



Tsunami Advisory and Warning Plan

Supporting Plan [SP 01/20]

Revised June 2020



Resilient New Zealand
Aotearoa Manahau

New Zealand Government

Tsunami Advisory and Warning Supporting Plan [SP 01/20]

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Preface

New Zealand is a member of the Pacific Tsunami Warning System (an international system under the auspices of the Intergovernmental Oceanographic Commission of UNESCO), that is designed to provide timely and effective information about tsunami or potential tsunami generated in the Pacific Basin. In New Zealand, the system is complemented by GeoNet geological hazards and sea level monitoring. The National Emergency Management Agency (NEMA) is the agency responsible for initiating national tsunami advisories and warnings to the communities of New Zealand.

This plan describes the procedures to receive, assess and disseminate tsunami notifications at the national level. However, national tsunami advisories or warnings may not reach all local communities at all times. Local authorities must therefore maintain public alerting systems and procedures to communicate tsunami advisories or warnings received from the national level further downstream to local communities. The arrangements for local level public alerting should be contained in Civil Defence Emergency Management (CDEM) Group Plans.

For any tsunami warning to be effective, the population must be aware of the nature of tsunami, the damage they can cause in their areas and ways to mitigate (prevent or avoid) the destructive aspects of tsunami. The responsibility for public awareness rests at both national and local levels.

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Section 1 Introduction

This section introduces the Tsunami Advisory and Warning Plan, including its purpose, scope, and use.

1.1 About this plan

The purpose of this plan is to outline the national procedures used by the National Emergency Management Agency (NEMA) to advise local authorities, national agencies and the media of possible tsunami that could affect coastal areas of New Zealand.

Structure

This plan has the following main sections:

- Section 1 [Introduction](#) – an introduction to this plan, including the scope of the plan, and its use.
- Section 2 [Responsibilities](#) – an overview of the responsibilities of agencies and organisations concerning tsunami warning.
- Section 3 [Initial tsunami threat assessment](#) – explains NEMA’s process for assessing tsunami information and determining the appropriate response.
- Section 4 [Further assessment of the tsunami](#) – an overview of additional information that can be provided around expected tsunami arrival times and threat levels.
- Section 5 [Types of notifications from](#) – an overview of the types of tsunami notifications issued by NEMA.
- Section 6 [Public tsunami notifications using Emergency Mobile Alert](#) provides information on rapid public notification via mobile telephone networks.

1.2 Scope

This is a National Advisory and Warning Plan. It deals with the arrangements to receive and assess tsunami information at the national level, and the dissemination of national official¹ notifications via the National Warning System (NWS) and the Emergency Mobile Alert (EMA) system.

The plan does not address the detailed actions to be taken by local authorities and national agencies upon receipt of national official tsunami notifications. Matters such as local public alerting systems, possible areas of inundation, public education and evacuation arrangements must be incorporated into local plans.

¹ “Official” notifications or warnings are issued by designated alerting authorities. They are different to “natural” warnings (felt, heard, and observed experiences) and “informal” warnings (informal means of communication e.g. person to person or media reports).

This plan can assist in the preparation of local plans and educational material.

This plan also does not address the response arrangements for tsunami impacts. Generic response arrangements are detailed in the National Civil Defence Emergency Management (CDEM) Plan and CDEM Group Plans.

1.3 Use of this plan

This plan is to be used by:

- NEMA
- science agencies with designated roles under this plan
- emergency services
- other government agencies
- CDEM Groups, and
- local government.

These organisations must align their plans and actions with the contents of this Plan to enable appropriate response.

1.4 Testing of this plan

Testing of this plan will be done in conjunction with the testing of the NWS and EMA, as well as specific exercises that NEMA initiates or is involved in.

1.5 Other documents relevant to this plan

Other documents that must be read in conjunction with this plan are:

- *Directors Guideline: Tsunami Evacuation Zones [DGL 08/16]*
- *Directors Guideline: Mass Evacuation Planning [DGL 07/08]*
- *Directors Guideline: Assessing and Planning for tsunami Vertical Evacuation [DGL 21/18]*
- *Technical Standard: National Tsunami Signage [TS 01/08]*
- *Technical Standard: Tsunami Warning Sirens [TS 03/14]*

These documents are available on the Publications page of NEMA's website: www.civildefence.govt.nz.

Section 2 Responsibilities

This section provides an overview of the responsibilities of organisations responding to a tsunami event.

Appendix A [Agency action guides](#) on page 30 provides detailed Action Guides for some agencies mentioned in this section.

2.1 NEMA

The responsibility for the initiation and issue of national official tsunami notifications in New Zealand rests with NEMA. NEMA receives tsunami notifications directly from the Pacific Tsunami Warning Center (PTWC), and earthquake (or other potential tsunami sources e.g. offshore volcano) reports from GeoNet.

NEMA represents New Zealand in the Pacific Tsunami Warning System. NEMA also maintains a Memorandum of Understanding with GNS Science for the provision of earthquake and tsunami information and advice to NEMA.

NEMA uses the NWS to disseminate official tsunami notifications in the form of national advisories and warnings on a 24/7 basis. Section 25 of the Guide to the National CDEM Plan describes the NWS.

When a tsunami has been forecasted to inundate land areas of New Zealand, NEMA will issue an alert directly to the public in the affected areas using the EMA system.

2.2 GNS Science and GeoNet

GNS Science maintains a national geological hazards monitoring and data collection system through its GeoNet Programme. Through this system, GeoNet is able to detect potentially tsunamigenic earthquakes onshore and offshore of New Zealand. GeoNet earthquake reports are disseminated to NEMA. GeoNet also monitors New Zealand's active volcanoes and landslide hazards; these are also potential tsunami sources.

GeoNet monitors and maintains New Zealand's tsunami gauge network around New Zealand coasts and offshore islands. GeoNet receives tsunami notifications directly from PTWC.

The National Geohazards Monitoring Centre (NGMC) is the 24/7 staffed monitoring capability of the GeoNet Programme and is part of GNS Science. The Geohazards Analysts who staff the centre are the initial contact for NEMA through which data, information and advice is provided.

GNS Science serves as NEMA's primary advisor for tsunami threat analysis (local, regional, and distant source).

For regional and distant-source tsunami, it can activate a Tsunami Experts Panel (TEP), usually consisting of representatives of GNS Science, National Institute of Water and Atmospheric Research (NIWA) and academic institutions when required.

GNS Science may also activate the TEP for local-source tsunami events, as appropriate and dependent on the situation.

2.3 Pacific Tsunami Warning Center (PTWC)

The Pacific Tsunami Warning Center (PTWC) is located in Hawaii and serves as the operational headquarters for the Pacific Tsunami Warning System (PTWS). The PTWS is governed by Pacific member countries of the Intergovernmental Oceanographic Commission (IOC), which is a body under the United Nations Educational, Scientific and Cultural Organization (UNESCO).

The PTWC monitors an extensive seismic and sea level network in the Pacific and issues tsunami notifications under the following categories (using the location and magnitude of earthquakes as the only initial determinants):

- Tsunami Information Statement, and
- Tsunami Threat Message.

NEMA uses PTWC tsunami notifications as one of several considerations to initiate official advisories or warnings in New Zealand. PTWC tsunami notifications are disseminated directly to NEMA and GNS Science. NEMA, with the support of GNS Science, assess all notifications received from the PTWC to determine the threat for New Zealand.

PTWC tsunami notifications are also sent to Airways Corporation New Zealand in Christchurch via the Aeronautical Fixed Telecommunication Network (AFTN) and to the MetService in Wellington via the Global Telecommunication System (GTS) as redundancy measures for NEMA.

2.4 Airways Corporation and MetService

Airways Corporation and MetService provide redundancy in the system to ensure all PTWC notifications are received by NEMA. Upon receipt of PTWC notifications, Airways Corporation sends a copy to NEMA and the MetService duty officer contacts the NEMA Duty Officer to confirm receipt of the notification.

2.5 CDEM Groups

CDEM Groups and CDEM Group members are responsible for the planning, development, and maintenance of appropriate public alerting and tsunami response systems, including public education and evacuation zone identification for their areas.

All CDEM Groups and CDEM Group members receive official national tsunami advisories and warnings via the NWS. When time and expertise is available, CDEM Groups are responsible for further local threat assessment and deciding on appropriate local public alerting and response for regional and distant-source tsunami. For example, designating which evacuation zones are relevant to evacuate, dependent on the threat.

2.6 Media

Under the arrangements contained in the Guide to the National CDEM Plan, NEMA can request public radio and television stations to broadcast official national advisories and warnings.

NEMA has a Memorandum of Understanding (MoU) with key national television and radio broadcasters for the broadcast of emergency announcements. See 5.10 [Requests for broadcast, or termination of broadcast](#) on page 24 for more information.

NEMA recognises the essential role media play during emergencies and provide contextual information for media in [Tsunami Warnings: A guide for media](#). This guide provides key information on official tsunami warnings and advisories for New Zealand, and describes how the media can work with agencies to help keep communities safe. CDEM Groups may also include local broadcasters in their local public alerting systems.

2.7 Maritime New Zealand

Maritime New Zealand, using the Maritime Operations Centre, is responsible for safety of life at sea communications, including maritime safety information in Navigation Area XIV. This area covers the Pacific stretching from the equator to the South Pole and the Mid Tasman to 120 degrees west. This includes the dissemination of maritime safety information in the area for which it is responsible.

2.8 Other agencies

A number of other New Zealand agencies, including emergency services, receive official national tsunami advisories and warnings from NEMA. These agencies respond to the information in accordance with their own

arrangements and/or procedures and where applicable, in support of CDEM Groups.

Section 3 Initial tsunami threat assessment

This section explains the process for assessing tsunami information and determining the appropriate response at the national level.

