



**SmartGrowth Strategy Update:**

**Discussion Paper:**

**Implications of tsunami risk for  
existing and future growth areas**

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## Executive summary:

The purpose of this discussion paper is to consider whether, taking account of the tsunami hazard and possible mitigation measures, SGIC can have confidence to approve the Settlement Pattern for the SmartGrowth Strategy Update in relation to:

- i) Undeveloped Urban Growth Areas (specifically Te Tumu)
- ii) Developed Urban Growth Areas (in which the risk<sup>1</sup> will be increased through intensification).

The workstream report *Review of Identified Residential Urban Growth Areas* (October 2012) noted that tsunami risk was subject to further technical assessment and would be part of the discussion paper on Future UGAs in the New Year. This discussion paper presents the findings of research that has been undertaken to assess the tsunami risk to SmartGrowth and whether the risk can be reduced to an acceptable level.

Two recent reports by the Institute of Geological and Nuclear Sciences Limited are the subject of this discussion report. They are:

*Modelling of the tsunami risk to Papamoa, Wairakei and Te Tumu assuming an altered ground level due to development of Wairakei and Te Tumu, and the implications for the SmartGrowth Strategy*, GNS Science Consultancy Report 2012/54, September 2012, and

*Modelling of the evacuation rates required to achieve an acceptable level of health and safety risk in Te Tumu from the Variation to the Southern Kermadec Scenario*, GNS Science Consultancy Report 2012/291, December 2012.

These Bay of Plenty Regional Council commissioned reports will contribute to better understanding of potential tsunami impacts on coastal development as well as the approach that should be adopted toward managing these impacts.

Tauranga City Council, using the data derived by GNS, is undertaking some additional work relating to the areas affected by tsunami inundation to provide the community with more accurate and up-to-date information on places to go to be safe should a local source event occur. This work is being undertaken by TCC as part of the preparation of a tsunami evacuation plan called Tsunami Survive. The preparation of the evacuation plan has raised awareness and understanding of the possible risk associated with a local source tsunami event, and this work is set to continue.

Two statutes provide an overlapping framework for managing natural hazards. Despite having different policy preparation timeframes, the current policy frameworks are consistent.

The Resource Management Act 1991 includes earthquake and tsunami in its definition of natural hazard. Under the RMA, the New Zealand Coastal Policy Statement 2010 specifically includes tsunami among coastal hazards to be managed, over at least 100 years. The Proposed Bay of Plenty Regional Policy Statement takes a risk management approach that requires intolerable risk to be avoided,

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<sup>1</sup> "Risk" is used in this sense:

**risk** means the likelihood and consequences of a hazard (Civil Defence Emergency Management 2002, section 4)

Risk is often expressed in terms of a combination of the consequences of an event (including changes in circumstances) and the associated likelihood of occurrence (AS/NZS ISO 31000:2009 *Risk management – Principles and guidelines*, November 2009). (New Zealand Coastal Policy Statement 2010, Glossary, Risk)

existing tolerable risk to be reduced and new development to not be subject to risk that exceeds acceptable levels. Policy statements are to be given effect by plans.

As part of the resolution of appeals on the Tauranga City Plan, BOPRC and TCC have entered into a Memorandum of Understanding. The two councils have agreed to collaborate in preparing district plan provisions that implement the risk management approach.

The Civil Defence Emergency Management Act 2002 includes in its purpose “encourage and enable communities to achieve acceptable levels of risk”. It requires local authorities to set up regional groups to co-ordinate planning, programmes and activities related to the 4Rs: [risk] reduction, readiness, response, and recovery. The BOP CDEM Group Plan’s risk reduction principles include:

- Events that have the potential to cause a significant number of deaths or injuries to people are not acceptable...
- Hazard information is to be freely available to enable the community to engage in decisions about the acceptability of the risks they face and to equip individuals to act to reduce their own risk.
- Comprehensive risk reduction is achieved through integrated planning and risk management across all councils....

A 2002 paleotsunami study found evidence of past tsunami and led to further studies over the following decade. SmartGrowth’s Implementation Management Group requested that BOPRC commission GNS to provide a further report examining the risk to Pāpāmoa, Wairakei and Te Tumu assuming ground levels were modified to reflect the final constructed situation. In turn, this led to another report examining whether mitigation could reduce Te Tumu risk to an acceptable level. These latest two GNS reports are the subject of this discussion report. The modelled results now align with the paleotsunami evidence, adding credibility to both the paleo evidence and the results of the modelling.

Compared with other hazards, tsunami are much riskier than earthquakes (based on estimates of deaths). New Zealanders have had little opportunity to be well-informed in terms of the risks associated with living on the coast. Comparison of the risk of tsunami and volcanic hazards has not been undertaken; however, warning systems would enable fatalities to be minimised in most volcanic events. With few if any fault lines within the SmartGrowth area and an evenly spread volcanic risk, these hazards do not influence where development should occur within the SmartGrowth area. The shaking hazard is addressed by engineering and the Building Act; the liquefaction hazard from earthquakes is addressed separately from this discussion paper.

To inform planning for evacuation, tsunami sources that impact on New Zealand are divided into three categories:

- Distant source — more than 3 hours travel time from New Zealand;
- Regional source — 1–3 hours travel time from New Zealand; and
- Local source — 0–60 minutes travel time to the nearest New Zealand coast.

The travel time of the most hazardous tsunami to the study area is approximately 50 minutes, qualifying this scenario as a local source. This is too short for formal warning and effective evacuation. While some natural signals may be able to be detected, effective evacuation will be dependent on the preparation and implementation of an entire evacuation strategy. Ongoing community engagement, sustained tsunami education and evacuation training is required to ensure appropriate evacuation response to natural signals so that individuals act to reduce their own risk.

