HAZARD RISK AND VULNERABILITY ANALYSIS

REGIONAL DISTRICT OF NANAIMO, TOWN OF QUALICUM BEACH, AND CITY OF PARKSVILLE

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PREPARED FOR:

Regional District of Nanaimo

Town of Qualicum Beach

City of Parksville

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This Hazard, Risk and Vulnerability Analysis (HRVA) was conducted collaboratively, with project sponsorship provided by:

- Regional District of Nanaimo – Director, Transportation and Emergency Services
- Town of Qualicum Beach – Chief Administrative Officer
- City of Parksville – Chief Administrative Officer

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PRODUCTION TEAM

The assessment was facilitated by a team of consultants from CCEM Strategies Ltd.

The Project was led by the following:

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- Town of Qualicum Beach – Rob Daman, Emergency Program Coordinator, and
- City of Parksville – Aaron Dawson, Emergency Program Coordinator

COMMUNITY REPRESENTATIVES & STAKEHOLDERS

The Project Sponsors and Production Team wish to acknowledge the support and contributions of the many local government and First Nation community representatives, subject matter experts, and other agency stakeholders who attended the engagement sessions and provided input and expertise to inform the process.

Executive Summary

The Regional District of Nanaimo (RDN), Town of Qualicum Beach, and the City of Parksville recently partnered to undertake a Hazard, Risk and Vulnerability Analysis (HRVA) with the goal of enhancing their cooperative approach to emergency management and generating a foundation for the next phase of preparedness and mitigation activities, while increasing the capacity and resiliency of the region.

The purpose of a Hazard, Risk and Vulnerability Analysis (HRVA) is to "help community leaders make risk-based choices to address vulnerabilities, mitigate hazards and prepare for response and recovery from emergencies" (EMBC, 2004). Risk assessments, such as HRVAs, are a regulatory requirement of local governments.

This HRVA provides a comparison of risks posed to the region across the full spectrum of hazards, including natural, technological, and conflict-related hazards. By providing a view of the relative risks across all hazards, local decision-makers are better able to prioritize risk management and emergency preparedness activities by focusing on the hazards that pose the greatest risk.

APPROACH

Engagement

Community engagement was a key component of the risk assessment. A series of engagement sessions were held to help identify potential hazards, gather perceptions of hazard consequences, and explore local vulnerabilities and resiliency strategies. The engagement sessions also served to strengthen inter-agency relationships and build a shared understanding of risks posed to the region. Engagement participants included representatives from government and non-government agencies, first responders, Indigenous community members, industry stakeholders, neighbouring community members, and subject matter experts.

Hazard Identification & Risk Assessment

The project team worked together to identify a list of hazards that could affect the region by surveying existing tools and reports, reviewing historical data, and consulting community members and subject matter experts. Ultimately 53 hazards, categorized as either natural, technological, or conflict-related, were identified.

Following the completion of the hazard list, the relative risk posed by each hazard was determined by calculating a risk score. Risk is defined as "as a measure of the probability [likelihood] and severity of an adverse effect to health, property, the environment, or other things of value" (EMBC, 2004). To calculate the risk scores, it was necessary to assess both the likelihood of each hazard's occurrence and its potential consequences.

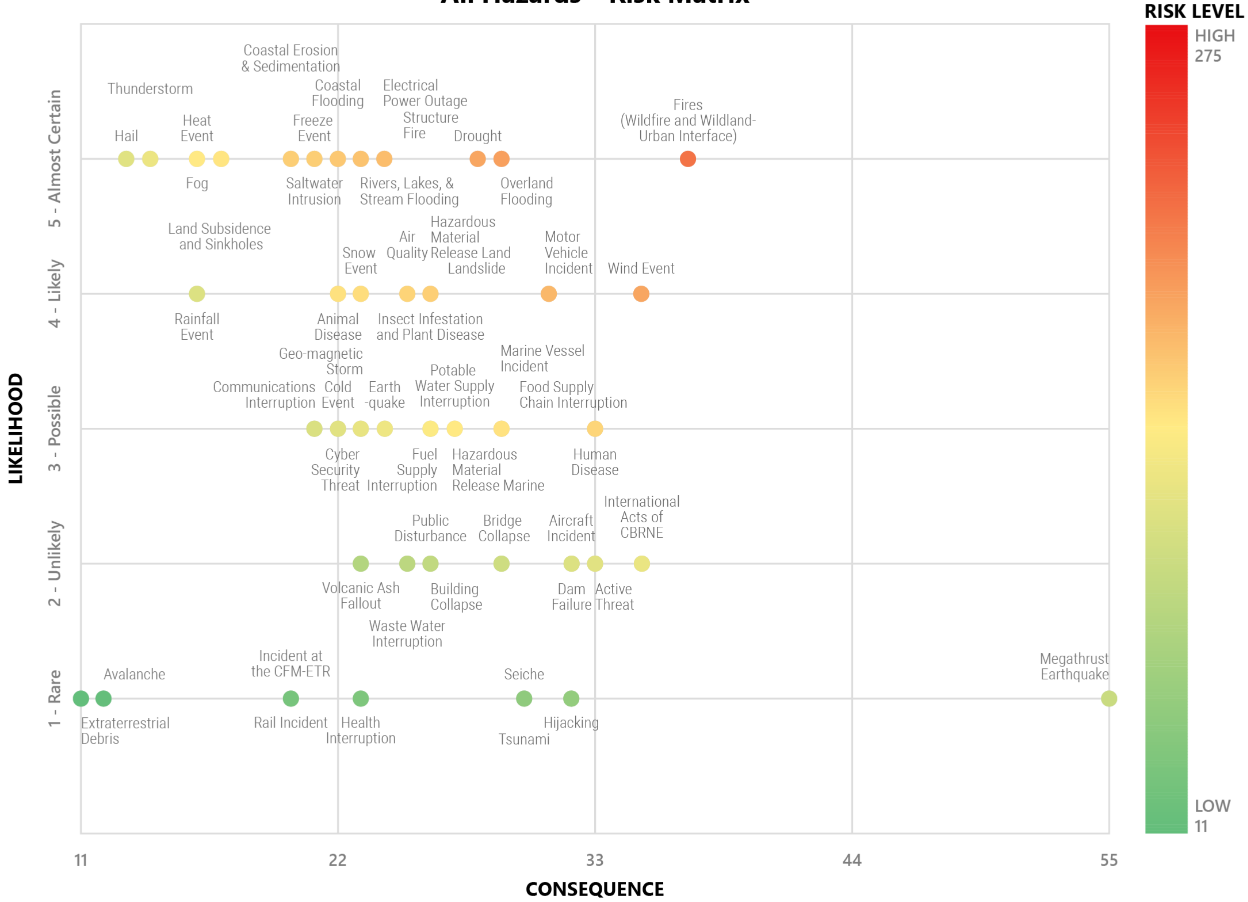
Each hazard was assigned a likelihood score of 1 to 5 and a consequence score of 11 to 55 (the consequence score is a sum of values from 11 different consequence categories, each with a possible score of 1 to 5). Using the common approach of multiplying likelihood by consequence to arrive at a measure of risk, each hazard was assigned a risk score between 11 and 275.

FINDINGS

Hazard Assessment Results & Risk Scores

The likelihood and consequence scores for each hazard were plotted on a risk matrix to provide a clear, visual representation of the risks across all hazards (see figure below).

All Hazards – Risk Matrix



A comparison of risk scores across all hazard categories (natural, technological, and conflict-related), revealed that natural hazards pose the greatest risk to the region. Natural hazards (Wildfire and Urban Interface Fire, Overland Flooding, Wind Event, and Drought) account for four out of the five highest rated hazards. The natural hazard category also accounts for the most likely hazards for the region, as well as many of those with the highest consequence. The

Megathrust Earthquake hazard, while low on the likelihood scale, has the highest overall consequence score (55) of all the hazards.

Of the technological hazards, Motor Vehicle Incident has the highest risk score, followed closely by Electrical Power Outage and Structure Fire. While several of the conflict hazards were found to have high overall consequence scores, e.g. Intentional Acts of CBRNE[1], Active Threat, Hijacking, these hazards scored relatively low on the likelihood scale and received lower risk scores as a result.

Due to the multiplication factor involved in calculating the overall risk score, the hazards with the highest overall risk score tended to be those which had higher likelihoods. Several hazards were determined to have a very high consequence rating, but a low likelihood rating, which meant they fell lower in the risk table. As such, when determining the "Top Hazards" for the region, a filter was applied to capture those high consequence/low likelihood hazards, in addition to the hazards with high overall risk scores. A total of 13 "Top Hazards" were identified for the region:

Hazard	Likelihood (1-5)	Overall Consequence (11-55)	Risk Score
Fires (Wildfire and Urban Interface)	5	37	185
Overland Flooding	5	29	145
Wind Event	4	35	140
Drought	5	28	140
Motor Vehicle Incident	4	31	124
Electrical Power Outage	5	24	120
Structure Fire	5	24	120
Rivers, Lakes, and Stream Flooding	5	23	115
Coastal Flooding	5	22	110
Human Disease	3	33	99
Intentional Acts of CBRNE	2	35	70
Active Threat	2	33	66
Megathrust Earthquake	1	55	55

Vulnerability and Resiliency

The HRVA also details areas of vulnerability as well as the strength and resiliency of the region. While being situated in a hazardous zone is a key determinant of risk, a community's

[1] A chemical, biological, radiological, nuclear, and explosives (CBRNE) event.

vulnerability defines the susceptibility of the people, property, industry, resources, and the environment to harm should a hazard event occur. Vulnerabilities were grouped into four sections within the report:

- Social Vulnerabilities (e.g. age, language, income levels);
- Economic Vulnerabilities (e.g. economic dependencies on industries and resources);
- Environmental Vulnerabilities (e.g. dependencies on sensitive natural areas); and
- Physical Vulnerabilities (e.g. critical infrastructure, locally owned assets).

HRVA engagement session participants identified various physical, social, and structural barriers to accessing services and supports encountered by vulnerable populations (e.g. elderly, homeless, and low-income families) in the region. Limited financial resources, inadequate housing or living conditions, and dependency on support services reduce the adaptive capacity and resilience of these populations.

The region has a relatively high percentage of elderly residents (27% of the population is age 65 or over) and the population is aging. Seniors are particularly vulnerable to the health impacts associated with natural hazards. Older adults are also more vulnerable to service disruptions which may follow hazard events such as wind storms and power outages.

With many tourists visiting the local destinations in the summer months, and the addition of those using the region as a thoroughfare to reach other destinations, there may also be a significant non-resident population at any one time that is potentially vulnerable to hazard events.

Just as social systems play a key role in human vulnerability to hazards, social systems also underpin many aspects of community resilience. The sense of community, or feelings of belonging, has been identified as an important component of a community's ability to "bounce back". The sense of connectedness and strong support networks in the region were highlighted by engagement session participants as an important aspect of the region's resiliency.

Climate Change

Canada's climate is currently warming at a rate nearly twice that of the global average. Projections suggest that by the years 2081 to 2100, Canada's climate will increase by 1.8°C if emissions are reduced, or up to 6.3°C if emissions remain high.

While climate change is a global phenomenon, a variety of factors determine how the impacts of climate change manifest at the local level. With projected population growth in the region estimated at 12% over the next decade, increased development and transition from a rural to more urban environment is anticipated. The impacts of urbanization and other land cover changes, and their compounding effects on climate change, should be considered when determining adaptation and mitigation strategies for the future.

Climate change is likely to affect the majority of hazards faced by the region. According to the BC Ministry of Environment and Climate Change, "the likelihood of most risk events increases over time based on projections of future climate change". A strong majority of engagement session participants agreed that climate change would have an impact on the occurrence or severity of most natural hazards.

The hazards anticipated to be most heavily impacted by climate change, leading to an increase in frequency and/or severity, include:

- Wildfire
- Flooding (Surface Water, Rivers, Lakes and Streams and Coastal)
- Wind Event
- Drought
- Salt Water Intrusion
- Heat Event
- Rainfall Event

The region is currently working on various initiatives to plan and prepare for the impacts of climate change. Recent initiatives include the Adaptation Changemakers Qualicum Beach climate change project and the RDN Coastal Floodplain Mapping project. As the local impacts of climate change transpire, and new information becomes available, the results of this hazard assessment should be re-evaluated, and the prioritization of associated mitigation and adaptation strategies reconsidered.

CONCLUSION

This HRVA is a foundational step towards enhancing regional resilience. Through the calculation and plotting of risk, the HRVA has provided local community members, stakeholders, and decision-makers with a view of the risks across all hazards. The findings can serve as a useful tool in promoting robust discussions, determining unacceptable levels of risk, and arriving at highest priority hazards for risk management, resiliency building, and emergency preparedness activities.

The results of the assessment reveal that natural hazards pose the greatest risk to the region, and that the risk from most hazards locally is increasing, due to climate change and urbanization.

Through the efforts of the Production Team and the engagement session participants, the region has an assessment that can be confidently used in risk-based decision making, the setting of priorities for proactive hazard mitigation, and in developing an action plan towards becoming a disaster resilient community.

01 Introduction

PURPOSE

The purpose of a Hazard, Risk and Vulnerability Analysis (HRVA) is to "help community leaders make risk-based choices to address vulnerabilities, mitigate hazards, and prepare for response and recovery from emergencies" (EMBC, 2004). The HRVA provides a comparison of risks that may exist within a community across the full spectrum of hazards, categorized into natural, technological, and conflict-related hazards. This approach enhances the understanding of the relative risks posed to the community by each hazard, as well as enables the community to prioritize risk management and emergency preparedness activities in relation to those hazards that pose the greatest risk.

When conducting an HRVA, it is important to not only consider the hazard, but its frequency or likelihood and its consequence. Even though a hazard may be highly likely to occur, its consequences may be minimal. Similarly, a hazard event that is unlikely to occur may have severe consequences. To fully assess the consequences of a hazard event, significant consideration of the various vulnerabilities a community might have to that hazard is required.

Risk assessments, such as HRVAs, are a requirement of the *Local Authority Emergency Management Regulation*. Section 2(1) of the regulation states:

> *A local authority must reflect in the local emergency plan prepared by it under section 6 (2) of the Act:*
>
> > *(a) the potential emergencies and disasters that could affect all or any part of the jurisdictional area for which the local authority has responsibility, and*
> >
> > *(b) the local authority's assessment of the relative risk of occurrence and the potential impact on people and property of the emergencies or disasters referred to under paragraph (a)* (Government of British Columbia, 2019).

This HRVA will be used as a foundation for the next phase of the region's emergency preparedness and mitigation activities. The report be used to support the improvement of emergency plans, the enhancement of community and responder education, and the expansion of training programs. The HRVA will also act as a source document – detailing areas of vulnerability as well as the strength and resiliency of the region – leading to the development and prioritization of mitigation strategies for hazard management, with a focus on hazards that are likely to occur or will have the greatest impact. With projected increases in the frequency and severity of many hazards due to climate change and urbanization, this HRVA also aims to inform local decision-makers when determining adaptation strategies for the future.

Previous Works

An HRVA for the Regional District was completed in 2006, with an update to the assessment completed in 2009. In 2009, the City of Parksville and District of Lantzville undertook individual HRVAs for their communities as well.

SCOPE

This HRVA considered and assessed those hazards which present a risk to the region overall inclusive of the Town of Qualicum Beach, City of Parksville, and District of Lantzville; Regional District of Nanaimo Electoral Areas A, B, C, E, F, G, and H; and the region's three First Nations communities: Qualicum, Snaw-naw-as (Nanoose), and Snuneymuxw First Nations.

The assessment was inclusive of natural, technological, and conflict-related hazards.

Out of Scope

This HRVA explored the level of risk and potential impacts of specific hazards to the region overall and did not assess the risk or specific impacts to individual communities. The risk scores presented in the assessment are applicable to the *region* and may not reflect the specific risk to an individual community.

The assessment of the hazard applicability, impacts, vulnerability, and resiliency factors for the City of Nanaimo was considered out of scope of this HRVA.

The depth of assessment of vulnerabilities did not allow for gathering of data specific to school attendance by geographic areas, the proximity of residents' work to their homes, or dependencies on large, single employers. Additionally, the analysis of building types and specific locations of critical infrastructure was out of scope for this assessment.

The scope of the project focused on identifying locally owned critical assets; identification of regional critical infrastructure in all ten sectors was considered out of scope. Local government owned assets, including response services such as Emergency Support Services and Fire Departments, were not analyzed for accessibility or availability. Exploration of mitigation, preparedness, and capacity of critical infrastructure was limited.

The consequences of the identified hazards were assessed through the consideration of individual hazard events. An assessment of the impacts of simultaneous or cascading hazard events was determined to be out of scope.

LIMITATIONS

Data Sources & Approach

The approach and tools used in this assessment align with the standard practices set out in Emergency Management British Columbia's (EMBC) Hazard Risk Vulnerability Analysis Toolkit (2019). The toolkit promotes the exploration and incorporation of both scientific data and local knowledge during the hazard assessment process. Following this approach, hazard assessments were conducted using a combination of observational data and background research cross-referenced against insights from local experts and community members.

The assessment of risk was completed with information available at the time the HRVA was conducted. Extensive research and information gathering efforts were undertaken to source the most current and relevant information, and efforts were made to engage subject matter experts and community members for input. Access to this local information and expertise was limited by attendance and participation levels at the engagement sessions. If individuals or organizations were not able or chose not to attend, the project team was limited in their ability to gather information from these sources to inform the assessment.

The use of anecdotal evidence in the assessment of hazard likelihood adds an additional layer of subjectivity to an inherently subjective process. Risk assessments rely on judgement to arrive at measures of likelihood and consequence, which inevitably introduces subjectivity and bias. The interpretation of a hazard description and the subsequent assessment of its likelihood and consequence are influenced by an analyst's professional expertise, individual experiences, responsibilities, and perspectives.

This assessment was undertaken by a diverse team who worked together to arrive at qualitative measures of likelihood and consequence by consensus. While each team member brought a wealth of experience and a unique outlook, repeating the assessment with a different group of people may lead to differences in the results. The risk ratings that resulted from this process should be interpreted as best estimates and not absolutes. As stated in the HRVA Toolkit (2019), "the value of the HRVA is just as much in the conversations that take place amongst a diversity of people and groups as it is in the final results".

Hazard Identification

A great deal of effort was invested in identifying a list of hazards that could impact the region. The definitions for each hazard were reviewed and edited for clarity and to ensure relevance to the region. While every attempt was made to arrive at a comprehensive, tailored list of hazards for the region, other, unidentified hazards may exist.

Regional Perspective

This HRVA was undertaken to provide an assessment of the hazards that may present risks to the region as a whole. The hazard assessment process was conducted at the region level and does not present a specific rating of likelihood or consequence for individual communities within the region. Efforts have been made to synthesize the available information and data and present summaries applicable to the region overall. Though the assessment was conducted with the perspective of the region as a whole, not all parts of the region will be equally at risk to each of the hazards. The results of this assessment serve as a starting point for additional efforts to tailor the hazard, risk, and vulnerability information for individual communities.

APPROACH

02 Engagement

A key component of the assessment was community engagement. A series of three engagement workshops were conducted to facilitate the sharing of traditional knowledge, personal perceptions, and local understanding of hazards, risks, and vulnerabilities within the region. The intention of the engagement was to determine perceptions of the community's vulnerabilities and resiliency strategies, while strengthening relationships and building a shared understanding of risks posed to the community as a method to contribute to long-term resiliency.

The workshops were organized and strategically facilitated to emphasize and encourage an open dialogue with all attendees, and to allow for both individual and group contributions. Each session focused on a specific component of the HRVA process and included activities to engage participants, meet workshop objectives, and gather input and feedback on identified project elements. In addition to the engagement sessions, outreach to interview specific individuals was conducted to obtain more technical or scientific information related to probabilities and historical instances of hazard events.

