Christchurch City Council
ATTACHMENTS - UNDER SEPARATE COVER

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CHRISTCHURCH AND BANKS PENINSULA TSUNAMI ALERTING SYSTEM REVIEW SUPPORTING PAPER

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Christchurch City Council
Civil Defence Emergency Management

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Executive Summary

The purpose of this report is to conduct a review of the current tsunami alerting methods and to recommend options for the future of tsunami alerting in Christchurch and Banks Peninsula. The recommended option would contribute to the public receiving timely and accurate tsunami alerts in line with national standards and international best practice.

Multi-modal alerting systems use primary notification methods that are reinforced by a number of secondary notification methods. Utilising numerous methods in a multi-modal approach has the potential to provide more thorough warning communication. Christchurch City Council use a range of methods to communicate tsunami alerts to the public. The main tsunami alerting methods used include Public Address (PA) sirens, Emergency Mobile Alerts (EMAs), television, radio, websites, and social media. Although a multi-modal approach for tsunami alerting is used, the current system is over-complicated and will benefit from being simplified. There are therefore opportunities for improving the tsunami alerting system in Christchurch and Banks Peninsula.

This review recommends that the best approach for the tsunami alerting system in Christchurch and Banks Peninsula is the use of EMAs as the primary tsunami alerting method, with PA sirens, television and radio, as well as websites and social media being used as secondary tsunami alerting methods. The multi-modal tsunami alerting system can be supported by education programmes, with any changes to the methods used for tsunami alerting being clearly communicated to the public to improve community resilience.

The recommendations put forward in this review aim to simplify the multi-modal tsunami alerting system, improve usability for Christchurch Civil Defence Emergency Management (CDEM), ensure value for money, and improve understandability for the public. The main concern within the tsunami alerting system is the fragile and outdated siren network that is not considered fit for purpose. Three options are presented in this report for the future of tsunami alerting in Christchurch and Banks Peninsula:

1. Rationalise and update the tsunami siren network.
2. Decommission the tsunami siren network.
3. Replace and expand the tsunami siren network.

Rationalising and updating the siren network is put forward as the recommended option in this report.

This report was prepared by Rachel Hunt, Community Resilience Coordinator for Christchurch CDEM who holds an Environmental Science PhD on New Zealand's tsunami warning system.

1. Background

New Zealand faces numerous tsunami risks, these hazards can arrive at the country's coastlines in under an hour to over 15 hours depending on the location of tsunami generation. Different regions within New Zealand use multiple methods for communicating tsunami warnings to the public, however there is no national consistency to the different methods used. The recommended option would contribute to the public receiving timely and accurate tsunami alerts in line with national standards and international best practice.

1.1 Report Purpose

The purpose of this report is to:

1. Conduct a review of the tsunami alerting methods currently used in Christchurch and Banks Peninsula (see Section 2).
2. Recommend options for the future of tsunami alerting in Christchurch and Banks Peninsula (see Sections 3 and 4).

1.2 Tsunami Hazards

A tsunami can be defined as the sudden mass displacement of water. These hazards are most commonly generated by earthquakes but can also be generated by landslides or volcanoes. New Zealand is exposed to distal, regional, and local source tsunami hazards (De Lange and Healy, 1986; New Zealand Government, 2007; NEMA, 2020a; NEMA, 2023a).

Distal source tsunami hazards take more than three hours to arrive at the nearest New Zealand coastline, originating from sources around the Pacific Ocean such as the west coast of South America. Regional source tsunami hazards take between one and three hours to arrive at the nearest New Zealand coastline, originating from sources in the southwest Pacific such as the Kermadec Trench. Local source tsunami hazards take less than one hour to arrive at the nearest New Zealand coastline, originating from sources on New Zealand's continental shelf such as the Hikurangi and Puysegur Trenches.

The approaches used to manage tsunami hazards differ based on the source location of the generating earthquake, landslide, or volcano. Official warnings can be communicated for distal source and some regional source tsunami hazards, whereas public education is used for natural warning signs of local source tsunami hazards (New Zealand Government, 2007; NEMA 2020b).

Christchurch and Banks Peninsula face more risk from distal source tsunami hazards due to the lack of island groups in the south Pacific acting as obstacles to tsunami waves generated from the west coast of South America (De Lange and Healy, 1986). Whereas Christchurch and Banks Peninsula face less risk from local source tsunami hazards due to the distance from the Hikurangi and Puysegur Trenches. Tsunami hazards generated from these trenches are unlikely to arrive at the Christchurch and Banks Peninsula coastlines within one hour, classifying these hazards as regional source for the Territorial Authority (TA). Christchurch and Banks Peninsula therefore face more risk from distal and regional source tsunami hazards, with local source tsunami hazards posing less risk.

1.3 Current Situation

The tsunami alerting methods used by Christchurch City Council have varied over time, however the current tsunami alerting system for Christchurch and Banks Peninsula is over-complicated. The recommendations put forward in this review aim to simplify this system, improve usability for Christchurch CDEM, ensure value for money, and improve understandability for the public.

Christchurch City Council use a range of methods to communicate tsunami alerts to the public in Christchurch and Banks Peninsula including PA sirens, EMAs, television, radio, websites, and social media. Christchurch has a fragile and outdated siren network in place that is not considered fit for purpose. There are therefore opportunities for improving the tsunami alerting system in Christchurch and Banks Peninsula.

The numerous alerting methods are managed at different levels of the Civil Defence system. EMAs are provided at the national level through the National Emergency Management Agency (NEMA), CDEM Groups can also issue these alerts at the regional level. Memorandums of Understanding (MoUs) with television and radio broadcasters are nationally developed. Whereas Christchurch City Council are responsible for the funding, installation, maintenance, testing, and replacement of PA sirens at the local level.

Regional alerting system reviews have been carried out for numerous hazards in the Bay of Plenty (Leonard et al., 2017) and Hawke’s Bay (Tan et al., 2021), as well as for tsunami hazards in Auckland (Beswick et al., 2023). These reports informed this review of the local alerting system for tsunami hazards in Christchurch and Banks Peninsula. These regional and local reviews assist in the move towards nationally consistent hazard alerting in New Zealand.

1.4 Multi-modal Alerting Systems

The United Nations Sendai Framework for Disaster Risk Reduction encourages the use of multiple channels for communicating warnings to the public (UNDRR, 2015). Multi-modal alerting systems use primary notification methods that are reinforced by a number of secondary notification methods. Utilising numerous methods in a multi-modal approach has the potential to provide more thorough warning communication, as one form of communication may fail or not reach all of the people exposed to the hazard (MCDEM, 2008).

The public may be hesitant to react to just one form of warning communication due to the potential for false alarms and may want to confirm the alert through other sources. The use of multiple methods for communicating tsunami warnings to the public can help to ensure coverage and overcome the limitations associated with each individual method within multi-modal systems (MCDEM, 2009, 2014).

2. Current Tsunami Alerting Methods

Christchurch City Council uses a range of methods to communicate tsunami alerts to the public in Christchurch and Banks Peninsula. The main tsunami alerting methods used within the TA include PA sirens, EMAs, television, radio, websites, and social media. These alerting methods are managed at national, regional, and local Civil Defence levels and are supported by public education.

Although Christchurch City Council use a multi-modal approach for tsunami alerting, the current system is over-complicated, and the public will benefit from the system being simplified. The main concern within this current system is the fragile and outdated siren network that is not considered fit for purpose and incurs substantial implementation and maintenance costs to Christchurch City Council. The proposed implementation and maintenance costs of the tsunami siren network are summarised in Appendix A. The costs outlined in Appendix A are estimates only.

2.1 Public Address (PA) Sirens

Christchurch has a network of 45 tsunami sirens installed from Brooklands to Taylors Mistake (Christchurch CDEM, 2021a, 2021b), these PA capable sirens sound pre-recorded voice messages (MCDEM, 2014). The siren network was installed in two stages, the first stage consisted of 22 sirens in 2012, and the second stage consisted of 23 sirens in 2015 (Christchurch CDEM, 2021b). The sirens have a design life of 15 years, the two stages of sirens will therefore need to be replaced in 2027 and 2030. Christchurch City Council are responsible for the funding, installation, maintenance, testing, and replacement of these PA sirens at the local level.

The current sirens are established on aging technology and infrastructure known as the Supervisory Control and Data Acquisition (SCADA) network. The control equipment for this network is located at the Citycare Wastewater Treatment Plant in Bromley and is integrated into their SCADA network (Christchurch CDEM, 2021b). The future ownership of this network is uncertain.

The SCADA network for the tsunami sirens relies on a contractor, a small family-owned business in Auckland to operate. There is a quarterly maintenance agreement in place with the contractor, but there is no operating contract in place.

The contractor has stated that they cannot resupply the current sirens, these can only be purchased through a custom bulk order from an offshore supplier (Beswick-Ngawaka et al., 2023). The contractor has also stated that siren maintenance services will be scaled down from December 2023, an alternative contractor would therefore be required to maintain the current network from 2024 onwards (Beswick-Ngawaka et al., 2023).

The annual cost of battery recharging for the current network of 45 tsunami sirens is $45,000, equivalent to $1,000 per siren per year. The tsunami siren network incurs substantial implementation and maintenance costs to Christchurch City Council.

In September 2023, an outage occurred where the contractor could not access the SCADA network. As a result, the contractor would not have been able to activate the tsunami sirens for Christchurch CDEM if they had been needed.

During this outage, a magnitude 6.9 earthquake in the Kermadec Islands was assessed by NEMA for tsunami risk to New Zealand. It was determined that there was no risk, but had this earthquake been tsunamigenic, there would have been no ability to activate the tsunami sirens. The delay in informing Christchurch CDEM of this outage would have led to efforts being focussed on an inoperable warning method with the potential to waste valuable response time. This outage highlights one of the fragilities of the siren network.

In August 2021, a proposal was made to expand the tsunami siren network by installing additional sirens in Christchurch and Banks Peninsula (Christchurch CDEM, 2021a). This proposal included installing 22 sirens within the orange and yellow tsunami evacuation zones in Christchurch as well as 19 sirens within the red and orange tsunami evacuation zones on Banks Peninsula (Christchurch CDEM, 2021a). The 2021 proposed siren expansion for Christchurch and Banks Peninsula can be seen in Appendix B.

In order to mitigate the fragility of any additional or replacement sirens, the SCADA contractor would need to rapidly inform Christchurch CDEM of any potential or existing outages affecting the tsunami sirens, the ability for the SCADA network to be operated from within Christchurch would need to be established, or the tsunami sirens would need to be moved to a new independent system that would be capable of being activated from within Christchurch when authorised by the Christchurch CDEM Controller.

NEMA does not support the use of sirens for local source tsunami hazards (MCDEM, 2014). GNS Science and New Zealand's Tsunami Working Group (TWG) agree with NEMA that sirens are not suitable for local source tsunami warnings (WREMO, 2023). The Public Alerting Options Assessment compiled in 2009 by the Ministry of Civil Defence and Emergency Management (MCDEM), now NEMA, states that the numerous limitations associated with sirens can substantially impact the effectiveness of this method for public alerting (MCDEM, 2009).

Siren deficiencies include technological failures as damage can be sustained or power can be cut to sirens during locally generated earthquakes, making them inoperable, and sirens may be inaudible in windy conditions (MCDEM, 2014; WREMO, 2023). A number of international events such as the Tōhoku, Great East Japan tsunami of March 2011 have revealed these deficiencies in siren networks. Many sirens were damaged and power to the sirens was cut during the earthquake, resulting in 17 of the 27 municipalities that were affected by the tsunami reporting that their siren networks could not be used during the emergency (Hasegawa, 2013).

Warnings from sirens can cause confusion and can be mistaken for different hazards, such as fire or flooding, due to the use of multi-purpose sirens in New Zealand (MCDEM, 2009; WREMO, 2023). The multi-purpose siren network in Maui, Hawaii was not activated during the wildfires of August 2023. These sirens are primarily used to warn for approaching tsunami hazards, it was therefore thought that the public would respond to the alert by evacuating to high ground, resulting in people moving towards areas with greater fire risks (Forbes, 2023).

Sirens can create a false sense of security, with communities waiting for official warnings that may not be issued in time during local and some regional source tsunami events (MCDEM, 2014). The use of sirens can distract from public education messages around responding to natural tsunami warning signs, with the public instead waiting for official warnings to be issued (MCDEM, 2014; WREMO, 2023).

Individuals, households, and communities experience a seven-step process when receiving and reacting to warnings (Mileti and Sorensen, 1990). These seven steps are:

1. Hearing
2. Understanding
3. Believing
4. Personalising
5. Deciding
6. Responding
7. Confirming

These steps are influenced by the agencies issuing the warnings, the methods used to communicate the warnings, as well as the people receiving the warnings (Mileti and Sorensen, 1990). The use of PA sirens principally meets the first and sometimes second of these steps, whereas the use of EMAs can help communities to progress through all seven of the steps.

2.2 Emergency Mobile Alerts (EMAs)

EMAs were first introduced in New Zealand in 2017. EMAs override targeted mobile phones, sound a loud and distinctive tone, and provide specific information and instructions on the actions to take during emergencies (NEMA, 2020a; 2020b; NEMA, 2023b). These details include the source the message is issued from, information on the hazard and likely impacts, guidance on how to respond, the locations likely to be affected, the time frame of the event, as well as a link to further information (Potter, 2021).

EMAs are issued at the national level by NEMA, regional CDEM Groups are also able to issue EMAs (NEMA, 2020a; 2020b; New Zealand Government, 2015). These alerts are received by mobile phones at no cost to local authorities and contain more information than siren alerts which require the public to seek further information (Mileti and Sorensen, 1990; MCDEM, 2014). The use of EMAs incurs no implementation or maintenance costs to Christchurch City Council.

The upgrades to mobile coverage in recent years have resulted in the improved efficacy of EMAs as a primary warning method for tsunami hazards in New Zealand. Approximately 97% of inhabited areas in New Zealand have sufficient network coverage to receive EMAs (MCDEM, 2009; NEMA, 2020b). Coverage maps for the three main mobile network providers in New Zealand, namely 2degrees, Spark, and One NZ, can be viewed on their websites through the following links.

- 2degrees: https://www.2degrees.nz/coverage
- Spark: https://www.spark.co.nz/shop/mobile/network
- One NZ: https://one.nz/network/coverage/

Official warnings can be classed as having effective coverage when these are received by two thirds of the population at risk (Mileti and Sorensen, 1990), informal warnings can then be passed on by those who received the official warnings. An independent disaster preparedness survey conducted in 2021 found that 91% of New Zealanders successfully received the test EMA alert or were near someone else who received the alert (Kantar Public, 2021). This is a significant increase from the results of two independent surveys conducted following the nationwide EMA tests in 2017 and 2018 where it was found that 49% and 69% of New Zealanders successfully received the test alert or were near someone else who received the alert (Colmar Brunton, 2018). The results of these surveys highlight the improvements to EMA coverage since 2017. The independent survey conducted following the nationwide EMA test in 2018 found that 75% of New Zealanders believe EMAs to be an effective alerting method in emergencies (Colmar Brunton, 2018).

NEMA are developing the capability of Low Earth Orbit (LEO) satellite connectivity for issuing EMAs, this service is currently in the experimental phase (Scott, 2023). The use of LEO satellites will further improve the resiliency of EMAs by supporting the delivery of these alerts in situations where mobile networks are unavailable (Scott, 2023). LEO satellites will increase the coverage of EMAs, as members of the public in areas beyond the reach of mobile coverage will still be able to receive EMAs by satellite (Scott, 2023).

2.3 Television and Radio

In 2017, NEMA developed MoUs with New Zealand television and radio broadcasters to outline the responsibilities of these organisations during emergencies. These MoUs state that publicly owned and commercial media are considered lifeline utilities for broadcasting official tsunami warnings to the public (MCDEM, 2017a, 2017b).

Television and radio broadcast support must be provided before and during emergency situations when requested by NEMA at the national level and by CDEM Groups at the regional level. These broadcasts have to be presented in the format specified by these agencies and must refrain from conflicting with or exaggerating the official warning information (MCDEM, 2017a, 2017b). Radio stations in Christchurch that are mandated to broadcast tsunami warning information include Newstalk ZB, More FM, The Hits, Radio New Zealand (RNZ) National, Plains FM, Magic, and the Breeze (Christchurch City Council, 2023a).

NEMA created a guide for the New Zealand media in September 2020 as an aid for television and radio broadcasters to refer to when issuing tsunami warnings, aiming to improve the consistency of the messages that are sent out (NEMA, 2020b). This guide includes information on tsunami generation, source locations, monitoring and detecting tsunami hazards, official warnings, education campaigns, issuing EMAs, as well as the different roles of the numerous agencies involved in responding to tsunami hazards (NEMA, 2020b).

2.4 Websites and Social Media

Agencies can display tsunami warnings and all-clear alerts on their websites as well as on their social media accounts, these pages can be updated as emergencies develop. The appearance of websites can be changed during emergencies to draw attention to the risk, with the homepages displaying information about the current hazard in a distinct colour scheme. Christchurch City Council display information during emergencies on their website and through their online news channel, Newsline (Christchurch City Council, 2023a).

Websites can contain resources for public education such as information on tsunami hazards and evacuation zone maps. Online tsunami resources can be accessed at the local level on the Christchurch City Council website (Christchurch City Council, 2023b), at the regional level on the Canterbury CDEM Group website (Canterbury CDEM Group, 2023), and at the national level on the Get Ready website (Get Ready, 2023).

2.5 Public Education

The range of methods used by Christchurch City Council to communicate tsunami alerts to the public in Christchurch and Banks Peninsula can be reinforced by public education. Education campaigns can be used to improve public awareness of the changes to, and limitations of, the tsunami alerting system as well as the importance of observing and responding to natural tsunami warning signs, improving community resilience. Although official warnings can be communicated for distal source and some regional source tsunami hazards, public education is used for natural warning signs of local source tsunami hazards (New Zealand Government, 2007; NEMA 2020b).

The Long or Strong, Get Gone campaign describes the actions to be carried out during a local tsunami. This education campaign states that if a coastal earthquake lasts longer than a minute or the shaking makes it difficult to stand up, the public should not wait for an official warning and should get further inland or go to high ground immediately (NEMA, 2020a, 2020b). The self-evacuation encouraged by the Long or Strong, Get Gone campaign also applies to observing sudden changes in sea level or hearing unusual noises from the sea (NEMA, 2020a).

However, Christchurch and Banks Peninsula may be too far away from local tsunami sources to feel the generating earthquake, meaning that the Long or Strong, Get Gone campaign may not be as relevant to the TA as to other areas of New Zealand that have a higher risk of local source tsunami hazards.

3. Future of Tsunami Alerting Methods

Conducting regional and local reviews of tsunami alerting systems assists in reducing complexity within these systems as well as in moving towards nationally consistent hazard alerting in New Zealand. This review was informed by the multi-hazard regional alerting system reviews for the Bay of Plenty (Leonard et al., 2017) and Hawke's Bay (Tan et al., 2021), as well as the tsunami hazard regional alerting system review for Auckland (Beswick et al., 2023).

Leonard et al. (2017) and Tan et al. (2021) recommended the use of EMAs and mobile apps as primary methods of notification in the Bay of Plenty and Hawke's Bay regions. It was recommended that these primary notification methods be infilled by messages through websites and social media as well as PA sirens in areas with poor mobile coverage or where the public may not hear mobile alerts.

Following the May 2023 options analysis report (Beswick et al., 2023), in September 2023 the Auckland CDEM Committee made the decision to decommission 42 of the 44 sirens in Auckland's tsunami siren network (Beswick-Ngawaka et al., 2023). This decommissioning will be carried out alongside a communication plan to reduce public anxiety and confusion around the removal of the sirens and to increase awareness of the range of other alerting methods used.

This review of the local alerting system for tsunami hazards in Christchurch and Banks Peninsula has revealed concerns around the fragile and outdated siren network as well as the improved efficacy of EMAs as a primary warning method in New Zealand. As a result, it would not be viable to expand the tsunami siren network by installing additional sirens in Christchurch and Banks Peninsula, as originally put forward in the August 2021 proposal (Christchurch CDEM, 2021a).

The tsunami alerting system will be improved by aligning with the positions of NEMA, GNS Science, New Zealand's TWG, and the 2023 decision of the Auckland CDEM Committee in not relying on the use of sirens (MCDEM, 2014; Beswick-Ngawaka et al., 2023; WREMO, 2023), and instead using sirens only as a secondary method of tsunami alerting as recommended in the Bay of Plenty and Hawke's Bay regional alerting system reviews (Leonard et al., 2017; Tan et al., 2021).

3.1 Primary Tsunami Alerting Method

Primary methods for tsunami alerting constitute the backbone of multi-modal alerting systems and are reinforced by numerous secondary tsunami alerting methods. This review finds that EMAs should be used as the primary notification method for tsunami hazards in Christchurch and Banks Peninsula.

EMAs can provide detailed information on hazards and how to respond (Potter, 2021), whilst improved mobile coverage means that these alerts can be received in more areas (MCDEM, 2009; NEMA, 2020b). EMAs are seen by the public as an effective alerting method (Colmar Brunton, 2018), and Christchurch City Council incurs no implementation or maintenance costs by using EMAs.

3.2 Secondary Tsunami Alerting Methods

Primary tsunami notification methods are reinforced by a number of secondary notification methods to infill multi-modal alerting systems. This review finds that PA sirens, television and radio, as well as websites and social media should be used as the secondary alerting methods for tsunami hazards in Christchurch and Banks Peninsula.

The tsunami sirens are not currently considered to be fit for purpose due to relying on the SCADA network that cannot be operated locally. Christchurch City Council incurs substantial implementation and maintenance costs from the funding, installation, testing, and replacement of the siren network. Sirens can create a false sense of security, undermine education programmes for self-evacuation, and may not be audible in windy conditions (MCDEM, 2014; WREMO, 2023).

Developments to EMAs have resulted in PA sirens no longer being seen as a primary alerting method for tsunami hazards. Rationalising the network of 45 sirens along the Christchurch coastline down to several updated sirens located in areas identified as needing additional communication channels to infill as secondary alerting methods would be a more appropriate use of this technology. These areas could include popular swimming and surfing beaches where there is likely to be a significant number of people in the water without access to mobile phones.

Television and radio as well as websites and social media are also suitable secondary notification methods for tsunami hazards. The MoUs developed with television and radio broadcasters (MCDEM, 2017a, 2017b), and the ability to update official websites and social media pages with warning information can be used to support the alerts received through EMAs.

3.3 Additional Considerations

Primary and secondary tsunami alerting methods within Christchurch and Banks Peninsula's multi-modal tsunami alerting system can be supported by public education. These education programmes can be used to mitigate over-reliance on official warnings, improve the understanding of natural warning signs for tsunami hazards, and clarify any changes made to the tsunami alerting system, improving community resilience.

The multi-hazard regional alerting system reviews for the Bay of Plenty and Hawke's Bay emphasise the importance of public education to strengthen self-evacuation when natural hazard warning signs are observed (Leonard et al., 2017; Tan et al., 2021). The tsunami hazard regional alerting system review for Auckland highlights that any changes to tsunami alerting systems can be underpinned by education schemes to raise public awareness (Beswick et al., 2023; Beswick-Ngawaka et al., 2023).

4. Recommendations

The current tsunami alerting system for Christchurch and Banks Peninsula will benefit from being simplified to reduce the complications associated with the multi-modal approach. This review recommends that the best approach for the tsunami alerting system in Christchurch and Banks Peninsula is the use of EMAs as the primary tsunami alerting method, with PA sirens, television and radio, as well as websites and social media being used as secondary tsunami alerting methods. The multi-modal tsunami alerting system can be supported by education programmes, with any changes to the methods used for tsunami alerting being clearly communicated to the public. This review therefore agrees with many of the recommendations and decisions outlined in the reviews conducted for the Bay of Plenty, Hawke's Bay, and Auckland (Leonard et al., 2017; Tan et al., 2021; Beswick et al., 2023; Beswick-Ngawaka et al., 2023).

The multi-modal approach, with a focus on EMAs, is recommended to deliver maximum coverage and cost effectiveness for tsunami warnings in Christchurch and Banks Peninsula. It is therefore no longer seen as viable to expand the tsunami siren network as put forward in the August 2021 proposal (Christchurch CDEM, 2021a), however PA sirens can be used as a secondary alerting method in areas where EMAs may not be received.

Three options of rationalising and updating, decommissioning, or replacing and expanding the tsunami siren network are presented below. Rationalising and updating the tsunami siren network is the recommended option. The three options for the future of tsunami alerting in Christchurch and Banks Peninsula are summarised in Appendix C. The costs outlined below, and in Appendices A and C, are estimates only.

4.1 Option 1: Rationalise and Update the Tsunami Siren Network

Rationalising and updating the tsunami siren network involves removing the majority of the current 45 sirens installed from Brooklands to Taylors Mistake and installing several new sirens in areas identified as needing additional communication channels to infill the primary alerting method. Community education and resilience programmes would be carried out to improve public awareness and understanding of the changes to the tsunami siren network.

This is the recommended option. The estimated implementation cost of this option is $2,667,247.

4.2 Option 2: Decommission the Tsunami Siren Network

Decommissioning the tsunami siren network involves disconnecting and disposing of the current 45 sirens installed from Brooklands to Taylors Mistake. Community education and resilience programmes would be carried out to improve public awareness and understanding of the changes to the tsunami siren network.

The estimated implementation cost of this option is $408,480.

4.3 Option 3: Replace and Expand the Tsunami Siren Network

Replacing and expanding the tsunami siren network involves replacing the current 45 sirens installed from Brooklands to Taylors Mistake when they reach the end of their design lives in 2027 and 2030 and installing an additional 41 sirens in Christchurch and Banks Peninsula, as put forward in the original proposal in August 2021 (Christchurch CDEM, 2021a). Community education and resilience programmes would be carried out to improve public awareness and understanding of the changes to the tsunami siren network.

The estimated implementation cost of this option is $9,274,775.

Acknowledgements

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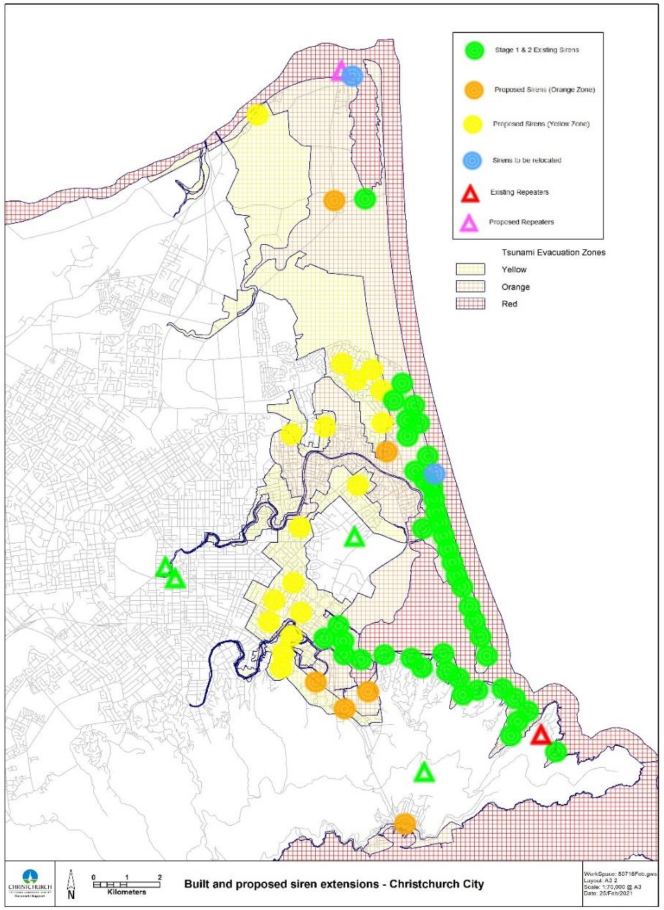
Appendices

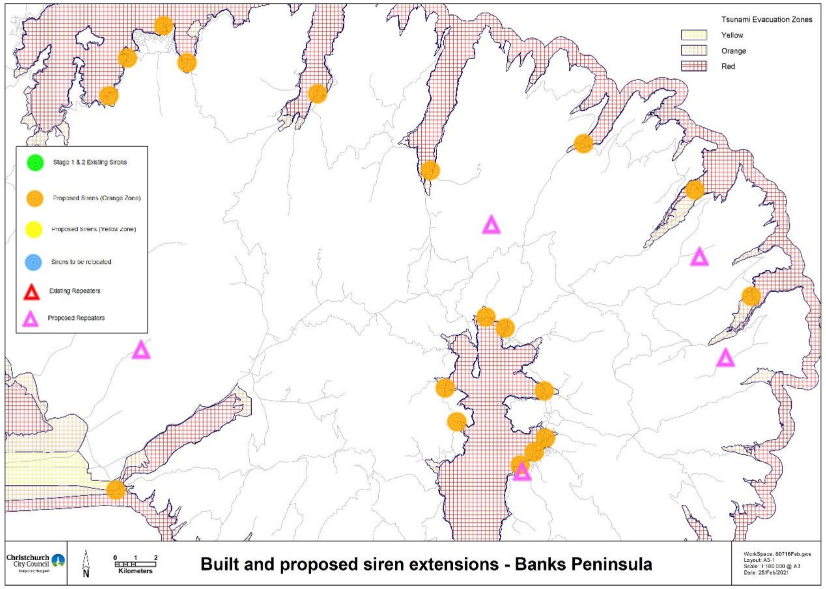
Appendix A: Proposed Implementation and Maintenance Costs of the Tsunami Siren Network

	Estimated Implementation Cost	Description
Proposed Costs	$2,667,247	Option 1: Budget needed to rationalise and update the tsunami siren network. This is the recommended option.
	$408,480	Option 2: Budget needed to decommission the tsunami siren network.
	$9,274,775	Option 3: Budget needed to replace and expand the tsunami siren network.

