Heretaunga Plains
Urban Development Study

Climate Change Component

Final Report 25 Oct 2009

E N V I R O N M E N T A L   M A N A G E M E N T   S E R V I C E S
Limited

Contents

1. Introduction

The following report presents the findings of a review of potential effects of future climate change on urban land use planning for the Heretaunga Plains area. The results of the study will be used as a component in the development of a long term urban development strategy for the Plains area for the period 2015 - 2045.

2. Methodology

This is a desk-top study based on a review of previous published reports and selected interviews. The report comprises a summary of findings of expected changes in climate in Hawke's Bay, as derived from these sources, and an assessment of how these changes may impact on long term urban planning in the Heretaunga Plains.

3. Summary of Key Findings

Most of the future effects of climate change will not be felt within the existing timeframe and planning horizon of the overall Heretaunga Plains Urban Development Study. The long term effects (on a 50 to 150 year time frame) will nevertheless be potentially significant and have a bearing on all land use planning decisions made in the present day.

Flood Risk

The main change affecting future urban development will be a predicted increase in the severity of rainstorms and resultant flooding. The risk of flooding already exists and is therefore not a 'new' risk, but the scale and frequency of flood events, and the probability of a flood breaking over or through of the existing river protection works, will steadily increase over time. Existing flood protections have only been designed to deal with historical patterns of rainfall and river-flow. Those patterns are now changing. Anywhere that is currently at risk from flooding will be all the more at risk of flooding in years to come. For urban planning purposes it will therefore be advisable to ensure that there is a higher standard of preparedness for future flood events, with care to be taken in deciding where houses are located, minimum heights above ground level, control of stormwater peaks, and protection of areas for flood water detention. By 2040 the risk of a 50 or 100-year flood event will be about 7% greater than now, and by 2090 will be 17% greater than now. By 2090, events on the scale of what would now be considered a 100-year flood will be occurring with an average 50-year frequency.

Coastal Inundation

The risk of inundation from coastal storms is not expected to increase appreciably over the next 50 years. Sea level rise over this period will not be enough, on its own, to exceed natural ground levels, and although there is likely to be an increase in the frequency and severity of coastal storm events, the height of the beach-crest should naturally self-adjust. Where overtopping does occur, the existing inland drainage systems should be able to cope. The areas of inundation risk that are already identified (as shown in maps reproduced in this report) are not predicted to increase.

Long term (150 – 200 year) predictions for sea level rise do, however, indicate that parts of the Heretaunga Plains, in the coastal fringe areas, will eventually be below sea level and protected only by the coastal berm, river stop-banks and continual pump drainage. There would be the potential for major flooding to result in the event of failure of any of these protections.

If a 200-year planning horizon was assumed it would therefore be advisable to minimise exposure to development on low-lying coastal land. Any land that is currently sitting below the RL 12 metre mark will be at risk of dropping below sea level within that period. If development is to proceed within these areas it would be advisable ensure that protection from flooding, including ability to pump-drain, is likely to be feasible in the longer term.

Coastal Erosion

Existing coastal erosion trends are likely to continue. Areas at risk from further retreat of the shoreline are identified in the Hawke’s Bay Regional Coastal Environment Plan. Those predictions are valid for the next 90 years, and are inclusive of predicted effects of climate change.

Salination of Groundwater

With sea level rise, and continued pumping of low-lying areas, it is anticipated that there will be salination of shallow groundwater in some areas. Although a nuisance, it should not have any major bearing on future urban planning decisions for the Heretaunga Plains. There will be no effect on the main Heretaunga Plains aquifer.

Water Supply

Future rainfall will be more intermittent – with longer periods of drought, and with rainfall tending to be more torrential when it comes. This prediction highlights the potential value of water harvesting. It does not, however, have specific implications for future urban design. Urban water supply will continue to be sourced from the Heretaunga Plains aquifer.

Reduction of Greenhouse Emissions

The greatest scope for reducing greenhouse gas emissions from existing industry, through the urban planning process, is through the development of a fuel-efficient transportation system. The most fuel-efficient transport mode is shipping. Linkages to the Port of Napier are therefore important. The establishment of a coastal shipping or barging service between the Port of Napier and Port of Gisborne could also be investigated.

4. Climate Change Predictions

Table 1, below, provides a summary of the main changes that can be expected to occur over the current century as a result of predicted climate change. The main driver behind these changes is the continuing build-up of greenhouse gases (mainly CO_2 and methane) in the earth's atmosphere and resulting increase in average global temperatures.

Some of these changes will have implications for future urban planning in the Heretaunga Plains.

Table 1 : Summary of Predicted Changes in Hawke's Bay Climate

Parameter	Predicted Change (Relative to Now)
Average Temperature[1]	1^{o}C increase by 2040 2^{o}C increase by 2090
Total Rainfall[2]	-15% decrease in winter -10% decrease in spring +10% increase in summer +5% increase in autumn
Storm Events (50yr event)[3]	7% increased risk of 50yr event by 2040 17% increased risk of 50yr event by 2090
Storm Events (100yr event)	7% increased risk of 100yr event by 2040 16% increased risk of 100yr event by 2090
Sea Level (current prediction)[4]	+0.2 m sea level rise by 2040 +0.5 m sea level rise by 2090
Sea Level (to prepare for)	+0.27 m sea level rise (minimum) by 2040 +0.80 m sea level rise (minimum) by 2090
Sea Level rise after 2100	Allow for 10mm/year[5].

[1] Source: NIWA (April 2008) Impacts of Climate Change on High Intensity Rainfall in Napier (p. 19).
[2] Ibid. (p.22). Based on averaged results from 12 different predictive models. Note that there is a high degree of variability between models.
[3] Ibid. (p.26, 27). There are alternative ways to express this data. In this case the data shows the increasing likelihood what are presently classed as 50yr or 100yr events, over time. Another way to look at it is to say that what is now classed as a 100yr event (a storm with an average recurring interval, or ARI, of 100 years) will, by 2040, have an average recurrence of more like once every 80 years, and by 2090 have an average recurrence of about once every 40 years. Storms on the scale of what would currently be considered a 150yr event will be become 100yr events by 2040, and 50 year events by 2090.
[4] Source : Ministry for the Environment (March 2009) *Preparing for Coastal Change : A Guide for Local Government in New Zealand*, (p.8)
[5] Ibid, p.8.