The engagement participants included representatives from government and non-government agencies, first responders, Indigenous community members, industry stakeholders, neighbouring community members, and subject matter experts. Two geographic groups, "North" and "South", were created for the engagement sessions. Separating the groups into North and South enhanced participation and aided engagement efficiency and focus allowing time to adequately explain processes and capture input into multiple elements per session. In addition, separating the groups into North and South highlighted the geographic, economic, demographic, and perceived differences between the two areas. Each session group was made up of identified key area representatives who utilized their expertise, local knowledge, and geographic familiarity, to provide input and contribute to the activities and assessments. The complete list of entities who participated is included in *Appendix 6* of this document.

The first engagement sessions were held on October 10, 2018 (Day One – North) in Qualicum Beach and October 11, 2018 (Day Two – South) in Nanaimo. There was a total of 66 participants in attendance at the two sessions. The objectives of the initial engagement session were to:

- Discuss hazard perceptions and historical experiences to assist in determining the list of applicable hazards for the Region.
- Explore the perceptions of risk, focusing on the frequency and severity of hazards.
- Discuss the preliminary critical asset list; understand perceptions of the impacts associated with the loss of those critical assets; and identify specific examples of additional local and community critical assets.

Participants were invited back for a second round of engagement on February 20, 2019 (Day One – South) in Nanaimo and February 21, 2019 (Day Two – North) in Qualicum Beach. There was a total of 56 participants in attendance; many of whom had attended the initial session. The objectives of the second engagement session were to:

- Highlight community perceptions of the consequences of hazard events.
- Explore physical conditions and resource accessibility issues that could contribute to local community vulnerabilities.
- Identify current and future strategies for strengthening community resiliency.

The final engagement session, held June 12, 2019 in Parksville, united the North and South groups into a single session. Having all attendees together allowed for the presentation of the findings of the hazard assessment for the region, and the subsequent dialogue to be inclusive to all the participants concurrently and with a united, regional perspective. Forty-four (44) people attended the final session; 70% of whom had been to at least one of the previous engagement workshops.

Results and information gathered during the engagement sessions provided context and background, including community and entity perceptions, which made it possible to conduct the assessment from the true perspective of the region. Information received from participants about historical events helped to inform discussions related to hazard likelihood and local relevance. Perceptions shared regarding the significance of the various hazard consequences were used to inform the evaluation of impacts per hazard, specific to the region.

"The sessions were open, informative and I felt we were heard and the information we bring is valuable" (Engagement Session Participant).

Feedback from participants suggested the benefits of the engagement session included:

- An opportunity to contribute to the identification and prioritization of hazards;
- An improved understanding of risks to the community;
- An understanding of how the HRVA will serve as a foundational tool to inform regional planning projects; and
- An opportunity to strengthen connectivity between organizations and communities.

94% of attendees either agreed or strongly agreed that they found the engagement process informative and provided an opportunity for learning and contribution of local knowledge.

03 Hazard Identification & Assessment

HAZARD IDENTIFICATION

The first step in the hazard assessment process was to identify the hazards that could affect the region. A comprehensive list of natural and human-caused hazards was created by surveying a variety of emergency management and risk reduction standards, frameworks, and tools including provincial (EMBC), federal (Public Safety Canada) and international hazard lists. This working list was then refined to capture hazards relevant to the region determined through the review of historical data, previous HRVAs, and engagement of community members and subject matter experts (SMEs). The project team ultimately identified 53 hazards that could affect the region. The hazards were then categorized into "natural", "technological", and "conflict" related hazards. The full list of hazards and their definitions can be found in *Appendix 2*.

RISK ASSESSMENT

Following the completion of the hazard list, the next step was to determine the relative risk posed by each hazard by calculating a risk score. Risk is defined as "as a measure of the probability [likelihood] and severity of an adverse effect to health, property, the environment, or other things of value" (EMBC, 2004). To calculate the risk scores, it was necessary to assess both the likelihood of each hazard's occurrence and its potential consequences. The assessment was grounded in engagement with stakeholders, community leaders, and subject matter experts, supplemented with research into historical and notable hazard events, and the consideration of influencing factors, particularly climate change.

Risk is commonly calculated by multiplying the likelihood score by the total consequence score, as follows:

$$Risk = Likelihood \; x \; Consequence$$

Likelihood Assessment

Likelihood is the probability of an event occurring and is commonly expressed as an expected rate of occurrence e.g. once every 15 years. Estimated rates of occurrence were obtained using published and historical records of notable incidents for the region, wider province, and country. Hazard likelihood information from previous risk assessments and reports relevant to the region was also considered.

Following the collection and review of hazard frequency data, the project team assigned a likelihood rating to each hazard. The likelihood rating was based on a 5-point scale (see *Table 1*) which is a combination of the scale provided in the EMBC HRVA Toolkit (2019) and the scale provided by the UN International Strategy for Disaster Reduction Resilient Cities' Quick Risk Estimation Tool. The likelihood assessment used a combined scale to permit the use of historical data when no frequency data or return period information was available.

Table 1 – Likelihood Scale

EMBC				UNISDR
Likelihood	**Rating**	**Frequency**	**Probability (% Chance)**	**Historical Data (Definition/Consideration)**
Almost certain	5	Event is expected to happen once every two years or more frequently	Annual chance ≥ 50%	Has occurred 3 or more times in the last 5 years
Likely	4	Event is expected to happen about once every 3-10 years	10% ≤ annual chance < 50%	Has occurred twice in the last 5 years
Possible	3	Event is expected to happen about once every 11-50 years	2% ≤ annual chance < 10%	Has occurred once in the last 5 years
Unlikely	2	Event is expected to happen about once every 51-100 years	1% ≤ annual chance < 2%	May occur and has occurred once in the last 10 years
Rare	1	Event is expected to happen less than once every 100 years	Annual chance <1%	May only occur in exceptional circumstances and has occurred in the last 20 years

Consequence Assessment

Consequences are the physical/environmental, social, economic, and political impacts or adverse effects that may occur as the result of a hazardous event (EMBC, 2019). Understanding the potential impacts of a hazard is a key step in assessing risks to a community. Any one hazard can have a variety of impacts and these impacts can differ in severity.

To support the measurement of consequences for a hazard event, EMBC has identified 11 consequence categories, divided into "Human and Social Impacts" and "Physical and Economic Impacts", and has provided defined impact rating scales for each category.

Human and Social Impacts:

- Fatalities
- Injury/Illness
- Displacement
- Psychosocial
- Support System Impact
- Cultural Resource Impact

Physical and Economic Impacts:

- Property Damage
- Critical Infrastructure
- Environmental
- Economic
- Reputational

The project team rated the severity of potential impacts for each hazard using the 5-point scale associated with each consequence category (see *Table 2* and *Table 3*). Current risk treatments and/or mitigation activities were considered when the project team rated the impacts of the various hazards.

The 11 consequence scores were summed to give a total consequence score out of 55 for each hazard.

Table 2 – Consequence Rating Scale (Human and Social Impacts)

Rating	Fatalities	Injury/Illness	Displacement	Psychosocial	Support System Impact	Cultural Resource Impact
1	Not likely to result in fatalities.	Not likely to result in injuries or illness.	Not likely to result in evacuation orders.	Event is unlikely to result in any short- or long term trauma.	Not likely to impact access to supports or networks. Community reciprocity, trust and cooperation are unaffected.	Little to no impact.
2 LOW	Loss of life that is manageable within the scope of normal operations.	Illness or injury that is manageable within the scope of normal operations.	Low percentage of the population evacuated, self-evacuated or sheltering in place. Supports are provided within the community.	Direct impacts to a few individuals. Psychosocial impacts can be primarily addressed by Psychological First Aid. Additional supports to those directly impacted and their families can be provided by local mental health professionals.	Hours-day-long disruption to daily life. Likely to result in some localized reduced access to supports/networks. Community reciprocity, trust, and cooperation are affected.	Recovery of the resource will take days to weeks.
3 MED	Loss of life that is beyond the scope of normal operations and may require overtime and/or additional resources.	Illness or injury that is beyond the scope of normal operations and may require additional capacity and/or resources, and/or the activation of response systems and emergency plans.	Enough of the population is evacuated, self-evacuated or sheltering in place to require external support.	Localized loss of property and/or fatalities or serious injuries. Those directly impacted are likely to experience both short- and long-term psychosocial impacts. Local and outside mental health professionals will be needed to provide support and treatment.	Days-long disruption to daily life. Likely to result in reduced access to supports or networks. Community reciprocity, trust, and cooperation are affected.	Recovery of the resource will take months.
4 HIGH	Loss of life severe enough for mass fatality procedures to be activated.	Extensive mass illness or injury requiring extra capacity and/or resources across multiple facilities in a health region and potentially specialized care from other health regions. Health authority response systems and emergency plans activated.	10-30 percent of the population evacuated or displaced.	Widespread loss of property and/or multiple fatalities or persons with serious injuries. Those directly impacted are likely to experience both short- and long-term psychosocial impacts. Local and outside mental health professionals will be needed to provide support and treatment.	Weeks or Months-long disruption to daily life. Significantly reduced access to supports or networks. Community reciprocity, trust, and cooperation are severely affected.	Recovery of the resource will take years.
5 EXTREME	Fatalities exceed capacity of existing plans and capabilities. Provincial, Federal and International resources may be required.	Extraordinary mass illness or injury. Provincial, Federal or international resources may be required. Multiple health region response systems are active.	High percentage of residents are displaced for years or permanently.	Widespread and long-term psychosocial impacts beyond those who are directly affected by property loss or fatalities. Extensive external supports required.	Months to years-long disruption to daily life. Supports or networks may be permanently changed.	Resource can never recover; destruction is permanent and irreversible (e.g., destruction of an irreplaceable artifact/knowledge).

Table 3 – Consequence Rating Scale (Physical and Economic Impacts)

Rating	Property Damage	Critical Infrastructure	Environmental	Economic	Reputational
1	Not likely to result in property damage.	Not likely to disrupt critical infrastructure services.	Not likely to result in environmental damage.	Not likely to disrupt business or financial activities.	Not likely to result in political or reputational impacts.
2 LOW	Minor, mostly non-structural damage.	Low percentage of the population impacted by few service disruptions. Disruptions last hours to days.	Localized and reversible damage. Hours to days-long clean up possible.	Days-long disruption to few businesses, financial activities, or livelihoods.	Limited or short-term political or reputational impacts.
3 MED	Localized severe damage.	Either a high percentage the population impacted by a few services OR a low percentage of the population impacted by a major or multiple service disruptions.	Full clean up possible but may take weeks.	Weeks-long losses to businesses, industry or livelihoods.	Some significant or long-term political or reputational impacts.
4 HIGH	Widespread structural damage.	High percentage of the population impacted by a major or multiple service disruptions.	Major but reversible damage. Full clean up difficult and could take months or years.	Months long losses to business, industry or livelihoods.	Significant and long term political or reputational impacts.
5 EXTREME	Widespread irreparable damage.	High percentage of the population is impacted by long-term outages.	Severe or irreversible damage. Full clean up not possible or could take decades.	Widespread or long-term loss of businesses, industry or livelihoods.	Significant and irreparable political or reputational impacts.

HRVA Findings

04 Community Profiles

GEOGRAPHIC SETTING

Situated on the central east coast of Vancouver Island, the Regional District of Nanaimo ("the region") covers a large, geographically diverse area of over 2,000 square kilometers. Bound by the Strait of Georgia to the east, the region is bordered by Comox Valley Regional District to the north, Alberni-Clayoquot Regional District to the west, and Cowichan Valley Regional District to the south (see *Figure 1*). There are four municipalities within the region – the Town of Qualicum Beach, City of Parksville, the District of Lantzville, and the City of Nanaimo, and seven unincorporated Electoral Areas. The Regional District of Nanaimo provides both regional governance and a variety of regional and local services to its constituent communities.

The electoral areas within the region are as follows:

- Electoral Area A: Cedar, South Wellington, Yellowpoint, Cassidy
- Electoral Area B: Gabriola, Decourcy, Mudge Islands
- Electoral Area C: Extension, Nanaimo Lakes, East Wellington, Pleasant Valley
- Electoral Area E: Nanoose Bay
- Electoral Area F: Coombs, Hilliers, Errington, Whiskey Creek, Meadowood
- Electoral Area G: French Creek, San Pareil, Little Qualicum
- Electoral Area H: Bowser, Qualicum Bay, Deep Bay

The Regional District of Nanaimo is situated within the traditional territory of several First Nations, including three that have communities and other lands under their jurisdiction: Snuneymuxw, Snaw-Naw-As (Nanoose), and Qualicum First Nation (Regional District of Nanaimo, 2013).

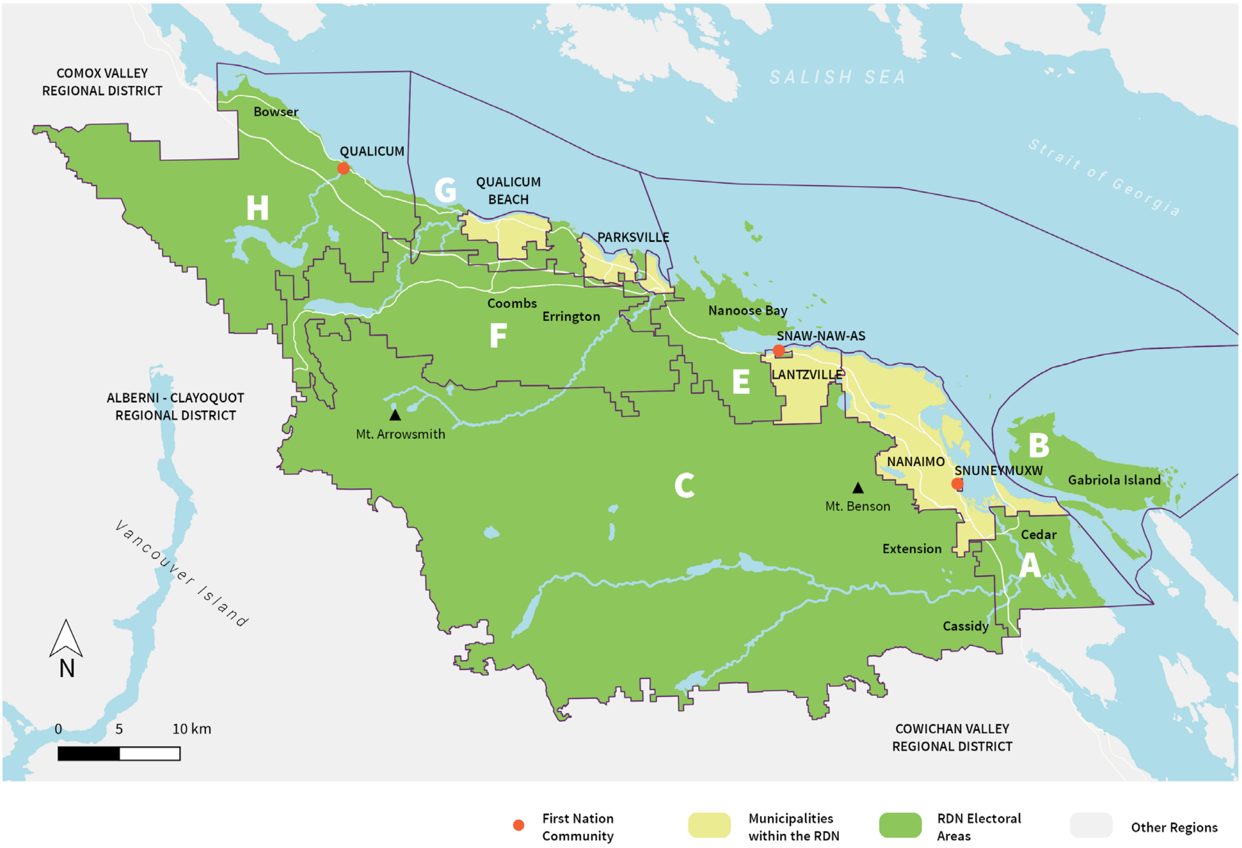


Figure 1 – Map of the Regional District of Nanaimo *Source: Regional District of Nanaimo, 2019*

Situated between the mountains and the ocean on the east side of Vancouver Island, the Regional District of Nanaimo encompasses a wide diversity of landscapes and ecosystems. The terrain ranges from steep forested headlands in the west (the highest point, Mount Arrowsmith ridge, is 1818 m above sea level) to gently undulating lowlands in the east where the region's watersheds discharge into the Georgia Strait.

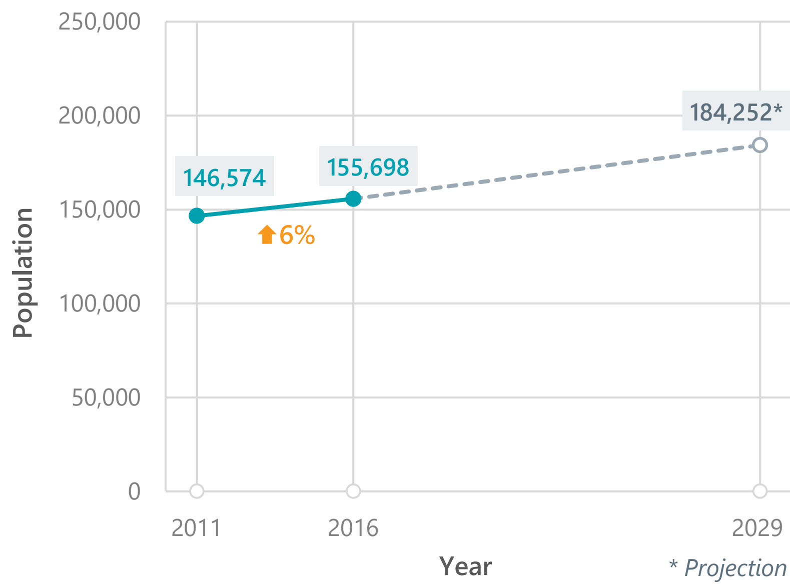
The region has a moderate coastal climate with warm dry summers (average daily high of 21°C) and mild, wet winters (average daily low of 10° C). As the region is located on the leeward side of Vancouver Island's mountain ranges, the rain shadow effect causes this region to experience a climate similar to the Mediterranean. There are two biogeoclimatic zones within the region: the Coastal Douglas Fir moist maritime zone (CDFmm), and the Coastal Western Hemlock very-dry maritime zone (CWHxm). The Coastal Douglas Fir biogeoclimatic zone dominates the portion adjacent to the coast and is the smallest and most at-risk zone in BC (CDFCP, 2018).

Most of the region's population lives and works within the lowland regions. Productive agricultural lands are found in the middle watersheds, and the majority of the upland regions are private forest land with active logging operations.

GENERAL DEMOGRAPHICS

With more than 160,000 people calling the Regional District of Nanaimo home, it is British Columbia's fifth most populous regional district (Statistics Canada, 2016). Between 2011 and 2016, the population of the region grew by 6% (see *Figure 2*). Current estimates suggest that the population will grow by another 12% over the next decade, from an estimated 164,546 residents in 2019 to 184,252 residents in 2029 (Stats BC, 2018).