	Estimated Maintenance Cost	Description
Proposed Costs	$70,000	Option 1: Recurring annual cost for maintenance and testing of the rationalised and updated tsunami siren network. This is the recommended option.
	$0	Option 2: No recurring annual cost for maintenance and testing of the decommissioned tsunami siren network.
	$536,000	Option 3: Recurring annual cost for maintenance and testing of the replaced and expanded tsunami siren network.

Appendix B: 2021 Proposed Siren Expansion for Christchurch and Banks Peninsula





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Appendix C: Options for the Future of Tsunami Alerting in Christchurch and Banks Peninsula

Option	Description	Estimated Cost	Advantages	Disadvantages
1	Rationalise and update the tsunami siren network. This is the recommended option.	$2,667,247	• Sirens no longer used as a primary tsunami alerting method. • Move towards national consistency for tsunami alerting in New Zealand. • Local consistency in alerting methods used in both Christchurch and Banks Peninsula. • Move away from current fragile and outdated system to new fit for purpose technology and infrastructure. • Move away from current contractor to a new independent system that can be operated locally from Christchurch. • Reduced recurring annual maintenance and testing costs. • Presents an opportunity for community education and resilience programmes to improve public awareness and understanding.	• Immediate action and associated implementation costs required, sufficient budget is available. • Second most expensive option.

2	Decommission the tsunami siren network.	$408,480	• Sirens no longer used as a primary tsunami alerting method. • Move towards national consistency for tsunami alerting in New Zealand. • Local consistency in alerting methods used in both Christchurch and Banks Peninsula. • Move away from current fragile and outdated system. • No recurring annual maintenance and testing costs. • Least expensive option. • Presents an opportunity for community education and resilience programmes to improve public awareness and understanding.	• Loss of sirens as a secondary tsunami alerting method. • Immediate action and associated implementation costs required, sufficient budget is available.
3	Replace and expand the tsunami siren network.	$9,274,775	• Local consistency in alerting methods used in both Christchurch and Banks Peninsula. • Presents an opportunity for community education and resilience programmes to improve public awareness and understanding.	• Continued use of sirens as a primary tsunami alerting method. • Does not move towards national consistency for tsunami alerting in New Zealand. • Current siren network is fragile, outdated, and not considered fit for purpose, established on aging technology and infrastructure.

				• Current siren network cannot be operated locally, relies on contractor in Auckland to operate, no operating contract in place with this contractor. • Current sirens cannot be resupplied by the contractor and can only be purchased through a custom bulk order from an offshore supplier. • Siren maintenance services from the current contractor will be scaled down from December 2023, an alternative contractor will be required to maintain the siren network from 2024 onwards. • Immediate action and associated implementation costs required, sufficient budget is available. • Recurring annual maintenance and testing costs, maintenance costs likely to increase over time for unscheduled repairs to the aging network. • Most expensive option.

Memos

Christchurch City Council

Memo

Date: 6 July 2023
From: Brenden Winder. Manager Civil Defence Emergency Management
To: All Councillors and Community Board Members
Cc: Mary Richardson. General Manager Citizens and Community
Reference: 23/1056846

Tsunami Warning System Update

1. Purpose of this Memo

1.1 The purpose of this Memo is to inform Councillors and Community Board members of a review of options regarding our Tsunami Early Warning System.

1.2 The review is underway; options for consideration are anticipated by December 2023.

1.3 Should an alternative option to the installation of fixed siren arrays be considered to provide a better outcome for Council and residents, staff will provide information to Council. Should no alternative be deemed better, staff will continue to implement the Council resolution to install a fixed siren array.

1.4 The information in this memo is not confidential and can be made public.

2. Update

2.1 A fixed siren array system is currently in place to alert low-lying coastal residents of a tsunami threat. The sirens provide coverage to the Eastern suburbs of Christchurch.

2.2 On 12 August 2021 Council resolved (CNCL/2021/00138):

That the Council:

1. *Agrees, in principle, to extend the Tsunami Warning System to reflect the updated tsunami evacuation zones (updated 2019/2020) noting that funding has been approved as part of the adopted 2021/31 Long Term Plan.*
2. *Agrees for staff to commence Initiation Phase of extending the Tsunami Warning System given finance has been allocated through the 2021/31 Long Term plan.*

2.3 Through the Long Term Plan 2021-31, $3M is on budget for the above resolution.

2.4 Since the staff report and Council decision in 2021, advances in early warning technology and best practice have made other alerting options more viable.

2.5 As such, staff are undertaking a scientific report to review the optimum configuration of our tsunami alerting system - prior to installing any further sirens.

2.6 The report will use a similar methodology to that undertaken by Leonard *et al.* (2017) and Tan *et al.* (2021) for the Bay of Plenty and Hawke's Bay (attached).

2.7 Specifically, the report will consider a mix of Emergency Mobile Alert (EMAs – alerts sent directly to compatible mobile phones, using the National Warning System protocols) and secondary sources of notification such as mainstream media, social media, local radio, television, mobile phone applications and sirens as alternatives.

2.8 Best practice indicates that a multi-modal approach will provide the optimum mix of warning coverage and cost.

2.9 This option is also anticipated to provide significant savings in both CAPEX and OPEX.

3. Detail

The existing system

3.1 A fixed siren array system is currently in place to alert low-lying coastal residents of a tsunami threat. Forty five siren arrays provide coverage for the Eastern Suburbs of Christchurch. There is not a fixed siren array tsunami alerting system for the eastern bays of Banks Peninsula.

3.2 The existing system is subject to degradation in high winds and ambient noise. It is not an official warning system; it is not directly connected to the National Warning System and is at risk of partial or complete failure in an earthquake.

3.3 The existing system is established on the SCADA (Three Waters) network. It is probable that this network will move to a new water entity shortly to maintain and operate. The tsunami alerting software and hardware, attached to the SCADA network - relies on a small family business in Auckland to operate; leaving Christchurch exposed if they aren't available to activate it.

3.4 Furthermore, one portion of the siren array was installed in 2012, with the remainder installed in 2015. The siren infrastructure has a design life of 15 years. No budget is currently on plan to replace the current array.

3.5 The siren system provider has indicated they will scale down their maintenance services this year, meaning an alternative contractor needs to be found to continue this service.

3.6 As such, Council at risk from aging technology (SCADA), changes in the agency that the technology resides within, ageing infrastructure (the siren arrays) and unpredictable cost escalation.

Best practice

3.7 The National Emergency Management Agency (NEMA) does not support the use of sirens for local source tsunami hazards (MCDEM, 2014). GNS Science and New Zealand's Tsunami Working Group (TWG) agree with international best practice that sirens are not suitable for local source tsunami warnings (WREMO, 2023).

3.8 Reasons that locally operated fixed tsunami sirens are no longer considered to be a suitable alerting tool include:

3.8.1 Findings from a number of international events, such as the Japan tsunami of March 2011, have revealed the deficiencies in siren warning technology. These deficiencies include technological failures as damage can be sustained, or power can be cut, to sirens during locally generated earthquakes, making them inoperable. Sirens may also not be audible in windy conditions (MCDEM, 2014; WREMO, 2023).

3.8.2 Sirens can create a false sense of security, with communities waiting for official warnings that may not be issued in time during local and some regional source events. The use of sirens can also distract from public education messages around responding to natural tsunami warning signs, with the public instead waiting for official warnings to be issued (MCDEM, 2014; WREMO, 2023).

3.9 Best practice warning systems, for tsunami risk and other hazards, incorporate a multi-modal approach. These systems use a primary source of notification, in New Zealand this is the Emergency Mobile Alert (EMA), and secondary sources of notification such as mainstream media, social media, local radio, television, mobile phone applications and sirens.

3.10 EMAs are nationally approved messages, developed with scientific input, that are sent directly to every compatible cell phone in the target area through the National Warning System (NEMA, 2023). Alerts that can be received through cell phones at no OPEX or CAPEX cost to the local authority and contain more information than siren alerts that require the public to seek further information (Mileti and Sorensen, 1990; MCDEM, 2014).

3.11 With the upgrading of the cell phone network in recent years, coverage across Banks Peninsula has increased. It is anticipated that all of the Peninsula will have cell phone coverage by 2024, as a result the efficacy of EMAs as a primary warning source has significantly increased. The report being commissioned will include recommendations on timing of any changes required. This ensures the anticipated improvements in cell coverage, and therefore alerting coverage, have been realised.

4. Conclusion

4.1 A report is underway to determine the optimal approach for alerting low-lying coastal residents of a tsunami threat.

4.2 Should findings of the report provide better options for consideration to provide better outcomes for Council and residents, staff will provide these options to Council for consideration. Should no alternative be deemed to provide a better option, staff will continue to implement the Council resolution of August 2021.

Attachments Ngā Tāpirihanga

No.	Title	Reference	Page
A	Bay of Plenty Regional Alerting Systems Review	23/1064631	
B	Hawke's Bay Regional Alerting Systems Review	23/1064634	

Signatories Ngā Kaiwaitohu

Author	Brenden Winder - Manager Civil Defence & Emergency Management
Approved By	Matthew Pratt - Acting Head of Community Support and Partnerships Mary Richardson - General Manager Citizens & Community

Bay of Plenty Regional Alerting Systems Review

G. S. Leonard
R. J. Woods
S. H. Potter

GNS Science Report 2017/36
September 2017

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BIBLIOGRAPHIC REFERENCE

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APPENDIX TABLES

EXECUTIVE SUMMARY

The purpose of this project is to provide a gap analysis and critical review of the Bay of Plenty's (BOP) current suite of warning public alerting tools and to assess the suitability of other alerting tool options for use across the region. Past events and testing of BOP Civil Defence and Emergency Management (CDEM) Group systems have identified that some mechanisms have a considerable delay in reaching the public (i.e. email alerting) and, during periods of high loads, text alerting has limited capacity to reach people quickly. Public feedback following events and tests are consistent in a call for an improved suite of alerting tools.

Recommendations

Public alerting should provide recipients with the best timely information to make an informed decision in a warning.

The public need to be clear that natural warnings are the fastest warnings. The 'Long, Strong, Gone' natural warning message for tsunami is the single most important warning that all people in the BOP and the wider country must (a) know and (b) respond to without hesitation. There is a risk that an enhanced alerting system may cause people to assume they should wait for an official alert. This must be mitigated. Regular exercises (e.g. annual for all schools) are seen as a very effective way to calibrate expectations and education about correct actions for each warning type.

This review recommends a system of options for multi-hazard public alerting. We recommend a backbone of a mobile app and Cell Broadcast to reach the majority of the population with a heads up and instructions.

Infill options for pockets and groups without mobile phone access should be given by telephone auto-dialler in the first instance, supported by warning into self-maintaining networks, agencies with people in their care, and reinforcement messages via web, and social media. A one-stop-shop to understand the alerting system for all people in the region is recommended. A multi-end-point platform should be considered to service all alerting options at once. Existing systems should be maintained until new options come online. Targeted options may continue to be needed for specific cases – e.g. SMS, email etc.

Targeted public address loudspeakers may be suitable for cases where a large number of people concentrate and are not expected to be near their phones, or to have cell coverage. It is important to recognise the high cost to coverage ratio for this, however.

The Red Cross Hazard App is currently in use for the region and has two substantial issues that need addressing before it achieves the high theoretical effectiveness of smartphone applications (along with a sustained and challenging need for it to be widely installed):

1. Alert fatigue and general poor reviews are contributing to people not installing, or uninstalling the app. And the volume of weather-related alerts may also be diluting the likelihood that people will notice infrequent life-safety alerts when they come through.
2. It does not currently effectively wake people up, because alerts come through as a typical push-notification with a minor alert sound and/or vibration.

To produce the correct response from at-risk citizens during emergency events, both *Heads-Up* and *Instruction* are important for effective alerting. We recommend that the BOP CDEM Group maintain regular contact with both The Red Cross Hazard App Working Group and MCDEM regarding Cell Broadcast. The ability to wake people up will become clearer from

August 2017 handset testing for Cell Broadcast, and similar functionality from the App is expected to follow.

A wide range of agencies have substantial numbers of people in their care, either because they are residing there, are visiting, or are working. Similar self-maintaining networks (especially ethnic groups) are also present in the region. Arrangements should be pursued to deliver alerting into the existing communications structures within these agencies/networks. Initial contacts have been made and most agencies are happy to explore this further.

Further work should be done to complete the mobile coverage mapping for the region – such as at the level of analysis already completed by Whakatane District. These should be coordinated with the rural broadband Initiative 2 – Mobile Black Spot Fund. We provide further reading around the fund and areas being targeted for improved coverage.

Note that tracts of forest, flood plain, river catchments, and coast continue across regional borders into neighbouring CDEM Groups. Harmonisation of warnings with these regions is essential. People may also travel inter-regionally on a regular basis or commute.

It is important to maintain all existing systems initially to overlap as the new systems come online over 2017-18 and beyond if necessary.

Cost

An initial indicative cost basis and comparison is given, which will need substantial refinement around preferred options at the Request for Proposal (RfP) from vendors stage. It is used to calculate an example costed solution for the region. This is not a quote and must be updated and revised during the RfP and implementation phase.

Methodology and context

This review utilises the national Public Alerting Options Assessment: 2014 update (Wright et al., 2014) and the updated decision support tool in Excel. The original assessment and tool are documented in MCDEM (2009). The project uses a streamlined version of the methodology used in the Waikato alerting review (Wright et al., 2015). The review characterised spatial pockets (places) and groups (primarily demographics) that need alternative or additional alerting channels to reach them because of incomplete coverage, or non-coverage, by the backbone option(s) – e.g. no mobile phone coverage. Recommendations for covering these pockets and groups focus on a regionally available alerting-end-point-platform delivering one or more additional in-fill options wherever possible. A platform avoids a proliferation of separate un-related options covering each place or group, unless absolutely necessary.

BOP CDEM Group members are drawn from the six territorial authorities (TAs) in the region and the BOP Regional Council. The BOP CDEM Group Plan describes the hazards managed by the Group and, based on life safety, how rapidly the warning is required to be disseminated. More rapid warnings require faster, more effective systems. Effective multi-hazard warning for, and public response to, these rapid-onset hazards is the dominant requirement for public alerting in general. If alerts work for rapid warnings they can be expected to, in many cases, be effective for less time-critical alerting. Rapid-onset hazards for BOP include:

- Tsunami – local source[1*]
- Tsunami – regional source[1]
- Serious Hazchem incident[2]

- Heavy rainfall (Severe Thunderstorm/Flash flooding/debris flow)[3]
- Stormwater surface flooding
- Wildfire/Rural fire[4]
- Large-scale lifelines failure (Major air accident, electrical failure, telecommunications failure, dam break, etc.)

*Natural warnings are the only possible warnings in the first hour. Enhancements to geohazard monitoring and cell broadcast are aiming to cover off time periods longer than this. [1]Not for the Rotorua and Kawerau Districts, [2]Especially Kawerau Mill and Port of Tauranga, [3]Especially Whakatane and Opotiki Districts. Includes rapid river flooding from short catchments or to people present within the source catchments. [4]Especially Rotorua District

Demographics are important to alerting option coverage: The large majority (79%) of the region's population live in urban areas (in census meshblocks with a population density >200 people/km^2). This includes all of Kawerau District and Tauranga City. Opotiki and Whakatane districts are, however, predominantly rural. According to the 2013 Census 97.1% of the population in the BOP region speak English. A further 1.5% do not speak a language (e.g. they are too young). This leaves up to 1.4%, or about 3,500 people who may not speak English. Specific Iwi communication channels also provide an opportunity to reach a notable part of the regional population. It should be noted, in terms of infill alerting demand, that Western Bay of Plenty rural has the highest proportion of people over 65 years of age and also may have mobile black spots. There are a notable number of elderly communities and retirement villages in Tauranga, with many in identified tsunami evacuation zones. Also note that Whakatane District report a very high forecast aged population growth rate. If backbone alerting relates to access to these technologies, a slightly higher rate of infill notification using other means may be needed in areas with older populations.

Existing alerting arrangements include:

- Text Alerting
- Email Alerting
- Facebook
- Twitter
- Red Cross Hazard App
- Land Based Sirens
- Stinger Sirens

Several new national initiatives are relevant to future alerting options and were considered in this review:

- The Red Cross Hazards app has been adopted by all 16 Regional CDEM Groups.
- Cell Broadcast will be activated by all three New Zealand mobile networks by December 2017. MCDEM are the business owner and it will provide a portal to originate geotargeted alerts that are received by every cell broadcast-enabled phone on cell towers in the selected area at the same time.
- The Common Alerting Protocol (CAP) XML standard is being used in New Zealand and implementation is guided by the CAP-NZ Working Group,
- An Enhanced Geohazard Monitoring (EGM) review is underway via GeoNet and comprises various improvements to tsunami advice, certainty, and speed of monitoring results in 2017 (including deep ocean tsunami detection buoy repairs), and the development of a business case for enhancements from 2018 onwards.

In general, most hazards which require alerting, can occur across the BOP region. However, discussion with district council representatives highlighted three cases which will require specific local attention:

- Rotorua District rural fire in plantation forests (although it is noted this should be considered widely for Whakatane District too)
- Kawerau mill hazardous chemical (chlorine) incidents.
- Tauranga City large facilities, especially: Baypark Stadium, Tauranga Airport, and Port of Tauranga.

Mobile phone coverage over farming agricultural areas is variable depending on topography, but in many cases can be found at least somewhere on many farms. In contrast, forested areas have many areas of minimal or no mobile coverage.

BOP Region includes eight Surf Lifesaving clubs each with a patrolled (variable daytime, seasonal hours) beach: Waihi, Mount Maunganui, Omanu, Papamoa, Maketu, Pukehina, Whakatane (Ohope), Opotiki (Waiotahi Beach). These beaches are expected to receive the majority of beach visitors in the region. Options to reach these beaches include widespread public alerting, e.g. via mobile phones, dedicated hardware at beaches, and existing communications to Surf Lifesaving facilities at these beaches.

KEYWORDS

Public Alerting Options, Warning Systems, Bay of Plenty, Hazards, Risk, Mitigation, Civil Defence Emergency Management

1.0 INTRODUCTION

1.1 PURPOSE AND CONTEXT

The purpose of this project is to provide a gap analysis and critical review of the Bay of Plenty's current suite of warning public alerting tools and to assess the suitability of other alerting tool options for use across the Bay of Plenty region (BOP).

Globally the UNISDR Sendai Framework for Action (UNISDR 2015) prescribes an enhanced focus on multi-hazard warning systems; a strong research and risk-based approach to mitigation. Implementation of the Sendai Framework in New Zealand is given effect through the National Disaster Resilience Strategy (in prep).

The following is reproduced from the project brief supplied by BOPCivil Defence Emergency Management (CDEM) Group.

The BOP CDEM Group has a requirement under s18(2)(e) of the CDEM Act 2002 to provide, maintain, control, and operate warning systems. The BOP's approach to public alerting and communications is outlined in the Regional Alerting and Communications Systems Strategy, in Appendix 1 of that document. The strategy seeks to achieve the ownership of an effective communications and alerting system enabling responding agencies to alert and communicate with audience groups, establish command and control, maintain situational awareness, manage the emergency response, and function under a common set of operating procedures.

The BOP CDEM Group identifies that its Alerting Suite shall:

- Reach Target Audience - As part of a comprehensive suite, the system should be able to effectively alert or communicate with target audience groups.
- Be Resilient - The individual systems shall be robust and resilient. However, the overall suite of systems must incorporate backup systems and capabilities to ensure provision of communications.
- Be Easy to Operate - Any system should be user friendly and easy to operate by all staff required to use it.
- Be Cost Effective - Any system should be financially cost effective and cognisant of on-going resources required to maintain and operate.
- Use Multiple Channels - The overall suite of systems must be able to effectively alert or communicate through a variety of means.
- Operate Remotely - The ability to remotely access and operate is essential to ensure that warnings can be issued and communication maintained.
- Interoperable - Where possible, systems should be able to share and exchange information between each other.

1.1.1 Out of scope

The BOP brief for this project states that there are several areas that will **not** be within the scope of the project:

- While the Group recognises that public communication is an important part of the public warning process, the focus of this assessment is on the Group's alerting capability.

- The project will assess the suite of tools available to the BOP CDEM Group and relevant protocols. It will not look to assess or make recommendations on alerting options associated with any National Warning Systems.
- The focus of this project is on a region-wide suite of tools. While the project will look at the suitability of sirens as a regional alerting tool it will not look to make a specific recommendation on the implementation of alerting tools specific to Tauranga City.
- The project will focus on public alerting and communication during an event. It will not seek to assess the internal alerting and communication tools in use by the BOP CDEM Group.
  - This is interpreted as excluding standard operating procedures from the review. Such procedures are, regardless, very important to the operation of an effective end-to-end warning system.
- The project will provide a recommendation that will be presented to the BOP CDEM Group for consideration. It will not seek to identify implementation plans for any new tools.

Additionally, the mapping of exact mobile phone coverage black spots is a complex task beyond scope, that could be its own project (see the Whakatane District project completed to date); or it could be developed as an ongoing programme of input from communities over the implementation phase of improved alerting for BOP region.

1.1.2 Current situation

In addition to the national media MOU, the BOP operates a suite of alerting tools for short lead-time hazards as outlined in Section 2.4. If the alerting arrangements recommended in this report are viable for the short lead-time hazards, they are expected to also be viable for longer lead-time hazards. Recent (e.g. tsunami) warning events have demonstrated that the current suite of BOP alerting tools has limited capacity and coverage. Past events and testing of BOP CDEM Group systems have identified that some mechanisms have a considerable delay in reaching the public (i.e. email alerting) and, during periods of high loads, text alerting has limited capacity to reach people quickly. Public feedback following events and tests are consistent in a call for an improved suite of alerting tools.

Tsunami warnings

The National Tsunami Advisory and Warning Plan (MCDEM, 2017) states that “New Zealand is a member of the Pacific Tsunami Warning System (an international system under the auspices of the Intergovernmental Oceanographic Commission of UNESCO) 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 GNS Science/GeoNet geological hazards and sea level monitoring. The Ministry of Civil Defence & Emergency Management (MCDEM) is the agency responsible for initiating national tsunami advisories and warnings to the communities of New Zealand.”

“MCDEM uses the National Warning System (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 this NWS.”

“Regional CDEM Groups and CDEM Group members are responsible for the planning for, 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 tsunami 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." This includes a responsibility to call evacuations.

These official warning arrangements are for regional- and distant-source tsunami only (>1hr travel time from source). For local-source tsunami, an official warning cannot be guaranteed and people are advised to evacuate to high ground based on the natural warning, most likely a long and/or strong earthquake.

Weather, flood and volcanic warnings

A suite of severe weather watches and warnings are provided to the public in the BOP by the Meteorological Service of New Zealand Ltd. (MetService) on its website, app, through social media, and via the media. GNS Science provides over similar channels (and via email) Volcanic Alert Bulletins which may contain Volcanic Alert Level Changes or Ashfall forecasts. Additional regional interpretation (including flood warnings), action information, and area targeting is added by the BOP CDEM Group and disseminated via regional public alerting channels.

Fire warnings and hazardous substances

The New Zealand Fire Service (NZFS) is the lead agency in urban fire and hazardous substance incidents, although in some cases the lead agency for a fire may become a regional CDEM group. Amalgamation starting in 2017 will join NZFS and rural fire under the same agency, Fire and Emergency New Zealand (FENZ). Public alerting for fire and hazardous substances is via the Fire Service to affected people directly, and more broadly via the media. NZFS are members of the CDEM Group and alerting can be via regional public alerting channels as well. There is some shared responsibility for hazardous substances with the Ministry of Health and regional health agencies. This can include smoke from fire.

1.2 RELATED DOCUMENTS AND PROJECTS

There are four key points of reference available for public alerting in New Zealand:

1. An updated review of public alerting options (Wright 2014)
2. An analysis of public alerting options for Waikato CDEM Group (Wright et al. 2015)
3. Updated arrangements for public alerting since 2014 (Draft New Zealand Common Alerting Protocol Guideline 2017; ongoing development of the Red Cross Hazard (alerting) Mobile App; Plans for a national (cell broadcast) public alerting option)
4. A review of Wellington Region's Flood Warning System (Leonard et al. 2016).

1.3 STRUCTURE OF THIS REVIEW

The project uses a streamlined version of the methodology used in the Waikato alerting review (Wright et al. 2015). That review involved workshops at each Waikato district to explore alerting needs and options based on hazards, spatial variation in alerting options, and demographic variation of the public. Based on lessons from that methodology, the BOP review can be more efficiently targeted. The process used is outlined in this section.

The project team worked with BOP CDEM Group to source and compile spatial and demographic variations that are pertinent to alerting. The BOP review looked at the possibility of identifying one or more 'backbone' alerting options that could alert a majority of people.

The review characterised spatial pockets (places) and groups (primarily demographics) that need alternative or additional alerting channels to reach them because of incomplete coverage, or non-coverage, by the backbone option(s) – e.g. no mobile phone coverage. Recommendations for covering these pockets and groups focus on a regionally available alerting-end-point-platform delivering one or more additional in-fill options wherever possible. A platform avoids a proliferation of separate un-related options covering each place or group, unless absolutely necessary.

The project recognises that providing a public alerting system that will effectively alert (with a noticed heads-up) and provide instructional information to the public regardless of where they are or what they are doing is a critical requirement to invoke an efficient response.

Stage 1 Analysis

We assessed the cost, reliability, reach, functionality, and effectiveness of each of the current alerting tools being utilised by the BOP CDEM Group. This was done as follows:

1. 2013 Census data was analysed by BOP Regional Council and GNS Science.
2. Additionally, BOP CDEM Group discussed specific context, needs and options (summarised in Sections 2.0 and 3.0) with representatives of each District Council, to ensure local knowledge of issues and needs were included.

The following specific topics were analysed by both of the above approaches:

- Population data (high and low density).
- Elderly populations (an indicator for hearing, sight and mobility impaired populations).
- Hazards that need a specific alerting focus in any district (e.g. tsunami in coastal districts).
- Rural/urban population split. Numbers of people in each category in each district.
- Telephone coverage (mobile and landline, separately).
- Known mobile phone black spots
- Transient populations (especially tourists)
- Spatial pockets that need in-fill alerting
- Groups that may need in-fill alerting - e.g. Elderly, children, second language, ethnic groups, impaired.
- Institutions with people in care.

Stage 2 Draft review

Recommendations were made for improvements, modifications and changes to the current alerting suite, including what systems should be retained and what systems may be retired.

Stage 3 Review finalisation and presentation

Comments from BOP CDEM Group on the draft review contributed towards this final recommendation report.

1.4 Capacity and Relationship Building

Data collection, partner agency contacts, and vendor price indications were all undertaken with, or led by, the CDEM Group team wherever possible to enhance sustainability at the conclusion of the project.

