

# Wellington City’s emergency management response to the November 2016 Kaikōura earthquake

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## Abstract

A magnitude 7.8 earthquake struck near Kaikōura township, Aotearoa New Zealand, on the 14<sup>th</sup> of November 2016 causing widespread damage and disruption. In the worst-affected areas (including Wellington City), Civil Defence and Emergency Management response organisations activated for extended periods of time to ensure safety and provide welfare support to affected people. The main priorities included taking charge of response efforts while collaborating with the emergency services and lifeline utilities. This ensured public safety, welfare support, and early preparation for the transition to recovery. In Wellington, approximately 80 buildings within the central business district were damaged, including the port area which suffered liquefaction. The overall cost of repairs, including insured losses to the city’s buildings, infrastructure, and economy was approximately NZ\$2 to 3 billion. Repairs will take many years to complete. However, feedback from lifeline utilities suggested that most services were not severely affected, except for the port. Roads, electricity, potable water, sewerage, and communications were the critical priorities for restoration. Despite ongoing remediation programmes, the Wellington region’s infrastructure (including Wellington City) remains vulnerable to the effects of a future large earthquake.

**Keywords:** Civil Defence, emergency management, disaster response, Kaikōura earthquake

**Disclaimer:** This article is the personal view of the author and not the view of either the Wellington City Council or the Wellington Civil Defence and Emergency Management Group.

On 14 November 2016 at 12:02 am local time, a large magnitude 7.8 earthquake struck near Kaikōura township, Aotearoa New Zealand (NZ; see Figure 1). The earthquake caused widespread damage to roads, buildings, utilities, and other infrastructure across a wide geographical area which included the upper South Island and the Wellington region of the North Island (GeoNet, 2017). There were two deaths in Kaikōura, but few other people were injured in the affected areas (Ministry of Civil Defence and Emergency Management, 2017a).

Although the epicentre was located more than 200 kilometres from Wellington, many commercial buildings and the port infrastructure within the city were damaged. The port suffered liquefaction and many high-rise buildings between eight and 15 stories were damaged (Kestrel Group Limited, 2017). The estimated value of insurance losses in Wellington totalled NZ\$2 to 3 billion (McBeth, 2017). This estimate has the potential

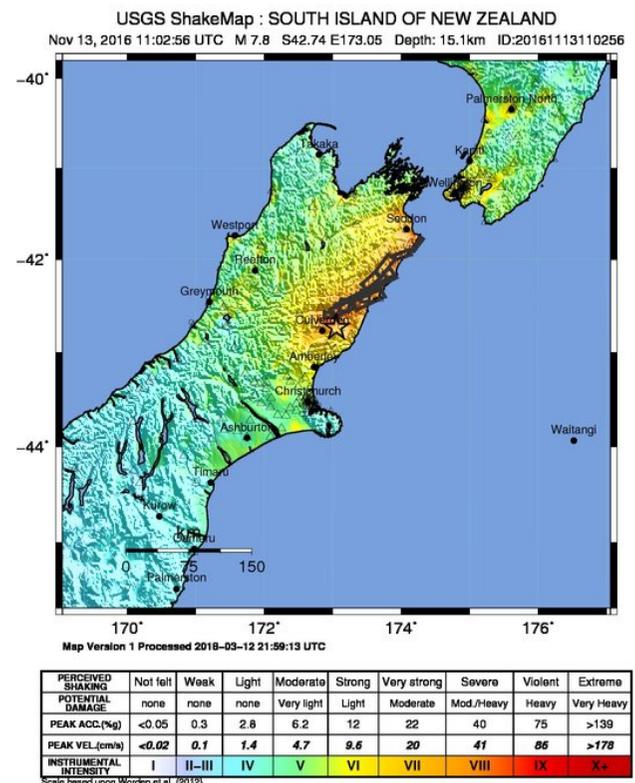


Figure 1. Map of New Zealand showing zones of tremor intensity radiating from the Kaikōura earthquake (United States Geological Survey, 2018).

to increase, with decisions on the fate of some buildings undecided at the time of writing this article (Devlin & Stewart, 2017). However, despite numerous electrical power outages and fractures in water pipes, there was comparatively little damage to utilities, considering the magnitude of the earthquake.

