The Eastern Coromandel Tsunami Strategy

Managing tsunami risks in Mercury Bay

January 2017

Why are we working on the Eastern Coromandel Tsunami Strategy?

The release of the "Review of Tsunami Hazard in New Zealand (2013 Update)"[1] indicates that while the risk of a near source „Maximum Credible Event" tsunami hitting the east coast of the Coromandel Peninsula is still relatively low, the risk is higher than we previously understood. The massive earthquakes which led to devastating tsunami events in Japan in 2011 and in South-east Asia in 2004, highlights the risks that New Zealand faces from large earthquakes and their tsunami-generating potential.

Recently completed tsunami modelling work reconfirms that the eastern Coromandel is vulnerable to the effects of tsunami events – similar to the rest of the north-east coast of the North Island[2].

While the new information does not provide cause for immediate alarm, Thames-Coromandel District Council and Waikato Regional Council are consulting with east coast Coromandel communities about the future management of tsunami risks. Consultation is part of the on-going Eastern Coromandel Tsunami Strategy – an initiative that seeks to improve tsunami risk management along the east coast of the Coromandel Peninsula.

The councils started this consultation process in Whitianga in 2011. Mercury Bay is considered the area most at risk from the impacts of tsunami on the east coast of the Coromandel Peninsula, due the natural amplification of tsunami waves. Since 2011, the councils have followed up with consultation in Tairua and Pauanui in 2014, Whangamata in 2015 and Kennedy Bay, Whangapoua, Matarangi, Kuaotunu and Opito Bay in 2016.

This summary document updates our understanding of the tsunami hazards in Mercury Bay, the issues and options for managing the risks from tsunami, and a process for deciding how best to manage tsunami risks. Given the potential for significant loss of life and property damage in a large tsunami, we are very keen to hear from Mercury Bay communities about how they want to manage the risks going forward.

This document updates and replaces the previous document issued in 2011. Please look through this summary document and give us your thoughts at the open day (see p. 18 for details). If you can't make it to the open day and have questions or ideas, you can call or email TCDC customer services at 07 868 0200 or customer.services@tcdc.govt.nz or get further information online at www.waikatoregion.govt.nz/tsunamistrategy

[1] Power, W. L. (compiler). 2013. Review of Tsunami Hazard in New Zealand (2013 Update), GNS Science Consultancy Report 2013/131. 222 p.

[2] Borrero, J. C. 2017. Numerical Modelling of Tsunami Inundation in Whitianga, Mercury Bay, Hahei and Hot Water Beach, New Zealand. eCoast Limited report commissioned by Waikato Regional Council, Hamilton.

Tsunami terminology

What's in a wave?

Run-up: A measure of how high the wave reaches above normal sea level when it hits the land. It depends upon the slope of the land and land use. It can also refer to how far inland water will reach. So, for example, a 5 m wave at the shoreline may actually run up to 10 m above normal sea level where the shoreline is steep, and may run inland for a kilometre or more in areas that are low-lying, such as rivers and estuaries.

Wave height: A measure of the trough-to-crest height of a tsunami wave. The trough may be below normal sea level due to tsunami behaviour (such as the 1960 Chilean tsunami waves that uncovered the wreck of the Buffalo in Whitianga).

Wave length: The distance between two consecutive wave crests.

Wave period: The time between two consecutive wave crests passing a point.

Wave amplitude: The vertical distance from the still water level to the crest of the wave.

Flow depth: The depth of water and debris flowing over the ground.

The above definitions are useful to remember when it comes to understanding tsunami[3] and their impacts. For many people, the run-up may be the most useful measure, as this describes the actual impacts of tsunami as they reach land.

But factors like wave period and the actual volume of water in tsunami waves may be just as, if not more important when it comes to their destructive impact.

Tsunami facts and figures

A tsunami is a series of water waves. The most common cause is a seafloor earthquake. Other triggers are undersea landslides, undersea volcanic eruptions, and less frequently, meteorite impacts.

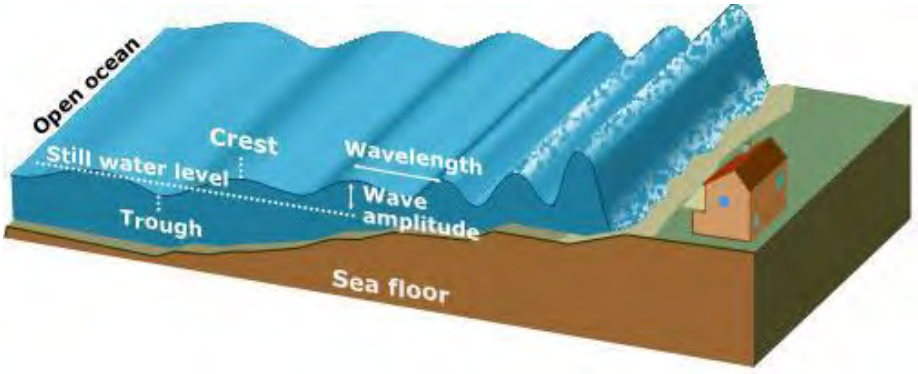
Tsunami are not like wind-generated waves. Wind-generated waves may, for example, be 10 seconds apart and the distance between wave crests might be 150 metres. Tsunami waves

[3] "Tsunami" is a Japanese word that is literally translated as "harbour wave". In Japanese, the word means both singular and plural, and this original usage of the word is adopted within this document.

may be an hour apart, and the distance between crests 100 kilometres or more in the deep ocean. Tsunami waves are therefore not just one wave but rather a series of waves. The first wave reaching the shoreline is often not the most damaging wave.