The reports found that, assuming no evacuation, the study areas of Pāpāmoa, Wairakei and Te Tumu are subject to intolerable risk from tsunamis. These are the first SmartGrowth areas where the consequences of tsunamis have been analysed and the risk assessed. It is likely that the level of risk throughout the settlement pattern will vary and further work is recommended to assess the specific risk of other developed and undeveloped urban growth areas in relation to their coastal location.

### **Undeveloped areas**

The second report found that, with vertical evacuation facilities and a combination of land use planning and emergency management measures, an acceptable level of risk could be achieved for Te Tumu. Te Tumu was the first area assessed in this way so as to inform the SmartGrowth review. Such mitigation measures may be an option to be assessed for other areas.

Modelling of tsunamis and their associated risk is a developing discipline and relies on many assumptions with consequential uncertainty. Much was learned from the March 2011 Tohoku event in Japan where the amount of slip was greater than expected; the Japan event occurred in a subduction zone similar to the Kermadec Trench, the source of the most hazardous tsunami scenario.

Traditionally, evacuation has aimed to move people out of the inundation zone entirely, inland or to high ground. Vertical evacuation provides people with safe refuge above maximum inundation height, while remaining within the inundation zone. New Zealand guidance for vertical evacuation is being developed, building on the USA's Federal Emergency Management Agency's published guidance and informed by review of the March 2011 Japan event.

In principle, the research has shown that including provision for vertical evacuation in the development at Te Tumu could reduce tsunami risk to an acceptable level. It remains to be shown that development that includes vertical evacuation facilities can also comply with other relevant planning provisions and be commercially viable.

### **Developed Areas**

Part of the current settlement strategy for accommodating future urban growth in the western Bay of Plenty sub-region is to facilitate a degree of residential intensification and encourage business growth in established urban areas, in an appropriate form and location. This creates a tension between strategic land use planning and hazard management policy that needs to be carefully considered.

The risk to Pāpāmoa, an already developed area, has been assessed to be intolerable. The risk to other already developed areas should also be assessed.

For existing developed urban areas, a key aim should be to manage future development and subdivision within an agreed 'tolerable' risk profile. That risk profile and related costs and benefits have yet to be discussed with affected people and communities. Part of the current emergency management work through such education programmes as 'Tsunami Survive' is to raise the awareness and understanding of tsunamis so that people are better informed to hold that conversation, and can take personal responsibility for action in a catastrophic emergency event.

Intensification should not increase risk above acceptable levels. In theory, intensification involving multi-storied buildings providing opportunities for vertical evacuation could be undertaken without increasing risk and could even reduce risk.

## **Recommendations:**

G1 That SmartGrowth, its constituent councils, and the CDEM Group collaborate in releasing information on the tsunami hazard and in engaging the relevant communities to manage the risk of tsunami in developed and yet to be developed areas.

### ***D Developed Urban Growth Areas and partially developed areas with further development options (including by intensification)***

D1 That SmartGrowth partner Councils collaborate to develop planning and other methods to manage tsunami risk.

D2 That SmartGrowth partner Councils engage with the community to define 'acceptable', 'tolerable' and 'intolerable' risk and appropriate land and building development solutions.

D3 That Regional Council prioritise areas for risk assessment in developed areas and undertake risk assessment.

D4 That Tauranga City Council funding for tsunami evacuation training be extended to the ongoing support of the 'Tsunami Survive' education and communication programme within Tauranga City.

D5 Review planning provisions in place for zoned but largely undeveloped Urban Growth Areas to ensure that they include mitigation measures.

D6 That current mapping work on the extent of tsunami inundation from Mount Maunganui to Pāpāmoa, and the low-lying areas around Tauranga Harbour (within Tauranga City) be completed and the spatial information displayed on GIS and made available to affected people and communities. This is to include identification of potential local vertical evacuation points, such as Mauāo and Mount Drury, and buildings within local neighbourhoods where that is possible.

D7. That technical work be commenced to enable tsunami related information to be provided on LIMs, PIMs, resource consents and building consents, as appropriate to meet statutory requirements, at an individual land parcel level where it is known.

D8. That further consideration be given to the construction of local vertical solutions in areas of the community where evacuation options outside of the inundation area do not exist.

D9. That, where private structures are identified as potential local vertical evacuation options, work is undertaken with property owners on how these structures could form part of a network of safe evacuation options for at risk areas.

### ***U Undeveloped Urban Growth Areas***

U1. That the CDEM Group continue its tsunami research programme to provide consistent coverage across the whole region. In particular, the effects of tsunami on Waihi Beach and the northern Tauranga Harbour should be examined.

U2. That the Regional Council assess the risk of tsunami for future growth areas, excluding Te Tumu which has already been assessed.

- U3. That Te Tumu be retained in the settlement pattern for the SmartGrowth Strategy Update.
- U4. That structure plans for undeveloped urban growth areas include tsunami mitigation measures (including, where necessary, identified areas of avoidance) which reduce the risk to, or maintain it at, an acceptable level.
- U5. That future sea level rise be taken into account in the design of tsunami mitigation measures relating to undeveloped urban growth areas.
- U6. Undertake development viability assessments which incorporate the inclusion of proposed hazard mitigation measures.
- U7. That CoastCare be supported in its protection of dunes that provide a natural defence against coastal hazards including tsunami.
- U8. That tsunami risk awareness be included in the long-term SmartGrowth Communications Strategy.

## 1. Purpose:

The purpose of this discussion paper is to consider whether, taking account of the tsunami hazard and possible mitigation measures, SGIC can have confidence to approve the Settlement Pattern for the SmartGrowth Strategy Update in relation to:

- i) Undeveloped Urban Growth Areas (specifically Te Tumu)
- ii) Developed Urban Growth Areas (in which the risk will be increased through intensification).

## 2. Background:

The SmartGrowth Strategy was adopted in 2004 and reviewed in 2007. SGIC has adopted a project plan to update the current SmartGrowth Strategy and work has commenced on that programme.