On the 14<sup>th</sup> and 15<sup>th</sup> of November, states of emergency were declared in the Kaikōura District, Hurunui District, Canterbury region, and Dunedin City but not Wellington City (the capital city of NZ) because it was deemed that local, regional, and national Civil Defence Emergency Management (CDEM) responses could be run from Wellington. Immediately after the earthquake, Wellington City Council's CDEM Emergency Operations Centre (EOC) was activated to support emergency services (Wellington City Council, 2017). It was active for 12 days before responsibility for the city's recovery was handed to Wellington City Council's recovery team. Response efforts were challenged by a sizeable storm with associated flooding on the 15<sup>th</sup> of November, the day after the earthquake ("Rain brings commuter chaos to capital highways", 2016).

Wellington City Council's CDEM EOC was established as part of the NZ government-mandated Coordinated Incident Management System (CIMS) framework under which CDEM is delivered. Within CIMS, local, regional, and national coordination centres are organised and managed in the same manner. Each EOC has six desk functions: Welfare, Logistics, Intelligence, Planning, Operations, and Public Information Management (PIM). In each EOC, a Local Controller oversees the six functions.



Figure 2. Damage to State Highway 1 and the railway track near Kaikōura (GeoNet, 2016; photo credit Julian Thomson).

I was the Primary Local Controller of the Wellington City EOC during Wellington City's CDEM response to the Kaikōura earthquake. In the following report, I summarise my perspective on and experience of the initial assessment of building damage, legalities associated with damaged buildings, public issues, and issues with utilities, in particular electricity, and present a subjective evaluation of the CDEM response based on personal observations.

### **Initial Response and Building Damage Assessment**

During the first few days of the response, most central government attention was focused on the damage in Kaikōura which was more severe than in Wellington. Kaikōura is in a remote coastal area. Severe damage to State Highway 1 and the railway line running from Picton township to Christchurch (see Figure 2) caused significant disruption of freight and passenger traffic between the north of the South Island and Christchurch City ("Kaikōura earthquake", 2016).

Wider afield, a small flotilla of foreign warships visiting Auckland for the Royal New Zealand Navy's 75<sup>th</sup> anniversary celebrations sailed to Kaikōura to render assistance to stranded tourists and homeless residents. Their helicopters were utilised for evacuations (see Figure 3) and delivery of essential supplies (Nichols, 2016).



Figure 3. Naval helicopters evacuating stranded people from Kaikōura township. Photo supplied by the New Zealand Defence Force.

Immediately after the earthquake, Wellington City Council's EOC was activated to support the emergency services (see Figure 4). The EOC had to deal with several high-impact, complex, hazardous, and potentially life-threatening scenarios that initially stretched its ability to cope (Wellington City Council, 2017).



Figure 4. Wellington City Council Emergency Operations Centre (EOC) in action. Photo supplied by Wellington City Council.

An hour after the earthquake, while damage reports were still being received, the Ministry of Civil Defence and Emergency Management (MCDEM) also issued a national tsunami warning (Ministry of Civil Defence and Emergency Management, 2017a). The tsunami warning caused confusion and frightened many people who were already stressed and fearful after the earthquake; many people evacuated to higher ground causing major road congestion (Stevenson et al., 2017). This made it difficult for emergency services to respond to the incident and undertake reconnaissance. The difficulties were exacerbated when the emergency telephone system (111) within Wellington was inoperable for some time after the initial earthquake due to evacuation of key buildings within the central business district (CBD).

Initial reports from inside the Wellington CBD suggested that although glass and debris from buildings covered many streets, most roads were passable and the damage from the earthquake was not critically serious. However, three hours after the earthquake, the first reports of liquefaction and extreme damage to the Statistics New Zealand building (Ministry of Business, Innovation and Employment, 2017b) in the vicinity of Wellington's port (CentrePort) suggested that the extent of building damage might be more severe than initially thought.

