EARTHQUAKE COMMISSION
Kōmihana Rūwhenua

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Briefing to the Public Inquiry into the Earthquake Commission

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Purpose

1 This briefing provides information on the Earthquake Commission's (EQC) research and education functions.

Executive summary

2 EQC's research and education functions and have enabled it to make substantial contributions to New Zealand's understanding of the natural hazard landscape and how to mitigate natural disaster damage. In addition, EQC funded research projects have delivered significant benefits for Canterbury in the aftermath of the earthquakes, but also for New Zealand.

3 The ground improvement research programme and the Canterbury Geotechnical Database are two examples where research funded by EQC in response to the Canterbury earthquakes has accelerated the Canterbury recovery, and benefited New Zealand as a whole. The ground improvement research programme produced scientific, technical and practical lessons for building or rebuilding houses on land that is vulnerable to liquefaction. These lessons have been used by engineers, construction workers, local authorities and other stakeholders to assist in the repair and rebuild of many homes in Canterbury. This information has been recognised as a critical resource that can be used in other areas that are vulnerable to liquefaction, both in New Zealand and around the world.

4 The Canterbury Geotechnical Database was developed initially as a searchable platform for geotechnical engineers and other professionals to store, share and readily assess the data files of geotechnical investigations. The value of this information was quickly realised, so it was made accessible to private and public sector entities to use in the rebuild. In 2016, the Ministry of Business, Innovation and Employment (in partnership with EQC) built on the success of the Canterbury Geotechnical Database and launched the New Zealand Geotechnical Database.

5 EQC's loss modelling analysis (the ability to effectively price known hazard risks) has helped reduce uncertainty for international reinsurers on the risks that they are covering. This work contributed to EQC's ability to continue to secure reinsurance in the aftermath of the Canterbury earthquake sequence.

6 EQC's public education function primarily focuses on preparedness steps that can be taken to make residential properties safer and stronger for natural hazard events. EQC's current public education activities are delivered through paid and unpaid advertising across various channels, museum partnerships (such as with Te Papa), and school education initiatives.

7 The facilitation of research and education is one of EQC's statutory functions. Funding for these functions is from the Natural Disaster Fund. EQC's legislative mandate and independent source of funds allowed it to invest in research and education before the recent Canterbury and Kaikōura events brought the importance of this work into national focus. EQC's contribution of research and education to improving resilience to natural hazards at the individual, household, and community level is significant and must continue into the future.

8 EQC's research and education functions need to be considered in the context of New Zealand's broader disaster risk management framework, which includes risks that are broader than natural hazards (such as terrorism, pandemic and climate change). There is real opportunity for better integration and coordination among the different central and local government agencies responsible for different parts of the broader risk management ecosystem, to ensure that their respective contributions to resilience are aligned and maximised.

Legislative mandate and funding for research and education

9 The Earthquake Commission Act 1993 states that one of EQC's functions is to "facilitate research and education about matters relevant to natural disaster damage, methods of reducing or preventing natural disaster damage, and the insurance provided under this Act."[1]

10 The Act also states that the Natural Disaster Fund[2] administered by EQC can be used to pay for (among other things):

a funding for research grants made by EQC; and

b costs incurred in campaigns to increase public awareness and education about EQC and the Natural Disaster Fund (including research and education in relation to preventing natural disaster damage).[3]

11 This clear legislative mandate to undertake research and education, combined with an independent funding source (that allows the EQC Board to make long-term investment decisions), have enabled EQC to make substantial contributions to New Zealand's understanding of the natural hazard landscape and the methods of reducing or preventing natural disaster damage.

[1] Section 5, Earthquake Commission Act 1993.
[2] See Briefing to the Public Inquiry into the Earthquake Commission, *Managing Risk – Premiums, Reinsurance and the National Disaster Fund* (4 July 2019), pages 9-10.
[3] Section 15, Earthquake Commission Act 1993.

Focus of EQC's research

12 New Zealand's hazard risk landscape, public sector management settings and disaster risk insurance arrangements are globally unique. As a result of this, some research can only be, or is best undertaken, in New Zealand because our knowledge needs are unique (and no one else will do it). This also provides essential support to important sectors of the economy and society.

13 Parallel needs also exist to use, adopt or adapt science-related knowledge, products, systems and technologies that have been developed elsewhere in a timely and efficient way to meet New Zealand's unique needs. It is also important to maintain the ability to appreciate the significance of trends and technologies that arise elsewhere and to evaluate their relevance and priority for potential use and further New Zealand involvement.

14 EQC undertakes its research function through a combination of investment in data, research capability and initiatives to integrate and apply research into policy and practice, and through collaboration to influence the national research agenda (such as through the National Science Challenges). The research remit is not confined to residential dwellings. The context for EQC's research mandate has always been holistic. For example, land and buildings are indivisible with commercial and residential buildings inhabiting the same spaces, commonly incorporating the same design practice and technologies and built on the same land.

15 The outcomes of EQC funded research feeds directly into loss modelling, whether it is the in-house Minerva model,[4] or those developed by third party vendors such as Risk Management Solutions (RMS) based in California and AIR Worldwide based in Boston. The research provides a credible New Zealand view of New Zealand risk.