A significant amount of research is being undertaken as part of the SmartGrowth Update.

The workstream report *Review of Identified Residential Urban Growth Areas* (October 2012) noted that tsunami risk was subject to further technical assessment and would be part of the discussion paper on Future UGAs in the New Year. This discussion paper presents the findings of research that has been undertaken to assess the tsunami risk to SmartGrowth and whether the risk can be reduced to an acceptable level.

### 2.1 Natural hazards SmartGrowth context

As noted in *Issues Discussion Paper* (24 July 2012), the current SmartGrowth Strategy contains a section on hazards which includes categories for assessing land as to its suitability for urban development given the risk of natural hazards. The Strategy advocates for a precautionary approach to hazard management.

During the life of the existing SmartGrowth Strategy, there has been a growing awareness of natural hazards by the community. This awareness is driven by:

- The impacts of global warming/climate change i.e. more intense rainfall and potentially more flooding
- The Canterbury earthquake sequence
- International earthquakes and tsunamis e.g. Fukushima earthquake and tsunami in Japan 2011
- An increasing awareness of the need for Civil Defence.

The Bay of Plenty Regional Council has recently commissioned work which will contribute to better understanding of potential tsunami impacts on coastal development as well as the approach that should be adopted toward managing these impacts. The impact of liquefaction arising from earthquakes on future settlement patterns is also being investigated. The results of this work will be fed into the Strategy Update. While the tsunami hazard is included in this discussion paper, liquefaction is considered separately.

Tauranga is a coastal city with exposure to the risk of inundation from tsunami. The greatest risk posed by tsunami on this portion of the Bay of Plenty coastline is an event triggered along the Kermadec Trench, located north-east of New Zealand, and is called a local source event. The at-risk areas of the city include the existing urban areas developed along the Bay of Plenty open coast from Mount Maunganui to Pāpāmoa (a distance of 19km) and those low-lying urban areas located adjacent to Tauranga Harbour. The potential effect of a tsunami on a landform normally depends

on the size and location of the source event and various local factors including the shape of the coastline, its aspect to the tsunami source, land form, and type and location of development.

Recent scientific work commissioned by BOPRC and undertaken by the Institute of Geological and Nuclear Sciences in 2011 and 2012 has provided more accurate information on the risks presented to this portion of the BOP coastline. Tauranga City Council, using the data derived by GNS, is undertaking some additional work relating to the areas affected by tsunami inundation to provide the community with more accurate and up-to-date information on places to go to be safe should a local source event occur. This work is being undertaken by TCC as part of the preparation of a tsunami evacuation plan called *Tsunami Survive*. The preparation of the evacuation plan has raised awareness and understanding of the possible risk associated with a local source tsunami event, and this work is set to continue.

## **2.2 Natural hazards policy context**

All Councils have statutory responsibilities for the management of natural hazards and the provision of emergency management. Part of these responsibilities is ongoing engagement with the community on these issues including discussing and developing an understanding of what is ‘acceptable’, ‘tolerable’ or ‘intolerable’ risk. What local people and communities are willing to accept needs to be weighed against the likely costs of mitigation measures to ensure the level of risk is at a tolerable level. Despite the timeframes for formally adopting policy varying significantly between the Resource Management Act 1991 and the Civil Defence Emergency Management Act 2002, the current policy frameworks are consistent.

### **Resource Management Act**

The Resource Management Act 1991 defines **natural hazard** as any atmospheric or earth or water related occurrence the action of which adversely affects or may adversely affect human life, property, or other aspects of the environment. The definition of natural hazard specifically includes earthquake, tsunami, erosion, volcanic and geothermal activity, landslip, subsidence, sedimentation, wind, drought, fire, or flooding. The Act provides that natural hazards are to be avoided or mitigated.

Following the Canterbury earthquake sequence 2010–2011, the Government appointed a Technical Advisory Group to review sections 6 and 7 of the RMA. The TAG was to focus on whether sections 6 and 7 could be improved including, in particular, giving greater attention to managing issues of natural hazards (noting the RMA issues arising from the Canterbury earthquakes). The TAG’s report to the Government recommends changes to how the RMA deals with natural hazards; the Government has not yet indicated its position regarding those recommendations. The Resource Management Reform Bill introduced to Parliament late in 2012 inserts a replacement Schedule 4, “Information required in application for resource consent”, which carries forward a natural hazard clause from the existing Schedule 4: “any risk to the neighbourhood, the wider community, or the environment through natural hazards”. Substantive change in response to the TAG report is yet to be announced.

Until now, the tsunami hazard has not been addressed in the context of land use planning to implement SmartGrowth. In deciding on Plan Change 44 (Wairakei), TCC declined to consider the tsunami hazard on the basis that “its risk is difficult to quantify and it is outside the 100-year planning horizon for hazard risk commonly accepted under the RMA”. It stated that such “low probability events are appropriately addressed as part of civil defence emergency management planning including planning for evacuation”. It can be inferred that “risk” is used here as meaning likelihood alone. Risk is now understood to be the combination of the

likelihood and consequence of an event (New Zealand Coastal Policy Statement 2010, Glossary, Risk).

Recent Environment Court case law indicates support for addressing natural hazards through land use planning on the basis of the risk they pose. Taking a risk approach allows for low likelihood hazards such as tsunami to be addressed depending on their consequences.

The NZCPS 2010 (to be given effect by the regional policy statement, regional plans and district plans) specifically includes tsunami among coastal hazards to be managed, over **at least** 100 years [emphasis added]. Objective 5 is to ensure that coastal hazard risks are managed by:

- locating new development away from areas prone to such risks;
- considering responses, including managed retreat, for existing development in this situation; and
- protecting or restoring natural defences to coastal hazards.

The operative Bay of Plenty Regional Coastal Environment Plan includes as an objective: *No increase in the total physical risk from coastal hazards*. District plans may not be inconsistent with a regional plan. The next regional coastal plan is being prepared.

