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Natural hazard risk assessment for Matamata Piako District

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Executive Summary

The purpose of this report is to provide an overview of natural hazards in the Matamata-Piako District as a basis for guiding and prioritising work activities for the Matamata-Piako District Council (MPDC) and Waikato Regional Council (WRC) for 2013/14 and beyond. This report also provides a useful insight into the district's natural hazards as part of the scheduled review of the Matamata-Piako District Plan.

Both agencies have responsibilities for the management of natural hazards in accordance to a complex set of statutory responsibilities, but primarily the Resource Management Act 1991.

The known natural hazards in the Matamata-Piako district are identified, explained and prioritised by a qualitative risk analysis.

Based on the qualitative risk analysis, earthquakes pose the greatest risk in terms of potential loss of human life, social disruption, economic cost and infrastructure damage. Drought is the second highest risk, followed by river and drainage flooding. A summary of the natural hazard prioritisation for MPDC is shown in . The report also identifies various factors/considerations that are likely to affect natural hazard planning such as predicted effects of climate change.

Table 1: Summary of natural hazard risk assessment

Hazard Scenario	Total Score	Priority
Earthquake	14.3	1
Drought	12.1	2
Flooding (River and drainage)	12.0	3
Severe Wind	10	4
Volcanic Ashfall	9.8	5
Debris flow	9.7	6
Land instability	8.7	7
Rural Fire	7.6	8

1 Introduction

1.1 Purpose

This report provides an overview of the significant natural hazards currently affecting and are likely to affect the Matamata-Piako District, including:

- An initial assessment of a range of existing and potential natural hazard risks that affect the Matamata-Piako District and how these may change over time.
- An initial qualitative risk assessment which identifies the risk to life and property in broad terms
- An identification of gaps and priorities
- A basis for developing effective District Plan provisions regarding natural hazards.

Both MPDC and WRC) have ongoing natural hazards commitments in the District. This report presents an initial analysis for the key natural hazards and provides guidance to MPDC and WRC for the prioritisation of natural hazards work programmes within the Matamata-Piako District.

The key drivers that for the preparation of this assessment are:

- The review of the Matamata-Piako District Plan (including the identification of future District growth priorities).
- The need to document/review the suite of natural hazards relevant to the MPDC area.
- Outline existing natural hazard information (and its status) held by WRC, including maps and other spatial information
- To identify any (research) gaps.
- Outline and identify options for addressing risk into the future.
- Form a basis for guiding and informing strategic policy formulation and implementation.
- Undertake a qualitative (desk top) risk assessment exercise in as a basis for determining future priorities (short and long term).

1.2 Background

MPDC is currently undertaking a sectional rolling review of the Matamata-Piako District Plan and it is expected the natural hazards section will be reviewed in the near future. In accordance with the Waikato Regional Policy Statement and Proposed Waikato Regional Policy Statement, this plan includes planning provisions that cover the management of land-use to reduce the actual or potential impact of natural hazards.

The first stage in the provision of natural hazard information, is to prioritise the hazards that affect the Matamata-Piako District Council, based on current information. The prioritisation is based on a qualitative natural hazards risk assessment.

1.3 Statutory and legal framework

The Local Government agencies responsible with managing the natural hazards that affect the Matamata-Piako District are MPDC and WRC. The responsibility includes the development of policy and implementing strategies and mechanisms to avoid or mitigate the effects of hazards on people, property and the environment. Further details regarding these responsibilities are presented in Appendix 2.

The statutory framework guiding WRC and MPDC is primarily determined by the Resource Management Act 1991. Other relevant statutes include the Local Government Act 2002, the Soil Conservation and Rivers Control Act 1941, the Land Drainage Act 1908, the Building Act 2005, the Public Works Act 1981, the Civil Defence Emergency Management Act 2002, and the Hauraki Gulf Marine Park Act 2000. Further discussion around the relevant provisions of these statutes is provided in Appendix 1.
The Ministry of Civil Defence and Emergency Management has a role in hazard management through its enabling legislation.

1.4 National drivers for hazard management

There are several key drivers which impact the way in which natural hazards are managed in New Zealand. These include:

- The emergency management focus on hazard risk reduction, the treatment of residual risk and an all hazards approach
- The recent review of the Resource Management Act which places more importance on natural hazards and their associated risk.
- Local Government New Zealand through the development of a Natural Hazards Guidance note.
- Increasing community expectations for natural hazard management to be linked with other community outcomes.
- The impact of predicted future climate change on natural hazards, including the need to adapt existing risk reduction measures (e.g. flood protection schemes).
- Increasing development pressure on land that is affected by natural hazards.
- The damage that continues to be sustained by numerous New Zealand communities due to natural hazards.

1.4.1 Review of the Resource Management Act

Since its enactment in 1991, the Resource Management Act (RMA) has undergone several reviews and amendments to keep up with changing needs and circumstances. The Minister for the Environment is currently leading a reform of the RMA which is being carried out in two phases. Phase one introduced the Resource Management (Simplifying and Streamlining) Amendment Act 2009 which was enacted on 1 October 2009. Phase two contains a package of reforms that touch on a number of resource management areas that are not only related to the RMA but cover resource management more broadly.

The second phase is split into two stages, the first is the Resource Management Reform Bill 2012 and the second is the 2013 reform package.

Sections 6 and 7 of the RMA set out the principles decision-makers must take into account when making decisions on resource management issues. These sections support section 5 which sets out the purpose of the RMA to promote the sustainable management of New Zealand's natural and physical resources.

The current sections 6 and 7 will be merged into one list of matters of national importance to be considered in decision making. The management of the significant risks of natural hazards is a new matter to be included in sections 6. This includes all aspects of hazard risk (both likelihood and impact) (Ministry for the Environment, 2013).

This change will give greater weight to natural hazards in decision-making and mean natural hazards are considered early and up front in resource and land use planning. Ultimately this means planners will avoid granting resource consents for inappropriate developments.

We note that the RMA reforms have been currently put on hold by central government.

1.5 Key hazard planning considerations for Matamata-Piako District

In addition to the statutory framework and national drivers, there are a number of other considerations that are or will affect the management of natural hazards in the Matamata-Piako District, including:

- Continuing population growth in known natural hazard areas.
- The proximity of existing development to land affected by natural hazards.
- The growing number of Resource Consent applications covering the development of marginal land.
- The incorporation of predicted future climate change into research, planning and operations.
- Increasing property values, particularly in areas that are affected by one or more natural hazards.
- Translating Central Government risk management guidelines into effective policies using the Regional and District planning framework.
- The increasing demand from Central and Regional Government for land use planning controls to be incorporated into a risk reduction strategy.
- The Increasing awareness of the importance of lifelines infrastructure (e.g. roading, electricity and potable water).
- The existing reliance of some communities on physical works that are unlikely to provide the unconditional protection that is often sought.
- The importance of maintaining public awareness and understanding regarding the management of natural hazards.

A crucial role for the Council in areas affected by natural hazards is raising public awareness and ensuring that the public is prepared for emergencies, to reduce the risk to lives and property.

2 Profile of Matamata-Piako District

2.1 General description

The Matamata-Piako District encompasses a large portion of the Waihou River Valley and covers an area of 1750km^2. It incorporates the major townships of Matamata, Morrinsville and Te Aroha and has a population of approximately 31,536 (2013 data). See Figure 1 for population densities (2012 data).

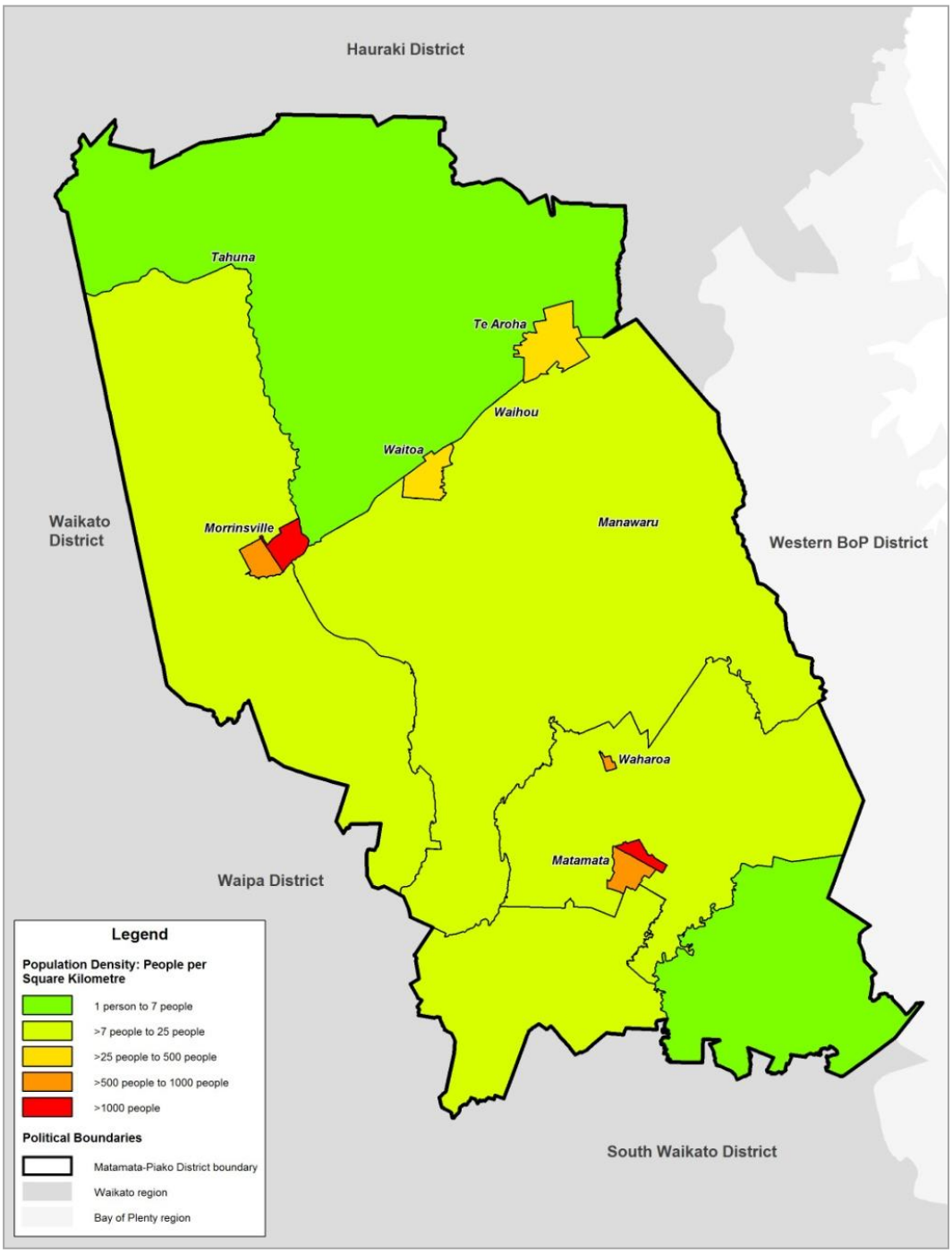

Figure 1: 2012 Population densities by area units of Matamata-Piako District. Most of the Matamata-Piako District population is centred on the three distinct urban areas with smaller population densities at each end of the district.

There are three wards which make up the district – Te Aroha, Matamata and Morrinsville. See Figure 2.