Pre-Canterbury research focus

16 In the three decades prior to the Canterbury earthquakes, EQC was at the forefront of investment in understanding geological hazards, including seismic hazards in Christchurch. The application of knowledge from studies that EQC funded or contributed to significantly reduced the infrastructure losses in the Canterbury earthquakes for those organisations which had chosen to invest in mitigation many years earlier.[5]

[4] See Briefing to the Public Inquiry into the Earthquake Commission, *Information Management and Technology* (27 June 2019), pages 25-26.

[5] See Tony Fenwick, *The Value of Lifeline Seismic Risk Mitigation in Christchurch: Summary Report* (2012), www.eqc.govt.nz/research/research-papers/ifeline-seismic-risk-mitigation-christchurch and Christchurch Engineering Lifelines Group, *Risks and Realities: A Multi-Disciplinary Approach to the Vulnerability of Lifelines to Natural Hazards* (1997) Christchurch: New Zealand Centre for Advanced Engineering, http://hdl.handle.net/10092/11544.

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GeoNet – New Zealand's national monitoring system

17 A belief in the importance of good data and shared information was behind EQC's decision in 2001 to partner with GNS Science and Land Information New Zealand to establish New Zealand's geological hazards monitoring system, GeoNet. GNS Science is the technical manager of the system, with EQC and Land Information New Zealand funding the system. EQC's funding contribution to GeoNet in 2018/19 was $12 million.[6]

18 The GeoNet partnership has delivered dividends well beyond what was first envisaged in the initial business case. The network of geophysical instruments across New Zealand, coupled with sophisticated software applications, has allowed GeoNet to gather and disseminate information about New Zealand's earthquakes, volcanic activity, large landslides and slow deformation that precedes large earthquakes. It also underpinned the modernisation by Land Information New Zealand of New Zealand's geodetic and cadastral survey system.

19 GeoNet's publicly available data enables high quality research and provides coverage that allows research to make gains in applicability and confidence, as well as opportunities for the increased research collaboration required to effectively analyse such as large data resource. The high degree of system automation, in near real time, permits the delivery of rapid alerts and, in certain circumstances, warnings, such as ash plume dangers to help inform aviation forecasting and, with additional funding from the Ministry of Business, Innovation and Employment during the past two years, the likelihood of tsunami generated by earthquakes offshore.

Case Study: Orion Infrastructure Upgrades[7]

In the early 1990s, a study of potential earthquake risks in Christchurch identified that much of the infrastructure of Orion (the electricity lines company in Christchurch) would not survive a major earthquake. Consequently, Orion embarked on a programme to upgrade its infrastructure.

Over a ten year period (1996–2006), Orion invested $6 million to upgrade various structures. Orion has estimated that about $60 million of direct asset replacement costs were avoided after the 22 February 2011 earthquake. This is money that Orion would have had to spend after the earthquake, if it had not carried out its upgrade programme.

Orion's main network was functioning within two days of the earthquake. By comparison, Christchurch's wastewater network took more than five years to repair at a cost of more than $2 billion.

The direct return on investment for Orion is an internal rate of return (IRR) of about 22% and a net present value (NPV) of about $16 million (1996).

If the impact of having a continuous electricity supply to the city of Christchurch is allowed for, then the value of this investment is likely to be considerably higher. Assuming a range of economic multipliers from three to nine would give returns to Christchurch of 33% to 46%.

[6] Earthquake Commission media release, *EQC confirms $12 million 2018/19 funding for GeoNet* (2 August 2018), https://www.eqc.govt.nz/news/eqc-confirms-12-million-2018-19-funding-for-geonet.
[7] Orion Case Study by Gravelroad, *Loss Modelling Capability Indicative Business Case* (16 November 2017), pages 33-34.

EQC's research contribution to the Canterbury response and recovery

20 GeoNet had an extensive network in Canterbury to monitor the effect to Christchurch of an earthquake on the Alpine Fault. The beginning of the Canterbury earthquake sequence triggered further expansion of the network resulting in the February 2011 earthquake becoming one of the better recorded earthquake events worldwide.

21 The value of GeoNet's data was recognised, enabling decisions relating to building reconstruction, engineering standards, defining the residential red zones, and reinsurance to be informed by science. The accurate and widespread GeoNet data in Canterbury, when combined with recorded ground damage (e.g., settlement and lateral spread), has also significantly advanced international knowledge on liquefaction vulnerability.

22 Utilising the available science and engineering information, EQC's Minerva loss modelling platform, developed by EQC since 1999 for the purpose of informing reinsurance buying to support disaster response, provided timely and informative assessments on likely scale of damage and volume of claims expected for each of the Canterbury events. This was invaluable for Government agencies as well as EQC's reinsurers as they grappled with the unprecedented nature of the Canterbury earthquake sequence. There were some acknowledged limitations on Minerva's ability to predict compounding impacts of the earthquake sequence or to quantify the impact of liquefaction on housing damage. That said, no existing loss models world-wide could do that either. The Canterbury earthquake sequence has accelerated the advance of global modelling capabilities.

Development of the Canterbury Geotechnical Database

23 When the earthquakes in Canterbury happened, EQC needed to understand the behaviour of soils to guide reconstruction and to find innovative and practical ways to reduce or avoid the risk of liquefaction. To do that, EQC and many others needed much better data than was currently available. Obtaining the data and sharing it in a way that others could use became an important factor in the recovery.