5. Implications of Climate Change

5.1 Risk of Coastal Inundation

Although sea level is predicted to rise (by between 0.5 and 0.8 metres), and coastal storms are predicted to increase in frequency and severity over the next century, the risk of inundation of land by seawater is not expected to change significantly compared with existing levels of risk, at least in the next 50 to 90 years. This is in part because the amount of sea level rise predicted to occur over the period will not be enough to overtop natural ground levels[6] and in part because the gravel beach crest (which provides front-line protection against inundation during storm events) will tend to gain in height as sea and wave heights increase[7]. The height of the beach crest is determined by the run-out point of gravel thrown on to the beach by incoming waves. The beach crest should therefore grow in tandem with sea level rise – although an inland retreat of the beach crest may also occur.

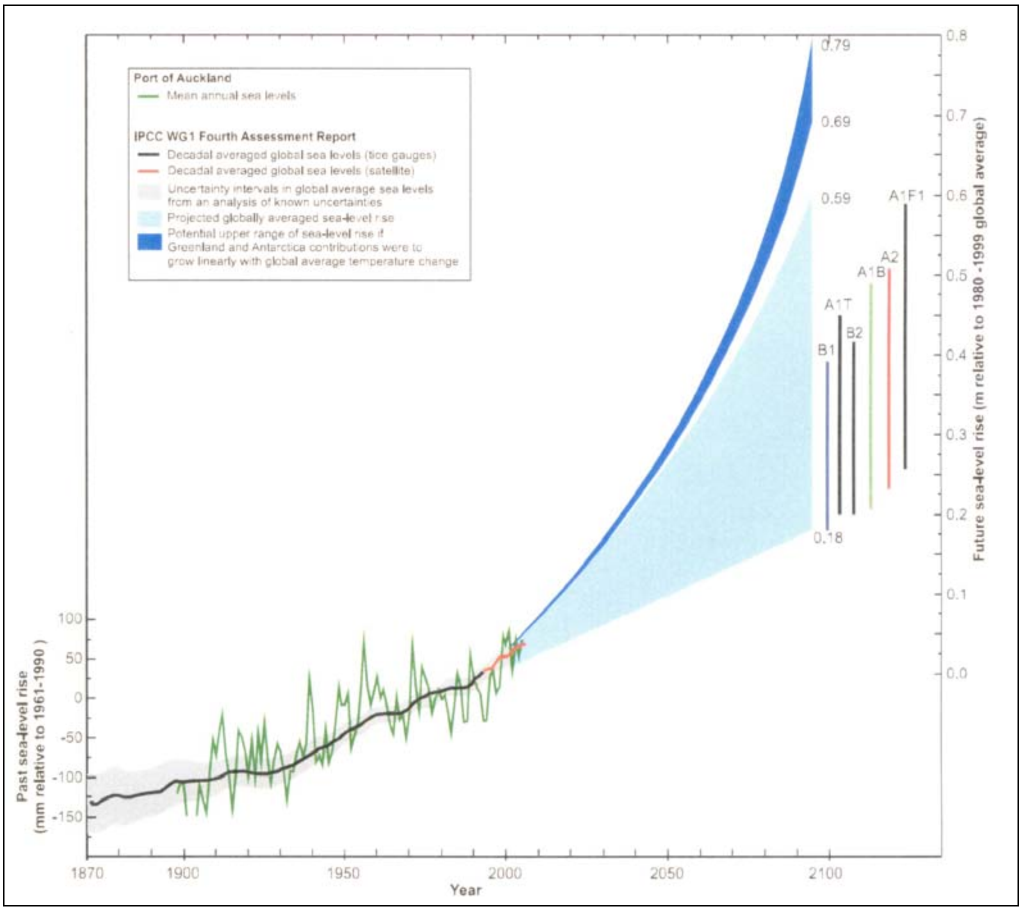

Figure 1 : Predicted sea level rise. The chart shows historical sea level rise and range of scenarios for future sea level rise (in the blue triangular band). The 'mid-range' increase by 2100 is 0.5 metres. The maximum value is 0.8 metres increase in sea level compared with existing. Source : Ministry for the Environment (March 2009) *Preparing for Coastal Change*.

6 With the exception of areas that are already bunded and pump-drained (notably the airport and Landcorp Farm).
7 Ministry for the Environment (March 2009) Preparing for Coastal Change (p.16).

Maintenance of the beach crest is likely to be assisted by a predicted increase in the amount of gravel and other sediment carried down to the coast by flooding in the rivers. The Tukituki River is a major source of gravel for the section of coastline between Cape Kidnappers and the Port of Napier. The Ngaruroro and Tutaekuri rivers contribute sand and silt. The supply of all of these materials to the beach and seabed is likely to increase if there is an increase in the frequency and severity of flood events. This will help the build-up of the beach crest and possibly help to counteract the deepening of the inshore seabed (which has an influence on power of incoming waves).

Existing coastal inundation hazard zones (as defined in the Hawke's Bay Regional Coastal Environment Plan) therefore should be largely unaltered by future climate change, at least within the current planning timeframe of 50 to 90 years.

The main coastal inundation hazard areas in the study area, which are identified in the Regional Coastal Plan, are shown in the following maps.