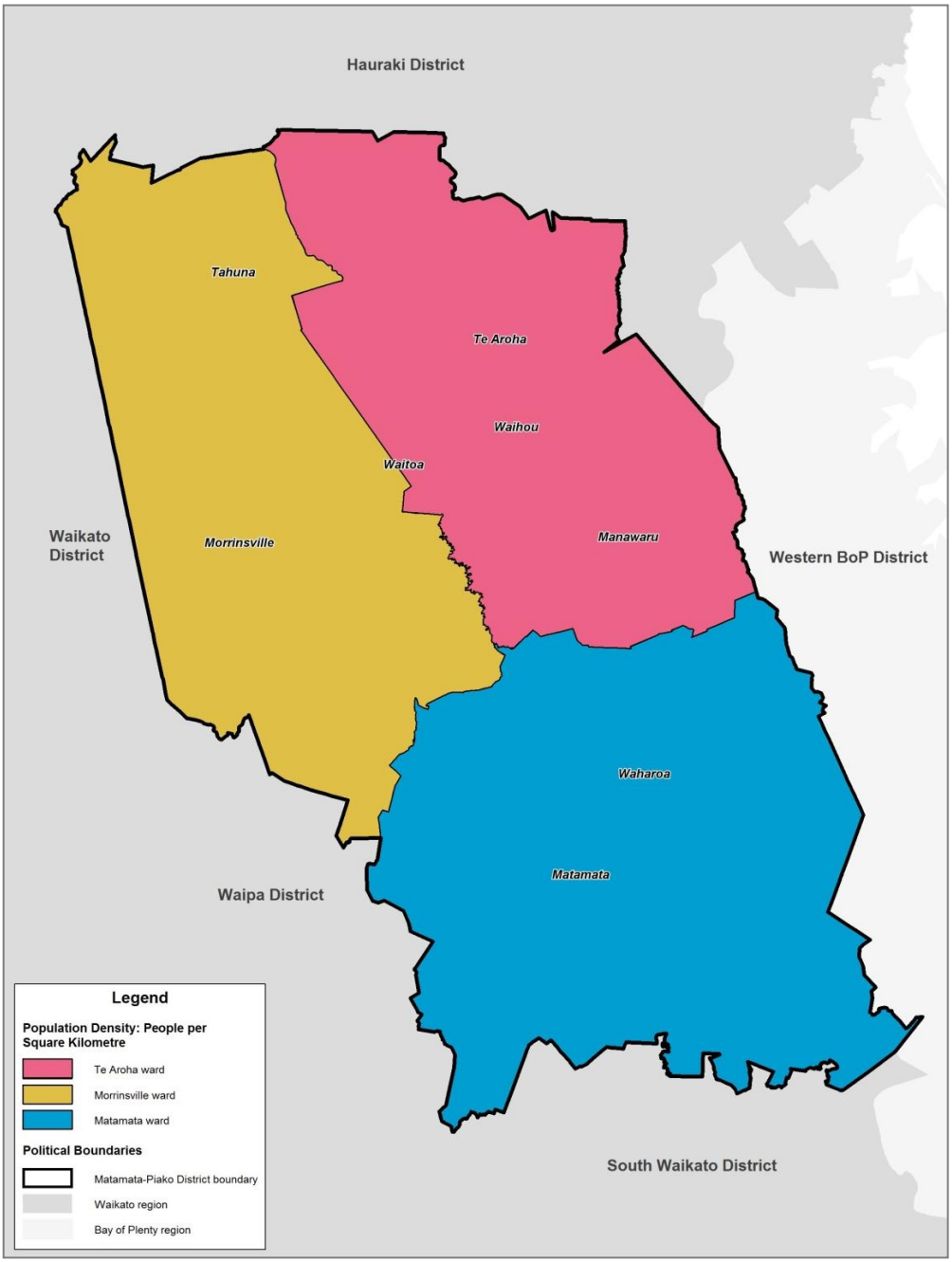

Figure 2: Matamata-Piako District Wards - Te Aroha, Matamata and Morrinsville

The south end of the District is also a major transport corridor which links Hamilton and Tauranga via SH26 over the Kaimai Range. Four other State Highways run through it, including SH27, SH26, SH24 and a small section of SH28, most of which eventually feed onto SH29. SH26 provides a vital link between Coromandel and the surrounding regions. Rail links are also prominent, with lines running over to Tauranga, to the south and west of the district. See Figure 3.

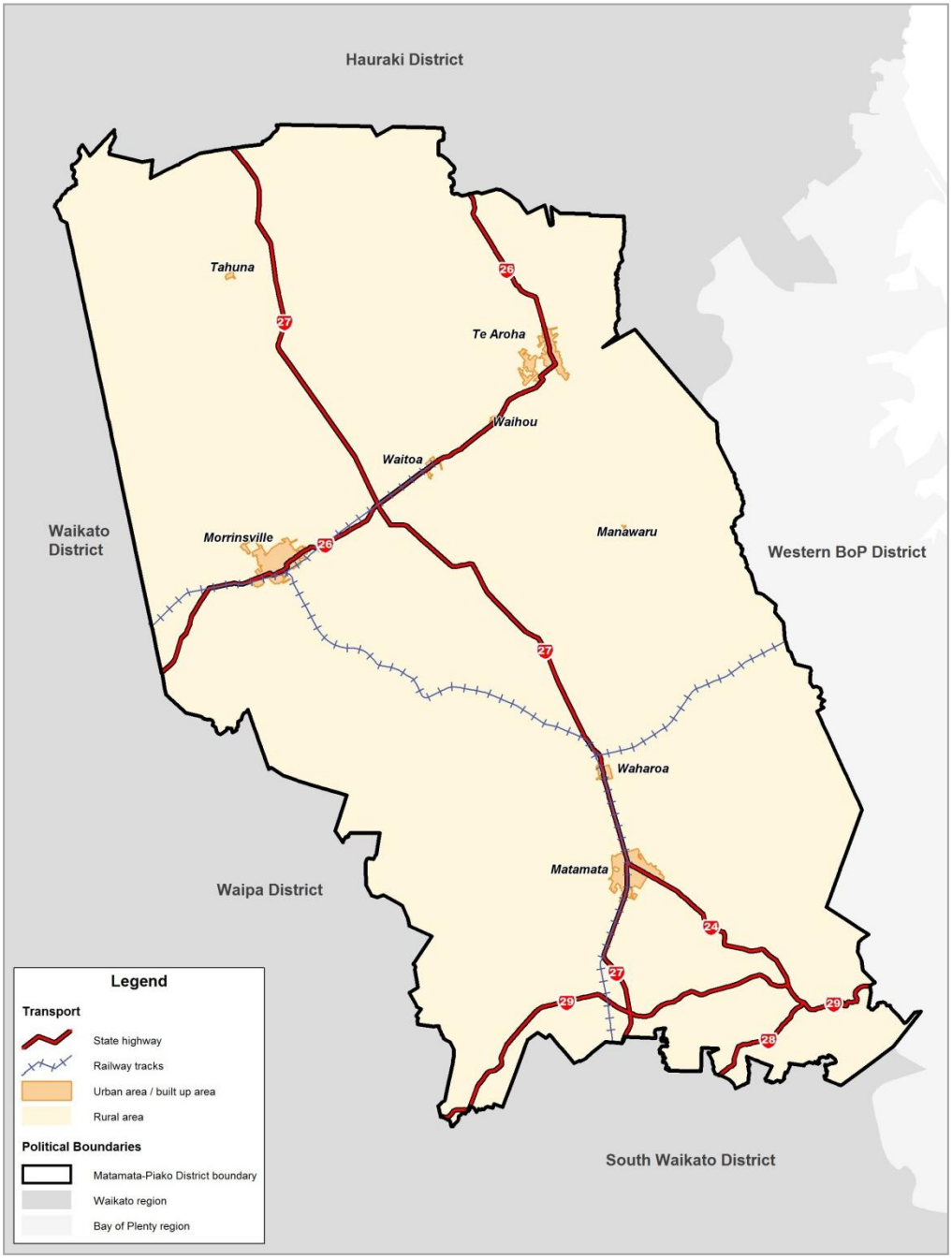

Figure 3: Matamata-Piako District main transport routes

2.2 Physical setting

2.2.1 Geology

The Matamata-Piako District encompasses the southern end of the Hauraki Plains and much of the Thames Valley. It is bounded in the east by the Kaimai Range with the Piako and Waihou rivers running through the district to the Firth of Thames.

The Kaimai Range has varied geology which influences natural hazard patterns within the Matamata-Piako District. On the western side of the range, lava bluffs are common, as well as small streams in which cascades and waterfalls are frequent, due to the hardness of the underlying bedrock. The entire Range is composed almost entirely of Miocene andesites and dacites overlain to the south by younger ignimbrites.

Figure 4 indicates that the district sits within an active rift valley which over time is extending its width as a result of ongoing tectonic processes. This process has given rise to about five “sharp” earthquakes in the last 9,000 years which has resulted in the

subsidence of the western depression by a total of 2.1m. It also details the geomorphology of the region.

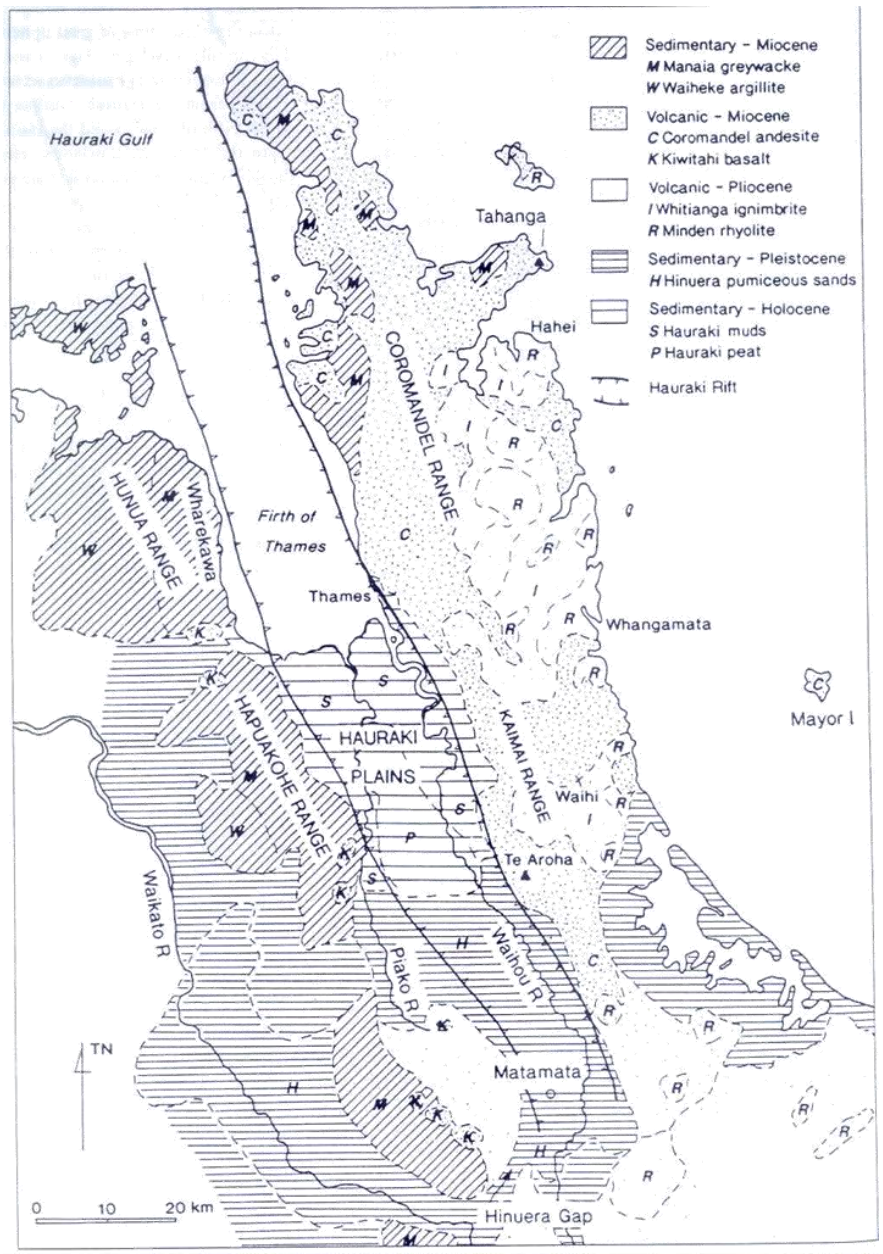

Figure 4: Geological setting of the Hauraki Plains and Matamata-Piako District (based on Healy et al. 1964: Scholefield 1973; Suggate et al. 1978; Thornton 1985).

Volcanic ash is a parent material in the area but also it may be mixed with materials derived from the underlying andesitic rock. More recent pumiceous ash from the Mangaone, Kaharoa, and Taupo eruptions is also present as a fine, white sand distributed throughout the soil structure. The difference in the parent materials gives rise to obvious differences in the type of clay and to soil properties.

Depending on the type of minerals present in the soil, clays can be found in large amounts in the valley which are very responsive to changes in moisture content by swelling or cracking. In contrast, the ash soils have a high phosphate retention and low cohesion. This influences the amount of risk to debris flows and landslides in the district.

Hazards from slips, landslides and erosion are important concerns in the hill country of the District, particularly on the steep slopes of Mt Te Aroha and along the Kaimai Range.

2.2.2 Climate

Generally, the Matamata-Piako district has weather patterns typical of the Waikato Region; warm, humid summers and mild winters, with prevailing west and southwest winds.

The Waikato region, centred around 38 degrees south, is exposed to prevailing west and southwest winds from the Tasman Sea. These bring mild, humid conditions. Sheltered and elevated inland places experience extremes of hot and cold. See Figure 5 for the Waikato Region's mean annual wind speed.