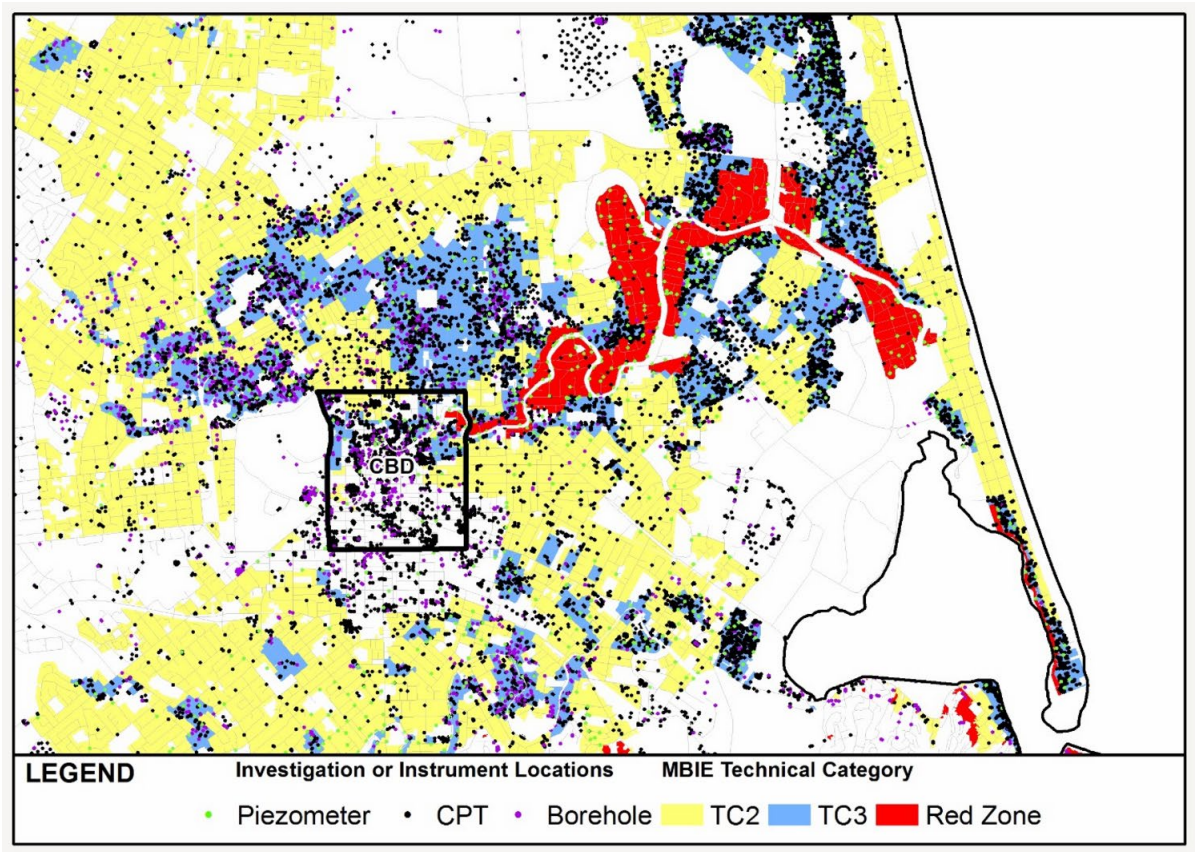
24 From September 2010, and following each major earthquake, EQC collaborated with Land Information New Zealand and the Ministry of Civil Defence and Emergency Management to acquire aerial photography and Light Detection and Ranging (LiDAR) elevation mapping, to guide and augment ground surveys of land movement.[8] In late 2011, the requirement for deep geotechnical investigations was introduced for the most vulnerable land and, recognising that geotechnical resources were scarce, an area-wide collaborative investigation programme was proposed early the following year.

[8] See Briefing to the Public Inquiry into the Earthquake Commission, *Canterbury Land Programme* (24 May 2019), pages 19-20.

25 This was accompanied by development of the Canterbury Geotechnical Database in May 2012 – a repository for the extensive data collected, to establish the engineering properties of the soils and understand their performance in earthquake shaking. The database was developed by engineering firm Tonkin + Taylor with the collaboration of EQC, the Canterbury Earthquake Recovery Authority, and the Department of Building and Housing (now Ministry of Business, Innovation and Employment). EQC seeded the database with the $30 million worth of data it had commissioned and this contribution was integral in the database gaining traction as a collaborative tool for professionals.[9] It provided a platform for geotechnical professionals to store, share and readily assess the data files of geotechnical investigations (bore holes, cone penetration tests, piezometers and groundwater monitoring, and other relevant data) during the rebuild. This information was made available, at no cost, to private and public sector entities including local authorities, universities and research institutes, and private insurers.

26 **Figure 1** below shows an example of the Canterbury Geotechnical Database user interface.

Figure 1: *Canterbury Geotechnical Database*[10]



[9] Earthquake Commission media release, *Canterbury Geotechnical Database awareded gold* (7 September 2016), https://www.eqc.govt.nz/news/canterbury-geotechnical-database-awarded-gold.
[10] Tonkin + Taylor media release, *Cardboard box sketch results in world first and gold award* (6 September 2016), https://www.tonkintaylor.co.nz/news/2016/9/cardboard-box-sketch-results-in-world-first-and-gold-award/.