2.0 CONTEXT FOR ALERTING IN THE BAY OF PLENTY

2.1 OVERVIEW OF THE BAY OF PLENTY CDEM STRUCTURE

BOP CDEM Group members are drawn from the six territorial authorities (TAs) in the region and the BOP Regional Council (Figure 2.1). The TAs in alphabetical order, are:

- Kawerau District;
- Opotiki District;
- Rotorua District;
- Tauranga City;
- Western BOP District;
- Whakatane District;

Figure 2.1 BOP CDEM Group boundaries, district boundaries, regional boundaries and local CDEM areas. Note all of Taupo district is included in Waikato CDEM Group and all of Rotorua District is included within BOP CDEM Group. Source: Local Government New Zealand.

The BOP CDEMG role is to provide a coordinated and integrated approach to the way significant risks and hazards are managed in the Bay of Plenty across the 4R's: Readiness, Response, Recovery and Reduction. The governance of the Group is provided by a joint committee of elected representatives from BOP Regional Council and TAs in the region, with the exception of Taupo District Council.

Supporting the CDEM Group is the Coordinating Executive Group (CEG), a statutorily mandated committee comprised of the CEOs (or their representative) of local authorities, New Zealand Fire Service[1], New Zealand Police, District Health Boards, Medical Officer of Health and Group Controllers. The CEG is responsible for:

- Providing advice to the CDEM Group and any subgroups or subcommittees of the Group
- Implementing, as appropriate, the decisions of the CDEM Group

[1] Which will become Fire and Emergency New Zealand (FENZ), effective 1 July 2017.

- Overseeing the implementation, development, maintenance, monitoring, and evaluation of the CDEM Group Plan
- Monitoring the performance and effectiveness of any agreement or contract that the Group may enter into for the provision of goods and services.

Responsibilities for public alerting fall to members of CDEM Groups under the National CDEM Plan Order 2015. The order states:

"CDEM Groups;

- - must maintain arrangements to respond to warnings (s60(5));
- - Are responsible for (s62(6)):
  a. Disseminating national warnings to local communities; and
  b. Maintaining local warning systems"

Budgeting and decision making lies at the political level, with advice from CDEM professionals; while the operational implementation of alerting systems is coordinated by Emergency Management BOP on behalf of the CDEM Group.

2.2 BOP WARNABLE HAZARDS

The BOP CDEM Group Plan describes the hazards managed by the Group and, based on life safety, how rapidly the warning is required to be disseminated (Table 2.1). More rapid warnings require faster, more effective systems. Effective multi-hazard warning for, and public response to, these rapid-onset hazards is the dominant requirement for public alerting in general. If alerts work for rapid warnings they can be expected to, in many cases, be effective for less time-critical alerting.

Table 2.1 Hazards applicable to the BOP CDEM Group (as per Section 2.6 of the Group Plan, 2012-2017) and the requirement for rapid warnings for life safety.

Hazards requiring rapid warnings for life safety (short-onset, less than 3 hours)	Hazards NOT requiring rapid warnings for life safety but still appropriate for alerting	Hazards which currently cannot be warned for
Tsunami – local source[1]* Tsunami – regional source[1] Serious Hazchem incident[2] Heavy rainfall (Severe Thunderstorm/Flash flooding/debris flow)[3] Stormwater surface flooding Wildfire/Rural fire[4] Large-scale lifelines failure (Major air accident, electrical failure, telecommunications failure, dam break, etc.)	River flooding Tsunami – distal source Coastal storm Volcanic eruption with precursor (local or distal) Animal disease epidemic Human disease pandemic Biological pests and new organisms Drought Coastal erosion Windstorms	Earthquakes Extreme geothermal events[5] or unheralded small volcanic eruptions Landslides Localised subsidence

*Natural warnings are the only possible warnings in the first hour. Enhancements to geohazard monitoring and cell broadcast are aiming to cover off time periods longer than this.

[1]Not for the Rotorua and Kawerau Districts

[2]Especially Kawerau Mill and Port of Tauranga

[3]Especially Whakatane and Opotiki Districts. Includes rapid river flooding from short catchments or to people present within the source catchments.

[4]Especially Rotorua District

[5]E.g. sudden large steam and mud eruptions within geothermal fields

Tsunami, rapid flooding, hazardous chemical and rural fire incidents are distributed in different areas throughout the region. Figure 2.2 shows the location of warnable short-fuse hazards such as plantation forests at risk of rural fire; the coastline and areas within a few kilometres of the coast (refer to regional tsunami evacuation maps), and coastal estuaries and rivers which are at risk of tsunami; and areas at risk of Hazchem events in Tauranga (particularly the port), Rotorua, and the Kawerau mill (chlorine). Rapid flooding is primarily a risk on the river floodplains from Kawerau to Whakatane, but also in steep catchments behind Matata and the hills behind the entire coast from Whakatane through Opotiki to the eastern boundary of the region. Surface flooding due to overwhelmed stormwater systems is a hazard in Tauranga and Rotorua cities.

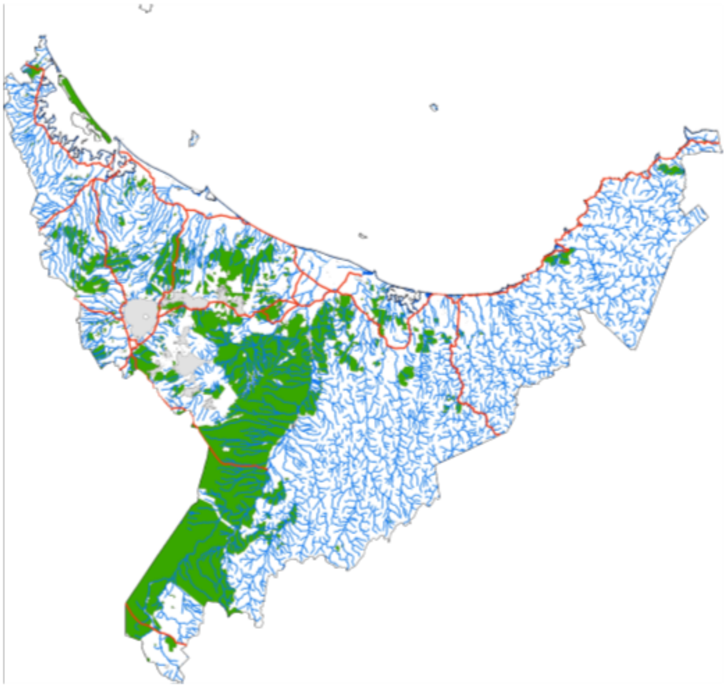

Figure 2.2 Illustration of the variability of the location of key warnable hazards (Dark blue –tsunami and coastal inundation; Light blue – river flooding; Green –rural fire in exotic forests) and the State Highway network (red lines).Source: LINZ TOPO50 data.

2.3 KEY DEMOGRAPHIC CHARACTERISTICS

This section describes the variation in demographics across the region that require consideration for different public alerting options.

Agencies with people in their care are considered in Section 3.3.5, but not under specific demography analyses.

2.3.1 Rural vs urban populations

The large majority (79%) of the region's population live in urban areas (in census meshblocks with a population density >200 people/km^2; Table 2.2). This includes all of Kawerau District and Tauranga City.

Opotiki and Whakatane districts are, however, predominantly rural.

The range of effective and feasible alerting measures differ for high and for low density populations. The distribution of urban populations is shown in Figure 2.3.

Table 2.2 2013 Census population data summary giving total population and percentage in urban vs. rural areas.

2013 Census data	Population	percentage
Kawerau Urban	6360	100%
Ōpōtiki Urban	3774	45%
Ōpōtiki Rural	4680	55%
Rotorua Urban	51114	78%
Rotorua Rural	14127	22%
Tauranga Urban	112470	100%
Western Bay Urban	26448	60%
Western Bay Rural	17274	40%
Whakatāne Urban	13065	40%
Whakatāne Rural	19578	60%
REGION TOTAL	**268890**	
REGION URBAN	**213231**	**79%**
REGION RURAL	**55659**	**21%**

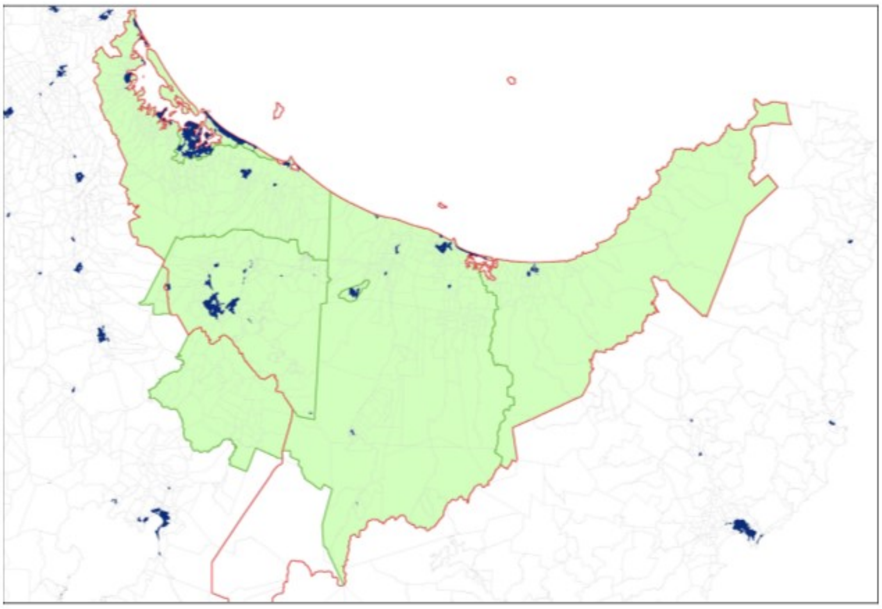

Figure 2.3 2013 Census Meshblocks (grey outlines) are shown coloured blue where they contain > 200 people/km² (urban areas). The BOP CDEM Group covers the green areas (compared to the red, Regional Council Boundaries). The green lines show the district council boundaries. The difference is the inclusion of all of Rotorua District and none of Taupo District in the CDEM Group. Source: Statistics New Zealand and LINZ Topo50 data.

2.3.2 Language barriers

According to the 2013 Census 97.1% of the population in the BOP region speak English. A further 1.5% do not speak a language (e.g. they are too young). This leaves up to 1.4%, or about 3,500 people who may not speak English. Given the overall low proportion of the region who do not speak English, and the diversity of other languages spoken, it is most effective to tie warnings directly into existing communication structures within these communities, rather than trying to warn in all of these languages through regionally delivered systems.

Table 2.3 Languages spoken as reported in the 2013 census.

	Number of people	Of those who stated a language
English	244,602	97.1%
Māori	21,213	8.4%
Samoan	1,068	0.4%
Hindi	1,548	0.6%
Northern Chinese	528	0.2%
French	2,196	0.9%
Yue	660	0.3%
Sinitic not further defined	534	0.2%
German	1,944	0.8%
Tongan	537	0.2%
Tagalog	1,035	0.4%
Afrikaans	1,467	0.6%
Spanish	1,404	0.6%
Korean	783	0.3%
New Zealand sign language	1,080	0.4%
Other	10,482	4.2%
None (eg too young to talk)	3,735	1.5%
Total people stated	251,796	
Not Elsewhere Included	20,013	
Total people	271,251	

Communication reach to those with English as a second language, or non-English speakers was not mentioned by any district representative when asked as part of this review.

2.3.3 Ethnic group self-maintaining networks

Specific Iwi communication channels provide an opportunity to reach a notable part of the regional population. 8.4% of 2013 census respondents report speaking Māori. Relative to some other regions, there is a large Māori population in BOP Region, with several Iwi represented. Maori communities within the Kawerau District are predominantly from one Iwi, which is also the case on Motiti Island.

Rotorua has notable populations of Philippine, Pacific Island, Māori, Indian, Korean and Chinese people. Opotiki has a large population of Māori and Pacific Islanders. There are some other specific ethnic groups in Tauranga and Western BOP that are being followed up by the CDEM Group for potential specific alerting.

BOP CDEM Group need to engage with Iwi group representatives to develop approaches to deliver alerts into and in collaboration with existing communication channels and community organisations.

2.3.4 Age

Tauranga and Western Bay of Plenty have the highest proportion of people over 65 (19% and 25% respectively), whereas Rotorua has the lowest (14%). However, this overall range is only 5%. Larger departures from the mean (17%) can be seen in Western Bay of Plenty rural areas (25%) and Whakatane urban areas (10%).

It should be noted, in terms of infill alerting demand, that the rural parts of Western Bay of Plenty has the highest proportion of people over 65 years of age and also may have mobile black spots. There are a notable number of elderly communities and retirement villages in Tauranga, with many in identified tsunami evacuation zones. Note also that Whakatane District report a very high forecast aged population growth rate.

2.4 Existing Regional Systems and Arrangements

Table 2.4 provides a summary of the existing alerting systems in use in BOP region. The largest coverage is provided by Text Alerting. Arrangements with Media (usually via phone call, email or fax), and uptake of press releases also provide widespread alerting.

Table 2.4 Existing systems summary (this is up to date as of May 2017 including the surge of subscriptions following the April 2017 weather events). Costs are met by the CDEM Group.

Alerting System	Text Alerting	Email Alerting	Facebook	Twitter	Red Cross Hazard App	Land Based Sirens	Stinger Sirens
Capital/ purchase cost ($NZ)	$400 for establishing Shortcode	0	0	0	0	$30,000 (including purchase and install for stand alone and fire service setups)	$55,600
Annual Maintenance cost ($NZ)	N/A	N/A	0	0	0	<$2000 (awaiting confirmation on exact cost from Kordia)	N/A (Batteries removed to avoid issues with battery maintenance)
Annual Contract cost ($NZ)	$5,700 (includes additional cost to maintain a dedicated shortcode)	$2,760 (cost of website hosting which includes email alerting functionality	0	0	0	N/A	N/A
Annual Testing Cost ($NZ)	$5,914 (Based on current number of subscribers)	N/A	0	0	0	N/A (the only cost associated with the siren test is for advertising/ publicity)	N/A (the only cost associated with the siren test is for advertising/ publicity)
Number of Units	N/A	N/A	N/A	N/A	N/A	10 (7 fire service conversions and 3 stand alone units)	7 full units (+spare control box)

Alerting System	Text Alerting	Email Alerting	Facebook	Twitter	Red Cross Hazard App	Land Based Sirens	Stinger Sirens
Locations	N/A	N/A	N/A	N/A	N/A	Ohope West End Ohiwa Waiotahi Beach Matatā (FS) Whakatāne(FS) Whakatāne (mill) Ōhope (FS) Ōpōtiki (FS) Te Kaha (FS) Waihau Bay (FS) (FS = Fire service siren)	Distributed at TA level.
Number of subscribers	34,048 (individual phone numbers)	27,468 (Individual email addresses)	25,209	1,149	Unknown	N/A	N/A

2.5 NATIONAL INITIATIVES

The following multi-hazard warning initiatives are available now, or will be available in 2017.

2.5.1 Red Cross Hazards App

The Red Cross Hazards app has been adopted by all 16 Regional CDEM Groups. It is Common Alerting Protocol (CAP) compliant, providing both a CAP origination form and the ability to read CAP feeds. It is provided free of charge and aims to be able to wake people up at night[2] even with the phone on silent. Red Cross tell us that this will be aided by MCDEM driving Cell Broadcast to do the same (below), setting a national precedent. As for all apps people need to download and install it for it to be effective, i.e. it is 'opt-in', reducing effectiveness. A widespread ongoing education and exercising campaign is needed to keep installation rates high.

https://www.redcross.org.nz/what-we-do/in-new-zealand/disaster-management/hazard-app/

2.5.2 Cell Broadcast

Cell Broadcast will be activated by all three New Zealand mobile networks by December 2017. MCDEM are the business owner and it will provide a portal to originate geotargeted alerts that are received by every cell broadcast-enabled phone on cell towers in the selected area at the same time. Character length is up to 930 characters. It is intended that this system will be able to wake people up in the middle of the night. Most handset manufacturers will need to include it in new phone models, or provide upgrades to existing models, so handset churn is expected to take 2+ years before most people have compliant handsets. Wake-up may be achieved by a mixture of (a) over-ride of silent mode, or (b) configuration of the handset, based on initial handset testing in August 2017. Some handsets will offer click-through hyperlinks. Agencies that will have access to Cell Broadcast are MCDEM, CDEM Groups, Fire and Emergency NZ, New Zealand Police, the Ministry of Health and the Ministry for Primary Industries.

http://www.civildefence.govt.nz/get-ready/civil-defence-emergency-management-alerts-and-warnings/cell-broadcast-alerting/

2.5.3 Common Alerting Protocol

The Common Alerting Protocol (CAP) XML standard is being used in New Zealand and implementation is guided by the CAP-NZ Working Group, chaired by MCDEM (NZCAP, 2017). The standard is mentioned in MCDEM's Cell Broadcast link above. A circulation CAP-NZ guideline draft is available from the MCDEM chair.

CAP is a consistent formalised structure for alerts with machine readable content headings to all aspects of an alert. The use of CAP means that a CAP formatted and validated message can be authored once, sit on an 'RSS' feed and be picked up by all CAP compliant alerting end-points (such as the Red Cross Hazard app, and some alerting end-point platforms) immediately and at the same time.

[2] Untested as of the date of publication.

2.5.4 Enhanced Geohazard Monitoring

This is underway via GeoNet and comprises various improvements to tsunami advice, certainty, and speed of monitoring results in 2017 (including deep ocean tsunami detection buoy repairs), and the development of a business case for enhancements from 2018 onwards. All of this will mean that monitoring and evaluation of geohazard threats, especially tsunami, can be expected to be faster from 2017, supporting and leveraging benefits from improved speed, effectiveness and coverage of alerting systems at a regional level.

See: https://www.beehive.govt.nz/release/3-million-boost-natural-hazards-monitoring

3.0 NEEDS AND OPTIONS ANALYSIS

The multi-hazard public alerting needs and potential options for the BOP Region are described in this section against the context given in Sections 1.0 and 2.0. Options are discussed in terms of alert channels that may reach each type of need; they are mostly dependent upon available telemetry (the communication path).

3.1 AVAILABLE ALERTING OPTIONS

The alerting options available to be considered for this review are listed here. More details as to their effectiveness and cost basis are given in Section 3.4.2 and Appendix 2.

1. **Natural warnings**
2. **Independently self-maintained networks**
3. **Systems reliant on third party hardware and/or staff:**
   - Aircraft banners
   - Helicopter PA loudspeaker
   - Billboards – static
   - Billboards - electronic telemetered
   - Break in broadcasting*
   - Call-in telephone line
   - E-mails
   - GPS receiver messaging*
   - Marine radio
   - Mobile PA loud speaker (Police / Fire)
   - Mobile device apps
   - Cell broadcast
   - Newspaper content
   - Pagers (triggering group of 200 people)
   - Power mains messaging
   - Radio announcements
   - Route alert (door-to-door)
   - Social Media
   - SMS-PP text messaging
   - Telephone auto-dialler
   - Telephone trees
   - Television announcements
   - Tourist radio
   - Websites
   - Website banners

4. **Systems using dedicated hardware:**
    - Fixed PA loud-speakers
    - Mobile PA loud-speakers
    - Bells, air horns
    - Flares, explosives
    - Radio Data Systems*
    - Radio (UHF, VHF or HF)
    - Sirens (signal-only) – Mobile
    - Sirens (signal-only) – Fixed
    - Tone-activated alert radio*

* = not currently available in New Zealand. Tone-activated alert radio is available elsewhere in New Zealand by Tsunado but is in development with broadcasters for potential availability in BOP.

3.1.1 The importance of available telemetry

The available telemetry channels to 'groups' and 'pockets' (isolated areas) govern the options that are available to select for alerting. They include:

- Mobile phone cell networks
- Landline copper phone lines (potentially being phased out to fibre and mobile over a number of years)
- Fibre-optic
- Radio – both as broadcast stations and as signals to alerting receivers on these frequencies
- TV broadcast stations
- Satellite – via specific alerting telemetry, or a GPS protocol in theory (unused)
- VHF – either as audio from handset to handset, or as data over this frequency.
- Power lines – This is through 'ripple control', which is a signal typically used to turn on hot water heaters. It is currently being implemented in Northland by their CDEM Group in conjunction with Northpower.

3.2 District specific considerations

In general, most hazards which require alerting occur throughout the region. However, discussion with district council representatives highlighted three cases which will require specific local attention:

- Rotorua District rural fire in plantation forests (although it is noted this should be considered widely for Whakatane District too)
- Kawerau mill hazardous chemical (chlorine) incidents.
- Tauranga City large facilities, especially: Baypark Stadium, Tauranga Airport, and Port of Tauranga.

3.3 Regional needs

The multi-hazard alerting needs for BOP are assessed at a regional level as per the scope in Section 1.1, with the exception of key District-specific issues highlighted in Section 3.2. Given that some of the available alerting options rely heavily on mobile phone coverage, the coverage for specific areas is discussed in this section.

3.3.1 Urban populations

Urban populations are concentrated in the following towns and cities (most have more than 1000 people):

Waihi Beach, greater Tauranga, Te Puke, Maketu, Kawerau, Katikati, Matata, Edgecumbe, Whakatane, Ohope, Taneatua, Ruatoke, Waimana, Opotiki, Te Kaha, Murupara, Rotorua, Minginui, Ruatahuna.

Smaller settlements exist throughout the region.

The majority of the populations in the listed urban centres have mobile coverage, however, mobile coverage in smaller settlements and outlying dwellings is patchy. The exceptions, that do not have coverage in Whakatane district, are reported (supplied by BOP CDEM Group) as Ruatahuna and Minginui.

Because mobile phones appear to cover the majority of urban populations, options that utilise mobile networks are therefore a high priority in those locations.

3.3.2 Rural diffuse population

Rural diffuse populations are present throughout most of the region. The main exception is forested land either in plantation or native forest. Plantation forest is predominantly in the Rotorua and Whakatane districts (Figure 2.3). In these areas rural fire alerting is a priority. Native forest is found throughout the region (expected to correlate with little or no population), with more extensive areas southwest of Tauranga, surrounding Rotorua lakes, and especially in Te Urewera south of Opotiki.

The remaining rural diffuse areas are heavily used for non-forestry agriculture and have distributed small communities and dwellings throughout, at various densities, but all considered to be 'low-density' or 'diffuse'.

Mobile phone coverage over farming agricultural areas is variable depending on topography, but in many cases can be found at least somewhere on many farms. In contrast, forested areas have many areas of minimal or no mobile coverage. Maps are provided by mobile phone companies (Figure 3.1) to give a broad view of the level of coverage, but the exact experience of coverage across any one square kilometre can vary markedly from the modelled coverage shown in these maps. This was shown from district-by-district workshop discussions in Waikato Region (part of Wright et al. 2015).

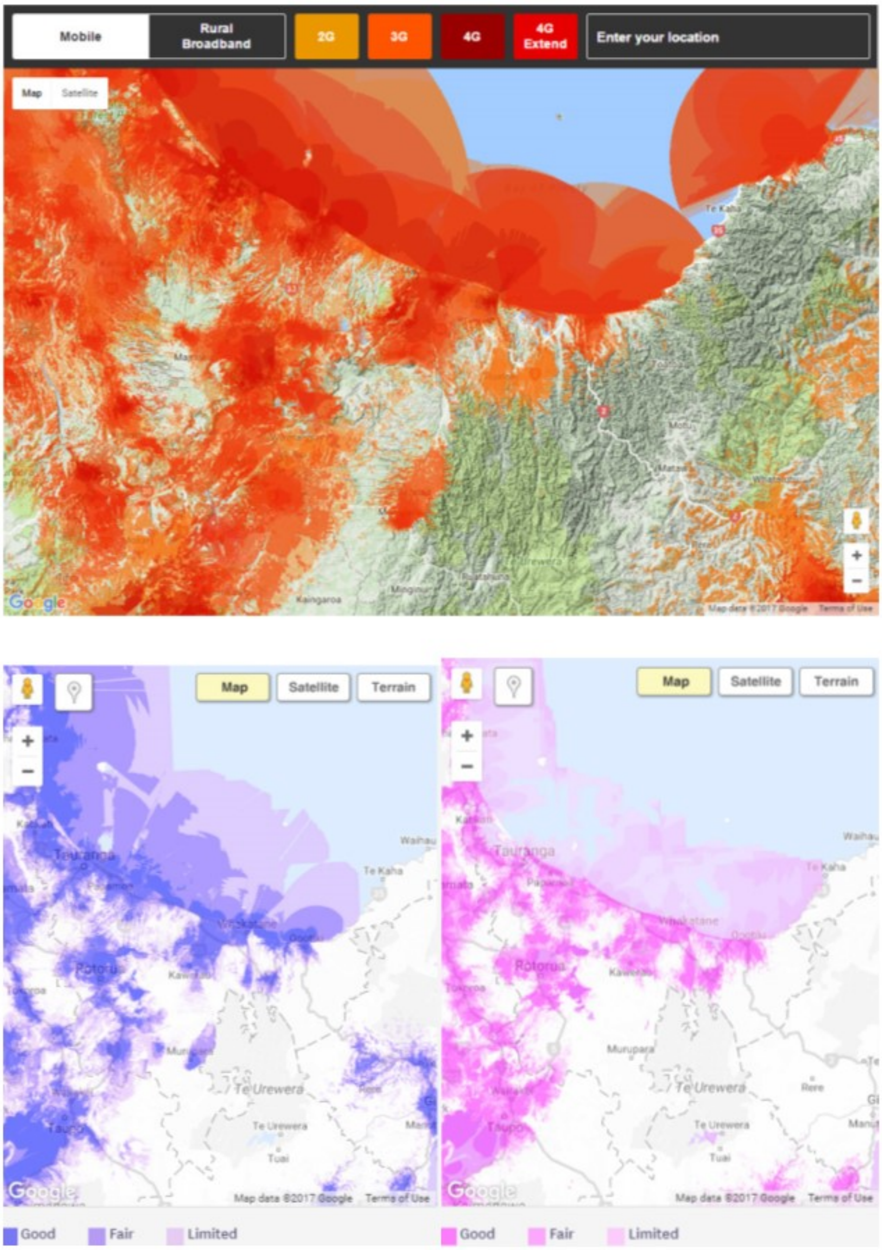

Figure 3.1 Above: Vodafone Combined 2G, 3G, 4G (extended) coverage map from http://www.vodafone.co.nz/network/coverage/. Below Spark 3G (left) and 4G 700 (right) coverage maps from http://www.spark.co.nz/coverage. All accessed 2/6/2017.

3.3.3 Isolated pockets – mobile blackspots and beaches

Isolated areas are referred to here as 'pockets' and the nature of the main pockets is discussed in terms of their common characteristics for public alerting needs.

Areas without mobile phone coverage

As discussed above, the vast majority of urban areas (which contain 79% of the regional population) are covered by mobile phones at home. Mobile coverage in rural areas is highly varied as follows:

- Whakatane District has commissioned a specific review of coverage.

Further partial analysis by CDEM Group staff has been conducted along the Opotiki coastal highway. It highlights the issue with coverage map accuracy mentioned in 3.3.2 – the Spark network coverage is mapped as more-limited, but also correlates more closely to the coverage experienced when driving this road.

- Blackspot highway areas have been provided by Western Bay District and correlate to Rural Broadband I2 coverage mapping discussed in Section.4.7.1.
- Rotorua District staff have identified that there are numerous isolated roads, recreational and other locations without coverage, which again correlates to the maps in Section 3.3.2. The district is land-locked and not exposed to tsunami risk, however there is concern about other fast-onset hazards needing warning, primarily rural fire. Flooding and volcanic/geothermal eruption are also a consideration in specific locations.

Because of the inaccuracy of network provider maps mapping of all blackspots is not possible within the scope of this report. A map of regional population coverage problems will need to be maintained and updated as the alerting options are rolled out, and used to target in-fill alerting (Section 4.7).

Beaches

BOP Region includes eight Surf Lifesaving clubs each with a patrolled (variable daytime, seasonal hours) beach: Waihi, Mount Maunganui, Omanu, Papamoa, Maketu, Pukehina, Whakatane (Ohope), Opotiki (Waiotahi Beach). These beaches are expected to receive the majority of beach visitors in the region. Options to reach these beaches include widespread public alerting, e.g. via mobile phones, dedicated hardware at beaches, and existing communications to Surf Lifesaving facilities at these beaches. People visiting or living near the remaining beaches in the region would need to be reached by widespread regional alerting (particularly mobile-phone based). There are currently phones at each club. In future a regional radio network is planned; some are already in place (existing radios could be linked by a phone number as above). Clubs also have well-used Facebook pages. Note that the surf lifesaving region extends into Gisborne and Waikato Regions. The BOP CDEM Group need to agree and harmonise the approach and messages with these groups.