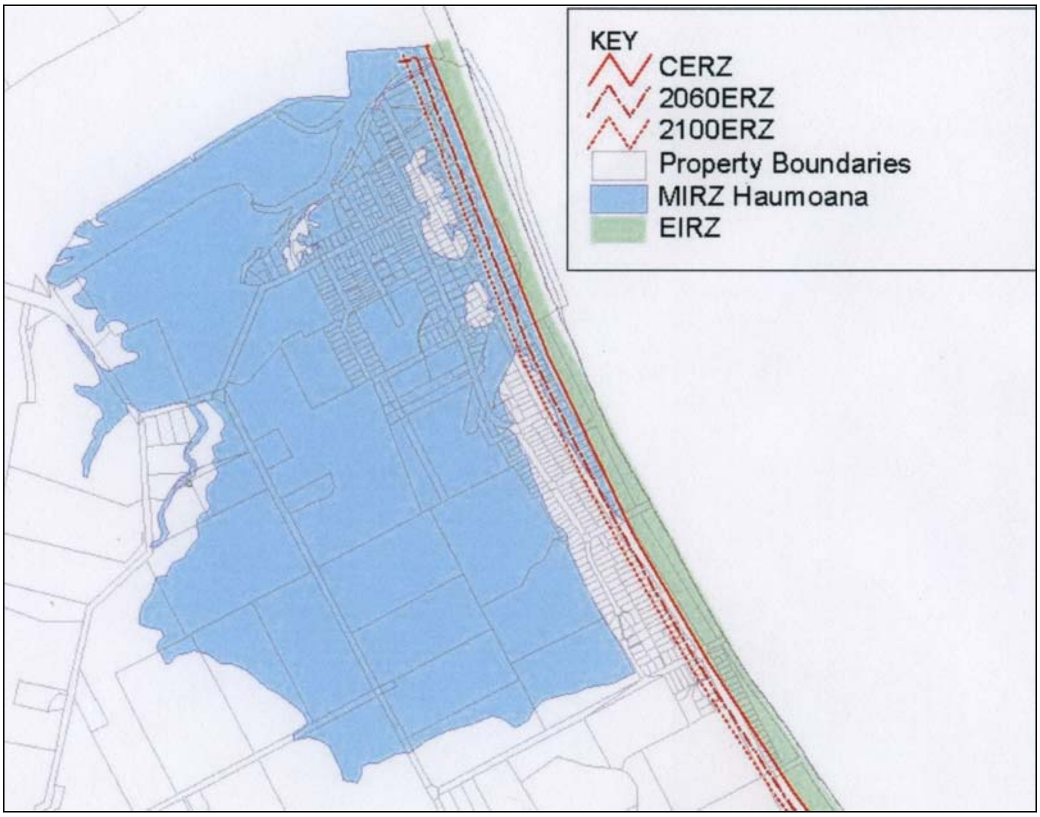

Figure 2 : Coastal Inundation Hazard Zone for Haumoana. Source: Hawke's Bay Regional Council (May 2006) Haumoana – Te Awanga Coastal Hazards Management Report on Management Options. Inundation hazard area shown in blue.

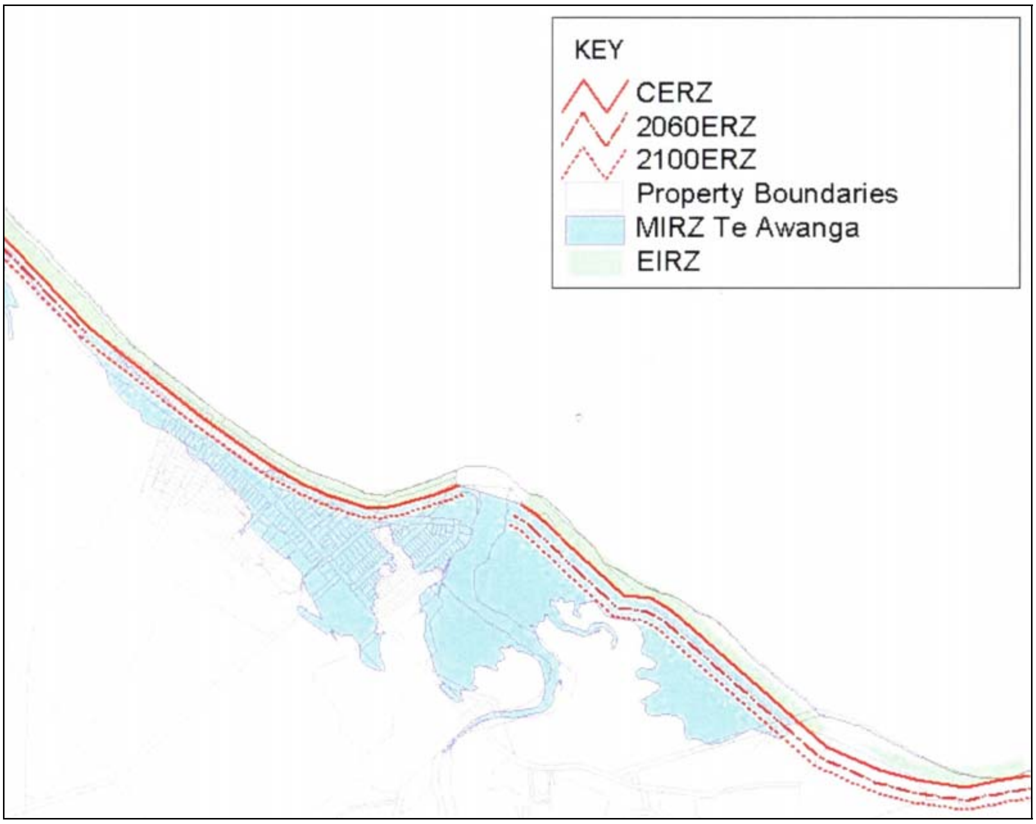

Figure 3 : Coastal Inundation Hazard Zone for Te Awanga. Source: Hawke's Bay Regional Council (May 2006) Haumoana – Te Awanga Coastal Hazards Management Report on Management Options. Inundation hazard area shown in blue.