27 The Canterbury Geotechnical Database delivered a range of benefits, including improving the efficiency of geotechnical surveying by avoiding duplication in field investigations, reducing the financial burden on land owners (because they had to arrange fewer tests), and encouraged a strong collaborative data-sharing culture amongst the user community. The Stronger Christchurch Infrastructure Team, which was established to repair horizontal infrastructure (waste water, storm water and fresh water networks, and roads), estimated that access to the Canterbury Geotechnical Database helped it save over $5 million.[11]

28 In recognition of the national potential for the database, the Ministry of Business, Innovation and Employment took over stewardship of the database in partnership with EQC. The database has since been expanded to cover geotechnical information throughout New Zealand as the New Zealand Geotechnical Database.[12] It now contains over 100,000 records, or in the order of $300 million worth of investigation information, and the data has on average been reused 30 times. Once there is sufficient data this nationwide resource will enable a much greater understanding of subsurface conditions allowing building projects to be much better informed about the likely ground behaviour during earthquakes. Buildings can also be more economically designed appropriate to ground conditions or the worst land can be avoided altogether.

29 The database supports the government philosophy of maximising the use of data – upload once and download multiple times. It has attracted international interest and is changing the way in which New Zealand geotechnical consultants operate, focusing on service and data interpretation (rather than proprietary data holdings) using a much more comprehensive dataset than would otherwise be possible. The database, when combined with other datasets EQC collected in the Canterbury response phase, has also facilitated international collaboration with New Zealand researchers developing tools to better predict ground behaviour.[13]

Ground Improvement Research Programme

30 In 2013, EQC embarked on a ground improvement research programme to inform appropriate integrated solutions for building houses on land vulnerable to liquefaction. It was coordinated by EQC's geotechnical advisors, Tonkin + Taylor, with assistance from leading experts from New Zealand and around the world – comprising one of the largest teams of geotechnical engineers and scientists ever to work on a single project in New Zealand. The work has led to substantial advances in the global understanding of liquefaction and its assessment and mitigation.[14]

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[11] Canterbury Earthquake Recovery Authority, *The Canterbury Geotechnical Database: An authoritative source of geotechnical data* (April 2016), page 5, https://www.eqrecoverylearning.org/assets/downloads/res0013-canterbury-geotechnical-database2.pdf.

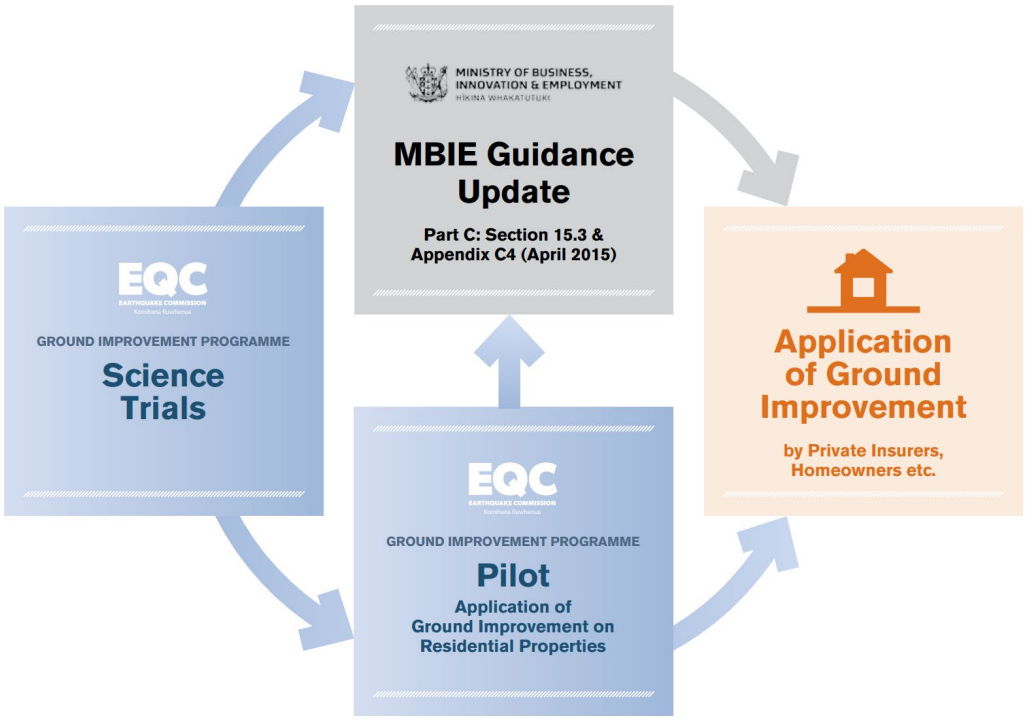
[12] See New Zealand Geotechnical Database brochure, *About NZGD* (undated), https://www.nzgd.org.nz/HelpSupport/AboutNZGD.pdf.

[13] Bryce Williamson and Eric Crampton, *Recipe for Disaster: Building Policy on Shaky Ground* (2018), The New Zealand Initiative, page 37, https://nzinitiative.org.nz/reports-and-media/reports/recipe-for-disaster-building-policy-on-shaky-ground/.

[14] Since 2013 more than 60 peer reviewed journal articles, conference proceedings and other publications have been authored and published based on the geotechnical data and information gathered by EQC. These include: S. van Ballegooy,

31 The ground improvement research programme identified, developed and trialed practical and affordable shallow ground improvement methods that could mitigate the potential for liquefaction and associated damage to houses built on land vulnerable to liquefaction.[15] The programme and subsequent changes to regulatory guidance by the Ministry of Business, Innovation and Employment have provided more affordable ground improvement options for building or rebuilding houses on residential land.[16] **Figure 2** below shows the relationship between the ground improvement research programme and the Ministry of Business, Innovation and Employment, and how this information is used in practice by homeowners, private insurers and contractors.