Figure 2 – RDN population growth



Source: 2011 and 2016 data – Statistics Canada, 2016
2019 population estimate – Stats BC, 2018

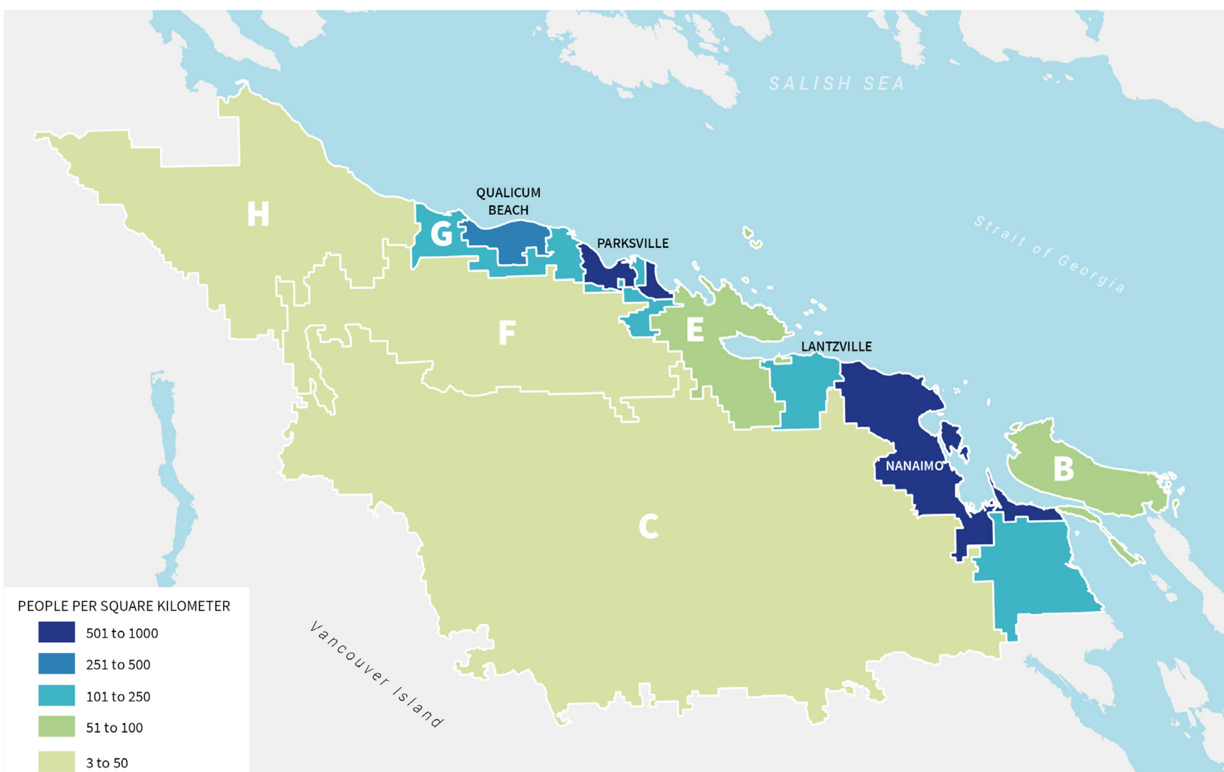


Figure 3 – Population density by municipality and electoral area

The density of settlements is highly varied across the region with a mixture of high-density urban areas, moderate density urban and suburban areas, and swathes of sparsely populated rural areas. The population density of the member municipalities and unincorporated rural electoral areas ranges from a high of 859.6 persons per km^2 in the City of Parksville to just 2.6 persons per km^2 in Electoral Area C (see *Figure 3* and *Table 4*) (Statistics Canada, 2016).

The First Nations reserves in the region all have a relatively small land base (see *Table 4*). The largest of the reserves is the Snuneymuxw "Nanaimo River" reserve, which is 2.24 km^2 (see *Table 4*). Although the on-reserve populations are small compared to those of the neighbouring municipalities and electoral areas, the population density of each reserve is relatively high. The Nanaimo Town 1 reserve has the highest population density in the region at 1,783.1 persons per km^2.

Table 4 – Population statistics for communities within the RDN

Community	Census 2016 Population	Land Area (km^2)	Population Density (people per km^2)
Parksville	12,514	14.56	859.6
Qualicum Beach	8,943	17.98	497.4
Electoral Area F	7,724	264.36	29.2
Electoral Area G	7,465	49.32	151.4
Electoral Area A	7,058	60.31	117
Electoral Area E	6,125	75.08	81.6
Electoral Area B	4,033	57.76	69.8
Electoral Area H	3,884	277.41	14
Lantzville	3,605	27.68	130.2
Electoral Area C	2,808	1,098.94	2.6
Nanaimo River*	371	2.24	165.7
Nanaimo Town 1†	360	0.2	1,783.1
Nanoose‡	230	0.71	326
Qualicum§	74	0.74	99.4

** Snuneymuxw First Nation Reserve Land*

† Snuneymuxw First Nation Reserve Land

‡ Snaw-Naw-As (Nanoose) First Nation Reserve Land

§ Qualicum First Nation Reserve Land

Source: Statistics Canada, 2016

AGE

There is a greater proportion of seniors (age ≥65 years) in the region compared to the province (see *Table 5*). Over a quarter (27%) of the population in the region is age 65 or over, compared to 18% of the population of British Columbia (Statistics Canada, 2016). The Town of Qualicum Beach and the City of Parksville have the greatest proportion of seniors at 52% and 42% of the population, respectively. In 2016, the median age in the region was 51.1 years, compared to a median age of 43.0 years in British Columbia. Approximately 13% of the population of the region is 14 years of age or younger.

The populations on the First Nations reserves skew much younger than the populations of the municipalities and electoral areas in the region (see *Table 5*). Approximately two-thirds of those living on the Qualicum, Snaw-Naw-As (Nanoose), and Snuneymuxw First Nations reserves are between the ages of 15-64 years, and close to a quarter are under the age of 15.

Table 5 – Age characteristics of communities within the RDN

Community	0 – 14 years		15 – 64 years		65 years+	
British Columbia	691,390	15%	3,107,680	67%	848,985	18%
RDN[2]	19,985	13%	93,625	60%	42,090	27%
Parksville	1155	9%	6055	48%	5305	42%
Lantzville	505	14%	2260	63%	840	23%
Qualicum Beach	555	6%	3730	42%	4660	52%
Electoral Area A	965	14%	4680	66%	1410	20%
Electoral Area B	300	7%	2220	55%	1510	37%
Electoral Area C	405	14%	1930	69%	475	17%
Electoral Area E	545	9%	3405	56%	2165	35%
Electoral Area F	1155	15%	5090	66%	1480	19%
Electoral Area G	745	10%	4000	54%	2715	36%
Electoral Area H	370	10%	2275	59%	1235	32%
Nanaimo Town 1	85	24%	235	65%	40	11%
Nanaimo River	85	23%	240	65%	45	12%
Nanoose	60	26%	150	65%	15	7%
Qualicum	15	20%	50	68%	10	14%
		BC		BC		BC

Source: Statistics Canada, 2016

[2] RDN aggregate statistics include the City of Nanaimo.

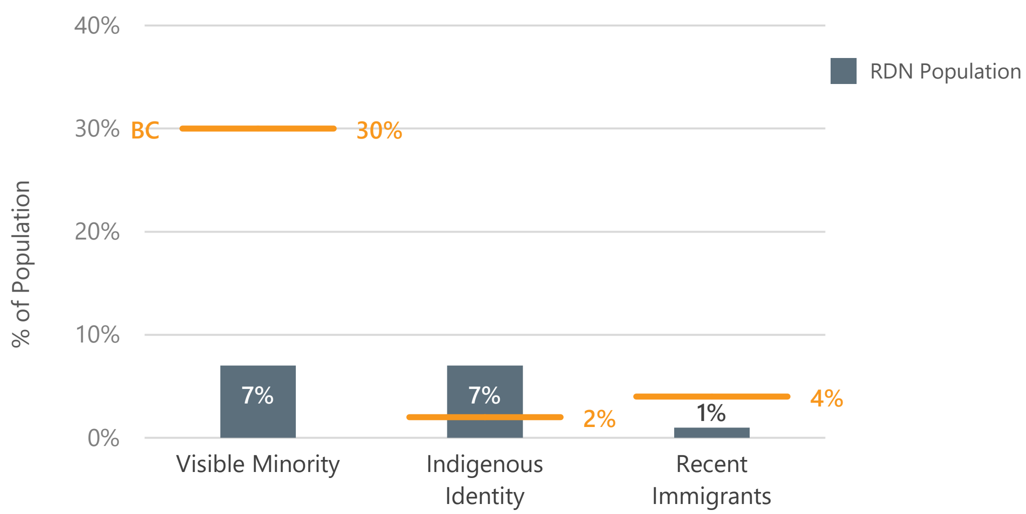
CULTURAL IDENTITY

Approximately 7% (10,855) of people within the region belong to a visible minority[3] (see *Figure 4*), which is significantly lower than the percentage of British Columbia's population belonging to a visible minority (30%). The percent of visible minorities in the municipalities and electoral areas ranges from 2% (Town of Qualicum Beach) to 7% (District of Lantzville). The visible minority population within the region consist mainly of the following groups: Chinese (2695 people, 1.8%), South Asian (2255 people, 1.5%), Filipino (1290 people, 0.9%), and Southeast Asian (985 people, 0.6%).

A further 7% (10,635 people) of the region's population identify as First Nation, Métis or Inuit, which is higher than the 2% of the population of British Columbia that identifies as Indigenous.

Of the regional district's population, only 1% are considered recent immigrants (arriving between 2011 and 2016), compared to 4% of British Columbia's population.

Figure 4 – Cultural identity statistics for the region *Source: Statistics Canada, 2016*



LANGUAGE

In 2016, 99% of the population in the regional district could conduct a conversation in English (Statistics Canada, 2016). Only 3% of the population of the region speak a language other than English or French (i.e. a "non-official language") most often at home. In British Columbia, 13% of the population speaks a non-official language most often at home.

[3] *Visible minority refers to whether a person belongs to a visible minority group as defined by the Employment Equity Act and, if so, the visible minority group to which the person belongs. The Employment Equity Act defines visible minorities as "persons, other than Aboriginal peoples, who are non-Caucasian in race or non-white in colour."* (Statistics Canada, 2016)

FAMILY AND HOUSEHOLD CHARACTERISTICS

There were 68,904 occupied private dwellings in the region in 2016 (Statistics Canada, 2016). Almost three-quarters of these households (71%, 48,720 people) have 2 or more persons. Of those aged 15 years or older, 60% (81,785 people) are either married or living in a common law relationship. This is comparable to the marital status of the population in British Columbia (58% of those 15 years or older are either married or living common law).

The proportion of couples with children varies across the region but is less than the provincial statistic (48%) in all municipalities and electoral areas (see *Table 6*). A greater proportion of couples on the First Nations reserves have children, ranging from 62% of couples in Nanaimo Town 1 to 83% of couples in Nanoose.

In 2016, there were 6,780 lone parent families in the region (representing 15% of families) (see *Table 6*). Of these families, 77% were female-led. Over a quarter of families on the First Nations reserves are lone parent families (46% in Qualicum Reserve).

Table 6 – Household characteristics of communities within the RDN

Community	Total number of *census families* in private households	Lone-parent families		Total – *Couple census families* in private households	Couples with children	
		n	%		n	%
British Columbia	1,311,345	197,940	15%	1,113,400	535,610	48%
RDN	46,660	6,780	15%	39,880	13,745	34%
Parksville	3835	515	13%	3325	845	25%
Lantzville	1145	120	10%	1020	435	43%
Qualicum Beach	3025	250	8%	2775	505	18%
Electoral Area A	2240	310	14%	1925	740	38%
Electoral Area B	1320	110	8%	1215	230	19%
Electoral Area C	875	80	9%	795	340	43%
Electoral Area E	2195	135	6%	2065	500	24%
Electoral Area F	2315	350	15%	1965	765	39%
Electoral Area G	2615	215	8%	2400	630	26%
Electoral Area H	1290	100	8%	1185	280	24%
Nanaimo Town 1	100	35	35%	65	40	62%
Nanaimo River	105	30	29%	70	50	71%
Nanoose	65	30	46%	30	25	83%
Qualicum	20	5	25%	15	10	67%
			BC			BC

Source: Statistics Canada, 2016

INCOME

The median total income of households in the regional district was $62,349 in 2015, which was slightly lower than the 2015 median total income of households in British Columbia ($69,999) (see *Table 7*) (Statistics Canada, 2016). The member municipalities and electoral areas with the lowest median total household incomes were: the City of Parksville ($55,771), Electoral Area F ($54,800), Electoral Area H ($54,323), and Electoral Area B ($47,795).The lowest 2015 median total household incomes were found in the First Nations Reserves: Nanaimo River ($46,720), Nanaimo Town 1 ($42,240), Qualicum ($38,016), and Nanoose ($23,328).

Approximately 16% of households in the region are classified as low income (based on the Low-income measure, after tax (LIM-AT)), which is in line with the 16% of households in British Columbia that are classified as low income (see *Table 7*). Approximately one-fifth of households in Electoral Area F (22%) and Electoral Area H (20%) are classified as low income. The largest proportion of low-income households were found in Electoral Area B (25%).[4]

Table 7 – Income of households in the region

Community	Median total income of households in 2015 ($)	Prevalence of low income based on the *Low-income measure, after tax* (LIM-AT) (%)
Electoral Area C	$84,173	11%
Lantzville	$82,871	8%
Electoral Area E	$79,680	11%
Electoral Area G	$72,158	11%
Electoral Area A	$71,680	14%
British Columbia	**$69,995**	**16%**
Qualicum Beach	$65,692	11%
RDN	$62,349	16%
Parksville	$55,771	14%
Electoral Area F	$54,800	22%
Electoral Area H	$54,323	20%
Electoral Area B	$47,795	25%
Nanaimo River	$46,720	n/a (see note below)
Nanaimo Town 1	$42,240	n/a
Qualicum	$38,016	n/a
Nanoose	$23,32	n/a

Source: Statistics Canada, 2016

[4] *"The low-income concepts are not applied in the territories and in certain areas based on census subdivision type (such as Indian reserves). The existence of substantial in-kind transfers (such as subsidized housing and First Nations band housing) and sizeable barter economies or consumption from own production (such as product from hunting, farming or fishing) could make the interpretation of low-income statistics more difficult in these situations."* (Statistics Canada, 2016)

ECONOMY

The region's labour force participation rate[5] (55.2%) is lower than the BC average (63.9%), but it varies greatly across the individual communities (see *Table 8*) (Statistics Canada, 2016). The Town of Qualicum Beach and City of Parksville have the lowest labour force participation rates in the region (35% and 43.4%, respectively), which is likely due to the large proportion of retired persons in these areas.

The unemployment rate for the region (7.7%) is slightly higher than the BC average of 6.7% (see *Table 8*). Of the member municipalities and electoral areas, the highest unemployment rates were found in Electoral Area H (11.3%), Electoral Area, B (9.6%), and Electoral Area F (8.5%). The highest unemployment rates in the region were observed in three of the First Nations reserves; Nanoose (23.8%), Nanaimo Town 1 (22.2%), and Nanaimo River (19.2%).

The service sector accounts for most of the economic base within the region with service industries employing 79% of the labour force (Statistics Canada, 2016). Goods-producing industries employ 19% of the labour force. This breakdown mirrors the provincial statistics; service industries employ 80% of the labour force in BC and goods-producing industries employ 19%.

The retail sector and health care sector are the largest employers in the region with each sector providing approximately 10,000 jobs or approximately 14% of all jobs (Statistics Canada, 2016). Construction is another important economic activity in the region, providing employment for approximately 10% of the region's labour force (approximately 7,000 jobs). The tourism industry accounts for 8% of all jobs in the region (approximately 6,000 jobs) and includes accommodation, food services, entertainment and recreation, plus a variety of economic activities that support the industry.

[5] The labour force is composed of those 15 years of age and older who are either employed or actively seeking work. The labour force participation rate represents the ratio between those in the labour force and the total population that is of working age. (Statistics Canada, 2016)

Table 8 – Labour force and unemployment statistics for communities within the region

Community	Labour force participation rate (%)	Unemployment rate (%)
Qualicum	73%	0%
Electoral Area C	66%	7%
British Columbia	64%	7%
Nanoose	64%	24%
Electoral Area A	62%	8%
Electoral Area F	60%	9%
Lantzville	59%	7%
RDN	**55%**	**8%**
Nanaimo Town 1	49%	22%
Electoral Area H	47%	11%
Electoral Area E	47%	7%
Electoral Area B	46%	10%
Electoral Area G	46%	8%
Nanaimo River	46%	19%
Parksville	43%	7%
Qualicum Beach	35%	6%

BC

Source: Statistics Canada, 2016

05 Vulnerability

INTRODUCTION

To fully understand how a hazard might impact a community, it is necessary to consider the degree of vulnerability to the hazard. While being situated in a hazardous zone is a key determinant of risk, a community's vulnerability defines the susceptibility of the people, property, industry, resources, and the environment to harm should a hazard event occur.

The UN Office for Disaster Risk Reduction defines vulnerability as:

The conditions determined by physical, social, economic and environmental factors or processes which increase the susceptibility of an individual, a community, assets or systems to the impacts of hazards. (UN Office for Disaster Risk Reduction, 2017)

The Government of British Columbia defines vulnerability as:

"people, property, infrastructure, industry and resources, or environments that are particularly exposed to adverse impact from a hazard event" (EMBC, 2004, p. 12)

To capture these various factors, vulnerabilities have been grouped into four sections within this report: Social Vulnerabilities (e.g., age, language, income levels); Economic Vulnerabilities (e.g. economic dependencies on industries and resources); Environmental Vulnerabilities (e.g. dependencies on sensitive natural areas); and Physical Vulnerabilities (e.g. critical infrastructure, locally owned assets). Considering how these factors increase a community's susceptibility to the impact of hazards will ultimately permit the prioritization of risks based on where communities are most vulnerable.

SOCIAL VULNERABILITY

The occurrence of similar hazard events in different communities will likely reveal significant variations in consequences due to differing levels of social vulnerability. Social vulnerability refers to the (limited) ability of a population to withstand and recover from the adverse impacts of a hazard event. Heightened levels of social vulnerability typically stem from a combination of economic, social, and political processes which give rise to social and economic inequalities (Perdikaris, 2014; IPCC, 2014). In this sense, social vulnerability can be thought of as "a condition which is constantly being altered, reinforced, or diminished" (Prowse, 2003).

Inequitable distribution of social, cultural and economic resources results in social groups that are more susceptible to the impacts of hazards and in greater need of coping assistance. As part of one of the HRVA engagement workshops, participants were asked to consider local resource limitations which have the potential to contribute to vulnerability within the community. The workshop participants identified several resource limitations encountered by seniors, homeless persons, and people of low social-economic status in the region (see *Table 9*).

Many of the physical, social, and structural barriers to accessing services and supports encountered by the elderly, homeless, and low-income individuals, as identified by the workshop participants, are similar in nature. Limited income, inadequate housing or living conditions, and dependency on support services reduce the adaptive capacity and resilience of these populations.

Through the review of data collected from the engagement workshops and available census information (see *Community Profiles*), the following vulnerable populations within the region were identified.

Seniors

The region has a relatively high percentage of elderly residents (27% of the population is age 65 or over) and the population is aging. As the baby boomer generation grows older, the number of seniors in the region will increase which is expected to have significant implications for housing, support services, and employment (Regional District of Nanaimo, n.d.-a).

Seniors are particularly vulnerable to the health impacts associated with natural hazards. Extreme heat events, for example, can lead to serious illness and even death in older adults (Health Canada, 2011). The physiological characteristics of seniors can reduce their ability to adapt to heat events (e.g. older adults may be prone to dehydration and overheating due to a reduced thirst sensation, fitness level, and sweating ability). These health impacts can be compounded by their social isolation; visual, cognitive, and hearing impairments; and agility and mobility limitations giving rise to increased levels of vulnerability (Health Canada, 2011).

Older adults are also more vulnerable to service disruptions which may follow hazard events such as wind storms and power outages. With an increased reliance on caregivers, medications, and healthcare services, any interruption to these services can disproportionately impact senior populations.

