Accessibility of Metro Vancouver Fire Personnel Following a Damaging Earthquake

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Completion of this major project would not have been possible without the participation of the municipalities that provided the requested data and for this I’m grateful. The Fire Chiefs who belong to the Greater Vancouver Fire Chief’s Association fully supported my project; thank-you Chiefs for seeing the value in this research and for providing your practical and valued input.

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Thank-you to John Leeburn, CAO, Port Coquitlam. Your quiet encouragement and belief in me is unwavering and always appreciated. To my lovely and brilliant life-long partner Diana, thank-you for your endless encouragement and support. You make me better in all parts of my life. Finally, to my academic supervisor, Dr. Laurie Pearce, your guidance and wisdom was exceptional and without which, I would not have succeeded in completing this project.
EXECUTIVE SUMMARY

Metro Vancouver will experience a damaging earthquake at some point in the future. Emergency planning has a key role to ensure that the region responds efficiently to save lives and limit the damage. Emergency plans require that first responders travel to their workplace; however, their ability to access their workplace from their home has not previously been evaluated. This report outlines the accessibility of Metro Vancouver’s fire personnel relative to their regular workplace and home location immediately following, and in the hours and days after a damaging earthquake.

In the event of a damaging earthquake, transportation infrastructure will be disrupted limiting accessibility in the region. By examining the travel routes required by fire personnel, emergency planning can address any anomalies or identified gaps in service needs.

The first step was to determine where first responders live so a request for first responder postal code data based on forward sortation area (FSA) information was made to Metro Vancouver municipalities. Based on this request, an inventory of Metro Vancouver fire personnel was compiled. This data was analyzed and assessed to determine the accessibility of fire personnel resources throughout the region. Based on this analysis, it was determined that there will be a shortage of fire personnel resources in many Metro Vancouver municipalities following a damaging earthquake. To lessen these shortages, resource sharing and alternative travel methods and routes will need to be considered. Some municipalities, however, may have an oversupply of fire personnel resources if region-wide policies direct fire personnel to report to their home municipality in the event they are unable to return to their regular place of work.

This report is intended to provide information to guide the development of regional policies to ensure that available fire personnel resources are deployed in the most beneficial and effective way. To be most effective, other first responder and receiver agencies should consider a similar evaluation so the data can be assessed collectively. Given that a damaging earthquake in Metro Vancouver will impact the Fraser Valley Regional District, Fraser Valley communities should also be included. It would be beneficial for the provincial government to share in the responsibility to compile and analyze the data to encourage participation. As additional data is provided, the analysis should be repeated to capture changing travel and demographics in the region.

Further research is recommended to determine resource needs in the event of a damaging earthquake. Once a better picture of the total resource needs is known, a gap analysis can be conducted to identify what resources are available and accessible from within Metro Vancouver and what resources would need to come from outside the region.
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INTRODUCTION

Metro Vancouver is comprised of 24 local authorities, consists of a population of approximately 2.5 million, and is overdue for a major damaging earthquake.\(^1\) In such a disaster, many people will be injured by fire, falling debris and building collapse and will rely heavily on first responders (police, fire, ambulance, and municipal staff), first receivers (health services) Emergency Social Services (ESS) and critical infrastructure providers such as utilities.\(^2\) Unfortunately, many first responders will be unable to get to these injured people and utility crews will be unable to respond to restore services because of damaged transportation infrastructure. Therefore, typically, when a disaster occurs, additional responders, receivers and utility personnel are called into work to meet the needs of the affected population. When first responders do not live near their regular workplace, this may result in some municipalities having few first responders and receivers to meet the needs of their citizens. In other cases, other municipalities may have an over-representation of response personnel living within their boundaries.

All Metro Vancouver municipalities, the Health Authorities, the RCMP and the BC Ambulance Service were invited to participate in this study, however, the most complete data received was from municipal fire services, and, therefore, the analysis and findings of this research study are focused on fire services.

This research assesses the accessibility of Metro Vancouver’s fire personnel to respond to their regular workplace versus where they live immediately following, and in the hours and days after a major damaging earthquake. My report will include an analysis of the implications of these findings and recommendations for future research and planning.
BACKGROUND

The Metro Vancouver region does not have an overall inventory of where first responders and receivers live in relation to their regular place of work. Given this gap, the Integrated Partnership for Regional Emergency Management (IPREM) identified the need to establish this inventory to prompt policy development to support regional planning and operations, training and personnel resource-sharing during a major disaster. IPREM was established in 2009 through a Memorandum of Agreement between Metro Vancouver and the Province of British Columbia and its mandate is to improve emergency management at all levels of government in the Metro Vancouver region.3

As a Master of Arts in Interdisciplinary Studies student and given my role as the Director of Human Resources for the City of Port Coquitlam, a Metro Vancouver municipality, I saw IPREM’s need for this research as an ideal major research project that would benefit the region and individual municipalities.

Metro Vancouver is prone to several natural hazards that could severely impact transportation infrastructure and movement throughout the region. Hazards include seismic, hydrologic and meteorological events such as earthquakes, flooding and severe winter storms.4 I chose an earthquake as a useful scenario to study given that an earthquake has the potential to cause significant infrastructure and building damage, fires and mass casualties across the entire region. This would necessitate the need for all levels of government, emergency response, and receiver agencies to work collaboratively.5

EARTHQUAKE SCENARIO

Given the infrequent nature of destructive earthquakes, geological data is used to predict their future occurrence and their potential impacts are extrapolated from other regions of the world that have experienced a destructive earthquake and have similar built environments and geology. Metro Vancouver is one of the few places in the world where three different earthquake plate boundaries exist thus generating three types of earthquakes.6(Figure 2):

1. Shallow earthquakes in the North America plate such as the 1946 M=7.3 near Courtenay
2. Deep earthquakes in the subducting oceanic plate such as the 2001 M=6.8 Nisqually earthquake near Olympia Washington that was felt in Victoria and the Lower Mainland
3. Large subduction zone earthquakes that occur between the interface of the Juan de Fuca plate and North American plate such as the 1700 M=9 Cascadia earthquake.
Subduction zone earthquakes that occur between the interface of the Juan de Fuca plate and North American plate are predicted to occur on average every 500 years somewhere between California and Vancouver Island along the Cascadia subduction zone fault. The last M=8 or greater subduction earthquake affecting Metro Vancouver occurred in 1700 off the coast of Vancouver Island. However, currently this fault appears to be locked and seismologists predict that there is a high probability of a similar magnitude earthquake occurring in the next 200 years. Statistically however, a major shallow earthquake in the North American plate near the highly-populated Metro Vancouver region poses the greatest threat.

Regardless of the type of earthquake, a major destructive earthquake has at least a 30% probability of occurring in this high-risk area of southwestern British Columbia in the next fifty years. The M=4.7 quake on December 29, 2015, centered off Victoria, is a recent reminder of the earthquake risk that is present in the Metro Vancouver region.