3.1 Receipt of tsunami information

NEMA receives tsunami notifications directly from the PTWC, as well as earthquake notifications (for local earthquakes) from GeoNet.

PTWC notifications are also sent to GNS Science, Airways Corporation and MetService.

3.2 Initial assessment – regional and distant-source tsunami

For regional and distant-source tsunami, the NEMA Duty Manager determines if the information received meets the indicators identified in [Table 1 Response indicators](#) on the next page.

Where necessary, the NEMA Duty Team will engage with GeoNet who will assist with the initial assessment.

3.3 Initial assessment – local-source tsunami

NEMA and GeoNet will seek to monitor for, detect, and provide threat advice for all tsunami. However, it may not be possible for the NEMA Duty Team to issue warnings in sufficient time and/or accuracy in the case of local-source tsunami (a tsunami generated in conjunction with a nearby large earthquake, volcanic activity or undersea landslide).

CDEM Groups, agencies, and the public should not wait for an official warning if long or strong shaking is felt (“Long or Strong, Get Gone”). They must take immediate action to evacuate predetermined evacuation zones, or in the absence of predetermined evacuation zones, go to high ground or go inland. Natural signs include:

- experience strong earthquakes (hard to stand up), or
- experience weak earthquakes lasting for a minute or more, or
- observe strange sea behaviour such as the sea level rising and falling unusually², or hear the sea making loud and unusual noises or roaring like a jet engine.

² ‘Rising and falling unusually’ may mean a sudden rise or fall, or a rise or fall that takes place across minutes, or tens of minutes.

If a large earthquake occurs close to New Zealand, it may not always be felt. Therefore, CDEM Groups, agencies, and the public, must follow instructions and advice in national tsunami warnings in all instances.

See Appendix B [Tsunami categories and threat](#) on page 35 for more information on tsunami sources.

3.4 “Response indicators” for NEMA

Table 1 below explains the “*Response indicators*” used by NEMA to initiate national tsunami advisories or warnings. The table details the thresholds for the respective origin locations, and the possible notifications that may be issued by NEMA if the thresholds are met.

Note: As the characteristics of each earthquake can differ, NEMA may issue national tsunami advisories or warnings that do not meet the thresholds of the response indicators below. This will occur when the earthquake parameters are poorly defined, or NEMA is unable to readily confirm the parameters, and it is deemed that the actual parameters may fall within the thresholds. This provides for a safety margin when the initial earthquake parameters are just outside or near the thresholds.

Table 1 refers to [Figure 1 Tsunami Origin Locations \(Regions 1-3*\)](#) on the next page.

Table 1 Response indicators

Region	Location	Thresholds	Possible notification issued via the National Warning System
1	New Zealand (0-1 hour to nearest coast Local source)	M≥6.5 and <100km depth	<p>Natural, felt signs are the primary warning for local source tsunami (Region 1).</p> <p>If possible and as appropriate, NEMA will issue one or a sequence of the following Advisories and Warnings:</p> <ul style="list-style-type: none"> • <i>National Advisory: Earthquake Being Assessed</i> (“Long or Strong, Get Gone” holding message) • <i>National Advisory: Tsunami Activity – Strong Unusual Currents</i> • <i>National Warning: Tsunami Threat</i> • <i>Emergency Mobile Alert</i> (to areas where land inundation is forecast) • <i>National Advisory: No Tsunami Threat</i> • <i>National Advisory: Earthquake – No Tsunami Threat</i>

Region	Location	Thresholds	Possible notification issued via the National Warning System
	Southern Kermadec (<1 hour to nearest coast Local source)	M≥7.9 and <150km depth	<p>Natural, felt signs are the primary warning for local source tsunami (Region 1), however Southern Kermadec earthquakes located between 25°S and 33°S may not be widely felt in New Zealand.</p> <p>If possible and as appropriate, NEMA will issue one or a sequence of the following Advisories and Warnings:</p> <ul style="list-style-type: none"> • <i>National Advisory: Earthquake Being Assessed</i> (local/regional boundary holding message) • <i>National Advisory: Tsunami Activity – Strong Unusual Currents</i> • <i>National Warning: Tsunami Threat</i> • <i>Emergency Mobile Alert</i> (to areas where land inundation is forecast) • <i>National Advisory: No Tsunami Threat</i>
2	South-West Pacific (1-3 hours Regional source)	M≥7.5 and <100km depth	<p>Initial message:</p> <ul style="list-style-type: none"> • <i>National Advisory: Large Pacific Earthquake Being Assessed</i> (holding message) <p>Followed by (as appropriate, once confirmed data and advice received from GNS Science):</p>
3	Wider Pacific (>3 hours Distant source)	M≥8.0 and <100km depth	<ul style="list-style-type: none"> • <i>National Advisory: Tsunami Activity – Strong Unusual Currents</i> • <i>National Warning: Tsunami Threat</i> • <i>National Advisory: No Tsunami Threat to New Zealand</i> • <i>Emergency Mobile Alert</i> (to areas where land inundation is forecast)

3.5 Use of social media and NEMA website

All national advisories and warnings issued via the National Warning System are also communicated via social media channels (Facebook and Twitter) and the NEMA website.

NEMA may issue no threat advice on social media channels and/or its website, in response to events that do not meet the response indicator thresholds detailed in 'Table 1 Response indicators' above. This decision will be made by the NEMA Duty Manager, and will depend on anticipated public and media interest in the event.

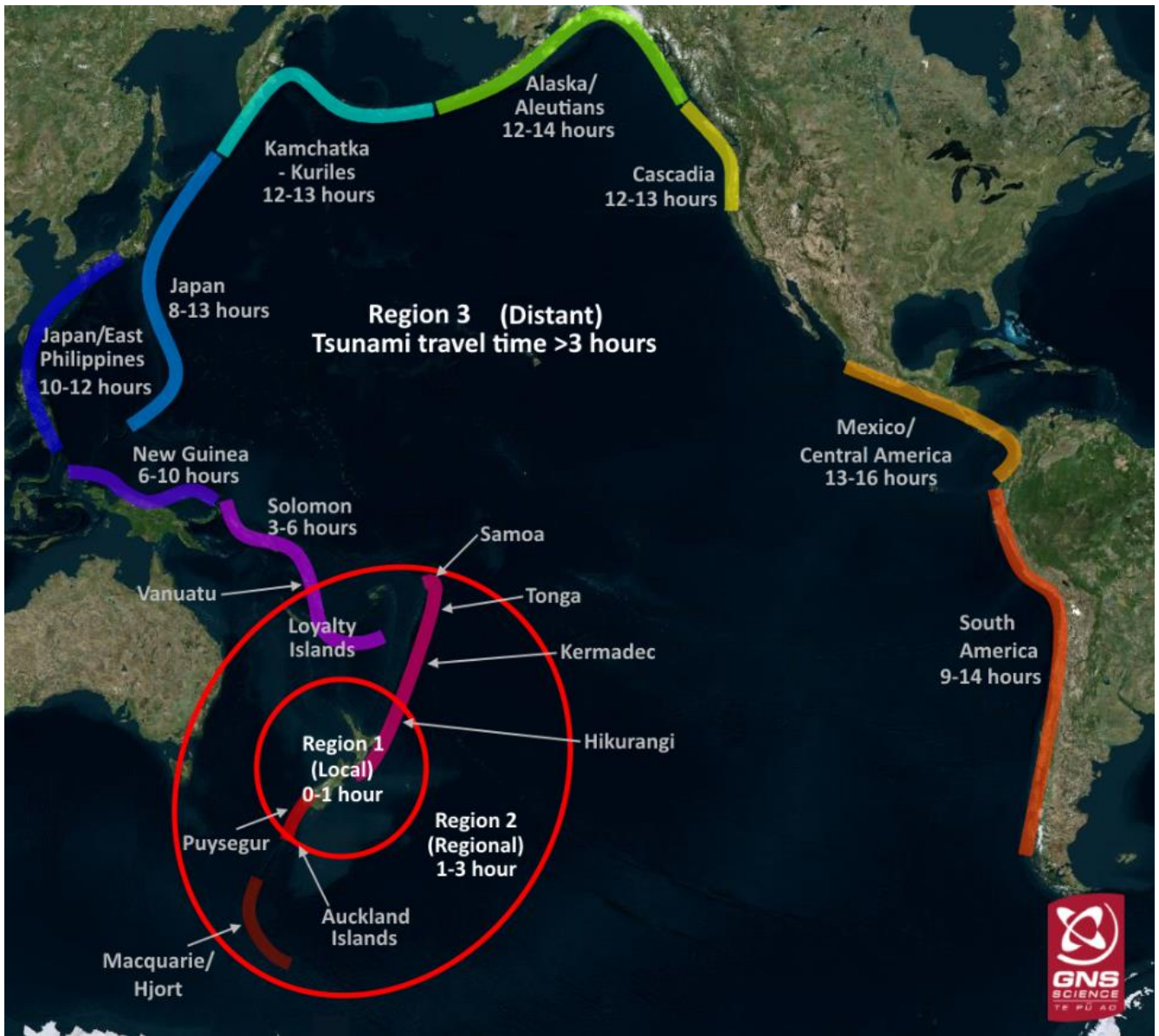


Figure 1 Tsunami Origin Locations (Regions 1-3*)

* More information about these regions is included in Appendix B.3 [Regions where tsunami originate](#) on page 39. Timeframes are for arrival at the nearest coast. Tsunami from Region 1 sources will continue to arrive at coastal regions around New Zealand after more than an hour.

Section 4 Further assessment of the tsunami

When the first National Advisory or Warning is issued by NEMA, information about the expected threat may be provided if available in the form of estimated wave arrival times and/or a threat map (or table) that shows coastal regions at risk. Often this data is not available at the time of the initial advisory or warning.

Subsequent National Advisories or Warnings will include any new information as it becomes available, including new or revised wave arrival times, amplitudes, and threat maps.