The Proposed Bay of Plenty Regional Policy Statement has adopted a risk management framework for managing natural hazards. It follows the New Zealand Standards typology of acceptable, tolerable and intolerable risk (refer AS/NZS ISO 31000:2009 *Risk management — Principles and guidelines* and SAA/SNZ HB 436:2004 *Risk Management Guidelines*). The Proposed RPS policy regime requires intolerable risk to be avoided, existing tolerable risk to be reduced and new development to not be subject to risk that exceeds acceptable levels. BOPRC's decisions on submissions retained the risk management policy framework. The decisions removed from the notified version the criteria for the thresholds between the three risk levels in favour of requiring reference to authoritative guidance. The decisions have been appealed to the Environment Court by developers, an energy utility, a transport agency, and advocacy organisations from the environmental and rural sectors. The appeals, which range from seeking technical changes to questioning the concept of acceptable risk, are yet to be decided. The Proposed RPS includes a method of implementation that obliges the BOPRC to assess the level of risk due to volcanic eruption, earthquakes and associated hazards, and tsunami. Another method obliges all local authorities to collaborate in gathering hazard information and, with their communities, establishing levels of risk acceptability. Explanation of the relevant policy states that, in the end, judgement is required to be exercised by or under the authority of elected representatives.

As part of the resolution of appeals on the Tauranga City Plan, BOPRC and TCC have entered into a Memorandum of Understanding. The two councils have agreed to collaborate in preparing district plan provisions that implement the risk management approach.

Several national guides on how to manage natural hazard risk through land use planning have been published recently. (See, for example, Saunders, W.S.A.; Prasetya, G. and Leonard, G.S. 2011. New Zealand's Next Top Model: Integrating tsunami inundation modelling into land use planning, *GNS Science Miscellaneous Series 34*, 42p.) Further work is in preparation.

## **Civil Defence Emergency Management Act**

The purpose of the Civil Defence Emergency Management Act 2002 includes the following relevant provisions:

- (a) improve and promote the sustainable management of hazards (as that term is defined in this Act) in a way that contributes to the social, economic, cultural, and environmental well-being and safety of the public and also to the protection of property; and
- (b) encourage and enable communities to achieve acceptable levels of risk including—
  - (i) identifying, assessing, and managing risks; and
  - (ii) consulting and communicating about risks; and
  - (iii) identifying and implementing cost-effective risk reduction; and
  - (iv) monitoring and reviewing the process; and
- (c) provide for planning and preparation for emergencies and for response and recovery in the event of an emergency; and
- (d) require local authorities to co-ordinate, through regional groups, planning, programmes, and activities related to civil defence emergency management across the areas of reduction, readiness, response, and recovery, and encourage co-operation and joint action within those regional groups.

Under this Act, the Bay of Plenty Civil Defence Emergency Management Group has been established. The BOP CDEMG comprises all seven councils in the Bay of Plenty: BOPRC, TCC, and Kawerau, Ōpōtiki, Rotorua, Western Bay of Plenty and Whakatāne District Councils (but not Taupō District Council). As required by the CDEM Act, the Group has prepared its *Bay of Plenty Civil Defence Emergency Management Group Plan 2012-2017*. In keeping with the 4Rs set out in (d) above, the Group Plan includes a section on Risk Reduction with the following principles:

- Events that have the potential to cause a significant number of deaths or injuries to people are not acceptable – human life and safety will therefore take precedence over all other risk priorities.
- Events that have the potential to cause severe economic losses, substantial damage to buildings, infrastructure or lifeline utilities will be prioritised according to their risk.
- The Bay of Plenty CDEM Group is risk averse and will apply the prudent person principle for managing risk. (Prudence is demonstrated by the process through which risk is managed, the process by which strategies are developed, adopted, implemented, monitored and reviewed, based on an established policy and review procedure, in light of their purposes.)
- Hazard information is to be freely available to enable the community to engage in decisions about the acceptability of the risks they face and to equip individuals to act to reduce their own risk.
- Comprehensive risk reduction is achieved through integrated planning and risk management across all councils, and at the ‘all-of-council’ level within each council, taking a multi-agency all-of-government approach, involving central government and partner agencies such as lifelines and utility providers.

The Group Plan acknowledges that the CDEM Group is only one part of the region’s risk management context, which involves many other stakeholders including central government organisations, local authorities, emergency services and lifeline utilities. Additionally individuals and communities should consider risk reduction. The Group Plan notes that other statutes that provide legislatively for risk reduction include:

- Resource Management Act 1991
- Local Government Act 2002
- Building Act 2004
- Soil Conservation and Rivers Control Act 1941

as well as growth strategies, guidelines and plans.

CDEM uses the framework of the 4Rs to meet its responsibilities under the CDEM Act in any community. The 4Rs provide a useful basis for outlining the thinking in regard to tsunami:

#### Reduction

- Land use planning and building design and construction provisions to reduce the level of existing tsunami risk to a tolerable level and managing new development within acceptable risk through such methods as City Plan policy and rules on new development, subdivision and/or building design. Examples of the methods may be minimum floor/platform heights, specific building design to resist tsunami forces, and the provision of local vertical evacuation options in identified hazard areas. The preference is to apply a remedy or mitigation when new development occurs rather than retrofitting existing developed areas. Such controls will have a cost impact which has, at this time, not been considered or quantified. Consideration of cost and benefit impacts would form part of any community discussion on what constitutes 'acceptable', 'tolerable' and 'intolerable' risk.
- Ongoing work is being undertaken by TCC using the GNS tsunami model outputs to gain more accurate understanding on the potential extent of tsunami inundation on Tauranga City. This work will provide a greater understanding of the effects on people and property and will assist in appropriate planning techniques (Reduction), public education and evacuation planning (Readiness), and evacuation (Response).
- As part of the further work TCC is aiming to identify/map areas that are safe to evacuate to, either by distance or vertically. Further consideration needs to be given as to how the community could access some of the areas of vertical evacuation that may be identified as well as the need to construct local vertical evacuation facilities. Undertaking this work will ensure that people have a safe place to go in a timely manner in the event of a 'worst case' tsunami.

