

Earthquake Integrated Asset Management Plan

Committing to Seismic Resilience

British Columbia



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PROJECT SUMMARY

The Province of British Columbia recognized the benefits of a holistic approach for earthquake preparedness, and retained Associated Engineering to develop a plan. Working collaboratively with asset-managing Ministries and stakeholders, the Associated Engineering team led the development of the Earthquake Integrated Asset Management Plan. The Plan provides a collaborative framework to improve earthquake preparedness and resilience across all Ministries, and expedite post-earthquake response and recovery for the social and economic benefits of all British Columbians.

PROJECT TEAM

Prime Consultant: **Associated Engineering**

Owner/Client: Ministry of Transportation and Infrastructure – British Columbia

Other Consultants: **Ausenco** (Structural engineer – schools and standards), **VC Structural Dynamics** (Earthquake hazard, risk and monitoring), **Bush, Bohlman and Partners** (Structural engineer – health care facilities), **David Bonowitz Consulting** (Seismic resiliency), **Collaborative Global Initiative** (Facilitation), **Phillip Chambers Consulting** (Seismic mitigation program - schools), **Hill + Knowlton Strategies** (Policy and strategic communications), **David Hopkins Consulting** (Seismic hazard planning – structural and policy), **Terra Firm Earthquake Preparedness** (Non-structural seismic risk mitigation), **Thrive Consulting** (Emergency preparedness and planning)

INTRODUCTION


British Columbians live in one of the most high-risk seismic zones in Canada along the edge of three, major, active tectonic plates. Earthquakes can have destructive effects on life, property, and infrastructure, which can be particularly devastating in large urban centres like Victoria and Vancouver – areas that are vitally important to the national economy.

The Province of British Columbia has a long history and commitment to earthquake preparedness. Various Ministries within the government have developed mature programs for planning improvements to new and existing provincial infrastructure to increase seismic resilience. These Ministries operate a variety of effective, but independent systems to identify and prioritize investments for seismic resilience of their infrastructure assets, including transportation and communication infrastructure, hospitals, and schools—all critical to life safety, earthquake resilience, and post-earthquake response and recovery. Accordingly, some seismic investments may be undertaken in isolation of other Ministries' programs, and independent of the Province's overall objectives.

The BC Provincial Government recognized the need to tackle seismic risk in a holistic manner. The Province retained Associated Engineering to lead the development of BC's Earthquake Integrated Asset Management Plan. The purpose of the Plan is to provide a collaboration framework across the Province's Ministries to manage their key infrastructure assets for seismic resilience.

The Provincial Government wanted to gather the best practices from each Ministry, and prepare a roadmap for an overarching approach for assessing risks, prioritizing needs, recommending investment, and managing asset inventories – for structural and non-structural assets. Developing a provincial framework for seismic hazard mitigation facilitates the Government's objective of improved seismic resilience over the long term. Key benefits include better decision-making, improved value from investments, coordinated investment in interdependent assets, improved life safety, and expedited community and economic recovery.





The Province's leadership in developing this Plan will result in improved seismic resilience, post-earthquake response and recovery, and economic benefits for BC and Canada.

INNOVATION

Working collaboratively with five key Ministries and other major stakeholders, the Associated Engineering team documented how each Ministry manages its seismic management program, evaluated global best management practices, identified improvements to the Province's earthquake asset management program, and recommended how Ministries and stakeholders can coordinate and collaborate to improve earthquake preparedness, response and recovery. The Plan provides a framework for collaborating across government organizations to improve seismic resilience by coordinating investments and taking advantage of synergistic opportunities. The Plan identifies opportunities to leverage and multiply the overall value of the government's investments extending beyond life safety to provide for community and economic recovery. The recommendations include immediate and short-term actions that can be implemented with minimal capital investment. The Plan also identifies opportunities to leverage Federal government seismic programs and funding, as well as coordinating with other levels of government, agencies, and organizations.

Key recommendations include the adoption of third generation seismic criteria for the Province's school retrofit program; encouragement for the continued use of a national performance-based seismic design philosophy for bridges; strategic expansion of the Province's earthquake early warning system; and the preference for low-damage, seismic design methods and systems to achieve higher life safety and a more rapid return to function following damaging earthquakes.

COMPLEXITY

Each Ministry and stakeholder came into the project with ownership of their effective, but independent seismic risk management programs for asset investment. Ministries had individual systems, budgets, and priorities that they did not want to be affected by the development of the Earthquake Integrated Asset Management Plan. Thus, the major challenge of developing the Plan was engaging participants from key Ministries and stakeholders to:

- Develop a common understanding of the importance and interdependencies of infrastructure assets
- Agree on the benefits of collaborating on earthquake asset management planning
- Agree on opportunities and shared goals
- Develop a mutually beneficial framework for effective planning and investment decision-making and
- Agree to move forward with the new approach.