4.1 Estimated times of arrival

For regional and distant-source events, information regarding expected arrival times is derived from modelling conducted by the PTWC and moderated by GNS Science. The information is expressed as the estimated earliest possible time of arrival (ETA) of the first (lead) wave at given coastal locations. The modelling applied is not precise and data for all coastal locations may not be available. Only those coastal locations for which data is available, are covered in National Advisory and Warning ETAs.

The coastal locations that ETAs may be provided for are:

New Plymouth	Kaingaroa (Chatham Islands)
North Cape	Waitangi (Chatham Islands)
Auckland East	Whangarei
Auckland West	Mount Maunganui
East Cape	Whanganui
Gisborne	Marlborough Sounds
Napier	Timaru
Wellington	Stewart Island
Lyttelton	Jackson Bay
Dunedin	Great Barrier Island
Bluff	Port Tauranga
Milford Sound	Lottin Point (East Cape)
Westport	Picton
Nelson	Greymouth

As they become available, estimated arrival times will be displayed in table format in National Advisories and Warnings.

NOTES:

1. The first wave is not always the largest or highest and waves are likely to continue for many hours. Sometimes later waves may be significantly larger than the first arrivals.
2. ETAs for regional and distant-source tsunami are only provided for up to an hour after the time when all the estimated arrival times have passed. It is likely that advisories or warnings will remain in force after that.
3. ETAs are given in terms of date and NZ Standard Time (NZST) or NZ Daylight Saving Time (NZDT) – whichever applies.
4. Not all the coastal regions given in the list above may be covered at all times. For locations that are not included, the nearest available location will be provided.

4.2 Threat estimation

GNS Science will apply tsunami modelling to provide information about the expected tsunami threat for specific coastal regions along the New Zealand coast. The coastal regions are shown in Figure 2 on the next page. GNS Science may activate the Tsunami Experts Panel (TEP) for support in this regard, under the circumstances described in Section 2.2 of this plan (Page 3).

4.3 Coastal region boundary locations

The 43 coastal regions for which estimates will be made are as follows:

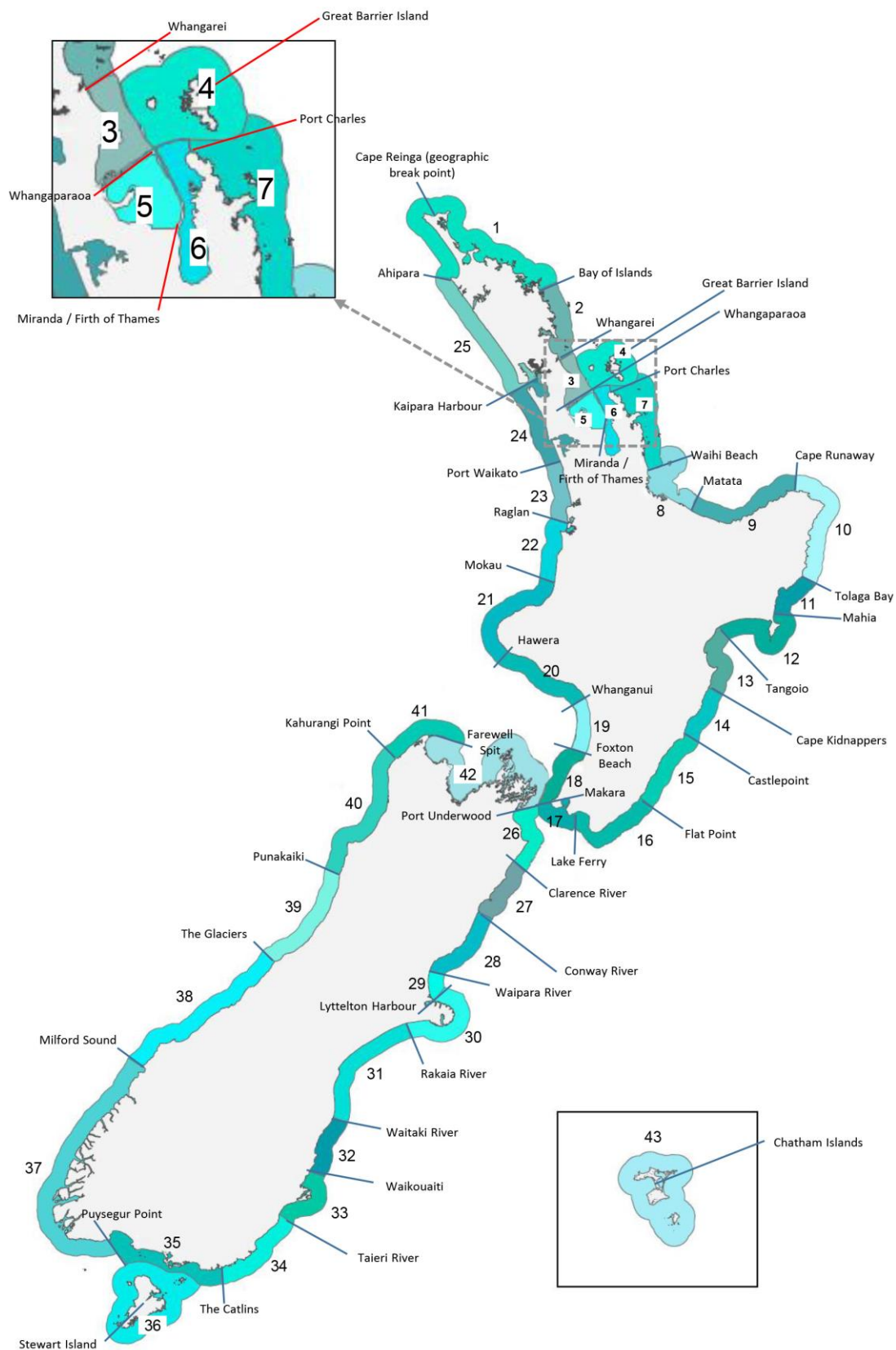


Figure 2 New Zealand coastal regions for tsunami threat forecasts

4.4 Threat maps

If available, NEMA may issue two types of threat maps:

- **Action Map:** a rapid threat evacuation map (local source only)
- **Forecast Map:** a threat forecast map (all sources)

Action Map

These maps advise the immediate areas to be evacuated by showing the coastal regions that are expected to experience land inundation in black. Areas that are still under assessment are shown in grey (crosshatch). These maps are only used for local-source events to support rapid and consistent evacuations.

For local-source 'Region 1 - New Zealand' earthquakes: These maps take approximately ten to fifteen minutes for NEMA to issue after receiving the map, as they are developed specific to each earthquake event. CDEM Groups and the public should not wait for an Action Map and instead heed the natural, felt warning signs. 'Long or Strong, Get Gone' should always apply in the first instance.

For local-source 'Region 1 - Southern Kermadec' earthquakes: These maps take approximately five to ten minutes for NEMA to issue as they are pre-prepared. Some at-risk areas of New Zealand may not experience shaking from an earthquake in this region. However, if the earthquake is felt, CDEM Groups and the public should heed natural, felt warning signs and 'Long or Strong, Get Gone' should still apply (in addition to receiving the Action Map).

An Action Map is replaced by a Forecast Map when it becomes available.

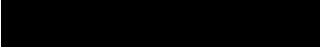

An example of an Action Map is provided on the following page:



Figure 3 Example of an Action Map

The definitions of the shading used in Action Maps are as follows:

Table 2 Tsunami threat definitions - Action Maps

Shading	Threat definition
	Land threat expected: Evacuate immediately
Crosshatch 	'Long or Strong, Get Gone'; under assessment

NOTE:

1. An Emergency Mobile Alert will be sent to all shaded areas but not to those under assessment.

Forecast Map

These maps show wave amplitude forecasts, illustrated in a coloured scale for different threat levels for the coastal regions. They are used for local, regional and distant-source events to support local level assessments. They take approximately one hour to produce; therefore the inclusion of a Forecast Map in an initial National Advisory or Warning is very unlikely.

An example of a Forecast Map is provided below:

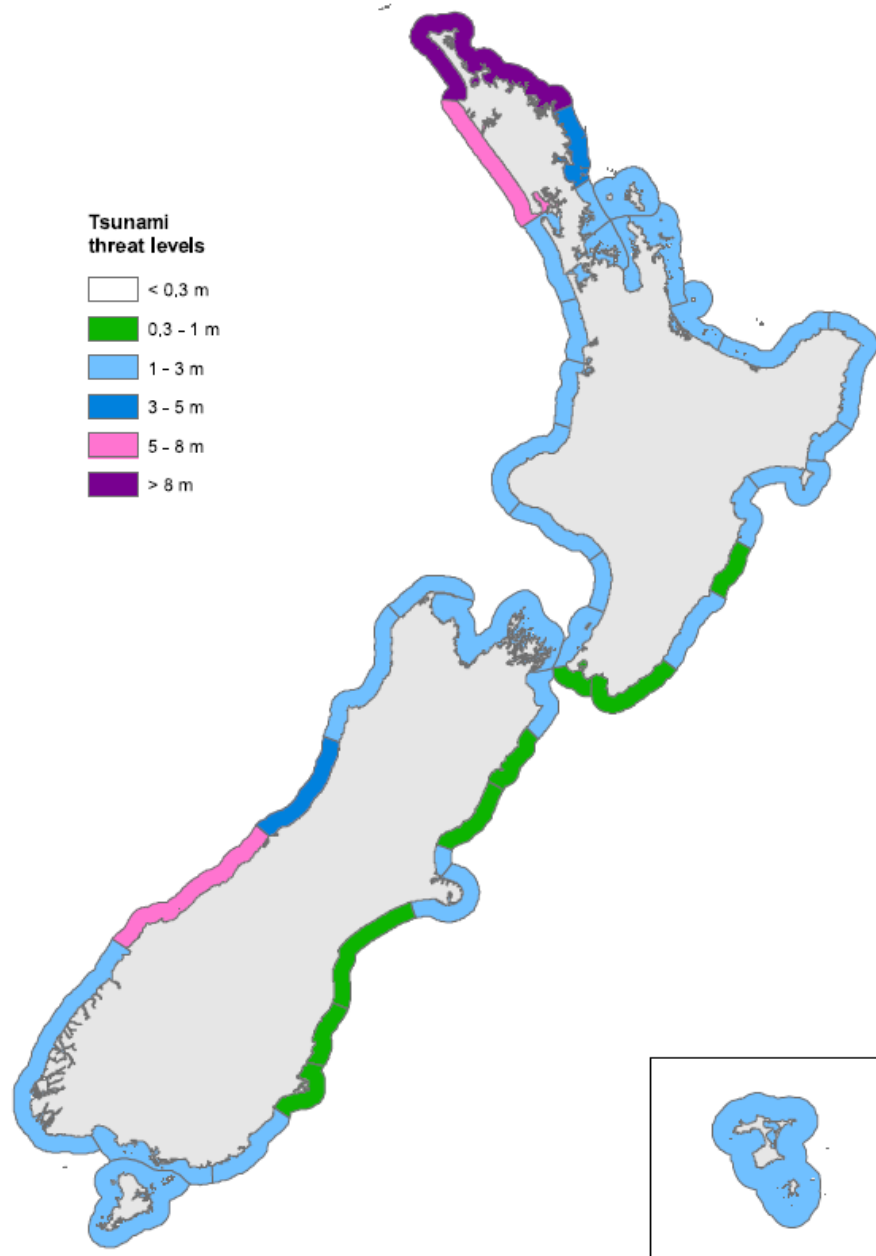


Figure 4 Example of a Forecast Map

The amplitudes at shore and threat definitions that can be assigned for the coastal regions in Forecast Maps are as follows:

Table 3 Tsunami threat definitions - Forecast Maps

Maximum expected amplitude at shore		Threat definition
	<0.3m	No threat
	0.3-1m	Beach & Marine Tsunami Activity (incl. harbours, estuaries & small boats)
	1-3m	Land & Marine Threat
	3-5m	
	5-8m	
	>8m	

CDEM Groups and CDEM Group members must apply these threat indicators including consideration of wave run-up to decide appropriate evacuation zones (see **Notes** below).

NOTES:

1. The stated amplitudes may apply to any one of the series of waves generated by the event and not necessarily to the first wave. The first wave is not always the largest or highest and waves are likely to continue for many hours.
2. The amplitudes suggest the largest wave to occur within the coastal regions. Wave heights will vary within the coastal regions.
3. The amplitudes do not include the tidal state (high/low sea level) at the time the wave reaches the shore.
4. The estimate is for the maximum expected wave amplitude at shore. Run-up can be twice as high on steep slopes onshore near the coast, i.e. a wave measuring 5m at shore can run up as high as 10m on-land near the shore.
5. For regional and distant-source tsunamis, the expected wave amplitudes at the shore are likely to be different to measurements given in PTWC notifications. PTWC measurements are taken at sea level gauges in the open ocean or at locations offshore from New Zealand. NEMA information represents the official threat estimates.
6. An Emergency Mobile Alert will be sent to all zones above the 1 metre threat level.

Section 5 Types of notifications from NEMA

5.1 Introduction

Depending on the assessment of the information received for an earthquake, NEMA may issue one or more of the following official notifications:

National Advisories:

- *National Advisory: Earthquake Being Assessed*
- *National Advisory: Large Pacific Earthquake Being Assessed*
- *National Advisory: No Tsunami Threat to New Zealand*
- *National Advisory: Earthquake – No Tsunami Threat*
- *National Advisory: Tsunami Activity - Strong Unusual Currents*

National Warnings:

- *National Warning: Tsunami Threat*

Tsunami cancellation messages:

- *National Advisory: Tsunami Activity CANCELLED*
- *National Warning: Tsunami Threat CANCELLED*

Requests for broadcast, or termination of broadcast:

- *Request for the broadcast of a Tsunami Threat*
- *Request for the termination of an emergency announcement*

Emergency Mobile Alerts:

- See Section 6

Additional messages from NEMA

NEMA may issue messaging on social media channels and/or its website in response to events that may or may not meet the requirements of the response indicators (see [Table 1 Response indicators](#)), depending on anticipated public and media interest.

5.2 National Advisory: No Tsunami Threat to New Zealand

Description	<p>A <i>National Advisory: No Tsunami Threat to New Zealand</i> is a message that earthquake or tsunami information has been received, and:</p> <ul style="list-style-type: none">• no tsunami has been generated following an initial detection of a large earthquake, or• a tsunami that has been detected does not pose a threat to New Zealand coastlines, or• regardless, NEMA considers that the event is of significant interest to New Zealand.
Issuing process	<p>A <i>National Advisory: No Tsunami Threat to New Zealand</i> is issued through the NWS to all those that are registered on the NWS register.</p> <p>A <i>National Advisory: No Tsunami Threat to New Zealand</i> is normally the final message for the event. However, when significant new information is received that indicates a threat, an appropriate new notification will be issued.</p>

5.3 National Advisory: Earthquake Being Assessed

Description	<p>A <i>National Advisory: Earthquake Being Assessed</i> is a message that:</p> <ul style="list-style-type: none">• information has been received about a large (>M6.5) earthquake located in Region 1 (local source) as outlined in the response indicators table (see Table 1 Response indicators), and• NEMA and GNS Science are currently assessing whether the earthquake has created a tsunami threat for New Zealand. <p>This message may include the <i>LONG or STRONG, GET GONE advice</i>.</p>
Issuing process	<p>A <i>National Advisory: Earthquake Being Assessed</i> is issued through the NWS to all those that are registered on the NWS register.</p> <p>A <i>National Advisory: Earthquake Being Assessed</i> is followed up by either:</p> <ul style="list-style-type: none">• a National Advisory: No Tsunami Threat to New Zealand; or• a National Warning: Tsunami Threat

5.4 National Advisory: Large Pacific Earthquake Being Assessed

Description	<p>A <i>National Advisory: Large Pacific Earthquake Being Assessed</i> is a message that:</p> <ul style="list-style-type: none">• information has been received about a large (>M7.5) earthquake located in Region 2 (regional source), or a M>8 earthquake in Region 3 (distant source) (see Figure 1 Tsunami Origin Locations (Regions 1-3*) on page 10, and• NEMA and GNS Science are currently assessing whether the earthquake has created a tsunami threat for New Zealand.
Issuing process	<p>A <i>National Advisory: Large Pacific Earthquake Being Assessed</i> is issued through the NWS to all those that are registered on the NWS register.</p> <p>A <i>National Advisory: Large Pacific Earthquake Being Assessed</i> is followed up by either:</p> <ul style="list-style-type: none">• a National Advisory: Large Pacific Earthquake Still Being Assessed (when the assessment is still incomplete);• a National Advisory: No Tsunami Threat to New Zealand• a National Advisory: Tsunami Activity, or• a National Warning: Tsunami Threat to Land and Marine Areas.

5.5 National Advisory: Earthquake – No Tsunami Threat to New Zealand

Description	<p>A <i>National Advisory: Earthquake - No Tsunami Threat to New Zealand</i> is a message that an earthquake has occurred, and:</p> <ul style="list-style-type: none">• no tsunami has been generated following an initial detection of a large earthquake, or• a tsunami that has been detected does not pose a threat to New Zealand coastlines, or• regardless, NEMA considers that the earthquake event is of significant interest to New Zealand and there is likely to be some level of CDEM response required.
Issuing process	<p>A <i>National Advisory: Earthquake - No Tsunami Threat to New Zealand</i> is issued through the NWS to all those that are registered on the NWS register.</p> <p>A <i>National Advisory: Earthquake - No Tsunami Threat to New Zealand</i> may be the final message for the event; or it may be followed by further NWS messages if the earthquake as such requires CDEM activation and response.</p>

5.6 National Advisory: Tsunami Activity – Expect strong and unusual currents and unpredictable surges at the shore

Description

A National Advisory: Tsunami Activity – Expect strong and unusual currents and unpredictable surges at the shore is a message that tsunami activity at the New Zealand coastline is imminent or likely. Unusually strong currents and unpredictable water flows near the shore can be expected. This means a danger to beach, harbour, estuary and small boat activities. Coastal inundation (flooding of land areas near the shore) is not expected but this assessment may change.

Where known, messages will contain the following information:

- estimated tsunami arrival times at specific New Zealand coastal regions, and
- estimated threat levels for specific coastal regions.

Issuing process

A National Advisory: Tsunami Activity – Expect strong and unusual currents and unpredictable surges at the shore is issued through the NWS to all those that are registered on the NWS register, as well as via social media and the NEMA website.

A National Advisory: Tsunami Activity – Expect strong and unusual currents and unpredictable surges at the shore is followed up by either:

- a National Warning: Tsunami Threat to Land and Marine Areas (if further assessment indicates an increased threat), or
- a National Advisory: Tsunami Activity CANCELLED

5.7 National Warning: Tsunami Threat

Description

This includes two types of local-source national warnings 1) 'Region 1 - New Zealand' and 2) 'Region 1 – Southern Kermadec'.

Natural, felt signs are the primary warning for local-source tsunami. Should long or strong shaking be felt, **CDEM Groups, agencies, and the public should not wait for an official warning.** They should respond to natural, felt signs (see Appendix B.1 [Categories of tsunami](#) on page 35).

Some at risk areas of New Zealand may not experience shaking from an earthquake located in Region 1 (local source). **CDEM Groups, agencies, and the public should respond immediately** on receiving national warnings and the accompanying Action Map. 'Long or Strong, Get Gone' still applies if natural, felt warning signs are experienced.