On the first day of the response, people were discouraged from entering the CBD. When daylight arrived, Wellington City Council's building inspectors commenced "rapid external building assessments" of all buildings within the CBD. The council's mandate did not include full structural inspections, which was not widely understood at the time causing considerable

misunderstanding (Ministry of Business, Innovation and Employment, 2017a). Due to the heightened risk of injury during building inspections, an Urban Search and Rescue (USAR) team was deployed to support the building inspectors. Concurrently, many building owners arranged for commercial engineers to undertake more comprehensive building inspections, in many instances at the request of their insurance companies.

By 15:00 local time on the 15<sup>th</sup> of November the EOC received a report from structural engineers who had inspected a high-rise building in Molesworth Street, Thorndon. The building had severe structural damage and was considered at risk of collapsing during a subsequent large aftershock. A cordon was soon established around the 37-metre-tall building by the Fire Service at 60 metres (at least 1.5 times the height of the building) to protect the public. Since a state of emergency had not been declared the cordon was enforced initially by the Fire Service (now Fire and Emergency New Zealand; FENZ) and USAR, under the Fire Service Act 1975. Cordon control was subsequently handed over to the Wellington City Council CDEM Local Controller the following day. It was determined that the building was beyond economically viable repair. Preparations began to demolish the building, enforced by Wellington City Council using powers available under the Building Act 2004.

Over the next four days, structural engineers and the council's building inspectors accompanied by the USAR team checked the CBD. A considerable number of buildings were identified that had significant structural damage (Engineering New Zealand 2016). Cordons were established around buildings while repair schemes were decided. Building owners consulted with insurance companies to assess what needed to be done and decide on who was going to pay for repair or demolition. Unexpectedly, a sizeable storm with associated flooding overwhelmed Wellington on the 15<sup>th</sup> of November which complicated the earthquake response efforts. Although people were able to return to work within the CBD on that day ("Rain brings commuter chaos to capital highways", 2016), many struggled to return home that evening due to the flooding.

By the 17<sup>th</sup> of November, the number of evacuated buildings in the Wellington CBD had increased to the point that central government was concerned that some government functions could potentially be at risk. This led the Ministry of Business, Innovation, and Employment (MBIE) to instruct Wellington City Council

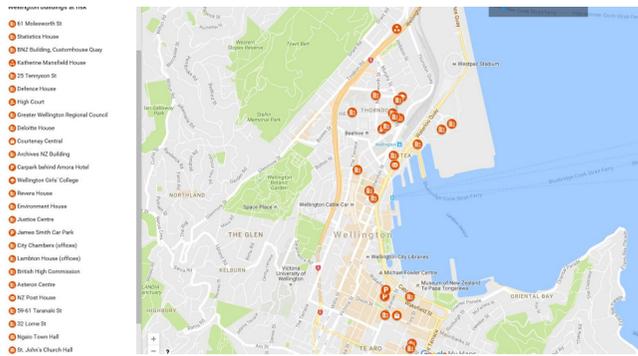


Figure 5. Location of damaged buildings in Wellington City. Provided by Wellington City Council

to a) determine the total number and type of buildings damaged (see Figure 5); b) undertake more detailed inspections of buildings that had been damaged; c) establish why only certain building types had been damaged; and d) determine if the geographical zone encompassing the inspected damaged buildings needed to be expanded.

### **Response to Other Issues Arising from the Earthquake and Severe Weather**

Wellington's undulating landscape causes frequent road and public transport network congestion. On a normal working day, 80,000 commuters join Wellington's 200,000 inhabitants that travel to and from work and educational establishments, putting pressure on roads and the public transport network. People were discouraged from coming into the CBD on the day of the earthquake. Unfortunately, the weather forecasts available on that day did not accurately predict the storm and consequential flooding that engulfed the region (Hurley, Burrow, & Baird, 2016). The rail network was shut down due to torrential rain and flooding and the three state highways that traverse the region were all blocked. This led to traffic congestion that delayed and disrupted response efforts ("Wellington cut off", 2016).