#### Readiness

- Distribution to the community of the completed 'Tsunami Survive' evacuation plan is planned for 2013.
- Proactive education of local people and communities through the TCC "Tsunami Survive" education programme. TCC staff have been working through community networks in the low-lying parts of Tauranga and the open coastal areas along Mount Maunganui to Pāpāmoa to communicate messages on preparation, responsibility and action plans if a tsunami event occurs.
- The focus for 2013 is to heighten the awareness of the issue within individual households. The aim is to gain acknowledgement by individuals of their personal responsibility to prepare and take action in a tsunami emergency event.
- Council is in the process of installing tsunami sirens for the most affected areas of the city. It is noted however that sirens are best suited for regional and distant-sourced tsunami events, rather than local events which pose the greatest risk.
- Information on tsunami is proposed to be placed with Land Information Memoranda (LIMs), Project Information Memoranda (PIMs), resource consents and building consents. Further technical work is required to bring the information to a point where it meets the needs of Council's statutory responsibilities. This will inform engagement with the community on this matter, subject to TCC elected members' direction.

#### Response

- Response commences when an actual tsunami threat or event occurs. CDEM at Local, Regional and National levels provides a lead role and works with emergency services, public agencies and other service providers to appropriately respond to the event. Part of the response may include radio messaging,

activation of warning sirens, traffic management, or in the case of a minor threat, placing warnings for people on beaches and at boat ramps.

### Recovery

- CDEM works with welfare and utility organisations, local and regional authorities, public agencies and service providers to support the affected community to re-establish the community structures and return to normality as promptly as possible.
- BOP has two CDEM groups, the Welfare Advisory Group and the Lifeline Group for infrastructural assets, whose role is to improve multi-agency communications. This greater understanding of the relationships between organisations will both assist in reducing impacts and enhance the speed of recovery.

Supporting the CDEMG is the Coordinating Executive Group (CEG), a statutorily mandated committee made up of the CEOs (or their representative) of local authorities, Fire Service, Police, District Health Boards, the Medical Officer of Health and the Group Controller.

### Integration of policy response

The role of the RPS in achieving integrated management and the co-ordinating structure of the CDEM Group both point to local authorities in the region combining to develop and implement a consistent approach to engaging with the community about tsunami. The roles entrusted to councils carry a corresponding responsibility: the duty for councils to carry out their functions with reasonable skill and care<sup>2</sup>; councils ought to know that, if they do their work badly, people may be injured or worse<sup>3</sup>.

### **2.3 Tsunami research context**

Research into the tsunami hazard to the Bay of Plenty region was commenced in 2001. A 2002 paleotsunami study found evidence of past tsunami and led to further studies over the following decade. One output derived from these studies is mapped tsunami evacuation zones.

The Ministry of Civil Defence and Emergency Management recognises four development levels for mapping tsunami evacuation zones. The recommended approach is to map now, and progressively refine the accuracy of boundaries as the science improves over time. As the understanding of local tsunami hazard and risk improves, the level of technical sophistication used in defining tsunami hazard and evacuation zones should be advanced. Until higher stage assessments can be undertaken, a precautionary approach is recommended.

In the Bay of Plenty, maps have been prepared to the recommended minimum Level 2 standard of the *Director's Guideline for Civil Defence Emergency Management Groups* (December 2008). The Level 2 maps were published in December 2010 and can be viewed on:

<http://www.bopcivildefence.govt.nz/bay-of-plenty-hazards/natural-hazards/#Tsunami>

The latest two GNS studies, the subject of this discussion paper, followed four reports commissioned by the CDEM CEG. One of those four reports identifies possible tsunami sources and two relate to SmartGrowth's area of interest. (These four reports have not yet been released by the CEG.) It should be noted that the CEG-commissioned research does not cover Waihi Beach. After receiving a

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<sup>2</sup> After *North Shore City Council v Body Corporate 188529 (Sunset Terraces) and Ors*, SC 27/2010, at [17].

<sup>3</sup> After *Body Corporate No. 207624 v North Shore City Council* SC 58/2011, at [76].

presentation on a draft of one of the reports, SmartGrowth's Implementation Management Group requested that BOPRC commission GNS to provide a further report examining the risk to Pāpāmoa, Wairakei and Te Tumu assuming ground levels were modified to reflect the final constructed situation. In turn, this led to another report examining whether mitigation could reduce Te Tumu risk to an acceptable level. These latest two GNS reports are the subject of this discussion report:

*Modelling of the tsunami risk to Papamoā, Wairakei and Te Tumu assuming an altered ground level due to development of Wairakei and Te Tumu, and the implications for the SmartGrowth Strategy*, GNS Science Consultancy Report 2012/54, September 2012, and

*Modelling of the evacuation rates required to achieve an acceptable level of health and safety risk in Te Tumu from the Variation to the Southern Kermadec Scenario*, GNS Science Consultancy Report 2012/291, December 2012.

The more detailed modelling undertaken for these reports would meet CDEM Level 3 standards except that the necessary probabilistic analysis is not yet available.

An earlier report "Tsunami source study", referenced in Beban et al. September 2012 section 1.5 as "Goff et al (2006)", found that some paleotsunami sites could not be explained by the modelling available at that time. Modellers had been unwilling to use scenarios with initiating seismic events of magnitude Mw 8.5 to 9.0 since, at that time, the geophysical consensus understanding of subduction zones did not support such large events. The Great East Japan earthquake in March 2011, magnitude Mw 9.0, demonstrated that such large events are possible. Lessons from that subduction trench event have been taken into account in the scenarios modelled in these latest two reports. The modelled results now align with the paleotsunami evidence, adding credibility to both the paleo evidence and the modelling.