Figure 2: *Relationship between Ground Improvement Programme science trials and pilot to regulatory guidance and practical application*[17]



J. Roberts, K. Stokoe, B. Cox, F. Wentz & S. Hwang, *Large scale testing of ground improvements using controlled, dynamic staged loading with T-Rex* (2015), Proceedings of the 6th International Conference on Earthquake Geotechnical Engineering, https://secure.tcc.co.nz/ei/images/ICEGE15%20Papers/van%20Ballegooy_694.00.pdf; and S. van Ballegooy, R. Wentz, & R. Boulanger, *Evaluation of CPT-based liquefaction procedures at regional scale. Soil Dynamics and Earthquake Engineering* (2015), Special Issue: Liquefaction in New Zealand and Japan.

[15] Earthquake Commission, *Residential Ground Improvement: Findings from trials to manage liquefaction vulnerability* (2015), https://www.eqc.govt.nz/canterbury/ground-improvement-programme/summary-of-gips-findings.

[16] Ministry of Business, Innovation and Employment, *Guidance on repairing and rebuilding houses affected by the Canterbury earthquake sequence* (2012, as updated April 2015), https://www.building.govt.nz/building-code-compliance/canterbury-rebuild/repairing-and-rebuilding-houses-affected-by-the-canterbury-earthquakes/.

[17] Earthquake Commission, *Residential Ground Improvement: Findings from trials to manage liquefaction vulnerability* (2015), https://www.eqc.govt.nz/sites/public_files/TT_EQC_GIP%20Report_WEB_200dpi_MAPS.pdf.

32 Although the ground improvement research programme was primarily driven by the needs of the Canterbury community, its scientific, technical and practical lessons can be applied throughout New Zealand and across the world.

33 EQC has also looked to use the advances in scientific and engineering knowledge in impacts of liquefaction on buildings to develop specific modelling and training tools. The development of EQC's liquefaction model is a good example of contemporary model development and business practice. Multiple parties developed this new model.

New Forms of Land Damage Observed – Increased Flooding Vulnerability and Increased Liquefaction Vulnerability

34 New Zealand is the only jurisdiction in which land is insured separately from residential buildings.[18] A defining attribute of the Canterbury earthquakes was the extensive land damage. The scale and complexity of the land damage, together with the unique nature of EQC's land insurance cover, created significant challenges.

35 Some of the land damage was obvious. There was widespread damage to houses and services on the loose saturated sandy or silty soils of the Canterbury Plains from liquefaction and lateral spreading. Slope stability, rock roll and cliff collapse in the Port Hills also affected many other properties.[19]

36 Some types of change to the land caused by the earthquakes were invisible and took time to recognise and understand. Following the February and June 2011 earthquakes, Tonkin + Taylor identified that land subsidence caused by the earthquakes may have led to worsening land performance. Specifically, the land had become more vulnerable in future flooding events and in future earthquake events. These invisible, complex forms of land damage were ultimately recognised by EQC as Increased Flooding Vulnerability and Increased Liquefaction Vulnerability.

37 This type of damage had never previously been identified as land damage for insurance purposes anywhere in the world. The determination of EQC's liability has involved complex engineering studies of the unique attributes of the damage and testing of practical repair solutions, and geotechnical work to support legal and policy analysis. The extensive engineering studies undertaken by Tonkin + Taylor were peer reviewed by a panel of independent engineering experts.[20]

[18] See Briefing to the Public Inquiry into the Earthquake Commission, *Canterbury Land Programme* (24 May 2019), pages 13-15.
[19] See Briefing to the Public Inquiry into the Earthquake Commission, *Canterbury Land Programme* (24 May 2019), page 16.
[20] See Briefing to the Public Inquiry into the Earthquake Commission, *Canterbury Land Programme* (24 May 2019), pages 42-47 and 56-59.

DEVELOPMENT OF GUIDANCE FOR ASSESSMENT, REPAIR AND REBUILD OF DAMAGED HOUSES

38 Shortly after the 4 September 2010 Canterbury earthquake, EQC initiated the establishment of an Engineering Advisory Group comprising a small team of experienced structural and geotechnical engineers and remediation specialists. The Engineering Advisory Group was formally transferred to the Department of Building and Housing (now the Ministry of Business, Innovation and Employment) in November 2010.

39 The group was tasked with establishing appropriate geotechnical and structural engineering approaches to the assessment, repair and rebuild of damaged houses, and providing technical guidance under the Building Act on appropriate methodologies.

40 The guidance has been updated progressively as new requests for assistance or developments arose during the rebuild.[21] A key principle was to focus the scarce engineering resource to areas where it was most needed – the areas of highest risk.

Current research focus

41 EQC facilitates theme-specific rather than sector-specific research, and seeks to ensure a broad perspective is maintained through the following objectives;

a addressing gaps in knowledge about New Zealand's exposure to geological hazards;

b facilitating the integration of knowledge and accelerating its uptake to reduce the occurrence and severity of future hazard event impacts;

c supporting training and capability development in relevant disciplines, supplementary to baseline public investment in higher education and basic research; and

d stewardship of data gathering and technologies to support modern hazard risk research and risk management (e.g. GeoNet, the New Zealand Geotechnical Database and Minerva).

