sections 1-23, the duneline has advanced (Figure 12) over the last 54 years at rates increasing from south to north from 0.25m/year to 0.58m/year (see Figure 10). The trend of advance being punctuated by an episode of short-term duneline retreat that occurred from 1971-1980.

Figure 11: Photograph looking east from Station 1 (Table B-1) showing locally wide beach and accretion of foredune adjacent to a wide, protective, shore platform and stable hillslope of about 35-40^0. Photo taken 2 May 2007 by [redacted]

Figure 12: Photograph looking south along Sections 1-23 showing sand accretion since 1927. Photo taken 2 May 2007 by [redacted]

v. North of Sections 1-23, the cliffline cut into both the Late Tertiary mudstone and more recent landslide colluvium is in a state of dynamic equilibrium (Table B-1) owing to protection from erosive waves by a relatively wide sand beach that has accumulated in the lee of some nearshore reefs that extend several hundred metres northeast of the beach.

vi. North of this point up to a small ephemeral stream mouth, the duneline has advanced at 0.33 to 0.47m/year from accretion of sand which has provided a narrow coastal plain for the construction and retention of Pourerere Beach access road to the southern settlement in the early 1970s (see Figure 4). Since that time the road has not been damaged or destroyed by sea erosion.

5.4.2. Shoreline Movements 1927-2006

i. Table B-2, Appendix B, provides tabulated rates of erosion or accretion for 8 survey intervals over a 79-year survey period from 1927-2006 for 12 Stations along about 500m of beach adjacent to the Pourerere Beach south settlement.

ii. From south to north, the duneline adjacent to Sections 13-23 has advanced at 0.11 to 0.39m/year from 1927-2006, averaging 0.24m/year (Figure 13), punctuated by episodic short-term duneline retreat of 4.3-7.1m in the 1970s (Table B-2).

iii. Adjacent to the Pourerere Caravan Park, the duneline advanced at 0.36m/year from 1927-2006 (Figure 13), punctuated by episodic short-term duneline retreat of 1.9-3.3m in the 1970s. Note that the 1975 cadastral survey which provided the landward limit of short-term retreat was confined to Sections 1-12 and 13-23.

iv. Adjacent to Sections 1-12, the duneline advanced at 0.37 to 0.43m/year, averaging 0.40m/year (Figure 13), punctuated by episodic short-term duneline retreat of 2.5-4.2m in 1970s.

v. North of Section 1, the duneline has also advanced at 0.20 to 0.43m/year (Table B-2). It is noticeable on the aerial surveys that the 510m-wide shore platform at Tuingara Point and the 360-485m-wide nearshore reefs along the beach are all acting positively to retain a wide stable beach adjacent to the entire settlement, whilst reducing the magnitude of short-term duneline fluctuations.