Table 9 – Resource limitations of local community groups

(Input gathered from engagement session participants)

Resource	Seniors (≥65 years of age)	Homeless	Low SES (Socio-Economic Status)
Housing	• Limited independent living facilities and other types of suitable housing. • Limited home care services available.	• Limited access to warm shelters with sanitation facilities. • No ability to stockpile food, water, fuel etc. for use in an emergency.	• Lack of affordable housing. May be housed in unsuitable/unstable accommodation that is vulnerable to hazards.
Income	• May not have savings. • May be on a fixed/low income and reliant on pension cheques or other form of income assistance that could be interrupted.	• Limited access to savings/ credit. • May be on a fixed/low income and reliant on income assistance that could be interrupted.	• Limited access to savings/credit. • May be on a fixed/low income and reliant on income assistance that could be interrupted. • Limited ability to stockpile food, water, fuel etc. for use in an emergency.
Employment	• May encounter barriers to employment due to age discrimination.	• May encounter barriers to employment due discrimination and/or to lack of a permanent address.	• May work in service sector jobs that are susceptible to interruption during emergencies.
Social Supports	• Many seniors live on their own. • May not have anyone to check on them or may become cut-off from supports.	• Limited mental health care, social workers, and drug addiction programs.	

Resource	Seniors (≥65 years of age)	Homeless	Low SES (Socio-Economic Status)
Transportation	• May no longer drive and so rely on public transportation which is limited in terms of routes and scheduling. • Use of mobility devices may limit transportation options.	• May not have a vehicle and so rely on public transportation which is limited in terms of routes and scheduling.	• May not have a vehicle and so rely on public transportation which is limited in terms of routes and scheduling.
Technology	• Lack of IT skills may limit access to current information.	• Lack of computer/phone/ internet may limit access to current information.	• Lack of computer/phone/ internet may limit access to current information.
Other	• Health/physical barriers may prevent the moving and stockpiling of resources for an emergency, e.g. water, wood, fuel, food. • Hearing/sight/physical impairments and health issues may increase dependence on medical resources/services.	• May be experiencing mental health or addiction issues. • Limited access to resources may be due to social stigma.	• Limited access to resources may be due to social stigma.

Children/Youth

The region as a whole does not have a high percentage of children and youth (just 13% of the population is 14 years of age or younger), but close to a quarter of those living on the Qualicum, Snaw-Naw-As (Nanoose), and Snuneymuxw First Nations reserves are under the age of 15. Children are particularly vulnerable when separated from their parents or guardians as they are dependent on their caregivers for access to resources, decision-making, mobility, and emotional support (Sharma, 2016). Young children are also more psychologically and physically vulnerable to the impacts from hazards.

Single-Parent Households

The structure of households has been identified as an important factor in social vulnerability (RAND, 2011). There are approximately 7,000 single parent families in the region, three-quarters of which are female-led households. Single parents are over-represented in precarious jobs and may have limited working hours in order to balance childcare responsibilities (Mitchell & Murray, 2017). As a result, these households may have lower income, lower entitlement to health benefits, and reduced social contacts. Households led by single mothers may be particularly vulnerable due to their limited access to resources that arises from issues of power and privilege, and lower wages (Donner & Rodríguez, 2011).

Low Income Households

Approximately one-fifth of households in the region are low income and the median household income on the local First Nations Reserves was found to be far lower than the provincial statistic (see *Community Profiles – Income*). Low income populations are generally more vulnerable to hazard impacts due to both the location and quality of their housing, limited mobility, and lack of insurance and savings (City of Vancouver, 2012). Limited financial resources can reduce the ability of a household to both prepare for, endure, and recover from hazard events.

Indigenous Peoples

Approximately 7% (10,635) of the region's population identify as Aboriginal (of which approximately 60% identify as First Nations, 39% identify as Métis, and <1% identify as Inuk). There is a long history of oppression and marginalization of Indigenous peoples in Canada, which has heightened the vulnerability of these populations. The impacts of colonial policies, residential schooling, inter-generational trauma, and continued racism and social exclusion have led to a greater number of health and socioeconomic inequities (Reading & Wien, 2009). Lower income, inadequate housing and living conditions, and limited access to culturally appropriate support services are just some of the factors that have reduced the adaptive capacity and resiliency of Indigenous populations to hazard events. Displacement and evacuations following a hazard event can exacerbate existing resource inequalities and can also be extremely traumatic for those who were affected by residential schools (Indigenous Corporate Training Inc., 2018).

Homeless

In recent years there has been a significant growth in the region's homeless population. The 2018 Point-in-Time (PIT) homeless count coordinated by the province documented 42 individuals experiencing homelessness between Nanoose Bay and Bowser (BC Housing, Homelessness Services Association of BC, Urban Matters, and BC Non-Profit Housing Association, 2018). This count likely vastly underestimates the numbers of unsheltered homeless individuals, according to the Coalition of the Homeless, as PIT data on unsheltered homeless does not include homeless people sleeping in non-visible locations (i.e. the "hidden homeless") (Weesjes, 2015). Furthermore, it is estimated that "for every person who's homeless in Canada, there are an additional 23 households that are vulnerably housed and at high risk of becoming homeless" (Hwang, 2018).

The lack of access to adequate, secure housing increases an individual's ability to endure and recover from a hazard event. Homeless individuals are particularly vulnerable to the impacts of weather-related hazards due to their increased exposure and limited access to climate-controlled (e.g. air conditioned and heated) spaces.

There is a "clustering of vulnerability factors" in homeless populations, which can in turn result in a greater susceptibility to the adverse impacts of hazards (Settembrino, 2015). Those experiencing homelessness may be facing a number of barriers that limit access to housing including high rents, low income, substance-use disorders, disabilities, mental health issues, trauma, and discrimination. With limited access to resources and increased prevalence of health conditions, many homeless individuals are reliant on social and healthcare services that may be disrupted during a hazard event (Gin, 2018). Homeless individuals may be less likely to evacuate or follow suggested safety precautions during a hazard event due to a lack of information and distrust of messengers (Gin, 2018). Those with negative past experiences of institutional settings (e.g. hospitals, psychiatric facilities, jails, residential schools etc.) may be unwilling to enter into emergency shelters or access resources provided by authorities during disaster response and recovery.

Tourists and Travelers

Vancouver Island is a popular tourist destination receiving 4,430,000 overnight visitors (representing 23% of provincial overnight visitation) in 2014 and $1.77 billion in associated spending (Destination BC, 2017). The region itself has a number of popular tourist destinations and is also home to several major transportation hubs connecting the Regional District of Nanaimo, Vancouver Island, and the BC Mainland. With a large number of tourists visiting the local destinations in the summer months, and the addition of those using the region as a thoroughfare to reach other destinations, there may be a significant non-resident population at any one time that is potentially vulnerable to hazard events. Non-residents may be unaware of the risks to the region and be unfamiliar with where they should go for information or to seek safety in the event of an emergency. Language barriers, scarce social supports, and limited access to financial resources (including local currency) can all heighten the vulnerability of tourists to hazard events.

ECONOMIC VULNERABILITY

Economic resiliency drives a community's recovery post-disaster (FEMA, 2013). Therefore, economic vulnerability is a key determinant of a community's ability to withstand and rebound from a hazard event. Single industry communities may be more susceptible to harm than those with diverse economic sectors (Bergstrand, Mayer, & Zhang, 2015). If a community is highly dependent on one major industry or employer, the community may have difficulty in recovering from damages to economic assets (i.e. property damage) and economic flows (i.e. damages to the production of goods and services).

The destruction or damage of business facilities, interruptions to public utilities and transportation networks, and the loss of suppliers following a hazard event can lead to business closures. These business closures can, in turn, lead to job losses, an increase in foreclosed homes, and a decrease in population. There may also be an accompanying decrease in tax revenue and local operating budgets, which can further impact the ability of the local economy to recover from the hazard event.

The region has a fairly diverse economic base with four main economic sectors: 1) retail trade, 2) health care and social assistance, 3) construction, 4) accommodation and food services (see *Community Profiles – Economy*). Although the agriculture, forestry, fishing and hunting industry category accounts for only 3% of jobs within the region, these activities are important contributors to the local economy and provide a multitude of related opportunities in the region.

ENVIRONMENTAL VULNERABILITY

The region contains a diversity of valuable, sensitive aquatic and terrestrial ecosystems including, but not limited to: older forests and second-growth forests, riparian thickets, rivers and riverine flats, estuarine vegetation, and a variety of shoreline ecosystems. The value of these ecosystems stems from their ecological, cultural, and social significance. These ecosystems provide essential habitat for many plant and animal species within the region including eagles, osprey, and herons and several red- and blue- listed[6] species and ecological communities.

[6] In BC, each species and ecosystem are assigned to the red, blue or yellow list based on the level of concern to their risk of being lost. Red indicates "any species or ecosystem that is at risk of being lost (extirpated, endangered or threatened)"; blue indicates "any species or ecosystem that is of special concern"; and yellow is assigned to those "species or ecosystems at the least risk of being lost" (Government of British Columbia, n.d.-h, para. 4).

Natural ecosystems also provide a variety of services that contribute to human well-being. These services include "*provisioning services* such as food, water, timber, and fiber; *regulating services* that affect climate, floods, disease, wastes, and water quality; and *cultural services* that provide recreational, aesthetic, and spiritual benefits" (Millenium Ecosystem Assessment, 2005).

There are many sensitive ecosystems and natural features that are critical to the long-term health of the region. For example, some groundwater aquifers in the region are highly vulnerable to contamination from surface activities such as the improper use/disposal of hazardous materials. With many residents using groundwater as their main source of drinking water, these populations are vulnerable to disruptions to watershed services that affect the quality and quantity of water. Hazard events that may disrupt the groundwater supply include, but are not limited to hazardous material release, drought, and saltwater intrusion.

While many natural areas are highly susceptible to human activities and the impacts of hazard events, the natural environment can also provide a protective buffering service that reduces the magnitude or impacts of hazard events. For example, wetland and riparian areas reduce flooding through the absorption of flood waters, provide erosion and sedimentation control, and recharge groundwater. Environmental degradation diminishes the buffering capacity of these ecosystems against hazard events, which can, in turn, lead to diminished resiliency and greater hazard impacts.

The natural resources in the region are important to community identity as they have long provided economic opportunities in agriculture, forestry, and fishing while also offering aesthetic value and outdoor recreational opportunities for residents and tourists alike. Many natural areas in the region are also valuable in terms of their historical and cultural significance. For instance, Cathedral Grove is a stand of cherished old-growth forest located in Electoral Area F. This ancient forest is valued for its biodiversity and habitat provision, traditional medicines, and cultural significance. The December 2018 windstorm (see *Wind Event*) brought highly destructive winds that resulted in significant losses to the park. The degradation or destruction of the natural areas, such as Cathedral Grove, have the potential to increase the social and economic vulnerability of people that depend on these resources.

PHYSICAL VULNERABILITY

Physical vulnerability is a measure of how damage to the built environment impacts a community's ability to withstand and recover from a hazard event. The built environment encompasses the buildings, facilities, and infrastructure, e.g. transportation, electricity, telecommunication, water supply etc., that provide the flow of services critical for economic vitality and social well-being.

Public Safety Canada defines critical infrastructure (CI) as: "services essential to the health, safety, security or economic well-being of Canadians and the effective functioning of government" (2019b, para. 1). The following ten sectors are considered critical infrastructure in Canada:

- Health;
- Food;
- Finance;
- Water;
- Information and Communication Technology;
- Safety;
- Energy and Utilities;
- Manufacturing;
- Government; and
- Transportation.

The network of infrastructure in a community can be highly complex, with various interdependencies, meaning that impacts to one sector may have cascading effects across other sectors. Forecasting the failure of these complex networks is challenging as weaknesses in the system and feedback loops may be unknown until the system fails. Also, the responsibility for various critical assets and infrastructure is divided between different levels of government and public and private agencies, further adding to the difficulty of preparing for and mitigating against critical infrastructure disruption and damage.

Despite the challenges of planning for disruptions to critical infrastructure, proactive measures are required as disruptions could result in "catastrophic loss of life, adverse economic effects and significant harm to public confidence" (Public Safety Canada, 2019b, para. 1). The continued functioning of critical infrastructure during and after a hazard event is considered to be a key determinant of the severity of consequences and speed of recovery (FEMA, 2013).

Interruptions to Critical Infrastructure as Hazard Events

While disruptions in critical infrastructure are often an impact of a natural hazard, failures in critical infrastructure can also be thought of as hazard events in their own right and are not necessarily preceded by a natural hazard event. An electrical power outage, for example, could follow a wind storm or an act of vandalism, but it could also occur due to a failure in equipment and result in hazardous conditions (see *Top Hazards – Electrical Power Outage*).

To help assess the risks posed to the region by critical infrastructure disruption, 10 separate hazard events that specifically address critical infrastructure were included in the hazard assessment (see *Table 10* and *Appendix 2 – Hazard Definitions: Infrastructure Failure* and *Appendix 2 – Hazard Definitions: Transportation Incident Hazards*).

Table 10 – Hazards related to critical infrastructure failure

Critical Infrastructure Category	Hazard
Health	• Health Interruption
Food	• Food Supply Chain Interruption
Water	• Potable Water Supply Interruption • Waste Water Interruption
Information & Communications Technology	• Communications Interruption
Energy & Utilities	• Electrical Power Outage
Transportation	• Aircraft Incident • Marine Vessel Incident • Motor Vehicle Incident • Rail Incident

Two of these infrastructure related hazards, Electrical Power Outage and Motor Vehicle Incident, appear in the list of "Top Hazards" for the region. The full assessment results for these hazard events can be found in the All Scores Table (see *Appendix 3*).

Measuring Hazard-Specific Impacts to Critical Infrastructure

The impacts to critical infrastructure from hazard events were also considered during the hazard assessment through the use of the Consequence Rating Scale (see *Table 3*). "Critical Infrastructure" is one of the five consequence categories under "Physical and Economic Impacts" and the associated scale considers the level of disruption to critical infrastructure services and the proportion of the population affected. The "Critical Infrastructure" consequence score assigned to each hazard can be found in the All Scores Table (see *Appendix 3*).

Identification of Locally Owned Critical Assets and Infrastructure

With the region spanning over 2,000 square kilometers and serving over 160,000 residents, there is a relatively extensive network of critical infrastructure. There are a multitude of critical infrastructure owners and operators in the region, including federal, provincial, regional, and local governments, as well as public and private agencies. These CI owners and operators have responsibilities, some of which are regulatory requirements, to plan and prepare for emergencies to ensure adequate response procedures and business continuity practices are in place.

The project team worked together to identify *locally owned infrastructure* components that are fundamental to the viability and sustainability of the region. Understanding what local critical infrastructure (CI) and assets might be exposed to hazards is key to understanding how a hazard might impact the community.

Critical infrastructure owned or controlled by outside agencies was "out of scope" for the purposes of this assessment. While efforts were made to connect with external critical infrastructure owners/operators, there was minimal participation from these bodies, limiting the availability of information to inform the understanding and assessment of external critical infrastructure in the region, and external dependencies of the local government owned infrastructure.

With a focus on critical assets owned by the Electoral Areas, the Regional District of Nanaimo, Town of Qualicum Beach, City of Parksville, and District of Lantzville, the project team used the *EMBC Critical Infrastructure Assessment Tool* to explore the internal dependencies of these assets. This assessment tool was developed by Emergency Management British Columbia, in partnership with Defence Research and Development Canada and the Justice Institute of BC. The tool has been designed to assist local authorities in identifying services critical to residents in an emergency, the assets needed to provide those services, and the dependencies between those assets and goods and services (Government of British Columbia, 2016b).

Key terms from the Critical Infrastructure Assessment Tool:

Asset: *an item or resource that is under control of the local government. This includes tangible things like equipment, vehicles and trained staff. It can also include intangible things like radio networks and software.*

Goods & Services: *these are goods or resources and services provided to the community by the local government. This includes goods like drinking water and services like policing.*

Dependency: *this is the term used when goods and services cannot be delivered without a specific asset. For example, providing fire and rescue service as a service is dependent on fire engines and equipment, which are assets.*

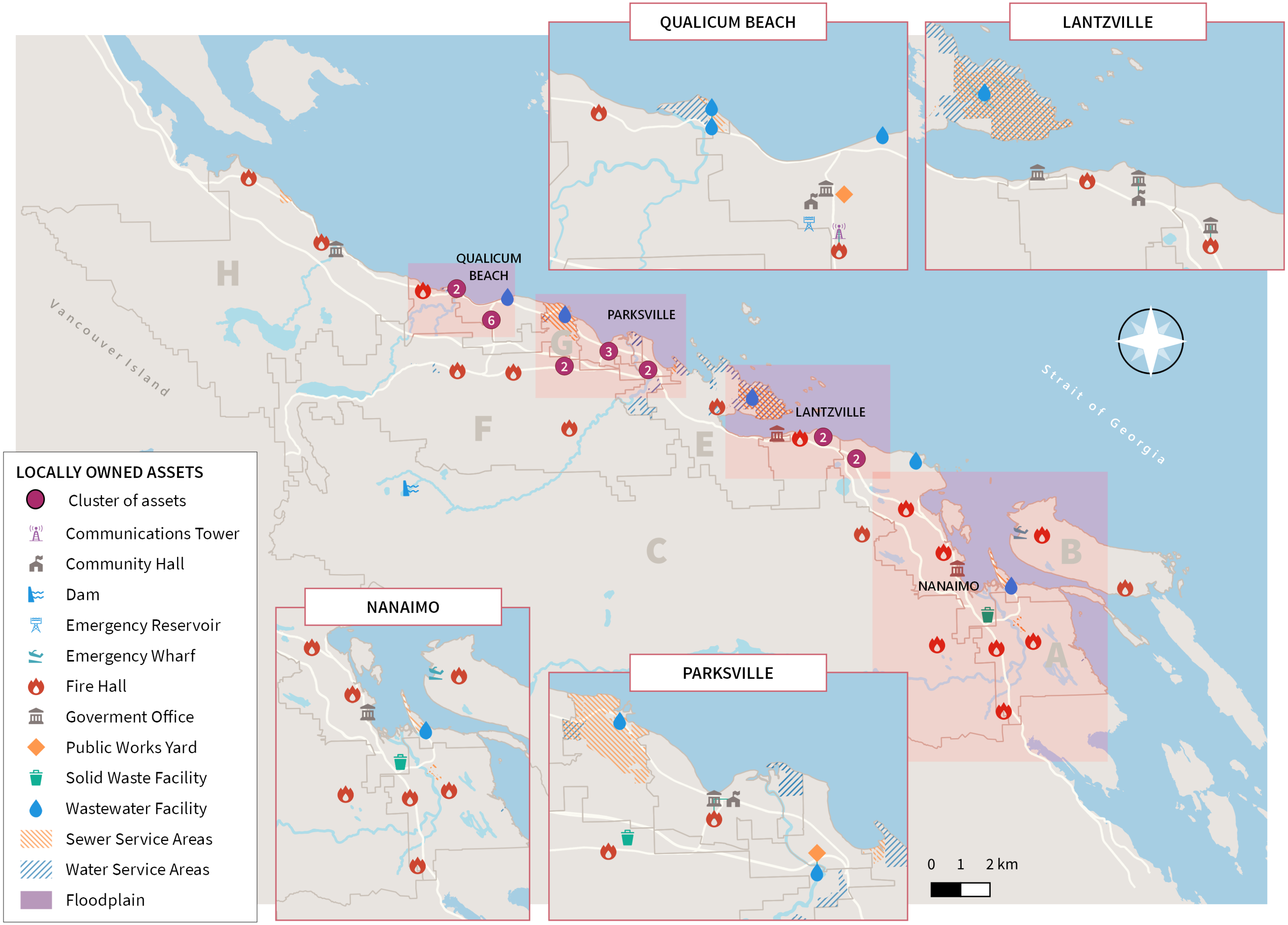
The assessment tool encourages the classification of relationships between services and assets as either "Critical" or "Important". Goods or services that must have a specific asset to which there are no alternatives are classified as "Critical", and goods or services that need a specific asset for which there are alternatives are classed as "Important". In reviewing the relationships between services and local assets, a far greater number of "Important" dependencies were identified than "Critical" dependencies. This finding suggests that local governments have an element of redundancy, and thus resiliency, built into their critical infrastructure.