42 EQC currently invests around $4.5 million each year in research, not including GeoNet. This allocation supports a range of basic and applied research, facilitation of strategic data gathering, and activities to translate and apply research knowledge into policy and practices for improved risk management.

[21] Ministry of Business, Innovation and Employment, *Guidance on repairing and rebuilding houses affected by the Canterbury earthquake sequence* (2012, as updated April 2015), https://www.building.govt.nz/building-code-compliance/canterbury-rebuild/repairing-and-rebuilding-houses-affected-by-the-canterbury-earthquakes/.

43 The Board of EQC has periodically commissioned reviews of its research function to ensure the purpose and return from the investment being made is consistent with the Board's strategic direction. For example, in 2015 a review undertaken by the New Zealand Institute of Economic Research[22] found that:

a EQC's programme compares very favourably with other government funders, with EQC's long term focus on building trust and collaborative relationships; and

b EQC has managed to retain a good balance between stability and agility, robustness of process and lightness of touch.

FUNDING OF RESEARCH AND TEACHING AT UNIVERSITIES

44 A key part of EQC's research investment is in fellowships and capability programmes at four New Zealand universities in disciplines relevant to EQC's strategic objectives. The disciplines include:

a seismology and tectonics (Victoria University of Wellington and University of Canterbury);

b volcanic and landslide hazards (University of Auckland and University of Canterbury);

c geotechnical and structural engineering (University of Auckland and University of Canterbury);

d disaster economics and finance (Victoria University of Wellington); and

e resilience planning (Massey University).

45 EQC's funding supports the delivery and maintenance of hazard risk programmes that underpin targeted teaching and research at undergraduate and postgraduate levels, which is not guaranteed by the general Vote Education or Vote Science and Innovation allocations from central government.

46 Key outcomes and features of the university agreements have been:

a strong academic leadership;

b development of extensive collaborative relationships with local and international researchers, media, business and important leadership roles in other EQC-supported activities; and

c leveraging research partnerships with GNS Science and widespread use of GeoNet data in applicable research areas.

[22] New Zealand Institute of Economic Research, *EQC Research and Education Strategy: Impact and allocation evaluation* (December 2015).

47 EQC historically has also recognised great value in the major involvement of talented graduate students in university research. The non-biennial grants programme for postgraduate student research is intended to enable academics to capitalise at short notice on the availability of a high-calibre student and to attract those who might otherwise be lost to those areas of science relevant to EQC's strategic objectives. Talented students bring drive, enthusiasm and innovation to projects, which can produce important advances, with expert guidance. Student involvement is also important for the development of human resources and the advancement of education in New Zealand.

Regional Research Consortia

48 A core component of EQC's facilitation role is the ability to enter into collaborative, multi-year arrangements. EQC has established a strong reputation for effective partnerships between central and local government sectors.

49 GeoNet is the best known example of EQC's effective partnerships, but others include:

a *It's Our Fault* assessment and reduction of seismic risk in Wellington region – EQC in partnership with the Accident Compensation Corporation (until 2009), Wellington City Council, and Wellington Regional Council;[23]

b *Determining Volcanic Risk in Auckland* (DEVORA) hazard and risk assessment programme – EQC in partnership with Auckland Council;[24] and

c *National Risk Agency business case* – EQC in partnership with Local Government New Zealand and The Treasury.

50 The *Determining Volcanic Risk in Auckland* and *It's Our Fault* programmes have delivered significant insight into volcanic and earthquake risks in the respective regions and strategies for quantifying and mitigating risk.

51 These programmes owe their success and continued end-user support to strong involvement of steering committees, comprising senior representatives of the funding partner organisations, chaired by EQC. This approach has ensured that research scope and directions are subject to regular funder and end-user scrutiny, aligned co-funding is well-targeted, and the end-users maintain high awareness of the potential application of the research to operational planning.

[23] See GNS Science website: https://www.gns.cri.nz/Home/IOF/It-s-Our-Fault.
[24] See *Determining Volcanic Risk in Auckland* programme website: http://www.devora.org.nz/.

ACADEMIC – INDUSTRY PARTNERSHIPS

52 Partnerships with research consortia foster strong linkages between academia and industry with a focus on incorporating practical lessons learned from natural hazard events such as the Canterbury and Kaikōura earthquakes.

53 A fellowship at the University of Canterbury QuakeCentre provides annual support for experienced practicing engineers to advance the transfer of earthquake engineering research to industry. This funding uses more than $10 million of government and industry funding over the next 5-7 years, with EQC's investment targeted specifically to address gaps in the transfer of science research to practice. Current projects include:

a retrofit strategies for pre-cast concrete floors – prevalent in post-1980s, Wellington multi-storey buildings (with the Building Research Association of New Zealand);

b strategies for improved procurement, design and fit-out of non-structural building elements, which have performed poorly and dominated the financial and economic urban building losses in recent earthquakes (with the Building Research Association of New Zealand); and

c research on building more resilient three waters (drinking water, storm water and fresh water) infrastructure, building on lessons from Canterbury.

54 EQC is also a member of the New Zealand Lifelines Council and has been a strong supporter of the resilience work of Lifelines for over thirty years. EQC and the New Zealand Lifelines Council work closely to identify and advocate research and development in areas aligned to EQC's resilience strategy for which sponsorship is granted on an annual basis. The two organisations recognise mutual benefit and efficiencies are to be gained in being informed and supportive of each other's public good activities and through engagement with appropriate all-of-government initiatives.