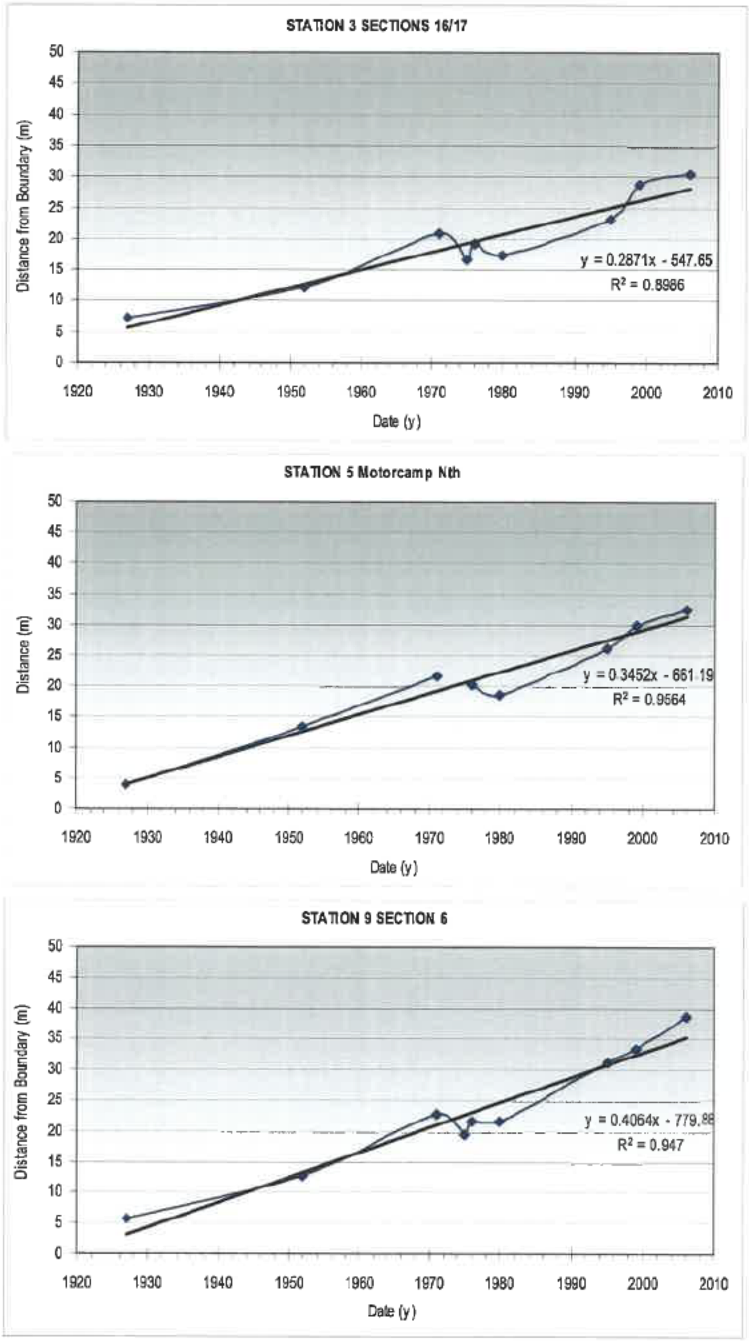

Figure 13: Duneline trend and variability from 1927 adjacent to Section 13-23 (top), the Pourerere Caravan Park (middle), and Sections 1-12 (bottom). Data from Table B-2, Appendix B.

6. COASTAL HAZARD ZONE ASSESSMENT

Data collected in this study fully justify a review of CHZ-1 and CHZ-2 assessed by Tonkin & Taylor Ltd for Pourerere South (T&TL 2004; 2006a).As described in Section 4 of this report both CHZ-1 and CHZ-2 apply to the hazard of sea erosion. Our findings reveal that Sections 1-23 are not presently subject to sea erosion and appear to have not been since the land was first subdivided in 1927. Furthermore, the coastline north and south of the study area has clearly reached a state of geologic dynamic equilibrium. In our opinion, these compelling facts must be taken into account in any assessment of a CEHZ for a hazard assessment period up to 2100.

The long-term trend of accretion along Pourerere Beach, punctuated by relatively minor short-term duneline fluctuations, is largely a function of a plentiful sand supply from sources along the North Island east coast, combined with the unique natural beach protection offered by the extensive wave-cut shore platforms and nearshore reefs. In our opinion, these critical factors will continue to positively act for the long-term benefit of Pourerere Beach this century, although a projected acceleration in the rate of the sea level rise this century from about 1.6mm/year to 8.0mm/year in response to Climate Change and global warming may progressively slow historical rates of accretion over time.

6.1. CEHZ ASSESSMENT

The following simple equations were adapted from recent CEHZ assessments used by CMCL (1999b, 2001a, 2001b, 2002a, 2002b, 2004, 2005), Komar *et al.* (1999), T&TL (2004, 2006a), and de Lange (2004), to calculate CEHZ widths for Pourerere Beach with respect to the 2006 duneline position, where:

$$\mathbf{CEHZ} = [\,(\mathbf{D} + \mathbf{S_{max}}) + (\mathbf{R} - \mathbf{X})\,\mathbf{T}]\,\mathbf{F} \qquad \text{Eqn [3]}$$

And;

$$\mathbf{D} = [\,1.6\mathbf{h}\,]\,0.5 \qquad \text{Eqn [4]}$$

$$\mathbf{X} = \frac{\ell.\mathbf{a}}{\mathbf{h}+\mathbf{d}} \qquad \text{See Eqn [2] Sect. 4.4.1}$$

Where;

R = Average historic rate of long-term retreat or advance of the duneline in metres per year (m/y) from 1927-2006.