The following locally owned assets were deemed critical as a result of the *EMBC Critical Infrastructure Assessment Tool*:

- Fire halls and their assets
- Local government and First Nation Band offices
- Communication technology and infrastructure, including SCADA
- Waste water and solid waste assets
- Drinking water assets

A map of the identified locally owned assets is provided on the following page (see *Figure 5*). The full list of the region's local government owned/operated critical assets can be found in *Appendix 4*.

Figure 5 – Map of locally owned critical assets and infrastructure



Community Perceptions of Physical Vulnerabilities

As part of one of the engagement session activities, participants were asked to provide details of the physical conditions that they perceive to have the potential to contribute to vulnerability within the region. Thematic analysis of inputs received revealed that participants detailed physical conditions of concern for five of the ten infrastructure sectors: Transportation, Water, Information & Communication Technology, Energy & Utilities, and Healthcare. The summarized and paraphrased results of this activity are presented below:

Transportation Sector

Highway 19

A strong majority of workshop participants expressed concern about the limited transportation connectivity in the region. Highway 19 was identified as a critical piece of infrastructure, with one participant describing it as the "spine that connects the region". Many workshop participants expressed concern that stretches of Highway 19 are impassable in the event of a disruption or damage due to a lack of alternative routes. The "Nanoose Flats" section of highway (located in Electoral Area E) was identified as a source of particular concern as the section sees high volumes of traffic and has no detour routes. The ability to evacuate and/or access help could be limited should a hazard event impact the highway.

Public Transportation

The limited availability of public transportation in rural areas of the region was highlighted by some participants. With limited bus schedules, and further reduced schedules in the event of inclement weather, some residents may have restricted ability to access resources, e.g. health care centres, food stores etc.

Ferry Infrastructure

As the region is located on an island, there is a dependency on the transportation of resources to the island by ferry. With two ferry terminals in the region (Duke Point and Departure Bay) there is some redundancy, but some participants highlighted the vulnerability of this transportation connection to extreme weather events. The dependency of the region's small island residents (e.g. those on Gabriola Island) on ferry transport was also noted.

Single Access Route Communities

Several workshop participants noted that there are many rural residences and subdivisions in the region that have only one entry/exit route. If the connecting road is damaged or blocked in a hazard event these residents may have difficulty evacuating their property and first responders may have difficulty accessing and assisting residents.

Energy & Utilities

Power Lines

A majority of workshop participants commented on the susceptibility of the power grid to outages due to downed trees. The proximity of trees to overhead power lines was identified as a physical condition contributing to the community's vulnerability.

Water Sector

Arrowsmith Dam

The Arrowsmith Dam, which is located approximately 35 km south of the City of Parksville and provides Parksville and Nanoose Peninsula with water, was identified as a critical source of water. The failure of the dam was also noted as a possible hazard event.

Water Treatment Plants

A few workshop participants expressed concern about the ability of the existing water treatment plants to provide sufficient drinking water in a hazard event.

Healthcare

Hospital

The capacity of the local healthcare facilities was identified as a vulnerability by several workshop participants. A number of comments were captured regarding the possible insufficiency of the smaller health care centres and limited access to the region's sole hospital (Nanaimo Regional Hospital) in a hazard event.

Information & Communication Technology

Cell Towers

The heavy reliance on cell towers and potential for outages was noted by a number of workshop participants.

06 Climate Change

Climate change is not an abstract future concern, but rather a current, evolving reality experienced in Canada today. Driven largely by the emissions of greenhouse gases from human activities, Canada's climate has been increasing in temperature and will continue to increase in the coming years. According to a recent report, Canada's climate is warming at a rate nearly twice the global average (Environment and Climate Change Canada, 2019a). Projections suggest that by the years 2081 to 2100, Canada's climate will increase by 1.8°C if emissions are reduced, or up to 6.3°C if emissions remain high (Environment and Climate Change Canada, 2019a).

Within British Columbia, climate change has already resulted in increased average temperatures, rising sea levels, as well as increased rates of severe weather events (BC Ministry of Environment and Climate Change Strategy, 2019). Canada's oceans have also been changing due to increased temperatures contributing to waters that are less oxygenated and increased carbon dioxides in the atmosphere driving acidification of ocean surface waters (Environment and Climate Change Canada, 2019a).

The recently released *Preliminary Strategic Climate Risk Assessment for British Columbia* states that, by the year 2050, the greatest risks to all of British Columbia as a result of climate change will be severe wildfire seasons and seasonal water shortages (BC Ministry of Environment and Climate Change Strategy, 2019).

Climate change is likely to affect the majority of hazards faced in the region. According to the BC Ministry of Environment and Climate Change, "the likelihood of most risk events increases over time based on projections of future climate change" (BC Ministry of Environment and Climate Change Strategy, 2019, p. 1). A large majority of HRVA engagement session participants agreed that climate change would have an impact on the occurrence or severity of most natural hazards. Additionally, those hazards which may result from natural hazards such as a power outages or motor vehicle incidents resulting from severe weather, were also considered likely to increase.

Notable hazards which are projected to increase in frequency and/or severity are outlined below. Additional discussion surrounding the current and anticipated impacts of climate change is included for the Top Hazards identified in the region in *Section 08*.

Wildfire

Climate change is a significant contributing factor to the recent trend of longer and more extreme fire seasons. As several areas in the region are classified as extreme or high interface fire hazard ratings, the overall risk of wildfires to the region is projected to increase. Severe wildfires can cause negative health impacts, which can be particularly hazardous for those with pre-existing health conditions; population displacement, which can have lasting impacts on the psychological wellness and result in economic losses for individuals and families; and cause serious disruptions or damage to infrastructure systems such as transportation, telecommunications, electricity supply, water treatment and sewage systems (BC Ministry of Environment and Climate Change Strategy, 2019).

Flooding

Overland Flooding

Overland flooding (also known as "pluvial flooding") is usually associated with high intensity rainfall events but can also occur with lower intensity rainfall or melting snow where the ground is saturated, frozen, developed or otherwise has low permeability, resulting in overland flow and flooding (Maksimovic, 2015). As communities continue to develop and grow, and further effects of climate change appear, the likelihood and severity of overland flooding will increase through the combination of increased rainfall, increased impermable surfaces, and drainage systems reaching capacity ultimately restricting rainwater from either being absorbed into the ground or draining properly (Szewrański, et al., 2018).

Rivers, Lakes and Streams Flooding

With global temperatures rising due to climate change, rainfall and storm events are anticipated to increase in severity and frequency, which will have a cascading effect to river and streamflow regimes that may elevate the potential for fluvial floods over time (Ashmore & Church, 2001).

Coastal Flooding

Climate change is a probable contributor to the occurrence of coastal flooding. Temperature increase affects sea level rise and causes "thermal expansion of the oceans and melting of glaciers, ice caps, and ice sheets" (Shaw, Taylor, Solomon, Christian, & Forbes, 1998, p. 365). It is projected the waters along Vancouver Island's east coast will rise by a minimum of 0.8m by the year 2100 (Regional District of Nanaimo, 2019b), and that coastal regions will not only be affected by rising sea levels, but also storm surges, wave conditions, and river flow (Ranasinghe & Jongejan, 2018). As these levels continue to increase, coastal communities that are extremely low-lying may be at risk of consistent flooding (Regional District of Nanaimo, 2017a). Furthermore, the frequency of king tides is predicted to increase in the coming years due to the effects of climate change (Hernandez, 2018). While king tide events on their own can result in water levels that are upwards of five metres, if they occur in combination with a storm surge, these levels can be even greater with the severity of impacts escalating as well (Little, 2018).

Flood Consequences

The impacts of major floods can be devasting and range from property damage and population displacement, to impacts to the environment and cultural resources (Regional District of Nanaimo, 2019b). Flood, as a single hazard, is considered the costliest hazard event for Canadians with respect to property damage (Public Safety Canada, 2015c), and can have lasting psychosocial and support system impacts.

Wind Event

The frequency and intensity of wind events is expected to increase as the climate warms. In fact, a recent report from BC Hydro (2018) states that there has already been a noted increase in both the recurrence and severity of storms and extreme weather events. These stronger, more frequent wind events will likely cause considerable damage to infrastructure, properties, power lines, and trees resulting in increased social and economic costs to the region.

Drought

A warming climate and changes in precipitation are projected to increase the likelihood, and therefore the risk, of drought in the future (BC Ministry of Environment and Climate Change Strategy, 2019). The potential effects of climate change on drought were discussed during the HRVA engagement process. Participants anticipate that a decrease in snowpack will lead to less water supply for rivers and streams in the region and will likely contribute to drought conditions in the future (Engagement Process, 2018-2019). In addition, engagement participants shared details of long-term cascading effects of drought such as the risk of trees drying out, ultimately becoming more vulnerable to strong winds in the fall and winter months, and the risk of being uprooted and falling. These conditions during a severe windstorm could pose a serious risk to safety and cause power outages in the region.

Salt Water Intrusion

Contributing factors to saltwater intrusion include sea level rise, which can affect the hydraulic gradient and cause saltwater to move towards the aquifer; storm surge, which can lead to saltwater intrusion due to surface flooding; as well as coastal erosion, which reduces landmass and moves the saltwater/freshwater interface closer to land, thus allowing saltwater to enter the freshwater aquifer. All three of these factors (sea level rise, storm surge and coastal erosion) have been identified as hazards that will be affected by climate change.

As the need for drinking water increases as a result of population growth or climatological factors such as increased heat events or drought, an increased stress is placed on groundwater supply, which leads to a greater risk of saltwater intrusion (Government of British Columbia, 2016b; Prince Edward Island Department of Environment, Labour and Justice, 2011).

Saltwater intrusion has already started occurring in several of the communities located in the region. A study conducted in 1978 found evidence of saltwater intrusion in aquifers in the areas of Silva Bay, Degnen Bay, east of Lock Bay, and Pilot-Taylor Bay (Hodge, 1978). Gabriola Island has been identified as having high well density ratings, limited lakes and rivers on the island, and receives little to no snow in winter. As a result, in the summer months when precipitation declines and demand for water increases, saltwater intrusion occurs in deeper wells. The effects of saltwater intrusion have also been observed in other areas of the region such as the Dashwood area located in Watershed #1, and along the foreshore of both Watershed #6 and #7 (Regional District of Nanaimo, 2011b).

In addition to the drinking water impact, saltwater intrusion can have negative consequences on soil fertility and the health of plants, affecting local industry and agricultural resources. The presence of salt in soil can significantly affect crop growth and therefore directly impact agriculture industry if the saltwater intrusion into the aquifer continues (Delta Optimist, 2015).

Heat Event

According to Environment and Climate Change Canada, it is virtually certain that Canada's climate has warmed and that it will warm further in the future (Bush & Lemmen, 2019). Within BC, heat events or days with temperatures of 32°C or higher are anticipated to be more prevalent in the years to come, with heat waves predicted to occur roughly every 3 to 10 years (BC Ministry of Environment and Climate Change Strategy, 2019).

As heat waves become more frequent and severe, impacts may intensify with risks to human health, stress to infrastructure and transportation systems, economic productivity, and ecosystems (BC Ministry of Environment and Climate Change Strategy, 2019).

Rainfall Event

It is predicted that within the next 30 years, climate change will result in an increase in both the severity and occurrence of rainfall events, as well as a minor annual precipitation increase in BC (BC Ministry of Environment and Climate Change Strategy, 2019). High intensity rainfall events can cause localized flooding as well as flooding over a large region, resulting in population displacement, and damage to infrastructure, such as roads and buildings (Bush & Lemmen, 2019).

In Summary

While climate change is a global phenomenon, a variety of factors determine how the impacts of climate change manifest at the local level. Of note, urbanization can substantially influence local climate resilience. The development and transformation of the natural environment to urban landscapes, composed of buildings, parking lots and roadways, increases the impermeable surfaces leading to reduced rainfall absorption which, in turn, increases the potential for localized flooding. The conversion from rural to urban also introduces materials which typically absorb more solar radiation, and thus increases local temperatures (Environment and Climate Change Canada, 2019a).

With projected population growth in the region estimated at 12% over the next decade, increased development and transition from a rural to more urban environment is anticipated. The impacts of urbanization and other land cover changes and their compounding effects on climate change should be considered when determining adaptation and mitigation strategies for the future.

07 Hazard Assessment Results & Risk Scores

Risk is commonly calculated by multiplying the likelihood score by the total consequence score, as follows:

$$Risk = Likelihood \times Consequence$$

While this equation provides a useful measure of the risk posed by each hazard to the region, the scores should be interpreted as best estimates and not absolutes. The qualitative methods used to assess hazard likelihood and consequence entail a degree of subjectivity that cannot be eliminated. Repeating the assessment with a different group of people may produce differences in results.

RISK SCORES

The comparison of risk scores across all hazard categories (natural, technological, and conflict-related), revealed that natural hazards pose the greatest risk to the region (see Table 11). Natural hazards (Wildfire and Urban Interface Fire, Overland Flooding, Wind Event, and Drought) account for the top four highest rated hazards. The Wildfire and Urban Interface Fire hazard has the highest risk score (185) of all the hazards, with a likelihood value of 5 and an overall consequence value of 37. The natural hazard category also accounts for the most likely hazards for the region, as well as many of those with the highest consequence. The Megathrust Earthquake hazard, while low on the likelihood scale, has the highest overall consequence score (55) of all the hazards.

Of the technological hazards, Motor Vehicle Incident has the highest risk score (124), followed closely by Electrical Power Outage and Structure Fire (both have risk scores of 120). While several of the conflict hazards were found to have high overall consequence scores, e.g. Intentional Acts of CBRNE, Active Threat, Hijacking, all these hazards were relatively low on the likelihood scale and received lower risk scores as a result.

Previous HRVAs conducted for the Regional District of Nanaimo, City of Parksville and District of Lantzville in 2009 noted the following as the highest rated hazards.

Regional District of Nanaimo	City of Parksville	District of Lantzville
• Earthquakes • Epidemics – Human • Fire – Interface & Wildfire • Floods	• Earthquake • Fire – Interface & Wildfire • Epidemics – Human	• Earthquake • Fire – Interface & Wildfire • Epidemics – Human

The top hazards identified in this HRVA (2019) are aligned with previous HRVAs. Wildfire and floods were identified as presenting the greatest risk to the region, and earthquakes (megathrust) determined to have the highest total consequence. The HRVA also identified human disease as posing very high consequences to the region, though the likelihood assigned resulted in a lower overall risk score.

Additional top hazards identified in this 2019 HRVA have been detailed in *Section 08*.

Risk Score Table

The results of the analysis are presented in the risk score table below (see Table 11). Hazards are listed from highest to lowest risk (hazards with tied risk scores are ordered by total consequence score and then alphabetically). The scoring system yields a minimum total risk score of 11, and a maximum of 275 (see calculations below):

Minimum likelihood rating		*Minimum* consequence rating for all 11 categories		*Minimum* risk score
1	x	(1 x 11)	=	11
Maximum likelihood rating		*Maximum* consequence rating for all 11 categories		*Maximum* risk score
5	x	(5 x 11)	=	275

Accompanying each hazard's risk score is a measure of confidence (rated A – "very high" to E – "very low") in the likelihood estimate and impact ratings for the specific hazard event. When determining the level of confidence in the hazard assessment, the project team considered the quality and type of available data (e.g. qualitative vs. quantitative), the availability of subject matter experts during the risk assessment process, and the current body of knowledge for specific hazard events.

Full hazard assessment scores (including confidence ratings for all 11 consequence categories can be found in the All Scores Table in *Appendix 3*.

Table 11 – Risk Scores

Category	Hazard	Likelihood (1-5)	Human & Social Impacts (6-30)	Physical & Economic Impacts (5-25)	Overall Consequence (11-55)	Risk	Confidence Rating
	Fires (Wildfire and Wildland-Urban Interface)	5	19	18	37	185	Ⓐ
	Overland Flooding	5	15	14	29	145	Ⓒ
	Wind Event	4	16	19	35	140	Ⓐ
	Drought	5	12	16	28	140	Ⓑ
	Motor Vehicle Incident	4	19	12	31	124	Ⓑ
	Electrical Power Outage	5	13	11	24	120	Ⓑ
	Structure Fire	5	14	10	24	120	Ⓐ
	Rivers, Lakes, and Stream Flooding	5	9	14	23	115	Ⓑ
	Coastal Flooding	5	10	12	22	110	Ⓒ
	Freeze Event	5	10	11	21	105	Ⓑ
	Saltwater Intrusion	5	10	11	21	105	Ⓒ
	Landslide	4	13	13	26	104	Ⓒ
	Hazardous Material Release Land	4	13	13	26	104	Ⓒ
	Insect Infestation and Plant Disease	4	12	14	26	104	Ⓓ
	Air Quality	4	14	11	25	100	Ⓑ
	Coastal Erosion and Sedimentation	5	8	12	20	100	Ⓒ
	Human Disease	3	21	12	33	99	Ⓒ
	Snow Event	4	13	10	23	92	Ⓑ
	Animal Disease	4	9	13	22	88	Ⓓ
	Food Supply Chain Interruption	3	16	13	29	87	Ⓓ
	Marine Vessel Incident	3	16	13	29	87	Ⓒ
	Land Subsidence and Sinkholes	5	9	8	17	85	Ⓒ
	Hazardous Material Release Marine	3	12	15	27	81	Ⓒ
	Potable Water Supply Interruption	3	16	11	27	81	Ⓒ
	Fog	5	9	7	16	80	Ⓑ
	Heat Event	5	11	5	16	80	Ⓑ
	Fuel Supply Interruption	3	13	13	26	78	Ⓓ
	Earthquake	3	11	13	24	72	Ⓑ
	Intentional Acts of CBRNE	2	18	17	35	70	Ⓔ
	Thunderstorm	5	6	8	14	70	Ⓒ

Category	Hazard	Likelihood (1-5)	Human & Social Impacts (6-30)	Physical & Economic Impacts (5-25)	Overall Consequence (11-55)	Risk	Confidence Rating
Conflict	Cyber Security Threat	3	10	13	23	69	Ⓓ
Natural	Geomagnetic Storm	3	8	15	23	69	Ⓓ
Conflict	Active Threat	2	19	14	33	66	Ⓓ
Natural	Cold Event	3	12	10	22	66	Ⓑ
Natural	Hail	5	7	6	13	65	Ⓒ
Technological	Aircraft Incident	2	18	14	32	64	Ⓒ
Technological	Dam Failure	2	16	16	32	64	Ⓑ
Natural	Rainfall Event	4	10	6	16	64	Ⓑ
Technological	Communications Interruption	3	10	11	21	63	Ⓑ
Technological	Bridge Collapse	2	15	14	29	58	Ⓓ
Natural	Megathrust Earthquake	1	30	25	55	55	Ⓒ
Technological	Building Collapse	2	15	11	26	52	Ⓒ
Conflict	Public Disturbance	2	14	12	26	52	Ⓒ
Technological	Waste Water Interruption	2	12	13	25	50	Ⓒ
Natural	Volcanic Ash Fallout	2	10	13	23	46	Ⓒ
Conflict	Hijacking	1	16	16	32	32	Ⓓ
Natural	Seiche	1	18	12	30	30	Ⓔ
Natural	Tsunami	1	17	13	30	30	Ⓑ
Technological	Health Interruption	1	13	10	23	23	Ⓑ
Technological	Incident at the CFM-ETR	1	11	9	20	20	Ⓓ
Technological	Rail Incident	1	10	10	20	20	Ⓒ
Natural	Avalanche	1	7	5	12	12	Ⓑ
Natural	Extraterrestrial Debris	1	6	5	11	11	Ⓔ

Legend

Hazard Category

- Natural Hazard
- Technological Hazard
- Conflict Hazard

Confidence Rating

- Ⓐ Very high degree of confidence
- Ⓑ High degree of confidence
- Ⓒ Moderate confidence
- Ⓓ Low confidence
- Ⓔ Very low confidence

Risk Matrices

Risk matrices provide a visual representation of the values presented in Table 11. The likelihood that the hazard will occur is represented on the y-axis and the consequence of the hazard is represented on the x-axis in the following matrices (*Figure 6 – Figure 9*). Plotting risk in this fashion provides a quick, clear view of the risks across all hazards and can serve as a useful tool in promoting robust discussions, determining unacceptable levels of risk, and arriving at highest priority hazards for risk management and emergency preparedness activities. Four risk matrices are provided on the following pages, one for all hazards considered in the assessment and one for each hazard category (natural hazards, technological hazards, and conflict-related hazards).