The degree of damage caused by an earthquake is dependent on the magnitude, distance from the epicentre, the geology and geography of the region and the construction characteristics of buildings and infrastructure. Much of Metro Vancouver is situated on the Fraser River delta which consists of sediments that will liquefy during a significant seismic event causing widespread ground failure. The geography of Metro Vancouver further increases the potential for significant damage to occur due to ground motion amplification caused by refraction and reflection off the steep slopes surrounding the region.

Recently developed Metro Vancouver earthquake scenarios provide compelling arguments for emergency preparedness...
and the need to establish evidence-based research on the location and movement of first responders and receivers throughout the region. In these scenarios, critical infrastructure was damaged, there was significant loss of life, and municipalities needed to rely on local resources immediately following the earthquake. A recent study commissioned by the University of British Columbia concluded that for a considerable period (96 hours or more) following a damaging earthquake, the university will be reliant on a self-generated response and it will be essential to utilize available operational constructs and capabilities.

**METRO VANCOUVER TRANSPORTATION**

Historically, in other major disasters around the world, regardless of the nature of the event, many local government employees were “unable to return to work immediately because of transportation issues. The roads took several days to clear, and fuel shortages also delayed some employees’ return to work” (p. 7). Particularly when a damaging earthquake occurs, first responders and receivers may have difficulty travelling to and from their homes and places of work due to damage and disruption to transportation infrastructure. A 2010 City of Vancouver report to Council demonstrates the importance of having first responders and receivers available following a disaster and discusses the issues that occur when first responders and receivers are not living close to their place of work. Given the high cost of property in the City of Vancouver, and the concern that many emergency personnel do not live in the city, staff recommended that priority be given to prospective tenants of the Olympic Village to those who work in Vancouver and provide health care and emergency services to the community.

**DISASTER RESPONSE ROUTES**

Recognizing the importance of facilitating the transportation of first responders and receivers following a disaster, the provincial government has established designated disaster response routes throughout the region. These routes are not for evacuation of residents but for the movement of emergency personnel who will be tasked with moving and treating injured people, fighting fires and restoring critical infrastructure.

**MARINE TRANSPORTATION ROUTES**

Given the potential damage to roads and access to bridges and tunnels based on a credible earthquake scenario, the Vancouver Port Authority is developing marine transportation routes as an alternative to land-based movement. A draft map of the marine transportation routes was discussed with Cindy Jeromin, Port Metro Vancouver, in September, 2016. These routes offer another planning tool for municipalities to consider as an alternative to land-based transportation routes for transporting people and supplies.
FIGURE 3 LOWER MAINLAND DISASTER RESPONSE ROUTES (PROVINCE OF BRITISH COLUMBIA, 2008)

FIGURE 4 DRAFT METRO VANCOUVER MARINE TRANSPORTATION ROUTES (VANCOUVER FRASER PORT AUTHORITY, 2017)
By investing in the research and development of marine transportation routes, the Port Authority demonstrates the importance of looking at other modes of transportation beyond the highway network as a means of getting people and resources moving around the region following a significant event such as an earthquake.

This also demonstrates the importance of regional collaboration when considering the impacts of a natural hazard and how one agency can benefit another. Marine transportation routes will become an especially important consideration where these routes parallel road routes that are prone to earthquake triggered landslides such as the Sea to Sky corridor.

**LANDSLIDES**

Earthquake triggered landslides are likely to occur in Metro Vancouver posing significant threats and inhibiting recovery efforts by blocking transportation routes.24

Given the mountainous terrain in numerous Metro Vancouver communities, there is a high probability that access into and out of the region may be cut off because of landslides in the Fraser Valley and the Sea to Sky corridor.25 An August 2010 slide near Meager Mountain26 and a July 2008 slide onto the Sea to Sky highway remind us of the instability of these slopes and the likelihood of landslides in a significant seismic event.27 (Figure 5). In an area with geological similarities to the Lower Mainland, in November, 2016, an M=7.8 earthquake outside of Christchurch, New Zealand triggered thousands of landslides cutting off the coastal community of Kaikoura.28
**Bridges**

Metro Vancouver is reliant on bridges, overpasses and approaches for movement around the region. Even if bridges do not sustain significant damage, the access routes to the bridges may be damaged. Immediately after a damaging earthquake, bridges will be closed until they can be inspected to ensure that they are safe. If bridges become impassable, parts of the Lower Mainland will become “isolated from one another without the ability to provide relief except internally with whatever resources you have.” (p. 1)

In 2005, the provincial government developed policies to retrofit bridges that were not built to current earthquake standards. These policies specify that lifeline and disaster response bridges built before 1983 are to be upgraded to withstand an M=6.5 to M=7.0 shallow type earthquake and an M=8.0 Cascadia subduction event. Since this policy was written, most of the lifeline and disaster response route bridges in Metro Vancouver have been retrofitted or replaced, except for the Patullo Bridge, which is now scheduled for replacement by 2023, and the Knight Street Bridge. Even with these retrofits, any bridge into Richmond will likely be compromised by soil liquefaction in an M=6.5 or M=7.0 shallow type earthquake given soil characteristics.

Critical transportation infrastructure will be severely damaged following a significant earthquake. Given this vulnerability, it is likely that first responders and receivers will have difficulty travelling to and from work as roads and bridges will be damaged or blocked. These emergency personnel will be relied upon to respond to the disaster but unfortunately may not be available for some time.
CRITICAL INFRASTRUCTURE

“Critical Infrastructure” is defined as a complex system of components that ensure production, transportation, communication, health, safety and all other activities necessary to support a society’s needs. It is estimated that in the event of an M=7.3 earthquake affecting Metro Vancouver, virtually all infrastructure would suffer severe disruption of service in the immediate aftermath and that there would be a moderate level of disruption lasting longer than two weeks. Without power, pumping stations running on backup generators will be vulnerable to failure, people’s homes will be without lights, heat and refrigeration and further harm will come to survivors after the initial quake.

An August 29, 2015 windstorm highlights the significant impact that even a relatively minor event has on people’s ability to function normally as over 500,000 BC Hydro customers were without power at the height of the storm. Because of this storm, in my Maple Ridge neighbourhood, we were without power for nearly a week resulting in food spoilage and a significant disruption to regular daily routines.

WATER SUPPLY

Most of the water that is piped through the region is supplied by the Metro Vancouver Water District and travels through three main pipes, two of which cross Burrard Inlet. These pipes are at significant risk of damage because of liquefaction in the event of an earthquake which would directly affect firefighting capability throughout the region. To help address these concerns, the City of Vancouver has invested $57 million to build a dedicated fire protection system consisting of earthquake resistant piping and saltwater pumping stations that supply hydrants in the densely populated downtown peninsula, Kitsilano, and Fairview Slopes.

FIRST RESPONDER AND RECEIVER AGENCIES

It is important to understand the critical role of first responders and receivers following an earthquake, and the mobility issues that will be present, in order to determine potential accessibility issues of first responders and receivers in Metro Vancouver. An earthquake of the magnitude and characteristics described above will necessitate a multi-agency response effort.