$\mathbf{S_{max}}$ = Horizontal distance subject to maximum short-term duneline fluctuations in meters (m), as recorded by 1927-2006 surveys.

T = Hazard assessment period of 94 years (2006-2100).

D = Dune instability factor representing the horizontal retreat in metres (m) of the top seaward edge of the dune erosion scarp to attain a stable slope angle determined by the angle of repose (AOR) of dry loose medium to fine sand, using Equation [4], where **h** is the average height of the foredune crest above MSL

X = Potential rate of duneline retreat (m/y) from local relative sea level rise (SLR), calculated by the Bruun Rule, using Equation [2].

F = Safety factor representing uncertainties in the data, expressed on a scale from 1.0 (0%) for no uncertainty, up to 2.0 (100%)

for very high uncertainty.

In terms of complying with definitions within the Proposed RCEP and using Equation [3]:

CHZ-1	=	$[\,D + S_{max}\,]\,F$	Eqn [5]
CHZ-2	=	$[\,(\,R - X\,)\,T\,]\,F$	Eqn [6]

Note that the alphabet letters used above to define each factor have been used in Australasia since the 1970s and consistently by CMCL since 1993, and are preferred in this study on the grounds of simplicity over the more complex symbols used by T&TL (2004; 2006a) in Equation [1]. Apart from this minor difference, the factors considered by both T&TL and CMCL for CEHZ assessment are broadly similar.

6.2. CEHZ CALCULATIONS

CEHZ calculations are limited in this study to the 500m-length of developed coastline since 1927at the southern end of Pourerere Beach. Table B-3, Appendix B, provides CEHZ calculations for Stations 1-12 (Table B-2), adjacent to the Pourerere Beach settlement. In keeping with established best practice, the various factors in Equations [2] to [6] were quantified as follows:

REFERENCE SHORELINE:	The 2006 duneline shown on the coloured orthphotomap was used to offset CEHZ widths.
FACTOR **T**:	For Equations [3] & [6], a hazard assessment period of 94 years was adopted (2006-2100).
FACTOR **S**:	For all 12 Stations, the overall maximum measured short-term duneline fluctuation of 7.1m was adopted from Station 2, Table B-2, Appendix B, from the survey interval 1971-1975, a period of intense storm activity in the southwest Pacific.
FACTOR **D**:	For all 12 Stations, an average maximum height of the foredune crest of 3.31m MSL was adopted from measurements made in this study. Using Equation [4] provided a value of 2.65m for all Stations.
FACTOR **R**:	In Table B-2, Appendix B, the more robust long-term rate of duneline trend from 1927-2006 provided by linear regression analysis of each data set for the 12 Stations was adopted.
FACTOR **X**:	For Equation [2], the 0.8m, SLR above 1990 levels by 2090-2100 (8.0mm/y) recommended in July 2007 by NIWA (Doug Ramsay, pers. comm. 9 July 2007) was adopted. The historical average rise of 0.16m (1.6mm/y) for last century for New Zealand (Hannah 2003) was then subtracted from the 0.8m value to give 0.64m by 2100 (6.4mm/y), based on the rationale that Factor **R** (historical accretion) already includes the effects of historical SLR of 0.16m at Pourerere Beach and to include this value would be double counting the effects of SLR. Although Pourerere Beach is subject to long-term tectonic uplift at about 1.45m/1000 years which could be argued to reduce the effects of SLR this century still further, this factor was discounted on the basis that uplift is mostly coseismic in association with large earthquakes which occur about

every 600-1600 years in southern Hawke's Bay (Hayward *et al.* 2006).