During the first 48 hours after the earthquake, many people were still in shock, and matters became worse when several large buildings were evacuated at short notice. Temporary accommodation was provided to help displaced people. Welfare provision is a core responsibility of local authorities in Civil Defence emergencies (Ministry of Civil Defence and Emergency Management, 2015a).

Despite numerous electrical power outages and fractures in water pipes, there was comparatively little damage to utilities, except for the port where the earthquake caused major damage and disrupted

operations. This included widespread liquefaction and significant damage to three large travelling cranes, jetties, storage areas, and buildings. As the damage assessment and understanding of the impact of the earthquake became more complete, Civil Defence staff were able to more effectively help displaced residents and struggling businesses.

The public and media questioned why a cordon was not established around the centre of Wellington City making it a "Red Zone" as was done following the 2010 and 2011 Canterbury earthquakes. The option of a cordon was investigated and decided against because it was impossible to provide temporary accommodation for the tens of thousands of residents who lived within the affected area and none of the 80 badly damaged buildings had collapsed. The public were also concerned as to why certain buildings were severely damaged and others largely undamaged. A combination of earthquake magnitude, shaking duration, ground substrate beneath Wellington, and distance from the earthquake's epicentre led to resonant vibrations predominantly affecting buildings between eight and 15 stories in height. There was also a public perception that the damage to land, jetties, and buildings in the CentrePort area was due to their construction on reclaimed land. After careful geotechnical and structural analysis, the public were reassured that the extent of damage was related to the vertical distance between the building foundations and the bedrock below.

By the 18<sup>th</sup> of November, most damaged buildings had been identified and appropriate cordon management put in place. All civil and structural engineers working in Wellington had been told to report their findings to a building assessment team attached to the EOC so that a complete picture of structural damage and common failure modes could be corroborated (Kestrel Group Limited, 2017).

The EOC remained active for a further week (until the 25<sup>th</sup> of November) when responsibility for public safety was handed over to a full recovery team led by Wellington City Council. The council's brief was to take over responsibility for ongoing actions. This included demolishing a building on Molesworth Street and a large car park on Wakefield Street and assessing more buildings (Wellington City Council, 2017).

### **Legalities Associated with Damaged Buildings After an Earthquake**

After an earthquake, it is usually unclear to the public who is responsible for safety in and outside buildings, who should inspect buildings, and how the inspections should be done. In NZ, the Civil Defence and Emergency Management Act 2002 requires local authorities to “take all necessary steps to undertake civil defence and emergency management or to perform these functions and duties” (s 59). Local authorities (e.g., Wellington City Council) are also the road controlling authorities for public roads (except state highways) and, by definition, have control over publicly owned roads, pavements, and utilities in accordance with the Land Transport Act 1998. Furthermore, local authorities have powers under the Building Act 2004 to prohibit entry, and to compel building owners to take a range of actions (including demolition) in respect of “dangerous, affected, earthquake-prone or insanitary buildings” (s 120).

Local authorities and regional CDEM groups collectively have responsibility to ensure public safety and to take whatever action is required in the event of an emergency requiring a coordinated CDEM response. Common law dictates that building owners are still responsible for the material state of their property, for themselves, and for any tenants that may occupy these buildings. Furthermore, companies who rent or lease space have a primary duty of care to their employees to “provide and maintain a work environment that is without risks to health and safety” in accordance with Section 36 of the Health and Safety at Work Act 2015.

In NZ, local authorities provide the CDEM response in the immediate aftermath of a large seismic event. Where there is a concern that buildings and other structures may have been damaged significantly such that they could pose a threat to public safety, rapid external building assessments are undertaken initially. These are followed by more comprehensive structural assessments by the building owners to meet their legal requirements as outlined above (Ministry of Business, Innovation and Employment, 2017b).