In the early stages of response, the focus will be on saving lives through search and rescue, first aid and evacuation. Professional first responders will include fire fighters, police officers, ambulance paramedics, public works staff, building officials and public and private utility workers. First receivers will include primary and tertiary medical professionals and ESS personnel.
Each first responder and receiver agency will have expertise in specific response and recovery tasks. First responder agencies that have a variety of capabilities that overlap with other agencies will be very important as there will be significant resource shortages and skill gaps following a damaging earthquake.42

**FIRE SERVICES**

Firefighters provide many critical first responder duties that will be important following a disaster, especially if other first responder agencies are unable, or are delayed, in responding. The fire service operates 24 hours a day, seven days a week from predominately staffed fire halls that are spaced throughout the region and are ready to respond quickly. Fire responders are trained to provide emergency medical treatment, urban search and rescue (USAR), traffic control, utility shut-off, hazardous spill response, rapid damage assessment and removal of hazards.43

USAR teams, made up of fire personnel and building officials, played a key role in carrying out building assessments following the September 4, 2010 Christchurch earthquake. The USAR crews were involved in assessing if buildings were safe to occupy and performed the demolition of building structures that were deemed to be unsafe.44

In another example, a captain with the Tokyo Fire Department recounted his experience in being dispatched to Kesennuma City, an area devastated by

the March, 2011 Great East Japan Earthquake. His crews were some of the first to arrive and were tasked with fighting fires over a large area, a response that was only possible given their training and specialized equipment.45

**POLICE**

Typical policing roles in a disaster response include disaster scene security, issuing warning and ordering evacuations, security at critical facilities, search and rescue, crime fighting, crowd control, traffic control and investigation.46

Another important but unfortunate policing role is identifying the remains of victims impacted in a disaster. In the 2011 Christchurch earthquake where over a hundred people were killed, a special policing unit was deployed within two hours of the quake to begin the job of identifying human remains. Through the work of the Disaster Victim Identification (DVI) unit, 97% of the deceased were successfully identified and their remains returned to their families.47 Despite a perceived perception of looting and lawlessness following a disaster, this rarely occurs and policing resources are typically used for humanitarian purposes.48

**PUBLIC WORKS**

Public works responders provide a vital role in response and recovery through such efforts as clearing debris from roadways so that other responders can move to areas of need and assist with rescue, evacuation, and sheltering and
provide temporary traffic control, perimeter security, animal control, transportation of supplies and equipment, on-site vehicle service, debris management, and restoration of infrastructure. Each municipality will be required to restore local infrastructure such as water and sanitary sewer infrastructure and clear debris from municipal roads.

**Ambulance Service**

In a disaster, ambulance services (also known as emergency medical services or EMS) provide on-scene pre-hospital care to patients experiencing medical emergencies, transport of patients to hospitals and relocate at-risk patients from harm’s way. In the aftermath of the M=6.3 Christchurch earthquake, paramedics were responsible for locating and treating earthquake victims and ensuring the health of their urban search and rescue team members. The level of treatment provided by EMS exceeds that of the basic first aid that fire and police officials are trained for and, therefore, ambulance paramedics can provide not only basic life support but advanced life support through invasive procedures as well.

**Health Care**

In a Christchurch hospital emergency room, nurses had the challenge of caring for an influx of patients in a hospital that had been damaged by the earthquake, and dealing with continued aftershocks while fearing for their own safety and worrying if their families were safe. There was little time to reflect on these concerns as within ten minutes of the initial earthquake, survivors began to arrive in need of treatment with a steady flow of people seeking help lasting for hours.

These accounts further illustrate the importance of mobilizing professional first responders and receivers to ensure an effective and timely response following a damaging earthquake.

**Municipal Roles and Responsibilities in a Disaster**

In British Columbia, under the Community Charter and Local Government Act, each municipality has the autonomy to make decisions on funding and services for its citizens and regional districts can do so for their member municipalities. Thus, municipalities are inherently independent and have developed plans and policies around self-sufficiency but, however, work cooperatively in the delivery of regional services such as water and wastewater. Many neighbouring municipalities have shared service agreements in place to support each other in the case of significant events or the need for a specialized response.

I met with Port Coquitlam’s Fire Chief, Nick Delmonico, on February 26, 2017, to get his insights into mutual aid agreements. He noted that mutual aid agreements are only as good as the resources that are available to be shared. In the event of a significant event, a city’s
own welfare will come first and mutual aid agreements do not require a municipality to share resources. Regional policies for mutual aid are related to standardizing on costing and do not stipulate sharing of resources in the context of those in greatest need.

I recently asked Metro Vancouver municipalities if they have a policy for firefighters on the requirement to report to work, or alternatively to report to the nearest fire hall, following a damaging earthquake that disrupts transportation infrastructure. Of the five municipalities that responded, none reported having any policies in place with respect to reporting expectations. Thus, at this point, staff have no direction as to what they are to do once they and their families are safe.

Following a disaster, the goal of municipalities will be to minimize interruptions of local services, and by working together they will be less likely to duplicate efforts and be more likely to create a greater, multi-organizational and regional response. A recent study suggests that “well-organized collaborative networks offer cities a way of reducing their disaster preparedness burden and improving their disaster response” (p. 1466).

By reviewing disasters that have occurred in other regions around the world, it is apparent that first responders and receivers will be an important consideration as they may not be able to travel to and from work. Consideration of alternative reporting policies need to be considered so that trained professionals that are unable to return to their regular place of work can be deployed to accessible areas of greatest need.

Accordingly, in summary, knowing where first responders live and how many would be available to report to work when Metro Vancouver experiences a major earthquake is an important element. In the next chapter, I review the research project and methodology that I used to gather this information.
METHODOLOGY AND METHODS

The initial request from IPREM was to explore “good neighbor agreements” between municipalities in Metro Vancouver in the event of a regional disaster. However, further exploration revealed that additional research was needed as there was no inventory of where first responders and receivers worked, as compared to where they lived. Given this gap, using a mixed methods approach with a strong emphasis on quantitative analyses, I focused my research on determining the accessibility of first responders and receivers in Metro Vancouver in the context of a disaster.

Different disaster scenarios were considered including a damaging earthquake, a wildland urban interface fire, a liquefied natural gas marine tanker explosion and a chemical release. An earthquake scenario was ultimately chosen because it would require a region-wide response; would result in a shortage of resources and significant damage to infrastructure; and loss of life. Additionally, the potential of a damaging earthquake was high. Based on these initial steps, I generated the following research question:

This research will determine the accessibility of Metro Vancouver’s first responders (police, fire, ambulance, utilities, municipal public works), receivers (health authority), and ESS relative to their regular workplace and home location in the hours following a major damaging earthquake.

RESEARCH DESIGN

With my research question confirmed, my next step was to design the research project. The qualitative design process included identifying key stakeholders, determining what information would be gathered, piloting data collection, developing information request packages, completing data collection, and determining how the information would be analyzed and presented.