In the open ocean, tsunami waves travel at up to 700 kilometres per hour. In the deep ocean, the waves may be as little as 60 centimetres high, passing ships unnoticed. As they encounter shallow water, they slow down to about 30 kilometres per hour and can increase dramatically in height – see Figure 1.

Figure 1: Change in tsunami wave shape as it approaches land.



Tsunami wave threats

The immense volumes of water and debris tsunami waves contain and the speed with which they can travel are the core threats to people and property in coastal and low-lying estuarine areas. Tsunami may rapidly flood and damage coastal communities, with the damage compounded by the impacts of debris they pick up along the way.

A central element in responding to these threats is the time people have to respond to a tsunami warning.

Therefore, the source of tsunami that can affect Mercury Bay is a crucial factor for our response considerations. Examples of the sorts of warning times Mercury Bay can expect are:

- **Near source:**
  - **Local:** travel time between the source - such as an earthquake on a fault line just offshore - and impact on the New Zealand mainland is one hour or less.
  - **Regional:** travel time between the source - such as an earthquake in the Tonga-Kermadec Trench - and impact on the New Zealand mainland is between one and three hours.
- **Distant source:** travel time between the source and impact on the New Zealand mainland is greater than three hours. Travel times for distant source tsunami from South America are usually 12-15 hours.

Our understanding about tsunami on the east coast of the Coromandel Peninsula

Distant source tsunami

Studies have indicated the most significant distant sources for tsunami are large earthquakes in South America. The following table provides a summary of large earthquake events in South America since 1562 that have produced significant run-up in South America, and are either known to have, or are thought to have, affected New Zealand.[4]

Large South American earthquakes since 1562 and their impacts

Year	Source	Earthquake magnitude[5]	Maximum run-up in NZ (m)	Maximum run-up in the source region (m)
1562	South-central Chile	Unknown	Unknown	16
1575[6]	Central Chile	"	"	25+
1586	Off Lima, Peru	"	"	26
1604	Arica, Northern Chile	"	"	16
1730	Valparaiso, Chile	"	"	16
1746	Callao, Lima, Peru	8.6	"	24
1835	Conception, Southern Chile	Unknown	"	14
1868	Arica, Northern Chile/ Southern Peru	9.1	10 (Chatham Islands); 4 (Mainland)	18
1877	Inquique, Northern Chile	9.0	3.5	21
1960	Southern Chile	9.5	5	25

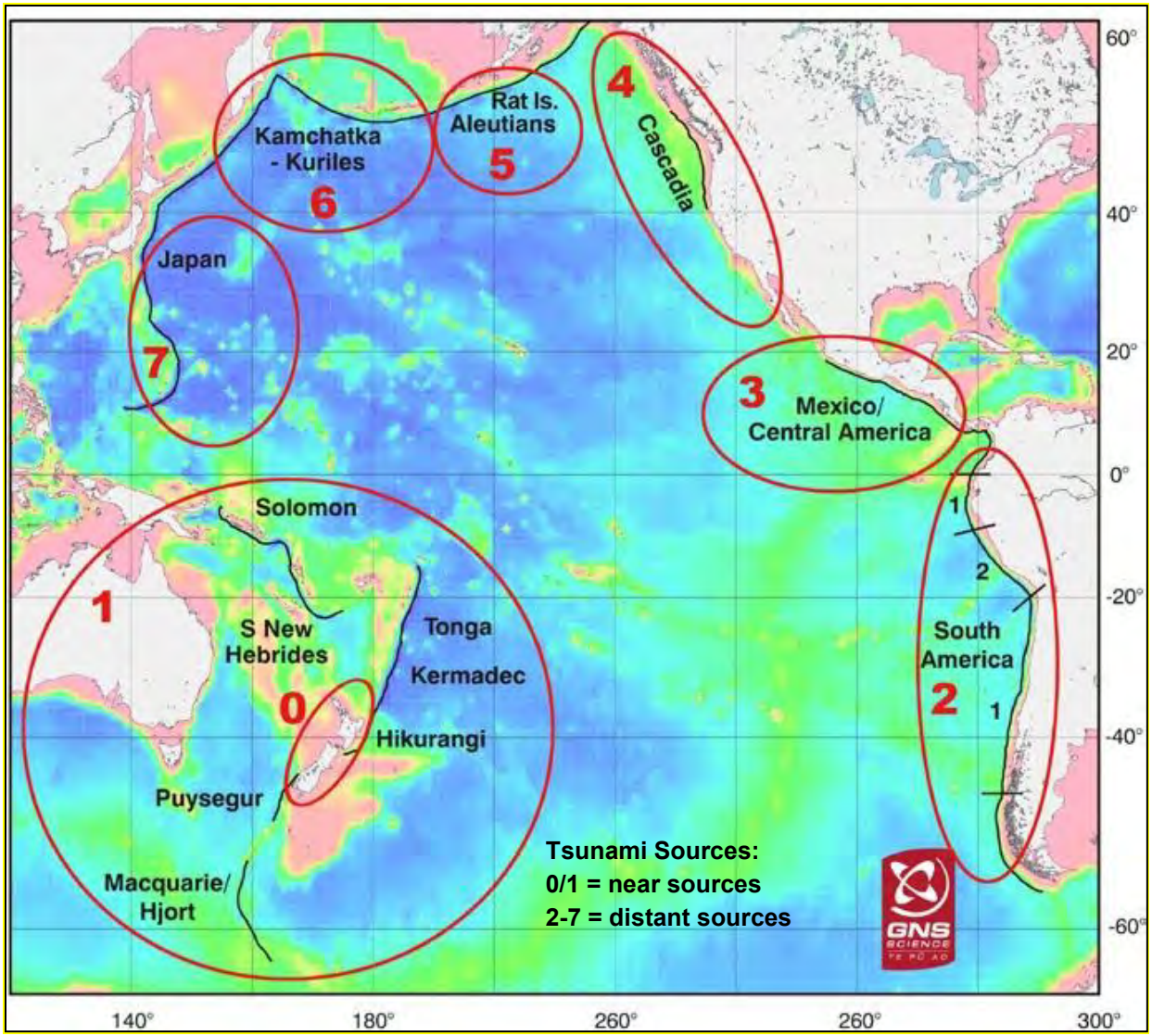
In the past century, the largest distant source tsunami event known to have caused significant run-up in parts of the Coromandel Peninsula was the Chilean earthquake event in 1960. The 1960 Chilean tsunami had a wave height in excess of 5m at Whitianga, inundated parts of Whitianga town, and caused significant currents to flow in and out of harbours around the Coromandel Peninsula. The most recent significant distant source tsunami to hit the eastern Coromandel Peninsula was the 2011 Japan tsunami.