Extensive analysis of earthquake damaged buildings in many countries has shown significant correlation between peak ground acceleration (PGA) and the extent of damage. The total strain energy imparted is important for long-duration earthquakes, such as the Kaikōura earthquake, which lasted for more than 90 seconds setting up a series of resonant vibrations (Richards,

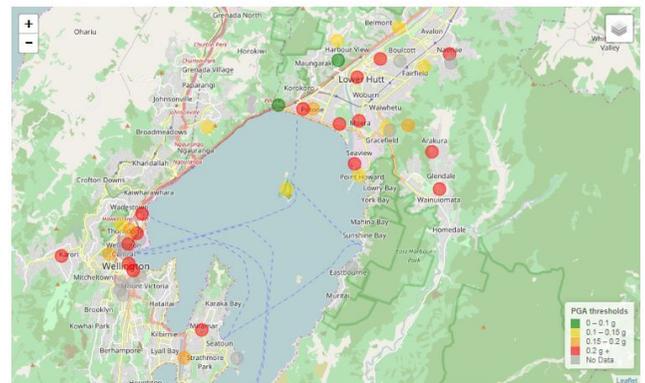


Figure 6. Peak ground accelerations experienced in Wellington during the Kaikōura earthquake. Red spots indicate localities that experienced  $\geq 0.2G$  during shaking. Provided by Wellington City Council.

2012). Immediately after the Kaikōura earthquake, Wellington City Council, MBIE, and GNS Science (Cousins, Zhao, & Perrin, 1993) worked together to establish a threshold PGA that would inform Wellington City Council when to undertake rapid external building assessments of all buildings within an affected zone. The PGA threshold subsequently adopted in Wellington was 0.2G (where  $G = 9.81 \text{ m/s}^2$ ; see Figure 6).

Finally, whenever an earthquake occurs, response organisations intuitively focus on the magnitude and the depth of the fault rupture. In the case of the Kaikōura earthquake, the geotechnical condition of the ground and supporting structure underneath buildings was also important in terms of understanding how and why buildings suffered damage.

### **Lifeline Utilities**

Restoring lifeline utilities is essential after a natural hazard event such as an earthquake. These lifelines include potable water, sewerage, electricity, fuel, communication systems, and navigable roads. All are necessary and are interdependent on each other (Ministry of Civil Defence and Emergency Management, 2017b). Within the Wellington region, the Wellington Regional Emergency Management Office and the local authorities have prepared a list of priority services deemed essential for public safety (see Table 1). In addition to obvious facilities such as hospitals and key government and emergency services, the list includes many important lifeline services that are Civil Defence’s priority for restoration. The operating functionality of lifeline utilities is given special attention after a disaster. These facilities are checked during the first round of communications and have a higher priority for response co-ordination than many other services.

Using electricity restoration as an example, all the lifeline authorities work closely with the Local and Group Controllers to ensure that priorities for electrical restoration are aligned between the CDEM authorities and electricity companies, such as Transpower and the lines companies (Ministry of Civil Defence and Emergency Management, 2015b, 2017b, 2018). In NZ, most electricity is generated by hydro-electric schemes in the South Island, but two-thirds of the load is in the North Island. Transpower noted that transmission performance and resilience during recent large earthquakes (Canterbury in 2010 and 2011, Cook Strait and Seddon in 2013, and Kaikōura in November 2016) was credible, with few significant issues (A. Renton [Transpower], personal communication, April 20, 2017). Nonetheless, if a sizeable seismic event struck Wellington, widespread damage may cause significant power outages despite pre-planned contingencies. Although the electricity-related assets may survive the seismic event, other second order effects may prevent access to facilities or cause electrical isolations. These include building collapses and sites with multiple

fatalities. At a local distribution level, supplies could be lost for a sustained time after a major earthquake.

There is a strong desire to improve electricity supply resilience in NZ. Some investigative work has been undertaken jointly by several power companies. However, the regulatory regime under which the national grid and lines companies work is based on “normal” events and does not cater for reducing the risk of high impact, low probability events such as earthquakes. Work is progressing to reduce risk, but the process will require significant financial resources, administrative commitment, and time to resolve. For example, wind-powered electricity could potentially be available from several companies and, dependent upon wind conditions and generator availability, could provide additional local supply capacity (Meridian Energy, 2017).