To confirm the validity of my research, I met with several local experts in the field of emergency management and representatives of IPREM. Over the months of July and August, 2016 I met with Heather Lyle, Director of Integrated Public Safety with Emergency Management BC, Dorit Mason, Director of the North Shore Emergency Management Office, Rod Salem, Director of Emergency Management Special Operations, British Columbia Emergency Health Services, and Daniel Stevens, Manager of Emergency Planning, City of Vancouver. These individuals confirmed that research in this area would be of significant value and the results would help to address the original request to explore good neighbour agreements to prepare for a regional disaster.
PILOT STUDY

To test the feasibility of collecting the data I decided to conduct a pilot study using the City of Port Coquitlam’s data. As the Director of Human Resources for the City of Port Coquitlam, I had access to the City’s payroll information and given this authority, I requested a report that would identify the City’s first responders (fire, public works, emergency operations center) by position and home location using the first three digits of their postal code also known as forward sortation area (FSA). The payroll department produced the requested report in less than an hour demonstrating that the information was readily available and the task was not onerous. Given this result, I was confident that requesting first responder and receiver agencies to provide a similar report on their staffing was reasonable.

In addition to this analysis, I provided the

After reviewing the Port Coquitlam data, I further defined the data collection categories into:

- Position title
- Position category (fire, police, public works, emergency operations centre, ambulance, utilities, ESS, primary medical care, tertiary medical care)
- Rank (operational or management)
- Home FSA
- Home municipality

After sorting the Port Coquitlam data into these categories, I conducted some initial analyses to see what findings could be drawn from the data. Given the context of my research question, I looked at each first responder’s travel route to determine if he or she were required to cross a bridge as well as the total distance travelled. This initial analysis is represented in Table 1.

Port Coquitlam dataset to Anthony Smith,
a geomatics consultant and he refined the map generating parameters within the mapping software and created an initial visualization of the data. Though an iterative process, I worked with Smith to further refine the map until I was satisfied that it could be used as a representation of what the final Metro Vancouver first responder and receiver aggregate map would look like.

**ETHICAL REVIEW**

Given the nature of the data, the Royal Roads Office of Research and Ethics recommended that I proceed with a Request for Ethical Review application. The ethical review was completed and I was granted approval to proceed with the data collection portion of my research.

**INFORMATION PACKAGE DISTRIBUTION**

An information package was then developed and distributed to Metro Vancouver’s first responder and receiver agencies requesting their first responder or receiver’s information using direct email and regional association’s distribution lists (Appendix 1). To facilitate increased stakeholder participation, I asked John Leeburn, Port Coquitlam’s Chief Administrative Officer and Co-Chair of IPREM to make the initial information request.

After distributing the information request, some organizations raised general privacy concerns with respect to releasing position information, and especially so when there were less than five employees in a position.

**LEGAL OPINION ON PRIVACY CONSIDERATIONS**

To address these concerns, I sought a legal opinion from a leading privacy expert, David Loukidelis, with the law firm, Young Anderson. Mr. Loukidelis confirmed that the FSA information requested is not private and is releasable. He did identify a potential innocuous risk to privacy for unique positions.

To ameliorate this potential risk, I revised my information request and asked participating organizations to not provide position titles but instead use designated position categories such as fire management, or fire operational staff. This relieved privacy concerns and most municipalities began to submit the requested information.

Despite these assurances, one municipality requested a non-disclosure agreement specifying that the municipality’s fire responders not be identified as working for that municipality on any regional aggregate maps. A non-disclosure agreement was provided and the requested information was released.

Unfortunately, despite these reassurances, the RCMP, the Regional Health Authority and the BC Ambulance Service decided not to provide the requested information. Given this lack of participation, following the data
This research will determine the accessibility of Metro Vancouver’s fire personnel relative to their regular workplace and home location following a major damaging earthquake.

collection phase of my research, I had to reconsider the scope of my project.

**NARROWING OF RESEARCH**

The scope of the research question was further refined based on which organizations provided responder and receiver information and which first responder information participating organizations provided.

The most complete dataset was that of the fire service with over 2,500 fire personnel included in the study representing over 89% of all fire personnel in Metro Vancouver.

Data for other municipal first responder groups were reported inconsistently.

Public and private utilities were not contacted to provide first responder information given the initial breadth of data being sought and the challenges presented with obtaining the first responder and receiver agencies data. Therefore, the focus and Individual and regional analyses were completed solely on the fire service data.

The following Metro Vancouver municipalities, representing over 88% of Metro Vancouver’s population, provided some or all the requested information:

- Burnaby
- Langley City
- Langley Township
- Maple Ridge
- New Westminster
- North Vancouver City
- North Vancouver District
- Pitt Meadows
- Port Coquitlam
- Port Moody
- Richmond
- Surrey
- Vancouver
- West Vancouver

Coquitlam, Delta and White Rock confirmed that they would not be providing the requested information. Bowen Island, Lions Bay, Anmore, Belcarra, and Tsawwassen First Nation did not reply to the request for information. Participation in this research was voluntary and there was no obligation to participate.

**DATA COLLECTION**

Data was provided by participating organizations in the form of an excel spreadsheet which included columns for the home organization, the position or category of position and the first three digits of the employee’s home postal code. From this information, I applied aggregated position categories (e.g., fire, public works) and rank (i.e., operational or management) to any positions not categorized by the participating organization and included the name of
the home community based on the provided FSA information. I then assessed each responder given his or her work and home location and considered the need to cross bridges. The individual participating organization’s information was then added to a master spreadsheet.

**Mapping of Results**

From these spreadsheets, aggregated regional first responder spatial maps were created using ArcMap 10.3, a geographic information system (GIS) software program created by Environmental Systems Research Institute (ESRI). The approximate home locations of first responders and receivers were graphically represented by applying the individual FSA information to a FSA boundary file. This file was produced by DMTI Spatial Incorporated and was obtained through the ABACUS Dataverse Network Project version 3.6. Each first responder or receiver was represented on the map by a single dot using the “generate random points” tool in ArcMap. Dots were excluded from areas with non-residential land uses (industrial, resource, transportation, etc.) and areas with zero residential population. This was based on the 2013 consolidated land use file from the Metro Vancouver Open Data site and the 2011 census of population per census block from Statistics Canada. Dots were colour coded to distinguish different categories of first responders and receivers. The base map layer containing bridges, tunnels, roads and disaster response routes was created using GeoBC Open Data.

**Validity and Reliability**

The information received from participating municipalities included all first responders or receivers from that organization. Given that 100% of the community’s fire personnel data was provided there was no need to test for sampling error. Further to this, given that the data reflected real-time payroll data, validity was not a concern in terms of currency or validity.
**ANALYSIS OF RESULTS AND DISCUSSION**

My analysis looked at the accessibility of fire personnel to report to work in Metro Vancouver based on sub-regions and individual municipalities following a damaging earthquake.

In some geographically large municipalities, such as “L” and “C”, large numbers of fire personnel are spread out across the community, while in communities such as “K” and “N” there are relatively few fire personnel who reside there. (*Note, specific municipal information has been anonymized at the request of participating municipalities*).