For Equation [2], an average closure depth of -10m MSL was adopted from previous work by CMCL from 1995-2005 along the North Island east coast along with the average dune crest height of 2.9m MSL. Determining the distance from the crest to the closure depth was impossible as the nearshore area at Pourerere has many dangerous reefs and was not surveyed by the Royal New Zealand Navy for Chart NZ56. On this basis, an average distance of 716m was assumed from measurements at Ocean Beach (CMCL 2005). Using Equation [2] provided a value of potential erosion rate from SLR of -0.36m/year by 2100.

FACTOR **F**: Although the data used in this assessment are reasonably robust, there are still uncertainties that justify a precautionary approach particularly with estimating the effects of Factors $\mathbf{S_{max}}$ & **X**. On this basis a Safety Factor of 1.3 (30%) is adopted for Equations [3], [5] & [6] from previous assessments by T&TL (2004) and CMCL (2005).

6.3. CEHZ WIDTHS

Table B-3, Appendix B, provides CEHZ widths of 15m for Stations 4, 5 & 7-11, 20m for Station 3, 35m for Stations 2 & 12, and 45m for Station 1. The relatively smaller CEHZ widths of 15m are for those Stations where historic accretion is likely to persist this century from an adequate sand supply offsetting potential erosion from a projected sea level rise from global warming of 0.8m above 1990 levels by 2090-2100. The relatively larger CEHZ widths of 20-45m are for those Stations where sea level rise eventually overwhelms the natural sand accretion rates causing a progressive reverse in trend to long-term retreat. Within the CEHZ, CHZ-1 is a uniform 13m in width whereas CHZ-2 ranges in width from 0-33m (Table B-3, Appendix B)

Whilst the historic duneline trend since 1927 and short-term duneline fluctuations are based on solid, reliable, survey evidence, the estimated erosion from SLR is regarded here as a first approximation because of both the well-known limitations of the Bruun Rule and complexity of the marine geology of the area. At Pourerere Beach, the complexities include the unknown effects of shore platforms and nearshore reefs on sand transport pathways and likely beach profile adjustments in response to rising sea levels. Along the shore platforms the sand beaches are perched at the back of the platforms and the seaward toe of the beach is at about low tide level.

It is emphasized that notwithstanding a sea level rise of 0.16m around New Zealand last century coupled with the occurrence of damaging coastal storms (e.g. 1936, 1974, 1968, 1988, 1990s, 2002 etc.), the duneline at Pourerere Beach has continued to advance indicating that a plentiful supply of sand to the area from the net northerly longshore drift has offset any erosion effects from historic sea level rise. Another potential factor contributing to the accretion is the possibility of aseismic uplift of the shore platforms between coseismic uplift during large earthquakes. If this was occurring it would be similar to a local relative fall in sea level offsetting actual SLR, which would promote accretion but little is known of this potential effect at Pourerere.

6.4. IMPLICATIONS FOR SECTIONS 1-23

In terms of Sections 1-23, CHZ-1 assessed in this study is seaward of the Pourerere Beach Road, the Pourerere Caravan Park, and the 23 Sections with respect to the 2006 duneline position. As a consequence, the proposed rules under HBRC's Proposed RCEP and Section 71 of the Building Act

2004 as applied by CHBDC should have no effect. In contrast, CHZ-2 impacts on the Sections 20-23 and on the baches to a greater or lesser degree, but not on Sections 1-19. For Sections 20-23 the Proposed RCEP and Section 72 of the Building Act 2004 should apply but not to Sections 1-19.

7. DIFFERENCES IN CHZ WIDTHS

The T&TL (2006a) CEHZ assessment at this point in time is preferred by HBRC and has the statutory force of the Proposed RCEP. Table 6 summarises the differences in CEHZ widths between T&TL (2004; 2006a) and this study which are significant and require explanations.

Table 6: Differences in CEHZ widths for Pourerere South between T&TL (2004, 2006a) and this study and net difference 2006-2007.