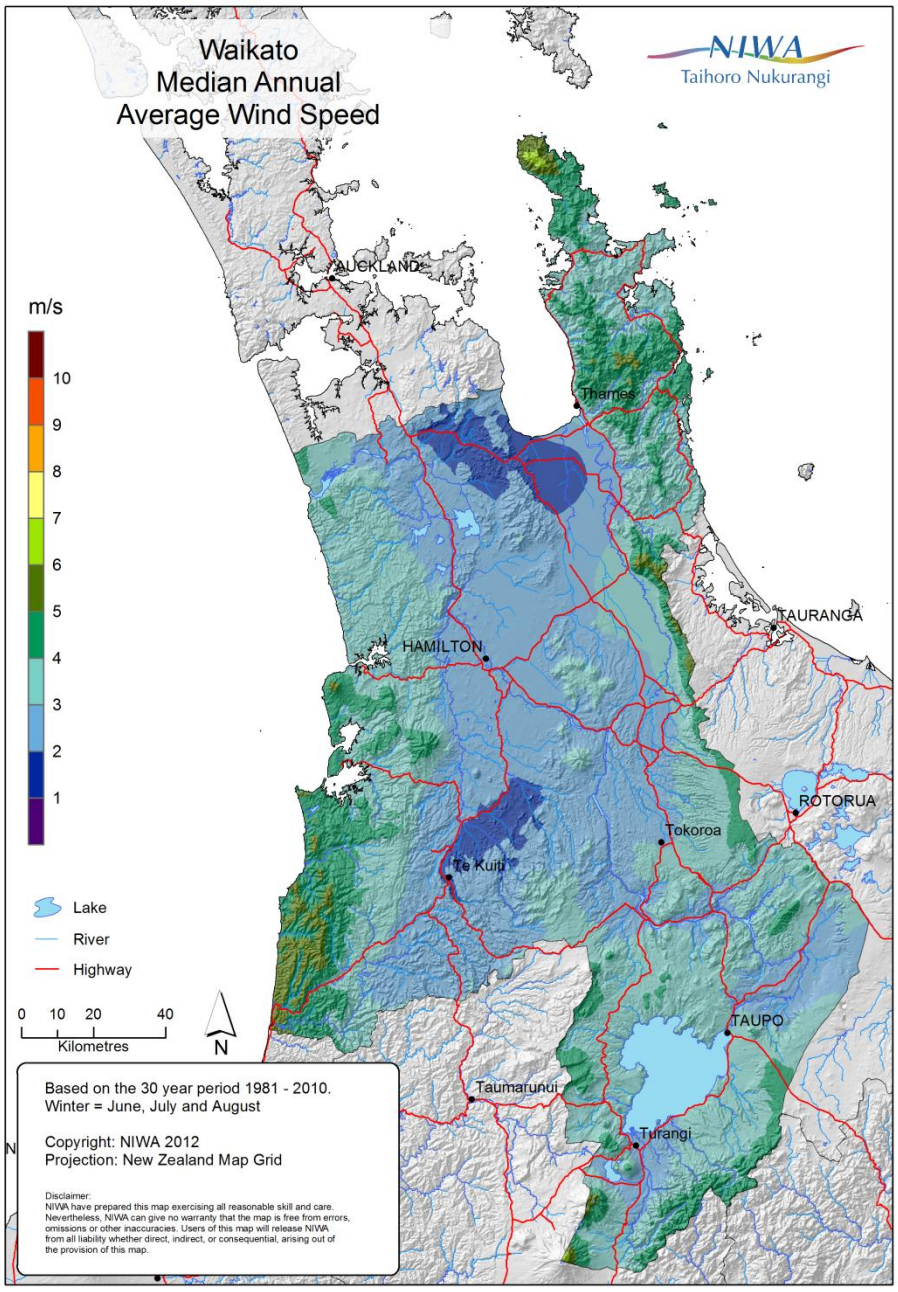

Figure 5: Waikato Median Annual Wind Speed (based on data from the period 1981-2010)

The Kaimai Range has a large influence on the variable weather patterns of the Waikato Region, specifically the Matamata – Piako District. The Range separates two weather districts. To the west, the Waikato Region is largely influenced by the predominant easterly movement of frontal systems onto New Zealand, while in the Bay of Plenty Region, to the east, most of the summer rainfall arises from tropical storms which originate north of New Zealand (Jane & Green, 1984).

Rainfall is influenced by the Kaimai ranges as there is a steep gradient in rainfall on the western face of the range. For example, at the summit of Mt Te Aroha, the annual rainfall total is 2000 mm, compared to, the town of Te Aroha, two kilometers away at the base of the mountain has an annual rainfall of only 1500 mm. The rainfall decreases further to 1100 mm at Morrinsville on the Hauraki Plains 20 km to the west. The rest of the district is quite sheltered by the Coromandel range and the central North Island plateau and receives an annual rainfall average of 1200-1600 mm (see Figure 6).

Further information on local wind and rain effects due to the Kaimai Range is contained in Section 3.

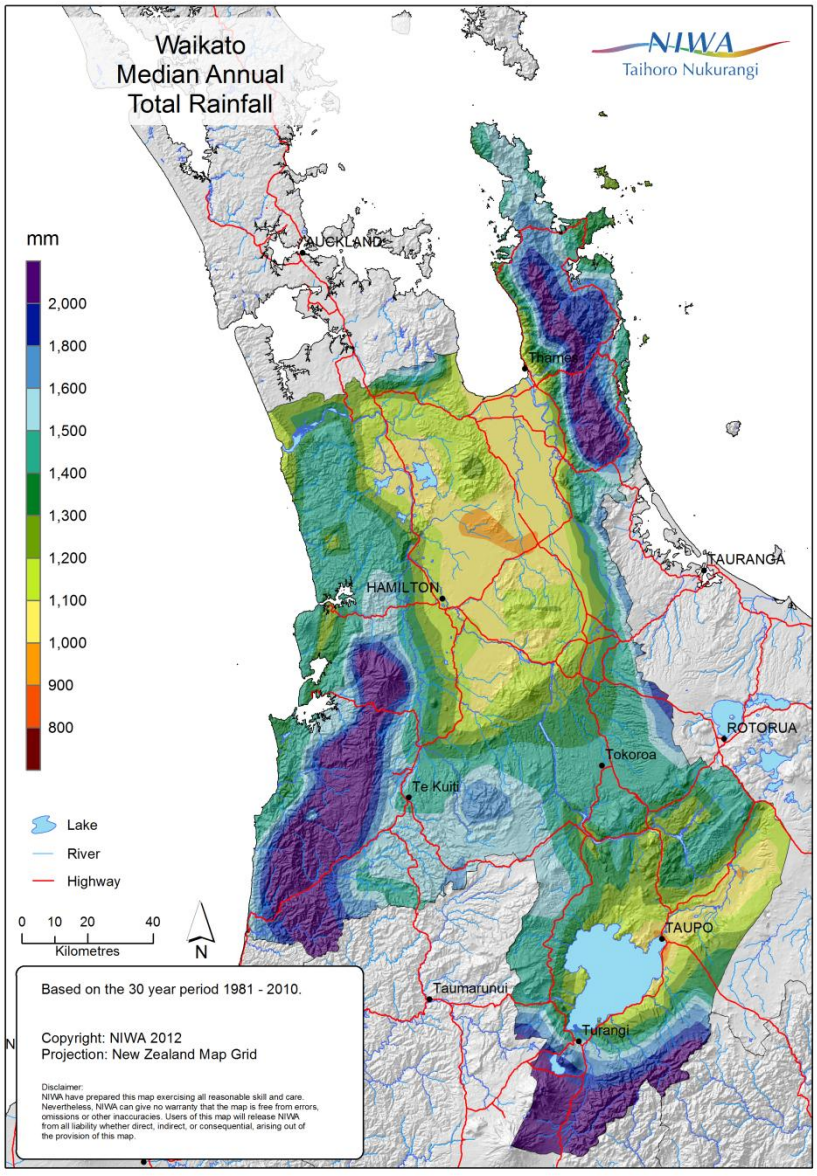

Figure 6: Annual rainfall averages of the Waikato Region (based on data from the period 1981-2010)

3 Natural hazards in the Matamata-Piako district

3.1 Introduction

The Matamata-Piako district is similar to many areas of New Zealand in that it is subject to a number of natural hazards such as tectonic (earthquake), volcanic, and severe weather. Our present knowledge of natural hazards within the district is based on a number of sources including:

- Local knowledge and experience, particularly with river flooding, coastal flooding, and severe storm events.
- Detailed investigations and research of specific hazards including:
    - River flood engineering, mapping and surveying work.
    - General hazard studies such as earthquake risks.
    - The regional hazard risk analysis completed as part of the Civil Defence Emergency Management Group Plan.

The Matamata-Piako district is particularly at risk from geological and meterological based natural hazards. An assessment of the probability and the effects of natural hazard events can be based on knowledge of the history of past occurrences as well as a comprehensive hazard analysis. The following natural hazards have been identified as particularly relevant for the Matamata-Piako district:

- Earthquake
- River flooding
- Drought
- Volcanic activity
- Land slides and erosion
- Debris flow
- Forest fire

3.1.1 Current and previous research

Several research projects have been identified to improve the understanding of the Waikato Region, which can be applied to the Matamata-Piako District (**Error! eference source not found.**).

Table 2: Research projects for the Waikato region

Research Project	Researcher	Year	Hazard
Earthquake Hazard Assessment for the Waikato Region	IGNS	1996	Earthquake
Volcanic Hazard Assessment for the Waikato Region	IGNS	1997	Volcanic
Land Susceptibility Mapping and Risk Assessment for the Waikato Region	University of Waikato	1999	Landslides

3.1.2 Natural hazard indicators

MPDC has identified a list of natural hazard indicators to better assess and measure natural hazard risk, pressures and their response. The natural hazard indicators provide a useful guide to policymakers for the reduction of human, financial, economic and infrastructural losses caused by natural hazards.

The natural hazard indicators for MPDC are:

Pressures (increase in risk from natural hazards)

- Number of resource or building consents applied for/granted within flood protection area
- Number of buildings within flood protection area
- Number of buildings within identified fire buffer
- Number of dwellings built on potentially unstable land (i.e. land classed as having a degree of erosion of 2 or greater and/or slopes of >20 degrees)
- Number of resource or building consent applications applied for/granted for development on potentially unstable land

State (Measurable risks or factors which increase risks)

- Number and severity of flood events annually
- Area of land subject to flooding
- Number and area affected by rural fires annually
- Area of vegetated and un-vegetated land classified as having a degree of erosion of 2 or greater
- Area of headwater catchment in vegetation
- Number and size of earthquakes recorded annually
- Annual damage ($) to public and private property

Response (What MPDC are doing)

- Area of land identified on planning maps being subject to flooding
- Amount of Council spending on resourcing rural fire fighting emergency services
- Area of land being identified on planning maps as being subject to land instability
- Number of resource and building consents declined in areas identified as being subject to flooding, fire or instability
- Council expenditure on educating community about hazards.

3.2 Earthquake hazards

New Zealand experiences large numbers of small earthquakes, in a well-defined belt stretching from Fiordland to East Cape and the Bay of Plenty. The pattern is part of the ‘Ring of Fire’, the almost continuous belt of volcanoes and earthquakes rimming the Pacific Ocean. Shallow earthquakes (less than 40 km deep) are spread in a wide belt through the country (Figure 7)

Figure 7: Shallow earthquakes in New Zealand over the past 10 years (depth < 40km) (GNS Science)

In the Matamata Piako District there are several active fault lines, the most prominent being the Kerepehi fault line which runs in a southeast – northwest direction through the Hauraki Plains and into the Forth of Thames. (Figure 8). This fault line is thought to be responsible for both of the Districts largest recorded earthquakes which measured 6 and 6.9 in magnitude. The latest of these earthquakes occurred on 8 January 1972 near Te Aroha.

The effects of earthquakes include structural damage to buildings and infrastructure due to shaking and also liquefaction.

Figure 8: Active faults in the Matamata Piako District (sourced from GNS Science NZ Active Faults Database)

3.2.1 Liquefaction

Liquefaction occurs when a saturated or partially saturated soil loses strength and stiffness in response to an applied stress, usually earthquake shaking or other sudden change in stress condition, causing it to behave like a liquid. For liquefaction to occur, it is likely that the following three factors are present:

- Soil characteristics such as un-consolidated sands and silts, typically of Holocene Age (<10,000 years),
- A high water table
- Earthquakes large and long enough to trigger liquefaction.

The Peak Ground Acceleration (PGA) must be at least 0.1g[1] for liquefaction to occur, in addition to the other criteria being met. Figure 9 shows the expected PGA's for a 475 and 2,500 year return period. It is expected that the Matamata Piako District would be affected by greater than 0.1g PGA for both return periods. Table 3 illustrates the relationship between PGA and perceived shaking and damage of an earthquake. Geonet has strong motion recorders at Te Aroha and Matamata, as well as Thames. For comparative purposes, 2.2g was recorded in the February 2011 Christchurch Earthquake.

The effects of liquefaction can primarily be seen in the built environment, when parts of a building may sink into the ground or when underground infrastructure is damaged. The liquefied soil cannot support the weight of whatever is lying on top of it – be it the surface layers of dry soil, concrete floors, roads or building piles. The liquefied soil is forced into cracks, including those in dry soils or between concrete slabs. This can cause loss of support to building foundations, "floating" of manholes and buried infrastructure, as well as lateral spreading which is shown in Figure 10 (Saunders & Berryman 2012).

[1] PGA is expressed in "g", being the acceleration due to the earth's gravity equivalent to a g-force. Unlike the Richter (Ms) or moment magnitude (Mw) scales, PGA is not a measure of the total energy (i.e magnitude or size) of an earthquake, but how much the earth shakes at a given place (where the recording instrument is located).