[4] NIWA (2004); GNS (2005); NIWA (2008).
[5] Mw – moment magnitude
[6] NIWA (2008), p. 20.

The 2011 Japan tsunami had a wave height of 1.6m at Whitianga Harbour, produced strong currents in harbour entrances, and inundated parts of the foreshore at Port Charles

While the exact impacts on Mercury Bay from other previous large distant source earthquake events are unknown, it is likely that many had similar or greater impacts on Mercury Bay, especially those from southern Peru. On the basis of historical information, we can conclude that Mercury Bay may be impacted by a large distant source tsunami about once every 50-100 years. Figure 2 shows the main tsunami sources that affect New Zealand – including distant sources.

Figure 2: Main sources of tsunami in New Zealand



The results from recent modelling work indicate that the threats to Mercury Bay from distant source tsunami are foreshore inundation in Whitianga, Brophy"s Beach, Wharekaho and Cooks Beach, largely around low-lying areas (refer to Figure 3). The modelling correlates well to impact reports based on historical accounts, eyewitness interviews and surveyed water levels[7]. Distant source tsunami cause significant, dangerous currents within Mercury Bay, and these may persist for several days following wave arrival.

Near source tsunami

Previous scientific studies commissioned by Thames Coromandel District Council and Waikato Regional Council indicate that a large earthquake event along the Tonga-Kermadec Trench to the north-east of New Zealand represents the most significant near-source tsunami threat for the east coast of the Coromandel Peninsula[8].

Recent modelling work indicates that inundation in Mercury Bay may occur as the result of large earthquake events from the Tonga-Kermadec Trench. Figure 4 shows the segments of the Tonga-Kermadec Trench[9]. Since 1904, there have been at least seven earthquakes of magnitude 7.0 or above along the Tonga-Kermadec Trench, including one earthquake of magnitude 8.3 in 1986, and recently, a magnitude 7.1 earthquake in September 2016.

Mercury Bay is particularly at risk from earthquakes from segments 1 and 2 because these segments produce greater wave impacts on the eastern Coromandel and shorter wave travel times than the other segments.

The recent modelling work considered a number of different earthquake scenarios from the Tonga-Kermadec Trench – all with slightly different assumptions. Figure 5 shows the likely inundation area for Mercury Bay at high tide from an earthquake event similar to the Japan 2011 event – an event which the Tonga-Kermadec Trench is thought to be capable of producing.

Other recent scientific work completed in the Bay of Plenty has identified several additional local tsunami sources – the Astrolabe, Volkner and White Island faults[10]. Previous modeling of these sources indicates that tsunami generated by these faults do not cause impacts as great as the Tonga-Kermadec Trench event in Mercury Bay. The Bay of Plenty work is new information that helps to further refine our understanding about tsunami risks to Mercury Bay.

[7] Refer to Morris, B. and Borrero, J.C. (2014) Inundation of Whitianga town during the 1960 Chilean Tsunami, Waikato Regional Council Technical Report 2014/65, June 2014, ISSN 2230-4363 (Online).