SOURCE	CHZ-1 (m)	CHZ-2 (m)	CEHZ (m)
T&TL 2004	43.8	38.5	82.3
T&TL 2006	43.8	51.3	95.1
CMCL 2007	13.0	0-33	15-45
DIFFERENCE IN METRES (2006-2007)	30.8	18.3 to 51.3	50.1 to 80.1

For the short-term duneline fluctuation (Factor **S**) and dune stability factor (Factor **D**) comprising CHZ-1, we have used site specific survey data for the Pourerere Beach area over a 79-year period and a safety factor of 30% to allow for uncertainties to derive the distance of 13m. T&TL (2004; 2006a) have used beach profile data from Waimarama Beach collected over a very small period of 5 years that relates to beach profile fluctuations at 1.0m MSL and not to duneline fluctuations to derive the distance of 43.8m (Table 6).

Survey evidence in T&TL (2004) reveals that the duneline at Profiles WM-10 & WM-11 at Waimarama Beach is at about 2m MSL and has fluctuated over a relatively small range of 2.5-3.0m from 1992-2002. If a duneline fluctuation of about 44m as assumed by T&TL (2006a) had ever occurred at Pourerere Beach it would have damaged or destroyed many of the 28 baches that have been there for the last 70 years or so. We could find no evidence of such large historical short-term erosion nor any likelihood that events of this magnitude would occur this century.

For CHZ-2, T&TL (2004, 2006a) have assumed a long-term erosion trend of -0.18m/year for the study area and an additional erosion rate of about -0.33m/year for the effects of sea level rise from 1990-2100. The erosion rate of -0.18m/year was derived by dividing a nearby shore platform width of 1170m by an assumed formation age of 6500 years. The nearest and widest shore platform is at Tuingara Point where it is 510m in width. Sea level has been relatively stable around New Zealand for the last 7300±100 calendar years (Gibb 1986) which provides a net long-term rate of sea cliff retreat of -0.07m/year. There is neither evidence of a 1170m-wide shore platform nor a net retreat of the duneline at Pourerere Beach of -0.18m/year. Rather, the historic evidence is compelling for a net accretion rate at 0.2-0.4m/year since 1927. In contrast, our SLR erosion rate of -0.36m/year is in close agreement with the T&TL rate of -0.33m/year.

Whilst the assumption by T&TL (2004, 2006a) that the long-term trend of the bay beaches is controlled by the retreating headlands may have validity elsewhere on the east coast (e.g. Wainui & Waimarama Beaches), the assumption is invalid at Pourerere Beach. The landforms that control the trend of accretion along the beach are the 510m-wide shore platform at Tuingara Point and the adjacent nearshore reefs. The small amount of retreat of the toe of the Tuingara landslide does not appear to be having an adverse effect and has supplied a natural breakwater of boulders that protect the shore, reducing erosion.

In summary, the T&TL CEHZ assessment is based almost entirely on invalid assumptions and inferred values compared to this study which is based on site specific quantified geologic and historic evidence and field observations. Because of the very significant differences in widths for CHZ-1 and CHZ-2 (Table 6) that are likely to affect property values for Sections 1-23, we recommend that the CEHZ assessed in this study be adopted for the purposes set out in Section 1.0 of this report.

7.1. CFHZ WIDTHS

The CFHZ determined by T&TL (2004) is delineated by the 6.2m contour in CHZ-1 and 4.0m contour in CHZ-2. Whilst we are in general agreement with the methodology used to derive these values (see Table 4), we question the values for maximum wave setup and maximum wave runup in Table 4. The uniform values adopted by T&TL (2004) for both these components make no provision for the significant effects of shore platforms and adjacent reefs at Pourerere which have been found in this study to reduce breaking waves heights by an order of magnitude at Pourerere south.

Such a significant effect would reduce both wave setup and wave runup values along Sections 1-23, reducing the 4.0m and 6.2m inundation levels proportionately. It is beyond the scope of this study to evaluate these factors except to note that a storm tide of 3.5-6.5m above MSL would temporarily inundate all 23 properties for a period of a few hours. We have no knowledge as to whether such an event has ever occurred over the last 80 years. To resolve this issue satisfactorily, it would be important to interview reliable long-standing locals who may have observed the effects of significant wave storms over the last 50-80 years.