These latest two reports have been prepared specifically to feed into the review of the Settlement Pattern for the SmartGrowth Strategy Update.

## **2.4 Risk comparison context**

Taking a risk approach provides a common basis for comparing different hazards. Deaths are the predominant contributor to the "consequence" factor in risk. The first report (Beban et al. September 2012, section 3.12) includes a comparison of the risk of death from tsunami and earthquakes. This indicates that, for events with equivalent return periods, the number of deaths from tsunami is several orders of magnitude greater than from earthquakes. The comparison assumes no evacuation. (Evacuation is discussed in the next section.) Property damage repair costs were also estimated to be much greater for tsunami than for earthquakes.

This is consistent with an analysis undertaken following the disastrous Boxing Day tsunami in the Indian Ocean in 2004 and reported in Webb 2005<sup>4</sup>. The Webb report compares the risk from tsunami for a number of New Zealand cities in which Tauranga's tsunami risk is shown as mid-range among the cities. Taig et al. 2012<sup>5</sup> includes a brief analysis of tsunami risk for some east coast cities (including Whakatāne but not Tauranga); it concludes: "...tens of thousands of people in these

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<sup>4</sup> Webb, T. 2005. Review of New Zealand's preparedness for tsunami hazard, comparison to risk and recommendation for treatment, *GNS Client Report 2005/162*

<sup>5</sup> Taig, T., Massey, C., Webb T. 2012. Canterbury Earthquakes Port Hills Slope Stability: Principles and Criteria for the Assessment of Risk from Slope Instability in the Port Hills, Christchurch, *GNS Science Consultancy Report 2011/319*

cities are likely to be living with tsunami annual individual fatality risk in excess of  $10^{-5}$  per year, while hundreds, if not thousands, are likely to be living with tsunami annual individual fatality risk in excess of  $10^{-4}$  per year. Such risk levels are the reason for substantial initiatives having been taken in the relevant communities to mitigate tsunami risks.” Annual individual fatality risk in excess of  $10^{-5}$  per year is in the “tolerable” risk range; in excess of  $10^{-4}$  per year is “intolerable”. This situation corresponds with a comment made by Taig (section 3.1.3) as involving “hazards of which people had been aware of for some time without necessarily recognising the level of risk involved (the risk might have been “accepted”, without being deemed “acceptable” with reference to relevant risk criterion).” Webb commented (section 3.1), “In general, New Zealanders have had little opportunity to be well-informed in terms of the associated risks of a coastal habitation.”

Comparison with volcanic risk has not been undertaken but it is expected that warning systems would enable fatalities to be minimised in a large majority of volcanic events (Taig et al. 2012); in any case, the volcanic risk to the SmartGrowth area is not spatially differentiated and any mitigation would apply across the whole area. This also applies to seismic risk: few if any fault lines are within the SmartGrowth area leaving the shaking hazard to be addressed by engineering and the Building Act; the liquefaction hazard deriving from earthquakes is addressed separately.

## **2.5 Evacuation context**

To inform planning for evacuation, tsunami sources that impact on New Zealand can be divided into three categories:

- Distant source — more than 3 hours travel time from New Zealand;
- Regional source — 1–3 hours travel time from New Zealand; and
- Local source — 0–60 minutes travel time to the nearest New Zealand coast.

The second report (Beban et al. December 2012) assesses the scenario that causes the greatest level of inundation, the Variation to the Southern Kermadec Scenario. The travel time of such a tsunami to the study area is approximately 50 minutes qualifying this scenario as a local source. The Webb (2005) report noted that there are no formal warning arrangements for local-source tsunami. “... [E]ffective local warnings are not currently available and are likely to take considerable time to develop ...”. Although seven years have passed, this statement holds true. The Ministry of CDEM<sup>6</sup> advises people to respond to natural warning signals:

“Natural warning signals are of key importance in response to local source tsunami and they may be the *only* warnings possible for local or regional source tsunami.

- Strong earthquake shaking (i.e. it is hard to stand up)
- Weak, rolling earthquake shaking of unusually long duration (i.e. a minute or more)
- Out of ordinary sea behaviour, such as unusual and sudden sea level fall or rise
- The sea making loud and unusual noises, especially roaring like a jet engine.

“When experiencing any of the above go immediately to high ground or, if the surrounding area is flat, go as far inland as possible, evacuating all coastal areas or, where present, all evacuation zones. The first wave may arrive within minutes. Once away from the water, listen to a radio station for information from local civil defence about further action you should take.”

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<sup>6</sup> Working from the same page — consistent messages for CDEM, PART B: Hazard-specific information — Tsunami. Published by the Ministry of Civil Defence & Emergency Management, Version 1.0 April 2010

Traditionally, evacuation has aimed to move people out of the inundation zone entirely, inland or to high ground. The physical setting of Te Tumu, at the end of a sand spit with a river and low ground on the landward side, precludes the option of going inland and evacuating all coastal areas. However, some high ground exists, opening the possibility of vertical evacuation. Vertical evacuation provides people with safe refuge above maximum inundation height, while remaining within the inundation zone. New Zealand guidance for vertical evacuation is being developed, building on the USA's Federal Emergency Management Agency's published guidance and informed by review of the March 2011 Japan event.

### **3. Research findings:**

The reports found that, assuming no evacuation, the study areas of Pāpāmoa, Wairakei and Te Tumu are subject to intolerable risk from tsunamis. These are the first SmartGrowth areas where the consequences of tsunamis have been analysed and the risk assessed. It is likely that the level of risk throughout the settlement pattern will vary and further work is recommended to assess the specific risk of other developed and undeveloped urban growth areas in relation to their coastal location.