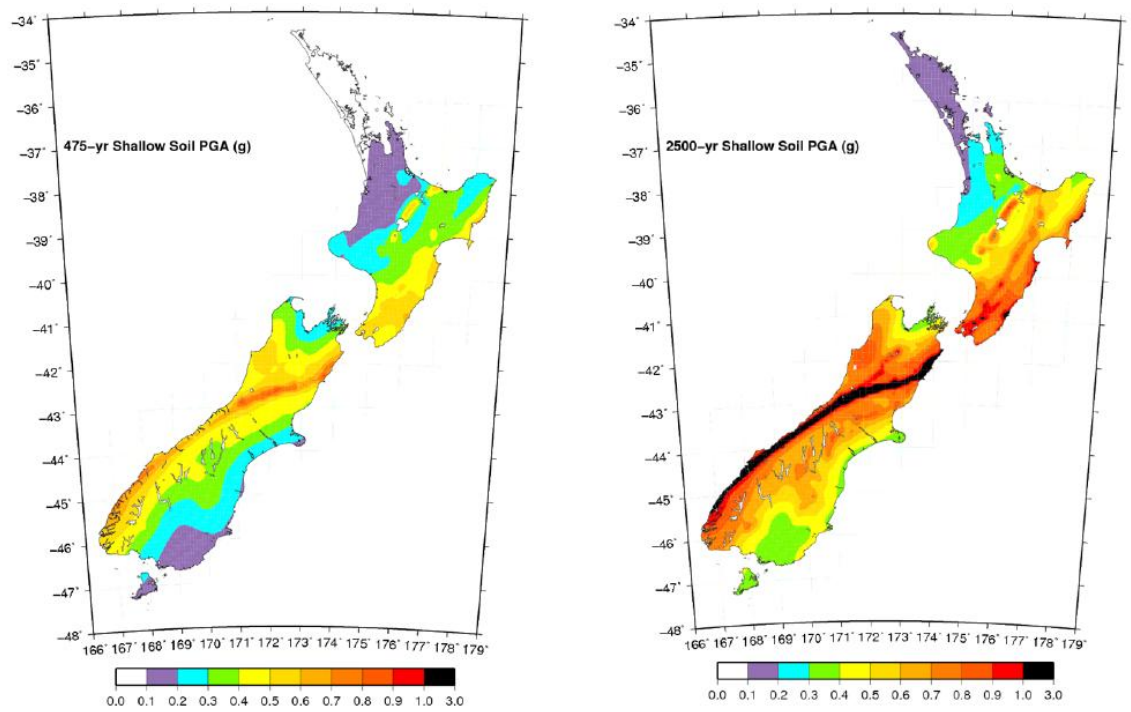

Figure 9 : 2010 National seismic hazard model for New Zealand showing expected PGA's for a 475 and 2,500 year return period earthquake for shallow soils (Saunders & Berryman 2012)

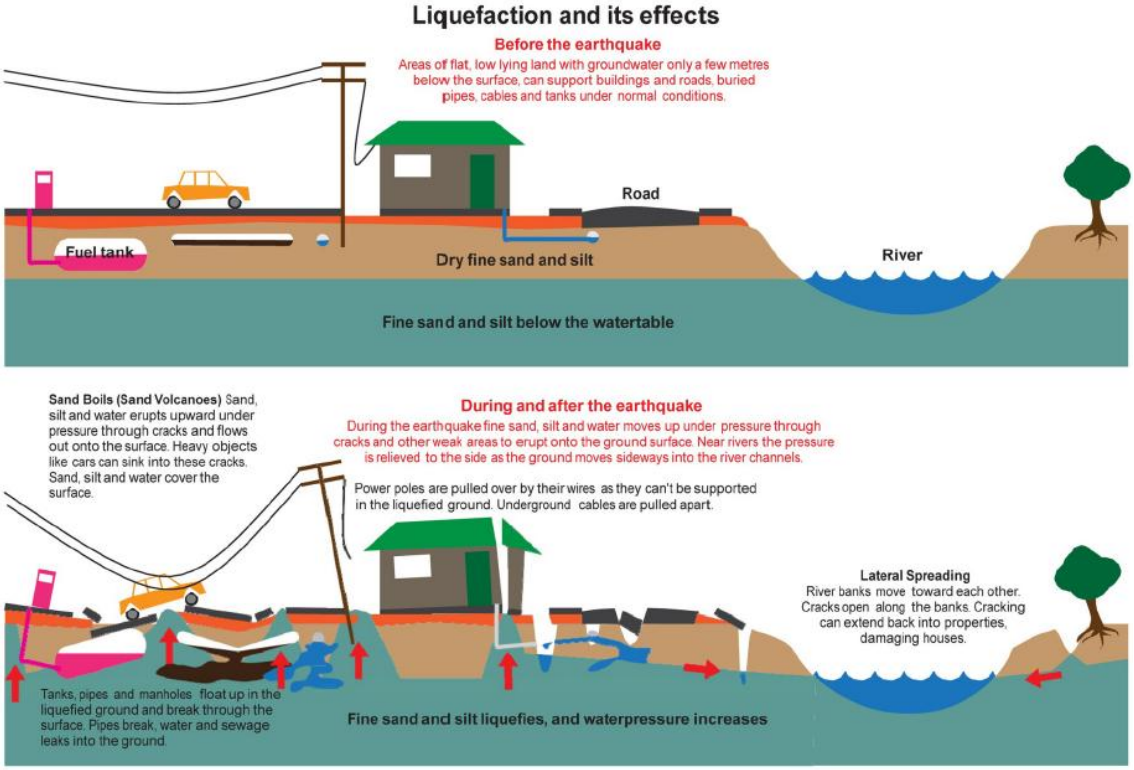

Figure 10: Liquefation and its effects (Saunders & Berryman 2012)

Table 3: Relationship between PGA and perceived shaking and damage of an earthquake

Instrumental Intensity	Acceleration (g)	Velocity (cm/s)	Perceived Shaking	Potential Damage
I	< 0.0017	< 0.1	Not felt	None
II-III	0.0017 - 0.014	0.1 - 1.1	Weak	None
IV	0.014 - 0.039	1.1 - 3.4	Light	None
V	0.039 - 0.092	3.4 - 8.1	Moderate	Very light
VI	0.092 - 0.18	8.1 - 16	Strong	Light
VII	0.18 - 0.34	16 - 31	Very strong	Moderate
VIII	0.34 - 0.65	31 - 60	Severe	Moderate to heavy
IX	0.65 - 1.24	60 - 116	Violent	Heavy
X+	> 1.24	> 116	Extreme	Very heavy

Matamata-Piako District has recent unconsolidated material (one of the three factors for Liquefaction - broad scale) in 10% of the urban area and 12% of the total area. See Figure 11 for an overview of the earthquake hazard zones in the Waikato region.

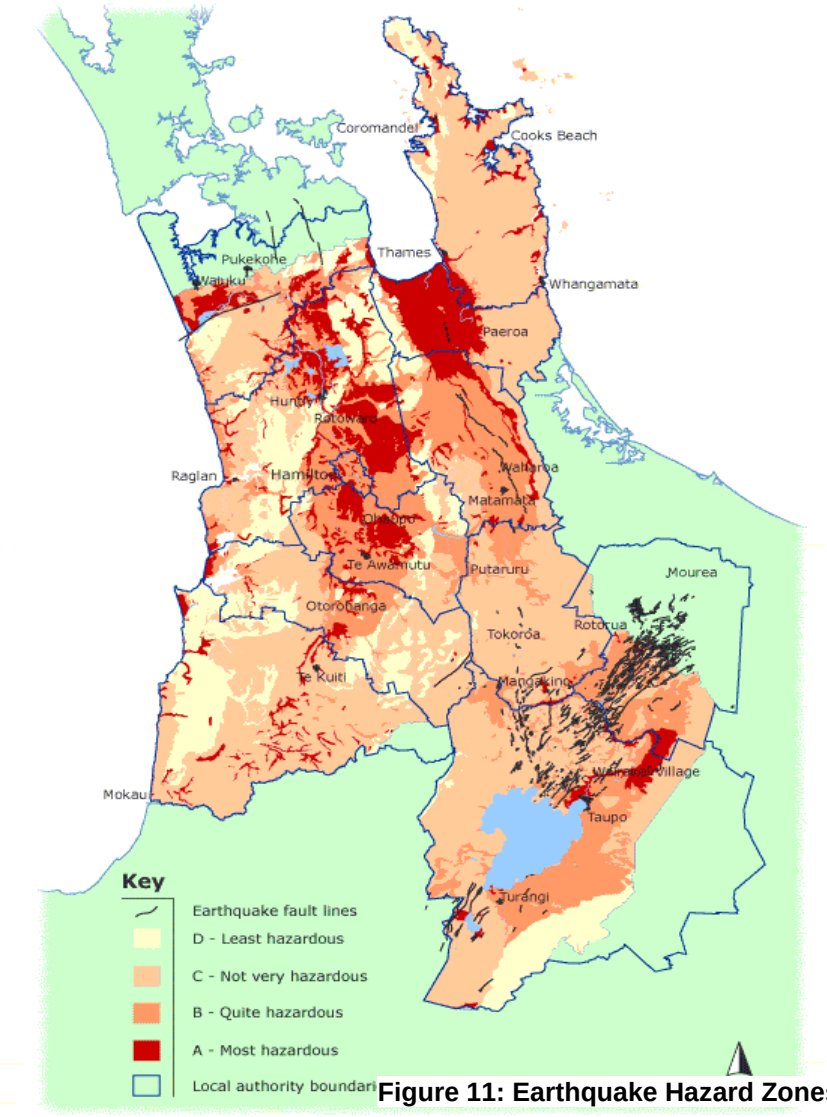

Figure 11: Earthquake Hazard Zones

Summary of material and hazard classes in Figure 11:

The most hazardous materials were formed less than 10,000 years ago. These have high volcanic ash content, mixed with peat, clay, silt, ash, sand and gravel. They may include layers that are easily saturated with water and are liquefiable.

Materials that are quite hazardous were formed less than 2.5 million years ago.These include river and marine terrace deposits, lignite, dune sand, pumice, gravel and ignimbrite (volcanic rock) flows.

Not very hazardous materials formed between 75 and 2.5 million years ago and include sandstone, siltstone, mudstone, coal measures, limestone and conglomerate.The least hazardous materials are Basement rocks formed more than 75 million years ago.

3.3 Drought

Historically, water shortage and drought within the Waikato region has not been as severe as in other regions of New Zealand, such as Otago, Marlborough, and Hawke's Bay. However, drought events have impacted communities and the Waikato region's economy in the past few years, with the most recent declared drought in 2013. Areas typically most affected by water shortage and drought conditions are the Hauraki Plains, lower Waikato Basin, Thames-Coromandel, and Pukekohe areas.

A summary of the Waikato Regions recent droughts are summarised in Table 4.

Table 4: Recent drought in the Waikato Region

Year	Effects
2007- 2008	This drought event lasted from November 2007 to April 2008, during which the Waikato experienced its driest January in a century. A shortage of feed caused by the drought increased the price of silage to four times its normal rate. The cost of the drought was believed to be $1.5 billion to the Dairy sector alone. The economic effect of the drought was one of the factors that threw New Zealand's economy into recession by mid 2008.
2009	The Waikato experienced a dry spring, the effects of which were compounded by the previous drought of 2007-2008.
2010	Waikato had two dry springs, which resulted in a double drought. The drought led to the owners of the Waikato River hydro scheme, Might River Power, announcing a 10 per cent drop in hydro production for the December quarter. Dairy farmers were estimated to have lost an average $100,000- $150,000 in income over the previous three years due to consecutive drought events.
2013	This drought affected more of New Zealand than any other drought in the past 40 years. See Section 3.3.1.
2014	Parts of the Waikato Region, including North to Central Waikato, Morrinsville through to Tahuna and south to Te Awamutu had very low soil moisture levels, similar to those of 2013.

NIWA has undertaken some specific research on how the frequency of drought might change over the coming century. The resulting report (NIWA 2005) developed drought risk projections for a range of climate change scenarios, corresponding to approximately the middle 75% of the IPCC (Intergovernmental Panel on Climate Change 3rd report)global temperature change projection range.

Under both the "low-medium" and the "medium-high" scenarios (which bracketed this 75% range), the drought risk was projected to increase in frequency during the coming century for all areas that are currently drought prone.

Since drought affects a large area, the Matamata-Piako District would be affected if drought was declared in the Waikato Region.

3.3.1 2013 Drought

The 2013 drought was a severe event and the impacts on farming and growth may continue for years. NIWA has confirmed that for parts of Waikato the 2013 drought was the worst in terms of soil moisture deficit in 40 years or, in some areas, as many as 70 years (as far back as records go). Figure 12: Soil moisture deficit maps for New Zealand on 1 March 2013. shows a comparison of soil moisture deficits.

These record breaking levels were high enough for the entire North Island to be declared in drought on March 15 2013. The cost of the drought for New Zealand was estimated at $2 billion dollars.