3.3.4 Specific groups

This section discusses some key groups that need alerting. It also refers to other sections of the report (e.g. for ethnic groups, seasonal workers, and children via schools).

English as a second language

No notable spatial clusters of people with English as a second language are apparent from the 2013 census data or from discussion with district representatives. The overall number of people for whom English is not spoken appears to be approximately 3,500 people (total number of people who gave any language spoken in the 2013 census, less the number who stated English as one of the languages they spoke). There remains an opportunity for additional alerting via ethnic groups' self-maintaining networks (Section 2.3.3) and into agencies with people in their care (e.g. seasonal workers, Section 3.3.5), potentially reaching most dispersed non-English speakers.

Elderly

There is an elevated proportion of older populations in some areas (Section 2.2.4). The most significant impact of age is likely to be a decreased access to technology, which is relevant to internet and mobile phone-based alerting, and in aged care facilities, a reliance on carers to disseminate information or take action. If backbone alerting relates to access to these technologies, a slightly higher rate of infill notification using other means may be needed in areas with older populations, especially Western Bay of Plenty rural areas.

Limited access to technology

It is recognised that access to technology, particularly to mobile phones, is a factor in alerting coverage. However, the scope of this review is limited to approximating these issues through known associations such as an inverse correlation of mobile phone and internet use to age in those over 65. There may be a similar correlation to level of income. No additional groups with access issues were noted in discussion with district representatives.

Effectiveness for impaired

There is a proportion of the BOP population that are affected by an impairment which may inhibit their ability to receive a warning. Most alerting solutions under consideration are audible so sight impaired public should not experience an issue. However, their ability to respond to the warning needs to be considered in wider community response planning.

Hearing impaired alerting needs to be considered through the existing channels to communicate with this community, e.g. voice to text solutions. Along with considering other disabilities, solutions for these groups need to be explored by the BOP CDEM Group in collaboration with supporting agencies for respective communities.

Transient populations

Transient populations are especially comprised of tourists in the BOP region, along with people travelling on state highways. There are at least eight numbered state highways crossing the region (red lines, Figure 2.3).

Tourists can be expected to be in larger numbers at congregation points, especially accommodation and attraction locations. This includes urban areas such as Tauranga and Rotorua in terms of accommodation, where standard urban warnings may cover them. International tourists may not have as much access to mobile phones as do locals, however, remote attractions (beaches, Rotorua Lakes, adventure activities, scenic areas, cultural experiences, etc.) may need specific coverage.

3.3.5 Agencies with people in their care

A wide range of agencies have substantial numbers of people in their care, either because they are residing there, are visiting, or are working. These include schools, the Department Of Conservation (DOC), hospitals, aged care facilities, large employers (e.g. Fonterra and orchards in BOP region), large sites (ports, stadiums, etc.). Connecting to these agencies is an effective additional alerting channel particularly in two cases:

1. Any site or area where people may not have access to regional public alerting options
2. or where the agency provides an additional opportunity to get an alert message to people via their existing communication structures, reinforcing or providing redundancy to regional options.

As part of this review the following agencies have been contacted:

- Fonterra
- Department of Conservation (DOC)
- Ministry of Health
- Ministry of Social Development (MSD)
- Department of Corrections
- NZ Transport Agency (NZTA)
- Port of Tauranga
- Tasman Mill, Kawerau
- Orcharding groups
- Ministry for Primary Industries (MPI)
- Camper van providers
- Tourism NZ
- Campgrounds
- Surf Lifesaving
- Forestry groups

Fonterra have indicated that they are interested in following up on alerting people on their sites nationally and this is being discussed with the Common Alerting Protocol Working Group. DOC, NZTA, Ministry of Health (MOH) and MSD were also contacted nationally and options for getting alerts into these agencies in BOP and perhaps nationwide are under discussion with the working group. BOP CDEM Group regularly attends this working group and we recommend they take up opportunities with these agencies as they emerge from that forum.

The Ministry of Education has indicated that alerting into schools should be explored for BOP schools via the Regional Director based in Tauranga. This should be followed up by BOP CDEM.

Remaining agencies should be followed up by BOP CDEM Group at a regional level.

There is an additional opportunity to alert people on Matakana and Motiti Islands via existing communication networks there; this should also be explored by BOP CDEM Group.

3.3.6 Cross border issues

Note that tracts of forest, flood plain, river catchments, and coast continue across regional borders into neighbouring CDEM Groups. Harmonisation of warnings with these regions is essential so that a consistent warning message is received by all in an impacted area. This will reduce confusion and improve the rate of effective protective action being taken. This relates directly to the work already underway in respect of Land-based sirens.

In addition, warning of volcanic ash relates to volcanoes in other regions as well as within BOP, but rapid delivery of these warnings must nonetheless be planned in BOP as one of the main down-wind regions for receiving ashfall from New Zealand volcanoes.

3.4 Needs compared to options

3.4.1 Methodology for this options and needs review

This review utilises the national Public Alerting Options Assessment: 2014 update (Wright et al. 2014) and the updated decision support tool in Excel. The original assessment and tool are documented in MCDEM (2009).

The review follows a streamlined regional-level approach based upon the review of options for Waikato Region in 2015 (Wright et al.,2015).

All methodologies have been updated to incorporate new emerging options, including CAP, Cell Broadcast and the evolving capabilities of specific alerting platform and end-point vendors as available in New Zealand.

3.4.2 Scoring and basis

To successfully use the decision support tool to evaluate alerting options for BOP communities, a considerable amount of local information is required (Section 2.0). The methodology to collect this information and populate and use the tool is described below.

There is a wealth of information on the effectiveness of public alerting systems based on case studies from a range of hazard types and locations both national and international, as well as theory-based research applying psychology principles. The evidence for what constitutes an effective alerting system has been summarised and used to develop an effectiveness evaluation methodology for alerting systems in New Zealand (Leonard et al. 2005, 2006, 2008; Wright et al. 2014, 2015, Leonard et al. 2016). The effectiveness of each option is determined using a range of criteria, with an evidence-based scoring system. This scoring system forms the basis for a Public Alerting Decision Support Tool, which is described further in Appendix 2. The tool contains base effectiveness scores and these are modified as more detailed information on local hazards and demographics are added into the tool.

The tool also applies an estimated cost for each alerting system, which provides for cost effectiveness comparisons of systems. The range of criteria used to determine effectiveness of each alerting system is shown in Table 3.1. The ‘showstoppers’ (most critical considerations for effectiveness) are highlighted in red.

Table 3.1 Evaluation Criteria for Determining Effectiveness in the Public Alerting Decision Support Tool.

Evaluation Criteria	**Explanation, implications**
Activation time – Fast or nothing	Alerting and action time available
For fast onset, localised	Hazard, alerting and action time available
For fast onset, widespread	Hazard, alerting and action time, cost
For slow onset, localised	Hazard, alerting and action time available
For slow onset, widespread	Hazard, alerting and action time available, cost
Heads-up	**Reach people whatever they are doing**
Hearing impaired	Vulnerable groups, receipt of message
High pop density	Cost, economy of scale, reach of system
Immobile	Vulnerable groups, action esp. evacuation
Institutions	Vulnerable groups, dependent
Instruction	**Provides appropriate action information**
Language	Vulnerable groups, understanding of message
Low pop density	Cost, economy of scale, reach of system
Mental capacity	Vulnerable groups, understanding of message
On-going effect (ability to update message)	Change in at-risk area or required action
Opt-in required	**At risk population must subscribe and cannot unsubscribe**
Relies on (landline) telephony	Potential point of failure
Relies on electricity	Potential point of failure
Relies on internet connection	Potential point of failure
Robustness/resilience	Maintenance required, hazard resistant
Sight impaired	Vulnerable groups, receipt of message
Terrain	Topographic constraints on alert delivery
Time to reach all	**Congestion of networks, delivery time**
Transients/Visitors	Unfamiliar with local hazards, alerting systems and required actions

3.4.3 Heads up and instruction, and other 'showstoppers'

To produce the correct response from at-risk citizens during emergency events, both *Heads-Up* and *Instruction* are important for effective alerting.

Heads-up is the ability to inform a person that something unusual is occurring, regardless of where they are and what they are doing. It is something that inescapably grabs the attention.

Instruction is the content of the alert which informs the recipient not only that something is happening (heads-up), but provides detail on what is happening, where and when it is happening and what action is appropriate in response to the threat. For example, a hazardous chemical (hazchem) leak may require a different response (e.g., stay indoors and seal doors and windows) than a regional source tsunami (evacuate tsunami hazard zones) therefore *Instruction* is a critical part of the alerting message.

Opt-in highlights the need for the public to subscribe to, or install an alerting system to be able to receive alerts. An example of a subscription-based opt-in is signing up to an email, telephone-tree, telephone auto-dialler, or SMS-text alert distribution list. Opt-in systems that require installation include mobile device applications (apps) power mains messaging systems (ripple control) and tone activated alert radio. If people are required to subscribe to or install an alerting system this creates a potential barrier to uptake, particularly if there is a cost involved or requirement for technological proficiency. If a system is Opt-in then it is also likely to be able to be 'Opt-out', meaning at-risk citizens have the capability to modify the heads-up or instruction, or turn it off completely. This lowers the effectiveness of the alerting option.

Timely warnings are essential to maximising appropriate responses. The time to activate a system and create and deliver an alert to all of those at risk is an important consideration.

3.4.4 Initial indicative cost comparison

Table 3.2 provides relative effectiveness scores for selected alerting options, with indicative costs if implemented across the BOP CDEM Group. See Wright et al. (2014) for details on how the effectiveness scores were calculated.

The costs in Table 3.2 are not intended as a quote, but rather an indication of relative cost based on the per-unit costs given in Appendix 2.0

Table 3.2 effectiveness and indicative costs for alerting options for the region. Sorted by score under the categories of rapid widespread coverage, can reach 70% (more slowly), and cannot reach 70%.

		LOWDensity(100ppl/sq.km)		HIGHDensity(2500ppl/sq.km)		
		costSTART	costANNUAL	costSTART	costANNUAL	
	Effectiveness Score	Population:55659people		Population:213231people		
Rapid Widespread Coverage:		$k	$k	$k	$k	
Mobile device apps	83%	24	24	92	92	
Cell Broadcast	84%	10	10	39	39	
Tone-activated alert radio*	82%					
Fixed PA loud-speakers	68%	NA	NA	4,705	440	Maintenance, telemetry and testing
Can reach 70%						
High effectiveness:						
Power mains messaging	66%	1,114	0	4,266	1	Heads up only
Natural warnings	66%	200	200	768	768	ESSENTIAL FOR TSUNAMI
Slow to reach 70%:						
Radio announcements	82%	2	2	7	7	
Route alert(door-to-door)	71%	3,618	3,618	13,860	13,860	#staff available and time to walk/drive
Moderate effectiveness:						
Mobile PA loud-speakers	74%	558	0	220	1	GOODFORPOCKETS
Slow to reach 70%:						
Telephone trees	65%	145	145	557	557	
Radio (UHF, VHF or HF)	64%	1,415	24	5,421	91	Only houses/buildings
Telephone auto-dialler	64%	15	15	57	57	GOOD FOR POCKETS
Helicopter PA loudspeaker	64%	535	446	108	23	Due to #aircraft
SMS-PP text messaging	63%	16	11	47	42	GOOD FOR POCKETS
Pager s(triggering 200 people)	62%	174	87	667	334	Phasing out
Lower effectiveness:						
Sirens (signal-only) - Mobile	56%	-	-	-	-	CheaperthanPA,butslow response
Radio Data Systems*	52%					Noheadsup,slowtoreach 70%
Call-in telephone line	47%	1,166	1,146	4,412	4,392	Veryslowtoreach70%
Sirens(signal-only)-Fixed	44%	6,751	463	6,674	496	Headsuponly–slowresponse
Cannotreach70%:						
Television announcements	73%	2	2	7	7	GOOD BACKUP
Website banners	66%	280	2	1,073	7	
Independent self-maint networks	66%	10	10	38	38	GOOD FOR POCKETS
Mobile PA loudspeaker(Police/Fire)	66%	2	2	7	7	# vehicles & staff
E-mails	59%	25	10	52	37	
Newspaper content	58%	0	0	1	1	
GPS receiver messaging*	57%					Not internationally implemented
Websites	56%	286	7	1,094	28	
Marine radio	53%	2	2	7	7	
Tourist/Iwi radio	49%	2	2	7	7	
Billboards-static	47%	201	89	193	87	
Billboards-electronic telemetered	45%	0	0	1	1	GOOD FOR POCKETS

4.0 RECOMMENDATIONS

The following recommendations focus on public alerting as per the scope in Section 1.1. It is critical that public alerting is conducted within a wider context of risk management, community engagement, integrated planning (especially regularly-exercised Standard Operating Procedures), education, public physical exercises and evaluation.

4.1 SUMMARY – BACKBONES WITH INFILL OPTIONS

Public alerting should provide recipients with the best timely information to make an informed decision in a warning.

The public need to be clear that natural warnings are the fastest warnings. They must act on these without hesitation. There is a risk that an enhanced alerting system may cause people to assume they should wait for an official alert. This must be mitigated. Regular exercises (e.g. annual for all schools) are seen as a very effective way to calibrate expectations and education about correct actions for each warning type.

This review recommends a system of options for multi-hazard public alerting. The effectiveness scores of Wright et al. (2014) for each tool are used here unmodified. We recommend a backbone of a mobile app and Cell Broadcast to reach the majority of the population with a heads up and instructions. These two options score most highly in Wright et al. (2014) based on warnings best-practice, and are now both available in New Zealand. In addition, they are expected to be the most cost-effective way to reach the vast majority of the population. A summary of alerting best-practice and the scoring and pricing basis are given in Appendices 1 and 2. Detailed referencing of research behind Appendix 1, and the scores given in Appendix 2 are detailed in Wright et al. (2014).

Infill options for pockets and groups without mobile phone access should be given by telephone auto-dialler in the first instance, supported by warning into self-maintaining networks, agencies with people in their care, and reinforcement messages via web, and social media. A one-stop-shop (e.g. single focal point website, Section 4.6) to understand the alerting system for all people in the region is recommended. A multi-end-point platform should be considered to service all alerting options at once. Whispir is vendor that provides such a platform currently to Auckland CDEM Group and MCDEM for the National Warning System. Existing systems should be maintained until new options come online. Targeted options may continue to be needed for specific cases – e.g. SMS, email etc.

Recommendations are given for the detailed RfP and procurement processes in Section 4.11. An approximate Whispir-type pricing is used for the indicative costs in Section 4.12.

4.2 MUST SUPPORT NOT CONFUSE NATURAL WARNINGS

The 'Long, Strong, Gone' natural warning message for tsunami is the single most important warning that all people in the BOP and the wider country must (a) know and (b) respond to without hesitation. It is important because it gives the maximum time for protective action, and for close tsunami sources it may be the only warning before impact. This is in addition to 'Drop, Cover and Hold' during the earthquake itself.

If official warning is perceived to cover local-source tsunami, or is expected to be required before protective action is taken, the risk can actually be increased by the enhancement of technological warning systems. This is a real concern, voiced by emergency managers in

Tohoku in 2011 (Fraser et al., 2012) following that tsunami, and seen in recent surveys in New Zealand (Dhellemmes, in prep). The development of official warnings as recommended here MUST be accompanied by education and annual physical evacuation exercises to clarify the over-riding importance of responding to natural warnings without hesitation. This is included as FTE staffing to support response to natural warnings indicatively costed in Section 4.12. This would include community response plans, wide education and engagement with the whole community annually, and annual exercises. The costing is based on 6 years of experience in Wellington Region, where a 1 FTE : 70,000 people ratio is producing only moderate preparedness and action (2015 survey - Dhellemmes, in prep, and Kaikoura 2016 actions survey - Johnston, in prep). Wellington Staff agree that a roughly 1 : 25,000 people ratio would be needed (ie. I staff member per four 6000 person neighbourhoods, or per eight 3000 person towns or neighbourhoods, etc.). There would also be additional benefit for wider community resilience and multi-hazard preparedness provided by this level of community engagement.

4.3 IMPORTANCE OF HEADS-UP AND MESSAGE

While some systems may give an awareness (e.g. tone-only sirens) and others may give a message (e.g. Radio Stations), systems that provide a heads up and message wherever a person is or what they are doing are far more effective (e.g. Smartphone app, Cell Broadcast, Public Address Loudspeakers, Telephone Autodiallers, VHF Radio, RDS data systems).

We recommend that the BOP CDEM Group maintain regular contact with both The Red Cross Hazard App and MCDEM regarding Cell Broadcast. The ability to wake people up will become clearer from August 2017 handset testing, and similar functionality from the App is expected to follow.

4.4 BACKBONES

Cell Broadcast and a Mobile App should be considered as backbones that can reach the large majority of the population at home and work. They are cost effective and are in theory very high scoring for effectiveness. Substantial FTE staff costs must be allocated to support the roll-out, education, planning and exercise testing to maintain and improve effective response to these systems. This should be delivered as part of the job of FTE staffing to support response to natural warnings indicatively costed in Section 4.12.

The actual effectiveness of apps depends on whether people have installed and configured them correctly. Therefore, a substantial permanent sustained education and exercising effort is needed to maintain a high level of installation, testing and effectiveness. Some evaluation of the rate of uptake is needed. Regular physical exercises for the public (e.g. annually) are a particularly effective component of education and testing. This should be delivered as part of the job of FTE staffing to support response to natural warnings indicatively costed in Section 4.12.

The Red Cross Hazard App is currently in use for the region and has two substantial issues that need addressing before it achieves the high theoretical effectiveness of apps, besides the above-mentioned need for it to be installed:

1. Alert fatigue and general poor reviews are contributing to people not installing, or uninstalling the app. And the volume of weather-related alerts may also be diluting the likelihood that people will notice infrequent life-safety alerts when they come through.
2. It does not currently effectively wake people up, because alerts come through as a typical push-notification with a minor alert sound and/or vibration.

Cell Broadcast cannot be uninstalled, and the rate of alert fatigue is aimed to be minimised by limiting its use via criteria for use to infrequent life, health or property safety alerts only. Wake-up may be achieved by, for examplea mixture of, (a) over-ride of silent mode, or (b) configuration of the handset, based on initial handset testing in August 2017.

Because of the availability of WIFI provided by non-cellular Internet Service Providers at most homes and workplaces, the Cell Broadcast/Mobile app backbone combination can be considered a partial redundancy in terms of channel, and also in terms of the technology originating and delivering across different channels.

4.5 ALERTING END-POINT PLATFORM

An alerting end-point platform should be implemented that ingests CAP alerts and distributes them to the following end-points at the same time.

- VOIP auto-dialler
- SMS lists (for any specific small groups that need different alerting to Cell Broadcast, or which are not currently Cell Broadcast enabled).
- Email
- Social media
- Press release
- Website
- CAP RSS feed for all other alerting end points

Whispir is vendor that provides such a platform currently to Auckland CDEM Group and MCDEM for the National Warning System.

4.6 ONE-STOP-SHOP

A one-stop-shop should be considered – a place where all people in the region can go to understand what channels are available to whom and for where, and for what hazards throughout the region. This could be a website and is not intended as a warning system, but rather a pre-warning portal to allow clear explanation of and access to warning services ahead of the need to warn.

It should be made clear how the population are grouped in terms of channels available for alerting, how to identify what group(s) you are in, and how to get those alerts for each group e.g. Leonard et al. 2016.

4.7 INFILL

An additional layer of regionally-coordinated alerting is also needed for people and areas (groups and pockets) that are without mobile phone coverage or smartphone access. This will depend on the cost and on the total number of people who need to be reached beyond the backbone. The following high-scoring relatively low-cost systems should be coordinated at a regional level and made available for CDEM Group members to use:

- Voice-Over-Internet-Protocol (VOIP) auto-dialler system – should be investigated as a first priority. These use copper (and in future likely fibre-optic) connections which are separate to cell phones, providing a suitable alternative in many cases where cell cover is lacking. VOIP has the advantage of being possible relatively quickly to many lines from a server, rather than older obsolete physical analogue auto-diallers that required one phone line out for every parallel phonecall – heavily limiting the rate of calling.
- SMS should be maintained while Cell Broadcast compliant handsets become more readily available (see Section 4.4).
- A watching brief should be maintained on other emerging options in Section 4.9
- Public Address Loud Hailers may be appropriate and cost effective in a limited number of areas where large numbers of people are vulnerable to short lead-time warnable hazards (e.g. tsunami) but may not have access to Cell Phone or landline alerting (e.g. beaches).

4.7.1 Determine areas lacking mobile coverage

Further work should be done to complete the mobile coverage mapping for the region – such as at the level of analysis already completed by Whakatane District. This could be a piece of GIS in-house or contract work at districts' or regional level.

These should be coordinated with the rural broadband Initiative 2 – Mobile Black Spot Fund. The two links below provide further reading around the fund and areas being targeted for improved coverage.

Overview of RBI2 Mobile Black Spot Fund:

https://www.crownfibre.govt.nz/ufb-initiative/rbi2-mobile-black-spot-fund/

RBI2 MBS Tender – has PDFs listing tourist and highway locations targeted with the fund: http://www.crownfibre.govt.nz/tenders/

4.7.2 Areas covered by landline but without mobile coverage

These areas should be covered by VOIP telephone autodialler utilising the landline network.

Note that recently Spark has announced that the copper wire network may be replaced by fibre optic and other technologies in the future: https://www.sparknz.co.nz/news/pstn-upgrade/

4.7.3 Groups that do not speak English

These should be covered by specific warning arrangements into their existing self-maintained networks

4.7.4 People travelling on highways

Specific warning arrangements with NZTA via CAP will be developed via the CAP Working Group. The Region should originate it's warning in CAP to access the increasing number of NZTA end-points (such as digital sign boards).

4.7.5 Tourists

Additional mobile alerting to tourists should be explored. There is a potential variability in operation of Cell Broadcast on foreign handsets brought in by tourists. Two options include liaison with the Campermate App to get warnings to its users, and discussion with Tourism New Zealand on advertising for the installation of the Red Cross Hazard app with arriving tourists. Commercial tourist attractions could be a conduit for disseminating warnings to tourists at their facilities.

See: https://www.campermate.co.nz/

4.7.6 Places where people may not have or may not hear their mobile device, and are not near a land-line

Beaches may need outdoor alerting via PA Loudspeakers because of the potential for rapid onset hazards (regional-source tsunami). These are expensive to install and maintain and coverage should be prioritised within budget to the largest numbers of people present, and also consider areas without mobile coverage as a higher priority. If these options are feasible, they should not be installed without a permanent adequate ongoing budget for regular maintenance, testing and exercises. Section 3.3.3 names beaches patrolled by Surf Lifesaving Clubs and these could perhaps be the 8 highest priority locations in terms of population at risk. Additional redundancy during patrol periods into existing club arrangements (phone line) should be developed.

Additional remote tourism hotspots have been considered for similar arrangements, e.g. Blue Lake (Rotorua District) and McLaren Falls (Western Bay District) – however, the lack of rapid onset hazard at these types of locations indicates that mobile device alerting would likely suffice, even if there is a delay in people noticing the alert.

4.7.7 Agencies with people in their care

Specific warning arrangements into existing internal communications of large companies and government agencies should be developed. The list of organisations considered in this review is given in 3.3.5 with an estimate of the population included.

4.7.8 Helicopter mobile PA

Wellington Region has previously used and tested Public Address systems attached to helicopters for public alerting, and Auckland has one unit available for use now.

Media reports during testing indicated that a significant proportion of the population could not clearly hear the address message and the exercises caused confusion.

4.8 ADDITIONAL LOW COST REDUNDANCY/REINFORCEMENT CHANNELS

The following options should be enhanced and maintained permanently at a regional level because they provide very cost effective additional alerting:

- Media arrangements
- Connection to self-maintaining networks
- Connection to large agencies with people in their care
- Social media

- Websites
- Other CDEM Group members alerting capacity (especially route alert door to door, Police and Fire vehicle loud hailers)

4.9 OTHER OPTIONS TO WATCH

Two options that are potentially available in the future are:

- Tsunado – a Radio Data System triggered option that is currently in concept phase. A detailed specification and potential cost basis has been delivered to BOP CDEM Group.
- Power Line messaging – available only in Northland. This is developmental in another region

We recommend maintain a watching brief to keep an eye on viability for both of these options. Neither is currently a mature viable option for BOP. Their effectiveness, cost and exact details will need further work and analysis if they become available in BOP.

4.10 MAINTAIN EXISTING SYSTEMS

It is important to maintain all existing systems initially to overlap as the new systems come online over 2017-18 and beyond if necessary.

The existing systems should be integrated to the above systems as follows:

- Text Alerting – largely replaced by Cell Broadcast, available via End-point Platform provider as needed
- Email Alerting – to platform
- Facebook – to platform
- Twitter – to platform
- Red Cross Hazard App – to CAP RSS feed
- Land Based Sirens – replace to CAP RSS triggered PA loudspeakers, only in areas where the backbone is ineffective (e.g. large populations at beaches). Beware of cost and relative cost effectiveness compared to the backbones.
- Stinger Sirens that give a message should be maintained where they are an appropriate in-fill alerting option given their deployment time and rate of warning delivery (ie. driving time).

4.11 RFP AND IMPLEMENTATION PROCESS

Prior to implementation the balance of backbone and infill options will need to be agreed. Further specifications will then be needed for Requests for Proposals from manufacturing vendors. Points of clarity will be needed from external parties for national initiatives around Cell Broadcast and Mobile Apps (primarily a final statement on when wake-up functionality will be available and in what way), and for regional opportunities that are evolving as mentioned in Section 4.9.

4.12 EXAMPLE INDICATIVE SOLUTION

The breakdown of costing in **Table 4.1** is an indicative solution to implement the above recommendations. This is not a quote. The exact costs should not be relied upon because they will be dependent upon detailed proposals being quoted from vendors following this review.

The breakdown illustrates the following points:

- The backbone of an app and Cell Broadcast are cost effective but the annual cost of staff time to maintain procedures, education and exercising around them must be budgeted for as it is a substantial amount of work.
- The infill via a telephone auto-dialler system and targeted SMS messaging has an annualised direct and staff cost, and also a per message cost that must be allowed for.
- 10 Fixed PA loudspeakers are included for example. These could be targeted at the highest use beaches and/or tourist locations with limited cell coverage – for example. The cost basis needs to be confirmed at the RfP stage.
- Additional redundancy and reinforcement systems require staff time to be budgeted and annually sustained and are important for further infill and especially to reinforce warning messages in a crisis.

Table 4.1 Indicative approach to determining cost (in $1000 of dollars) of an example solution for BOP public alerting. Note the 70% reach criteria relates to a minimum reach dispersed throughout any one location of at least 70% of people to then be able to expect informal warning to be given to most of the remaining people.

		LOW Density (100 ppl/sq.km)				HIGH Density (2500 ppl/sq.km)				
		Population: 55659 people				Population: 213231 people				
	Score	reach/#	cost START	cost ANNUAL	ANNUAL IDIRECT	reach/#	cost START	cost ANNUAL	ANNUAL IDIRECT	
Rapid Widespread Coverage:			$k	$k	$I		$k	$k	$k	
Mobile device apps (score REQUIRES widespread install, and wakeup)	83%	90%	22	22	15	90%	83	83	58	
Cell Broadcast (score REQUIRES wakeup)	84%	60%	6	6	5	90%	35	35	29	
Rapid targeted coverage:										
Fixed PA loud-speakers (10 units)	68%		-	-		10 locations	500??	50??	25??	Maintenance, telemetry and testing
Can reach 70%										
High effectiveness:										
Radio announcements	82%	70%	1	1	0	70%	5	5	0	No heads up, slow to reach 70%
Moderate effectiveness:										
Natural warnings	66%	70%	140	140	39	70%	537	537	149	Required for tsunami. Cost = full plans, education and exercises supported.
Slow to reach 70%										
Telephone trees	65%	10%	94	94	0	5%	28	28	0	70%
Telephone auto-dialler	64%	10%	1	1	1	5%	3	3	2	GOOD FOR POCKETS
SMS-PP text messaging	63%	10%	6	1	1	10%	9	4	3	GOOD FOR POCKETS
Pagers (triggering 200 people)	62%	10%	17	9	9	5%	33	17	17	Phasing out
Cannot reach 70%:										
Mobile PA loud-speakers	74%	0%	0	0	0	5%	11	0	0	GOOD FOR POCKETS
Television announcements	73%	50%	1	1	0	50%	3	3	0	GOOD BACKUP
Website banners	66%	50%				50%				Provided with CAP uptake
Independent self-maintaining networks	66%	10%	1	1	0	10%	4	4	1	GOOD FOR POCKETS
Mobile PA loudspeaker (Police / Fire)	66%	1%	0	0	0	10%	1	1	0	# vehicles & staff
E-mails	59%	10%	16	1	0	10%	19	4	0	
Newspaper content	58%	50%	0	0	0	50%	1	1	0	
Websites	56%	2%	6	0	0	2%	22	1	0	
Marine radio	53%	2%	0	0	0	2%	0	0	0	
Tourist/Iwi radio	49%	5%	0	0	0	5%	0	0	0	
Billboards – static	47%	10%	20	9	9	10%	19	9	9	
Billboards - electronic telemetered	45%	15%	0	0	0	15%	0	0	0	GOOD FOR POCKETS
TOTALS			$331k	$286k	$79k		$1313k	$785k	$293k	
Startup total (year 1)	$ 1,644k									
Annual (Year 2 onwards)	$ 1,071k									
Annual Direct Costs (no FTE) only	$372k									

4.13 Additional recommendations that emerged

Section 1.1.1: Additionally, the mapping of exact mobile phone coverage black spots is a complex task beyond scope, that could be its own project (see the Whakatane District project completed to date); or it could be developed as an ongoing programme of input from communities over the implementation phase of improved alerting for BOP region.