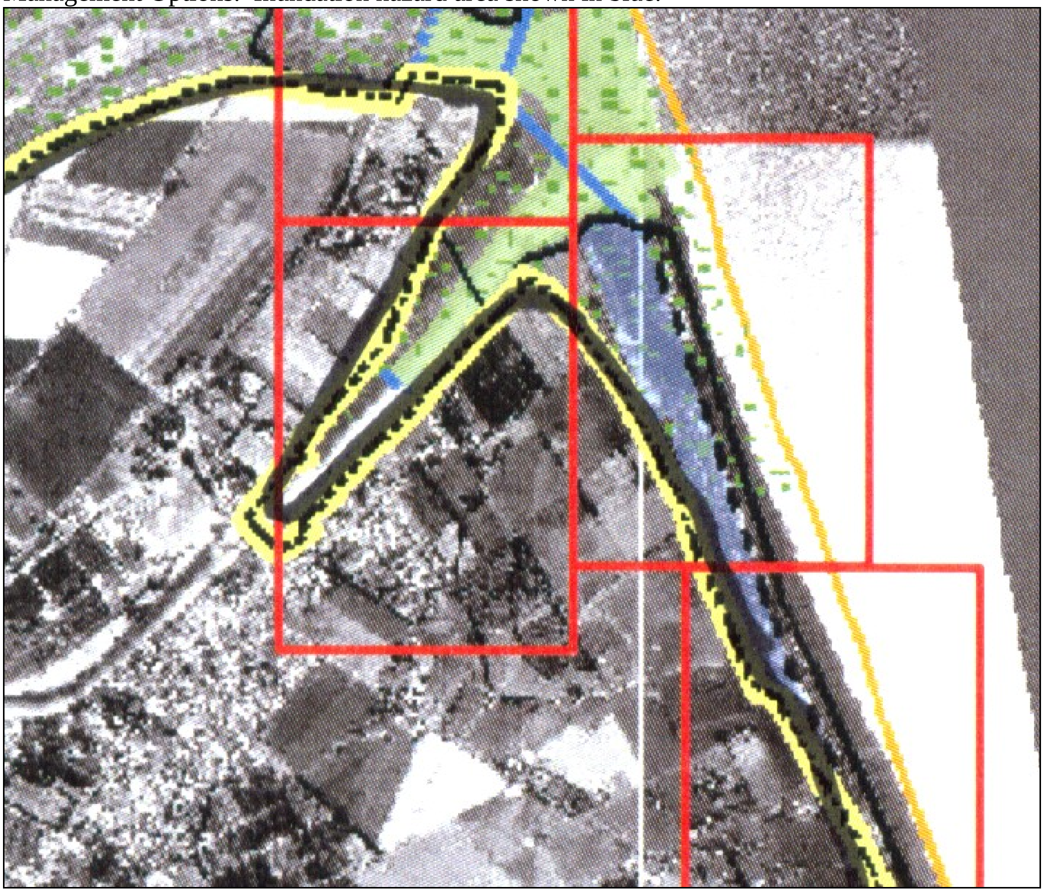

Figure 4 : Coastal Inundation Hazard Zone for East Clive. Source: Hawke's Bay Regional Council Proposed Regional Coastal Environment Plan. Inundation hazard area shown in blue.

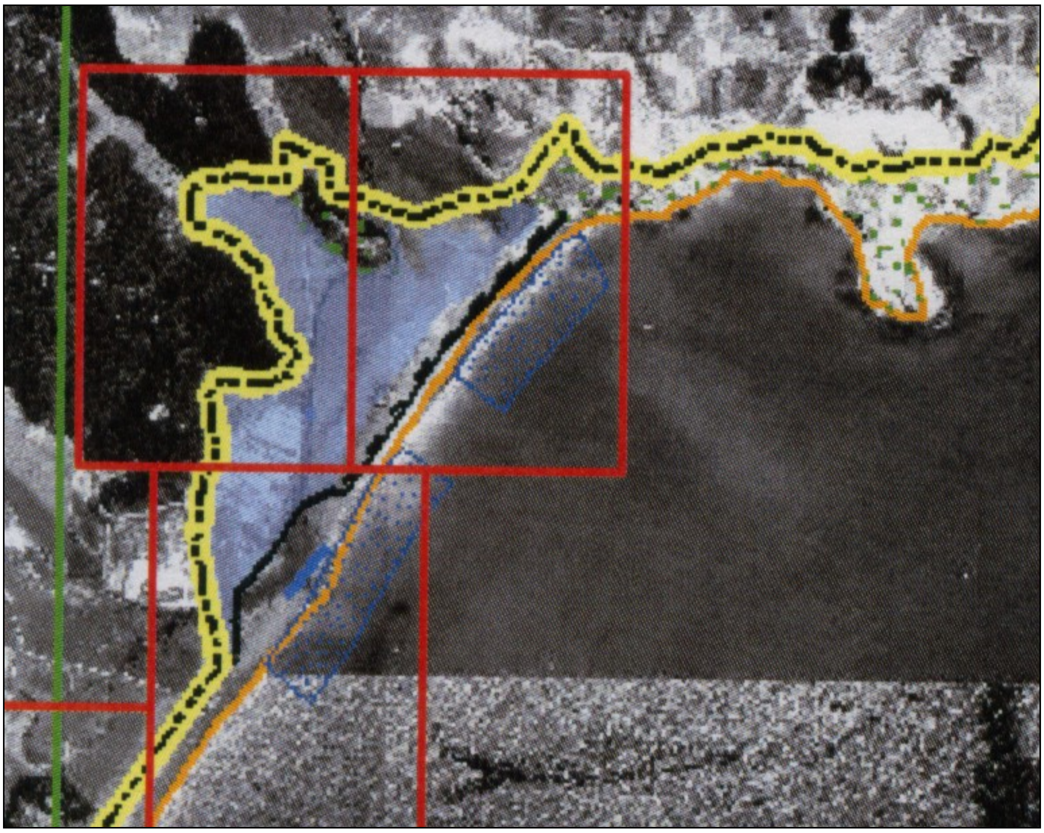

Figure 5 : Coastal Inundation Hazard Zone for Tangoio. Source: Hawke's Bay Regional Council Proposed Regional Coastal Environment Plan. Inundation hazard area shown in blue.