**DISTRIBUTION OF FIRE PERSONNEL**

The map on the following page (Figure 6) shows where participating municipalities’ fire personnel live throughout the region. This map shows that although fire personnel live throughout the region, there is considerable variation in the numbers of where they live. Table 2 shows the number of fire personnel that live in each community. A further, more detailed, breakdown and analysis of where fire personnel live and work follows.

<table>
<thead>
<tr>
<th>Municipality</th>
<th># of fire personnel living in municipality from data collected</th>
<th>% of fire personnel in each municipality from data collected</th>
</tr>
</thead>
<tbody>
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<td>A</td>
<td>80</td>
<td>3.9%</td>
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<td>L</td>
<td>432</td>
<td>20.8%</td>
</tr>
<tr>
<td>M</td>
<td>282</td>
<td>13.6%</td>
</tr>
<tr>
<td>N</td>
<td>16</td>
<td>0.8%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>2,074</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>

**TABLE 2 NUMBER OF FIRE PERSONNEL LIVING IN MUNICIPALITY**

Given the significant earthquake hazard potential in “K” due to soil characteristics, one advantage of the low concentration of fire personnel living there may be that in the event of an earthquake resulting in significant ground failure and building collapse, “K” fire personnel living in neighbouring, less impacted areas, may
be more likely to survive and, therefore, be able to return to “K” to provide support.

Maple Ridge and Pitt Meadows have a smaller overall population than the more urbanized areas such as Vancouver and Burnaby; however these eastern municipalities have relatively high numbers of fire personnel living in these communities. Given the population of these municipalities and the corresponding fire personnel needs, these municipalities will have a high number of fire personnel available to meet their fire operational needs.

**FIRE PERSONNEL WHO WORK AND LIVE IN THEIR HOME MUNICIPALITY**

There is also considerable variation in the percentage of fire personnel (fire operational and fire management) who work and live in the same community. “N” for example has 2% of its fire personnel living in the municipality whereas, “D” has 95% of its fire personnel living and working there.

The breakdown of fire personnel working and living in the same municipality is summarized in Table 3.

<table>
<thead>
<tr>
<th>Municipality</th>
<th>Fire personnel on staff</th>
<th># fire personnel who live and work in the municipality</th>
<th>% of staff needs met with own fire personnel who live and work in the municipality</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>284</td>
<td>21</td>
<td>7%</td>
</tr>
<tr>
<td>B</td>
<td>25</td>
<td>6</td>
<td>24%</td>
</tr>
<tr>
<td>C</td>
<td>199</td>
<td>145</td>
<td>73%</td>
</tr>
<tr>
<td>D</td>
<td>117</td>
<td>110</td>
<td>95%</td>
</tr>
<tr>
<td>E</td>
<td>96</td>
<td>19</td>
<td>20%</td>
</tr>
<tr>
<td>F</td>
<td>68</td>
<td>25</td>
<td>37%</td>
</tr>
<tr>
<td>G</td>
<td>131</td>
<td>40</td>
<td>31%</td>
</tr>
<tr>
<td>H</td>
<td>36</td>
<td>35</td>
<td>97%</td>
</tr>
<tr>
<td>I</td>
<td>71</td>
<td>12</td>
<td>17%</td>
</tr>
<tr>
<td>J</td>
<td>67</td>
<td>43</td>
<td>64%</td>
</tr>
<tr>
<td>K</td>
<td>222</td>
<td>30</td>
<td>14%</td>
</tr>
<tr>
<td>L</td>
<td>383</td>
<td>194</td>
<td>51%</td>
</tr>
<tr>
<td>M</td>
<td>792</td>
<td>181</td>
<td>23%</td>
</tr>
<tr>
<td>N</td>
<td>102</td>
<td>2</td>
<td>2%</td>
</tr>
</tbody>
</table>

**TABLE 3 – FIRE PERSONNEL WORKING AND LIVING IN SAME MUNICIPALITY**
Figure 6 Distribution of Fire Personnel from Participating Municipalities
Based on this information, in a damaging earthquake, many municipalities’ fire services will be understaffed when a shift change is required if inter-municipal transportation infrastructure is damaged and fire personnel are unable to return to their regular place of work. Unlike fire operational staff who are on-site to provide coverage 24 hours per day, 365 days per year, fire management (non-unionized, exempt management staff) generally work office hours, Monday to Friday. If a damaging earthquake occurs outside of regular office hours (typically 80% of the week), fire management must travel back to work. Depending on the home location of the fire management personnel, and the amount of damage caused to transportation infrastructure, he or she may or may not be able to get back to work right away. The percentage of fire management who live and work in the same municipality is summarized in table 4.

For those fire personnel who are on shift when a damaging earthquake occurs, they will eventually need to be relieved by fire personnel who are not on duty. Fatigue and concerns about their own family’s safety will limit on-shift fire personnel’s ability to continue to work effectively for extended periods. The percentage of staffing needs being met is based on the total number of fire personnel who are employed by a municipality. The actual staffing resources that will be required in a significant disaster have not been assessed; however, they are likely to be much greater than those required during regular fire operations.

<table>
<thead>
<tr>
<th>Municipality</th>
<th>Fire management on staff</th>
<th>Fire management who live and work in the same municipality</th>
<th>Percentage of fire management needs met with fire management who live and work in municipality</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>11</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>B</td>
<td>3</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>C</td>
<td>6</td>
<td>4</td>
<td>67%</td>
</tr>
<tr>
<td>D</td>
<td>5</td>
<td>4</td>
<td>80%</td>
</tr>
<tr>
<td>E</td>
<td>5</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>F</td>
<td>4</td>
<td>3</td>
<td>75%</td>
</tr>
<tr>
<td>G</td>
<td>6</td>
<td>2</td>
<td>33%</td>
</tr>
<tr>
<td>H</td>
<td>3</td>
<td>3</td>
<td>100%</td>
</tr>
<tr>
<td>I</td>
<td>6</td>
<td>1</td>
<td>17%</td>
</tr>
<tr>
<td>J</td>
<td>3</td>
<td>2</td>
<td>67%</td>
</tr>
<tr>
<td>K</td>
<td>4</td>
<td>2</td>
<td>50%</td>
</tr>
<tr>
<td>L</td>
<td>Not provided</td>
<td>Not provided</td>
<td>Not provided</td>
</tr>
<tr>
<td>M</td>
<td>14</td>
<td>4</td>
<td>29%</td>
</tr>
<tr>
<td>N</td>
<td>Not provided</td>
<td>Not provided</td>
<td>Not provided</td>
</tr>
</tbody>
</table>

**TABLE 4 – FIRE MANAGEMENT LIVING IN MUNICIPALITY**
There is a finite number of trained fire personnel in Metro Vancouver and in the event of a significant region-wide disaster, additional resources will need to come from outside of the region to meet the need. An analysis of the anticipated resource needs from beyond the region in a region-wide significant disaster is outside the scope of this report, however, this report does highlight where resource shortages will likely occur based on the accessibility of fire personnel living in the region. This will provide a starting point for determining available and required resource levels.