A *National Warning: Tsunami Threat* represents information about an imminent or likely tsunami that has been generated within Region 1 and has an expected travel time of <1 hour (see [Figure 1 Tsunami Origin Locations \(Regions 1-3*\)](#) on page 10). It is likely that tsunami waves will arrive in the closest locations to the source prior to the issuing of a National Warning.

A *National Warning: Tsunami Threat* will contain advice for the public, media, CDEM Groups, and emergency services. It will also include an Action Map. Note: It will not be issued until the Action Map becomes available.

Issuing process

A *National Warning: Tsunami Threat* is issued through the NWS to all those that are registered on the NWS register, as well as via social media and the NEMA website.

A *Request for the broadcast of a Tsunami Threat* will be made under the arrangements in the Guide to the National CDEM Plan - see section 5.10 [Requests for broadcast, or termination of broadcast](#) on page 24.

NEMA will follow up a *National Warning: Tsunami Threat* by hourly update messages (except between 10pm and 5am, when updates will only be issued if there is a significant change).

Update messages will continue to be sent until a cancellation message is issued.

Updates may be in the form of a *National Warning: Tsunami Threat to Land and Marine Areas*, or a *National Advisory: Tsunami Activity* (see next page).

A *National Warning: Tsunami Threat* will be followed by an *Emergency Mobile Alert* (see Section 6 for more detail).

5.8 National Warning: Tsunami Threat to Land and Marine Areas

Description

A *National Warning: Tsunami Threat to Land and Marine Areas* is a message that a tsunami threat to New Zealand coastal areas is imminent or likely. In addition to the threat described under *National Advisory: Tsunami Activity*, a threat of coastal inundation to land areas near the shore exists.

Where known, messages will contain the following information:

- estimated tsunami arrival times at specific New Zealand coastal regions, and
- estimated threat levels for specific coastal regions.

Issuing process

The issuing process for a *National Warning: Tsunami Threat to Land and Marine Areas* is the same as for a *National Warning: Tsunami Threat*.

A *Request for the broadcast of a Tsunami Threat* may be made under the arrangements in the Guide to the National CDEM Plan if NEMA considers it necessary - see section 5.10 [Requests for broadcast, or termination of broadcast](#) on page 24.

A *National Warning: Tsunami Threat to Land and Marine Areas* will be followed by an *Emergency Mobile Alert* (see Section 6 for more detail).

5.9 Tsunami cancellation messages

Description	<p>A <i>National Warning: Tsunami Threat CANCELLED</i> message informs all agencies that there is no longer a tsunami threat to New Zealand.</p> <p>NEMA will issue these notifications once it has received confirmation from its scientific advisors that the threat no longer exists. If there is a degree of uncertainty, the <i>National Warning: Tsunami Threat</i> will remain in place.</p>
Issuing process	<p>Tsunami cancellation messages are issued through the NWS to all those that are registered on the NWS database, including the media.</p> <p>All agencies should follow stand-down procedures as detailed in their own plans.</p> <p>A <i>Request for the termination of an emergency announcement</i> will be made under the arrangements in the Guide to the National CDEM Plan (see next section).</p>

5.10 Requests for broadcast, or termination of broadcast

Description	Table 4 below describes the two types of request for broadcast or termination messages.
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Table 4 Types of request for broadcast or termination messages for tsunami

Message	Issued by NEMA when...
<i>Request for the broadcast of a Tsunami Threat</i>	<p>A <i>National Warning: Tsunami Threat</i> or a <i>National Warning: Tsunami Threat to Land and Marine Areas</i> is issued.</p> <p>May be issued by NEMA when a <i>National Advisory: Tsunami Activity</i> is issued if NEMA considers it necessary</p>
<i>Request for the termination of an emergency announcement</i>	<p>A <i>National Warning: Tsunami Threat CANCELLED</i> or <i>National Advisory: Tsunami Activity CANCELLED</i> message is issued.</p>

The radio and television stations requested to broadcast the announcement under the terms of the Memorandum of Understanding (MoU) with NEMA are:

- Radio New Zealand
- The Radio Broadcasters' Association
- The Association of Community Access Broadcasters³
- Television New Zealand Limited, and
- Media Works TV Limited.

Depending on the priority (urgency), a request for the broadcast of an emergency announcement can state that the information must be broadcast at specified intervals until a request is made to terminate the broadcast.

Issuing process

Requests for broadcast are issued through the NWS to all those media organisations included in the MoU.

Any request for the broadcast of an emergency announcement must be closed by an official *Request for the termination of an emergency announcement*, forwarded in the same manner as the initiating request for broadcast.

³ NEMA acknowledges that the Association of Community Access Broadcasters, and some members of the Radio Broadcasters Association, will follow a 'best endeavours' approach to broadcasting emergency announcements, as described in the MoU.

Section 6 Public tsunami notifications using Emergency Mobile Alert

6.1 Emergency Mobile Alert system

The Emergency Mobile Alert (EMA) system delivers alerts directly to people’s mobile phones in targeted areas, without subscription required. NEMA and the CDEM Groups have agreed the optimum arrangements to alert people via EMA once a credible tsunami threat has been established.



Note: “Coastal regions” referred to in 6.2 – 6.4 below are the coastal regions identified in Section 4.3 of this Plan.

6.2 Use of EMA during a local-source tsunami

→ time

	Upon receipt of Threat Forecast Map or Rapid Threat Evacuation Map from GNS Science that includes at least one coastal region with land inundation.	Upon receipt of a further Threat Forecast Map or Rapid Threat Evacuation Map from GNS Science that increases or decreases the number of coastal regions with land inundation.	Upon advice from GNS Science that immediate threat has passed.
NEMA	Issue EMA to those coastal regions that are subject to a land threat telling people to evacuate from coastal areas.	Issue EMA with updated locations to the new and old coastal regions telling people to evacuate from coastal areas.	Teleconference between NEMA and CDEM Groups to agree further EMA messaging and responsibility for issuing, including cancellations.
CDEM Groups	If at least one coastal region with land inundation in their Group, issue EMA to those coastal regions with the locally appropriate evacuation messages, after the EMA issued by NEMA, <i>supporting that national message</i> .	If at least one coastal region with land inundation in their Group, issue EMA to new and old coastal regions with the locally appropriate evacuation messages, after the EMA issued by NEMA, <i>supporting that national message</i> .	

Note: For *National Advisory: Tsunami Activity* events, CDEM Groups may issue EMA at their discretion where they consider there to be a significant life-safety risk.

6.3 Use of EMA during a regional-source tsunami

→ time

	Upon receipt of Threat Forecast Map from GNS Science that includes at least one coastal region with land inundation.	Upon receipt of a further Threat Forecast Map from GNS Science that increases or decreases the number of coastal regions with land inundation.	Upon advice from GNS Science that immediate threat has passed.
NEMA	Issue EMA to those coastal regions that are subject to a land threat telling people to evacuate from coastal areas.	Issue EMA with updated locations to the new and old coastal regions telling people to evacuate from coastal areas.	Teleconference between NEMA and CDEM Groups to agree further EMA messaging and responsibility for issuing, including cancellations.
CDEM Groups	If at least one coastal region with land inundation in their Group, issue EMA to those coastal regions with the locally appropriate evacuation messages, after the EMA issued by NEMA, <i>supporting that national message</i> .	If at least one coastal region with land inundation in their Group, issue EMA to new and old coastal regions with the locally appropriate evacuation messages, after the EMA issued by NEMA, <i>supporting that national message</i> .	

Note: For *National Advisory: Tsunami Activity* events, CDEM Groups may issue EMA at their discretion where they consider there to be a significant life-safety risk.

6.4 Use of EMA during a distant-source tsunami

time →

	Upon receipt of Threat Forecast Map from GNS Science that includes at least one coastal region with land inundation.	Upon receipt of a further Threat Forecast Map from GNS Science that increases or decreases the number of coastal regions with land inundation.	Upon advice from GNS Science that immediate threat has passed.
NEMA	Issue EMA to those coastal regions that are subject to a land threat advising people to be prepared to move and check with local authorities for further information.	Issue EMA with updated locations to the new and old coastal regions advising people to be prepared to move and to continue to check and listen to local authorities for next steps.	Teleconference between NEMA and CDEM Groups to agree further EMA messaging and responsibility for issuing, including cancellations.
CDEM Groups	If at least one coastal region with land inundation in their Group, issue EMA to those coastal regions with the locally appropriate evacuation messages, after the EMA issued by NEMA.	If at least one coastal region with land inundation in their Group, issue EMA to the new and old coastal region with the locally appropriate evacuation messages, after the EMA issued by NEMA.	

Note: For *National Advisory: Tsunami Activity* events, CDEM Groups may issue EMA at their discretion where they consider there to be a significant life-safety risk.

Section 7 Appendices

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Appendix A Agency action guides

This section contains Action Guides for organisations that are responsible for responding to tsunami notifications. The guide lists what action each organisation should carry out once they have received a tsunami notification.

The following are the list of Action Guides contained within this section:

- NEMA
- GNS Science
- CDEM Groups
- Maritime New Zealand
- National Agencies

A.1 NEMA action guide

Notification

NEMA may receive one or more of the following initial notifications for a tsunami event:

- GeoNet earthquake report
- PTWC Tsunami Information Statement
- PTWC Tsunami Threat Message
- GeoNet Volcanic Alert Bulletin
- Other (e.g. large coastal landslide or oceanic meteorite strike)

On receipt of any of the above notifications, NEMA follows the steps in the table below. Note that PTWC will not always be able to provide guidance in sufficient time and/or accuracy in the case of local-source tsunami.