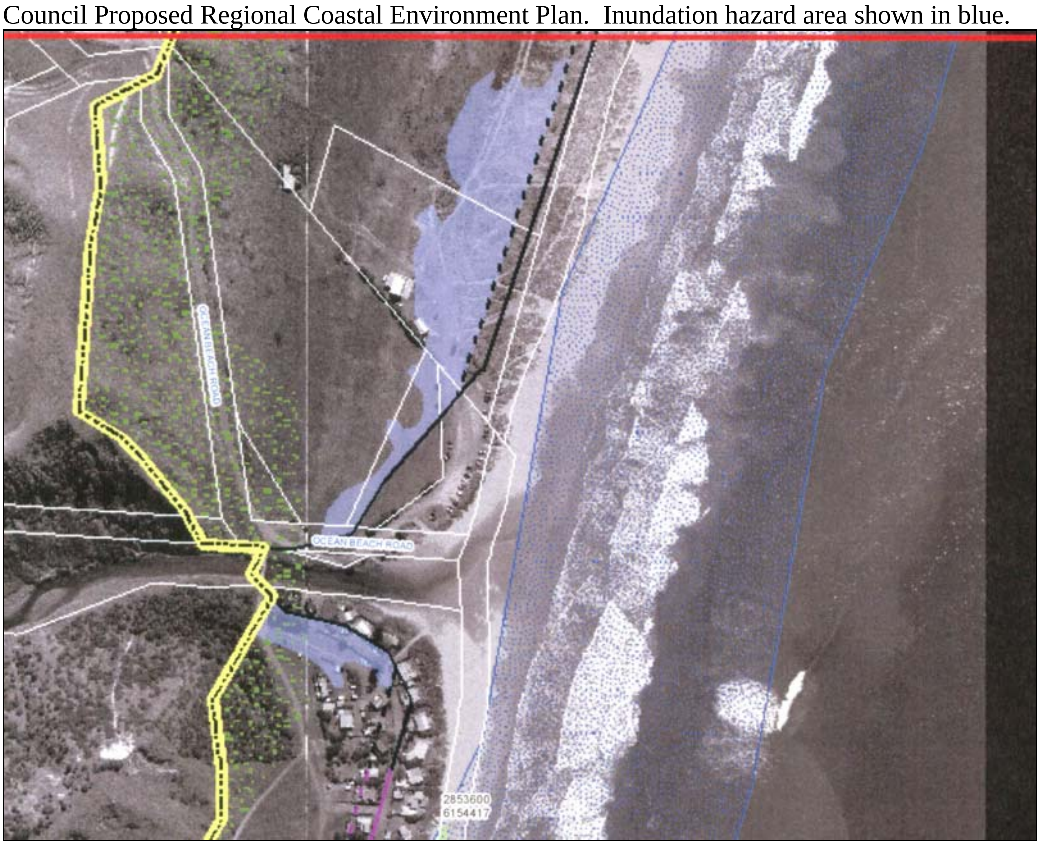

Figure 6 : Coastal Inundation Hazard Zone for Ocean Beach (Haupiri Flats). Source: Hawke's Bay Regional Council Proposed Regional Coastal Environment Plan. Inundation hazard area shown in blue.

The preceding maps are, however, only based on predictions through to the end of the century. Beyond that timeframe sea level can be expected to continue rising – with the Ministry for the Environment presently anticipating a post-2100 rate of sea level rise of 10mm per year.

On that basis a number of coastal areas would progressively drop below sea level. Table 2, below, provides a summary of typical ground levels and dates by which these areas would be at mean sea level, according to Ministry for the Environment sea level predictions. A detailed LiDAR contour plan, showing existing ground levels, is shown in Figure 7.

Table 2 : Ground Elevations & Allowance for Future Sea Level Rise (Table is based on existing ground elevations and MfE predictions for future rise in sea level. The column "Years from now" shows number of years until sea level reaches this elevation)

Locality	**RL (m)**[8]	**At sea level by**	**Years from now**
Meeanee Flats (excl Sandy Road)	10.6	2100	90
East Clive	11	2120	110
Te Awa Estate (on 1m raised ground)	11.3	2150	140
Clive	11.5	2170	160
Napier City	11 to 12	2120 to 2220	110 to 210
Parts of Te Awanga / Haumoana	12 to 13	2220 to 2320	210 to
Jervoistown	13	2320	310
Taradale	13 to 15	2320 to 2520	310 to 510
Hastings City	20	3020	1010

As sea level rises above the level of the ground in these areas it will be necessary to increasingly rely on pump drainage. Pumping will probably be feasible for most areas – even where ground level is below the level of the sea. About 75% of Napier City already has pump-assisted drainage. But in a future where there is no longer any gradient between the land and the sea (or indeed a reverse gradient) there will be an increasing reliance, and eventually a total reliance, on pump drainage, and on the protection provided by the coastal berms and river stop-banks. In this scenario the failure of any of these protections would result in serious flooding on the land. The potential scale of damage would be far more serious than now.

As the demand for pumping and flood protection increases, the cost of building, running and maintaining a pump-drainage infrastructure will also increase. This would add to the on-going cost (as well as risk) of living on low-lying coastal land.

[8] RL = Reduced Level, measured in metres above Hawke's Bay Regional Council datum. Existing mean sea level is at 10m relative to the datum. Metres above mean sea level therefore equals the stated figure minus 10 metres.

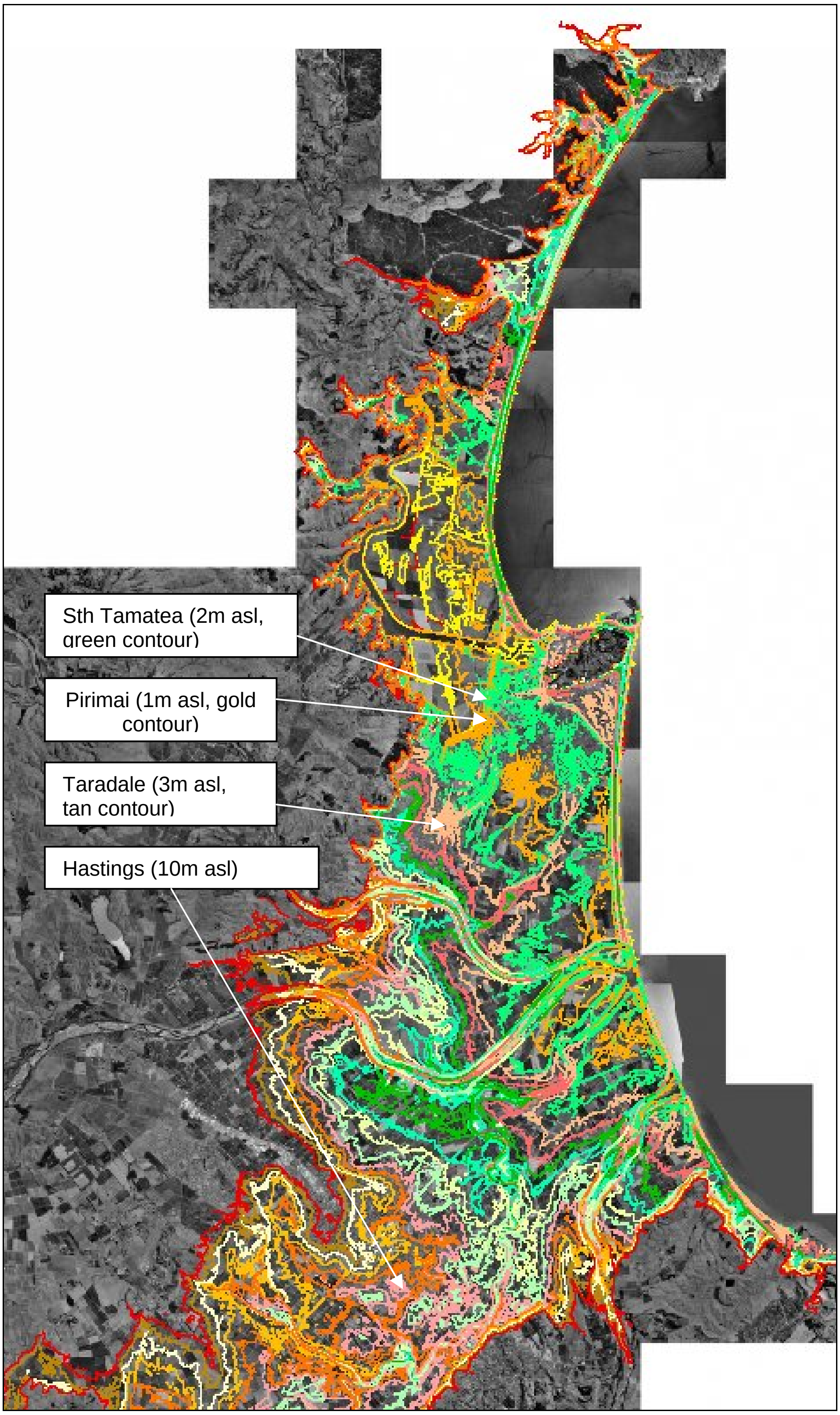

Figure 7 : Lidar image, showing averaged ground elevations on the Heretaunga Plains. Elevations are colour-coded. The elevations of selected representative examples are stated in metres above sea level (asl).