Loss modelling – turning research into access to global capital markets

55 New Zealand is highly exposed to geohazards with the potential to generate very large losses relative to the size of the economy. In October 2018, the Lloyd's of London study, *A world at risk: Closing the insurance gap*, rated New Zealand the second most exposed country in the world to the costs arising from natural disasters as a percentage of Gross Domestic Product (GDP).[25]

[25] Lloyd's, *A world at risk: Closing the insurance gap* (2018), page 15, https://www.lloyds.com/news-and-risk-insight/risk-reports/library/understanding-risk/a-world-at-risk.

56 Managing this risk is a critical national capability and at the centre of EQC's ability to deliver its strategic outcomes. A key enabler of an effective hazard risk management system is loss modelling, that is the ability to effectively price known hazard risks. New Zealand needs EQC to continue to provide loss modelling services to ensure continued credibility with the reinsurance industry.

57 Loss modelling is at the core of EQC's ability to maintain scenarios for planning purposes and to influence risk pricing for both EQC and the Crown by reducing the uncertainty included in reinsurers risk premium calculations. For many years EQC has provided the reinsurance market loss modelling analysis of its housing portfolio. Historically, the analysis generated by EQC and related research has demonstrated to international reinsurers that EQC has a current understanding of New Zealand–specific earthquake risks, compared to international models.

58 EQC's modelling analysis has helped reduce uncertainty for reinsurers on the risks that they are covering and has sustained market participation by reinsurers in the aftermath of the Canterbury earthquake sequence.

59 EQC's loss modelling is a cornerstone capability for its strategic objective of 'New Zealanders have access to natural hazard insurance and reinsurance'.[26] It is also a key element of the New Zealand natural hazards risk and resilience landscape by providing data and information that is required for informed risk management decisions to be made within the built environment. It is a strategic capability for EQC.

60 Minerva needs to be rebuilt or replaced with a modern modular construction if it is to sustain its relevance and take advantage of globally available models that can use New Zealand-specific data and information. In November 2017, the EQC Board agreed to support the redesign of EQC's loss modelling capability approach, which will allow EQC to leverage external best practice and enable multi-use models. This approach will also allow the required modelling to be sourced from various providers rather than exposing EQC to a single provider risk.

Focus of EQC's public education

61 EQC's public education work primarily focuses on three areas:

a encouraging New Zealanders to take preparedness actions that will mitigate their risk of damage and disruption from natural hazard events;

b educating about the insurance cover that EQC provides; and

c communicating/educating after a natural disaster has occurred.

[26] Earthquake Commission, *Statement of Intent 2018-2022* (2018), pages 4-5, https://www.eqc.govt.nz/sites/public_files/documents/publications/EQC-SOI-2018-WEB.pdf.

62 It is important to note distinctions between EQC's public education and sector education work. Public education tends to focus on householders, children and families as a target market or audience whereas sector education is focused on groups of professionals that have specific and significant roles in hazard risk management, for example, engineers, land-use planners and local and central government policy makers.

63 EQC primarily focuses on preparedness steps that can be taken to make residential properties safer and stronger for natural hazard events. For example, EQC's *Fix, Fasten, Don't Forget* advertising campaigns focusses on what people can do to make their homes safer (see paragraph 66 below). This is in contrast to preparedness messaging delivered by the Ministry of Civil Defence and Emergency Management, which focuses more heavily on personal preparedness (for example, storing food and water).

64 EQC's public education activities are currently delivered through three broad streams:

a paid and unpaid advertising across various channels;

b museum partnerships; and

c school education initiatives and partnerships.

Advertising and Marketing Campaigns

65 In recent years the majority of EQC's public education budget, resources and efforts have gone towards the development of advertising and marketing campaigns. As a general rule these campaigns have used a broad and centralised approach to raise awareness of, and inspire action towards, preparedness actions. However, certain campaigns have been more localised and also involved co-branding with various partners including Wellington Region Emergency Management Office and Mitre10.

66 In mid-2017 a process was initiated to decommission the *Fix, Fasten. Don't Forget* website and bring preparedness content back onto the main EQC website.[27] At this time, a more audience-centric approach was taken, with six main sections of content created based on the audience's relationship with property (homeowners, homebuyers, landlords, tenants, those living in shared property/apartments and those building or renovating). The development of this new content has resulted in recent marketing campaigns aimed at more highly targeted audiences.

[27] See the EQC website: https://www.eqc.govt.nz/be-prepared.

67 The years following the Canterbury earthquakes brought both challenges and opportunities for EQC's public education advertising. As a general rule the challenges seem to have had more prominence and influence. EQC advertising has, and continues to be, put through the 'Canterbury lens'. This means that from advertising brief creation through to conceptual development, how the campaign will be viewed and received in Canterbury is always a consideration. While this is appropriate and understandable it has also perhaps resulted in campaigns that avoid controversy and negative response, rather than striving for memorability and impact.

68 One of the significant challenges that EQC's social marketing campaigns face is to get people to take action before an event occurs. To compel people into action, EQC's marketing and advertising must work in tandem with other drivers such as legal compulsion, regulation and incentives.