Section 3.3.3: Because of the inaccuracy of network provider maps, mapping of all blackspots is not possible within the scope of this report. A map of regional population coverage problems will need to be maintained and updated as the alerting options are rolled out, and used to target in-fill alerting (Section 4.7).

Section 3.3.3: Note that the surf lifesaving region extends into Gisborne and Waikato Regions. The BOP CDEM Group need to agree and harmonise the approach and messages with these groups.

Section 3.3.4: The most significant impact of age is likely to be a decreased access to technology, which is relevant to internet and mobile phone-based alerting, and in aged care facilities, a reliance on carers to disseminate information or take action. If backbone alerting relates to access to these technologies, a slightly higher rate of infill notification using other means may be needed in areas with older populations, especially the Western Bay of Plenty rural areas.

Section 3.3.4: Hearing impaired alerting needs to be considered through the existing channels to communicate with this community, e.g. voice to text solutions. Along with considering other disabilities, solutions for these groups need to be explored by BOP CDEM Group with supporting agencies for this community.

Section 3.3.5: BOP CDEM Group regularly attends the NZCAP working group and we recommend they take up opportunities with national agencies with people in their care as they emerge from that forum.

Section 3.3.6: Note that tracts of forest, flood plain, river catchments, and coast continue across regional borders into neighbouring CDEM Groups. Harmonisation of warnings with these regions is essential. In addition, warning of volcanic ash relates to volcanoes in other regions as well as within BOP, but rapid delivery of these warnings must nonetheless be planned in BOP as one of the main down-wind regions for receiving ashfall from New Zealand volcanoes.

4.14 Prioritisation

1. We recommend that backbone options are costed in detail and implemented first.
2. Natural warning staff FTE increases should be implemented with high levels of community engagement, education and exercises throughout the region at a sustained level.
3. An RfP for an alerting end-point platform should be released
4. A full regional study of cell coverage should be commissioned, along with consideration of situations that may need fixed PA loudspeakers because of lack of access to mobile phone, internet and auto-dialler based alerting.
5. An RfP for fixed PA loudspeakers to match the above need (if any) should be released.
6. Ongoing research should be conducted or commissioned into infill needs to use the end-point platform options (particularly telephone autodialler).
7. The system should be reviewed in 3-5 years.

5.0 ACKNOWLEDGEMENTS

This analysis was conducted in partnership with the BOP CDEM Group for key aspects to ensure in-house capacity for implementation would remain following the completion of this report. Paul Bourton lead the compilation of much of the regional and district level demographic, alerting needs and hazard data, edited the wording of Section 1.1, 2.1 and 2.3 to ensure these match regional arrangements, and liaised with potential alerting system vendors to obtain indicative pricing. We thank Kevin Fenaughty at MCDEM for checking the report wording in relation to key national initiatives. We thank Maureen Coomer and Greg Holland for their review of the draft report. David Johnston and Julia Becker provided input on structure and approach.

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APPENDICES

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A1.0 APPENDIX 1: PRINCIPALS OF EFFECTIVE PUBLIC ALERTING

For a more detailed explanation, and comprehensive research referencing, of much of the content in this chapter see Wright et al. (2014) and Leonard et al. (2008). We also recommend Mileti and Sorensen (1990), Sorensen (2000) and Mileti and Kuligowski (2008) as essential reading.

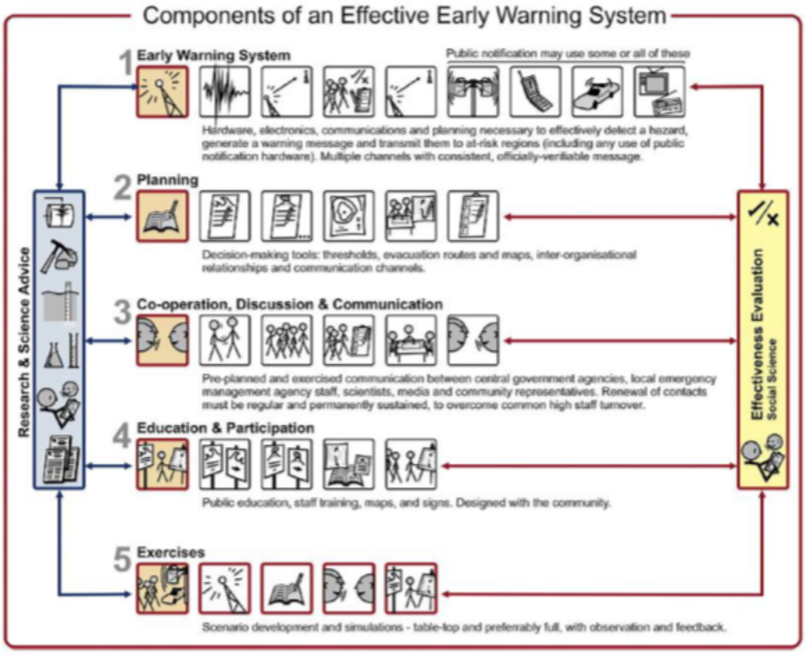

Figure A1.1 Components of effective early warning systems (Leonard 2008).

An effective early warning system includes the wider set of actions necessary to ensure that a hazard is not only detected and recognised, but also that the warning message to those at risk is delivered and acted upon in an appropriate way. Early warning systems encompass a broad range of technologies, behaviours and planning (**Figure A1.1**). Public alerting systems are only one component of an effective early warning system (EWS).

A1.1 MULTI-HAZARD EFFECTIVENESS

For maximum cost-benefit in a complex hazardscape (as exists in BOP), public alerting options that are appropriate for use during different types of emergencies are recommended. Many alerting options have the functionality to provide *Instruction* as well as '*Heads-Up*' (see Section 2.5), and this makes them more flexible for use in multi-hazard environments because the response and safety actions for different hazards can differ, so different alerting information needs to be delivered.

A1.2 Natural, Official, and Informal Warnings

There are three main types of warnings: natural, official and informal. Natural warnings are phenomena that could indicate to people that a hazard threat is imminent. Natural warnings can be thought of as triggers that can prompt those at-risk to take the correct actions if adequate understanding of the hazard and appropriate response is already established. Natural warnings are not available for all types of hazards but for some hazards they are the most reliable alerts available (e.g., earthquake shaking for local source tsunami threat). Natural warnings require considerable public education effort to be effective as they are *Heads-Up* only, and the associated threat often has a very rapid onset.

Official warnings are those delivered using public alerting mechanisms by agencies with a legal duty to maintain and use warning systems in emergencies as described in the CDEM Act 2002.

Informal warnings are those received from non-official sources, such as friends, family, overseas media channels, or (non-official) social media. They may be official warnings that are being passed on, or they may be from a less authoritative source. Informal warnings may be valid, and for life safety situations it is recommended that they be acted on if the threat could be immediate and then verified after safety actions have been taken.

A1.3 Multiple Systems and Minimum Desired Reach

Research into alerting effectiveness has indicated that if official warnings reach at least two thirds of the population, they have highly effective coverage (Mileti and Sorenson 1990, Mileti and Kuligowski 2008). This is because of the power of informal warnings. Informal warnings are passed on by those who receive official warnings. Research into warning delivery and receipt has shown that one out of three people will receive their first warning about an emergency as an informal warning. It is recommended that at least one official public alerting system reach at least two thirds (ideally >70%) of the population.

The 70% of people reached by the alerts must be distributed throughout the impacted population to allow for the informal warning. We recommend that the same warning message is delivered using as many different systems as are available. This provides redundancy should one system fail or be non-operative.

A1.4 Message Content

An official public alert should provide clear and concise information on the nature of the hazard threat, and the appropriate response to this threat. The alert should come from a single verified and trusted source and be delivered in a timely manner that allows those at-risk to respond effectively.

A2.0 APPENDIX 2: AVAILABLE ALERTING OPTIONS

This table presents the available alerting options, their effectiveness and cost-basis as per Wright et al., 2014, 2015, emerging technologies (primarily Cell Broadcast) and indicative quotes obtained from vendors for this project.

Table A2.1 Cost basis summary for alerting options.

		Additional startup	cost startup / 1000 people	FTE / 100,000 people	cost annual / 1000 people (minimum - includes training, exercises etc.)	cost startup / 1000 people	FTE / 100,000 people	cost annual / 1000 people (minimum - includes training, exercises etc.)	
	SCORE			LOW density			HIGH density		NOTES regarding cost basis
Natural warnings	66%			4.00	1,000		4.00	1,000	Based on education pre-event. Heads-up time depends on hazard. 1 FTE per 25,000 people, or 4 6000 person communities or neighbourhoods. Estimated from effort over 6 years in Wellington region across 70,000 people. Provides wider benefit for resilience building and multi-hazard preparedness.
Independently self-maintained networks	66%			0.20	50		0.20	50	Based on staff effort to maintain relationships and testing.
Reliant on third party hardware and/or staff									
Aircraft banners	48%	5,000	400	0.01	200	100	0.01	50	Based on equipment purchase, flight time costs.
Helicopter PA loudspeaker	64%	20,000	1,600	0.01	8,000	400	0.01	100	Based on equipment purchase, flight time costs. 2 minute hover, 1 minute flight. 1000 per hover HD, 10 per LD
Billboards - static	47%	3,500	2,000	0.01	1,600	500	0.01	400	Based on monthly rental, reaching 10k people per board
Billboards - electronic telemetered	45%		unknown	0.01	unknown	unknown	0.01	unknown	
Break in broadcasting*	77%	large cost	not costed		not costed	not costed		not costed	LIKELY TO NEED NATIONAL ARRANGEMENT
Call-in telephone line	47%	20,000	20	0.01	20,592	20	0.01	20,592	Based on autodialler costs. Passive mechanism.
E-mails	59%	15,000	1	0.25	10	1	0.25	10	Database build (partially source from platforms, subscribers), using infinite size, rate of emailing limit? End user cap?
GPS receiver messaging*	57%		unknown		unknown	unknown		unknown	Needs INTERNATIONAL work to cover New Zealand, receivers must be changed to receive.
Marine radio	53%			0.05			0.05		Only reaches boats. Assumes exist in all boats, already have transmitter. Effort to maintain and exercise.
Mobile PA loud speaker (Police / Fire)	66%			0.05			0.05		Effort to maintain and exercise. Limited by number of units and speed.
Mobile device apps	83%		-	0.20	300	-	0.20	300	Rough estimate based on general 2016 experience
Cell broadcast	84%	-	-	0.05	150	-	0.05	150	Assumed scaled to 2016 mobile device apps. NO DATA
Newspaper content	58%			0.01			0.01		Press release

Pagers (triggering group of 200 people)	62%	312	1,560	0.01	1,560	1,560	0.01	1,560	One pager reaches200 people, up to 100 pages per month. + effort to coordinate.
Power mains messaging	66%	250,000	20,000	0.01		20,000	0.01		$50 per house, 2.5 ppl/dwelling (2006 census)
Radio announcements	82%			0.05			0.05		Effort to maintain and exercise
Route alert (door-to-door)	71%			100.00			100.00		Limited by avg. proportion of staff on duty and per per person rate of visits. Wont reach the majority if widespread diffuse areas
Social Media									
SMS-PP text messaging	63%	5,000		0.10	130		0.10	130	BULLETIN - Annual licence for web-based system. Cost to send message 13c per SMS. Cost is based on two tests. Subscribers must sign up.
Telephone auto-dialler	64%			0.10	200		0.10	200	TNZ - VOIP based system - no subscription but must create and upload database - 0.5 FTE to create and 0.25 FTE for maintenance. Capacity 700 calls per minute. Can be increased by request for emergency or' burst' calls Broadly consistent with informal indication (1c per second) of 2017 cost for platform multi-endpoint option in place for another region (ongoing discussion with BOP CDEM Group)
Telephone trees	65%			4.00	10		4.00	10	High effort required. Likely cap on completeness and accuracy of list
Television announcements	73%			0.05			0.05		
Tourist radio	49%			0.05			0.05		Reaches only maximum number of people listening to this station
Websites	56%		5,000	0.05	100	5,000	0.05	100	Price of one website and hosting, but limited to people viewing
Website banners	66%		5,000	0.05		5,000	0.05		Not currently in use. Cost basis would need investigation with ISPs.
Dedicated hardware									
Fixed PA loud-speakers	68%	20,000	80,000	0.10	8,000	20,000	0.10	2,000	Limited by proportion of people who know meaning.
Mobile PA loud-speakers	74%	1,000	10,000	0.05	-	1,000	0.01	-	TAUPO - Wellington build your own. $50k for 12, reaches 400 ppl/sq km dense, 1/4 of that diffuse. 10% annual maintenance
Bells, air horns	50%			0.01			0.01		
Flares, explosives	43%		10,000	10.00	2,000	200	10.00	40	Pack of 30 = $3k, flare reaches a few people in diffuse areas and a few hundred dense. Replace 20% every year
Radio Data Systems*	52%	5,000	25,000	0.50	100	25,000	0.50	100	Cost to reach 200 people + effort to coordinate response groups and exercise
Radio (UHF, VHF or HF)	64%	5,000	25,000	0.50	100	25,000	0.50	100	Cost to reach 200 people ($5,000) + effort to coordinate response groups and exercise - Gisborne costs?
Sirens (signal-only) - Mobile	56%								
Sirens (signal-only) - Fixed	44%	28,000	112,000	2.00	8,000	28,000	0.50	2,000	Based on $1,130,000 for 45 towers (varying siren numbers per tower)
Tone-activated alert radio*	82%	120,000	50,000	0.10	1	50,000	0.10	1	E60 per unit - unlikely to have high uptake unless paid-for and supplied

A2.1 EFFECTIVENESS EVALUATION AND THE PUBLIC ALERTING OPTIONS DECISION SUPPORT TOOL

There is a wealth of information on the effectiveness of public alerting systems based on case studies from a range of hazard types and locations both national and international, as well as theory-based research applying psychology principles. The evidence for what constitutes an effective alerting system has been summarised and used to develop an effectiveness evaluation methodology for alerting systems in New Zealand (Leonard et al., 2005, 2006, 2008; Wright et al., 2014). The effectiveness of each option is determined using a range of criteria, with an evidence-based scoring system. This scoring system forms the basis for a Public Alerting Decision Support Tool. The tool contains base effectiveness scores and these are modified as more detailed information on local hazards and demographics are input to the tool.

The tool also applies an estimated cost for each alerting system, which provides for cost effectiveness comparisons of systems. The range of criteria used to determine effectiveness of each alerting system is shown in Section 3.4.2. The 'showstoppers' (most critical considerations for effectiveness) are highlighted in red and explained in Section 2.5.1.

A2.1.1 Information required to populate the decision support tool

The Public Alerting Decision Support Tool requires information to be input to determine the effectiveness of each system for specific communities, such as towns, cities, districts or regions. Some of the information is available from the NZ Census on the Statistics NZ website. Other information is best sought from local CDEM practitioners or local authority and community representatives. The following information is necessary to apply the tool:

- Population count – low and high density population counts for the area of interest; high density = >200 people/km2)
- Demographics – information about groups of citizens who might have increased barriers to receiving certain types of alerts (e.g., communities with many elderly people, possibly having higher levels of sight or hearing impairment and lower rates of mobile device ownership). The tool asks for information on groups with sight, hearing, mobility or intellectual impairments, and those with English as a second language
- Telephone coverage; mobile and fixed – many alerting systems require telecommunications through either mobile or landline networks
- Transient populations – this includes the number of visitors to the area (tourists and others from outside the location such as seasonal workers) who may be unfamiliar with the local hazards and the local alerting systems
- Those in the care of institutions – this includes the number of citizens who are housed in institutions such as hospitals; those who are temporarily in care such as pre-school, school and tertiary students; and those working in large campuses or workplaces. These people are likely to require an alert to be delivered to them via the institution in which they are housed
- Hazards of interest – hazards are grouped into four classes based on the lead-in time from hazard trigger to impact and the range or extent of impact. Classes are as follows: short lead-in time localised impact, short lead-in time widespread impact, long lead-in time localised impact and long lead-in time widespread impact.

- Budget – each alerting system requires some budget resource, which could be in the form of staff time for education and exercises, resources for education, financial input for purchase, installation and maintenance of dedicated systems, and/or licenses or charges to use third party systems. Costs are determined on a per-thousand population basis and are separated into start-up (establishment) and on-going.

Nearly forty alerting options are included in the decision support tool, including some options not yet readily available in NZ that are used overseas. These are categorised into third-party systems, dedicated hardware, natural warnings and independent self-maintained networks.

- Third-party systems are owned and operated by non CDEM agencies but can be used for alerting, e.g., TV, radio, mobile phone networks.
- Dedicated hardware is owned and operated by the CDEM agency e.g., PA systems or sirens.
- Natural warnings are those phenomena which are produced by the event that could indicate a hazard threat (e.g., strong or long shaking near the coast could indicate tsunami; heavy rainfall could indicate landslides or flooding).
- Independent self-maintained networks are non-CDEM agencies in contact with the public that could deliver an alert message to the public if agreements and arrangements are in place (e.g., surf-lifesaving groups, park rangers, neighbourhood watch). The decision support tool allows users to select which alerting options to include and exclude in any evaluation.

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Hawke's Bay Regional Alerting Systems Review

December 2021

Executive Summary

The project's purpose is to conduct a gap analysis and review of the current suite of public alerting tools in the Hawke's Bay region. This project also assesses the suitability of other alerting options for use across the region.

Public alerting systems should deliver the best timely information so that people can make an informed decision during a warning with as much time as possible for protective action. Two of the critical considerations for alerting are providing (1) *heads-up* and (2) *instructions*. *Heads-up* is the ability to inform people ahead of the threat. *Instruction* is the ability to provide details: what is happening, where, when, and what action is required to respond to the threat. This review recommends a system of public alerting options.

Recommendations

Emphasis on natural warnings. The public must be aware that an official warning may not be possible for certain events, and natural warnings may be the only source of warning. For local source tsunami, natural warnings are the fastest warnings. The public must be able to know and recognise these warnings and be ready to respond without hesitation. An enhanced alerting system may cause a risk of people waiting for an official alert before taking appropriate actions. This risk of overreliance on alerting systems must be mitigated with public education. Aligned with developing warning systems, it is recommended that warning systems MUST be accompanied by public education and with annual drills and exercises. Public education is needed to emphasise the overriding importance of responding to natural warnings.

Backbone. Emergency Mobile Alerts (EMA) through cell broadcasting, supported by mobile apps, should be considered the backbone of public alerting in Hawke's Bay. These systems can reach the vast majority of the population and give heads-up and instructions. During the 2019 nationwide EMA test, 77% of New Zealanders had access to the alert. EMAs rely on mobile coverage; to ensure broader coverage to areas with blackspots, we recommend the support of mobile apps. Mobile apps can ingest and replicate EMA using the internet (e.g., through fixed-line networks). Public education should also support the backbone to remind people about natural warnings and limits of EMA and mobile app systems.

Infill options. Additional layers of regionally coordinated alerting are needed to cover groups and pockets. An alternative option where cellular coverage is lacking is the voice-over-internet-protocol (VOIP) auto dialler system. Engagements, public education, and coordinated warning arrangements should be pursued with self-maintaining networks and agencies with people in their care.

Mobile coverage mapping. Further assessment is needed to investigate the available telemetry and alerting options to cover blackspots. An extensive regional study for network coverage should be commissioned. Information from the coverage mapping can be used to lobby for better coverage from providers.

Multi-end-point platform and one-stop-shop. Reinforcement messages should also be distributed through the web and social media to cover redundancy in various channels. A multi-end-point platform is encouraged to distribute alert information to different end-points (e.g. EMA, mobile app, social media, CAP RSS, etc.). The existing webpage on Hawke's Bay public warning system (https://www.hbemergency.govt.nz/get-ready/public-warning-systems/) should be maintained to be act as the one-stop-shop that provides clear explanation and access to various warning services.

Existing systems: Napier siren system. The current signal-only siren system in Napier is not fit-for-purpose in the context of current-day alerting. Although it provides a *heads-up,* it cannot provide detailed *instructions*. The rise-and-fall signal only intends to communicate the need to seek more information. The public might not know what the siren signal means unless this system is accompanied by extensive education on the appropriate actions to take when the signal is heard. Upgrading the current system to a PA loudspeaker system can be considered, so *instructions* can also be provided. However, a PA loudspeaker system has a high start-up cost and will have substantial ongoing maintenance costs. Its coverage is also restricted to narrow geographical areas. Therefore, the costs may not outweigh effectiveness in areas with already existing or alternative alerting options. Napier City, as an urban area, already has good coverage with EMA and mobile apps. Inclusion of an extensive plan for public education and exercises on sirens in Napier should take place, if it is decided the system be maintained or upgraded. Costs for maintenance or upgrade are likely to be better spent on public education on natural warnings, increasing network coverage, and strengthening the backbone.

Staff resourcing must be increased to enhance education on natural warnings and public alerting awareness, including recognizing and responding to warnings. Higher levels of community engagement, education, and exercise are needed throughout the region. The costs for these should be sustained on an annual basis.

Method

This review uses the national Public Alerting Options Assessment methods by Wright et al. (2014) and the updated Excel decision support tool. The methods were streamlined and used for regional-level review in Waikato (Wright et al., 2015) and Bay of Plenty (Leonard et al., 2017). The Public Alerting Options Assessment uses an evidence-based scoring system. The effectiveness of each alerting option was determined using a range of criteria developed from information from international and national cases studies and theory-based research (Leonard et al., 2017; Wright et al., 2014, 2015). An indicative solution with cost estimates is given in this report. However, the values are utilised only to compare the cost-effectiveness of systems. A caveat on the approximations, the costs will most likely have increased from the past studies' estimates.

The project team worked with the Hawke's Bay CDEM Group to source and compile information that is pertinent to alerting. This Hawke's Bay review looks at identifying alerting options that could alert the majority of the people. The review also focuses on finding gaps in the coverage of current alerting options. This review identifies 'pockets' – spatial gaps and special demographic groups – that would need alternative or additional alerting channels because of gaps in the current coverage. Recommendations for covering these gaps focus on available national and regional alerting options and identifying additional 'infill' options – potential solutions to fill these pockets.

Context

Hawke's Bay key demographics. Relative to some other regions, there is a sizeable Māori population in Hawke's Bay Region. Māori represents over a quarter of the region's population with 11 iwi groups, 91 hapū, and 79 marae throughout Hawke's Bay. Based on the 2018 census (Stats NZ, n.d.), the majority of the population (81%) reside in urban areas. Hawke's Bay population is older than the national average, with a median age of 40.6 years. Eighteen per cent of Hawke's Bay population is over 65, with Napier City and Central Hawke's Bay District having the highest proportion of people over 65 (at 20% each).

Hawke's Bay CDEM. The Hawke's Bay CDEM Group covers the four territorial authorities in the region: Central Hawke's Bay, Hastings, Napier, and Wairoa. Hawke's Bay CDEM manages multiple hazards, including hazards requiring rapid warnings for life safety. Rapid onset hazard events include tsunami from local or regional sources, serious chemical hazard incidents, heavy rainfall, surface flooding, wildfire, lifelines failure, and multiple urban fires. The Hawke's Bay CDEM Group provides the coordinated and integrated approach to how significant risks and hazards are managed in Hawke's Bay across the 4R's of emergency management: Reduction, Readiness, Response, and Recovery.

Regional and national alerting. Current arrangements for alerting in the region include using the following: EMA, social media, website, mobile app (Red Cross Hazard app), land-based sirens, helicopter public address system (PA), and door-knocking and outbound calling. Hawke’s Bay regional alerting aligns with national initiatives for alerting, including EMA, Red Cross Hazard App, Common Alerting Protocol, and the National Geohazard Monitoring Centre.

Keywords

Public alerting, hazards, options, warning systems

Bibliographic Reference

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Contents

1 Introduction

1.1 Purpose and context

The project's purpose is to conduct a gap analysis and review of the current suite of public alerting tools in the Hawke's Bay region. This project also assesses the suitability of other alerting options for use across the region.

The Sendai Framework for Disaster Risk Reduction (UNDRR, 2015) has emphasised developing people-centred multi-hazard warning systems and strong research and risk-based approaches to mitigation. New Zealand's National Disaster Resilience Strategy (Ministry of Civil Defence & Emergency Management, 2019) aligns with the Sendai Framework to gradually implement risk reduction efforts.

While at an overarching national level, various warnings are provided (e.g. Emergency Mobile Alerts (EMA), the Hawke's Bay Civil Defence Emergency Management (CDEM) Group and its Group members manage, maintain, and operate warning systems for the region. Communications and warning systems should have the components for effective alerting (Leonard et al., 2017). Ideally, the suite of alerting tool options for Hawke's Bay should:

- Reach Target Audience – The system should be able to alert or communicate with target groups effectively.
- Be Resilient – Individual systems should be resilient, and the comprehensive suite of systems should have redundancies. In addition, provisions should exist for backup systems and capabilities.
- Be Easy to Operate – Any system should be user-friendly and easy to operate for all the staff required to use it.
- Be Cost-Effective – Maintaining and managing systems should be cost-effective. The management of systems should consider ongoing and future costs for maintenance and operations.
- Use Multiple Channels – The comprehensive suite of systems should use different channels to ensure coverage.
- Operate Remotely – The systems should be accessible and operable remotely to guarantee warnings issuance and communication maintenance does not rely on fixed locations.
- Interoperable – Different warning systems, where possible, should be able to exchange information with each other.

1.1.1 Out of scope

Several areas will not be within the scope of the review:

- Public communication is an integral part of public warnings. However, the focus of this assessment will be on Hawke's Bay CDEM Group's alerting capability.
- The assessment will look at the set of available and existing tools and protocols of the Hawke's Bay CDEM Group. However, it will not assess or make recommendations on National Warning Systems-related alerting options.
- The assessment estimates costs for the alerting options, but these costs are indicative only based on the costs used in the Bay of Plenty Warning Alerting Systems review (Leonard et al., 2017). It is not within this project's scope to reassess these costs; however, it can be safely assumed that costs will have risen at least by the consumers' price index.
- The assessment will focus on the region-wide alerting options. The project will touch on Napier-specific issues and assess the Napier City Siren System's suitability against other options now available.

- The project will focus on public alerting and communication during an event and not assess the internal agency alerting and communication tools and protocols used within the Hawke's Bay CDEM Group and partners. Detailed assessments of the standard operating procedures to operate end-to-end warning systems are beyond this project's scope.
- The project provides recommendations to the Hawke's Bay CDEM group to consider but will not seek to identify any implementation plans for new alerting options.
- An overview of mobile coverage blackspots will be given in this report. However, detailed mapping for mobile coverage blackspots is beyond the scope of this project.

1.1.2 Current situation

The Hawke's Bay CDEM Group Plan indicates that the Group 'maintains an interagency warning and communication system, with the assistance of the administrative authority [...and] territorial local authorities maintain warning systems to alert their residents' (Hawke's Bay Emergency Management Group, 2014, p. 65) While the Hawke's Bay region has an adequate existing warning system, there is an opportunity to improve public alerting across the region. The Hawke's Bay region currently operates a suite of alerting tools as outlined in Section 2.4.