5.2 Coastal Erosion

Coastal erosion predictions have been mapped by the Hawke's Bay Regional Council and are shown in the Regional Coastal Environment Plan. The predictions take account of existing erosion trends and future sea level rise through to the year 2100. The at-risk areas for coastal erosion are typically within about a 75 metre band, measured landward of mean high water springs.

Climate change is expected to have an effect on coastal erosion trends as a result of rising sea level and increased frequency and intensity of coastal storms. This may cause a 'roll-back' of the beach crest – with the position of the shoreline, including the beach crest, adjusting to a new equilibrium point further inland, but higher in elevation.

Off-setting this effect, and also a result of climate change, will be a probable increase in the amount of sediment, including gravel, washed down the rivers as a result of a predicted increase in the frequency and intensity of rain storms, and therefore floods. This may help to counter-act some of the trend toward erosion along the shore.

5.3 Flooding

Global warming is expected to result in an increased frequency and severity of major storms. Predictions from NIWA suggest that the risk of what is currently considered to be a 50 or 100 year storm and flood event will be 7% more likely in the year 2040 than now, and 16% to 17% more likely by the year 2090.

Put another way: What is now (in 2009) considered to be a one-in-100 year event, by 2040 will be happening, on average, about once every 80 years, and by 2090 will be happening on average once every 40 years. The 'new' 100-year event will be on the scale of a one-in-150 year event in current terms.

This will have implications for the level of risk exposure for homes and infrastructure in existing flood zones. It does not automatically mean that these areas will be flooded – but it does mean that the likelihood of flooding will be significantly increased. Unless substantial improvements are made to existing flood protection works (increasing the height and breadth of stopbanks etc) the community living on the flood plain will, over time, have to accept an increasing level of risk.

The risk of flooding will be further exacerbated by sea level rise. This will effectively slow down the rate of discharge of water in to the sea when rivers are in flood. There will, therefore, be a greater tendency for flood waters back up in the river channel and spill out on to surrounding land.

The areas that are affected by these flood risks are the same areas as currently exposed to a risk of flooding. The difference is that, with time, the probability of a flood actually happening in those areas will steadily increase. This will make areas that are already at risk of flooding all the more risky to live in over time.

Future planning for urban development will therefore need to take seriously the potential for increased flooding and ensure that sites are chosen where the risk of flooding is relatively low, or can be effectively managed. At Te Awa estate

and Parklands Estate in Napier, for example, the land has been artificially built up prior to the erection of houses. Both areas are also pump drained.

Future land use planning will also need to be mindful of the need for flood detention areas to be provided. There is, at present, little formal protection of flood detention areas where these occur over private land. They are, however, an essential part of the overall flood protection plan.

Figure 8 : Heretaunga Plains Potential Floodable Areas. Source : Hawke's Bay Regional Council. Potential floodable areas are shown in blue. Note that the map only shows areas potentially flooded by a breach of one or more of the rivers and therefore does not include the airport flats / Ahuriri Farm. The low-lying parts of the farm, on the western side of the property, are also prone to flooding during heavy rain.