Step	Event and action	Responsibility
Timeframe target: Steps 1 to 4 will be completed within 15-30 minutes*		
1	Assess the risk to New Zealand Note: In the case of a large local earthquake in Region 1, Step 2 may follow after Step 3.	Duty Manager
2	Consult with GNS Science (NGMC Geohazards Analyst and/or GeoNet Duty Officer)	Duty Officer
3	If deemed appropriate, or advised by GNS Science, or if initial information meets the thresholds detailed in Table 1 Response indicators of this plan, NEMA will issue appropriate notifications to agencies and the public.	Duty Manager
4	When a <i>National Warning</i> is issued, request the broadcast of an emergency announcement and activate the National Crisis Management Centre (NCMC).	Duty Team
5	Establish ongoing communications with GNS Science for updated assessments.	Duty Officer
6	Provide updates at least hourly via the NWS and the media (except between 10pm and 5am – unless there is a significant change).	Duty Manager
7	Issue a cancellation message when there is no longer a threat to New Zealand.	Duty Manager

* The timeframe represents a target to aim for. It is not a formal performance measure.

A.2 GNS Science action guide

Notification

GNS Science may receive one or more of the following initial notifications:

- GeoNet seismic and sea level data
- PTWC Tsunami Information Statement
- PTWC Threat Message
- Volcanic activity notification

On receipt of notifications that indicate a potential threat or threat to New Zealand, GNS Science follows the steps in the table below. Note that PTWC information will not always be able to provide guidance in sufficient time and/or accuracy in the case of local-source tsunami.

Step	Event and action	Responsibility
Timeframe target: Steps 1 to 2 completed within 15-30 minutes*		
1	Monitor and assess information to provide advice to the NEMA Duty Team.	National Geohazards Monitoring Centre (NGMC)
2	Provide advice to NEMA Duty Team if required.	NGMC Geohazards Analyst/GeoNet Duty Officer
3	Activate the Tsunami Experts Panel (TEP) if required.	NGMC/GeoNet Duty Officer
4	Provide continual assessments of data, and advise updates when information changes to the Duty Officer/NCMC including the following specific areas if known: <ul style="list-style-type: none"> • travel-time estimates for the tsunami • wave amplitude estimates for coastal zones 	NGMC/GeoNet Duty Officer/TEP
5	Send a Liaison Officer to the NCMC when requested.	GNS Science
6	Provide ongoing advice to the Duty Team/National Controller/Intelligence & Planning functions.	GNS Science

* The timeframe represents a target to aim for. It is not a formal performance measure.

A.3 CDEM Group action guide

Notification

CDEM Groups will receive one or more of the following initial notifications:

- *National Advisory: Large Pacific Earthquake Being Assessed*
- *National Advisory: Earthquake Being Assessed*
- *National Advisory: Tsunami Activity*
- *National Advisory: No Tsunami Threat to New Zealand*
- *National Warning: Tsunami Threat* (one of two variants)

On receipt of one or more of the notifications listed above, CDEM Groups follow the steps in the table below.

Step	Event and action	Responsibility
Timeframe target: Steps 1 to 2 completed within 10-30 minutes*		
1	Follow Group emergency response procedures. If appropriate, issue local warnings and/or decide on evacuations.	Group Controller
2	In the event of a <i>National Warning</i> being issued, inform the appointed NEMA Regional Emergency Management Advisor about the response taken. Similarly when responding in reaction to any other notification, inform the appointed NEMA Regional Emergency Management Advisor.	Group Controller
3	Upon activation of the CDEM Group Emergency Coordination Centre, establish contact with the NCMC.	Group Controller
4	Update the NCMC and neighbouring CDEM Groups on response taken.	Group Controller

* The timeframe represents a target to aim for. It is not a formal performance measure.

A.4 Maritime New Zealand action guide

Notification	<p>Maritime New Zealand will receive one or more of the following initial notifications:</p> <ul style="list-style-type: none"> • <i>National Advisory: Large Pacific Earthquake Being Assessed</i> • <i>National Advisory: Earthquake Being Assessed</i> • <i>National Advisory: Tsunami Activity</i> • <i>National Advisory: No Tsunami Threat to New Zealand</i> • <i>National Warning: Tsunami Threat</i> (one of two variants) <p>On receipt of one or more of the notifications listed above, Maritime New Zealand follows the steps in the table below from the Maritime Operations Centre.</p>
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Step	Event and action	Responsibility
Timeframe target: Step 1 completed within 10-30 minutes*		
1	Broadcast the <i>National Advisory: Large Pacific Earthquake Being Assessed, National Advisory: Tsunami Activity</i> or <i>National Warning: Tsunami Threat</i> to mariners.	Duty Officer
2	Carry out own agency response actions.	Duty Officer

* The timeframe represents a target to aim for. It is not a formal performance measure.

A.5 National agencies action guide

Notification	<p>National Agencies will receive one or more of the following initial notifications:</p> <ul style="list-style-type: none"> • <i>National Advisory: Large Pacific Earthquake Being Assessed</i> • <i>National Advisory: No Tsunami Threat to New Zealand</i> • <i>National Advisory: Tsunami Activity</i> • <i>National Advisory: Earthquake Being Assessed</i> • <i>National Warning: Tsunami Threat</i> (one of two variants) <p>On receipt of one or more of the notifications listed above, national agencies follow the steps in the table below.</p>
---------------------	--

Step	Event and action	Responsibility
Timeframe target: Steps 1 completed within 10-30 minutes*		
1	Follow agency emergency response procedures.	Agency Duty Officer
2	Inform the NCMC about decisions made and activities undertaken.	Agency Duty Officer
3	Provide Liaison Officer(s) to the NCMC if requested.	Agency Controller

*The timeframe represents a target to aim for. It is not a formal performance measure.

Appendix B Tsunami categories and threat

B.1 Categories of tsunami

The three categories of tsunami

For the purposes of emergency management and the time needed to respond and act on warnings, tsunami are divided into three categories:

- Distant source
- Regional source
- Local source.

The categories are based on the shortest time it would take the tsunami to travel from its source to the point of first arrival at the New Zealand coastline (including the Chatham Islands); this will often be the point on the coastline nearest to the source. The travel times for the three categories are:

- Distant source – more than 3 hours travel time from New Zealand
- Regional source – 1 to 3 hours travel time from New Zealand
- Local source – 0 to 60 minutes travel time to the nearest New Zealand coastal regions; most local sources are less than 30 minutes travel time away from the nearest coast. Coastal regions further away will also receive the tsunami beyond one hour.

Warning consideration for the three categories of tsunami

Most distant tsunami sources are more than 10 hours travel time from New Zealand giving, in theory, adequate time for National Advisories or Warnings to be issued and subsequent response actions to be initiated. While wave amplitudes may be difficult to predict initially, more confident assessments will become available over time and with sufficient time to support local level decision-making and response.

Regional tsunami sources are one to three hours travel time to New Zealand and therefore provide much less time for assessment before National Advisories or Warnings are issued. Initial National Advisories or Warnings are likely to be issued based on 'rule of thumb' thresholds based on the location, size and depth of the earthquake. These National Advisories and Warnings are unlikely to include confident assessments of wave amplitude and local decisions may have to be made without that knowledge. The assessment of regional sources contained in this appendix must be used to support decision making at the local level.

Local tsunami sources offer very little, if any time for official warnings as most local-source tsunami are less than 30 minutes travel time to the nearest New Zealand coastal regions. In this case, public awareness to be able to recognise and individually respond to natural, felt warnings is vital. Official warnings will be issued (if possible) to reinforce the response to natural warnings.

In some cases, local-source tsunami may travel to further regions of the New Zealand coast and therefore travel times to these locations could be greater than 60 minutes and official warnings will still be valuable. In this situation, National Warnings may not include assessments of wave amplitude. The assessment of local-source tsunami contained in this appendix must be used to support decision making at local level.

Natural Warnings

'Natural warnings' are personal observations. They can include any of the following:

- Strong earthquakes (it's hard to stand up), or long earthquakes (including weak shaking) lasting for a minute or more; or
- Strange sea behaviour, such as the sea level suddenly rising and falling; or
- Hearing the sea making loud and unusual noises or roaring like a jet engine.

When any of the above observations apply, a Land Threat should be anticipated.

Public education about tsunami awareness, tailored to the specific community is critical in this regard.

B.2 The tsunami threat to New Zealand

Introduction

This section outlines the risk that New Zealand may face from a tsunamigenic earthquake in the Pacific.

Large tsunami have occurred in New Zealand within written history. However, early Maori historical traditions record several large tsunami killing many people within the last 1,000 years. Archaeological evidence indicates that several coastal settlements around New Zealand were abandoned for higher ground in the mid-1400s perhaps due to tsunami inundation. There is also geological evidence of tsunami with up to 35 metre run-ups affecting the New Zealand coast within the last 6,000 years.

National hazard and risk assessment

In 2005, GNS Science completed a comprehensive assessment of the tsunami hazard and risk to New Zealand based on existing knowledge, and of New Zealand's preparedness for this hazard. This review was updated in 2013 to highlight the results of new research and changes in scientific understanding between 2005 and 2013. This updated report focused on quantifying tsunami hazard, i.e. the likely size of tsunami for specified timescales, along with estimates of uncertainty. It did not provide estimates of risk, i.e. expected costs of damage and numbers of casualties.

The information on the respective tsunami sources relevant to New Zealand in this Plan was taken from the 2013 GNS Science hazard assessment report.