Figure 6 – All Hazards Risk Matrix

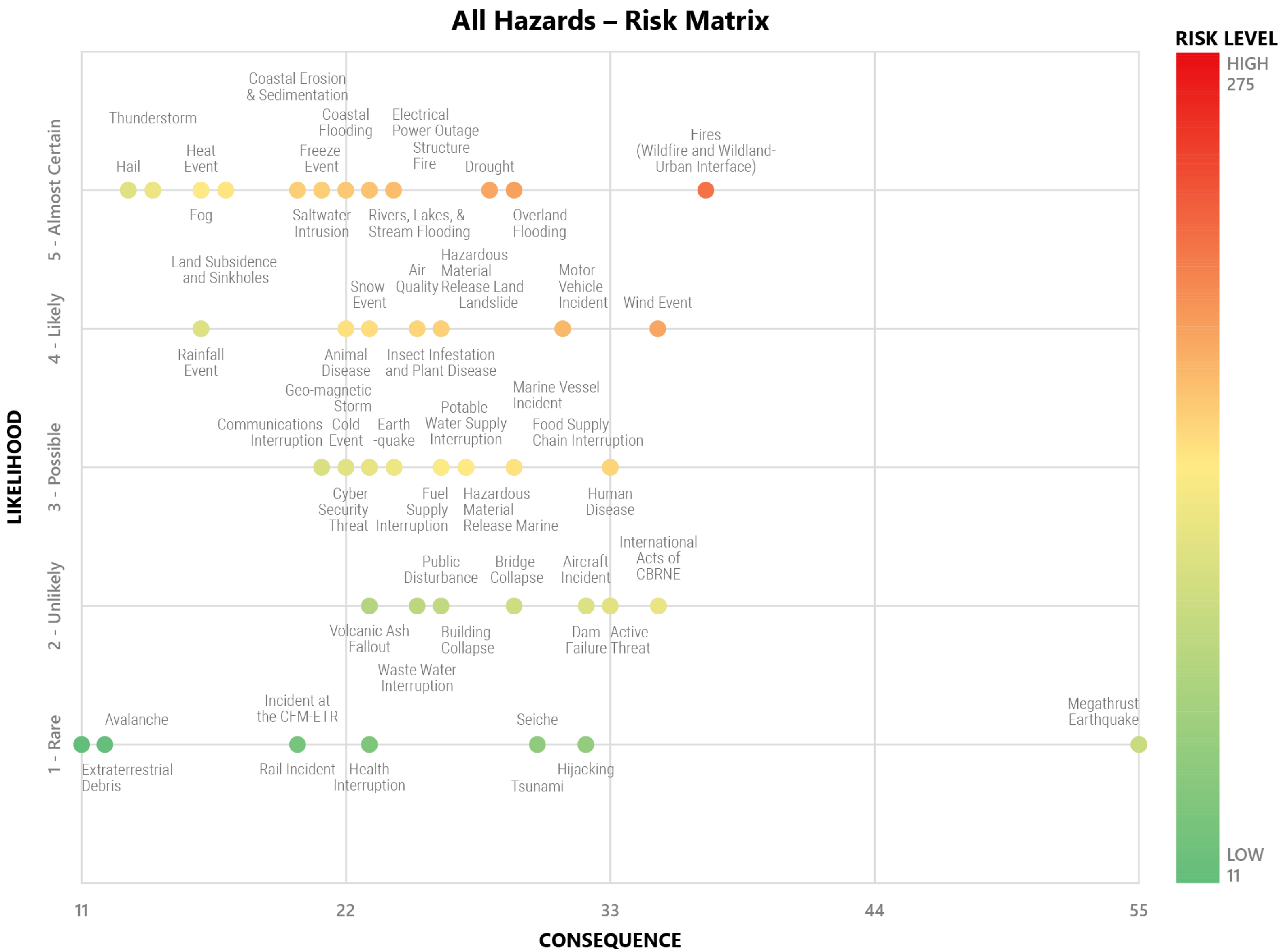


Figure 7 – Natural Hazards Risk Matrix

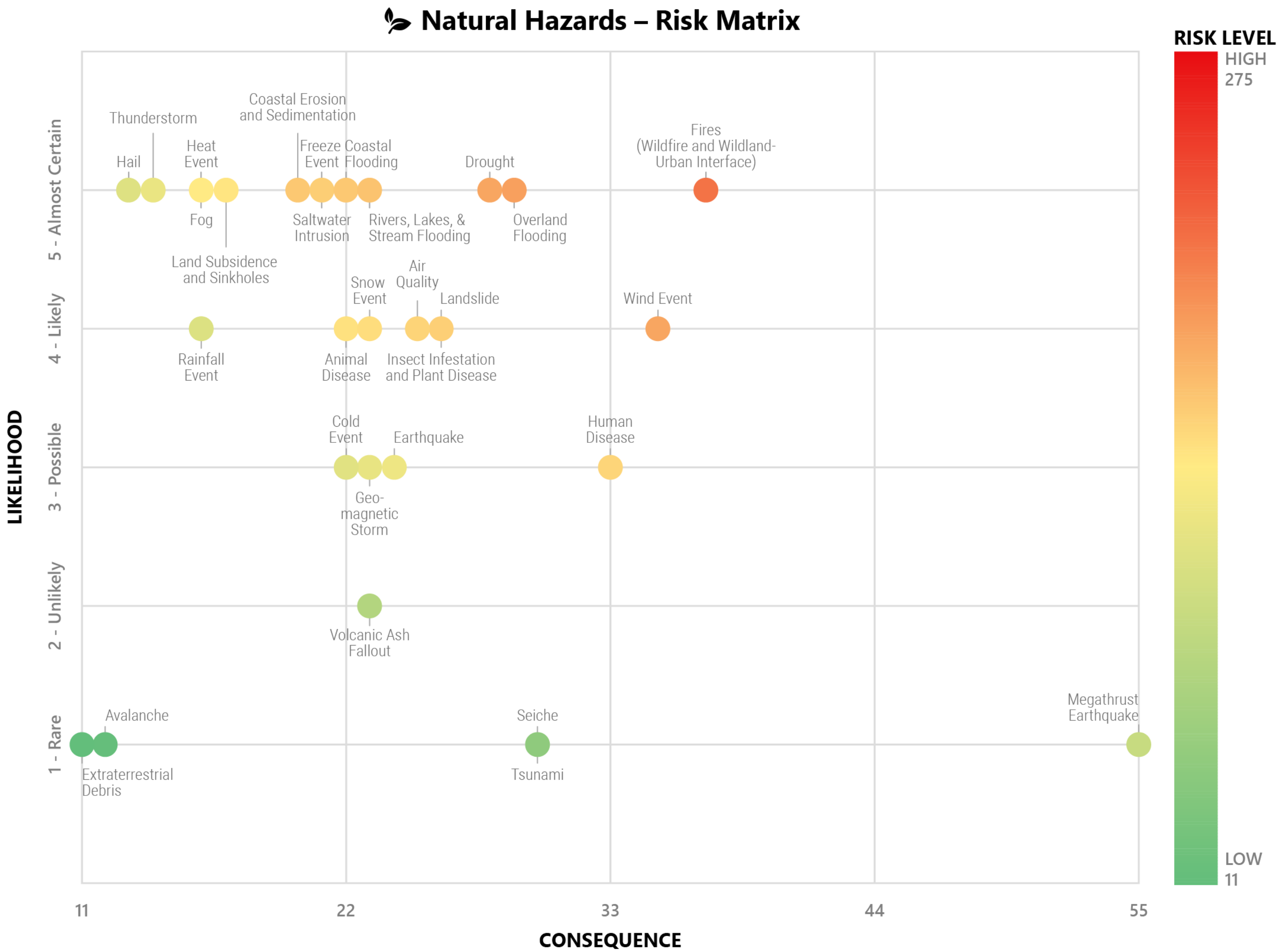
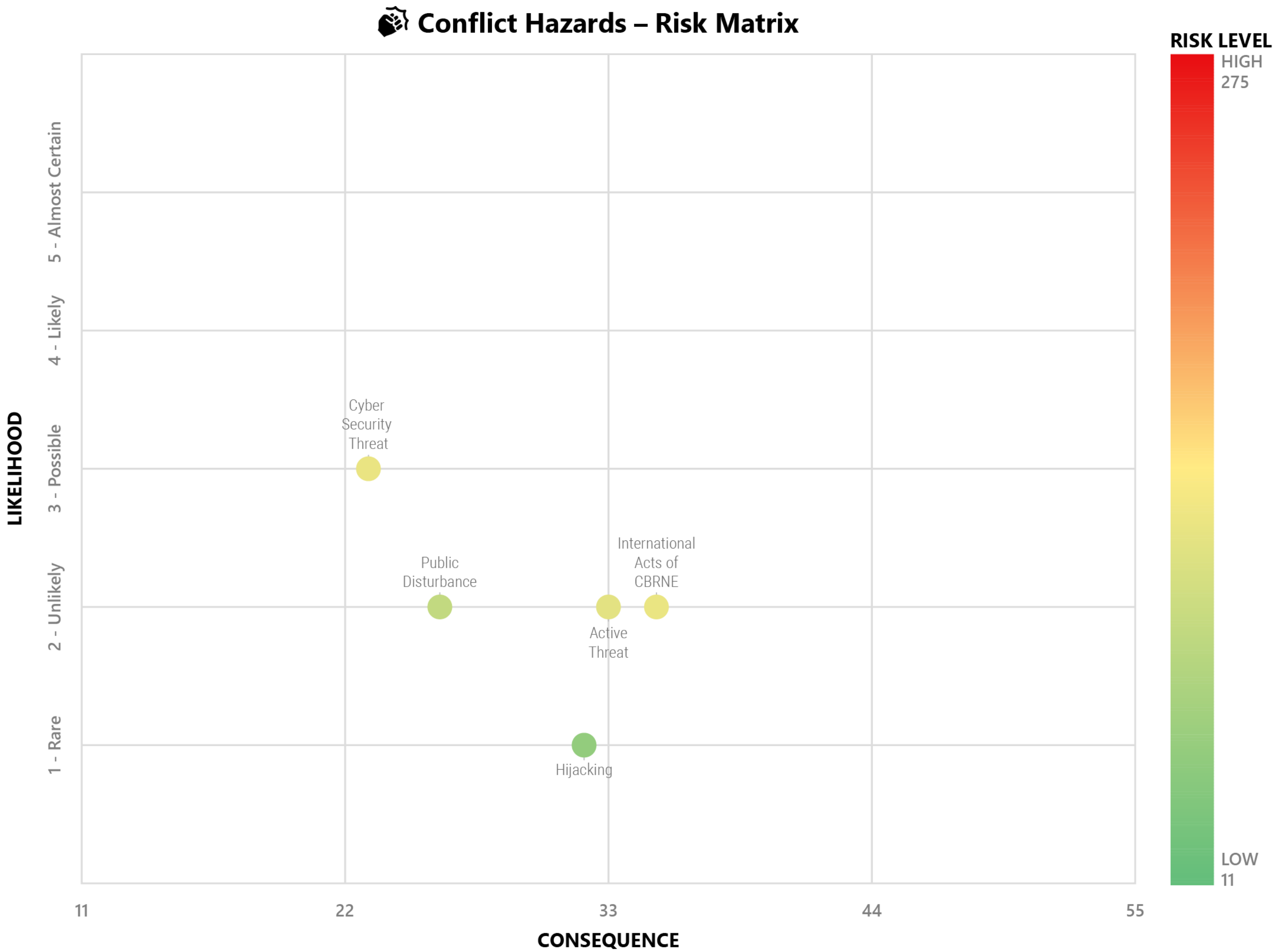


Figure 8 – Technological Hazards Risk Matrix

Figure 9 – Conflict Hazards Risk Matrix



08 Top Hazards

In total, the relative risk of 53 hazards was assessed based on their likelihood of occurring and potential consequences. Due to the multiplication factor involved in calculating the overall risk score, the hazards with the highest overall risk score tended to be those which had higher likelihoods. Several hazards were determined to have a very high consequence rating, but a low likelihood rating, which meant they fell lower in the risk table. As such, when determining the "Top Hazards" for the region, a filter was applied to capture those high consequence/low likelihood hazards, in addition to the hazards with high overall risk scores.

The Top Hazards for the region (see *Table 12* and *Figure 10*) were identified using the following criteria:

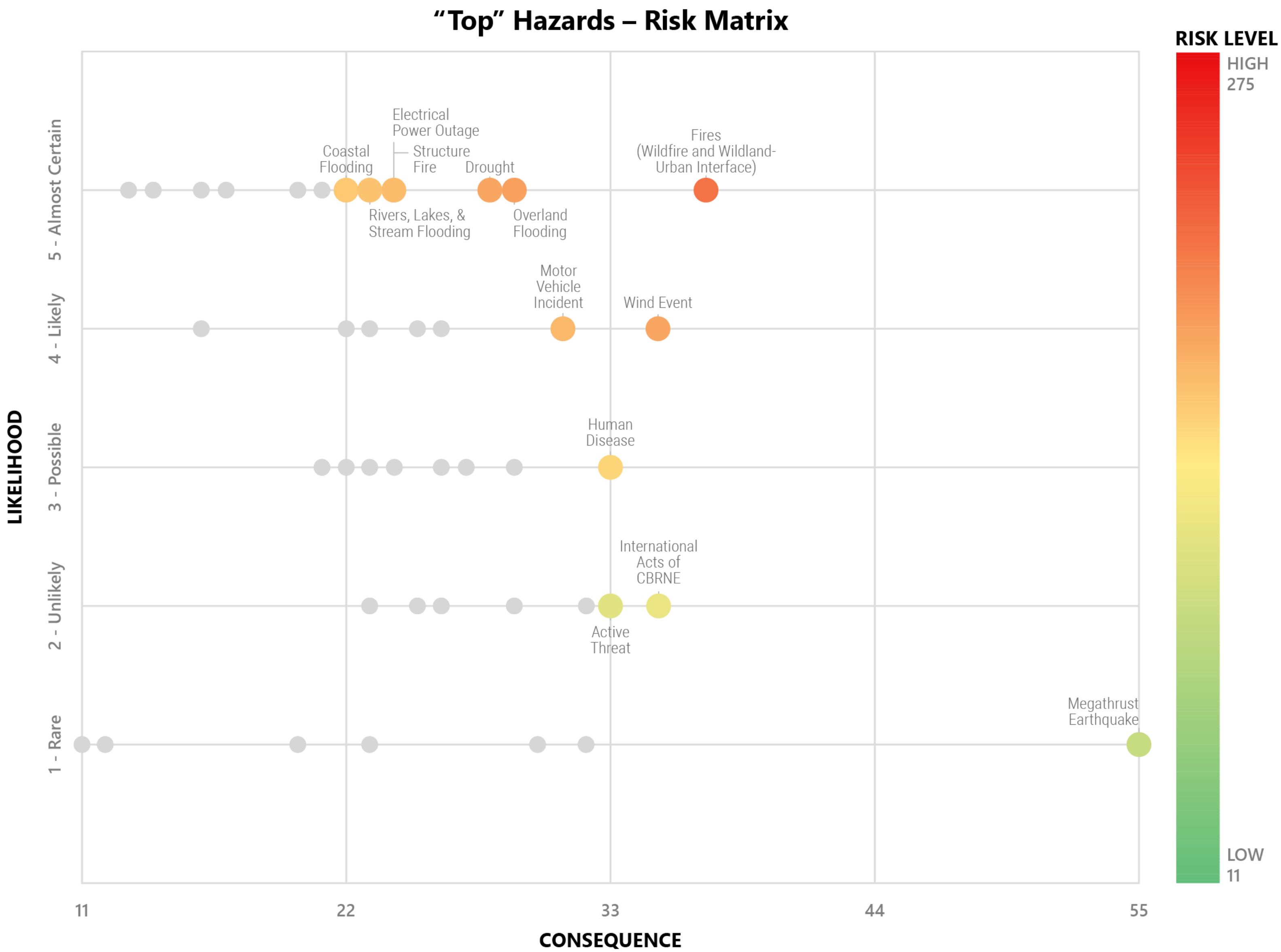
- a high overall risk score ≥110, or
- a high overall consequence rating ≥33

Table 12 – Top hazard for the region

Hazard	Likelihood (1-5)	Overall Consequence (11-55)	Risk
Fires (Wildfire and Urban Interface)	5	37	185
Overland Flooding	5	29	145
Wind Event	4	35	140
Drought	5	28	140
Motor Vehicle Incident	4	31	124
Electrical Power Outage	5	24	120
Structure Fire	5	24	120
Rivers, Lakes, and Stream Flooding	5	23	115
Coastal Flooding	5	22	110
Human Disease	3	33	99
Intentional Acts of CBRNE	2	35	70
Active Threat	2	33	66
Megathrust Earthquake	1	55	55

The Top Hazards described on the following pages provide further insight into the risk score assigned. The descriptions detail the occurrence of the hazard locally; potential or actual consequences of the hazard as evidenced through research or notable historical incidents; as well as a discussion around evolving conditions which may affect the likelihood and/or severity of impacts due to factors such as climate change or urbanization.

Figure 10 – "Top" Hazards Risk Matrix



FIRES (WILDFIRE AND URBAN INTERFACE)

HAZARD	LIKELIHOOD		HUMAN & SOCIAL IMPACTS		PHYSICAL & ECONOMIC IMPACTS		RISK
Wildfire and Urban Interface Fires	5	x	(19	+	18)	=	185

Wildfires are typical of forested and grassland areas. With more than 60 percent of the province forested, British Columbia is particularly susceptible (Government of British Columbia, n.d.-j). Wildfires can be natural or human-caused, with lightning strikes accounting for approximately 60 percent of ignitions in British Columbia annually (Government of British Columbia, n.d.-j).

Within the region, there are several zones with extreme or high interface fire hazard ratings. Electoral Areas A, B, C and H have a high concentration of regions rated as extreme, meaning the risk is very serious as fires can start easily, spread quickly and make suppression efforts difficult (Regional District of Nanaimo, n. d.-b; Government of British Columbia, n.d.-d).

Like many areas of BC, climate and topography make the region prone to wildfires. Bow Horn Bay, for example, which encompasses the Electoral Area H communities of Bowser, Qualicum Bay, Dunsmuir, Spider Lake and Qualicum First Nation, is in the Nanaimo Lowland Ecosection. As described in the Community Wildfire Protection Plan (2007), Bow Horn Bay is classified in the Coastal Douglas-fir Subzone (CDFmm), which extends along Vancouver Island's southeast coast. Douglas-fir is prominent in the CDFmm, while shore pine, red alder, dogwood, and broadleaf maple are also found in several areas, along with a variety of underlying tree and plant species. The dense coniferous stands, substantial ladder fuels like shrubs, low branches, and dry leaves, combined with steep slopes could influence both the likelihood of ignition and the speed at which a fire may spread (Strathcona Forestry Consulting, 2007). If extreme fire weather were to occur, strong winds could quickly advance a fire through large areas of lowland forest. Additionally, the risk of ignition to large forested properties and structures, including homes and businesses, is high in areas with close proximity to wildland fuels.