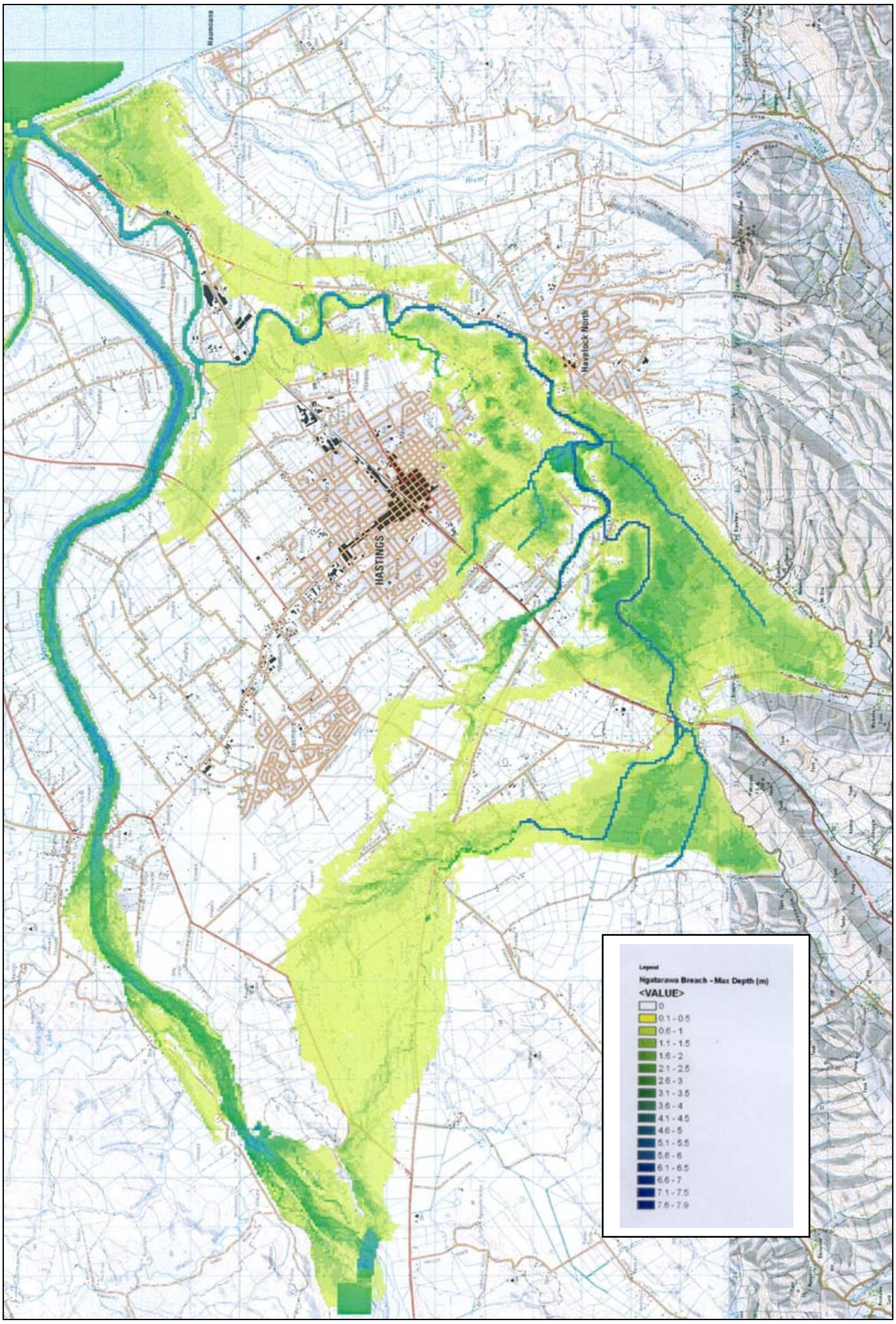

Figure 9 : Flood scenario involving a breach of the Ngaruroro River at Ngatarawa. This map shows the areas that would be most affected by such a breach. Water depths are colour-coded. Source: Hawke's Bay Regional Council.

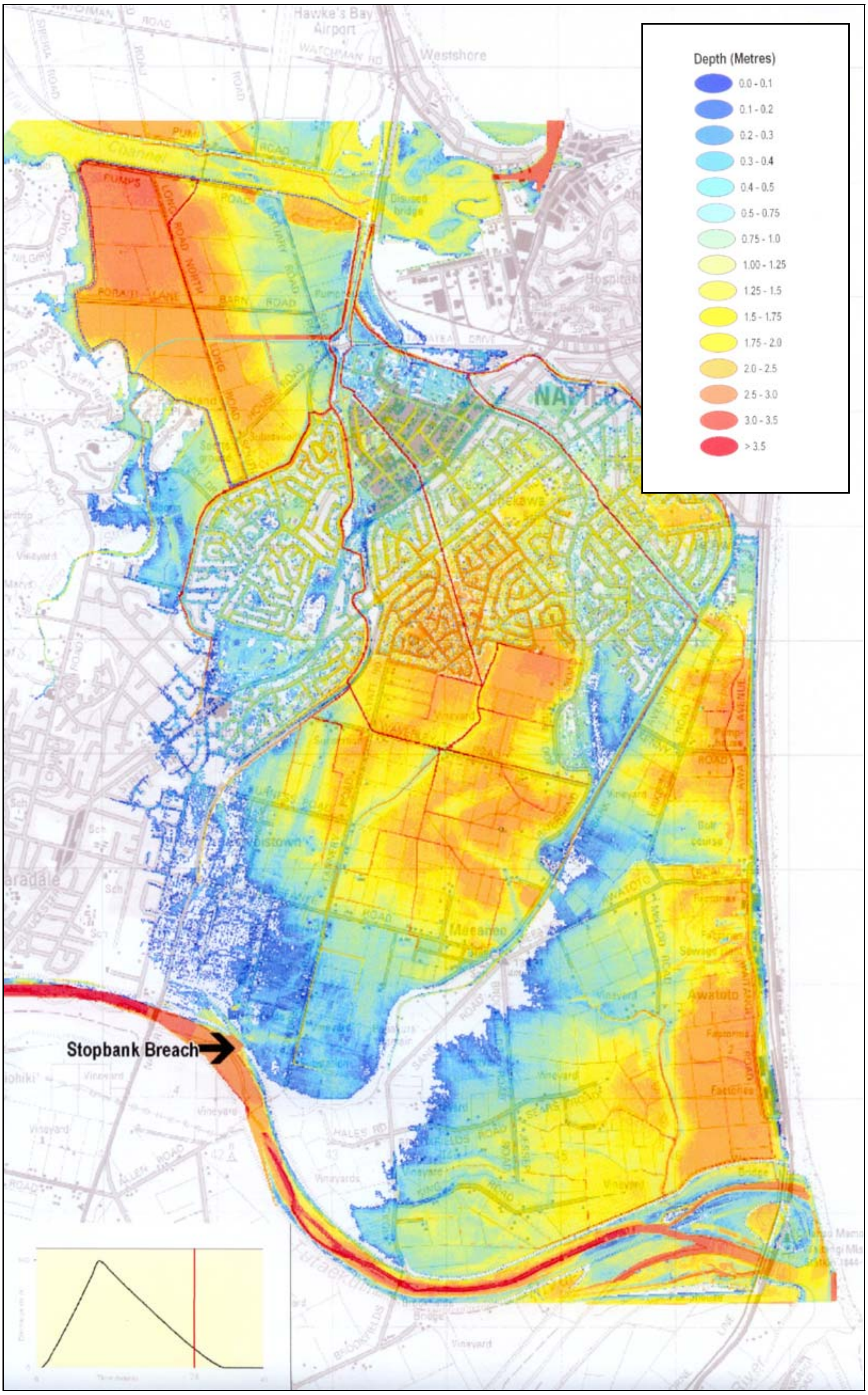

Figure 10 : Flood scenario involving a breach of the Tutaekuri River. This map shows the areas that would be most affected by such a breach. Water depths are colour-coded. The scenario shows water depths as they would be at their peak, about 28 hours after occurrence of the breach. Source: Hawke's Bay Regional Council.

5.4 Salination of Groundwater (Seawater Intrusion)

Rising sea level will mean an increasing likelihood of saltwater intrusion and salination of shallow groundwater in areas that are pump drained. The extent and degree of pump drainage required, especially in Napier, will increase over time as sea level rises

The area initially most likely to be affected is the Landcorp farm and Hawke's Bay Airport. Parts of the farm are already below sea level and rely on continual pump drainage.

The Heretaunga Plains aquifer will not, however, be affected.