Other challenges included the following:

- Establish cross-Ministry communication to develop collaborative planning and reach consensus for developing the framework
- Develop a common language and understanding
- Capture asset interdependency
- Commit to leadership
- Build on past work and ongoing programs
- Combine international experience and lessons with BC-based expertise and needs


The Associated Engineering team's collaborative and consultative approach was instrumental to overcoming the above challenges to reach consensus amongst a Working Committee comprised of more than 20 members of five key Ministries as well as members of three Provincial stakeholder groups.



COMPLEXITY (CONT'D)

Associated Engineering interviewed staff from each Ministry and coordinated four, full-day workshops to develop and foster a sense of trust and respect that allowed free expression of ideas on existing conditions and differences in capabilities and encouraged the participants to work together. The facilitated process resulted in a strong consensus across all Ministries to develop and adopt a set of six recommended strategies to meet the Province's four key seismic resilience goals: life safety, effective response, economic and community recovery, and informed decision-making. Collaborative planning allowed inter-dependency of key assets to be identified, achieving a broad understanding and support for asset and capital planning across Ministries. The participants understood and agreed that individual Ministries would still be accountable for presenting their own capital and renewal plans to the Treasury Board, supplemented by evidence of awareness and collaboration of plans for future improvements in seismic resilience.

To come to a common, true understanding of a complex and multi-discipline topic required establishing a common language and frame of reference early in the project. Participants from the consultant team and government with expertise in engineering, seismology, disaster recovery, asset management and planning gathered to present, listen, discuss, disclose and question each other to ensure that important concepts and meanings implicit in the terminology were understood. For example, seismic codes and standards have different meanings to engineers and seismologists, versus government members and facility managers. Engineers and scientists typically consider probabilities of exceedance, life safety, risk, damage, and collapse. Planners, government, and disaster recovery agencies communicate in terms of post-earthquake response, safety, recovery, and movement of goods and people. Insurers and re-insurers consider insured financial losses. These meanings and differences were explored in depth in the workshops.



Developing common terms and definitions, as well as mutually agreed interpretations and purpose laid the foundation for collaboration and building consensus on the Plan

An aerial photograph of a coastal area, likely a port or industrial zone. A large bridge spans a body of water, with a railway line running alongside it. To the right of the bridge is a marina filled with numerous boats. Various industrial buildings and structures are scattered throughout the area. The background shows more land with some greenery and distant buildings.

SOCIAL & ECONOMIC BENEFITS

The benefits of the Earthquake Integrated Asset Management Plan project was in the process and approach to developing the Plan, as well as its outcomes. Execution of the Plan will benefit the provincial and national economies.

The Associated Engineering team developed an approach that helped to unite the five key Ministries and key stakeholders in developing a common, shared plan that will reduce risk to British Columbians should a catastrophic earthquake occur. The communication, collaboration, and deep understanding among the consulting team, government Working Committee, and stakeholders were key achievements and contributed to the successful development of the Plan.

The Earthquake Integrated Asset Management Plan meets the Province's four key goals for seismic risk management, moving beyond increased life safety, to reduce earthquake damage to infrastructure, and improve post-earthquake response and recovery. This approach to earthquake preparedness will help people return to their daily lives and work, expedite restoration of social and community functions, and speed economic recovery in the Province and across the country. Earthquake preparedness and rapid response and recovery are key aspects that provide social and economic benefits after a catastrophic earthquake, helping to reduce national costs.

The interdependency of infrastructure classes, such as a critical transportation network to serve all other infrastructure assets and functions (schools, community centres and hospitals) was identified and embraced as a key platform in government planning and budgeting. Associated's workshops allowed participants to discuss inter-dependencies, and to capture them in the findings and recommendations. Many examples and benefits were captured; for example, recognizing that the transportation network should be considered in the siting of new critical infrastructure; that new or retrofitted low-damage buildings such as schools and community centres may be used for post-earthquake shelters; that some port facilities need to be available as staging areas for immediate and long-term response and recovery; and that asset management tools and systems could be used to capture and manage multiple infrastructure classes. The shared understanding of infrastructure interdependencies contributes dramatically to social, business and economic continuity in BC.

ENVIRONMENTAL BENEFITS

The Earthquake Integrated Asset Management Plan goes beyond seismic engineering and infrastructure resilience to consider and include environmental, community, cultural, psychological, and economic impacts of a catastrophic seismic event. Planning, response and recovery measures considering the environment and overall sustainability will reduce environmental impact, identify mitigation measures, and response and recovery measures to address environmental impacts of a catastrophic earthquake.