Tsunami warnings

The National Tsunami Warning and Advisory Plan by the National Emergency Management Agency (NEMA) states that:

> *'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'* (NEMA, 2020, p. i).
>
> *'NEMA uses the National Warning System (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'* (NEMA, 2020, p. 3).
>
> *'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'* (NEMA, 2020, p. 5).
>
> *'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'* (NEMA, 2020, p. 5).

CDEM Groups and CDEM Group members have responsibility for evacuations. The Tsunami Warning and Advisory Plan covers the three different categories of tsunami (distant-source, regional-source, and local-source). NEMA and GeoNet work to provide threat advice for all tsunami. However, an official warning may not be possible for local-source tsunami. Indeed, the National Tsunami Warning and Advisory Plan clarifies that official warnings are unlikely and should not be relied upon to take action. Natural felt signs are the primary warning for local-source tsunami.

'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' (NEMA, 2020, p. 7).

Weather, flood, and volcanic warnings

The Meteorological Service of New Zealand Ltd. (MetService) is the Official Alerting Authority that provides information about potential severe weather. It provides information to the individuals and agencies through a suite of different tools for issuing warnings and watches, including its website, app, the Common Alerting Protocol (CAP), social media, via media, email, and other communication channels (MetService, n.d.-a). GNS Science, through GeoNet, provides information on volcanic hazards; official volcano status information is given through the Volcanic Alert Bulletins, which summarises volcanic status, recent activities, forecasts, and any developing or expected problems (GeoNet, n.d.). The information is provided through several channels, including website, app, social media, media, and via email. For volcanic ash, the MetService operates the Wellington Volcanic Ash Advisory Centre (VAAC) and provides ash cloud forecast – ash suspended in atmosphere affecting aviation – for New Zealand and surrounding areas of responsibility (MetService, n.d.-b).

The Hawke's Bay CDEM Group runs the Hawke's Bay Regional Warning System (RWS) within the region using the Whispir Platform via SMS and email. A Hawke's Bay CDEM duty manager receives all warnings and alerts for the region, and seeks additional regional interpretation as appropriate, usually from the Hawke's Bay Regional Council, before disseminating using the RWS. The additional interpretation usually includes communication of severe weather impact (including flood warnings) and other hazards, aim at identifying potential risks and target areas

Fire warnings and hazardous substances

The Fire and Emergency New Zealand Act 2017 combined urban and rural fire services into a unified organisation: Fire and Emergency New Zealand (FENZ). FENZ has the mandate to cover urban and rural fire incidents and provide a range of emergency management functions, including events involving hazardous substances (FENZ, 2020). In addition, FENZ provides public alerting for fire and hazardous substances to directly affected people and, more broadly, via the media. The FENZ regional teams work closely with CDEM Groups' where alerting can be via regional public alerting channels as well. There is some shared responsibility with the Ministry of Health and regional health agencies on communication for hazardous substances, including warnings regarding smoke from fire.

1.2 Related documents

There are key references available for public alerting in New Zealand:

1. An updated review of public alerting options (Wright et al., 2014),
2. Hawke's Bay CDEM Group Plan (Hawke's Bay Emergency Management Group, 2014),
3. Emergency Mobile Alert: Protocol for user agencies (Ministry of Civil Defence and Emergency Management, 2017),
4. Technical standard Common Alerting Protocol: CAP-NZ (Ministry of Civil Defence and Emergency Management, 2018),
5. Tsunami advisory and warning plan: supporting plan (NEMA, 2020), and
6. An analysis of public alerting options for Bay of Plenty Regional Alerting System (Leonard et al., 2017).

1.3 Structure of this review

The project uses streamlined versions of the methods used in past alerting reviews like that conducted for the Bay of Plenty and Waikato regions (Leonard et al., 2017; Wright et al., 2015). This review uses tools and lessons from the past reviews. The review process is outlined below.

- The project team worked with the Hawke's Bay CDEM Group to source and compile information that is pertinent to alerting. This Hawke's Bay review looks at identifying alerting options that could alert the majority of the people.
- The review focuses on finding gaps in the coverage of current alerting options. This review identifies 'pockets' – spatial gaps and special demographic groups – that would need alternative or additional alerting channels because of gaps in the current coverage. Recommendations for covering these gaps focus on available national and regional alerting options and identifying additional 'infill' options – potential solutions to fill these pockets.
- The review also looks at special considerations for Napier, considering its denser urban population and specific hazards to tsunami.

Stage 1 – Analysis

We assessed the cost, reliability, reach functionality, and effectiveness of each alerting tool utilised by the Hawke's Bay CDEM Group.

1. The Joint Centre for Disaster Research (Massey University) team analysed the 2018 Census data(Stats NZ, n.d.).
2. The Hawke's Bay CDEM Group provided specific contexts, needs, and options (summarised in Sections 2 and 3) to ensure local knowledge was considered for the review.

The following specific topics were analysed:

- population data (high and low density),
- elderly populations (used as an indicator for hearing, sight, and mobility impaired populations),
- hazards that need a specific alerting focus (e.g., tsunami for coastal areas),
- rural and urban population composition of the region,
- telecommunications coverage,
- approximate mobile phone coverage,
- transient populations, and
- pockets that need infill options:
    - spatial gaps,
    - specific demographic groups (e.g. ethnic, language, special needs), and
    - agencies with people in care.

Stage 2 – Draft review

The draft review was subjected to feedback from the Hawke's Bay CDEM Group and was peer-reviewed by JCDR experts. As a result, further recommendations were made for improvements, modifications, and changes to the alerting suite.

Stage 3 – Review finalisation

Comments from Hawke's Bay CDEM Group on the draft review contributed towards the final recommendations presented in this report.

1.4 Capacity and relationship building

Data collection, partner agency contacts, and price indications were undertaken with consultation with the Hawke's Bay CDEM Group, wherever possible.

2 Context for alerting in the Hawke's Bay

2.1 Overview of the Hawke's Bay CDEM structure

The Hawke's Bay CDEM Group's role is to provide a coordinated and integrated approach to how significant risks and hazards are managed in Hawke's Bay across the 4R's of emergency management: Reduction, Readiness, Response, and Recovery. The Hawke's Bay CDEM Group covers the four territorial authorities (Figure 1): Central Hawke's Bay, Hastings, Napier, and Wairoa.

Figure 1. Hawke's Bay Territorial Authorities. Source: Hawke's Bay Emergency Management Group Plan 2014-2019

The Hawke's Bay CDEM Group is comprised of the following local authorities:

- Central Hawke's Bay District Council,
- Hastings District Council,
- Hawke's Bay Regional Council,
- Napier City Council, and
- Wairoa District Council.

The Joint Committee oversees the governance of the Group. The Joint Committee comprises the Chair of the Regional Council and elected representatives of each territorial authority in the region. The Coordinating Executive Group (CEG) oversees the management of the CDEM Group, membership to the CEG comprises of statutory or co-opted members. The Hawke's Bay CEG members include CEOs from the local authorities, representatives from the Fire Service Eastern Region, Police Eastern District, and Hawke's Bay District Health Board, CDEM Group Controllers, Group Recovery Manager, Chair of the Welfare Coordination Group, Medical Officer of Health, and the Chair of the Hawke's Bay Engineering Lifeline Group (Hawke's Bay Emergency Management Group, 2014).

Responsibilities for public alerting fall to members of CDEM Groups under the National CDEM Plan Order 2015. The order states:

'CDEM Groups;

- - must maintain arrangements to respond to warnings (s60(5));
- - Are responsible for (s62(6)):
  a. Disseminating national warnings to local communities; and
  b. Maintaining local warning systems. '

2.2 Hawke's Bay warnable hazards

The Hawke's Bay CDEM Group Plan describes the hazards managed by the Group. Table 1 summarises the hazards based on the need to disseminate rapid warnings from a life safety perspective. Rapid warnings require faster and more effective systems. In general, public alerting systems should have capabilities to warn the public of these rapid-onset hazards effectively. If alerts work for rapid warnings, they can also be expected to be effective for less time-critical events.

Table 1. Hazards applicable to the Hawke's Bay CDEM group (as per Part 1 of the Group Plan, 2014-2019) and the requirements for rapid warnings for life safety

Hazards requiring rapid warnings for life safety (short-onset, less than 3 hours)	**Hazards NOT requiring rapid warnings for life safety but are still appropriate for alerting**	**Hazards that currently cannot be warned for**
Tsunami – local source[1] Tsunami – regional source Serious Hazchem incident Heavy rainfall (Severe Thunderstorm/Flash flooding/debris flow) Stormwater surface flooding Wildfire/Rural fire Large-scale lifelines failure (Major air accident, electrical failure, telecommunications failure, dam break, etc.) Urban fire multiple	Flooding Tsunami – distal source Coastal storm Volcanic eruption with precursor (local or distal) Animal disease epidemic Human disease pandemic Biological pests and new organisms Drought Coastal erosion Windstorms Snow Hail Pollution over unconfined aquifer	Earthquakes[2] Extreme geothermal events or unheralded small volcanic eruptions Landslides Localised subsidence

[1]NEMA and GeoNet will seek to monitor, detect, and provide threat advice for all tsunami (including local-source). However, it may not be possible to issue warnings within sufficient time or accuracy. Natural warnings are still the best possible warnings in the immediate time. Groups, agencies, and the public should not wait for an official warning from NEMA (NEMA, 2020).

[2]The Android Earthquake Alerts System was initiated in New Zealand starting April 2021 and has issued a few earthquake early warning alerts to Android users. This alerting system was deployed without officials' involvement and should not be confused with alerts issued by civil defence authorities (McDonald, 2021).

2.3 Key demographic characteristics

This section describes the variation in demographics across the region that require consideration for different public alerting options. Agencies with people in their care are considered in Section 3.3.5 but not under specific demographic analysis.

2.3.1 Rural vs urban populations

The majority of the population (81%) reside in urban areas (based on the 2018 census). However, the range of effective and feasible alerting measures differs for high-density and low-density populations. Table 2 shows the distribution of urban-rural populations in Hawke's Bay.

Table 2. 2018 Census population summary giving total population and percentage in urban vs rural areas.

2018 Census Data	Population	Percentage
Urban Wairoa	4,527	54%
Rural Wairoa	3,840	46%
Urban Hastings	61,521	75%
Rural Hastings	20,016	25%
Urban Napier	62,241	100%
Urban Central Hawke's Bay	6,468	46%
Rural Central Hawke's Bay	7,674	54%
Region Total	166,287	
Region Urban	134,757	81%
Region Rural	31,530	19%

2.3.2 Ethnic group self-maintaining networks

Specific iwi communication channels provide an opportunity to reach a substantial part of the regional population. 6.8% of 2018 census respondents report speaking Māori (Stats NZ, n.d.). Relative to some other regions, there is a sizeable Māori population in Hawke's Bay Region. The Hawke's Bay Regional Council (2021) describes the culturally rich landscape of the region:

> *Hawke's Bay has a diverse and culturally rich landscape. Māori are Treaty partners as mana whenua and key members of our community.*
>
> - *Māori represent over a quarter of the region's population*
> - *There are 11 iwi groups, 91 hapū and 79 marae throughout Hawke's Bay*
> - *Eight iwi groups are represented post-settlement governance entities (PSGEs) on the Hawkes Bay Regional Planning Committee*
> - *Ngāti Kahungunu with Rongomaiwahine, coastal area is said to be from Paritū north of Mahia to Tūrakirae on the south Wellington Coast. Ngāti Kahungunu Iwi Inc composes six Taiwhenua with governance entities and operations on the ground, 4 of which are within the region*
> - *6.8% of Hawke's Bay speak Te Reo Māori*
>
> *Māori make a significant contribution to our region both as mana whenua and treaty partners and also through their ownership of assets; to economic development; participation in co-governance and their growing influence as kaitiaki in the conservation, preservation and management of our natural resources.*

Hawke's Bay CDEM Group needs to continue engaging with iwi group representatives to develop approaches to deliver alerts and collaborate with existing communication channels and community organisations. Hawke's Bay CDEM Group also needs to identify and follow up with other ethnic groups and communities for potential alerting.

2.3.3 Language barriers

According to the 2018 Census (Stats NZ, n.d.), 96.7% of the Hawke's Bay region population speak English. Two per cent (2.0%) do not speak a language (e.g., they are too young), leaving 1.3% – about 2,100 people – who may not speak English. Given the overall low proportion of the region who do not speak English and the diversity of other languages spoken, it is most effective to tie warnings directly into existing communication structures within these communities. Coordinating with self-maintaining networks is more effective than creating a regional system that warns in all languages.

Table 3. Spoken languages in Hawke's Bay as indicated in the 2018 Census

	Number of people	Of those who stated a language
English	160,908	96.70%
Maori	11,361	6.80%
Samoan	2,604	1.60%
Northern Chinese	435	0.30%
Hindi	696	0.40%
French	1,452	0.90%
Yue	525	0.30%
Sinitic not further defined	309	0.20%
Tagalog	633	0.40%
German	1,152	0.70%
Spanish	750	0.50%
Afrikaans	855	0.50%
Tongan	435	0.30%
Panjabi	1,125	0.70%
New Zealand Sign Language	948	0.60%
Other	5,436	3.30%
None (e.g., too young to talk)	3,357	2.00%
Total people stated	**166,365**	**100.00%**

2.3.4 Age

Hawke's Bay population is older than the national average, with a median age of 40.6 years. Eighteen per cent of Hawke's Bay population is over the age of 65. Napier City and Central Hawke's Bay District have the highest proportion of people over 65 (both at 20%), whereas Wairoa District and Hastings District have a slightly lower proportion of people over 65 (at 17%). See Table 4 for a summary of the district's age distribution of the region's population.

Table 4. Summary of Hawke's Bay population's age by district, based on the 2018 Census

	Wairoa		Hastings		Napier		Central Hawke's Bay	
	Count	% over total district pop.	Count	% over total district pop.	Count	% over total district pop.	Count	% over total district pop.
Under 15 years	1,965	23%	17,700	22%	12,321	20%	2,940	21%
15-29 years	1,503	18%	14,961	18%	10,740	17%	1,974	14%
30-64 years	3,465	41%	35,199	43%	26,712	43%	6,423	45%
65 years over	1,431	17%	13,689	17%	12,465	20%	2,799	20%

In terms of infill alerting demand, it should be noted that some rural parts of Hawke's Bay have a higher proportion of people over 65 years of age than the regional average; and these locations may also have mobile blackspots. Table 5 summarises the population counts of people aged over 65 in rural areas in Hawke's Bay using 2018 census data (Stats NZ, n.d.).

Table 5. Count and % population of people 65 years and over in rural Hawke's Bay

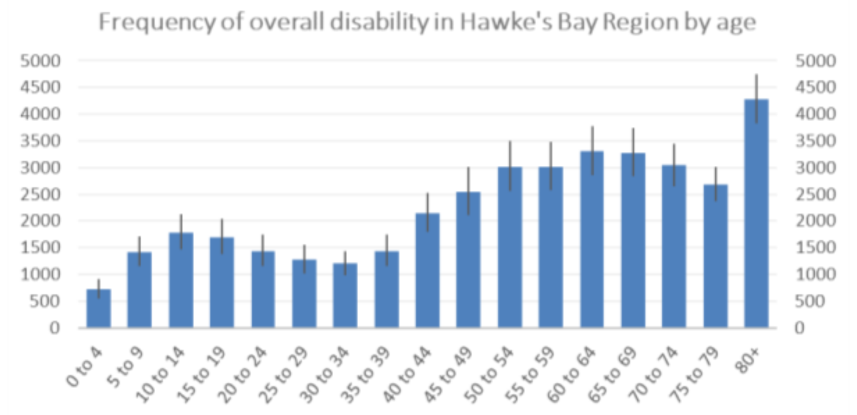
	People 65 years and over	
Rural areas	Count	% of the total area population
Tuai	27	12.50%
Other rural Wairoa District	477	15.96%
Frasertown	57	22.35%
Nuhaka	42	21.21%
Mahia Beach	60	32.79%
Other rural Hastings District	2331	13.84%
Whirinaki	87	22.48%
Whakatu	66	10.33%
Haumoana	150	12.95%
Te Awanga	150	19.53%
Waimarama	48	22.22%
Tikokino	27	14.06%
Ongaonga	45	26.79%
Takapau	102	17.17%
Otane	111	16.74%
Other rural Central Hawke's Bay District	939	15.87%
Porangahau	30	21.28%

**highlighted cells indicate % higher than the regional average of 18%*

Furthermore, there are many elderly communities and retirement villages in Napier, Hastings, and Havelock North. Several of the elderly care facilities in Napier are also in identified tsunami evacuation zones.

2.3.5 People with disabilities

Age also correlates with the proportion of people with disabilities. Figure 2 summarises people with overall disabilities (hearing, vision, physical, or psychological) based on the 2013 National Disability Survey (Stats NZ, 2014). People's disabilities may inhibit their ability to receive and respond to a warning. Infill considerations should be given on reaching people with disabilities through solutions with supporting agencies for the respective communities.



Note: The numbers and rates provided estimates of the true value. The lines represent error bars at 95% confidence intervals, representing the range where the true value will likely fall.

Figure 2. Frequency of people with disabilities in the Hawke's Bay Region by age. Data from the 2013 Disability Survey.

2.4 Existing regional systems and arrangements

Table 6 summarises existing alerting systems in use in Hawke's Bay region. Arrangements with media (usually via phone call, email, or fax) and uptake of press releases also provide widespread alerting.

Table 6. Existing systems summary. Costs are met by the CDEM Group.

	EMA	Social media & website	Red Cross Hazard App	Land-Based Sirens[1]	Stinger Siren[2]	Helicopter PA[2]	Door knocking and outbound calling
Capital/ purchase cost ($NZ)	N/A	0	0	$51,000 (including purchase and install for standalone and fire service setups)	$1,500	$20,000	N/A
Annual Maintenance cost ($NZ)	Costs included in council staff time	$9,000[4]	0	<$3,400	N/A	Ongoing cost estimated at $1,000/hr during event	Already included in council staff time
Annual Contract cost ($NZ)	N/A	0	0	N/A	N/A	N/A	N/A
Annual Testing Cost ($NZ)	NEMA is the operational custodian and responsible for testing	0	0	N/A (the only cost associated with the siren test is for advertising/ publicity)	N/A	N/A	Already included in council staff time
Number of Units	N/A	N/A	N/A	17 (in Napier)	1 remaining	1	N/A

	EMA	Social media & website	Red Cross Hazard App	Land-Based Sirens[1]	Stinger Siren[2]	Helicopter PA[2]	Door knocking and outbound calling
Locations	N/A	N/A	N/A	Eskdale School Bayview Fire Station – Shared Hawke's Bay airport Westshore School Napier Port – Shared Battery Road Napier Fire Station – Shared McLean Park Napier Library building Napier Awatoto site Maraenui Shop site Meeanee Sports Hall site Waverley/Tannery Road EIT Building Taradale Fire Station – Shared Anderson Park NCC Depot	Hastings District	Wairoa District	Region-wide
Number of subscribers	All mobile phone users in the region (non-opt out option)	36,602 Facebook 225 Twitter	Unknown	N/A	N/A	N/A	N/A

[1] Land-based siren capital cost and annual maintenance cost are approximated only; using proportional costs as estimated on the Bay of Plenty report by Leonard et al. (2017)
[2] Stringer sirens estimated capital cost was $15,000 for ten units. Hastings District Council previously owned these, but most have been gifted to Manawatu-Wanganui. Only one remained in the region but has been decommissioned.
[3] Helicopter PA costs based on minimum estimates per assessment tool Wright et al. (2014) review of public alerting options in New Zealand
[4]$9,000 is the estimated cost to maintain the entire Hawke's Bay CDEM website, not just the warning system-related pages.

2.5 National initiatives

2.5.1 Emergency Mobile Alert (EMA)

Emergency Mobile Alert (EMA) is a cell broadcast system used by authorised agencies 'to send alerts about actual or suspected threats, risks, hazards, or emergencies to mobile phones in selected area(s) via a dedicated cell broadcast channel' (Ministry of Civil Defence and Emergency Management, 2017, p. 3). The system works on a push basis, meaning the public does need to subscribe and cannot opt out of receiving the alerts. Mobile phones may show settings to opt-out from EMAs, as used in other countries, but New Zealand authorities use a special broadcast channel that is permanently on (National Emergency Management Agency, n.d.).

EMA is delivered over 3G and 4G on the three mobile networks (2degrees, Spark, and Vodafone). The specific mobile network will deliver to any mobile phone in coverage on any other network. Individual authorised agencies, including CDEM Groups, can distribute EMA to selected area(s). NEMA is the custodian of the EMA System and sets the restrictions on who and how it can be used. Since the nationwide launch test in November 2017, the EMA has been tested and used in actual events in New Zealand.

2.5.2 Red Cross Hazard App

The Red Cross Hazards App is a multi-hazard app that can receive alerts from participating alerting authorities via the app (New Zealand Red Cross, n.d.). The Red Cross Hazards app has been rolled out to the 16 Regional CDEM Groups. The Red Cross Hazards App complements the EMA system for areas without mobile coverage as it uses internet from various sources, including fixed-line broadband, Wi-Fi, and cell phone data. The Red Cross Hazard App can replicate EMA information and deliver the notification via the app through internet service. It is Common Alerting Protocol (CAP) compliant; it can read CAP feeds and provide a CAP origination form. The app is free of charge for the public to download. However, as for all apps, people need to download and install them to be effective. It is an 'opt-in' option, thus reducing effectiveness. A widespread and ongoing campaign is needed to keep the app installation rates high.

2.5.3 Common Alerting Protocol (CAP)

'Common Alerting Protocol (CAP) is an international XML1-based open, non-proprietary digital message format for exchanging all-hazard emergency alerts. It supports consistency in applying public warnings across Alerting Authorities and the dissemination of warnings over many channels simultaneously. The net result is increased effectiveness of warnings' (Ministry of Civil Defence and Emergency Management, 2018, p. 1)

CAP is used in New Zealand, where the CAP-NZ Working Group guides its implementation. NEMA leads the CAP-NZ Working Group. A technical standard for implementing CAP is available on the NEMA website[1].

CAP uses a consistent formalised structure for alerts; which means that CAP messages, once authored, can sit on a feed and be picked up immediately and automatically at the same time by all CAP compliant and compatible alerting end-points (e.g., Red Cross Hazard App and other alerting platforms).

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[1] https://www.civildefence.govt.nz/assets/Uploads/publications/Common-Alerting-Protocol/Common-Alerting-Protocol-CAP-NZ-Technical-Standard-TS04-18-FINAL.pdf

2.5.4 National Geohazard Monitoring Centre

Starting December 2018, New Zealand started enhanced monitoring of geohazards (earthquake, landslide, tsunami, volcano) on a 24/7 basis through the National Geohazards Monitoring Centre (NGMC). NGMC received live data feeds from GeoNet supported monitoring equipment located around New Zealand and from international stations. The NGMC is supported by the GeoNet programme and is part of GNS Science; the Geohazards Analysts staffing the centre are in contact with NEMA through which data, information, and advice is provided (NEMA, 2020).

3 Needs and options analysis

This section describes the multi-hazard public alerting needs and potential options for the Hawke's Bay region within the context given in Sections 1 and 2. The options discussed are in terms of alert channels that may reach each type of need, primarily dependent on the available telemetry (the telecommunication path).

3.1 Available alerting options

The alerting options considered in this review are listed here. Details on their effectiveness and cost basis are given in Section 3.5.2 and Appendix B.

1. Natural warnings
2. Independently self-maintained networks
3. System reliant on third-party hardware or staff
    - Aircraft banners
    - Helicopter PA loudspeaker
    - Billboards – static
    - Billboards – electronic telemetered
    - Break-in broadcasting*
    - Call-in telephone line
    - Emails
    - Emergency mobile alert (cell broadcast)
    - GPS receiver messaging*
    - Marine radio
    - Mobile PA loudspeaker (Police/Fire)
    - Mobile apps
    - Newspaper content
    - Pagers (triggering group of 200 people)
    - Power mains messaging
    - Radio announcements
    - Route alert (door-to-door)
    - Social media
    - SMS-PP text messaging
    - Telephone auto-diallers
    - Telephone trees
    - Television announcements
    - Tourist radio
    - Websites
    - Website banners
4. Systems using dedicated hardware
    - Fixed PA loudspeakers
    - Mobile PA loudspeakers
    - Bells, airhorns
    - Flares, explosives
    - Radio data systems*
    - Radio (UHF, VHF, or HF)
    - Sirens (signal-only) – Mobile
    - Sirens (signal-only) – Fixed
    - Tone-activated alert radio*

**Not currently available in New Zealand*

3.1.1 The importance of available telemetry

The available telemetry channels and the pockets of isolated areas govern the options available for alerting; these include:

- Mobile networks
  - Wireless broadband – also known as Fixed Wireless Access (FWA), does not rely on a physical connection (e.g., fibre cable or copper line). Instead, it enables users to have access to high-speed data through radio waves. However, it still requires a modem to be installed. It uses radio waves and typically connects to cellular networks.
  - Mobile – text messaging, voice calls, and mobile data are provided through the three companies (2degrees, Spark, Vodafone) through their network of cell towers using different technologies available (3G, 4G, 5G, etc.).
- Fixed-line networks
  - Copper – copper lines are used for traditional telephone lines and copper broadband (ADSL and VDSL), but copper connections are being replaced by fibre and wireless and ultimately will be phased out in areas in New Zealand.
  - Fibre – fibre-optic cables deliver ultra-fast broadband speeds to users. 87% of New Zealanders will be able to connect to a fibre connection by the end of 2022 (NZ Telecommunications Forum, 2021).
- Satellite – accessed through a satellite dish, particularly useful in remote areas where fixed and mobile solutions are unavailable or of poor quality
- Radio – both as broadcast stations and as signals to alerting receivers on these frequencies
- TV broadcast stations
- VHF radios
- Audio-frequency signals through the electricity network – also known as ripple control – are used by New Zealand's Electricity Distribution Businesses; can be used to reduce the load in grid emergencies (EECA, 2020).
- Electric power -- Electric power supporting these networks is also a factor as Hawke's Bay is limited by the capacity of single main transmission routes. Alternative supply routes for electricity could maintain only a very restricted supply. Some channels may become dependent on limited alternative supplies such as batteries.

3.2 District specific needs

In general, most hazards will require wide coverage alerting throughout the region. However, some cases as listed below may require specific local attention:

- rural and urban fire risk
- flood plains and urban flood basins
- sites for hazardous chemicals
- large facilities such as stadium, airport, and seaport
- critical points in lifeline services
- tsunami inundation areas.

3.3 Regional needs

The multi-hazard alerting needs are assessed at a regional level given the scope outlined in Section 1.1, except for location-specific needs as highlighted in Section 3.2. In addition, some of the available alerting options rely heavily on mobile phone coverage; we discuss coverage in specific areas in this section.

3.3.1 Urban populations

Urban populations in the Hawke's Bay region concentrate on the following areas: Hastings and Napier as the two main large urban areas, Havelock North as a medium urban area, and Wairoa, Clive, Waipawa, and Waipukurau as small urban areas. The majority of the populations in the urban centres have mobile coverage; however, there may be blackspots on the hills and in outlying dwellings.

As mobile phones appear to cover most urban populations, options that utilise mobile networks are therefore a high priority in those locations.

3.3.2 Rural populations

Rural and smaller settlements exist throughout the region. The main exception would be in forested land in plantation or native forests. Plantation areas include those highlighted in Figure 3. In these plantation areas, rural fire alerting should be a priority.

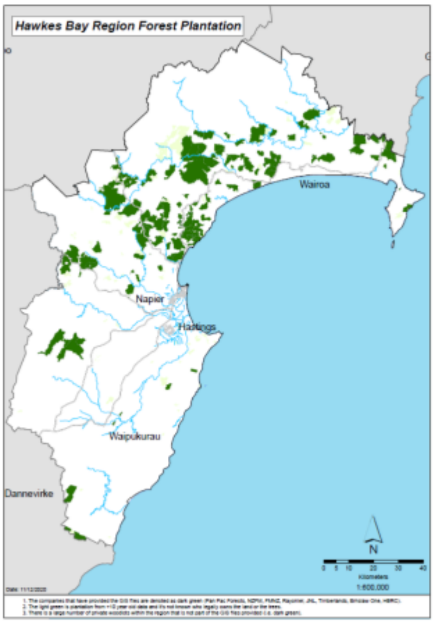

Figure 3. Hawke's Bay Region Forest Plantations Location map by the Hawke's Bay Forestry Group. Original image accessible at https://hbforestrygroup.co.nz/wp-content/uploads/2020/12/HBRC_Forest_Location_Map_122020_v4.pdf

The remaining settlement areas are related to non-forestry agriculture. These have distributed small communities and dwellings throughout and, therefore, low-density. Mobile phone coverage over farming agricultural areas is variable depending on topography, but in many cases can be found at least somewhere on many farms.