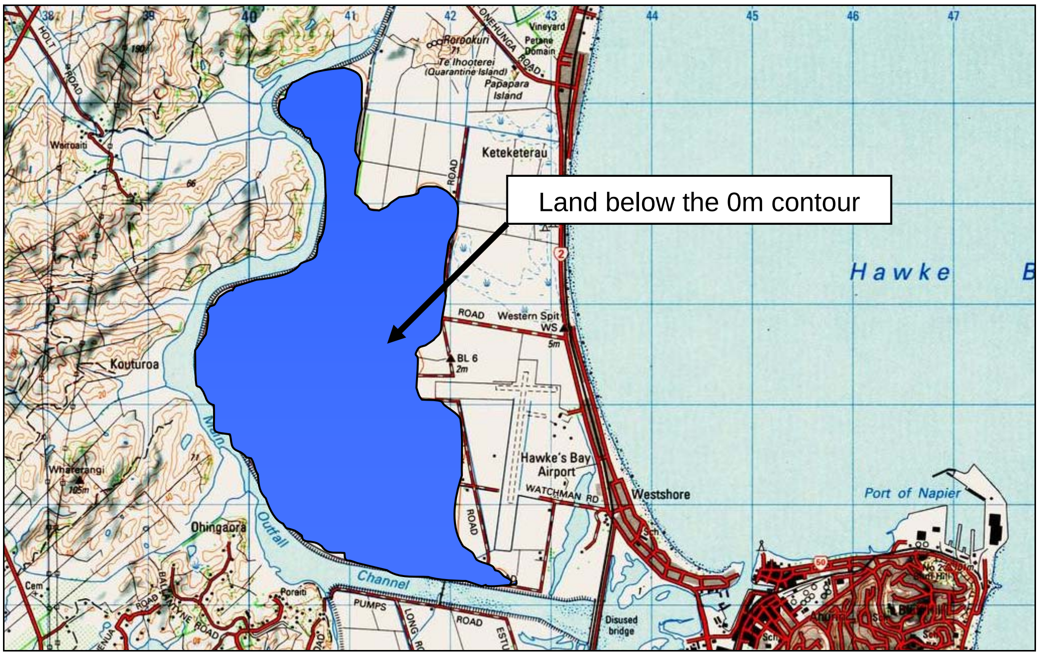

Figure 11 : Pump-drained, low-lying ground on the airport flats / Ahuriri Farm, below the 0 metre (mean sea level) contour.

5.5 Water Supply

An increasing frequency of drought can be expected in the whole of the East Coast, including Hawke's Bay, as a result of future climate change. Rain, when it comes, will tend to drop in heavier storms. The patterns of rainfall will therefore be more extreme – with more droughts and more heavy bursts of rainfall rather than slow-soaking rain.

A response that is now being investigated to cope with the expected shift in rainfall patterns (as well as agricultural water shortages that are already being experienced) is to focus on the construction of water storage reservoirs whereby water can be stored during times of high river flow for use in dryer periods. Investigations are currently being led by the Hawke's Bay Regional Council.

While this is, and will continue to be, an important regional issue, it is not considered likely to have any significant bearing on planning for future urban development in the Heretaunga Plains. Urban water supply is from the confined Heretaunga Plains aquifer – although greater use of stored surface water in the

agricultural areas will have secondary benefits in terms of reduced reliance on aquifer supply and therefore potential over-extraction from the Plains aquifer.

6. Effects of Local Industry on Climate Change

The effects of current industry within the area on climate change are related to the generation of greenhouse gas emissions. These are derived from either processing or transportation. There is little that can be done, within the scope of urban land use planning, to limit processing-related emissions. It is, however, possible to have a considerable influence on emissions resulting from transportation – specifically by improving the efficiency of transportation in the region and by promoting the use of more fuel-efficient modes of travel. Also relevant will be the physical placement of industry, so that travel distances are minimised for regularly made trips.

The most fuel efficient mode of transport is shipping. Linkages between the Port of Napier and regional industries are therefore relevant. Also potentially relevant is the link between the Port of Napier and Port of Gisborne to the north. The existing transport links between Hawke's Bay and Gisborne are dominated by road, and secondarily by rail. The development of a coastal shipping or barging service between the two centres could be investigated.

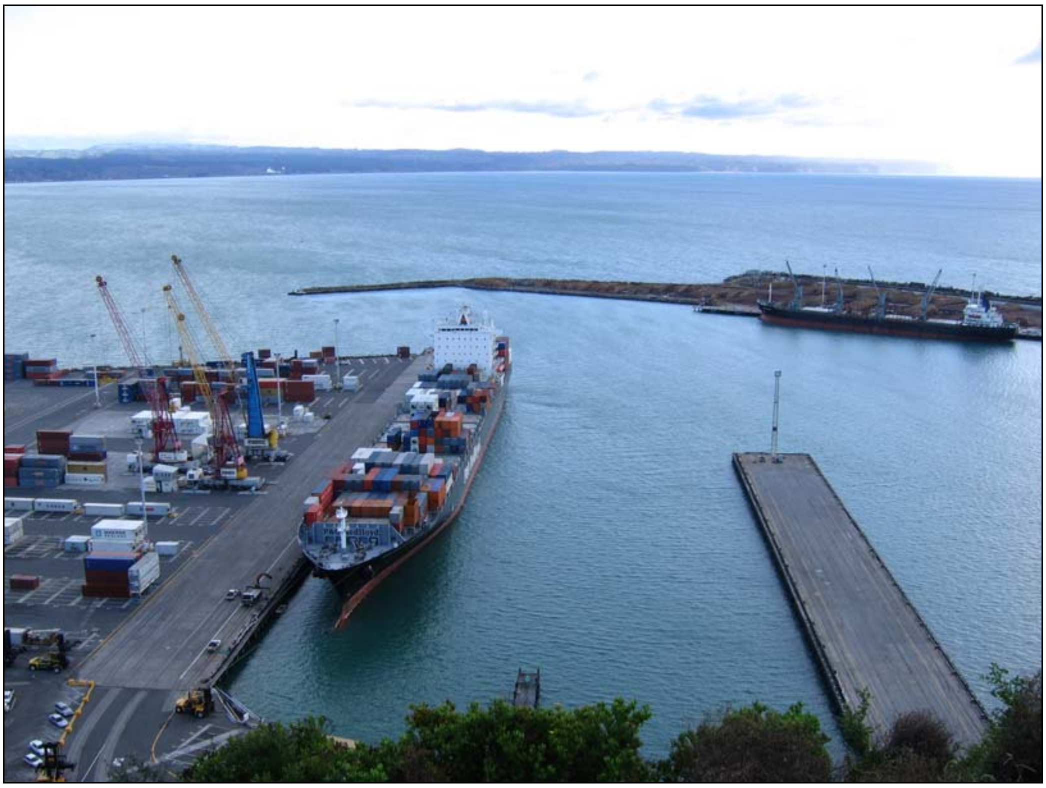

Figure 12 : Port of Napier. Shipping is the most fuel-efficient transport mode.