**FIRE PERSONNEL WHO LIVE OUTSIDE OF THEIR HOME MUNICIPALITY**

Of the participating Metro Vancouver municipalities, overall, there are considerably more fire personnel working outside of the municipality in which they live compared to fire personnel who live and work in the same community (1646 versus 863). This breakdown of fire personnel who live and work in the same municipality versus those fire personnel who work in one municipality but live in another is illustrated in the following map (Figure 7).

**TOTAL FIRE PERSONNEL LIVING IN MUNICIPALITY**

A damaging earthquake will limit travel between municipalities and understanding the total number of fire personnel who live in the municipality will be important. If a municipality has a limited number of its own fire personnel living in the municipality, a source of additional fire resources may be fire personnel who are employed by other municipalities but who live in the municipality. If these fire personnel are unable to get to their regular place of work but can travel to a fire hall close to their home, there is a potential they could provide support to their home municipality.

Having fire personnel living in the municipality they work in provides the greatest access to these staff resources in the event of a disaster impacting regional transportation routes. Increasing the number of fire personnel living in the municipality in which they work could be accomplished through collective bargaining and collective agreement language changes. These requirements could be based on a set threshold; for example, requiring at least 50% of firefighters to live in the municipality they work or on the “land island” they share. Alternatively, local resident incentives or subsidies could be implemented, similar to the recommendations made in the report to City of Vancouver Council recommending housing incentives be given to first responders and heath care professionals at Olympic Village.

Unfortunately, the municipalities that have the fewest number of fire personnel living in their community also have some of the highest real estate prices in the region. Addressing fire personnel resource shortages through residency
Figure 7 Fire Personnel Home Versus Work Location
requirements or incentives is therefore unlikely to be a practical solution.

Municipalities that have a high proportion of their own fire personnel who live and work in the municipality such as “D” (95%) will have little need to draw on fire personnel who live in their municipality but work for other municipalities. Conversely, municipalities that have limited numbers of their own fire personnel who live locally will have a higher need to consider staff-sharing arrangements (e.g., “N”). Figure 8 presents the percentage of fire personnel needs that are met (based on regular operations full staff complement) by staff who live and work in their home municipality and those who don’t work in their home municipality. The diagram is divided into four quadrants:

- **Quadrant 1 (Q1)** - Municipalities that have less than 50% of their own fire personnel living locally and more than 100% of their needs met with fire personnel who live in the municipality but work elsewhere (“F”, “I”)
- **Quadrant 2 (Q2)** - Municipalities that have more than 50% of their own fire personnel living locally and more than 100% of their needs met with fire personnel who live in the municipality but work elsewhere (“J”, “H”)
- **Quadrant 3 (Q3)** – Municipalities that have less than 50% of their own fire personnel living locally and more than 100% of their needs met with fire personnel who live in the other municipalities (“A”, “K”, “M”)
- **Quadrant 4 (Q4)** – Municipalities that have more than 50% of their own fire personnel living locally and more than 100% of their needs met with fire personnel who live in the other municipalities (“L”, “C”, “D”)

**FIGURE 8 – PERCENTAGE OF NEEDS MET BY MUNICIPALITY-BASED AND OTHER FIRE PERSONNEL LIVING IN MUNICIPALITY**
personnel living locally and less than 100% of their needs met with fire personnel who live in the municipality but work elsewhere ("A", "E", "G", "K", "M", "N").

- **Quadrant 4 (Q4)** – Municipalities that have more than 50% of their own fire personnel living locally and less than 100% of their needs met with fire personnel who live in the municipality but work elsewhere. ("C", "D", "L").

Municipalities that fall into Quadrant 1 will be well served by a policy that supports the sharing of fire personnel. "I", for example, has only 17% of its staffing needs met by its own fire personnel who live in the municipality. Conversely, 123% of its needs could be met by fire personnel who reside in "I" but work elsewhere. For "F", 37% of its fire personnel live in the municipality however 124% of its needs could be met by non-"F" fire personnel who live in the municipality.

"B" is not included on the graph as it is outside of the scale shown with 394% of its fire personnel needs met with fire personnel residents who do not work for the municipality. 24% of its own fire personnel live in the municipality. "B" relies on a composite staffing model so some of its resident fire personnel may work outside of the municipality. "H" and "J" fall into Quadrant 2 and are not only well resourced by their own fire personnel living in their municipality but are also well-resourced by fire personnel who live in the municipalities but work elsewhere. Although "H" has the highest percentage of its own fire personnel living in the municipality at 97%, this is somewhat misleading as "H" relies on a paid on-call system without staffed halls. It is possible that many of its firefighters work outside of the municipality.

"J" has a composite staffing model with paid on-call and career fire fighters. If a damaging earthquake occurs during regular business hours, many "H" fire personnel (and some of "J"’s) may be working outside of the municipality and unavailable due to transportation infrastructure damage. It will be important for "H", and to a lesser degree "J", to consider how many of their paid on-call fire personnel work away from the municipality during business hours. The daytime work location of “H” paid on-call firefighters will have a significant impact on resource levels if roads and bridges become impassable given the reliance on bridges to access the municipality from the west and south.

During my data collection, I did inquire with “H” fire management about the number of fire personnel who work away from the municipality. At the time of my request, they were unable to provide this information as part of this research but acknowledged this would be useful information to obtain from their paid on-call staff.

Municipalities that fall into Quadrant 3 have a shortage of their own fire personnel who live in their municipality and a shortage of fire personnel from other municipalities living in their
Accessibility of Metro Vancouver Fire Personnel Following a Damaging Earthquake

The municipalities in this quadrant also have the greatest overall resource needs as they represent the largest fire services in the region.

For example, for “M”, only 23% of its own fire personnel live in the municipality and 13% of its needs could be met by non-“M” fire personnel living there. If all fire personnel living in “M” were directed to report for work there, only 36% of “M”’s staffing needs would be met. Municipalities in this quadrant will rely heavily on staff being able to get back to work in the event of a damaging earthquake, a directive that may not be achievable if transportation infrastructure is significantly damaged in an earthquake.

Municipal fire services in Quadrant 4 are the most self-sufficient. “D” is in the enviable position of having 95% of its fire personnel residing within its boundaries. It is also very well served by fire personnel who live there but work for other municipalities. Rather than a shortage of resources, municipalities in this quadrant could have an over-supply of fire personnel resources if there were a regional policy directing fire personnel to report to their nearest fire hall if roads and bridges in and out of the municipality were impassable because of a damaging earthquake. “L” also has a composite staffing model.

“D” and “C” recently transitioned from a paid-on call department to a composite department. Most of the hiring for career positions came from the paid-on-call ranks who resided in the municipality.

Over time, it is likely that the percentage of their own fire personnel who live in these municipalities will decrease unless specific measures are taken to limit fire personnel from moving out of the community.

**BARRIERS TO MOVEMENT – “LAND-ISLANDS”**

Metro Vancouver is not an uninterrupted land mass but is intersected with rivers and inlets throughout the region. Given these natural barriers, movement throughout the region is heavily reliant on bridges (and the George Massey tunnel). During a damaging earthquake, it is very likely that these structures will be impassable for some time because of damage or the need for inspection to ensure safety. Although not a water barrier, given the terrain of the Sea to Sky Highway, this transportation corridor will likely also be impassable due to landslides limiting travel between the North Shore and points north of Horseshoe Bay.