Wellington Electricity’s feedback after the incident response noted good liaisons with other utilities (in particular Wellington Water and CentrePort) following the Kaikōura earthquake. They knew about Civil Defence’s priority services and their procedures focused on restoring these first. The emergency services knew from previous events that they would liaise with CDEM authorities if priorities needed to change during a response event for any reason (R. Hardy [Wellington Electricity], personal communication, April 18, 2017).

Table 1.  
Top regionally important lifeline sites in Wellington.

	Sector	Asset Owner	Asset	Features
1	Medical	CCDHB	Wellington Hospital	Partial Alternates Serves 100,000+ People
2	Medical	CCDHB	Kenepuru Hospital and Mental Health Campus	Partial Alternates Serves 10,000 – 100,000 People
3	Medical	Wairarapa DHB	Wairarapa Hospital	Partial Alternates Serves 10,000 – 100,000 People
4	Medical	CCDHB	Kapiti Health Centre	Alternates Exist Serves 1,000 - 10,000 People
5	Medical	Hutt Valley DHB	Hutt Hospital	Partial Alternates Serves 100,000+ People
6	Police	NZ Police	Police National HQ	Partial Alternates Serves 100,000+ People
7	Police	NZ Police	Wellington Victoria Street Station	Partial Alternates Serves 100,000+ People
8	Police	NZ Police	Porirua Police College	Serves 1,000 People
9	Fire	FENZ	Wellington City Station	Serves 10,000 – 100,000 People
10	Fire	FENZ	Avalon Station	Serves 10,000 – 100,000 People
11	Ambulance	WFA	WFA HQ (Thorndon)	Serves 100,000+ People
12	CDEM	MCDEM (DPMC)	Beehive Bunker (NCMC)	Serves 100,000+ People

Note. CCDHB = Capital & Coast District Health Board; FENZ = Fire and Emergency New Zealand; CDEM = Civil Defence and Emergency Management; MCDEM = Ministry of Civil Defence and Emergency Management; DPMC = Department of the Prime Minister and Cabinet; NCMC = National Crisis Management Centre; WFA = Wellington Free Ambulance.

**Evaluation of the Earthquake Response**

The Kaikōura earthquake tested the leadership strength of both CDEM and the community. There was a lack of understanding of Civil Defence’s mandate during the disaster response. The lessons learned from the CDEM response are valuable for responders in the electricity supply industry and lifeline authorities. These lessons will help such utilities to provide a better response to a future event.

An evaluation of some of the key areas of the response and recovery are outlined in Table 2. The assessment included the categories “Good” (three key areas in total), “Fair” (four in total), and “Developing” (three in

Table 2.  
*Assessment of key response areas.*

Key response area	Assessment	Comment
Initial CDEM response	Good	The EOC was activated promptly with experienced people. Good support was received by the emergency services (including a USAR team), volunteers and the Capital and Coast District Health Board.
Initial decision-making and determining the scale of the event	Fair	Decision-making was reasonable initially, but lacked effective situational awareness, particularly with respect to the tsunami warnings and the extent of damage to the region's building stock.
Declaration of state of emergency	Fair	The MCDEM directors' guidelines were followed closely. The threshold for a state of emergency was not reached. There was debate on whether the threshold should be revised.
Situational awareness	Developing	The size and scale of the event, and complexity of the damaged buildings made it difficult for structural engineers' to initially obtain an accurate picture of the zone of damage. Many building owner's reluctance to share information with the Council was an obstacle. The ability to build situational awareness was patchy across the CDEM sector, and there were technical solutions that could have been implemented.
Control of public safety	Good	A key decision was made initially to discourage people from entering the CBD. No red zone was declared because conditions did not warrant it. Buildings and locations deemed unsafe were cordoned off quickly. Cordons were vigilantly enforced.
Welfare arrangements	Good	Welfare arrangements for displaced people were handled and administered well, including dealing with people who were socially vulnerable, or had special needs.
Communications	Fair	Local communications were handled well and were proactively managed across a variety of media types, including television, radio, conventional media, and social media. The diversity of media confused the public (e.g. websites and social media channels belonging to public organisations including WCC, WREMO, GWRC, NZTA, Metlink, and MCDEM).
Liaison with lifeline authorities	Fair	This was not the major focus as building damage dominated this event. The electricity supply industry was generally well organised. Other services operated independently without an awareness of CDEM priorities.
Sustainability	Developing	Any prolonged response quickly puts a strain on staff resources, and this became evident after the first week of the response. This is an area that requires national-level support to provide additional resources that can be deployed at short notice.
Transition to Recovery	Developing	While the need for a dedicated Recovery team was identified early in the piece, Recovery was complex and had not been required locally after other recent earthquakes. Therefore, transition took longer than it should have done.