In contrast, forested areas have many locations with minimal or no mobile coverage. Maps are provided by mobile phone companies (Figure 4 to Figure 6) to give a broad view of the level of coverage, but the exact coverage experience across any one square kilometre can vary from the coverage shown in these maps.

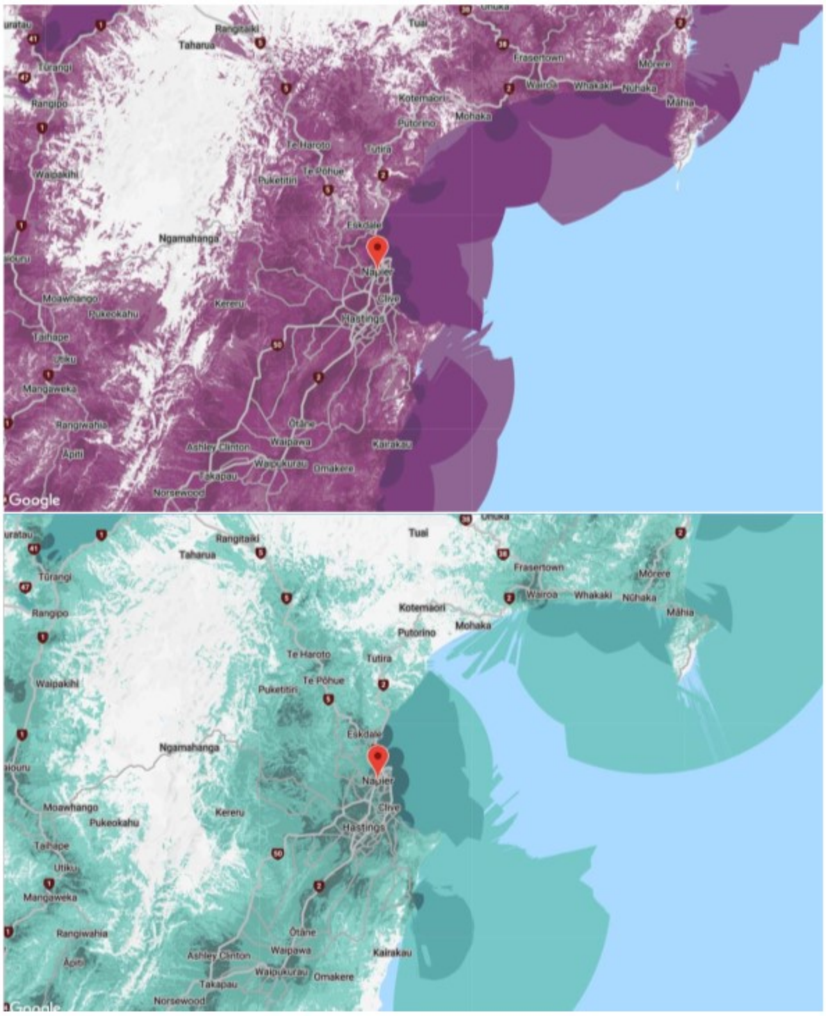

Figure 4. Two-Degrees Coverage maps of Hawke's Bay. Top image shows 4G coverage, and the bottom image shows 3G-Boosted coverage. Snapshots taken from https://www.2degrees.nz/coverage/, accessed on 8 September 2021.

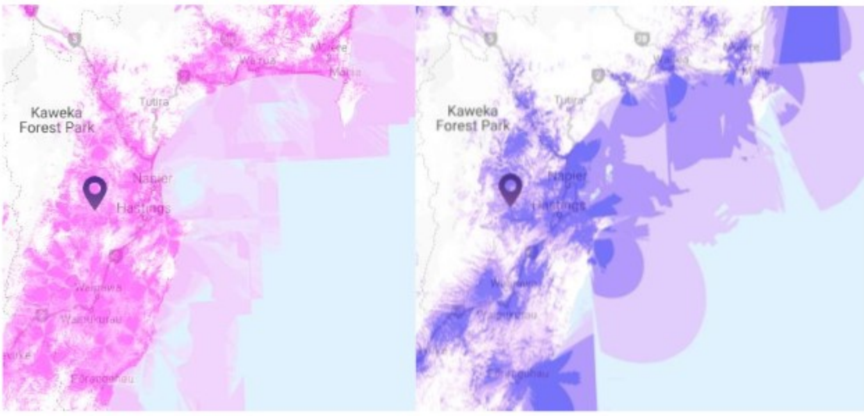

Figure 5. Spark coverage map for Hawke's Bay. Left image shows 4G coverage, and right image shows 3G coverage. Snapshots are taken from https://www.spark.co.nz/shop/mobile/network.html accessed on 8 September 2021.

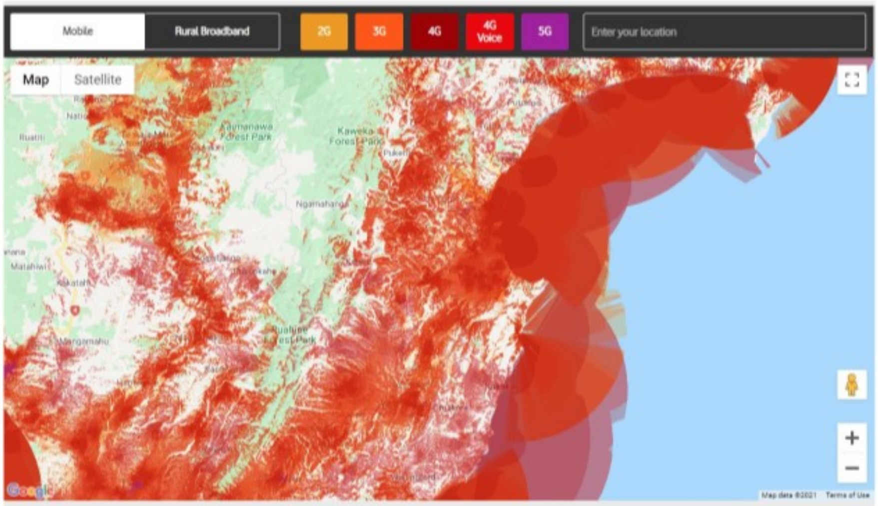

Figure 6. Vodafone coverage map in Hawke's Bay, including overlapping layers for 2G, 3G, 4G, 4G Voice, and 5G. Snapshot taken from http://www.vodafone.co.nz/network/coverage/, accessed on 8 September 2021

3.3.3 Isolated pockets

Isolated areas are referred to here as 'pockets', and the nature of the main pockets is discussed in terms of their common characteristics for public alerting needs.

Areas without mobile coverage

The urban areas, which contains 81% of the regional population, have mobile coverage. However, mobile coverage in rural areas may be highly varied. The maps provided in Figures 4 to 6 provide an overview of potential blackspots, but granular details on these blackspots are not within this report's scope. A project to conduct detailed mapping is recommended.

Beaches

The Hawke's Bay Region includes four Surf Lifesaving clubs, each with a patrolled beach (variable daytime and seasonal hours): Westshore Beach, Napier's Marine Parade, Ocean Beach, and Waimarama Beach). Alerting options to reach these beaches include mobile phones, dedicated hardware at the locations, and existing communications to the Surf Lifesaving facilities in these locations. In addition, each of the surf clubs has phones and radios. The clubs also have active social media pages. The Hawke's Bay CDEM Group needs to agree to harmonise the approach and messaging with these groups.

Most of the popular beaches in Hawke's Bay have good mobile coverage, with some exceptions on Mahia Peninsula. People visiting beaches in the region would be reached through widespread alerting (particularly mobile-phone-based).

3.3.4 Specific groups

This section discusses some key groups that need alerting. It also refers to other sections of the report (e.g., for ethnic groups, seasonal workers, and children via schools).

English as a second language

No notable spatial clusters with English as a second language are apparent from the 2018 census data. The overall number of people for whom English is not spoken appears to be approximately 2,100 people. There remains an opportunity for additional alerting via ethnic groups' self-maintaining networks (Section 2.3.3) and into agencies with people in their care (e.g., seasonal workers, Section 3.3.5), potentially reaching most dispersed non-English speakers.

Elderly

Hawke's Bay population is older than the national average. There are areas with a high proportion of older populations (Section 2.2.4). The most significant impact of age is likely to be a decreased access to technology, which is relevant to internet and mobile phone-based alerting. In aged-care facilities, the elderly will have reliance on carers to disseminate information or take action. If alerting requires access to these technologies, other means may be needed to ensure notifications reach areas with older populations, especially in rural areas.

Limited access to technology

It is recognised that access to technology, particularly to mobile phones, is a factor in alerting coverage. Most people in New Zealand have access to smartphones. Although on average, people in New Zealand have more than 1.3 smartphones per person (Statista, 2021), this does not imply everyone has a smartphone. In fact, digital inclusion varies based on demographics. Older populations may have less digital access (Digital Government, 2019). The scope of the review is limited to approximating issues through known associations, such as an inverse correlation between mobile phone and internet use to the age (e.g., 65 and older).

People with disability

A proportion of the Hawke's Bay population may be affected by disability (hearing, vision, physical, or psychological). See Section 2.3.5 for a summary of people with disabilities in the region. People with disabilities may have an inhibited ability to receive and respond to a warning.

Most alerting solutions under consideration are audible; therefore, receiving the initial alert may not be an issue for the sight-impaired. However, receiving content details from a warning may rely on the accessibility and availability of assistive/adaptive technologies for the sight-impaired population. Therefore, their ability to respond to the warning needs to be considered in broader community response planning. Reaching the hearing-impaired community through existing channels must also be considered (e.g., voice to text solutions). Considerations must be provided for other disabilities, including physical and psychological. The Hawke's Bay CDEM group needs to explore solutions for people with disabilities with the supporting agencies for the respective communities.

Transient populations

Transient populations are comprised of tourists in the Hawke's Bay region and people travelling on state highways and docking through Napier Port. Tourists can be in larger numbers in accommodation and attraction locations (assuming a return to pre-COVID-19 pandemic levels). This includes urban areas such as Napier and Hastings in terms of accommodation, where standard urban warnings may cover transient populations. However, remote attractions may need specific coverage. Special attention may need to be given to international tourists travelling to remote locations, as they may not have the same access to mobile coverage as domestic tourists.

3.3.5 Agencies with people in their care

Many agencies have substantial numbers of people in their care because they reside, visit, or work there. These agencies may include schools, the Department of Conservation, the Hawke's Bay Regional Prison, hospitals, aged care facilities, large employers (e.g., primary production and manufacturing sectors) and large sites (e.g., ports, stadiums, etc.).

Connecting with these agencies is an effective additional alerting channel to reach people in their care. Especially important for sites or areas where there are people who may not have access to regional public alerting options. The agency provides an additional opportunity to get an alert message to people in their care via their existing communication structures, reinforcing and providing redundancy to regional options.

As part of enhancing coverage, Hawke's Bay CDEM Group is already connected or needs to connect with agencies with people under their care, including

- Hawke’s Bay District Health Board – may also be able to liaise with via their networks Mental Health Social Service providers
- Ministry of Education – to liaise with alerting Oranga Tamariki and Young People Social Service providers
- Ministry of Social Development (MSD) – may be able to liaise with via their networks for Older People, Homeless and Family Social Services providers
- Ministry for Primary Industries (MPI) – may be able to liaise with the Forestry Group, also horticulture, agriculture, and viticulture sector - via the Rural Advisory Group (Rural Network)
- Eastern Institute of Technology (EIT)
- Te Puni Kōkiri – for alerting marae
- Hawke’ Bay Tourism
- Department of Conservation (DOC)
- Department of Corrections
- NZ Transport Agency (NZTA)
- Hawke’s Bay Airport
- Port of Napier
- Camper van providers
- Campgrounds

- Surf Lifesaving
- Large commercial entities (e.g., supermarkets and large format retailers)
- Regional Sport Park.

3.3.6 Cross border issues

Hazards can be shared across regional borders. Harmonisation of warning systems between neighbouring CDEM groups is essential to share consistent warning messages in impacted areas. Harmonisation will reduce confusion and improve responses to take protective action.

3.4 Napier specific considerations

Napier City is particularly vulnerable to earthquake and tsunami impacts due to its exposure to the Hikurangi Subduction Zone and other local faults (Payne et al., 2019). Around 62,000 people live in Napier as of the 2018 census (Stats NZ, n.d.). Napier's population mostly lives in low-lying land within tsunami evacuation zones. See Figure 7 for an overview of Napier City's tsunami evacuation zones. Populations north of the city will likely evacuate to Napier Hill. It is estimated that 20,000 people live in this area (Power et al., 2019). People west of the drainage channel separating Onekawa from Pirimai would evacuate to the Taradale Hills (Power et al., 2019).

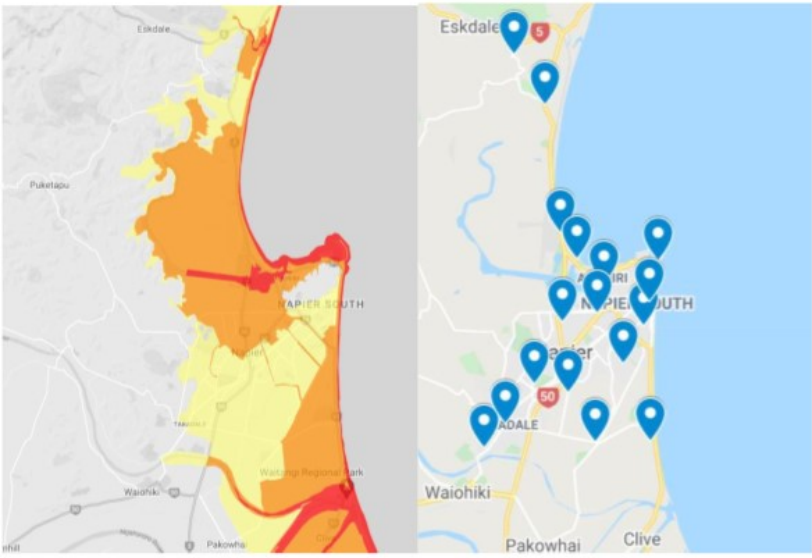

Figure 7. Overview of Napier City's Tsunami Evacuation Zones and Locations of Napier Siren System. The left figure shows three coloured zones in Napier per NEMA guidance on tsunami evacuation zones (2016). Red – shore exclusion zone, Orange – area evacuated in distant and regional-source official warnings, Yellow – coverage for all maximum credible tsunami events. The right figure shows the location of sirens in Napier. Images sourced from Hawke's Bay Emergency Management Group.

Systems are in place for public alerting to tsunami hazards in Napier. Napier has a siren system installed since the late 1960s and upgraded in about 2002 (Morris & Leonard, 2013). The initial development of tsunami sirens followed reviews after the unwarned damaging May 1960 tsunami (Johnston et al., 2008). The Napier Siren System is mechanical. They are fixed sirens mounted on establishments. Previously, tsunami sirens were mounted on fire stations around Napier. But according to Hawke's Bay CDEM, these have been disabled following FENZ's organisational directive across New Zealand that no tsunami sirens be located at fire stations.

Napier's siren coverage is from Eskdale to Taradale with 17 sensors (see Figure 7 for a summary of the siren locations). The sirens use a rise and fall signal. The signal means that an emergency is imminent, and the public is advised to listen to the radio for more information (Morris & Leonard, 2013). NEMA has national guidance for tsunami warnings (Ministry of Civil Defence & Emergency Management, 2014). In addition, tsunami warning must employ a multi-channel system where sirens could be one of many public alerting options. Appendix A lists the key principles for tsunami warning systems.

It must be noted that the Emergency Mobile Alerts (EMA) system is used for public tsunami notifications in New Zealand. NEMA and CDEM Group Controllers may issue EMA for local, regional, and distant source tsunami where there is significant life-safety risk (NEMA, 2020).

However, for local tsunami sources, there is very little or no time to send official warnings; people will need to respond and make decisions based on natural warnings (NEMA, 2020). People in all three zones (in Figure 7) will need to self-evacuate immediately on feeling a long or strong earthquake to avoid the impacts of tsunami that could arrive within 15-40 minutes from the initial ground shaking (Hawke's Bay Emergency Management Group, 2021). Public awareness is vital, so people can recognise and respond to natural warnings. Local agencies such as the Hawke's Bay CDEM Group and Napier City Council work to enhance community readiness and resilience as an ongoing and critical focus (Payne et al., 2019).

3.5 Needs compared to options

3.5.1 Methods

This review uses the national Public Alerting Options Assessment by Wright et al. (2014) and the updated Excel decision support tool. The methods used were streamlined and applied for regional-level review in Waikato (Wright et al., 2015) and Bay of Plenty (Leonard et al., 2017). This assessment has been updated with developments in emerging options, including EMA, CAP, and other evolving capabilities available in New Zealand.

3.5.2 Scoring and basis

A Public Alerting Options Assessment was developed using an evidence-based scoring system. The effectiveness of each alerting option was determined using a range of criteria developed from information from international and national cases studies and theory-based research (Leonard et al., 2017; Wright et al., 2014, 2015). The tool contains base effectiveness scores, which are modified based on local and contextualised information added to the tool. The alerting options and the effectiveness evaluation tool are discussed more in Appendix B.

The tool used for this assessment used approximated costs for each alerting system based on the estimates from the Bay of Plenty review (Leonard et al., 2017). These values provide a way to compare the cost-effectiveness of systems. A caveat on the approximations, the costs will most likely have increased from the 2017 estimates. The range of criteria used to determine the effectiveness of each alerting system is shown in Table 7.

Table 7. Evaluation Criteria for Determining Effectiveness in the Public Alerting Decision Support Tool, taken from Leonard et al. (2017)

Evaluation Criteria	Explanation, implications
Activation time – Fast or nothing	Alerting and action time available
For fast onset, localised	Hazard, alerting and action time available
For fast onset, widespread	Hazard, alerting and action time, cost
For slow onset, localised	Hazard, alerting and action time available
For slow onset, widespread	Hazard, alerting and action time available, cost
Heads-up	Reach people whatever they are doing
Hearing-impaired	Vulnerable groups, receipt of message
High pop density	Cost, economy of scale, reach of system
Immobile	Vulnerable groups, action esp. evacuation
Institutions	Vulnerable groups, dependent
Instruction	Provides appropriate action information
Language	Vulnerable groups, understanding of message
Low pop density	Cost, economy of scale, reach of system
Mental capacity	Vulnerable groups, understanding of message
Ongoing effect (ability to update message)	Change in at-risk area or required action
Opt-in required	At-risk population must subscribe and cannot unsubscribe
Relies on (landline) telephony	Potential point of failure
Relies on electricity	Potential point of failure
Relies on internet connection	Potential point of failure
Robustness/resilience	Maintenance required, hazard resistant
Sight impaired	Vulnerable groups, receipt of message
Terrain	Topographic constraints on alert delivery
Time to reach all	Congestion of networks, delivery time
Transients/Visitors	Unfamiliar with local hazards, alerting systems, and required actions

Highlighted cells indicate showstoppers – most critical considerations

3.5.3 Showstoppers

The most critical considerations (i.e., 'showstoppers') for the evaluation are (1) *heads-up*, (2) *instruction*, (3) *opt-in required*, and (4) *time to reach all*. These are highlighted in Table 7 and discussed in more detail below.

- *Heads-up* and *instruction* are necessary for alerting to produce the appropriate response from the at-risk public during emergency events. *Heads-up* is the ability to inform people regardless of where they are and what they are doing. It needs to be attention-grabbing.
- *Instruction* is the content information of the alert for the recipient. It should contain *heads-up* information that indicates that something is happening. It should provide the following details: what is happening, where, when, and what action is required to respond to the threat.
    - For example, a severe Hazchem incident and a regional tsunami event may require different responses (e.g., staying indoors and sealing doors and windows vs evacuating tsunami hazard zone). *Instruction* is a critical part of alerting.

- *Opt-in* criterion captures the need to subscribe or install components to be part of the alerting system. Examples for *opt-in* subscriptions include signing up to an email list, telephone-tree, telephone auto-dialler, SMS-text alert distribution list. Examples of *opt-in* systems that require installation include mobile applications (apps), audio-frequency signals through the electricity network (ripple control), and tone-activated alert radio. The need to subscribe or install to be part of the alerting system creates a potential barrier for uptake, especially if it involves costs or technological proficiency. An *opt-in* system most likely also allows people to opt-out. This would give capability and option for citizens to modify when they would receive alerts and can also turn off completely. Therefore, alerting opt-in options have lower effectiveness.
- *Time to reach all* is essential to maximise appropriate responses to warnings. Timeliness must be considered, including system activation time and the time to create and deliver the alert to all at risk.

3.5.4 Initial indicative cost comparison

Table 8 provides relative effectiveness scores for selected alerting options, with indicative costs if implemented across the Hawke's Bay CDEM Group. See the Public Alerting Options Assessment (Wright et al., 2014) for details on how the effectiveness scores were calculated. The costs in the table are not intended as a quote but rather an indication of relative cost based on the per-unit costs used in computation in past reports (Leonard et al., 2017).

Table 8. Effectiveness scores and indicative costs for alerting options to reach 100% of the region's population. Sorted by effectiveness score under different coverage categories

	Effectiveness score	Low Density Population. 31,530		High Density Population: 135,000		
		Start Cost $k	Cost/ year $k	Start Cost $k	Cost/ year $k	
Rapid widespread coverage:						
EMA Cell Broadcast	84%	6	6	25	25	Already funded centrally
Mobile device apps	82%	14	14	58	58	Opt-in
Fixed PA loud-speakers	68%	NA	NA	2979	279	Maintenance, telemetry and testing
Coverage can reach 70%						
High effectiveness:						
Radio announcements	82%	1	1	4	4	No heads up, slow to reach 70%
Route alert (door-to-door)	71%	2049	2049	8775	8775	# staff available and time to walk/drive
Moderate effectiveness:						
Power mains messaging	66%	631	0	2701	1	Heads up only – slow response
Natural warnings	66%	114	114	486	486	Only for a few hazards **Good for coasts**
Telephone trees	65%	82	82	352	352	Slow to reach 70%
Telephone auto-dialler	64%	8	8	36	36	Slow to reach 70% **Good for pockets**
SMS-PP text messaging	63%	11	6	31	26	Slow to reach 70% **Good for pockets**
Pagers (triggering 200 people)	62%	99	49	422	211	Slow to reach 70%, phasing out
Lower effectiveness:						
Call-in telephone line	47%	669	649	2801	2781	Very slow to reach 70%
Sirens (signal-only) - Fixed	44%	3825	262	4226	314	Heads up only – slow response
Coverage cannot reach 70%						
Mobile PA loud-speakers	74%	316	0	139	1	Cannot reach 70% **Good for pockets**
Television announcements	73%	1	1	4	4	Cannot reach 70% **Good backup**
Website banners	66%	159	1	679	4	Cannot reach 70%
Independent self-maintaining networks	66%	6	6	24	24	Cannot reach 70% **Good for pockets**
Mobile PA loudspeaker (Police / Fire)	66%	1	1	4	4	# vehicles & staff; time required
E-mails	59%	20	5	38	23	Cannot reach 70%
Newspaper content	58%	0	0	1	1	Cannot reach 70%
Websites	56%	162	4	693	18	Cannot reach 70%
Marine radio	53%	1	1	4	4	Cannot reach 70%
Tourist/Iwi radio	49%	1	1	4	4	Cannot reach 70%
Billboards - static	47%	114	51	122	55	Cannot reach 70%
Billboards - electronic telemetered	45%	0	0	1	1	Cannot reach 70% **Good for pockets**

4 Recommendations

Public alerting systems should deliver the best timely information so that people can make an informed decision during a warning with as much time as possible for protective action. This review recommends a system of public alerting options. Following the scope outlined in Section 1.1, the recommendations focus on public alerting. It must be noted that public alerting occurs in broader contexts of risk management, community engagement, planning, public education and exercises, and evaluation.

Recommendations discussed in this section:

- 4.1 Public alerting system to support response to natural warnings
- 4.2 Backbone of EMA supported by mobile apps
- 4.3 Infill options to cover pockets
- 4.4 Other considerations include multi-end point platform, one-stop-shop, low-cost reinforcement channels, and technologies to watch
- 4.5 Suggestions for existing systems
- 4.6 Example indicative solutions
- 4.7 Prioritisation of the recommendations.

4.1 Public alerting system must support response to natural warnings

The public must be aware that for certain events, an official warning may not be possible. For example, natural warnings are the fastest warnings for local source tsunami, and the public must be ready to act on these without hesitation.

If an earthquake is LONG or STRONG: GET GONE – is a natural warning message for tsunami. It is an important warning for people in Hawke's Bay and the rest of New Zealand, and people must know how to respond and do so without any hesitation. They must move immediately to the nearest high ground or as far inland as possible upon experiencing an earthquake that lasts more than a minute or makes it hard to stand up. People should not wait for an official warning. This is in addition to DROP, COVER and HOLD during the earthquake itself. Knowing the natural warning, the corresponding message, and appropriate action is important as it will give the maximum time and may be the only warning before impact.

An enhanced alerting system may cause a risk of people waiting for an official alert before taking appropriate actions. Over-reliance on official announcements and technical systems may have fatal consequences, as seen in the 2011 Tohoku earthquake and tsunami in Japan (Ishida & Ando, 2014). This was also seen following the 2005 Crescent City earthquake and tsunami warning in the USA, where a technical error led to the failure of the alerting system (Biever & Hecht, 2005; NOAA, 2005). In recent surveys in New Zealand, many people still indicated that they would wait for an official public warning before evacuating after a large earthquake (Dhellemmes et al., 2021).

This risk of over-reliance on alerting systems must be mitigated with public education. Regular exercises (e.g., annual tsunami hīkoi for all schools) can be an effective way to educate about correct actions for different warnings and regulate expectations on alerting systems. Resourcing adequate levels of public education and exercises requires substantial ongoing investment for staff resourcing. There is still a gap in educating the New Zealand public about natural warnings for tsunami. Aligned with developing warning systems, it is recommended that warning systems MUST be accompanied by public education and with annual physical evacuation exercises. Public education is needed to emphasise the overriding importance of responding to natural warnings.

Public education campaigns around natural warnings, EMA, and supporting public alerting tools with evacuation exercises, require staff resourcing. Section 4.6 shows indicative costing for staffing support that includes community response plans, education campaigns, engagement with the whole community, and annual exercises. Note that the staff ratios are indicative only using estimates from more densely populated urban areas. For Hawke's Bay, staffing must consider the local context, including the geographical spread and risk exposure needs.

4.2 Backbone

EMA, supported by mobile apps, should be considered the backbone of public alerting in Hawke's Bay as the systems can reach the vast majority of the population whether they are at home or work. EMA and mobile apps are cost-effective and have high effectiveness scores. All EMA-compatible phones[2] can receive an alert if issued within the broadcast network. EMAs do not need to be installed and cannot be uninstalled.

However, FTE staff costs must be allocated to reinforce public education of these systems. Since its implementation in 2017, EMA has been tested nationwide annually (in 2017, 2018, and 2019). No tests were conducted in 2020 in consideration of the COVID-19 pandemic. However, the EMA system has been widely used in response to the pandemic, and notifications have been sent out to communicate about Alert Level changes. The New Zealand public is now well acquainted with the EMA. However, there is a risk that the public will over-rely on the EMA and may not respond to natural warnings. Public education should continue to remind people of natural warnings and the limits of the EMA system (especially to warn for local source tsunami). The cost for FTE should be accounted as part of the job of staffing to support response to natural warnings.

Mobile apps should be promoted to areas where there is limited mobile coverage but may have internet connectivity. The Hawke's Bay CDEM Group is promoting the Red Cross Hazard App. The Red Cross Hazard App is an app that is CAP-ready. In recent developments, the Hazard App can replicate the EMA in the app. This app alerting option will suit people whose phones cannot receive EMAs and those outside mobile coverage areas but are connected to the internet by other means. Apps have a lower penetration rate to the New Zealand public as substantial effort needs to promote the installation, educate about the correct configuration, test its effectiveness, and evaluate its uptake. There should be regular promotion, education, testing, and physical exercises (e.g., during annual ShakeOut/Tsunami Hīkoi) for the public. The cost for FTE staffing is indicatively costed in Section 4.12 for the support staff to support response to natural warnings.