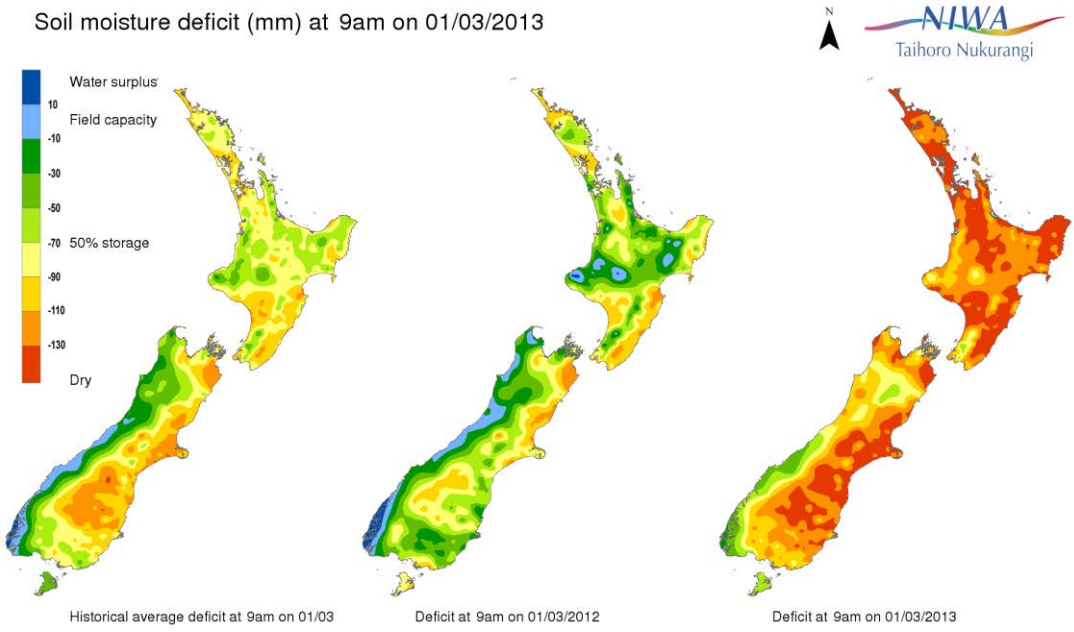

Figure 12: Soil moisture deficit maps for New Zealand on 1 March 2013.

Changes in weather patterns can affect the likelihood of drought in our region. Both El Niño and La Niña phases of the Southern Oscillation weather pattern can cause droughts around the country, however an El Niño pattern is more likely to cause droughts in the Waikato region. .However, the 2013 drought was not caused by either El Niño or La Niña patterns.

NIWA found the 2013 drought was due to slow-moving high pressure systems over the Tasman Sea and New Zealand during summer. These effectively blocked any other sorts of weather systems approaching the country (NIWA 2013).

Matamata-Piako District suffered along with all other districts in the Waikato Region. Water restrictions were put in place and the town water supplies in Matamata, Morrinsville and Waharoa were at critical levels during March 2013. Total fire bans were in force and the farming community were suffering due to drying out crops and grass for stock feed as well as increased prices for supplementary feed which lead to pressure on farm cash flows and income.

Climate change is predicted to increase the frequency, severity and length of droughts

3.4 River flood hazards

Flooding is the most significant and frequent natural hazard that affects the Matamata-Piako District (Figure 13). The district has two major river systems, the Piako and the Waihou flowing through populated areas and prime agricultural land.

The Matamata Piako district is particularly vulnerable to flood events due to:

- It's geographic (northern location) making it susceptible to storms of tropical origin.
- The orographic effect of the Kaimai and Coromandel ranges which cause localised, high intensity rainfall events on a regular basis.
- Many catchments that drain the ranges are steep and short, creating flood events and debris flows that are generally of short duration.
- Te Aroha in particular is at risk of flooding due to the location of the town on alluvial fans of Mt Te Aroha. Additionally the very steep catchments on the mountain are likely to be unstable and subject to significant natural erosion (BECA et al 1988).
- The most significant hydrological event in recent history for flooding in the Matamata-Piako District occurred on 17 February 1985. This event inundated the Te Aroha township with flood waters and debris (BECA et al 1988).
- While the construction of remedial options will improve flooding situations, the design philosophy should be to reduce flooding to a minimal inconvenience rather than provide protection against all circumstances. Maintenance will be an important feature for the effective operation of any remedial or protective structures.

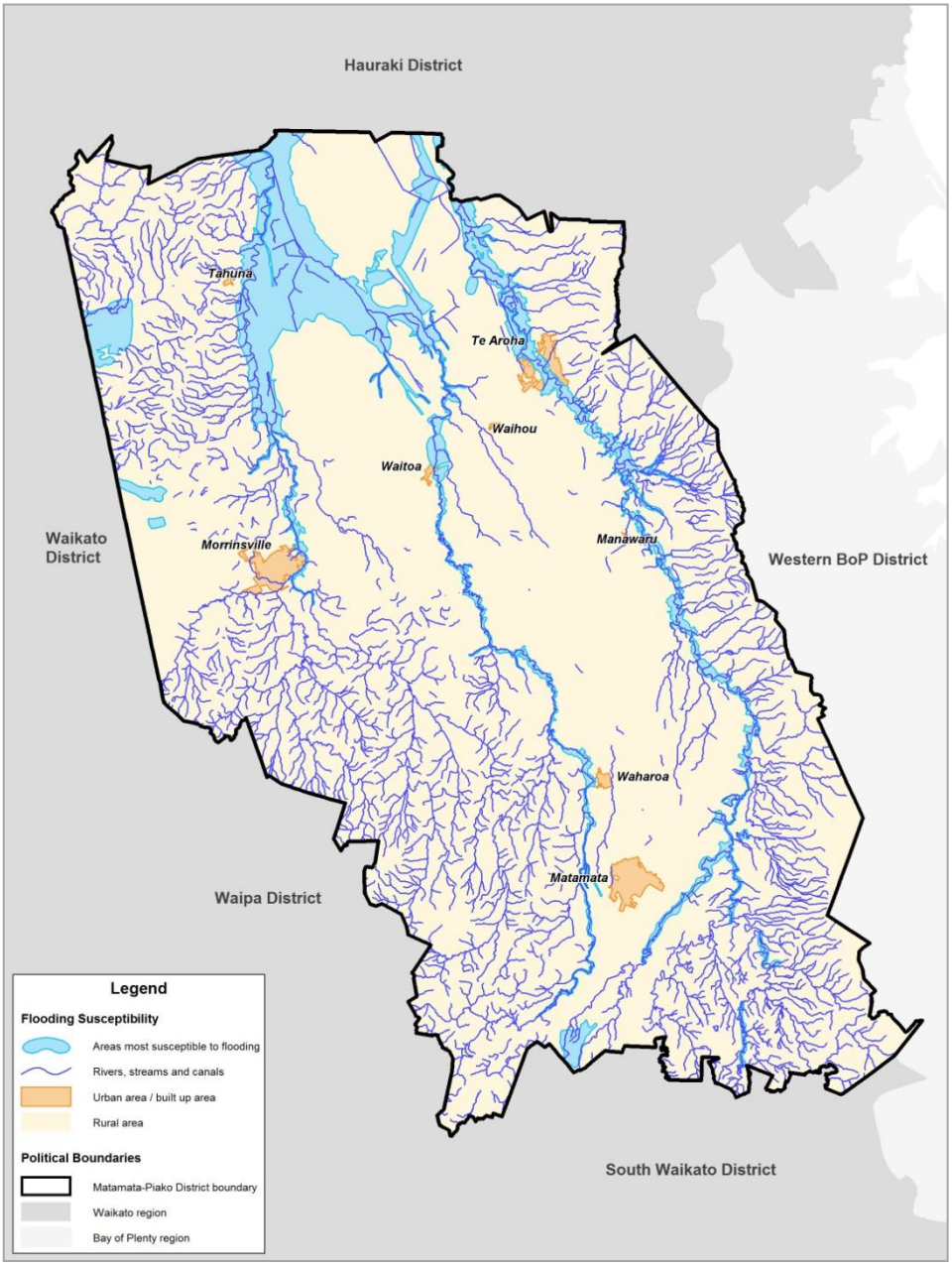

Figure 13: Flooding susceptibility in the Matamata-Piako District

3.5 Volcanic hazards

The Waikato region faces threat from future activity in the Taupo Volcanic Zone (TVZ), Mayor Island, White Island, Rotorua volcanic field and the Taranaki volcano field. Rhyolitic and andesitic volcanic centres in the TVZ have been active during most of the Quaternary (approximately 1.6 million years ago), depositing large volumes of volcanic material across the Waikato Region.

The magnitude of eruption could vary between violent to relatively quiet, largely ash eruptions such asNgauruhoe and Ruapehu. While the amount of ash produced by an eruption and the extent of fallout is variable and difficult to predict, large areas of farmland and forest, some urban areas and many rivers are likely to be seriously affected by ash and mud during a major eruption. Even relatively small thickness of ash fall can have a significant impact on the environment and human activity.

The Matamata Piako District would possibly have to deal with the effects of ash fall from a volcanic eruption from the TVZ, Taranaki or White Island volcanoes. See Table 5 for effects of volcanic ash fall.

Table 5: Some effects of volcanic ash fall (Adapted from Edbrooke, 2005)

Less than 1mm ash thickness • Irritant to lungs and eyes • Possible contamination of water supplies • Minor damage to houses, vehicles and equipment caused by abrasive ash
1-5mm ash thickness *Effects that occur with <1mm of ash will be amplified plus:* • Possible crop damage • Some minor effects of livestock (lack of feed, wear on teeth, possible water contamination) • Water supplies may be cut or limited due to electricity failure • Roads may needs to be cleared to reduce dust nuisance and prevent storm water systems becoming blocked
5-100mm ash thickness *Effects that occur with <5mm of ash will be amplified plus:* • Burial of pasture and low plants. Foliage may be stripped but most trees should survive • Most pastures killed over 50mm of ash • Major ash removal operations in urban areas • Weaker roof structures may collapse at 100mm ash thickness • Road transport may be halted due to ash build up
100-300mm ash thickness *Effects that occur with <100mm of ash will be amplified plus:* • Buildings that are not cleared of ash will run the risk of roof collapse (particularly if the ash becomes wet) • Severe damage to trees • Loss of electrical reticulation
>300mm ash thickness *Effects that occur with <300mm of ash will be amplified plus:* • Heavy kill of vegetation • Complete burial of soil horizon • Livestock or animals killed or heavily distressed • Kill of aquatic life in lakes and rivers • Roads unusable until cleared

The only volcanic activity within the Matamata-Piako District is the geothermal hot springs and geyser located at the Te Aroha Domain and the Opal hot springs near Matamata. However, the district is located in the volcanic ash deposition zone from the surrounding volcanic areas (Figure 14). The most recent volcanic event, the eruption of Mt Ruapehu in 1995 forced millions of tonnes of volcanic ash into the atmosphere to eventually settle over an area covering hundreds of square kilometres. Some volcanic ash settled within the Matamata-Piako District.