Within Electoral Area B, much of Gabriola Island is rated at a high to extreme risk of interface fire (Strathcona Forestry Consulting, 2008). Summer weather systems in the area can range from moist with low to moderate fire conditions, to windy and excessively dry, resulting in high to extreme risk of fire hazard. The steepness of a slope affects the speed and direction in which wildfire spreads; steep dry slopes can cause fires to spread more rapidly, as compared to moist flat areas (Government of British Columbia, n.d.-i). Gabriola Island is made up of gentle to moderate slopes, with a long gradual northwest-southeast ridge extending along its centre. Should an ignition occur amid high temperatures and low humidity, winds could cause a fire to spread quickly up the slopes of the Island and through its wooded interior (Strathcona Forestry

Consulting, 2008). Dense coniferous stands combined with a high proportion of extremely flammable ladder fuels pose a greater risk of ignition and spread of wildfire, and a moderately deep organic layer of woody debris, foliage, needles and brush may be highly combustible in certain seasons. Additionally, several large grassy areas like parks, agricultural lands and coastal bluffs are present, through which wildfire can travel in dry conditions. Many residential and commercial structures are located in high-risk interface areas and surrounded by combustible vegetation, while remote or difficult to access properties could make fire suppression challenging (Strathcona Forestry Consulting, 2008).

The majority of Electoral Area C is heavily forested, with its population density concentrated along the southeast boundary. While the fire hazard ratings of communities like Extension, Pleasant Valley and East Wellington can range from moderate to high depending on conditions, the stretch to the west, along South Forks Road and Nanaimo River Road, rates as extreme, as do the forested landscapes north of and bisecting Nanaimo Lakes (Regional District of Nanaimo, n.d.-b) Much of this electoral area is made up of rugged second and third growth forested hills of varying slope, with rural residential, agricultural, forestry and recreational properties dispersed throughout. While the upper portion consists primarily of unpopulated forestry land, a number of campgrounds and recreational vehicle parks are concentrated around the Nanaimo Lakes region, as are popular hiking and biking trails (Regional District of Nanaimo, 2019c). Warm dry summers, which are not uncommon for the region and often include periods of drought, may create high-risk interface areas in remote locations, which could make evacuation and/or firefighting efforts difficult in the event of a fast-moving wildfire.

As described in Electoral Area A's Official Community Plan, the risk of interface fire is rated moderate, high or extreme for a substantial portion of the region (Regional District of Nanaimo, 2011a). With rural developments, agricultural lands, and recreational areas, such as Hemer Provincial Park, intersecting with second growth forest, the majority of the electoral area's eastern stretch is at extreme risk of interface fire.

Wildfire events can seriously impact the communities in which they occur, as illustrated by Vancouver Island's wildfire event that took place on August 5, 2018. The human-caused "Nanaimo Lakes Wildfire" burned 185.3 hectares near Nanaimo River Road (British Columbia iMapBC). The Regional District of Nanaimo declared a local state of emergency issuing an evacuation order and alert on August 6, 2018, placing 77 homes east of the fire on evacuation alert, displacing residents at Barsby Lakes and recreational users and cabin residents at Nanaimo Lakes (Regional District of Nanaimo, 2018b).

Disruption to or loss of the region's critical infrastructure could have significant adverse effects. Though critical infrastructure owners and operators have protective measures in place to mitigate impacts from wildfires, and are represented in the planning and coordination calls hosted by the Province, impacts can happen to critical infrastructure which complicate the response and recovery to wildfires in the region. Disruption to transportation routes, communications services, medical facilities or utilities within the interface area could also put the safety, security or economic well-being of the affected community at risk.

An engagement session participant who was the Operations Section Chief at the Incident Command Post (ICP) for the Nanaimo Lakes Fire recapped his experience:

> *"The fire broke out early August, grew to about 25 hectares within the first couple of hours, and eventually to 180 hectares. It started under a power line that actually serves a bunch of southern Vancouver Island, quite a high risk there with the BC Hydro lines. It was also in close proximity to the City of Nanaimo water supply, as well as the water treatment plants, resulting in the evacuation order for a couple of homes and an alert for several dozen more. It was initially the highest priority fire in BC by BC Wildfire, but quickly overtaken by many other fires in the interior and up north. At one point BC Wildfire had 3 heavy helicopters on scene, great collaboration by BC Wildfire, Vancouver West, Regional District of Nanaimo and the City of Nanaimo. There was one responder fatality; a water tender driver unfortunately had a heart attack and he passed away." – Operations Section Chief at Nanaimo Lakes Fire ICP*

As evidenced during the Fort McMurray wildfires of 2016, transportation corridors play a critical role as evacuation routes anddisruptions due to fire activity can lead to potentially devastating consequences. Approximately 88,000 people were forced to evacuate via Highway 63, the city's only road in and out of town, as "walls of flames showered embers and ash onto the road" (Thurton, 2017, para. 2). The mass evacuation resulted in massive traffic jams that caused people to be stuck on the highway for up to 15 hours, as "flames whipped alongside them" (Thurton, 2017, para. 12).

The region's Gabriola Island is accessible only by ferry, which could make evacuation of the island's more than 4,000 residents difficult in the event of a fast moving wildfire (Government of British Columbia, n.d.-b). Within other areas of the region, closure or delay along major roads or intersections such as Highway 1 or Highway 19 could directly impact those required to use these routes during an evacuation. For example, Highway 19's Nanoose Flats is considered to be a detour-less portion of the highway with no alternate routes for redirecting traffic through which an average of 30,000 vehicles travel daily (BC Ministry of Transportation and Infrastructure Online, 2019). A number of communities and properties in the region are accessible only by one road in and out, which could also pose challenges evacuating if those routes were impacted by fire.

Wildfires can be traumatic and painful events for those affected. Psychological distress may follow the loss of a home or belongings, the act of having to leave pets and livestock behind, and the stress of the unknown (Vomiero, 2017). Trauma caused by wildfire may lead to a variety of psychological issues, including (but not limited to) acute stress disorder, adjustment disorder, and post-traumatic stress disorder (PSTD), all of which can impact social, familial or occupational functioning (Vomiero, 2017). A study following the 2016 Fort McMurray wildfire found many victims experienced "elevated rates of depression and related mental health problems," (Weber, 2018) such as substance or alcohol abuse disorder, depression and/or anxiety. Similarly, mental health symptoms such as depression and suicidal thinking among impacted adolescents were significantly higher, as compared to adolecents unaffected by the Fort McMurray fires (Brown, et al., 2019).

Wildfires can have significant economic and environmental impacts. Provincial wildfire suppression and response costs exceeded $1.1 billion between 2017 and 2018, which does not take into account indirect costs like economic disruptions, lost tourism revenues or social impacts like unemployment (Abbott & Chapman, 2018; Government of British Columbia, n.d.-k). The economic costs of fires are also noted to be increasing over time. The 2011 Slave Lake fire cost insurance companies an estimated $700 million, while costs from the 2016 Fort McMurray fire are estimated at $9 billion.

In recent years, the frequency and severity of wildfires has increased, and this trend is predicted to continue. The 2018 wildfire season marked British Columbia's worst fire season on record in terms of area, with 1.35 million hectares burned, up from 1.2 million in 2017. Additionally, the number of people displaced was unprecedented at approximately 65,000 (Government of British Columbia, n.d.-k). As a result of the wildfires, hundreds of families lost their homes and dozens of other structures were lost, including commercial buildings, sheds, and barns (Johnston, 2018). Contributing factors include the continued growth of the wildland urban interface, the expansion of infrastructure on forested land base, and fires that burn hotter due to prolonged drought conditions, and faster and more dangerously due to unnaturally high fuel loads (Ministry of Forest, Lands and Natural Resource Operations, 2015; Maher, 2019). The intense heat involved in major fires can also pose greater environmental consequences if the soil in forests becomes dried out and damaged to the point it cannot reforest (Maher, 2019).

With several areas in the region classified with extreme or high interface fire hazard ratings, the significant consequences posed by wildfire and wildland urban interface fires, and the trend to longer and more extreme fire seasons as a result of climate change, the wildfire hazard presents the greatest risk to the region.

Wildfire and Urban Interface Fires

Wildfire: *An unplanned fire – including unauthorized human-caused fires – occurring on forest or range lands, burning forest vegetation, grass, brush, shrub, peat lands, or a prescribed fire set under a regulation which spreads beyond the area authorized for burning* (EMBC, n.d.-b).

Wildland Urban Interface (WUI): *Any area where combustible forest fuel is found adjacent to homes, farm structures, or other outbuildings. This may occur at the interface, where development and forest fuel (vegetation) meet at a well-defined boundary, or in the intermix, where development and forest fuel intermingle with no clearly defined boundary* (EMBC, n.d.-b).

FLOOD HAZARDS

Floods are the most frequent natural hazard in Canada. They can occur at any time of the year and are most often caused by heavy rainfall, rapid melting of a thick snow pack, ice jams, or more rarely, the failure of a natural or human-made dam (Public Safety Canada, 2018b).

While water level fluctuations are natural occurrences, people generally refer to high-water levels as flood conditions when the water threatens lives, property, and critical infrastructure (Public Safety Canada, 2015c). Flood, as a single hazard, is considered the most economically impactful hazard event for Canadians with respect to property damage (Public Safety Canada, 2015c),

For this HRVA, various flood hazard types were assessed individually to provide a more specific and accurate analysis of the flood risk in the region and include:

- Overland Flooding
- Rivers, Lakes, and Stream Flooding
- Coastal Flooding

The assessment concluded that all three flood hazard types were "Almost Certain" to occur (likelihood score = 5) within the region. The susceptibility of individual areas within the region to each flooding type varies and is a function of an area's exposure, vulnerability, and local conditions. A combination of local geography, topography and meteorological conditions may result in multiple flood types occurring at once, or one flood type causing secondary flood hazards. For example, highly populated areas are typically more developed and contain a greater presence of impermeable surfaces. Within the region, coastal areas have the greatest population density, and as such, are susceptible to the impacts of both coastal flooding, as well as overland flooding.

The potential consequences of the various flood types are, for the most part, very similar. Possible impacts across all flood types include property damage, the requirement to evacuate resulting in population displacement, as well as impacts to the environment and cultural resources (Regional District of Nanaimo, 2019b).

For these reasons, while each flood hazard has been described separately in the sections below to communicate the individual risk score and describe the relevance of the specific hazard to the region, the discussion of the consequences of the three flood hazard types, has been combined.

OVERLAND FLOODING

	HAZARD	LIKELIHOOD		HUMAN & SOCIAL IMPACTS		PHYSICAL & ECONOMIC IMPACTS		RISK
	Overland Flooding	5	x	(15	+	14)	=	145

Overland flooding (also known as "pluvial flooding") results from rainfall generated overland water flow, before the runoff enters any watercourse or sewer. It is usually associated with high intensity rainfall events but can also occur with lower intensity rainfall or melting snow where the ground is saturated, frozen, developed or otherwise has low permeability resulting in overland flow and ponding in depressions in the topography (Maksimovic, 2015). High intensity 'extreme' rainfall events in urban environments may cause sewerage or drainage systems to be completely overwhelmed and result in flooding. Agricultural areas where natural drainage has been altered over time can also be susceptible to overland flooding impacts.

Overland flooding has also been referred to as the "invisible hazard" as it can happen without notice in areas that do not typically experience regular flooding (Houston, et al., 2011). With limited or no time to prepare, coupled with the fact that typical flood mitigation measures are likely not in place, the potential consequences associated with overland flood events can be severe.

Within the region, increasing urban development in lower watershed reaches has led to an increase in impervious surfaces such as roads, buildings, driveways, sidewalks etc. This shift in the built environment has, in some areas, resulted in the loss of natural hydrologic function and an associated increase in surface runoff. This growth in urbanized areas, paired with increases in high intensity rainfall events due to climate change, is expected to result in more frequent and severe pluvial flooding events (Szewrański, et al., 2018).

Overland Flooding

Overland flooding (also known as "pluvial flooding") results from rainfall-generated overland flow. This type of flooding is usually associated with high intensity rainfall events (typically >30mm/h) but can also occur with lower intensity rainfall or melting snow where the ground is saturated, frozen, developed or otherwise has low permeability resulting in overland flow and ponding in depressions in the topography (Maksimovic, 2015).

High intensity 'extreme' rainfall events in urban environments may cause sewerage/drainage systems to be completely overwhelmed and result in flooding.

RIVERS, LAKES, AND STREAM FLOODING

HAZARD	LIKELIHOOD		HUMAN & SOCIAL IMPACTS		PHYSICAL & ECONOMIC IMPACTS		RISK
Rivers, Lakes, And Stream Flooding	5	x	(9	+	14)	=	115

The region contains a variety of freshwater features including a large number of rivers, lakes, and streams, a selection of which are listed in *Table 13* (Regional District of Nanaimo, 2011b).

There are three major floodplains within the region: The Nanaimo River Floodplain; the Little Qualicum River Floodplain; and Englishman River Floodplain (Regional District of Nanaimo, 2018a). Each of these rivers has a notable flooding history, which is captured in a subsequent section (see *Flooding in the Region*).

Table 13 – Rivers, lakes, and streams within the region

RIVERS	LAKES	STREAMS
Englishman River	Beck Lake	Beck Creek
Little Qualicum River	Cameron Lake	Bonnell Creek
Millstone River	Dolphin Lake	Chase River
Nanaimo River	Enos Lake	French Creek
Qualicum River	Hoggan Lake	Grandon Creek
	Holden Lake	Haslam Creek
	Horne Lake	Jump Creek
	Nanaimo Lakes	Kinkade Creek
	Quennell Lake	Morningstar Cr.
	Spider Lake	Morrison Creek
		Nile Creek
		Thames Creek
		Whiskey Creek

In addition to these significant floodplains, additional watercourse floodplains have been identified according to the floodplain designations detailed under the "Regional District of Nanaimo Floodplain Management Bylaw No. 1469, 2006".

Under the requirements of the bylaw, land that is:

- within thirty (30) metres from the Natural Boundary of the Englishman River, Little Qualicum River, Millstone River, Nanaimo River or French Creek; or
- within fifteen (15) metres from the Natural Boundary of any other Watercourse including a lake, marsh, or pond;

is designated as floodplain. These areas have been identified based on their susceptibility to "experience periodic flooding from nearby rivers, lakes, and streams" (Government of British Columbia, n.d.-e, para. 1).

With urbanization and a projected 12% increase in population over the next decade, the region has the potential for altering the risk of fluvial floods. River morphology and dynamics are influenced by their neighboring environment, which supplies water and sediment (Ashmore &

Church, 2001). As such, development and altered land use can contribute to the risk of fluvial floods; with varying impacts on different water bodies.

Flooding in most areas of Canada typically occurs in the spring months due to freshet where melting snow and ice increases the water levels in lakes, rivers or streams (Weston, Guthrie, & McTaggart-Cowan, 2003). Along BC's west coast however, it is more common for floods to occur during the fall and winter as a result of severe rainstorms or rain-on-snow events (Weston, et. al, 2003). With global temperatures rising due to climate change, rainfall and storm events are anticipated to increase in severity and frequency, which will have a cascading effect to river and streamflow regimes that may elevate the potential for fluvial floods over time (Ashmore & Church, 2001).

A study published in 2003 predicted a climate change induced shift in the flood regime of the Englishman River. Peak annual flows for the river were predicted to be 8% larger by 2020, 14% larger by 2050 and 17% larger by 2080 (Weston, et. al, 2003, p. 657). The study stated that during rainfall events, the Englishman River is very responsive to rain and snowmelt; its flow increases rapidly during the event but will also decrease rapidly once the rainfall ends (Weston, et. al, 2003). The 'flashy' nature of the river combined with a predicted increase in flood frequency and magnitude presents an increased risk of severe flooding with rapid onset for those living on the floodplain.

Rivers, Lakes, and Stream Flooding

A type of flooding resulting from the overflow of natural lake shorelines or water from a stream or river channel onto normally dry land in the floodplain adjacent to the channel (Integrated Research on Disaster Risk, 2014, p. 16).

These floods can be caused by intense rainfall, rapid snowmelt (including freshet events), and ice jams blocking the rivers.

Freshet: *The movement of water associated with the thawing of ice and snow each spring. This runoff can result in high water levels in streams, lakes and other waterways* (Abbott & Chapman, 2018, p. 17).

Ice Jams: *The accumulation of floating ice restricting or blocking a river's flow and drainage. Ice jams tend to develop near river bends and obstructions (e.g., bridges)* (Integrated Research on Disaster Risk, 2014, p. 15).

COASTAL FLOODING

HAZARD	LIKELIHOOD		HUMAN & SOCIAL IMPACTS		PHYSICAL & ECONOMIC IMPACTS		RISK
Coastal Flooding	5	x	(10	+	12)	=	110

Coastal flooding is defined as higher-than-normal water levels along the coast caused by tidal changes or thunderstorms that result in flooding (Integrated Research on Disaster Risk, 2014, p. 13). High winds from tropical cyclones or other storms push water onshore to create a storm surge, which is the leading cause of coastal flooding. Coastal flooding can be amplified or dampened by tides (both daily tides and periodic king tides) (Resource and Environment Working, n.d., p. 7).

The region has an extensive (188 km) coastline encompassing portions of Electoral Areas A, B, E, G, and H, the Town of Qualicum Beach, the City of Parksville, the District of Lantzville, and the City of Nanaimo, as well as portions of land under the jurisdiction of the Qualicum First Nation, Snaw-Naw-As (Nanoose) First Nation, and the Snuneymuxw First Nation.

Globally, coastal regions typically have the highest density of population and are experiencing rapid growth in both residential and infrastructure developments, as well as expanding economic and tourist activities (Ranasinghe & Jongejan, 2018). This trend is reflected locally, with the coastal areas of the region holding the highest concentration of the population, government infrastructure, and the highest value properties in the region. Within the region, the coastal areas with the highest density of population and infrastructure include the Town of Qualicum Beach and City of Parksville (Houston, et al. 2011, p. 11). With a higher degree of exposure to instances of coastal flooding, these areas posess a greater risk to the impacts of such an event.

Climate change is a probable contributor to the occurrence of coastal flooding. Temperature increase affects sea level rise and causes "thermal expansion of the oceans and melting of glaciers, ice caps, and ice sheets" (Shaw, Taylor, Solomon, Christian, & Forbes, 1998, p. 365). It is projected the waters along Vancouver Island's east coast will rise by a minimum of 0.8m by the year 2100 (Regional District of Nanaimo, 2019b), and that coastal regions will not only be affected by rising sea levels, but also storm surges, wave conditions and river flow (Ranasinghe & Jongejan, 2018). As these levels continue to increase, coastal communities that are extremely low-lying may be at risk of consistent flooding (Regional District of Nanaimo, 2017a). Furthermore, the frequency of king tides is predicted to increase in the coming years due to the effects of climate change (Hernandez, 2018). While king tides alone can reach as high as five meters in elevation, the flooding risk and potential impacts are heightened if the king tide occurs in combination with a storm surge(Little, 2018).

As communities continue to occupy and use coastal regions, risks associated with coastal flooding will remain and flood events will likely become a more frequent occurence (Ranasinghe & Jongejan, 2018).

Coastal Flooding

Higher-than-normal water levels along the coast caused by tidal changes or thunderstorms that result in flooding, which can last from days to weeks (Integrated Research on Disaster Risk, 2014, p. 13).

High winds from tropical cyclones or other storms push water onshore to create a storm surge, which is the leading cause of coastal flooding and represents the greatest threat associated with such storms. Coastal flooding can be amplified or dampened by tides, both daily tides and periodic king tides, which are much larger tides that occur monthly or yearly due to the interaction of the earth, moon, and sun in their orbits (Resource and Environment Working, n.d., p. 7).

Storm Surge: *A storm surge consists of very high waves and high water levels caused by the wind and air pressure "pushing" the water onto the shore, often resulting in high waves and flooding. Storm surge can occur along all coastal areas of Canada. It can also occur in large lakes, such as the Great Lakes* (Public Safety Canada, 2018c).

King Tide: *King Tides (also known as perigean spring tides) are extreme high tide events that occur when the sun and moon's gravitation forces reinforce one another at times of the year when the moon is closest to the earth. They happen twice a year but are typically more dramatic during the winter* (Government of British Columbia, 2015, para. 1).