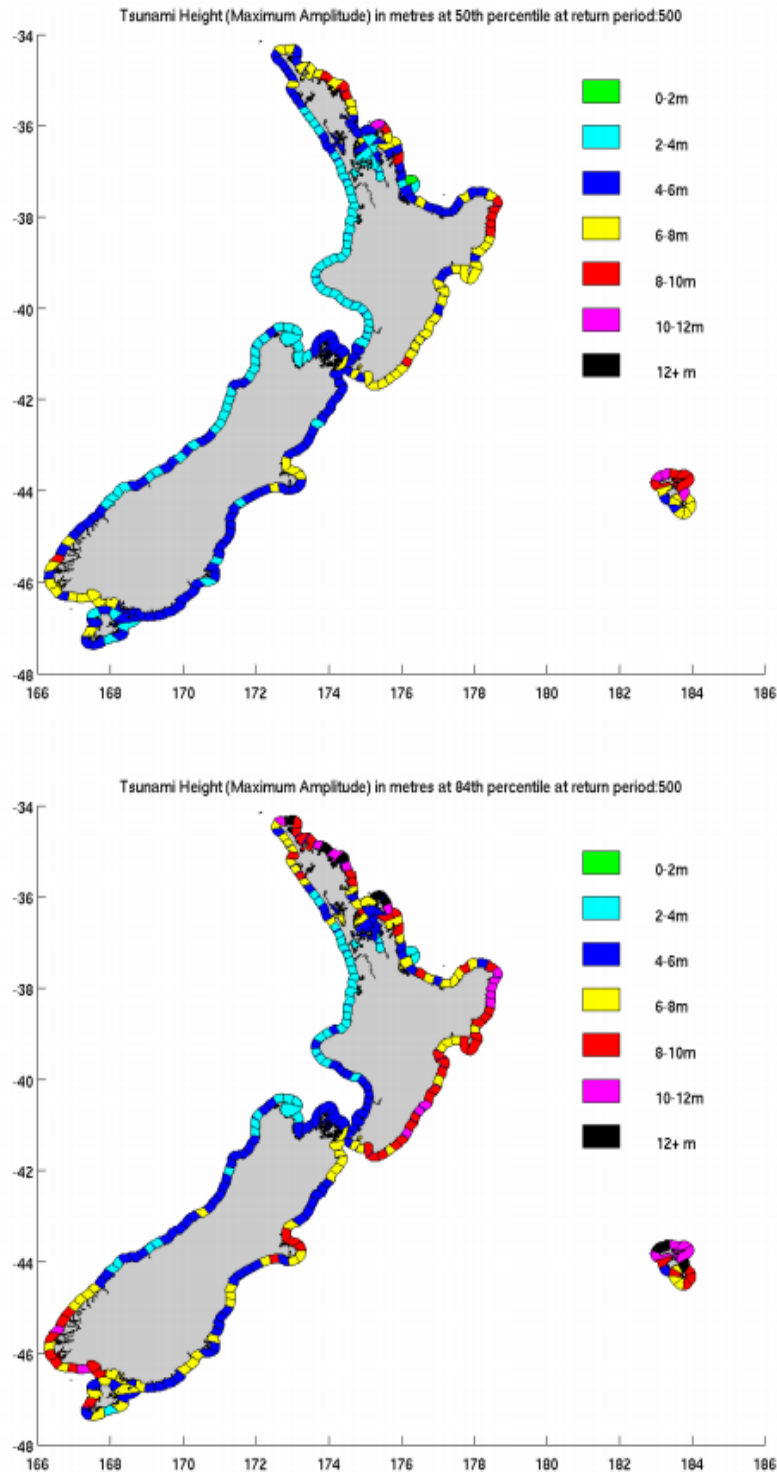


Figure 5 Estimate of tsunami hazard in New Zealand expressed as expected maximum wave height at the shore for a 500-year return period.

Significantly higher or lower water elevations may occur locally. These maps should not be used for site-specific assessments. The 50th percentile (upper figure) represents a best estimate of expected maximum wave heights within each coastal section, and the 84th percentile (lower figure) represents a conservative estimate of the maximum heights after considering uncertainties.

Source: Review of Tsunami Hazard in New Zealand (2013 Update), GNS Science.

B.3 Regions where tsunami originate

List of regions

Note: for detailed information on tsunami sources and their implications for New Zealand refer to the “Review of Tsunami Hazard in New Zealand” GNS Science report (2013). The following regions represent potential origins of tsunami that can affect New Zealand:

Table 5 Tsunami regions

Region	Description
1	New Zealand, including Hikurangi Trench, Kermadec Trench and Puysegur Trench
2	South-West Pacific, including Loyalty Islands, Samoa, Tonga, Kermadec, Auckland Islands, Macquarie Islands
3	Solomon islands, New Guinea, Japan, East Philippines, Kamchatka / Kuriles, Alaska / Aleutians, Cascadia, Mexico / Central America, South America.



Figure 6 Tsunami source regions. Regions are determined based on minimum travel time from source to the point of first arrival at the New Zealand coastline (including the Chatham Islands); this will often be the point on the coastline nearest to the source. Timeframes are for arrival at the nearest coast. Tsunami from Region 1 sources will continue to arrive at coastal regions around New Zealand after more than an hour.

Local Sources, Region 1 – New Zealand

Earthquake sources

Local earthquakes have the potential to produce catastrophic tsunami, with run-up heights of 10m or more, at the New Zealand coast. The impact depends on the source of tsunami, i.e. earthquake, volcano, or landslide. Generally, earthquakes are the predominant source of local tsunami and the impact depends on the extent of fault rupture and seafloor deformation, which in turn depends on the magnitude and other characteristics of the earthquake. A tsunami resulting from a very large, 200-300 km long rupture of the Hikurangi Trench located on the east coast of the North Island, could affect 200-300 km or more of the nearby coast with large run-up heights. Such an event could cause severely damaging waves along much of the east coast and in the Chatham Islands.

Some coasts are more exposed to local-source tsunami than others because of their proximity to subduction zones and other faults around New Zealand. No part of New Zealand coastline can be considered completely free from local-source tsunami hazards.

Subduction zone tsunami sources

New Zealand has three subduction zones capable of generating tsunami: the Kermadec Trench, the Hikurangi Trench and the Puysegur Trench. Each has the potential to generate earthquakes greater than magnitude 8. For locations closest to these sources, very large damaging waves could arrive within minutes. These subduction zones can also behave as regional sources for locations further away within New Zealand and the Chatham Islands, in that the first wave arrival could be one hour after fault rupture in these locations. The return period for tsunamigenic earthquakes on all of New Zealand's subduction zones is unknown as no significant events have occurred in historic times and subduction plate research under the ocean floor is a relatively new area of research in New Zealand.

Because the Pacific and Australian Plates meet under New Zealand and the interface extends offshore, very large ruptures on the subduction zone can appear on seismic instruments as on-shore earthquakes. For this reason, very large (>M8) onshore earthquakes (under the North Island in particular), should be considered as potentially tsunamigenic as the rupture is likely to have moved the oceanic crust also (out under the ocean). Smaller onshore subduction zone earthquakes M7-8 may also be potentially tsunamigenic if close enough to the coast.

Onshore active faults that extend offshore

Many onshore faults extend offshore and are present in all regions of New Zealand except Northland, and there are few in Auckland, Southland and Otago (from GNS Science's *New Zealand Active Fault Database*). Large movements on these faults have the potential to cause tsunami, where the earthquake is of sufficient magnitude and the seabed is deformed in a particular way to create a tsunami, or where movement causes large submarine landslides. The recurrence intervals of most onshore active faults in New Zealand are reasonably well defined, with the most active faults and those near major urban areas being the best understood. Onshore active faults extending offshore are considered to be important sources for localised tsunami, but not likely to generate widespread impacts across multiple regions. Historical events from such sources include the Wairarapa earthquake and tsunami of 1855, and the Kaikōura earthquake of 2017, during which multiple faults ruptured onshore and offshore.

Other offshore fault sources (non subduction zone)

NIWA mapping of the seabed surrounding New Zealand has identified many offshore faults with no clear link to onshore faults. As with subduction zone faults, these weaknesses in the oceanic crust are difficult to investigate in terms of return periods and size of past ruptures. Some of these sources have created damaging tsunami in historical times, in particular the two "tsunami earthquakes" (not strongly felt but capable of generating local tsunami) that occurred in Poverty Bay off the coast of Gisborne in 1947.

Landslide sources

New Zealand has a tsunami hazard from coastal, lacustrine (lakes) and submarine landslides. Research indicates that several landslides that have been triggered by earthquakes have resulted in significant tsunami. Landslide-triggered tsunami are most likely to be triggered by large earthquakes, and therefore some natural warning is likely. However, wave action or weather conditions can trigger coastal landslides and these events may occur with little warning.

Lacustrine landslide-triggered tsunami are possible in New Zealand, but have not been the subject of much research and effects are expected to be localised, similar to those from coastal landslides.

Submarine landslides, especially in sea floor canyons such as those in Cook Strait and off the coast of Kaikōura, can move large volumes of material and potentially generate very large, localised tsunami waves.

Volcanic sources

Mayor and White Island volcanoes represent potential local tsunami sources.

Mayor Island has produced both explosive and lava flow eruptions, and includes three phases of caldera collapse. The last caldera collapse, associated with the largest eruption, occurred 6,300 years ago (Houghton et al., 1992) and included the movement of rock and ash flows into the sea. This event is probably the only recorded instance of rock and ash flow entering the sea within the New Zealand region.

Numerical modelling of a credible 1km³ (“Mt. St Helens scale”) rock and ash flow from Mayor Island, that enters the sea, suggests that it would produce a 0.5m high tsunami on the adjacent coast around Whakatane (de Lange and Healy, 1986; de Lange, 1997).

The possibility of a significant tsunami generated from White Island is considered to be low (de Lange and Healy 1986; de Lange and Prasetya, 1997), not least because the most likely sector collapse direction is towards the east and any tsunami generated would be directed offshore.