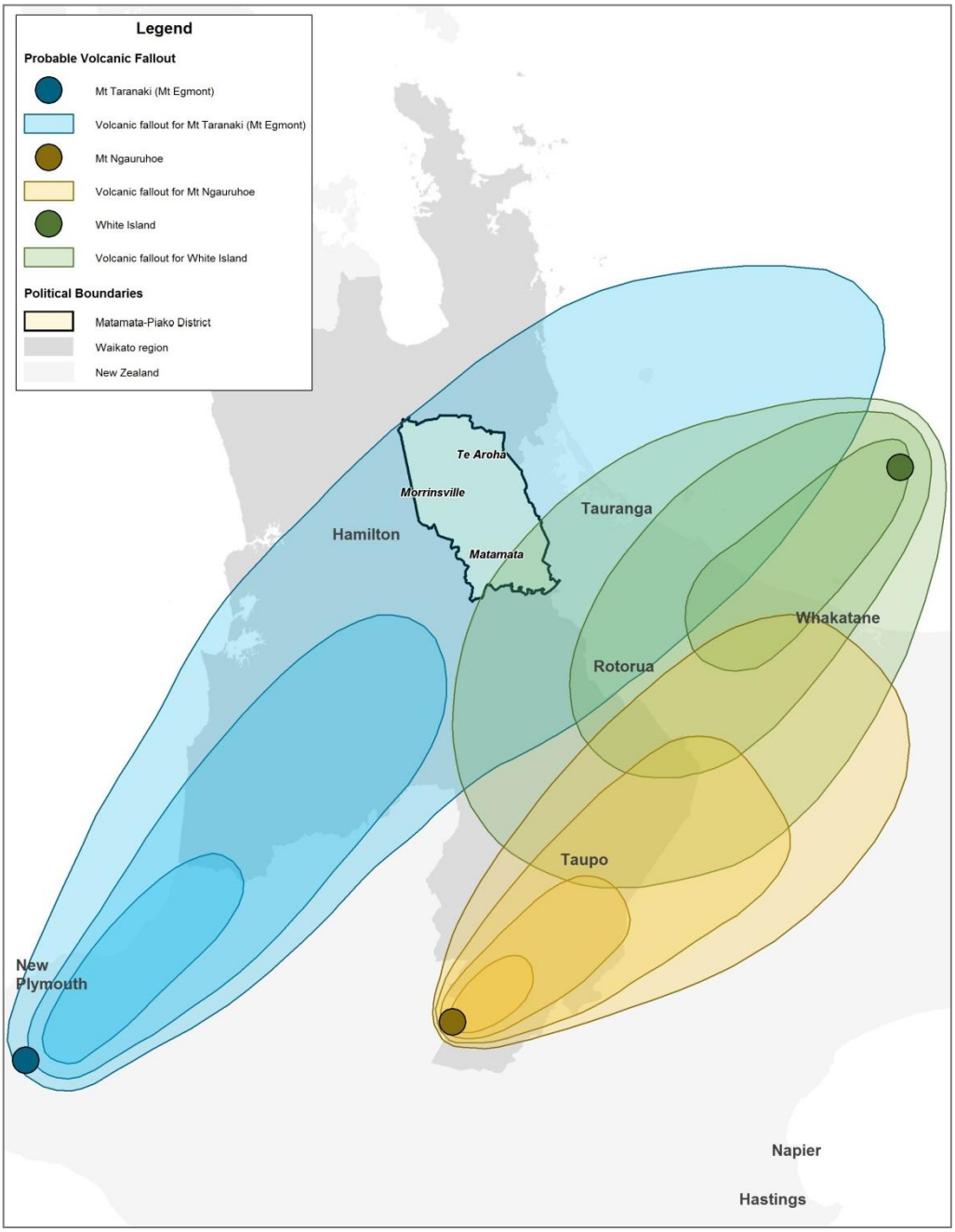

Figure 14: Matamata-Piako District volcanic fallout range predictions

3.6 Debris flows

Very little is known about the current risk of debris flows across New Zealand. Rapid development in New Zealand has led to an increasing use of alluvial fans for residential development. As yet, there's little appreciation of the hazards posed by infrequent but devastating debris-flows on these fans.. The 1981 Te Aroha and more recently the 2005 Matata (Bay of Plenty region) debris flow events are examples of events which have affected the Matamata-Piako District.

Debris-flows pose a hazard that is difficult to identify and manage. During an intense rainstorm a small creek can generate several-metre-high surges of mixed boulders, sediment and trees that can leave the channel and travel anywhere on an alluvial fan. In a typical catchment, this process might occur only once in a century or two, depending on the occurrence of sufficiently intense rain and the availability of sufficient sediment.

Figure 15: Image of the 1981 debris flow through Te Aroha

3.7 Severe Winds

Historically the western side of the Kaimai Range has been particularly prone to high winds. Extreme winds have caused considerable damage and disruption to the district. Historic events include those of 1936 and in 1978 when strong winds affected the region. In 1978, winds of 140 knots were recorded on top of Mt Te Aroha.

There are also other areas within the District that are subject to local wind tunnelling. In these areas what can appear to be a mild storm event can in fact result in quite substantial wind damage to property. However, high wind zones can be identified, with building standards and locations controlled according to the predicted level of risk.

Severe weather is a natural hazard event where further research is recommended.

3.8 Land instability

While only 2% of the district (or 3,282.73 hectares) has an erosion potential of moderate or severe, the adjacent map "Erosion potential" shows that one of the most severe of these areas is in the Kaimai Ranges above Te Aroha. Movement in this area could cause severe effects in Te Aroha which is located on alluvial fans between the Kaimai Ranges and the Waihou River. These alluvial fan deposits are very unstable and prone to landslide, slips and erosion (Figure 16).

In 1996, ex-tropical cyclone Fergus hit the Coromandel Peninsula and caused widespread damage. All major Coromandel roads were closed by slips and flooding and a State of Emergency was declared for the Thames-Coromandel District, as well as parts of Hauraki and Matamata-Piako Districts.

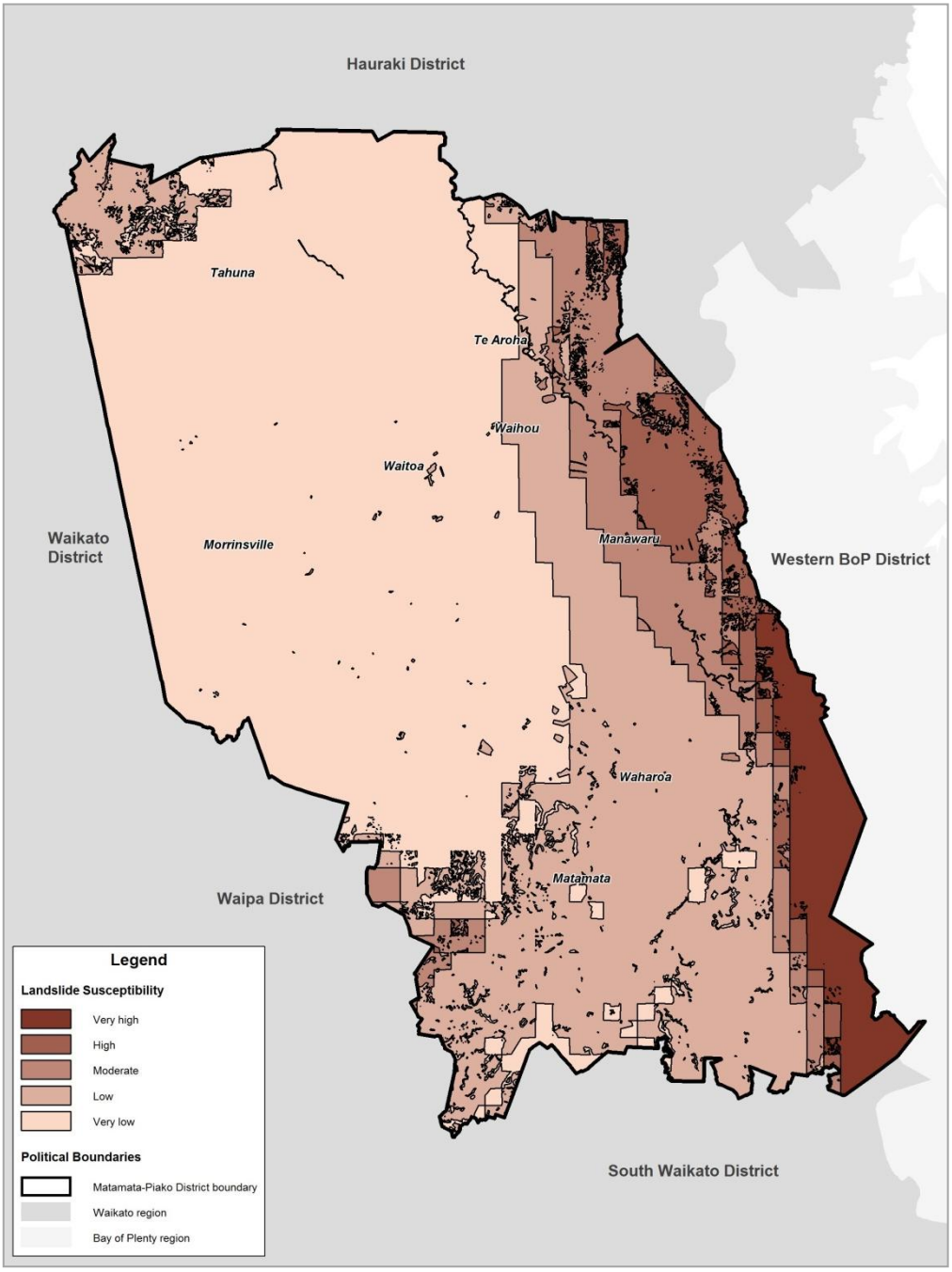

Figure 16: Matamata Piako District landslide potential

3.9 Climate change

Normal climate cycles are being affected by a gradual increase in the levels of greenhouse gases around the earth's atmosphere. This could see a rise in sea levels and changes in climate patterns, increasing the number of storms, rain, coastal flooding and erosion in the region.

The Intergovernmental Panel on Climate Change (IPCC) has stated that future sea level rise, in an unmitigated future rise in emission, is expected to be half a meter to a meter by the end of this century. This rise is largely contributed to by ocean thermal expansion due to warming, from changes in glaciers, Greenland ice sheet, Antarctic ice sheet, and land water storage. A rise in this magnitude would threaten the survival of coastal cities and entire island nations. Even with aggressive emissions reductions, a rise by 28-61cm is still predicted. Even under this highly optimistic scenario we might see over half a meter of sea-level rise, with serious impacts on many coastal areas, including coastal erosion and a greatly increased risk of flooding.

Human influence has been detected in warming of the atmosphere and the ocean, in changes in the global water cycle, in reductions in snow and ice, in global mean sea level rise, and in changes in some climate extremes. It is extremely likely that human influence has been the dominant cause of the observed warming since the mid-20th century and that more than half of the observed increase in global average surface temperature from 1951 to 2010 was caused by the anthropogenic increase in greenhouse gas concentrations and other anthropogenic factors. Continued emissions of greenhouse gases will cause further warming and changes in all components of the climate system. Limiting climate change will require substantial and sustained reductions of greenhouse gas emissions.

The global mean surface temperature change for the period 2016–2035 relative to 1986–2005 will likely be in the range of 0.3°C to 0.7°C. This assessment is based on multiple lines of evidence and assumes there will be no major volcanic eruptions or secular changes in total solar irradiance. Relative to natural internal variability, near-term increases in seasonal mean and annual mean temperatures are expected to be larger in the tropics and subtropics than in mid-latitudes. It is virtually certain that there will be more frequent hot and fewer cold temperature extremes over most land areas on daily and seasonal timescales as global mean temperatures increase. It is very likely that heat waves will occur with a higher frequency and duration. Occasional cold winter extremes will continue to occur.

For the Matamata Piako District and wider Waikato region, rainfall is expected to vary but higher annual rainfall is more likely in south and west parts of Waikato and lower annual rainfall is more likely in Coromandel. Heavy rainfall events may become more frequent in the Waikato.

The potential effects of climate change on the Waikato Region, including the Matamata-Piako District include:

- Changes in weather patterns – differences in rainfall, temperature and microclimates could affect agriculture and horticulture. The location of some industries, agriculture, horticulture and tourism may change.
- More turbulent weather - extreme weather can increase flooding, erosion, droughts, severe winds and damage ecosystems.
- Sea level rise - higher sea levels will affect coastal communities increasing coastal flooding and erosion.
- Threats to biodiversity - species that are already under threat or at the limit of their climatic range may not be able to survive.
- New diseases and pests may take hold. Tropical pests and tropical diseases like malaria may become established in areas where they currently do not exist.

An increase in the amount and frequency of rainfall could cause more river flooding in some areas of the Matamata Piako District, while decreases may cause drought. Land use, such as cropping and forestry may need to change to suit new weather patterns, affecting runoff, hillside and valley drainage as well as increasing fire risks due to vegetation changes.

4 Risk Assessment

4.1 Introduction

Having determined the most common and significant natural hazards in the Matamata-Piako District, it is necessary to analyse and evaluate the level of risk associated with each hazard. This will allow a comparison between different hazards in order to guide prioritisation for the level of work effort. One important precursor to this exercise is determining what the outcome or goal of the hazard mitigation work should be. Suggested goals for both MPDC and WRC are:

- To work towards the resolution of natural hazard issues in the district.
- To minimise risks from natural hazards to people and infrastructure in the district.
- To determine natural hazard management priorities for the purposes of long term planning.

Work actions should be determined using the combination of agency goals, current work commitments and level of risk associated with the hazard.

4.2 Description of scenarios

The assessment of risk can involve a broad range of approaches, including:

- Checklists.
- Judgements based on experience and records.
- Brainstorming.
- Flow charts and scenario analysis.

One of the most intuitive ways to describe risk is in the form of scenarios, and this approach has been adopted for this risk assessment.

Based on the natural hazard commentary provided, a scenario has been developed for each natural hazard that represents the 'maximum credible event'. These scenarios are outlined as follows:

- River flood involving the 1 % AEP year flood event, resulting in widespread inundation, as indicated by the existing flood hazard information.
- Land instability following a 1 % AEP rainfall event, resulting in numerous landslides on land that is identified as being highly or very highly susceptible
- Volcanic activity involving a 0.1 % AEP event from the Taupo Volcanic Zone, resulting in most of the district being covered in ash to a depth of 2 mm (weather conditions permitting).

4.3 Risk assessment methodology

Risk analysis and evaluation typically involves determining the likelihood of a hazard event occurring and the consequences of the hazard event. A commonly accepted standard for risk management in New Zealand is the AS/NZS 4360: Risk Management Standard. This standard is used as the basis for this report in order to:

- Establish the context (Section 2)
- Identify risks (Section 3)
- Analyse risks (Section 4.4)
- Evaluate risks (Section 4.4)
- Treat risks.