8. CONCLUSIONS AND RECOMMENDATIONS

i. The coastline between Pourerere and Aramoana has generally reached a state of geologic dynamic equilibrium over the last 7300 years with the shoreline advancing at Pourerere Beach at about 0.2-0.4m/year last century from a continuing plentiful supply of sand.

ii. Sections 1-23 (0.8457ha) were first subdivided from the Landing Reserve (10.016ha) in 1927 and the first leases offered by the Crown to the public in November 1927, with renewable terms of 33 years in perpetuity being granted in 1974.

iii. With respect to Sections 1-23, it is recommended that the 2007 Pourerere Beach CEHZ comprising CHZ-1 and CHZ-2, assessed in this study, be preferred ahead of the 2006 CEHZ assessed by T&TL (2006a) on the basis of reliable, site specific geologic and historic evidence.

iv. Sections 1-23 are not subject to, or likely to be subject to, short-term duneline erosion-accretion cycles this century.

v. Sections 1-19 are not subject to, or likely to be subject to, a long-term trend of duneline retreat from erosion enhanced by the erosion effects of a rise in sea level of 0.8m by 2090-2100.

vi. Sections 20-23 are likely to subject to erosion from a sea level rise of 0.8m by 2090-2100.

vii. The proposed rules in HBRC's Proposed RCEP and Section 71 of the Building Act 2004 that apply to CHZ-1 should not apply to Sections 1-23 as all Sections are located landward of CHZ-1 derived in this study.

viii. The proposed rules in the Proposed RCEP and Section 72 of the Building Act 2004 that apply to CHZ-2, should apply only to Sections 20-23 and not to Sections 1-19.

ix. Subject to decisions by HBRC's Hearing Committee before October 2007 and possibly by the Environment Court over the next few years, the present rules in the Proposed RCEP may remain the same or be revised as they apply to the 2007 Pourerere Beach CEHZ.

x. All or part of Sections 1-23 would be temporarily inundated by a potential storm tide of 3.5-6.5m above MSL but whether such an event has occurred historically, has yet to be established.

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APPENDIX A

NZAM Photogrammetry Project Report

APPENDIX B

TABLES B-1, B-2 Historic Erosion/Accretion Rates

TABLE B-3 CEHZ Assessment

APPENDIX C

HBRC Information Sheet Coastal Hazards

TABLE B-3: CHZ calculations using Equations [2] to [6] for Stations 1-12 along the Pourerere Beach settlement over a distance of 502m from the southern boundary of Section 23. All CEHZ widths are rounded to the nearest 5m and are offset from the 2006 duneline positon on the 2006 orthorectified photomap. Note that when Factor **R** exceeds Factor **X**, accretion offsets potential erosion from SLR and CHZ-2 sets to zero.

STATIONS	DISTANCE NORTH (m)	D (m)	Smax (m)	F	CHZ-1 (m)	R (m/y)	X (m/y)	T	F	CHZ-2 (m)	CEHZ (m)	ROUNDED (m)
1	0	2.65	7.1	1.3	13	0.09	-0.36	94	1.3	33	46	45
2	49	2.65	7.1	1.3	13	0.16	-0.36	94	1.3	24	37	35
3	98	2.65	7.1	1.3	13	0.29	-0.36	94	1.3	9	22	20
4	148	2.65	7.1	1.3	13	0.36	-0.36	94	1.3	0	13	15
5	194	2.65	7.1	1.3	13	0.35	-0.36	94	1.3	1	14	15
6	240	2.65	7.1	1.3	13	0.32	-0.36	94	1.3	5	18	20
7	285	2.65	7.1	1.3	13	0.33	-0.36	94	1.3	4	17	15
8	327	2.65	7.1	1.3	13	0.36	-0.36	94	1.3	0	13	15
9	369	2.65	7.1	1.3	13	0.41	-0.36	94	1.3	0	13	15
10	411	2.65	7.1	1.3	13	0.43	-0.36	94	1.3	0	13	15
11	453	2.65	7.1	1.3	13	0.41	-0.36	94	1.3	0	13	15
12	502	2.65	7.1	1.3	13	0.19	-0.36	94	1.3	21	34	35