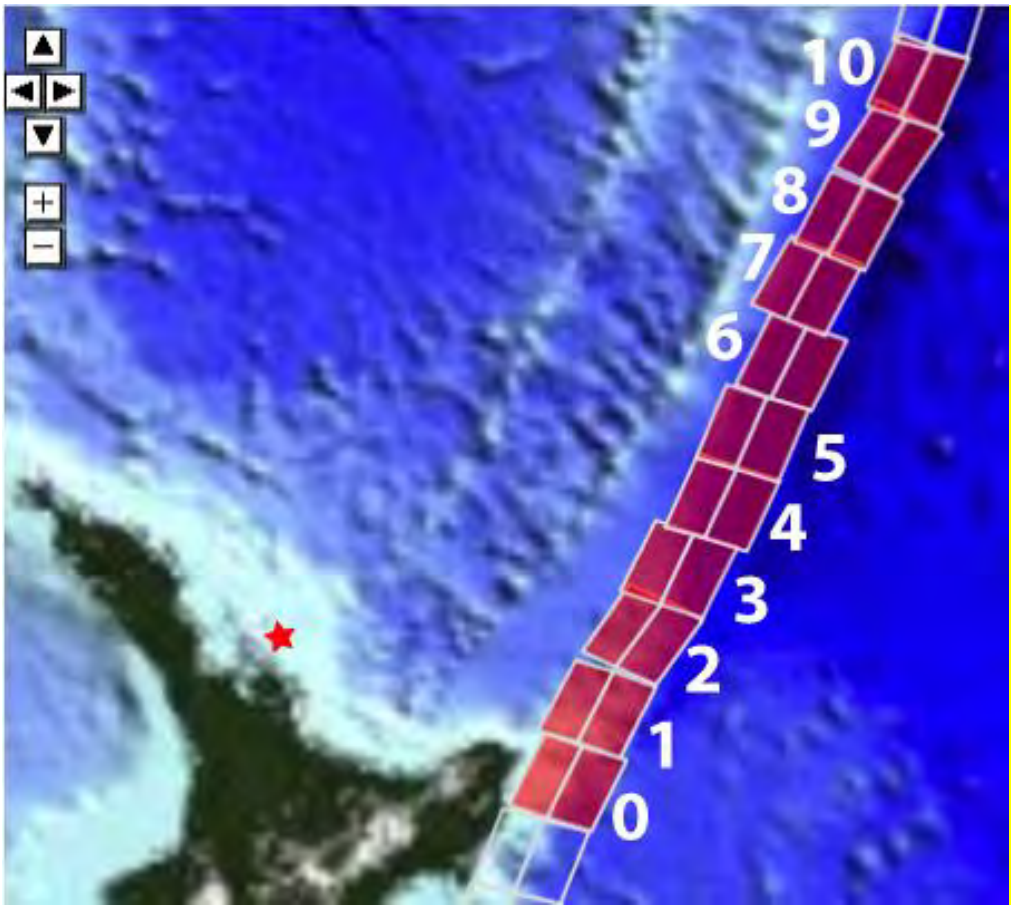
[8] Bell, R.G. (NIWA), Goff, J. (GeoEnvironmental Consultants Ltd), Downes, G. (GNS), Berryman, K. (GNS), Walters, R. A. (NIWA), Chagué-Goff, C. (NIWA), Barnes, P. (NIWA), Wright, I. (NIWA) 2004. Tsunami hazard for the Bay of Plenty and Eastern Coromandel Peninsula: Stage 2. Report prepared for Waikato Regional Council (WRC Technical Report 04/32), Hamilton; Goff, J., Walters, R., Callaghan, F. 2006. Tsunami Source Study. Report prepared by NIWA, on behalf of Environment Waikato, Auckland Regional Council, Environment Bay of Plenty, Northland Regional Council (Technical Report 2006/49), Hamilton.

[9] Borrero, J.C. 2015.

[10] Walters, R., Callaghan, F., Goff, J. 2006. Wairakei/Te Tumu tsunami inundation study. Prepared by NIWA for Environment Bay of Plenty. NIWA Client Report CHC2006-020.

Figure 3: Whitianga Tsunami Modelling ‘A Distant Source Scenario’. Maximum hazard classification from six distant source scenarios.

Figure 4: Fault segments along the Hikurangi/Tonga-Kermadec Trench likely to affect the east coast of the Coromandel (Red Star)