4.4 Analysis and evaluation

Problematic to any risk analysis is the level of detail and characterisation of the importance rankings. Table 6 shows a two stage approach to analysing and evaluating risks. Stage 1 involves the evaluation of risk based on likelihood and consequences of each scenario. Stage 2 involves a more detailed analysis based on the Risk Profile Template (detailed in the CDEM Group Plan Review), which allows the evaluation of risk based on these factors:

1. Seriousness: The measure of the potential impact, based on five areas that may be impacted (i.e. human, social, economic, infrastructure and geographic).

2. Manageability: The measure of the ability to manage either the hazard or the potential impacts on the community.

3. Growth rating: The measure of the potential for the risk to grow (e.g. the hazard may occur more frequently or the community exposure to the hazard may increase).

The 2 stage approach to risk evaluation is necessary to allow the prioritisation of risks that receive the same evaluation during Stage 1 (e.g. ‘high’).

Table 6: Risk analysis and evaluation

Hazard Scenario	Likelihood	Consequence	Risk Evaluation										Total	Priority
			Seriousness					Manageability					Growth			
			Social	Built	Economic	Natural	*Sub-total*	Reduction	Readiness	Response	Recovery	*Sub-total*	*Sub-total*		
Earthquake	*B*	*4*	4	4	4	3	**7.8**	3 MM	3 MM	4 HL	4 HM	**3.5**	**3** **MM**	**14.3**	1
Drought	*A*	*3*	3	**1**	4	3	**5.3**	5 HL	5 HL	3 HH	2 MH	**3.75**	**3** **MM**	**12.1**	2
Flooding (river and drainage)	*A*	*3*	4	4	3	3	**7.5**	3 MM	3 MM	1 LH	3 MM	**2.5**	**2** **ML**	**12.0**	3
Severe wind	*A*	*4*	3	**3**	2	3	**5.7**	4 LL	4 LL	3 MM	2 LM	**3.25**	**1** **LL**	**10**	4
Volcanic ashfall	*C*	*2*	2	3	3	2	**4.8**	4 LL	4 LL	4 LL	4 LL	**4**	**1** **LL**	**9.8**	5
Debris flow	*C*	*5*	2	2	2	3	**4.2**	3 HH	3 HH	4 HM	4 HM	**3.5**	**2** **ML**	**9.7**	6
Land Instability	*A*	*2*	2	2	1	2	**3.7**	2 LM	2 LM	5 HL	3 HH	**3**	**2** **ML**	**8.7**	7
Rural fire	*C*	*2*	2	1	1	4	**3.6**	2 MH	2 MH	2 MH	2 LM	**2**	**2** **ML**	**7.6**	8

Note: An outline of the terms and scales used in Table 6 are presented in Appendix 6: Key to Table 2 (risk analysis evaluation key).

- The hazards listed under “Hazard Scenario” have been identified as being most relevant to the Matamata-Piako District based on the discussion in Section 3.

- These natural hazards are all identified as creating a significant risk to the Matamata-Piako District, with earthquake and drought being identified as being particularly significant.

- Further analysis of these natural hazards using the Risk Profile model confirms that earthquake and drought are most significant, followed by flooding, severe wind and volcanic ashfall.

- The priority assigned to earthquake is driven by the seriousness of the hazard, along with the potential for the risk associated with the hazard to escalate due to both increased development and increased awareness of the hazard type due to the 2011 Christchurch Earthquake.

- Volcanic ashfall has been assigned the fourth highest priority out of the 8 hazards, but it is noted that this hazard has received the highest ‘manageability’ rating, indicating the lack of measures available to prevent the hazard from occurring.

- River flooding is assigned a lower priority than earthquake or drought due to a lower manageability and growth rating. However, it is important to note that this priority is based on the current environment, and that there is a significant potential for the risk associated with this hazard to escalate due to inappropriate development and medium to long term changes in the natural environment (e.g. sea level rise and the natural dynamics of the coastal environment).

4.5 Residual risks

Residual risk is the term used to define those risks that cannot be defined in more detail after elimination or inclusion of all conceivable quantified risks have been addressed. Residual risk can also be described in terms of “the bigger than event”. For example, if planning and operational measures are only implemented against the 1 % AEP event scenario, then anything larger (e.g. 0.2 % or 0.1 % AEP events) would be considered a residual risk.

Figure 17: Internal stopbank flooding creates residual risk

WRC aims to address the residual risk component through the proposed regional flood risk management strategy. Residual risk is also a key consideration within the proposed national and regional flood risk management strategies.

4.6 Conclusion

As a result of the risk assessment and evaluation, it is concluded that earthquake, drought and flooding are the highest priority natural hazards currently facing the Matamata-Piako district. The reasoning for this conclusion is presented in Table 6.

5 Summary, discussion and recommendations

5.1 Summary of natural hazard risks

While drought, river flooding (river and drainage) and volcanic ashfall have been identified as important natural hazard priorities for the Matamata-Piako District, they do not carry the same level of risk as earthquakes. Earthquakes carry greater threat in terms of social disruption, economic cost, infrastructure damage and possibly loss of human life. It should also be noted that earthquakes have the potential to affect other natural hazard risks in the district, particularly flooding in terms of damaging existing flood protection schemes. This is an important consideration for the district in light of possible future growth and the associated pressure to increase development in known flood hazard areas.

Further discussion regarding the basis for this prioritisation of natural hazard risks in the Matamata-Piako District can be found in Sections 3 and 3.9.

5.2 Discussion

The following discussion is relevant to natural hazards in the Matamata-Piako District:

- The proposed prioritisation of natural hazards in the Matamata-Piako District is based on a variety of considerations. It is however important to note that the relative significance of a natural hazard is generally dependant on the nature of development on susceptible land. It is therefore important that a range of natural hazards continue to be considered when planning for future growth, including those hazards that are currently assessed as being less significant.

- The characteristics of most natural hazards are dependent on the natural environment. Therefore, a natural hazard that is currently relatively insignificant may become significant following changes in the environment (e.g. climate change that is currently predicted due to global warming or a change in the coastal environment accelerating in coastal erosion).

- This assessment is at a District Scale and is intended to assist with the identification of issues that may need to be considered. This may include a trigger for a more site specific assessment to confirm/discount any specific natural hazard threats.

5.3 Recommendations

As a result of this qualitative risk assessment, the following recommendations are proposed for the Matamata Piako District with regard to the management of natural hazards:

- It is recommended that earthquake risk be considered the highest priority natural hazard affecting the Matamata Piako District. This is because of the existing level of risk, along with the potential for the risk to escalate due to future development.

- It is also recommended that the approach to the management of earthquake risks is developed to be consistent with the Regional and National approaches (e.g. Earthquake Risk Mitigation Plan, Building Act 2004).

- It is recommended that the Matamata Piako District Plan be adopted as a key tool to reduce the risk and potential impact of natural hazards, particularly those identified as having a priority in the Matamata Piako District (e.g. earthquake, drought, flooding and volcanic ashfall).

- The significance of various natural hazards in the Matamata Piako District is partially dependant on the appropriate development of susceptible land. It is therefore recommended that the full range of natural hazards continue to be considered when planning for future growth, even those that have been identified as relatively insignificant by this assessment.

- MPDC and WRC continue to address the natural hazard risks together through sharing of information and sound policy and strategy formulation and implementation.

5.3.1 Further research

This report has highlighted the need for further research to be conducted in the interest of natural hazard risk reduction in the Matamata-Piako District. This research includes assessment and implications on the following natural hazards:

- Liquefaction
- Climate change
- Severe wind

6 References/Bibliography

6.1 Research

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6.2 Legislation and national standards

Building Act, 2005

Civil Defence Emergency Management Act, 2002

Land Drainage Act, 1908

Local Government Act, 2002

Local Government Official Information and Meetings Act, 1987

Public Works Act, 1981

Reserves Act 1977

Resource Management Act, 1991

Soil Conservation and Rivers Control Act, 1941

AS/NZS 4360: Risk Management Standard

7 Appendix 1: Statutory and legal framework

7.1 The Resource Management Act (RMA) 1991

7.1.1 Introduction

The RMA sets in place a planning framework with respect to hazard management. The Act defines the role of central government agencies, such as the Department of Conservation, and regional and district councils such as WRC and MPDC respectively. The mechanisms to achieve this include a hierarchy of linked interrelated policy statements supported by non-statutory documents such as action plans developed to address individual (river flooding) or a suite of related hazards (coastal erosion and flooding).

The RMA assigns to regional councils responsibility for the integrated management of natural and physical resources within their region. Regional councils are required to control the use of land, the taking and use of water, and the planting of plants in water bodies for soil conservation, the quality of water, the quantity of water, and the avoidance or mitigation of natural hazards. Regional and district functions are specified by the Act and are outlined in Appendix 2.

7.1.2 Long-term management strategies

The RMA provides for the long-term management of hazards through various policy mechanisms, some of which are discussed above. These include, in the case of coastal hazards, the New Zealand Coastal Policy Statement and regional coastal plans, and for other hazards regional policy statements, and district plans. Policy implementation is given effect through various methods and can include non-statutory mechanisms such as education programmes, advocacy and community consultation and engagement; or statutory mechanisms such as the application of rules and standards in respect of defined zones. Monitoring strategies provide feedback on the effectiveness of the various methods employed to mitigate or avoid the adverse effects of hazards.

7.1.3 Short-term management strategies

Section 330 of the RMA builds on powers presently available to Council pursuant to the Public Works Act 1981 (s.234) and the Local Government Act 1974 (s.708A(3)). The section permits activities in an emergency situation that might otherwise contravene the Act. The section empowers employees and agents of councils to enter upon land and take action in an emergency situation. Section 331 of the Act requires that the appropriate consent authority must be advised when emergency works have been undertaken. Resource consents must be sought where adverse effects of the activity continue. The provisions and a discussion of section 330 is outlined in *Appendix 3*.

7.2 Resource management policy statements

7.2.1 Introduction

The RMA requires that a hierarchy of policy documents is prepared by central, regional and local government bodies with respect to resource management issues generally including the management of natural hazards. The documents are interrelated (to achieve integrated management) and the Act requires that subordinate regional and

district documents are not inconsistent with each other or any national policy statement.

7.2.2 Regional Policy Statement (RPS)

WRC's RPS incorporates policy on natural hazards. The statement indicates the dual role of the region and district in managing hazards, but that the district council is likely to take a lead role in managing responses to localised hazard events.
The RPS identifies implementation methods for the management of natural hazards relating to both the region and the district. Those relating to district councils, in summary, refer to:

- The development of objectives, policies, rules and methods in district plans to control the use of land;
- The delivery of environmental education programmes;
- The implementation of hazard mitigation plans;
- To provide information on natural hazards through land information memoranda;
- To work in partnership with the regional council.
- Similarly, those implementation methods relating to the regional council include:
- The development of specific objectives, policies, rules and/or other methods in regional plans for the avoidance or mitigation of coastal hazards;
- To take a lead role in the collection, analysis, storage and communication of coastal hazard information to territorial authorities;
- The development, in conjunction with territorial authorities and the wider community, hazard mitigation plans for managing the risks associated with coastal hazards**;**
- To support the development and implementation of environmental education programmes related to coastal hazards.
- The text on the "Management of Natural Hazards" contained in the Regional Policy Statement is attached as *Appendix 4*.

7.2.3 Matamata-Piako District Plan

The Matamata-Piako District Plan includes a section on "Natural Hazards". This section identifies the relevant issues, objectives, policies, methods, principle reasons, environmental results and monitoring.

7.3 Other hazard management statutes

7.3.1 Introduction

This section will examine in greater detail the legal obligations for WRC and the MPDC and the organisations' staff and elected members in terms of other relevant legislation

including the Civil Defence Emergency Management Act 2003, Building Act 1991, Soil Conservation and Rivers Control Act 1941 and the Local Government Official Information and Meetings Act 1987.

7.3.2 Civil Defence Emergency Management (CDEM) Act 2002

This Act establishes a framework for CDEM aimed at building resilient New Zealand communities. Its purpose is to improve and promote the sustainable management of hazards in a way that contributes to the social, economic, cultural, and environmental well-being and safety of the public and also to the protection of property. It also provides for the planning and preparation for an emergency and for response and recovery in the event of an emergency.

Under the Act, MPDC is a member of the Waikato CDEM Group (a consortia of local authorities working with emergency services and lifeline utilities to reduce risk across the region). It is also one of the councils that make up the Waikato Valley Emergency Operating Area (EOA).

7.3.3 Soil Conservation and Rivers Control Act 1941

The provisions of the Soil Conservation & Rivers Control Act 1941 apply only to regional councils and determine their role for river and catchment management and include the following responsibilities:

- To minimise and prevent damage by floods and erosion;
- To construct, reconstruct, alter, repair, and maintain all such works it considers necessary;
- To exercise a general supervision over local authorities of any powers they exercise as to river and drainage matters;
- To give directions for the guidance of local authorities with regard to the above matters.

WRC also has responsibility for land drainage in terms of the provisions of the Land Drainage Act 1908, primarily within the specified drainage areas scheduled in 1989.