The research reported in the first report (Beban et al. September 2012) examined twelve scenarios with the potential to generate tsunamis that could affect the Bay of Plenty. Tsunamis from several Kermadec Trench scenarios could significantly inundate the study area. This is consistent with the findings of the research that has been undertaken over the last decade. When the risk (consequence and likelihood) of these events for Pāpāmoa, Wairakei and Te Tumu was assessed against criteria for acceptable, tolerable and intolerable risk, the risk was found to be intolerable.

The second report (Beban et al. December 2012) found that, with vertical evacuation facilities and a combination of land use planning and emergency management measures, an acceptable level of risk could be achieved for Te Tumu. Te Tumu was the first area assessed in this way so as to inform the SmartGrowth review of the Settlement Pattern for the SmartGrowth Strategy Update. Such mitigation measures may be an option to be assessed elsewhere.

The research reports acknowledge that there is a high degree of uncertainty in tsunami source models. Uncertainty arises under both aspects of risk: likelihood and consequences.

In the second report (Beban et al. December 2012), the likelihood of the modelled scenario (the Variation to the Southern Kermadec Scenario) derives from the "return period" ascribed to the causal event: 610 years. This is back-calculated from the slip observed in the Great East Japan earthquake in March 2011, the amount of convergence of the tectonic plates required to produce that slip, and the time for the average rate of plate convergence to produce that convergence. As such, the return period is conservative in that each of these factors are optimised to produce the minimum return period.

As reported in the first report (Beban et al. September 2012) other scenarios with similar effects (the Kermadec-Hikurangi Scenario and Variation of the Whole Kermadec Trench Scenario) have return periods of 360 years and 540 years respectively. (The researchers acknowledge that it is possible that earthquakes as large as those in these scenarios do not occur.) While the tsunami-producing mechanisms described in the scenarios suggest a cyclic return period, the possibilities raised by several such scenarios, each with its own return period, introduce an element of randomness. The return periods are therefore inverted to produce an indicative frequency or its approximate reciprocal, the annual exceedance probability. This provides the probability or likelihood of an event

occurring in any one year, rather than implying that such events occur at regular intervals. Nevertheless, it is sobering to note that the paleotsunami evidence is that large events, similar to the modelled scenario, last occurred 500–600 years ago.

In regard to “consequence” uncertainty, the second report (Beban et al. December 2012) assessed the degree of evacuation that would be required to achieve the necessary acceptable risk. It found that, of a design population of 20,000 people, 6000 are required to evacuate for a night-time event and 7000 for daytime. The report states that those people who do not evacuate are assumed to remain in their respective buildings and be located above the ground floor. This implies that all of the design population is safe. However, the tables showing how the evacuation rates are determined show that (various) numbers of deaths are expected. However, the risk of death (the combination of the event’s likelihood and the consequence (number of deaths)) is nevertheless assessed as acceptable against the criteria adopted. The minimum evacuation rates required to achieve an acceptable risk in relation to various land uses are:

	Night time	Day time
Housing (low density)	37%	37%
Housing (medium density)	27%	27%
Retirement	100%	100%
Mixed-use	0%	35%
Apartment Block	0%	0%
Rest-home/hospital	50%	50%
Education	0%	59%

These evacuation rates are presented by the researchers as showing that an acceptable level of risk can be achieved. However, the report contains no statement about the achievability of those evacuation rates. A report on evacuation lessons learned from the Great East Japan earthquake in March 2011<sup>7</sup> refers to previous studies. In Kesenuma City following a local offshore earthquake in 2003 (with shaking at the high end of the range expected from the scenarios modelled for Te Tumu (see next paragraph)) and despite regular education and evacuation drills, almost 86% of residents did not evacuate. Evacuation rates reported for the 2011 event ranged between 20% and 72%. The requirement for 100% evacuation from “Retirement” suggests that that land use may not be appropriate for the Te Tumu area. It appears that the required evacuation rates may be challenging to achieve.

As noted above, formal warnings are unlikely to be issued before the arrival of a tsunami with associated intolerable or tolerable risk and natural signals may provide the only warning. The first report (Beban et al. September 2012, section 3.12) includes estimates of the shaking that would be felt in the study areas of Pāpāmoa, Wairakei and Te Tumu from the studied tsunami scenarios. Tsunami giving rise to tolerable risk would result from scenarios with shaking intensities ranging between 5.3 and 7.1 Modified Mercalli Intensity; tsunami with intolerable risk from scenarios with shaking intensities of 7.7–8.3. The relevant range from a simplified Modified Mercalli Intensity Scale, further modified to suit New Zealand conditions, is presented in the table below<sup>8</sup>:

<sup>7</sup> Fraser, S.; Leonard, G.S.; Matsuo, I. and Murakami, H. 2012. Tsunami evacuation: Lessons from the Great East Japan earthquake and tsunami of March 11<sup>th</sup> 2011, *GNS Science Report* 2012/17. 89 p.

<sup>8</sup> <http://www.gns.cri.nz/Home/Learning/Science-Topics/Earthquakes/Monitoring-Earthquakes/Other-earthquake-questions/What-is-the-difference-between-Magnitude-and-Intensity/The-Modified-Mercalli-Intensity-Scale>

Category	Definition
MM 5: Strong	Generally felt outside and by almost everyone indoors. Most sleepers are awakened and a few people alarmed. Small objects are shifted or overturned, and pictures knock against the wall. Some glassware and crockery may break, and loosely secured doors may swing open and shut.
MM 6: Slightly damaging	Felt by all. People and animals are alarmed, and many run outside. Walking steadily is difficult. Furniture and appliances may move on smooth surfaces, and objects fall from walls and shelves. Glassware and crockery break. Slight non-structural damage to buildings may occur.
MM 7: Damaging	General alarm. People experience difficulty standing. Furniture and appliances are shifted. Substantial damage to fragile or unsecured objects. A few weak buildings are damaged.
MM 8: Heavily damaging	Alarm may approach panic. A few buildings are damaged and some weak buildings are destroyed.
MM 9: Destructive	Some buildings are damaged and many weak buildings are destroyed.