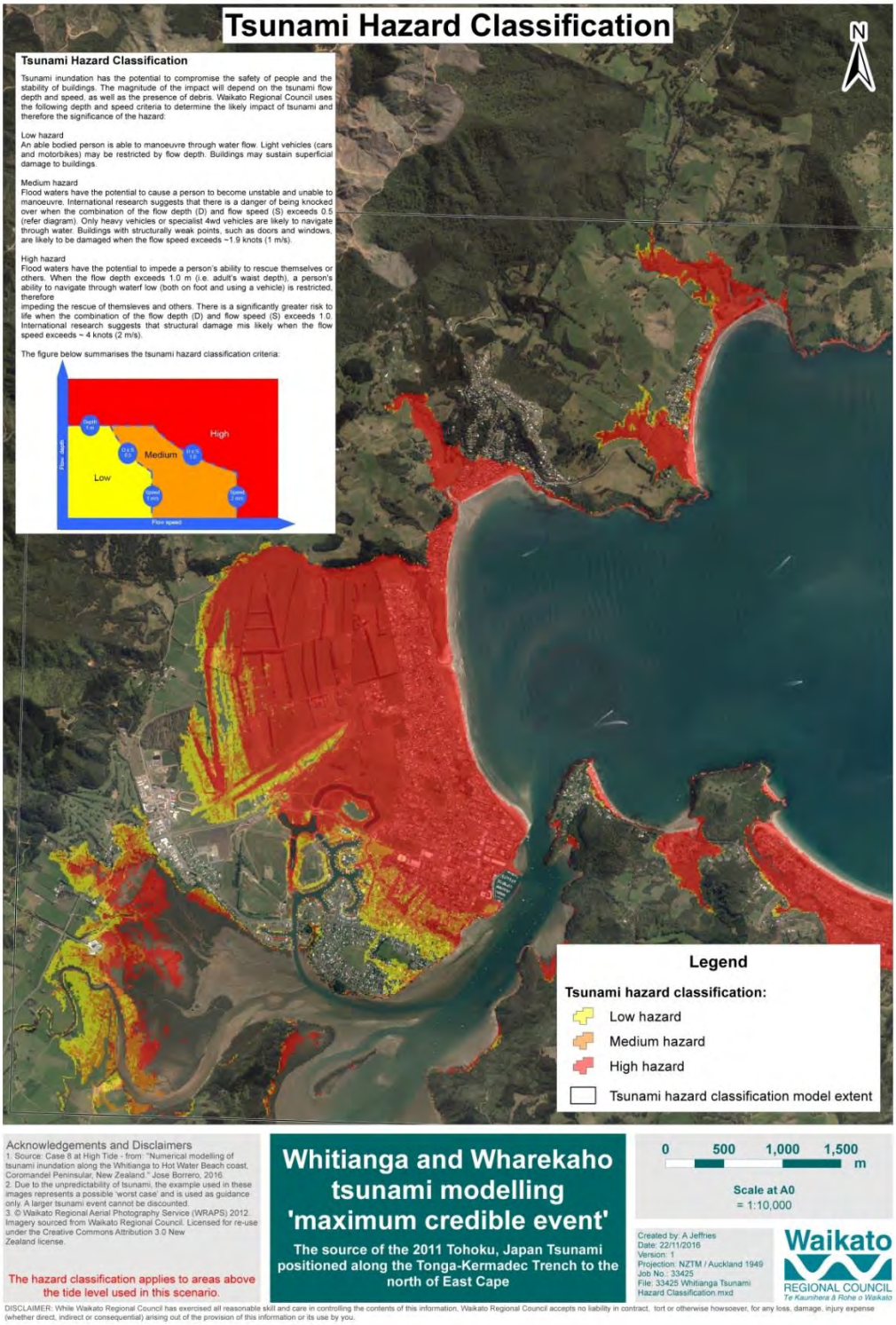


Mercury Bay has two main sources of tsunami – near source and distant source.

For Mercury Bay, the travel time from a near source Tonga-Kermadec Trench event from segments 1 and 2 is around one hour, while the travel time from a distant source South American event is usually 12-15 hours.

The level of potential inundation of Mercury Bay from a large near source event is significantly greater than for the largest distant tsunami events.

Figure 5: 'Maximum Credible Event' Tsunami inundation hazard due to Tonga-Kermadec event– using similar parameters as the Japan 2011 tsunami event (Magnitude 8.8, variable slip model, event occurs on Segment 1 – just off East Cape)



Current emergency response arrangements

Thames-Coromandel District Council has been working with east coast communities for many years, including Mercury Bay, to help them prepare for and respond to tsunami events.

In Mercury Bay, work with the community is ongoing via the local Community Emergency Response Group, involving representatives from emergency services, Thames-Coromandel District Council, Mercury Bay Area School and community groups.

The following arrangements are in place in Mercury Bay.

Near source tsunami (around one hour warning such as the Tonga-Kermadec Trench)

With a ***near source*** tsunami, natural warning signs include:

- Earthquakes felt at the coast that:
    1. Produce violent shaking, where people are unable to stand up, or
    2. Those that last for a minute or longer, but are less violent, and/or
- A sudden rise or fall in the level of the ocean accompanied by fast-moving currents and/or a "roaring" sound similar to a noisy jet engine.

With near source tsunami the priority is for self-evacuation from the „wet areas" to a safe zone („Plan A" - above the 20 m contour line). You must have a **self-evacuation** plan and know how to get to locations above the 20 m contour from your home, workplace and/or recreational places. If you are unable to reach a safe zone, head for areas outside the „wet areas" (Plan B – refer to Figures 6, 7 and 8 below).

Official warnings such as the sirens may not be able to be activated so you must respond to the natural warning signs. You may not be able to use a motor vehicle if there is a traffic jam after a significant earthquake, so plan to self-evacuate on foot with a Go Bag.

The sirens may be sounded for near source tsunami if there is time and they are still operational, but <u>their use cannot be guaranteed</u>.

Sign up for alerts direct to your mobile phone by downloading the Red Cross Hazard App or subscribing to text and email alerts. Details can be found on the emergency management page of the Thames-Coromandel District Council website.

If people feel a large earthquake, they should not wait for sirens, but evacuate to higher ground immediately.