7.3.4 Local Government Act 2002

Section 551 of the Local Government Act outlines the river clearance powers available to territorial local authorities. At present, responsibilities for these functions are generally shared.

7.3.5 Local Government Official Information and Meetings Act 1987 (LGOIMA)

Section 44A of LGOIMA deals with Land Information Memoranda (LIM). Any person may apply to council for a LIM in respect of any property in the district. Among the matters that must be included in a LIM is information relating to natural hazards that is known to council.

Unless there is proof to the contrary hazard information contained in a LIM shall be sufficient evidence of the correctness, as at the date of issue, of any hazard information. There is no opportunity or grounds that allow council to withhold hazard information.

These latter provisions of the Act have implications generally for council when receiving information such as reports that apply to a property or group of properties and more specifically when that information relates to hazards.

7.3.6 Building Act 1991

7.3.6.1 Project Information Memoranda (PIM)

A similar mechanism as land information memoranda is contained at Part V of the Building Act. Sections 30 and 31 of the Act makes provision for persons wishing to proceed with building works to first obtain a Project Information Memorandum (PIM) in respect of the works and the land upon which the works are to be established. As with the provisions of LGOIMA every PIM shall include information on "special features" of the land likely to be relevant to the proposed building work identifying, amongst other things, potential hazard information that falls within council's current knowledge-base. This requirement places a great deal of responsibility on council to get it right. One of the challenges will be to ascertain the "special features" of the land that do fall within council's knowledge. The section intends a considered response by council that will involve some research and investigation.

7.3.6.2 Building Consents

Council must refuse to issue a building consent in respect of any application for building works on land that is subject to, amongst other things, flooding or erosion or the building work itself is likely to worsen the effects of or cause erosion or flooding. If council is satisfied that adequate provision has been made to protect the hazard prone land a building consent will be issued.

Where council considers that the building works will not increase losses arising from an extreme natural event then a building consent may issue in terms of s74 of the Building Act, 2004 provided a notice to such effect is registered against the Certificate of Title of the land upon which the building works stand. The section absolves Council, its officers and elected representatives of any liability if the building works are subsequently damaged by an extreme event.

7.3.7 Reserves Act 1977

The Reserves Act guides district councils such as the MPDC in how they manage reserve lands that fall within their jurisdiction. It provides for the acquisition, control, management, maintenance, preservation (including the protection of the natural environment), development, and use, and to make provision for public access to the coastline and the countryside.

If applicable, the relevant district body must prepare a management plan for coastal reserve land. Such plans must provide for and ensure the use, enjoyment, maintenance, protection, preservation, and, where resources permit, the development of the reserve.

Plans must be submitted to the Minister of Conservation for approval within 5 years after the date of appointment of the administering body, although this time may be extended. In preparing a management plan public notice must be given, and all submissions received must be considered.

Local authorities must also keep management plans under continuous review so that they are adapted to changing circumstances or in accordance with increased knowledge.

8 Appendix 2: MPDC/WRC RMA Functions

The functions, powers and duties of local authorities with respect to hazards as defined by the Resource Management Act 1991 are outlined below.

Section 30(1)(d)(v):

Functions of regional councils under this Act:

Every regional council shall have the following functions for the purpose of giving effect to this Act in its region:

> *…(d) In respect of any coastal marine area in the region, the control (in conjunction with the Minister of Conservation) of—*
>
> *…(v) Any actual or potential effects of the use, development, or protection of land, including the avoidance or mitigation of natural hazards …*

And section 31(b):

Functions of territorial authorities under this Act—

Every territorial authority shall have the following functions for the purpose of giving effect to this Act in its district:

> *…(b) The control of any actual or potential effects of the use, development, or protection of land, including for the purpose of the avoidance or mitigation of natural hazards…*

Section 62(ha) requires that a regional council in its regional policy statement defines:

For the region or any part of the region, which local authority shall have responsibility within its own area for developing objectives, policies, and rules relating to the control of the use of land for—

The avoidance or mitigation of natural hazards … and may state particular responsibilities for particular hazards … or group of hazards …; but if no responsibilities for a hazard … are identified in the policy statement, the regional council shall retain primary responsibility for the hazard …

9 Appendix 3: RMA Section 330

9.1 Provisions and discussion of Section 330 of the Resource Management Act 1991

Section 330 provides (emphasis added):

Emergency works and power to take preventive or remedial action—

Where—

> *Any public work for which any person has financial responsibility; or*
> *Any natural and physical resource or area for which a local authority or consent authority has jurisdiction under this Act; or*
> *Is, in the opinion of the person or the authority…, affected by or likely to be affected by—*
>
> > *An adverse effect on the environment which requires immediate preventive measures; or*
> > *An adverse effect on the environment which requires immediate remedial measures; or*
> > *Any sudden event causing or likely to cause loss of life, injury, or serious damage to property—*

the provisions of sections 9, 12, 13, 14, and 15 shall not apply to any activity undertaken by or on behalf of that person, authority, … or mitigate any actual or likely adverse effect of, the emergency.

Where a local authority or consent authority—

> *Has financial responsibility for any public work; or*
> *Has jurisdiction under this Act in respect of any natural and physical resource or area—which is, in the reasonable opinion of that local authority or consent authority, likely to be affected by any of the conditions described in paragraphs (d) to (f) of subsection (1), the local authority or consent authority by its employees or agents may, without prior notice, enter any place (including a dwellinghouse when accompanied by a constable) and may take such action, or direct the occupier to take such action, as is immediately necessary and sufficient to remove the cause of, or mitigate any actual or likely adverse effect of, the emergency.*

As soon as practicable after entering any place under this section, every person must identify himself or herself and inform the occupier of the place of the entry and the reasons for it.

10 Appendix 4: RPS & natural hazards

10.1 Policy One: Consistent Management of Natural Hazards

Ensure that natural hazards are managed in a consistent manner throughout the Waikato Region and roles and responsibilities of agencies are defined.

Implementation Methods:

1. The Waikato Regional Council (WRC) will:

    i. develop specific objectives, policies, rules and/or other methods in regional plans for the avoidance or mitigation of natural hazards in the coastal marine area and in the beds of rivers and lakes
    ii. take a lead role in the collection, analysis, storage and communication of natural hazard information to territorial authorities
    iii. prioritise risks from natural hazards across the Region for further investigation, in consultation with territorial authorities and the Region's community
    iv. develop, in conjunction with territorial authorities and the wider community, hazard specific mitigation plans for managing the risks associated with natural hazards
    v. implement those aspects of mitigation plans that are relevant to WRC's functions
    vi. coordinate responses to regionally significant natural hazard events with those of territorial authorities, network utility operators, government departments and other relevant agencies
    vii. support the development and implementation of environmental education programmes related to specific natural hazards

2. Territorial authorities will:

    i. develop specific objectives, policies, rules and/or other methods in district plans that control the use of land (except for in the beds of lakes and rivers and the coastal marine area) for the avoidance or mitigation of natural hazards
    ii. deliver environmental education programmes on local natural hazards to their communities
    iii. implement relevant hazard specific mitigation plans through building consents and other regulatory and non-regulatory methods
    iv. provide information on the presence of natural hazards at specific sites through land information memoranda and project information memoranda where such information is known by the territorial authority
    v. work in partnership with the Waikato Regional Council (WRC) and their communities to ensure efficient and effective response and recovery to natural hazard events including planning for emergencies

3. Local authorities will advocate that other agencies such as network utility operators and neighbouring regional councils work with territorial authorities and the Waikato Regional Council (WRC) for the management of natural hazards through the development of partnership agreements and memoranda of understanding.

4. Local authorities will advocate that all the roles and responsibilities identified above are implemented through strategic plans, annual plans, district and regional plans, civil defence plans and partnership agreements within three years of this Regional Policy Statement becoming operative.

11 Appendix 5: Other work

11.1 Hydraulic modelling

WRC has developed a comprehensive/dedicated hydraulic modeling program in response a rapid increase in resource consent applications and river management issues. Hydraulic modeling is carried out on a priority basis and includes both one dimensional (Mike 11) and two dimensional (Mike 21) outputs. It is seen as being one of the most crucial elements of our flood risk management approach

WRC's modeling program aims to achieve the following:

- Outputs are based on best practice and methodology and includes all available information such as hydro-met data, climate change allowances, sea level rise, and land information
- Models provide a robust and sound basis for assessing/determining likely extents of flooding from a given-sized event (or across a range of scenarios)
- Flood hazard risk maps are produced that as accurately as possible depict the flood extent, velocity, and depth of floodwaters

District Plans use the assessed flood hazards/levels and employ a sound planning framework as a basis for reducing risks.

11.2 Categorisation of flood risk

To assess flood risks, it is necessary to consider the nature and degree of the potential impacts of flooding, which are dependent on the magnitude of specific hazard parameters within the overall flood hazard. During flooding, the primary hazard parameters in terms of potential impacts are:

- Flood depth: The potential impacts directly related to this parameter include:
  - Drowning (flood waters rising higher than waist level)
  - Damage (flood waters damaging property and contents as they rise)
  - Isolation (deep flood waters preventing escape by flood victims or access by emergency services)
- Flood flow velocity: The potential impacts directly related to this parameter include:
  - Drowning (flood waters flowing too fast for people to maintain balance or washing away occupied vehicles)
  - Damage (the force of fast flowing flood waters damaging structures)
  - Isolation (the force of fast flowing waters and/or debris transport preventing escape by flood victims or access by emergency services

The severity of flooding is largely governed on the magnitude of these two primary hazard parameters. For example, the higher the combined depth and velocity, greater are the risks to people and property.

12 Appendix 6: Key to Table 2 (risk analysis evaluation key)

12.1 Measure of likelihood

Table 7: Measure of likelihood - generic table

Level	Descriptor	Description
A	Almost certain	Expected to occur in most circumstances
B	Likely	Will probably occur in most circumstances
C	Possible	Might occur at some time
D	Unlikely	Could occur at some time
E	Rare	May only occur in exceptional circumstances

12.2 Manageability and Growth ratings

Table 8: Manageability table rating

Management difficulty	**Current effort (4Rs)**	**Rating**
Low	High	1
Low	Medium	2
Medium	High	
Medium	Medium	3
High	High	
Low	Low	4
Medium	Low	
High	Medium	
High	Low	5

For manageability, a rating is developed from 1 to 5 based on the combination of management difficulty and current level of effort being applied. The rating is developed and entered on the table (Table 6) for each of the 4Rs – Reduction, Readiness, Response, and Recovery.

Growth is the rate at which the risk will increase through time – either through an increase in the probability of the event occurring, an increase in the exposure to the community, or both. For growth, a rating is developed from 1 to 5 based on the combination of the probability of occurrence of the event arising and the changes in community exposure to the event.

Once all the ratings have been completed, the table will provide a risk total for each hazard identified. The hazards can then be ranked by risk and can assist in the approach to risk management.

12.3 Measure of consequence of impact and seriousness

Table 9: Measure of consequence of impact and seriousness

Level	Descriptor	Detail description
1	Insignificant	No injuries, little or no damage, low financial loss
2	Minor	First aid treatment, minor building damage, medium financial loss
3	Moderate	Medical treatment required, moderate building and infrastructure damage, high financial loss
4	Major	Extensive injuries, high level of building and infrastructure damage, major financial loss
5	Catastrophic	Deaths, most buildings extensively damaged and major infrastructure failure, huge financial loss

The seriousness criteria should be amended to reflect the relative importance of the four factors – social, built, economic and natural environments. The following definitions and weighting were followed:

- Social – population, social structures, vulnerable groups, ethnic diversity and tangata whenua. 50% of the total value, due to the high priority of protection of human life and safety.
- Built – residential, commercial, key lifelines, utilities and industrial and agricultural infrastructure. 25% of the total value, due to the importance of protecting lifelines and other critical infrastructure in relation to social concerns.
- Economic – regional economy, growth, employment, income, tourism and resources. 15% of the total value, reflecting a secondary priority and the fact that the built environment will normally account for most of the economic damage.
- Natural – geography, geology, and climate .10% of the total value, reflecting the relatively low level of concern.

Once complete, the seriousness value is completed. The minimum value is 2 and the maximum possible value is 10. Each environment is automatically weighed per the assumptions in Table 9: Measure of consequence of impact and seriousness, and the subtotal represents half the total maximum possible value of 20. Measure of consequence of impact and seriousness

12.4 Qualitative risk matrix

Table 10: Modified qualitative risk analysis matrix

	Consequences				
Likelihood	1 Insignificant	2 Minor	3 Moderate	4 Major	5 Catastrophic
A Almost certain	High	High	Extreme	Extreme	Extreme
B Likely	Moderate	High	High	Extreme	Extreme
C Possible	Low	Moderate	High	Extreme	Extreme
D Unlikely	Low	Low	Moderate	High	Extreme
E Rare	Low	Low	Moderate	High	High

This matrix has six rating levels. The process for risk analysis is a collaborative effort involving key stakeholders who can draw upon previous risk analyses, new hazard and

information and experience. The result of the analysis will rate each hazard risk as either very low, low, moderate, high, very high or extreme.