Improved infrastructure resilience protects the environment by reducing the risk of asset collapse that might harm the natural environment. This also provides for the construction of longer-life assets that improve sustainability of the built and natural environments.





MEETING CLIENT'S NEEDS

The Earthquake Integrated Asset Management Plan meets the Province's goal to develop a framework for collaboration between Ministries and stakeholders. The Plan identifies opportunities to leverage the value of each Ministry's seismic investments to improve earthquake preparedness, response, and recovery – and meet the Province's four key goals for seismic risk management. The Associated Engineering team brought the benefits of international experience and expertise to provide world-class advice to the Plan, providing sound, practical and well-focused direction to the development of the Plan.

Recommendations include immediate and short-term actions that can be implemented with minimal capital investment. The Plan also identifies opportunities to leverage Federal government seismic programs and funding to augment the Provincial government's investments. In addition, recommendations are made for working with other jurisdictions to coordinate earthquake preparedness and resilience investments.

In addition, the Plan documents the Province's asset management tools including school and facility databases, GIS, the MoTI bridge management and seismic management systems, seismic and structure health monitoring instrumentation, and early warning systems so that they can be further integrated and leveraged for use, from the political planning and funding levels through to coordinated implementation. Our team combined international specialists and BC-based seismic experts to ensure a BC-specific framework and approach that captures important international lessons. This project benefits from policy and planning successes and lessons from international jurisdictions, including governance, market-based approaches to incentives for seismic resilience, and motivational approaches to longer term planning and sustained commitment.

The Province's leadership in implementing this Plan will result in improved seismic resilience, expedited post-earthquake response and recovery, and improved seismic investment, safety, and economic benefits for British Columbians.

The Earthquake Integrated Asset Management Plan was enthusiastically received by all stakeholders. Senior Ministry representatives compared different approaches to asset seismic risk management, and identified common practices and effective strategies to move forward. From the Province's perspective, the collaborative approach to developing the Plan brought new insights that can greatly enhance the seismic performance of the Province's infrastructure, life safety, and community and economic recovery after a catastrophic earthquake. Implementation of the Plan will strengthen the continuity of the Provincial and National economies for future generations.

EARTHQUAKES IN BRITISH COLUMBIA EARTHQUAKE PREPARATION TODAY

BC is the most likely province to experience an earthquake
Source: Earthquakes Canada

60% of Canada's earthquakes occur on BC's coast
Source: Earthquakes Canada

\$75 billion Estimated cost of a 9.0 magnitude quake
Source: Insurance Bureau of Canada

1 in 5 chance large earthquake hitting BC in the next 5 years
Source: Office of Auditor General of BC

Risk Assessments Save



\$87 billion Value of goods imported & exported through BC's airport, ports, railways and roads in 2017
Source: Statistics Canada

1700 earthquakes in BC last year
Source: Earthquakes Canada

50 BC schools have earthquake early alert systems installed

168 of 346 BC schools seismically upgraded

190 BC bridges seismically upgraded

- Earthquake hazard-mapping
- Off- & on-shore earthquake early warning systems installed
- Seismic monitoring systems installed on bridges, dams and other infrastructure
- BC SIMS mapping and monitoring system installed on-line

\$1 Every invested in mitigation and risk reduction

saves an average of **\$4** in future avoided losses

Source: Godschalk et al 2009

Post-earthquake Recovery Planning Timeline

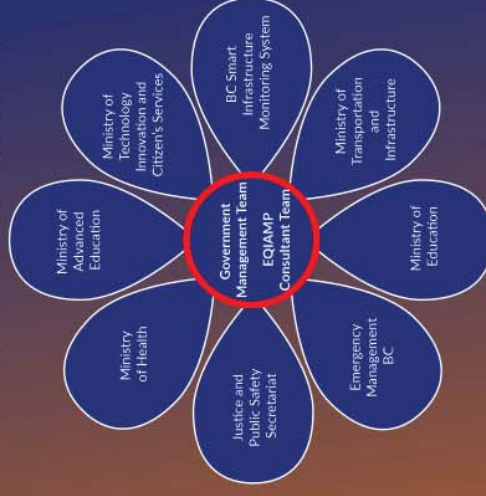
■ 1-7 Days Critical Services

■ 7-30 Days Social Needs

■ Years Reconstruction

Source: San Francisco ERP 2008

Government Working Team



6 Recommendations

- Commit to collaboration
- Build a culture of resilience
- Commit to leadership
- Invest in tools to support decision-making
- Establish program for seismic monitoring
- Broaden integration across all sectors

4 Goals

- Life safety
- Effective response
- Economic & community recovery
- Informed decision-making