Given this context, consideration of “land-islands” becomes important. A land-island is simply a land mass that is uninterrupted by waterways (or slide-prone transportation corridors) that require bridges or tunnels to cross. In Metro Vancouver and the Fraser Valley, the land-islands are as follows:

- North Shore – North Vancouver District, North Vancouver City, West Vancouver
- Vancouver and vicinity – Vancouver, Burnaby, Tri-Cities, New Westminster
In an earthquake, municipalities that share a “land-island” will have greater inter-municipal accessibility.

The following table shows the needed, versus the available, fire personnel broken down by land-island. Given that the Metro Vancouver Regional District municipalities of Coquitlam, Delta and White Rock did not provide the requested information and municipalities in the Fraser Valley Regional District were not included in the information request, the number of fire personnel in Table 5 does not represent the actual number of fire personnel living and working on each land-island, only the total fire personnel of participating municipalities (keeping in mind that the participating municipalities represent 89% of the population-base of Metro Vancouver). Rather than an exact representation, the information is presented as an approximation for planning purposes.

In the event of a damaging earthquake that disrupts transportation routes, specifically bridges and the sea to sky corridor, municipalities that share a land-island and are understaffed by fire personnel who live in their municipality, would be well served by pooling of fire personnel resources between all municipalities on the land-island. For example, “N”’s fire personnel staffing needs are met by 2% of its own staff who live in “N”, 12% by fire personnel who live in “N” but work elsewhere and 83% if it could rely on all the fire personnel living on the North Shore.

Knowing where fire personnel live in Metro Vancouver in relation to where they work provides important information for planning purposes.

Although this information represents a “snap shot in time,” it is still relevant. Having information that is representative of the entire region and not just individual municipalities is an important consideration in the context of a region-wide disaster such as an earthquake.

<table>
<thead>
<tr>
<th>Land-island</th>
<th>Total regular fire personnel staffing</th>
<th>Total fire personnel living on “land-island”</th>
<th>Percentage of staff needs met with fire personnel living on land-island</th>
</tr>
</thead>
<tbody>
<tr>
<td>North Shore</td>
<td>291</td>
<td>242</td>
<td>83%</td>
</tr>
<tr>
<td>Vancouver and vicinity</td>
<td>1116</td>
<td>660</td>
<td>50%</td>
</tr>
<tr>
<td>Richmond</td>
<td>218</td>
<td>48</td>
<td>22%</td>
</tr>
<tr>
<td>North of the Fraser</td>
<td>153</td>
<td>307</td>
<td>201%</td>
</tr>
<tr>
<td>South of the Fraser</td>
<td>607</td>
<td>804</td>
<td>132%</td>
</tr>
</tbody>
</table>

TABLE 5 – FIRE PERSONNEL ON EACH LAND ISLAND
**RECOMMENDATIONS**

**ESTABLISH A REGIONAL POLICY ON RESOURCE ALLOCATION**

Each municipality has differing levels of fire personnel resources available depending on where its employees live. Municipalities that have many of their fire personnel living in their community will be less likely to want to participate in regional resource sharing. Municipalities with a shortage of available fire personnel will want to establish a regional sharing policy. To address these inter-municipal resource issues will require a regional or provincial policy on resource sharing.

Current mutual aid agreements do not require neighbouring communities to share resources when their own communities are in need. To ensure that available resources are shared more equitably will require a policy that distributes fire resources based on need and not on local availability of resources. IPREM currently does not have the authority to establish regional policy and is an information-sharing group. However, under the Emergency Programs Act, Metro Vancouver does have the authority to declare a regional state of emergency. Given these powers, IPREM could work with its members to provide recommendations to Metro Vancouver to develop policy that would ensure a more equitable distribution of fire personnel resources in the event of disaster that impacts the entire region. Given that the inequity of firefighting resources between municipalities is now known, a proactive approach would be to establish resource sharing requirements based on the distribution of resources prior to a disaster occurring.

**ESTABLISH EMPLOYEE REPORTING REQUIREMENTS**

Based on my recent survey of Metro Vancouver municipalities, there appears to be no policies on where employees should report to if they are unable to return to work following a disaster. For municipalities that have an abundance of fire personnel, such as in “D”, their policy may be that non-municipally-based fire personnel should not report to their home municipality.

For municipalities that have a shortage of their own fire personnel living in their community, the policy may be that fire personnel who live in that community, but work elsewhere, should report to their home municipality. Such a policy however will need to be coordinated regionally as each municipality will need to agree so that contradictory policies are not put in place.

The information contained in this report will be helpful for individual municipalities to determine the accessibility of fire personnel resources in their community and what the direction and expectations should be of their employees and their citizens when establishing a reporting policy. Where agreement cannot be reached between municipalities that have
conflicting reporting expectations, regional or provincial policy may be required on where to report in the event of a natural disaster that impacts movement in the region.

However, a provincial or regionally mandated policy will still need to be municipality-specific depending on available resources. A blanket policy such as “if unable to return to your regular place of work, report to your nearest fire station” would not address the specific resource requirements of individual municipalities and would be ineffective.

**DETERMINE OVERALL REGIONAL RESOURCE REQUIREMENTS**

This report does not quantify the resource requirements in the event of disaster resulting from a natural hazard such as an earthquake. Knowing the overall resource requirements that will be needed in a major disaster is an important consideration as regional fire resources are finite. Knowing the total number of fire personnel needed and the number of fire personnel who are already in the region will help to determine how many extra personnel will be required. Knowing this number will allow emergency planners to build contingency plans and partnerships for obtaining fire personnel from outside of the region.

**PRIORITIZE TRANSPORTATION ROUTES**

Following a damaging earthquake, there may be a shortage of bridge inspectors and crews tasked with clearing debris on roadways. Given the distribution of fire personnel in the region, priority should be given to inspecting bridges and opening travel routes that will enable fire personnel to travel to and from their homes to municipalities that have limited fire personnel locally. The Pitt River Bridge, for example, is a main transportation route that will allow fire personnel from the over supplied Maple Ridge and Pitt Meadows municipalities to travel to the Tri-Cities, Burnaby and Vancouver. Bridges to and from the North Shore may be of secondary priority given that 83% of the North Shore’s fire personnel needs can be met with the fire personnel who live there.

Knowing which emergency evacuation routes will be prioritized first will be important information for fire personnel to plan the route to take to move around the region immediately following and in the hours and days after a disaster. In addition to road travel, marine transportation routes that enable movement to and from eastern Metro Vancouver municipalities will be an important consideration as the supply of fire personnel is concentrated in these eastern communities but is reliant on bridges to leave their home community. Following a damaging earthquake, marine transportation routes may be the most
efficient way to move people and equipment. Port Metro Vancouver is finalizing Fraser River transportation routes and this information will need to be shared with Metro Vancouver municipalities that border the Fraser River to ensure emergency plans have incorporated marine transportation routes. All municipalities will need to work collaboratively to establish marine muster points for the movement of personnel and resources from one municipality to the other.