*Note.* CDEM = Civil Defence Emergency Management; EOC = Emergency Operating Centre; USAR = Urban Search and Rescue; MCDEM = Ministry of Civil Defence Emergency Management; WCC = Wellington City Council; WREMO = Wellington Regional Emergency Management Office; GWRC = Greater Wellington Regional Council; NZTA = New Zealand Transport Agency, Metlink = Greater Wellington Region Public Transport Network; CBD = central business district.

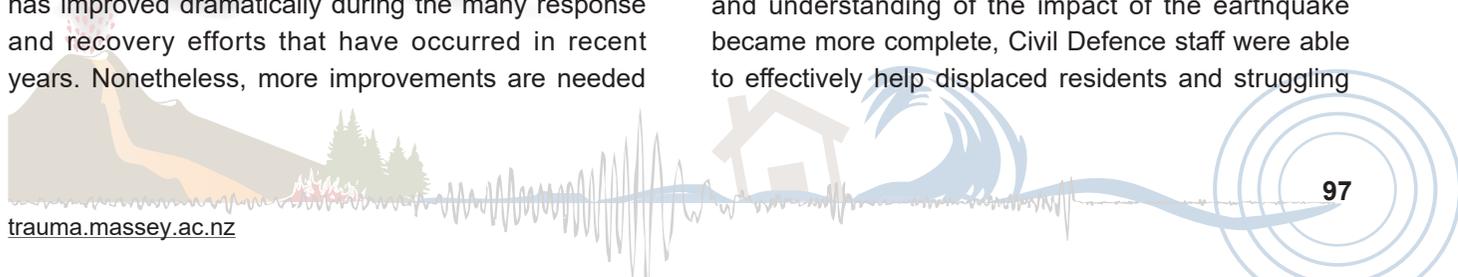
total). Noting that the earthquake was a large, complex event leading to a significant scale of damage, there are credible and systemic reasons for the "Fair" and "Developing" (i.e., Poor) assessments. Many of these were caused by generic difficulties in training and maintaining a cadre of part-time, local government staff who could respond to low probability, high impact, and extreme risk events.

Given the impact of the earthquake on Wellington City and the proximity of the epicentre to the city, the decision not to declare a state of emergency for Wellington was widely criticised and was a subject of a government review (New Zealand Government, 2018). There is no doubt that performance within the CDEM sector has improved dramatically during the many response and recovery efforts that have occurred in recent years. Nonetheless, more improvements are needed

before performance across all key areas is consistent. Capability gaps were obvious in some areas, such as situational awareness. There are potential solutions to these gaps, including updating technology.

## Conclusion

Wellington City Council has a strong CDEM capability, which quickly responded to the city's needs after the Kaikōura earthquake. Damaged buildings were quickly assessed and cordoned off to protect the public. Major damage at the Wellington port was assessed. Although a severe storm on the second day that caused flooding challenged responders, the public were able to return to work quickly. As the damage assessment and understanding of the impact of the earthquake became more complete, Civil Defence staff were able to effectively help displaced residents and struggling



businesses. Despite numerous electrical power outages and fractures in water pipes, there was comparatively little damage to utilities, except for the port which suffered widespread damage.

Further work is required locally and nationally to improve response performance and ensure that response capability within NZ is consistent and aligned with the public's expectations. This is important as some of the underlying reasons given for areas of response needing improvement were also identified during the Canterbury earthquakes in 2010 and 2011 (Canterbury Earthquakes Royal Commission, 2011).

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