Distant source tsunami (greater than 3 hours warning)

When a ***distant source*** tsunami warning is confirmed, the following actions will be taken to warn Mercury Bay communities:

- The fire brigade will have been alerted and will be operating from the fire station
- The local communications plan will be activated and essential personnel deployed
- Fire appliances and other emergency vehicles will travel around the area announcing the impending arrival and time of a tsunami and giving advice on what to do
- Television, radio and other media will have constant updates on the situation
- Warnings will be published via the Red Cross Hazard App
- Warnings and updates will be circulated via Thames-Coromandel District Council text and email alerts, and Council‟s website, Facebook and Twitter pages.

For Whitianga, there is a potential threat of localised land inundation from large distant tsunami, strong currents may be produced for up to 16 hours following the first wave arrival, and the largest waves arrive between two and six hours following the first wave arrival.

During a distant source tsunami event, stay out of the marine environment and stay clear of low-lying coastal areas - including beaches

Mercury Bay tsunami evacuation zones

Under current emergency management arrangements, local authorities and emergency services believe that in the event of a tsunami warning or event, residents should evacuate to a safe zone (Plan A - at least 20 metres above sea level) to ensure they are not affected by tsunami waves or debris, and to reduce congestion for emergency services in the affected areas. If reaching the safe zone is not possible, residents are advised to move as far away from „wet areas‟ as possible (Plan B).

Figures 6, 7 and 8 illustrate the safe zones and „wet areas‟.

While the “Maximum Credible Event” shown in Figure 5 is our current best estimate, the complexities of estimating tsunami generation mean that a larger tsunami event cannot be discounted. However, we are confident that tsunami inundation is unlikely to occur above the safe zones (20m lines) as shown in Figures 6, 7 and 8.