While some natural signals may therefore be able to be detected, effective evacuation will be dependent on the preparation and implementation of an entire evacuation strategy. (Not all tsunami sources generate natural signals; for example, some tsunami (not included among scenarios reported here) may be generated by non-seismic processes.) Ongoing community engagement, sustained tsunami education and evacuation training is required to ensure appropriate evacuation response to natural signals so that individuals act to reduce their own risk.

### **3.1 Research limitations**

The first report (Beban et al. September 2012) specifically discusses the limitations of the research in sections 1.1, 2.5, 3.13 and 4.8. While acknowledging the limitations, the modelling meets the principles in AS/NZS ISO 31000:2009 *Risk management — Principles and guidelines*. In particular, the reports:

- help decision makers take account of uncertainty, and are
- systematic,
- based on the best available information and
- responsive to change.

Modelling of tsunami and their associated risk is a developing discipline. Much was learned from the March 2011 Tohoku event in Japan where the amount of slip was much greater than expected; the Japan event occurred in a subduction zone similar to the Kermadec Trench.

The research has shown that, in principle, provision for vertical evacuation can be included at Te Tumu so that tsunami risk is reduced to an acceptable level. It remains to be shown that development that includes vertical evacuation facilities can also comply with other relevant planning provisions. For example, the researchers' assumptions include two ten-storey apartment blocks along the northern boundary of Te Tumu, just landward of the coastal dunes. It is not known whether such towers would meet obligations to protect the natural character of the coastal environment. Structure planning that incorporates evacuation requirements is still required to be undertaken and tested to ensure that it complies with the regional and city planning regime.

No analysis of the economic or commercial viability of including provision for vertical evacuation in development at Te Tumu has been undertaken.

The areas of Pāpāmoa, Wairakei and Te Tumu are the first to be researched to determine their level of tsunami risk; Te Tumu is the first to be investigated to determine whether intolerable risk can be reduced to an acceptable level. It is likely that the level of risk throughout the SmartGrowth settlement pattern will vary. Further work is recommended to assess the specific risk of other developed and undeveloped urban growth areas, such as North-west Bethlehem, Katikati Stages 1 & 2, Ōmokoroa Stages 1 & 2, and Waihī Beach Stages 1 & 2, in relation to their coastal location.

The modelling is based on current sea level and does not account for any sea level rise over time.

#### **4. Conclusions:**

##### **4.1 Developed areas**

In the Tauranga City area there is a significant established population, estimated to be 51,000 people, in areas that are predicted to be affected by tsunami, with the remainder of the population likely to be indirectly affected by a 'worst case' event. This number will vary depending on time of year, day in the week and time of day. Among councils' key statutory functions are control of the use of land to avoid or mitigate natural hazards (regional council) and control of any actual or potential effects of the use, development or protection of land to avoid or mitigate natural hazards (city and district councils); tsunami are natural hazards. In planning terms there are policy aims set out in the Resource Management Act 1991, the Regional Policy Statement, Tauranga City Plan and Western Bay of Plenty District Plan that cannot be ignored and will influence development/redevelopment provisions for land use and building going forward.

Part of the current settlement strategy for accommodating future urban growth in the western Bay of Plenty sub-region is to facilitate a degree of residential intensification and encourage business growth in established urban areas, in an appropriate form and location. This creates a tension between strategic land use planning and hazard management policy that needs to be carefully considered.

The risk to Pāpāmoa, an already developed area, has been assessed to be intolerable. The risk to other already developed areas should also be assessed.

For existing developed urban areas, a key aim should be to manage future development and subdivision within an agreed 'tolerable' risk profile. That risk profile and related costs and benefits have yet to be discussed with affected people and communities. Part of the current emergency management work through such education programmes as 'Tsunami Survive' is to raise awareness and understanding of tsunami so that people are better informed to hold that conversation, and can take personal responsibility for action in a catastrophic emergency event.

One principle that might be applied for existing developed areas is that where people cannot easily reach safety for various reasons, measures should be in place to increase their safety and /or chances of survival. This principle and the 'tolerable' risk policy suggest that new provisions relating to land use activity and/or building design be applied within areas identified as susceptible to inundation from tsunami. Such provisions could include minimum floor/platform levels or specific building design for dwellings or buildings located in a tsunami risk area. Allied to this would be displaying on mapping systems those existing areas or buildings that could be used for local vertical evacuation facilities.

Intensification should not increase risk above acceptable levels; in areas of existing development subject to tolerable risk, the risk should be reduced to be as low as reasonably practicable (not increased). In theory, intensification involving multi-storied buildings which provide for vertical evacuation could be undertaken without increasing risk and could even reduce risk.

#### **4.2 Undeveloped areas**

Research has modelled tsunami effects on the coast of much of the area covered by SmartGrowth. Recent research (some yet to be released) does not cover all of the SmartGrowth coast. In particular, tsunami effects at Waihi Beach and the northern Taranga Harbour have not been modelled in the recent research.

Risk arising from the recently modelled tsunami has been assessed for Wairakei (approved for development but as yet undeveloped) and for Te Tumu, which is being reconsidered for development. Without evacuation, the risk in both these areas has been found to be "intolerable" for several tsunami scenarios.

Further research has examined the risk to Te Tumu assuming several areas of existing high ground will be retained and engineered to provide vertical evacuation facilities. This research has found that, in principle and subject to the preparation and implementation of an entire evacuation strategy development could be undertaken without risk exceeding acceptable levels.

This "in principle" finding may be sufficient to justify not removing Te Tumu from being a future growth area for SmartGrowth. Further work is required to demonstrate that development could be formally approved.

The risk to other growth areas should also be assessed and managed according to the level of risk presented.

Recommendations are included in the Executive Summary.