The Red Cross Hazard App is currently in use for the region and has three substantial issues that need addressing before it achieves the high theoretical effectiveness of apps, besides the needs mentioned above:

1. Poor reviews in the app stores are contributing to people not installing the app.
2. Past performance on the volume of weather-related alerts may have contributed to alerting fatigue, causing people to uninstall the app. Too many alerts may dilute the likelihood that users will notice the important and less frequent life-safety alerts when they come through. Users may need to configure the app to the appropriate level of warnings they may want to receive.

[2] List of EMA Capable phones: https://getready.govt.nz/prepared/stay-informed/emergency-mobile-alert/capable-phones/

3. The app does not effectively wake people up because alerts come through as a regular push notification (as with other apps). Therefore, the sound and vibration may be minimal. However, future enhancements to the app may include a loud alarm.

Because of the availability of Wi-Fi provided by non-cellular Internet Service Providers at most homes and workplaces, the mobile app support to the EMA backbone can be considered a partial redundancy in terms of channel.

4.3 Infill options

Additional layers of regionally coordinated alerting are needed to cover groups and pockets (as identified in Section 3.3). The layers for coverage will depend on the costs and the number of people that the backbone cannot reach.

4.3.1 Possible alerting options for infill

The following alerting options score high on effectivity while having relatively low-cost that can be considered:

- Voice-Over-Internet-Protocol (VOIP) auto-dialler system – should be investigated as an alternative option where cellular coverage is lacking. VOIP uses technology to allow high rates of simultaneous calling. It allows for multiple simultaneous callers, where many lines can call a single server to receive information.
- SMS can deliver messages to a list of people in areas with cell cover but with phones that are not EMA capable. However, more handsets are becoming capable of receiving EMA.

An effective and more expensive option is PA loudspeakers:

- Fixed PA loudspeakers allow alerts to be telemetered in areas that have no cell or internet cover. However, this option is costly.

4.3.2 Linking alerting options to pockets

Applying alerting options solutions for infill coverage should consider the following pockets and their intersections:

- places where there is no mobile coverage or internet
- places where there are people, and
- groups of distributed people (specific groups 3.3.4) that the backbone may not reach.

4.3.3 Determining areas that lack mobile coverage

Further work is needed to map the mobile coverage for the region fully (indicative maps in Figures 4 to 6). Different providers have different blackspots. Mapping will help identify which blackspots may not receive EMAs and for apps that will require mobile internet. These can be cross-analysed with the available telemetry and risk profiles to determine what alerting options will be best suited. This information can be used to lobby for better coverage from providers.

4.3.4 Population centres' mobile coverage and other telemetry

To understand appropriate infill options, further assessment is needed to investigate the population centres and their available telemetry and mobile coverage. For example, there may be areas with mobile blackspots, but they may have access to fixed-line systems (e.g., copper wire or fibre optic); in such cases, these areas can be covered by VOIP auto-dialler using a landline or mobile apps.

4.3.5 Specific groups

Further work is needed to fill in alerting options to specific groups:

- **Iwi groups**. Relative to some other regions, there is a sizeable Māori population in Hawke's Bay Region. Specific Iwi communication channels provide an opportunity to reach a substantial part of the regional population. Hawke's Bay CDEM Group needs to continue engaging with Iwi group representatives to develop approaches to deliver alerts and collaborate with existing communication channels and community organisations.
- **Non-English speakers** – there is a need to enhance engagements with ethnic groups and support their self-maintaining networks. It is recommended to identify groups and ensure that their networks would have access to public alerting.
- **Elderly** – Access to technologies for the older population, especially in rural areas, must be considered. Using and installing mobile apps may be a problematic alternative for the elderly that EMA can't reach. However, access to landlines may allow for the use of auto-diallers. In aged-care facilities, the elderly will have reliance on carers to disseminate information or take action.
- **People with disabilities** – Access and availability to assistive/adaptive technologies may be a barrier for people with disabilities. It is recommended that Hawke's Bay CDEM explore solutions for people with disabilities with the supporting agencies for the respective communities.
- **Transient populations**
  - To cover people travelling on highways, specific warning arrangements may be needed with NZTA. Future CAP compliant public alerting endpoints could be used as an integrated system (e.g., digital signboards).
  - To cover tourists, additional mobile alerting options should be explored. Most domestic tourists will have EMA-capable mobile phones. However, there may be potential variability with foreign handsets. Mobile apps (e.g., New Zealand Red Cross Hazard App) may be an alerting option for foreign tourists. It must be explored how to get tourists to install the apps on their phones. Blackspots may be an issue with tourists as both EMA and apps have reliance on mobile coverage.
- **Agencies with people in their care** – The list in Section 3.3.5 identifies the agencies that Hawke's Bay CDEM Group must connect with to ensure coverage. Hawke's Bay CDEM Group should coordinate specific warning arrangements into the internal and broader communication channels of these agencies.

4.4 Other considerations

4.4.1 Multi-end-point platform

We suggest considering using an alerting end-point platform to ingest alerts and distribute to other end-points, including but not limited to:

- EMA
- Red Cross Hazard App
- VOIP auto-dialler
- SMS lists (for groups within cell coverage but are not capable of receiving EMA)
- social media
- website
- CAP RSS feed for all other alerting end-points.

4.4.2 One-stop-shop

The Hawke's Bay CDEM Group currently has a web page where a list of public alerting channels is available: https://www.hbemergency.govt.nz/get-ready/public-warning-systems/. We encourage using this page as a one-stop-shop portal to provide a clear explanation and access to warning services. It must be noted that the webpage in itself is not intended to be a warning system but a pre-warning portal of information. The page can be enhanced further to include what channels are available where, for whom, and what hazards. The current content is tsunami heavy for appropriate reasons, but the one-stop-shop must be balanced to include other hazards.

4.4.3 Additional Low-Cost Reinforcement Channels

The following should be enhanced and maintained at a regional level as they provide reinforcement to Hawke's Bay public alerting:

- Media arrangements
- Connection to self-maintaining networks
- Connection to large agencies with people in their care
- Social media
- Websites
- Other CDEM Group members alerting capacity.

4.4.4 Other technology to watch

More **CAP-compliant public alerting endpoints** will be available in the coming years. A public alerting endpoint is any piece of technology that can read CAP messages and deliver those messages to the public in a human-readable format (e.g., SMS, digital road signs, etc.). The Hawke's Bay CDEM Group should continue to work with the NZ CAP Working Group, where CDEM can originate CAP warnings that can be ingested and distributed to various end-points.

The **Android earthquake alerts system from Google** was initiated in New Zealand starting April 2021 and has issued out a few Earthquake Early Warning (EEW) alerts (which is intended to provide advanced notification of incoming earthquake shaking) to Android users. This alerting system was deployed without officials' involvement and should not be confused with alerts issued by civil defence authorities (McDonald, 2021). EEW is not an alerting option accessible for Hawke's Bay CDEM Group as this warning system is automated and run by Google. However, alerts coming from Android phones may confuse the public, and the Hawke's Bay CDEM Group must respond. It is recommended that the Group, with guidance and in coordination with NEMA, provide public education on the EEW alert and communicate its advice to the public about what they should do upon receiving the alert (e.g., include this in the one-stop-shop).

4.5 Existing systems

Existing systems should be maintained until consideration and implementation of installing new systems or decommissioning of old systems has taken place. The following are recommendations for the existing systems:

- Consider a **multi-end-point platform** that could deliver to multiple existing platforms at once. The platforms could integrate delivering consistent messaging to the existing end-points such as EMA, social media (Facebook and Twitter), the Hawke's Bay CDEM website, and the Red Cross Hazard App. The platform could integrate with future alerting options, including auto-diallers, etc.
- Consider **EMA** and **mobile apps** as a backbone to the alerting system. This should be accompanied by public education and exercises.
- **Social media** and **one-stop-shop webpage** should be maintained and enhanced for reinforcement alert messages and the public alerting system
- **Land-based siren**

- The current signal-only siren system in Napier is not fit-for-purpose in the context of current-day alerting. Although it provides a *heads-up,* it cannot provide detailed *instructions*. The rise-and-fall signal only intends to communicate the need to seek more information. The current Napier system does not comply with the NZ Standard for Tsunami Sirens and should not be used for this purpose.
- The public might not know what the siren signal means unless this system is accompanied by extensive education on the siren signal meaning and the appropriate actions to take when the signal is heard. The public may not respond because they are unsure of the meaning (Fraser et al., 2013). Especially for tone-only sirens, there may be a disconnect between the intended message and what the people's perception of the message. In Napier, the siren signal means that the public should seek further information through radio, and not necessarily indicating of threat of tsunami (Fraser et al., 2013). However, staff report that in their previous education campaigns, they have struggled to change community perceptions that these fixed sirens are 'tsunami sirens.' For tone-only sirens to work, a public education component is needed to enhance awareness and understanding of the system (Fraser et al., 2013). Staff resourcing for public education must be budgeted with the use of the current siren system.
- The existence of the siren system may increase the risk of over-reliance on the system and cause people to wait to hear the signal before acting on natural warnings. Potential earthquake damage itself can make the sirens fail. In a survey after the 2011 earthquake and tsunami in Japan, 17 out of 27 affected municipalities responded that their fixed tsunami alert transmission system failed from power cuts or earthquake damage and did not function properly at the time of the disaster (Hasegawa, 2013).
- Public education and exercises must reinforce natural warnings and the LONG or STRONG: GET GONE message. Staffing costs must be budgeted for public education.
- The costs of upgrading the current siren system to a PA loudspeaker system may not outweigh effectiveness in areas with already existing or alternative alerting options (i.e. good EMA or mobile app coverage). Although, a PA loudspeaker system has high effectiveness score, because it provides both *heads-up* and *instruction*, it has a high start-up cost and substantial ongoing maintenance costs (Wright et al., 2014). It is also considered to be prohibitive in low-density areas. Its coverage is restricted to narrow geographical areas and has audibility issues, especially in strong winds.
- Napier City, as an urban area, already has good coverage with the high-reliability backbone of EMA and mobile apps. EMA and mobile apps provide both *heads-up* and *instructions.* Capital and maintenance costs are likely to be better spent on public education and strengthening the backbone, rather than maintenance or upgrading of the land-based Napier Siren System.

- One **Stinger Siren** exists in the region but is currently decommissioned. Careful consideration should be given if it will be used as an infill alerting option. Effectiveness is questionable due to deployment time, the added exposure of the operator to the hazard, and the rate of warning delivery.
- **Helicopter PA** (currently in Wairoa) should be maintained if it is an appropriate infill alerting option to areas where the backbone is ineffective. However, use with caution, as media reports on helicopter PA testing in Wellington showed that a significant number of the population could not hear the address message clearly and caused confusion (Leonard et al., 2017). Main issues include service level, availability, speed for deployment, and speed to reach the populations at risk.

- **Door-to-door and outbound calling** should be maintained and integrated with public education and annual exercises. The effectiveness of the option is dependent on the availability and proportion of staff on duty and per per-person rate of visits. This option will not reach the majority of the population when peril is imminent but would be good as infill options for pockets. Appropriate staffing resources must be budgeted this option.

4.5.1 Requests for Proposals (RfP) and Implementation Process

Before implementing changes in the alerting system, the balance between the backbone and infill options will need to be agreed upon. After which, further specifications will be needed for RfPs from vendors. Points of clarity and alignment will be needed on national initiatives around EMA, CAP, mobile apps, and other technological trends.

4.6 Example indicative solution

Table 9 shows an indicative solution to implement the above recommendations. Table 9 is not a quote, and the costs are indicative only. The exact costs will be dependent on detailed proposals from vendors.

Note the following points for Table 9:

- The backbone of EMA and mobile apps is cost-effective as these alerting options will have rapid widespread coverage. However, the annual cost of staff time must be budgeted to account for the substantial amount of work to train, maintain procedures, and provide education and exercises around these options.
- Note that detailed pocket analysis was not in the scope of this report, so areas without access to EMA and mobile apps are indicative via population density only. This estimate must therefore be treated as speculative until Hawke's Bay has conducted a detailed pocket analysis.
- The infill via a telephone auto-dialler system and targeted SMS messaging has an annualised direct and staff cost. Charges per message will also be incurred.
- Upgrade of 17 Fixed PA loudspeakers are included as an example. These fixed PA systems could be targeted at the highest use beaches and tourist locations with limited cell coverage. The cost basis needs to be confirmed with RfP.
- It is necessary to budget staff time for additional redundancy and reinforcement systems. These must be annually sustained, and important to consider further infill options to reinforce warning messages.

Table 9. Example indicative approach to determining costs for alerting options for the Hawke's Bay region. Sorted by effectiveness score under the categories of rapid widespread coverage, can reach 70%, and cannot reach 70%. Costs are in proportion to the targeted reach (in terms of percentage population) of each alerting option.

		LOW Density (100 ppl/sq.km)				HIGH Density (2500 ppl/sq.km)				
		Population: 31,530 people				Population: 135,000 people				
	Effectiveness score	Reach	Start-up Cost	Annual Cost	Annual direct cost	Reach	Start-up Cost	Annual Cost	Annual direct cost	
Rapid Widespread Coverage:			$k	$k	$k		$k	$k	$k	
EMA	84%	60%	6	6	5	90%	35	35	29	Training, maintenance, education, and testing
Mobile apps	82%	90%	12	12	15	90%	52	52	58	Training, maintenance, education, and testing
Rapid targeted coverage:										
Fixed PA loud-speakers (17 units)	68%		NA	NA		10%	850	85	43	Maintenance, telemetry, and testing
Coverage can reach 70%										
High effectiveness:										
Radio announcements	82%	70%	1	1	0	70%	3	3	0	No heads up, slow to reach 70%
Moderate effectiveness:										
Natural warnings	66%	70%	79	79	22	70%	340	340	94	Required for tsunami. Cost = full plans, education, and exercises supported.
Slow to reach 70%										
Telephone trees	65%	10%	53	53	0	5%	18	18	0	
Telephone auto-dialler	64%	10%	1	1	1	5%	2	2	2	Good for pockets
SMS-PP text messaging	63%	10%	6	1	1	10%	9	4	3	Good for pockets
Cannot reach 70%:										
Mobile PA loud-speakers	74%	0%	0	0	0	5%	7	0	0	Good for pockets
Television announcements	73%	50%	1	1	0	50%	2	2	0	Good backup
Website banners	66%	50%				50%				Provided with CAP uptake
Independent self-maintaining networks	66%	10%	1	1	0	10%	2	2	1	Good for pockets
Mobile PA loudspeaker (Police / Fire)	66%	1%	0	0	0	10%	1	1	0	# vehicles & staff
E-mails	59%	10%	16	1	0	10%	17	2	0	
Newspaper content	58%	50%	0	0	0	50%	0	0	0	
Websites	56%	2%	3	0	0	2%	14	0	0	
Marine radio	53%	2%	0	0	0	2%	0	0	0	
Tourist/Iwi radio	49%	5%	0	0	0	5%	0	0	0	
Billboards – static	47%	10%	11	5	5	10%	12	5	5	
Billboards - electronic telemetered	45%	15%	0	0	0	15%	0	0	0	Good for pockets
TOTALS ($k)			**190**	**161**	**49**		**1364**	**551**	**235**	

Start-up total (year 1)	**1554**
Annual (Year 2 onwards)	**712**
Annual Direct Costs (no FTE) only	**284**

4.7 Prioritisation

1. We recommend that backbone options (both of which are currently in use) are costed in detail and implemented first.
2. Staff resourcing must be increased to enhance education on natural warnings awareness, including knowing how to act. Higher levels of community engagement, education, and exercise are needed throughout the region. The cost for this should be sustained on an annual basis. These programmes need to be appropriately evaluated.
3. A comprehensive regional study of network coverage should be commissioned. This mapping exercise should be cross-analysed with fixed-network systems, geographical risks, and an assessment for suitable infill alerting options for blackspots, recognising that different providers probably have different blackspots.
4. Ongoing research should be conducted or commissioned into infill needs to use the end-point platform options (particularly VOIP auto-dialler).
5. The system should be reviewed every three to five years
6. **IF** it be decided that the Napier siren system be maintained or upgraded, there should be inclusion of an extensive plan for public education and exercises. An RfP for enhancing the Napier Siren System with PA loudspeakers to match the above need (if any) should also be released.

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Appendix A: Principles for Tsunami Warning Sirens

From the Tsunami Warning Sirens Technical standard [03/14] (civildefence.govt.nz)

The following principles emerged as a part of consultation, and provide fundamental guidance to the use of sirens in tsunami warnings:

1. The term 'sirens' refers to a public alerting option only. The ability to detect earthquakes and tsunami, interpret that data, and trigger public alerting options (e.g. sirens) is a separate concept that should not be confused with activating siren hardware.
2. The use of sirens is a subset of CDEM Group/territorial authority warning systems, and is one public alerting option among many.
3. The use of sirens should be attuned with the national warning system and NEMA tsunami guidance.
4. The use of sirens must be risk based – that is, based on an understanding of CDEM Group/territorial authority tsunami hazards and risks.
5. Tsunami warning systems will employ the use of multiple alerting channels – one of which may be sirens.
6. Responsibility for activating sirens and the basis for activation must be clarified within CDEM Groups.
7. The use of sirens must be linked to continuous public education programmes and evacuation planning activities.
8. There should be national consistency in the signal and meaning of sirens.
9. Sirens should be used as an all-hazards alerting mechanism, and not only for tsunami warnings.
10. Sirens may be used for distant source tsunami events, and where possible, for regional source tsunami events, depending upon the policies of the CDEM Group and/or territorial authority. Activation of sirens must not be expected for local source tsunami events – the strong earthquake is the only reliable warning.
11. Communities should be involved in awareness raising, testing, and decisions on expanding or decommissioning siren systems, where possible. Testing must be done on a regular basis.
12. A realistic and achievable programme and budget must be developed for ongoing maintenance and operations.
13. Ongoing consideration of public alerting options by CDEM Groups is recommended – for both reach and cost effectiveness purposes.
14. Ideally, sirens should be public address (PA) capable to allow for direct, event-related messaging to be given. The use of sirens in tsunami warnings should not be inconsistent with the above principles.

Appendix B: Available Alerting Options

From the GNS Science Report: Bay of Plenty Regional Alerting Systems Review. https://doi.org/10.21420/G28043

Table B1. below shows the available alerting option, their costs-basis and effectiveness as per Public Alerting Options Assessment (Wright et al., 2014, 2015) and Leonard et al. (2017).

Table B1. Cost basis summary for alerting options

		Additional start-up	cost start-up / 1000 people	FTE / 100,000 people	cost annual / 1000 people (minimum - includes training, exercises etc.)	cost start-up / 1000 people	FTE / 100,000 people	cost annual / 1000 people (minimum - includes training, exercises etc.)	
	SCORE		**LOW density**			**HIGH density**			**NOTES regarding cost basis**
Natural warnings	66%			4.00	1,000		4.00	1,000	Based on education pre-event. Heads-up time depends on hazard. 1 FTE per 25,000 people, or four 6000 person communities or neighbourhoods. Estimated from effort over 6 years in Wellington region across 70,000 people. Provides wider benefit for resilience building and multi-hazard preparedness.
Independently self-maintained networks	66%			0.20	50		0.20	50	Based on staff effort to maintain relationships and testing.
Reliant on third party hardware and/or staff									
Aircraft banners	48%	5,000	400	0.01	200	100	0.01	50	Based on equipment purchase, flight time costs.
Helicopter PA loudspeaker	64%	20,000	1,600	0.01	8,000	400	0.01	100	Based on equipment purchase, flight time costs. 2 minute hover, 1 minute flight. 1000 per hover HD, 10 per LD
Billboards - static	47%	3,500	2,000	0.01	1,600	500	0.01	400	Based on monthly rental, reaching 10k people per board
Billboards - electronic telemetered	45%		unknown	0.01	unknown	unknown	0.01	unknown	
Break in broadcasting*	77%	large cost	not costed		not costed	not costed		not costed	LIKELY TO NEED NATIONAL ARRANGEMENT
Call-in telephone line	47%	20,000	20	0.01	20,592	20	0.01	20,592	Based on auto-dialler costs. Passive mechanism.
E-mails	59%	15,000	1	0.25	10	1	0.25	10	Database build (partially source from platforms, subscribers), using infinite size, rate of emailing limit? End user cap?
GPS receiver messaging*	57%		unknown		unknown	unknown		unknown	Needs INTERNATIONAL work to cover New Zealand, receivers must be changed to receive.

		Additional start-up	cost start-up / 1000 people	FTE / 100,000 people	cost annual / 1000 people (minimum - includes training, exercises etc.)	cost start-up / 1000 people	FTE / 100,000 people	cost annual / 1000 people (minimum - includes training, exercises etc.)	
	SCORE			**LOW density**			**HIGH density**		**NOTES regarding cost basis**
Marine radio	53%			0.05			0.05		Only reaches boats. Assumes exist in all boats, already have transmitter. Effort to maintain and exercise.
Mobile PA loud speaker (Police / Fire)	66%			0.05			0.05		Effort to maintain and exercise. Limited by number of units and speed.
Mobile device apps	83%		-	0.20	300	-	0.20	300	Rough estimate based on general 2016 experience
Cell broadcast	84%	-	-	0.05	150	-	0.05	150	Assumed scaled to 2016 mobile device apps. NO DATA
Newspaper content	58%			0.01			0.01		Press release
Pagers (triggering group of 200 people)	62%	312	1,560	0.01	1,560	1,560	0.01	1,560	One pager reaches200 people, up to 100 pages per month. + effort to coordinate.
Power mains messaging	66%	250,000	20,000	0.01		20,000	0.01		$50 per house, 2.5 ppl/dwelling (2006 census)
Radio announcements	82%			0.05			0.05		Effort to maintain and exercise
Route alert (door-to-door)	71%			100.00			100.00		Limited by avg. proportion of staff on duty and per person rate of visits. Won't reach the majority if widespread diffuse areas
Social Media									
SMS-PP text messaging	63%	5,000		0.10	130		0.10	130	BULLETIN - Annual licence for web-based system. Cost to send message 13c per SMS. Cost is based on two tests. Subscribers must sign up.
Telephone auto-dialler	64%			0.10	200		0.10	200	TNZ - VOIP based system - no subscription but must create and upload database - 0.5 FTE to create and 0.25 FTE for maintenance. Capacity 700 calls per minute. Can be increased by request for emergency or' burst' calls Broadly consistent with informal indication (1c per second) of 2017 cost for platform multi-endpoint option in place for another region (ongoing discussion with BOP CDEM Group)
Telephone trees	65%			4.00	10		4.00	10	High effort required. Likely cap on completeness and accuracy of list
Television announcements	73%			0.05			0.05		
Tourist radio	49%			0.05			0.05		Reaches only maximum number of people listening to this station
Websites	56%		5,000	0.05	100	5,000	0.05	100	Price of one website and hosting, but limited to people viewing
Website banners	66%		5,000	0.05		5,000	0.05		Not currently in use. Cost basis would need investigation with ISPs.

		Additional start-up	cost start-up / 1000 people	FTE / 100,000 people	cost annual / 1000 people (minimum - includes training, exercises etc.)	cost start-up / 1000 people	FTE / 100,000 people	cost annual / 1000 people (minimum - includes training, exercises etc.)	
	SCORE			**LOW density**			**HIGH density**		**NOTES regarding cost basis**
Dedicated hardware									
Fixed PA loud-speakers	68%	20,000	80,000	0.10	8,000	20,000	0.10	2,000	Limited by proportion of people who know meaning.
Mobile PA loud-speakers	74%	1,000	10,000	0.05	-	1,000	0.01	-	TAUPO - Wellington build your own. $50k for 12, reaches 400 ppl/sq km dense, 1/4 of that diffuse. 10% annual maintenance
Bells, air horns	50%			0.01			0.01		
Flares, explosives	43%		10,000	10.00	2,000	200	10.00	40	Pack of 30 = $3k, flare reaches a few people in diffuse areas and a few hundred dense. Replace 20% every year
Radio Data Systems*	52%	5,000	25,000	0.50	100	25,000	0.50	100	Cost to reach 200 people + effort to coordinate response groups and exercise
Radio (UHF, VHF or HF)	64%	5,000	25,000	0.50	100	25,000	0.50	100	Cost to reach 200 people ($5,000) + effort to coordinate response groups and exercise - Gisborne costs?
Sirens (signal-only) - Mobile	56%								
Sirens (signal-only) - Fixed	44%	28,000	112,000	2.00	8,000	28,000	0.50	2,000	Based on $1,130,000 for 45 towers (varying siren numbers per tower)
Tone-activated alert radio*	82%	120,000	50,000	0.10	1	50,000	0.10	1	E60 per unit - unlikely to have high uptake unless paid-for and supplied

Effectiveness evaluation and public alerting options decision support tool

There is a wealth of information on the effectiveness of public alerting systems based on case studies from a range of hazard types and locations both national and international, as well as theory-based research applying psychology principles. The evidence for what constitutes an effective alerting system has been summarised and used to develop an effectiveness evaluation methodology for alerting systems in New Zealand (Leonard et al., 2005, 2006, 2008; Wright et al., 2014). The effectiveness of each option is determined using a range of criteria, with an evidence-based scoring system. This scoring system forms the basis for a Public Alerting Decision Support Tool. The tool contains base effectiveness scores and these are modified as more detailed information on local hazards and demographics are input to the tool.

The tool also applies an estimated cost for each alerting system, which provides for cost effectiveness comparisons of systems. The range of criteria used to determine effectiveness of each alerting system is shown in Section 3.4.2. The 'showstoppers' (most critical considerations for effectiveness) are highlighted in red and explained in Section 2.5.1.

Information required to populate the decision support tool

The Public Alerting Decision Support Tool requires information to be input to determine the effectiveness of each system for specific communities, such as towns, cities, districts or regions. Some of the information is available from the NZ Census on the Statistics NZ website. Other information is best sought from local CDEM practitioners or local authority and community representatives. The following information is necessary to apply the tool:

- Population count – low and high density population counts for the area of interest; high density = >200 people/km2).
- Demographics – information about groups of citizens who might have increased barriers to receiving certain types of alerts (e.g., communities with many elderly people, possibly having higher levels of sight or hearing impairment and lower rates of mobile device ownership). The tool asks for information on groups with sight, hearing, mobility or intellectual impairments, and those with English as a second language.
- Telephone coverage; mobile and fixed – many alerting systems require telecommunications through either mobile or landline networks.
- Transient populations – this includes the number of visitors to the area (tourists and others from outside the location such as seasonal workers) who may be unfamiliar with the local hazards and the local alerting systems.
- Those in the care of institutions – this includes the number of citizens who are housed in institutions such as hospitals; those who are temporarily in care such as pre-school, school and tertiary students; and those working in large campuses or workplaces. These people are likely to require an alert to be delivered to them via the institution in which they are housed.
- Hazards of interest – hazards are grouped into four classes based on the lead-in time from hazard trigger to impact and the range or extent of impact. Classes are as follows: short lead-in time localised impact, short lead-in time widespread impact, long lead-in time localised impact and long lead-in time widespread impact.
- Budget – each alerting system requires some budget resource, which could be in the form of staff time for education and exercises, resources for education, financial input for purchase, installation and maintenance of dedicated systems, and/or licenses or charges to use third party systems. Costs are determined on a per-thousand population basis and are separated into start-up (establishment) and ongoing.

- Nearly forty alerting options are included in the decision support tool, including some options not yet readily available in NZ that are used overseas. These are categorised into third-party systems, dedicated hardware, natural warnings and independent self-maintained networks.
- Third-party systems are owned and operated by non CDEM agencies but can be used for alerting, e.g., TV, radio, mobile phone networks.
- Dedicated hardware is owned and operated by the CDEM agency e.g., PA systems or sirens.
- Natural warnings are those phenomena which are produced by the event that could indicate a hazard threat (e.g., strong or long shaking near the coast could indicate tsunami; heavy rainfall could indicate landslides or flooding).
- Independent self-maintained networks are non-CDEM agencies in contact with the public that could deliver an alert message to the public if agreements and arrangements are in place (e.g., surf-lifesaving groups, park rangers, neighbourhood watch). The decision support tool allows users to select which alerting options to include and exclude in any evaluation.

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MASSEY RESEARCH ONLINE http://mro.massey.ac.nz/

Massey Documents by Type Reports

Hawke's Bay Regional Alerting Systems Review

Tan, M

2021-12-15

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