Figure 6: Whitianga Tsunami Evacuation Zone

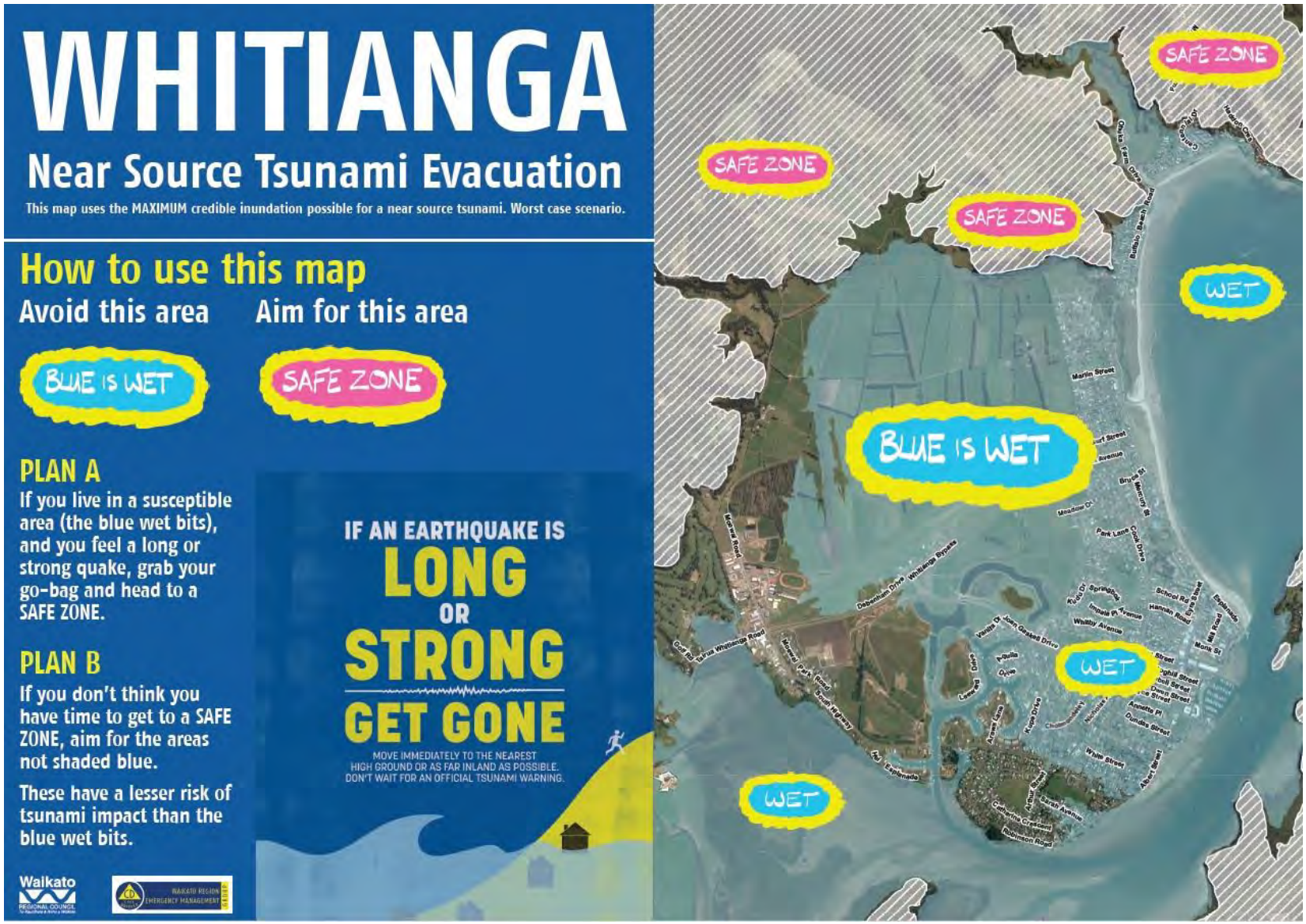


Figure 7: Cooks Beach Tsunami Evacuation Zone

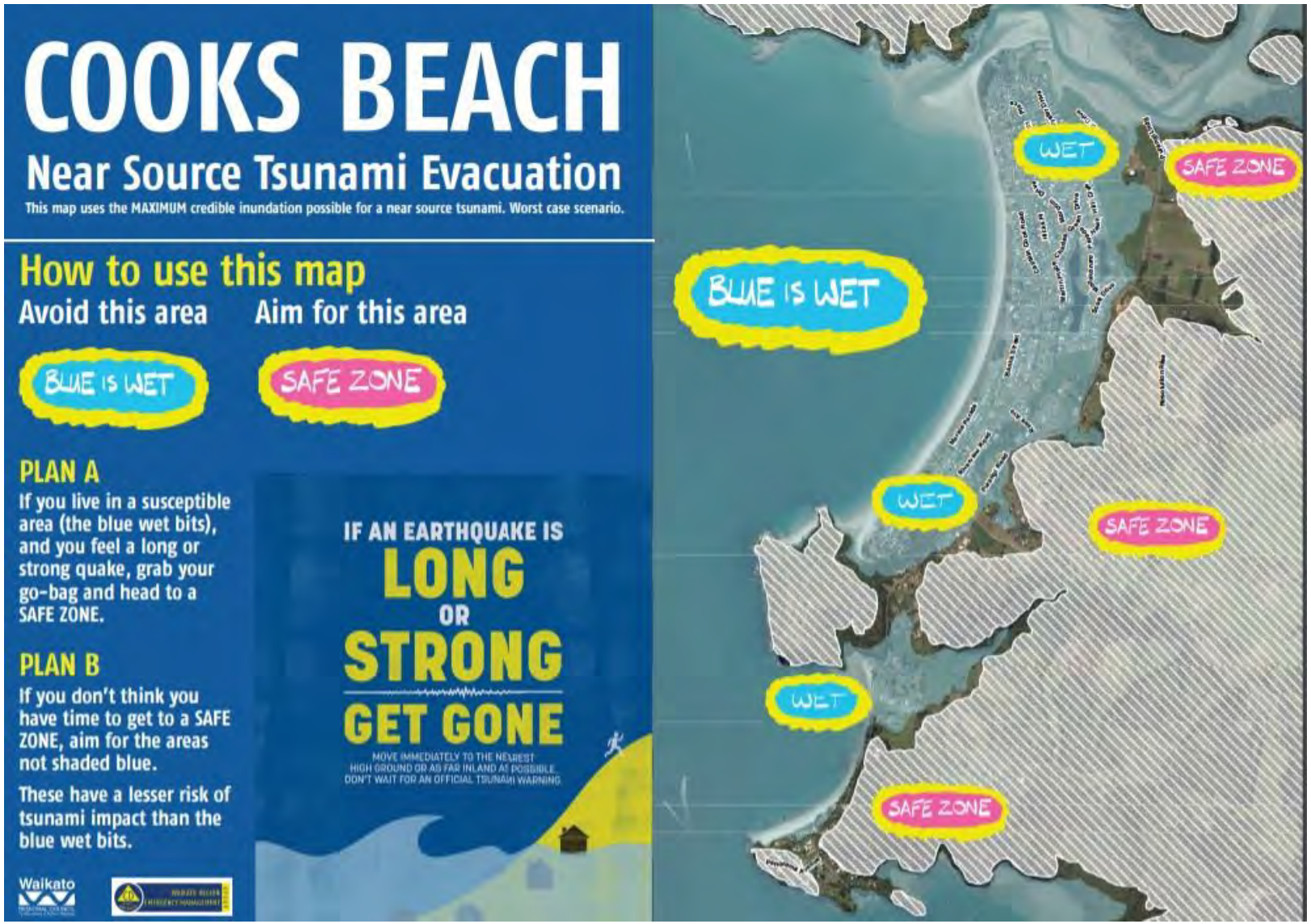
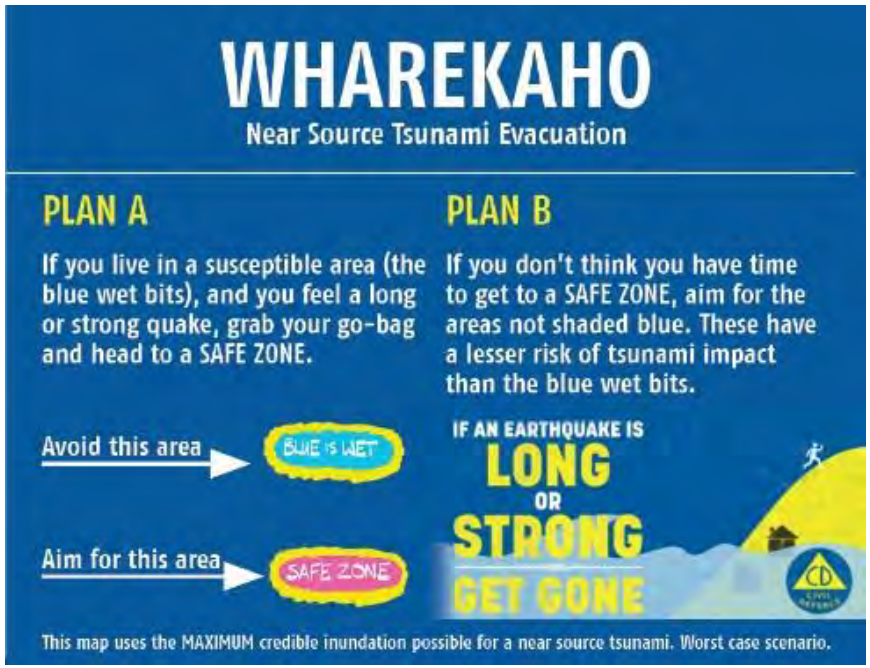