69 Advertising plays a vital role for EQC in connecting with people and communities following natural disaster events. The type of advertising used in this instance varies depending on the scale of the event and greater spend and media channels are employed for larger scale events (usually defined by either the total number of expected claims or the total value of those claims) to inform affected communities around various aspects, including: that they are able to make a claim to EQC; what specific types of damage EQC covers them for; that claim deadlines are approaching; and that community information events are taking place.

Museum Partnerships

70 EQC has some long-standing sponsorship arrangements with a number of New Zealand museums. Through sponsorship of museum exhibition spaces with a connection to natural hazards, EQC is able to reach a broad and captive audience to raise awareness of hazards and the risk they pose. EQC's support of museum school education programmes allows us to work regionally to provide curriculum-focused content on natural hazards that are most of interest to local schoolchildren and teachers.

71 EQC's current museum programme involves sponsorships with Te Papa in Wellington, Auckland Museum, Canterbury Museum's Quake City and the Volcanic Activity Centre in Tūrangi.

Schools Programme

72 EQC's schools activity is designed to educate young New Zealanders about natural disasters, how to minimise their impact, and the role EQC plays in helping people recover from them. A key aspect of this programme of work is EQC's relationship with the Ministry of Civil Defence and Emergency Management, and the collaborative initiatives *What's the Plan Stan?* and ShakeOut.

73 First produced in 2007, *What's the Plan Stan?* provides a curriculum-focused resource to teachers with comprehensive information on suggested learning experiences, resources and examples.[28] This content is divided into Years 1-3 and Years 4-8.

74 New Zealand ShakeOut is a national earthquake drill and tsunami hīkoi (walk) led by the Ministry of Civil Defence and Emergency Management.[29] For 2018 the decision was made for the majority of promotional activity to focus on the education sector and past participants. EQC's support enabling the production of a number of promotional items, including the Schools Challenge Student Resource, which featured eight preparedness challenges for students to complete with their families.

75 EQC has sponsored a Core Education virtual field trip each year since 2009. Each fieldtrip examines one or more of the natural hazards that EQC covers. For the trips a CORE teacher and subject experts go to a location such as the Taupō volcanic zone and through online video and audio, run a multi-day trip exploring the local geoscience and risk management as well as EQC's role in building New Zealand's resilience to natural hazards.

76 EQC's museum sponsorships also cover a number of school education programmes. In the case of Te Papa and the Volcanic Activity Centre (see paragraph 71 above) this involves students coming into the museum exhibit and education spaces to learn about natural hazards and preparedness.

Recent Public Education Reviews and Strategy

77 In the second half of 2018 an internal review of EQC's public education work was conducted and while not yet finalised, a number of opportunities for possible future improvements have been identified across EQC's public education scope of work.

78 One of the recommendations made in the public education review document is for the development of a more comprehensive and long-term public education strategy. EQC is currently in the process of scoping this piece of work with an external strategic facilitator.

EQC's Resilience Strategy – stronger homes built on better land

79 In November 2018 the EQC Board agreed to a ten-year Resilience Strategy. The premise of the Strategy is that the only way to lower damage levels and reduce the social disruption caused by natural disasters is to build more resilient buildings on suitable land, with more resilient essential service infrastructure.

[28] See the *What's the Plan, Stan?* website: https://whatstheplanstan.govt.nz/.
[29] See the Ministry of Civil Defence and Emergency Management website: https://www.civildefence.govt.nz/get-ready/new-zealand-shakeout-2019/.

80 To do this, decision makers and regulators need to use additional pre-event management tools including land use planning to avoid the worst risks where possible, and building regulation and innovative design to control damage where it makes sense. This will require better use of existing data and knowledge, and creation of new knowledge to fill gaps in our understanding of New Zealand's hazard risk profile. It also requires integration and translation of knowledge to generate new insights and solutions, and the right tools to assist complex decisions.

81 Moving forward we need effective and enduring mechanisms to support partnership so that risk exposures can be disclosed, evaluated, quantified and the cost and benefits of selective treatment can be distributed by consensus.

82 Changing the way New Zealand manages disaster risk will require natural hazard impacts to be considered in decision-making alongside all the other aspects of community wellbeing. This will require collaboration at all levels of society to agree the level of resilience considered cost-effective, from homeowners through to central government, and across the public and private sectors. Decisions made in this area will need to be informed by the ability to estimate the full costs of natural hazard impacts, which will enable assessment and prioritisation of resilience initiatives.

Future opportunities for research and education

Broadening EQC's Resilience Strategy

83 The New Zealand National Disaster Resilience Strategy identifies seven types of resilience – social resilience, cultural resilience, economic resilience, resilience of the built environment, resilience of the natural environment, governance of risk and resilience, and underpinning knowledge, research, data and assessment.[30]

84 EQC's research and education function has historically focused on four of these (the resilience of the built and natural environments, economic resilience, and the underpinning knowledge, research, data and assessment), and this is reflected in the EQC Resilience Strategy. There is an opportunity for EQC to diversify its research and education activities to include more focus on social and cultural resilience, and governance of risk and resilience.

85 This would be consistent with EQC's statutory mandate. Greater understanding of the social, cultural and governance aspects of natural hazard risk, including how to improve these types of resilience, will contribute to New Zealand's overall resilience.

[30] Ministry of Civil Defence and Emergency Management, *National Disaster Resilience Strategy* (2018), https://www.civildefence.govt.nz/cdem-sector/plans-and-strategies/national-disaster-resilience-strategy/.