Regional Sources, Region 2 – South-West Pacific

Earthquake sources

Regional sources for New Zealand include subduction zone interfaces along the Pacific “Ring of Fire” including the Tonga Trench, Vanuatu and the Loyalty Islands and the Macquarie Islands/Hjort Trench. In New Zealand’s historical record, the largest earthquakes along the arc between New Hebrides (Vanuatu), Kermadec Islands and Tonga have been less than magnitude 8.5. Only one of these is known to have caused run-ups in New Zealand approaching 1 metre.

To the south of New Zealand, only a few large earthquakes have occurred since the 1960s, when the installation of a worldwide seismic network allowed large earthquakes to be identified and located. The only three large earthquakes in the last 40 years had magnitudes between 7.8 and 8.4, and all were in areas of the plate boundary where earthquakes with horizontal (strike-slip) movement occur predominantly. These earthquakes do not usually generate large tsunami and none had run-up of more than 1 metre in New Zealand (along the south and west coasts of the South Island).

Regional-source tsunami earthquakes are considered problematic for tsunami warnings as they are not likely to be felt. Therefore natural warnings are not likely and the time for generating official warnings can be as little as one hour. These sources are monitored by the United States Geological Survey and via the PTWS.

Volcanic sources (Southern Kermadec arc)

There are 26 volcanoes (>10 km in diameter) along the active Taupo – Kermadec Arc that lie between 300 km and 1,000 km from mainland New Zealand. For these volcanoes there are three “scenarios” for the generation of possible regional tsunami:

- catastrophic submarine silicic eruption and caldera collapse
- large catastrophic sector collapse
- frequent small avalanches on edifice flanks.

No historical records exist of volcanic activity in the Kermadec chain producing tsunami in New Zealand or elsewhere. In general, the volumes of eruptions, associated caldera collapses and the scale of sector collapse features so far identified are significantly (at least an order of magnitude) smaller than has been proposed in the literature for damaging tsunami effects at distances of 1,000 km or so. Volcanic unrest in the Kermadec volcanoes leading to a major eruption is expected to have a long lead-time, therefore providing an extended period of preparation prior to any tsunami.

Distant Sources, Region 3

Earthquake source

Significant earthquakes (> magnitude 8.0) are the most frequently occurring source of damaging tsunami worldwide and 80% of these earthquakes occur around the margins of the Pacific Ocean. At many of the plate boundaries in the Pacific, one tectonic plate is subducting under (moving beneath) another tectonic plate. An example of this is the Tohoku (Japan) 2011 tsunami, where the Pacific plate subducts beneath northern Japan.

The potential of subduction zones to produce tsunami at the New Zealand coast has been assessed from the available data. This evaluation revealed that only sources in the circum-Pacific region (including New Zealand’s subduction zones and some offshore faults) are likely to generate tsunami with heights of greater than 2m. Tsunami have been recorded along the New Zealand coast from other sources (for example the 2004 Indian Ocean tsunami), but they are not expected to exceed 2m. New Zealand has experienced several damaging tsunami from subduction earthquakes in the Pacific, in particular from South America. Great earthquakes offshore of Peru and Chile are considered the most likely distant sources of damaging tsunami.

Volcanic source

Distant-source volcanoes are not considered to provide a significant tsunami threat to New Zealand, although smaller tsunami may reach our shores from such events. There is no historical record of significant tsunami because of distant-source volcanoes. The great 1883 eruption of Krakatau, Indonesia, produced huge local tsunami with some run-up heights exceeding 40m and tsunami waves did reach New Zealand.

Oscillations in New Zealand following the Krakatau eruption included 1.8m (measured peak to trough) waves at Whitianga and in the anchorage area at Auckland (although only 0.9-1.2m at the Auckland docks) (de Lange and Healy, 1986).

Meteorite source

As an island nation surrounded by a large deep sea, New Zealand has a tsunami hazard from the impacts of meteorites. This hazard is real, finite and determinable, but the probability of a damaging tsunami from these sources is low. Numerical estimates of the frequency of impact of a meteorite of sufficient size within a distance range of New Zealand, that could cause a damaging tsunami, appear to have a recurrence interval greater than 2,500 years. While most impacts occur as distant sources of tsunami to New Zealand, they may also occur at regional or local distances.

Appendix C Glossary

The following terms and abbreviations are frequently used in relation to tsunamis. Some but not all of these terms are used in this Plan, they may occur in tsunami notifications and discussions.

Amplitude	The absolute difference in value, between a particular crest or trough of a wave and the undisturbed sea level at the time. In the context of threat levels as amplitude relates to the wave at the shoreline.
Arrival time	The time of the arrival of the first tsunami wave.
Bathymetry	The science of measuring the depths of oceans, seas, etc. and the topographic maps of the sea floor resulting from such measurements.
Crest	The highest part of a wave.
Distant-source tsunami	A tsunami originating from a remote source, generally more than 3 hours travel time from a given coastal location. For the purpose of this Plan, more than 3 hours travel time to the nearest New Zealand coastline.
EMA	Emergency Mobile Alert (system), or an alert sent via EMA.
Estimated time of arrival (ETA)	The time of the first tsunami wave arrival at a fixed location, estimated through modelling the speed and refraction of the tsunami waves as they travel from the source. Accuracy depends on precision of source location, earthquake magnitude and bathymetry data.
GeoNet	The GeoNet Programme is hosted by GNS Science and funded by a stakeholder group who include: EQC, MBIE, LINZ and GNS Science. The Programme delivers information and advice on tsunami hazards to NEMA; this is typically via the NGMC. (See section 2.2 GNS Science and GeoNet on page 3.)
GNS Science	GNS Science is the host organisation for the GeoNet Programme and the NGMC, staff in the wider organisation provide expert science inputs, response advice and professional support into the delivery of the GeoNet Programme. (See section 2.2 GNS Science and GeoNet on page 3.)
Inundation	Tsunami inundation refers to the distance inland that a tsunami wave travels - this varies for different coasts or harbours affected by a tsunami.
Leading wave	The first arriving wave of a tsunami. In some cases, the leading wave produces an initial depression or drop in sea level. In other cases, an elevation or rise in sea level, due to either the trough or the crest of the wave reaching the shore first. When the trough arrives first, sea level recession is observed.

Local-source tsunami	A tsunami originating from a source within less than 1 hour travel time from a given coastal location. For the purpose of this Plan, local source means less than 1 hour travel time to the nearest New Zealand coastline, noting that travel times may be less than 30 minutes and as short as a few minutes.
Mean sea level	The average height of the sea surface, based upon observation of tide heights over a considerable period of time (years). Typically, it can be seen as the halfway point between the mean high tide and the mean low tide. Mean sea level varies from location to location; thirteen primary mean sea level vertical datums are used in New Zealand.
NGMC	National Geohazards Monitoring Centre located at GNS Science in Avalon. Staffed 24/7 by Geohazards Analysts and supported by on-call duty roster of peril scientists, PIM and application support.
NWS	National Warning System
PTWC	Pacific Tsunami Warning Center (see section 2.3 Pacific Tsunami Warning Center (PTWC) on page 4).
PTWS	Pacific Tsunami Warning System (see section 2.3 Pacific Tsunami Warning Center (PTWC) on page 4).
Regional-source tsunami	A tsunami originating from a source 1-3 hours travel time from the nearest New Zealand coastline.
Run-up height	The vertical height (elevation) that the tsunami reaches on land above the normal sea level status at the time. This can be up to double the wave height at shore on steep coastal land.
Sea level	The height of the sea at a given time measured relative to some datum such as mean sea level.
Seiche	A wave or waves oscillating in a partially or fully enclosed body of water.
Tidal wave	The wave motion of the tides. Often incorrectly used to describe a tsunami, storm surge, or other unusually high and therefore destructive water levels along a shore that are unrelated to the tides.
Travel time	The time required for the first tsunami wave to propagate from its source to a given point on a coastline.
Travel time map	A map showing isochrones or lines of equal tsunami travel time calculated from the source outwards toward points on coastlines.
Trough	The lowest part of a wave.
Tsunami	Japanese term meaning wave (“nami”) in a harbour (“tsu”). A natural phenomenon consisting of a series of waves generated when a large volume of water in the sea or in a lake is rapidly displaced.

Tsunamigenic	Capable of generating a tsunami. For instance, a tsunamigenic earthquake, tsunamigenic landslide.
Tsunami period	Tsunami can have wavelengths ranging from 10 to 500 km and wave periods of up to an hour. The period is the time it takes for successive wave crests to pass a given location.
Tsunami source	The origin of a tsunami, for example, earthquake, volcanic activity or landslide causing large, rapid displacement of water that initiates tsunami waves.
Tsunami wave	Tsunami waves differ from ordinary coastal waves. Coastal waves are associated with atmospheric pressure and move only the surface of the water. Tsunami waves move the entire column of water from the ocean floor to the surface. They have periods (see 'Tsunami period') that may range from a few minutes to an hour or more and wavelengths (see 'Wave length') that can span up to several hundred kilometres. Tsunami waves therefore contain significantly more energy than coastal waves. In the deep and open ocean, they can travel at speeds of 500 to 1,000 km per hour, while they also create other phenomena not characteristic of ordinary waves such as strong currents.
Water level (maximum)	The difference between the elevation of the highest local watermark and the elevation of the sea level at the time of the tsunami. This is different from maximum run-up because the watermark is often not observed at the inundation line, but may be halfway up the side of a building or a tree trunk.
Wave length	The horizontal distance between similar points on two successive waves measured perpendicular to the crest. For tsunami generated by earthquakes, the typical wavelength ranges from 20 to 300km. For tsunami generated by landslides, the wavelength is considerably shorter, ranging from hundreds of metres to tens of kilometres.
Wave height	The vertical trough-to-crest height of a wave. Tsunami wave height is not constant - it increases substantially as the wave approaches the shore, depending on the near-shore topography. In the deep ocean, the height of the waves is generally less than a metre even for the most destructive tsunami, and the waves easily pass ships unnoticed.