Figure 8: Wharekaho Tsunami Evacuation Zone



Who is responsible for managing tsunami risks?

Organisations

The primary organisations responsible for managing the risks from tsunami are:

- Local government – Thames Coromandel District Council and Waikato Regional Council (including issuing local emergency warnings for tsunami, and for research and public education and awareness)
- Emergency services – including Police, fire service and ambulance responders
- The Ministry of Civil Defence & Emergency Management (including issuing warnings for regional and distant source tsunami)
- Welfare organisations.

Local communities

While the primary responsibility for local tsunami risk management sits with local government, the role of communities and local individuals is critically important.

The National Civil Defence Emergency Management Strategy reinforces this within its first principle:

> **Principle One:** *"Individual and community responsibility and self-reliance"*
>
> *Individuals and communities are ultimately responsible for their own safety and the security of their livelihoods. CDEM arrangements in New Zealand support and encourage local ownership of this responsibility. Individuals and communities must be able to care for themselves and each other, as much as possible, when the normal functions of daily life are disrupted. Arrangements to support this are best developed at the local level. Local and regional efforts contribute to the overall national capability. Central government intervenes where an event is beyond the capacity of local resources.*

Partnership is essential

So, in summary, the responsibilities for managing tsunami hazards in Mercury Bay primarily fall on local government, emergency services and the communities.

The successful management of risks will continue to require a strong partnership approach between these parties.

What can we do to better manage risks?

Risk management goals

Defining goals for risk management can help confirm what aspects of risk are most important. We are suggesting the following tsunami risk management goals for Mercury Bay:

- The protection of human life and ensuring community safety is the most important priority
- That the community, in partnership with Thames-Coromandel District Council, Waikato Regional Council, civil defence and emergency services, build its awareness of the risks associated with tsunami
- Armed with that extra awareness, that the community work more closely with councils and emergency services to help avoid death and injury during tsunami, and damage to property.

Options for managing tsunami risks

Essentially the options going forward seem to boil down to the following:

1. **Status quo:** Stick with current arrangements
2. **Improve local emergency management arrangements:** Put in place improved systems for warning the community about tsunami and evacuating people
3. **Improve public education and awareness:** Provide people with more information to make good decisions about personal safety and avoiding property damage
4. **Land use planning:** we can either avoid or mitigate risks (or both):
   (a) **Avoid risks (change local policies and rules):** Put in place new rules and policies about how land can be used and what buildings can go where
   (b) **Mitigate risks:** Involves physical works to reduce the consequences of a tsunami event
5. **More insurance:** Using more insurance, both public and private, to insulate the community from the financial effects of tsunami damage.

Effectively improving risk management for tsunami would probably require a combination of these sorts of options.

Further information on these options will be provided at the open day
Have a look at these options and tell us what you think at the open days (see p. 18 for details).
If you can't make it to the open days and have questions or ideas, you can call or email TCDC customer services at 07 868 0200 or customer.services@tcdc.govt.nz.

Where to from here?

Tsunami Open Day

The Thames-Coromandel District Council and Waikato Regional Council believe the participation of Mercury Bay communities in improving tsunami risk management is essential if arrangements are to work effectively. Tsunami response arrangements should be tailored to suit community requirements, and have broad agreement and acceptance in the community.

During 2017, the two councils will undertake the following steps:

1. Hold open days on tsunami hazards and risks to encourage community awareness, understanding and feedback on solutions

> **Whitianga tsunami open day on Auckland Anniversary weekend 2017:**
>
> **Saturday 28 January**, 9.30am – 3.30pm, Whitianga Town Hall

2. Take open day feedback to community response groups for consideration and action
3. Seek Council support for improving tsunami hazard preparedness and implement improvement actions.

Further information

If you can't make the open day and have questions or ideas, you can call or email TCDC customer services at 07 868 0200 or customer.services@tcdc.govt.nz.

Staff from Waikato Regional Council can also answer questions on 0800 800 401, or may be contacted via email:

- Rick Liefting, Team Leader Regional Hazards (rick.liefting@waikatoregion.govt.nz)

The following links are useful if you want to access the technical data and maps that underpin the information in this summary document:

- Technical data and hazard maps: www.waikatoregion.govt.nz/tsunamistrategy
- Evacuation maps: www.waikatoregion.govt.nz/tsunamihazard

General information is available at www.tcdc.govt.nz/tsunami