**OBTAIN A COMPLETE DATASET**

The original research question for this report was to assess accessibility of all Metro Vancouver first responders and receivers. For various reasons, requested information was not provided by the different first responder and receiver agencies. In an earthquake, all first responder and receiver agencies will be required to address staff accessibility issues and will need to work collaboratively to ensure a coordinated and effective response.

Fire personnel data was obtained through a request to each individual municipality in Metro Vancouver. Of all the first responder information obtained, the fire service provided the most complete dataset, due in large part to the leadership shown by the Greater Vancouver Fire Chiefs Association. For future requests, it may be helpful to include the International Fire Fighters Association (IAFF) in the communication and education of the importance of this research. If the IAFF provided firefighter information, Municipal fire services would only need to provide non-union fire personnel information to complete the data collection.

The original research was requested by IPREM, a Metro Vancouver agency. Given that an earthquake will impact not only Metro Vancouver but also the Fraser Valley, and given that many Metro Vancouver first responders and receivers live in the Fraser Valley, it is recommended that first responder and receiver data is also collected and analyzed for both Lower Mainland regions.

Given the data that was provided and its usefulness, it is recommended that all first responder and receiver agencies provide their employee’s FSA information to facilitate these planning efforts for the entire region. To ensure full participation, another mechanism may be needed to obtain the information. This could require additional time and a higher level of government involvement than was available to collect data for this report.

Public and private utilities were not included in the data request for this report. These agencies should also be included in future research into accessibility of first responders in Metro Vancouver and the Fraser Valley given the critical role they will play in response and recovery following a natural disaster such as an earthquake.

Collection of all fire personnel data in Metro Vancouver should be completed
without delay, and the Fraser Valley fire data should also be collected and the results analyzed in concert with Metro Vancouver’s data.

Ideally, the first responder and receiver agency data should be collected and analyzed to provide a complete picture of the reality and the challenges that lie ahead.

**REVIEW ANALYSIS IN FIVE YEARS**

The purpose of this research was not to identify individual fire personnel travel accessibility issues but to assess municipal and regional travel patterns. Given this context, individuals who have moved since the research was gathered do not impact the analysis or recommendations. Over time, however, broader trends of where people live in relation to where they work involving many fire personnel or other first responders and receivers may impact the overall analysis. For example, most firefighters cannot afford to live in “N” and as such, only 2% of “N”’s fire personnel live there. It will be important to identify if the trend for firefighters in the western, high-priced, Metro Vancouver communities will continue to move eastwards and how this will impact the ability of municipalities to respond to a major disaster in Metro Vancouver. Will this trend continue for other high priced municipalities such as Vancouver, Burnaby or Coquitlam?

For municipalities that implement residency specific policies or incentives, it will be important to determine the impact such programs have on the accessibility of first responders in their municipality. For these reasons, it is recommended that once a complete data set of first responder and receiver information is obtained and analyzed, it should be reviewed at least every five years to identify what changes have occurred.

**CONCLUSION**

Following a damaging earthquake, Metro Vancouver municipalities will rely heavily on fire personnel being able to get to and from their regular place of work to provide a much-needed response. Unfortunately, many fire personnel will be unable to travel due to damaged infrastructure. Understanding where fire personnel live and work across the region is an important first step in determining what policies and agreements need to be developed to ensure individual municipalities will have access to necessary resources in the event of a significant natural hazard. Although this report has referenced an earthquake scenario, the findings and recommendations are applicable to any disaster that impacts the entire region.

Prior to this research being completed, no inventory of Metro Vancouver fire personnel had been analyzed to compare the correlation between work and home locations. Without this inventory and analysis, emergency planners did not have evidence-based research on accessibility considerations of fire personnel.
To address this gap, municipalities throughout the region were asked to provide their first responder information. This information request resulted in over 89% of Metro Vancouver fire personnel home FSA data being provided. With this information, regional maps showing fire personnel distribution were created and analyzed.

Based on this analysis, it was determined that there is considerable variation in available fire personnel resources across Metro Vancouver municipalities. Some municipalities will be well served by their own fire personnel who work and live in their community while others will have a shortage of their own fire personnel. Fire personnel who live in one municipality, but work in another, could be a potential resource to the municipality in which they live if they are unable to return to their regular place of work.

Given the “have” and “have not” nature of municipal fire personnel resources following a damaging earthquake, a regional policy is needed to ensure a more equitable distribution of available resources. As a regional district, Metro Vancouver would have the authority to enact such a policy under the Emergency Program Act. In addition, alternative means of travel throughout the region will need to be developed such as marine transportation routes given that many transportation corridors will be impassable due to inspection, damage or debris.

This report focused on fire personnel. In the event of a damaging earthquake, all first responders and receivers will be needed. It is recommended that all first responder and receiver agencies participate in compiling home FSA information including the Fraser Valley to enable a more fulsome and complete analysis of the accessibility of regional personnel resources.

The information that was gathered for this report relied on volunteer participation. To ensure a more complete set of data, it is recommended that EMBC work with IPREM and its member communities to facilitate the data collection and analysis. Given changing travel patterns and regional growth, it is further recommended that the complete data be collected and analyzed again at a minimum every five years.

To increase the region’s overall resiliency, regional planning is required. The information contained in this report needs to be incorporated into policy that will ensure that the region’s first responders and receivers will be deployed in a way that ensures the greatest benefit to the region. Without this planning, there will be greater suffering and loss of life and the region will take longer to recover following a damaging earthquake or other region wide disaster.
APPENDIX 1 – INFORMATION POSTER

The shaking has stopped but my staff can’t get to work?

As a participant in this study you will:

- KNOW where your first responders and receivers live
- KNOW how many first responders and receivers live in your community
- SEE the gaps and identify strategies to address

Contact: Steve Traviss, project lead
straviss@portcoquitlam.ca or 604-927-5435
ENDNOTES


5 A.I.R. Worldwide, Study of impact and the insurance and economic cost


7 Cassidy, J. F., Rogers, G. C., Lamontagne, M., Halchuk, S., & Adams, J., Canada's earthquakes

8 Province of British Columbia, BC earthquake immediate response plan

9 Cassidy, J. F., Rogers, G. C., Lamontagne, M., Halchuk, S., & Adams, J., Canada's earthquakes; Province of British Columbia, BC earthquake immediate response plan

10 Province of British Columbia, BC earthquake immediate response plan

11 A.I.R. Worldwide, Study of impact and the insurance and economic cost


13 A.I.R. Worldwide, Study of impact and the insurance and economic cost


15 Clague, J. J., The earthquake threat in southwestern British Columbia


20 Goodman, D., & Mann, S., Managing public human resources following catastrophic events


22 Klassen, M., City recommends spending $32 million on social housing at Olympic athlete’s village


24 Cassidy, J. F., Rogers, G. C., Lamontagne, M., Halchuk, S., & Adams, J., Canada's earthquakes


30 A.I.R. Worldwide, Study of impact and the insurance and economic cost


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