Flooding in the Region

Several notable flood incidents have occurred within the region. Researching these events helped shape the understanding of the flood hazards and their actual and potential impacts. During the engagement sessions, participants shared their most memorable hazard experiences, of which several related to historic floods in the region, e.g.:

> *"In 1997, a severe coastal rainfall event resulted in a record flow in Nash creek near Qualicum Bay. The overbank flow caused bank erosion and resulted in one house being undermined and the structure collapsed and was washed out to sea. Neighboring properties were also damaged and the RDN/MOE and EMBC constructed flood protection worked to stabilize the properties." – Representative from the Provincial Diking Authority*

> *"In 2007, after a lengthy period of abnormally warm temperatures, the above average snow-pack created significant snow melt runoff into the Nanaimo River. The river rose to flood stage overnight and approximately 60 residents awoke to their homes being flooded. The North Cedar Fire Department, Cranberry Fire Department, BC Ambulance Service, Nanaimo Search & Rescue, the RDN, and the contractor for Ministry of Transportation & Infrastructure met at Unified Command to affect the rescue of the flooded persons. Once rescue was completed, evacuees were cared for and processed by the RDN Emergency Social Services (ESS) for food and lodging until flood waters receded." – Representative from the North Cedar Fire Department*

Englishman River

As stated previously, the Englishman River near Parksville is one of the major floodplains within the region and has a history of annual flooding (Regional District of Nanaimo, 2007). In January 2018, heavy rainfall caused the river to flood, impacting Parry's RV Park. Twenty-two residents were evacuated from the area, extensive damage was caused to the park entrance, and many homes were uninhabitable for days because the water and wastewater system in the park was affected by the flood (Stoltz, 2018).

The owners and residents of Parry's RV Park are familiar with the impacts of flooding from the Englishman River. In April 2016, Parry's RV Park was placed on a state of local emergency after the river exceeded its banks. Similarly, in December 2014 the river flooded after an earthen berm failed to redirect river flow, and the community was set to a state of local emergency with a subsequent evacuation of the RV park (Regional District of Nanaimo, 2015). This event also resulted in flooding across Martindale Road which limited access to and from the RV Park. This event resulted in 12 people and their pets being evacuated, 7 of whom required 72-hour recovery services.

Martindale Road in Parksville also experiences flooding regularly. In early 2019, the Englishman River again flooded following heavy rains which led to the road being flooded near Highway 19A (Kveton, 2019).

There are also several more historic examples of the Englishman River flooding. For example, in the winter of 1949, the Englishman River flooded causing three homes in the area to be isolated (Septer, n. d.). Documentation indicates that the river flooded two further times in the subsequent months.

Nanaimo River

The Nanaimo River floodplain has been designated by the Government of BC as a "high risk" floodplain (Regional District of Nanaimo, 2018c). The river has a long-standing history of flooding. In the December of 1949, winter storms caused the Nanaimo River to flood causing significant damage to property (Septer, n. d.). In the winter of 2007, the river flooded near Wilkinson and Alice Road. Initially, the RDN was alerted to a resident who was trapped in a mobile home and could not get out due to increasing waters levels (Regional District of Nanaimo, 2008). A few hours later, a full evacuation was issued for Wilkinson, Alice, and Aros Roads.

More recently, in 2014, a period of severe weather caused the river to breach its banks resulting in minor flooding. Nearby communities were placed on an evacuation alert; however, the event did not escalate further (Regional District of Nanaimo, 2014).

Little Qualicum River

Flooding is also not uncommon along the Little Qualicum River. In December 2014, the Little Qualicum River flooded Cedar Grove Campground near Riverbend Road following the failure of an earthen berm (Regional District of Nanaimo, 2015). The flood water impacted transportation routes and required the Regional District of Nanaimo to declare a state of local emergency and issue an evacuation order. A total of 17 people, some accompanied by pets, were evacuated from the campground. Of those evacuated, 12 evacuees received 72-hour recovery support services. The heavy rain led to the evacuation of 15 homes in a neighbouring community, with another 70 homes being placed on an evacuation alert (The Canadian Press, 2014).

More historically, in October of 1921, the Little Qualicum River breached its banks following intense rains. The flood caused damage to nearby roads and led to a travel advisory for the public (Septer, n. d.).

French Creek

French Creek has a long-reported history of flooding, especially near River Crescent, Mason Trail and Lee Road, as well as near Grafton Road (BC Ministry of Environment and Climate Change, 2002). In November 2017, heavy rainfall caused French Creek to breach its banks and floodwaters damaged neighbouring homes (CTV News Vancouver Island, 2017). Flooding of French Creek into River Crescent occurred in 2005 and has also occurred more recently.

Flood Consequences

The impacts of major floods can be devastating, ranging from property damage and population displacement, to the damage and destruction of environmental and cultural resources (Regional District of Nanaimo, 2019b).

It was noted previously that flood, as a single hazard, is considered the most economically impactful hazard event for Canadians with respect to property damage (Public Safety Canada, 2015c). As evidenced by the 2013 Alberta flood, with an estimated $6 billion sustained in financial losses and property damage, flood events can cost billions of dollars (The City of Calgary, 2018). While flood insurance helps to reduce the financial burden, if homeowners or businesses have restricted, or no flood insurance coverage, it may be impossible to fully recover costs (Moudrak, et. al, 2018). The economic impacts of a flood event can place a significant strain on the ability of communities and families to recover from an incident.

Flood events leave a lasting impression on those who experience their impacts. During the engagement sessions for the project, the flooding of Whiskey Creek in 2018 was mentioned by multiple participants.

> *"The Coombs Fire Department responded to a flooding event affecting 40 homes around Whiskey Creek. A blocked culvert under the railway was identified as one of the contributory factors and has since been cleared out. The biggest challenge facing the response team was logistics and the one of the challenges and ultimate successes was the delivery of pizzas over a foot bridge." – Coombs Fire Department*

Flood incidents have the potential to cause psychological impacts, as well as support system impacts, leading to stress among those who are involved and those trying to help others cope. Following the 2013 Alberta flood, researcher Dr. Caroline McDonald-Harker conducted a study focusing on the families from one of the most significantly impacted communities, High River. In an interview, it was noted that "over half of the families [were] still suffering with some long-term effects, whether that be post-traumatic stress disorder, depression or anxiety" (CBC News, 2018, para. 4). Other studies show individuals involved in a natural disaster can still experience psychological impacts 10 years following an incident, which can place tension on relationships (CBC News, 2018).

Flood damage can pose extreme risks to residents returning home once flood waters have receded. Water impacts the structural integrity of homes and buildings, causing walls or floors to buckle and supports to weaken. Contamination from sewage and other pollutants pose a serious health hazard, as do moulds which thrive in damp conditions. For residents who rely on well-water, drinking water may be contaminated following a flood and require disinfecting (EMBC, 2015).

Flood events also have the potential to generate large quantities of debris and waste, which in turn can negatively impact recovery and re-entry efforts (BC Ministry of Environment and

Climate Change Strategy, 2018). The City of Grand Forks, in the interior of BC, experienced catastrophic flooding in May 2018 following a period of intense rainfall combined with runoff from an above-average snowpack. In total, 417 homes were damaged by floodwater in the Kootenay Boundary Regional District alone, with estimates of 67,000 cubic meters of waste generated. Debris ranged from soggy drywall and flooring, to fridges and freezers full of rotting meat, requiring significant clean up and management efforts on the part of residents, businesses, and local governments (Laanela & Keating, 2018).

While not within the Regional District of Nanaimo, the nearby City of Courtney experienced serious floods in 2009, 2010, and again in December 2014, when extreme rainfall (>180 mm in 48 hours) led to road closures and traffic delays, and flooding in homes and businesses. Approximately 15,000 Island customers were without power due to the winds accompanying the storm knocking trees onto power lines. Flooding delayed the response of BC Hydro crews due to road closures and the need to take detours to conduct repairs in affected areas. Similarly, the Cowichan Valley and City of Duncan experienced major flooding in 2007. An engagement session participant shared the impacts of this flood event:

> *"In November 2007, a major flooding event occurred in the Cowichan Valley including the City of Duncan. There was no loss of life, however, more than 300 homes and 1,000 residents were evacuated and almost 50 homes flooded. Utilities, gas and electricity were off, residents were warned in advance. While the flooding lasted about 4-6 weeks, restoration went on for upwards of 6 months before residents were able to return home. The event was generally caused by snow melt, excessive rain and higher than usual tides. An EOC was activated for the region and emergency services provided support for residents of the region."*
> *– Technical Safety BC representative*

WIND EVENT

	HAZARD	LIKELIHOOD		HUMAN & SOCIAL IMPACTS		PHYSICAL & ECONOMIC IMPACTS		RISK
	Wind Event	4	x	(16	+	19)	=	140

Windstorms are a common seasonal phenomenon in southwest BC (Read, 2015). In the fall and winter months, extratropical cyclones frequently pass over Vancouver Island bringing strong winds (Read, 2016). While the east coast of Vancouver Island is largely protected from these weather systems by the range of mountains which run the length of the island (the Vancouver Island Ranges), high wind events in the region are not uncommon.

Strong winds can topple trees, destroy structures, and disrupt power grids as evidenced by the windstorm which struck southwest British Columbia on December 20, 2018. This storm saw record-breaking sustained wind speeds of 85 km/hr recorded at the Nanaimo Airport, left over 750,000 BC Hydro customers without power and damaged or destroyed thousands of pieces of equipment – making it the most damaging storm in BC Hydro's history. Over 80% of electric customers (>350,000 customers) on Vancouver Island and the Gulf Islands lost power and many were subject to lengthy outages due to downed trees blocking crew's access to complete repairs (BC Hydro, 2019a). The communities of Gabriola Island (Electoral Area B), Cedar, and Yellow Point (Electoral Area A) were particularly hard hit, suffering extensive power infrastructure damage (Bush C. , 2018).

The windstorm highlighted the vulnerable nature of communities with limited connector routes or bypasses. With debris, downed trees, and fallen power lines blocking roads and traffic signals out in many places across the region, there were significant delays in travel time (Huffman, 2018). Transportation between Vancouver Island and the mainland was also disrupted with multiple ferry sailings cancelled or delayed during the windstorm.

Windstorms can also impact water infrastructure as shown by the disruptions that affected more than 100,000 people in nearby communities. In Nanaimo, residents were asked to conserve water for emergency use only as power outages impacted the ability of the South Fork Road Water Treatment Plant to produce drinking water (Bush C. , 2018). Meanwhile, on Salt Spring Island, water service to some areas was disrupted after downed trees damaged infrastructure (Bush C. , 2018).

The downing of trees and power lines during a windstorm can also threaten the health and safety of community members more directly. In the community of Duncan, just south of the region, one woman was killed, and two other people injured after a tree fell on their tent during the December 2018 windstorm (Judd & Schintz, 2018). Downed power lines also present a severe hazard of electrical shock or fire to people or things too close to the power line.

The frequency and intensity of wind events is expected to increase as the climate warms. Indeed, a recent report from BC Hydro (2018) indicates that there has already been a noted increase in both the recurrence and severity of storms and extreme weather events. These stronger, more frequent wind events will likely cause considerable damage to infrastructure, properties, power lines, and trees resulting in increased social and economic costs to the region.

WIND EVENT

Differences in air pressure resulting in the horizontal motion of air. The greater the difference in pressure, the stronger the wind. Wind moves from high pressure toward low pressure (Integrated Research on Disaster Risk, 2014, p. 18).

A wind warning is issued when there is "70 km/h or more sustained wind; and/or gusts to 90 km/h or more (Environment and Climate Change Canada, 2019b).

DROUGHT

HAZARD	LIKELIHOOD		HUMAN & SOCIAL IMPACTS		PHYSICAL & ECONOMIC IMPACTS		RISK
Drought Event	5	x	(12	+	16)	=	140

Water is a commodity that society has a critical dependence on; it is vital to sustain life, and to support ecosystems, agriculture, and the economy.

Approximately 64,000 residents in the region across all electoral areas and municipalities (excluding the City of Nanaimo) rely on groundwater for their water supply. In addition, many of the streams in the region rely on groundwater for base flow in the summer, which is essential to support aquatic life and habitat.

Although drought is more typical of drier areas (Natural Resources Canada, 2019b), BC's west coast is no exception and, in fact, may become more prone to the impacts of seasonal droughts in the future (Natural Resources Canada, 2019a).

Droughts can have varying impacts to society and the environment. Concerns include limitations to residential and commercial water supply (including drinking water supply); negative impacts to the agricultural industry due to early crop development; a lack of water to support crops and livestock and reduced groundwater levels resulting in decreased streamflow, warming river water, and impacts to aquatic and other wildlife.

In 2018, Vancouver Island, along with other regions of BC, experienced unparalleled heat triggering a level 4 drought (CTV News Vancouver Island, 2018). A level 4 drought is the most severe drought classification, indicating water supply is insufficient to meet socio-economic and ecosystem needs (see *Figure 11*) (Government of British Columbia, n.d.-c). Residents were encouraged to conserve as much water as possible in an effort to counteract the impacts of the drought (Crescenzi, 2018). This event contributed to several environmental impacts, including the ongoing elevated wildfire conditions, as well as record low flows for streams and tributaries, impacting aquatic life such as fish (Crescenzi, 2018).

The years 2014 through 2016 saw worrying drought conditions brought on by a combination of drivers including low snowpack, warmer than normal spring and summer air temperatures, and low spring and summer precipitation (Boon, 2016). As a result, the recreational fishery was closed for all three summers to protect the fish population, and efforts were made to capture Chinook salmon and truck them upstream to deeper, cooler spawning areas.

Figure 11 – Drought classification levels (Government of BC, n.d.)

LEVEL	CONDITIONS	SIGNIFICANCE	OBJECTIVE
1 (Green)	Normal Conditions	There is sufficient water to meet human and ecosystem needs	Preparedness
2 (Yellow)	Dry Conditions	First indications of a potential water supply problem	Voluntary conservation
3 (Orange)	Very Dry Conditions	Potentially serious ecosystem or socio-economic impacts possible	Voluntary conservation and restrictions
4 (Red)	Extremely Dry Conditions	Water supply insufficient to meet socio-economic and ecosystem needs	Voluntary conservation, restrictions and regulatory action as necessary

In 2015, the *Provincial Water Resource Management Branch* rated Vancouver Island as being at a Level 4 drought from July 3rd to September 3rd. During the summer of 2016, water was trucked-in, from external sources, when local residents' wells went dry and BC Hydro reduced north Island power generation to 15 per cent capacity, as flow in the Puntledge River was too low to activate their turbines (Boon, 2016).

With the region's significant dependence on tourism, droughts also have the potential to affect the region's economy and reputation. Tofino, another popular tourist destination on Vancouver Island, experienced a major water shortage in 2006 and had to rely on a backup reservoir (CBC News, 2006). With orders to conserve water, local businesses were forced to close and turn customers away.

With the effects of climate change, drought events are becoming increasingly common. The BC Government (n.d.) projects that with increasing temperatures, by the year 2050, droughts will become more severe and occur more frequently. The potential effects of climate change on drought were discussed during the HRVA engagement process. Participants agreed that the risk of decreased snowpack leading to less water supply for rivers and streams, will likely contribute to drought conditions in the future). In addition, engagement participants (2018–2019) shared details of long-term cascading effects of drought such as the risk of trees drying out, ultimately becoming more vulnerable to strong winds in the fall and winter months, and the risk of being uprooted and falling. These conditions could pose a serious risk to safety and result in power outages in the region in the event of a windstorm.

DROUGHT

Drought is a recurrent feature of climate involving a deficiency of precipitation over an extended period, resulting in a water shortage for activities, communities or aquatic ecosystems. In British Columbia (BC), combinations of insufficient snow accumulation, hot and dry weather, or a delay in rainfall may cause drought (Government of British Columbia, 2018, p. 1).

MOTOR VEHICLE INCIDENT

HAZARD	LIKELIHOOD		HUMAN & SOCIAL IMPACTS		PHYSICAL & ECONOMIC IMPACTS		RISK
Motor Vehicle Incident	4	x	(19	+	12)	=	124

Motor vehicle incidents can occur anywhere, at any time, which makes them difficult to predict. Accidents can be caused by a number of behavioural factors including distracted driving, speeding, driving under the influence of drugs or alcohol, and high-risk driving (ICBC, 2019b). Other factors include road conditions (e.g. damages, lighting, layout, animal crossings etc.), weather conditions (e.g. rain, snow, ice, etc.), and level of driving experience (Aljanahi, Rhodes, & Metcalfe, 1999). Motor vehicle incidents can vary in severity from minor fender-benders, to incidents causing lengthy transportation interruptions, extensive property or infrastructure damage, or resulting in multiple fatalities

Within the region (excluding the City of Nanaimo), ICBC documented a total of 3,186 crashes between 2013 and 2017 (see *Table 14*[7]). Of those crashes, a total of 925 resulted in injury or fatality (ICBC, 2019a).

Serious incidents involving fatalities can have devastating impacts for the families and communities of those involved. This was the case in the April 2018 Humboldt Broncos bus crash in Saskatchewan. This tragic incident took 16 lives and left 13 people with injuries (Malone, 2019). The psychosocial impacts of this crash rippled through the small community, and many of the first responders involved have been receiving mental health support following the incident (Malone, 2019). Events such as the tragedy presented can affect entire communities with impacts that far outlast the initial crash.

Table 14 – Crash statistics for the region (2013 – 2017) Source: (ICBC, 2019a)

Community	Total Crashes	Casualty Crashes
Bowser	56	11
Coombs	77	23
Errington	82	14
Gabriola Island	179	21
Lantzville	398	150
Nanoose Bay	362	92
Parksville	1,258	410
Qualicum Beach	774	204

Motor vehicle incidents also have the potential to cause damage to property including critical infrastructure and other buildings and structures. For example, in February 2019, a vehicle lost

[7] (ICBC, 2019a) **Data was unavailable for all communities within the seven Electoral Areas of the Regional District of Nanaimo*

control in Saanich and collided with a powerline pole, leaving over 2,300 customers without power (CTV News Vancouver Island, 2019b).

During the HRVA engagement process, participants discussed the potential impacts a motor vehicle incident could have in the region. Depending on the severity of the incident and technical requirements of an investigation or environmental clean-up requirements, major travel routes could be closed resulting in lengthy delays. Areas in the region without multiple or alternate access routes could be particularly vulnerable to traffic delays in the event of an accident. In cases where residents, businesses or industry are reliant on these transportation routes, this could also cause significant impacts on services and businesses overall. Constant disruptions can result in resident frustration and a desire for solutions, which, if it is not remedied, could place the region's reputation in to question as they may feel as though their concerns are not being addressed.

The potential impacts of traffic delays on Vancouver Island's tourist culture and the possible associated economic fallout was also discussed. Engagement participants expressed concern that tourists may decide to travel elsewhere to avoid regions that have a reputation of having difficult or regularly delayed travel routes which may, in turn, impact local business who rely on tourists for their income.

With a high percentage of senior residents and an aging population, the region has a large and growing population of people vulnerable to the impacts of a motor vehicle incident. The fatality rate for seniors involved in motor vehicle incidents far exceeds that of other age groups. Data obtained from Transport Canada revealed that from 2000 to 2015 more seniors died in traffic fatalities than in any other age group across Canada (Slaughter, 2018). Pre-existing health conditions and the diminished ability to withstand major trauma can make seniors more vulnerable to injury or death in a motor vehicle incident.

With the potential to damage property and infrastructure, as well as cause serious harm of fatality, motor vehicle incidents could greatly impact the region both social and economically. Additionally, the likelihood and/or consequences of motor vehicle incidents may also be affected by climate change in the future. Discussions during the engagement process (2018–2019) suggested that as weather events become more severe, driving conditions resulting from increased rain, wind, ice or snow can become increasingly hazardous and lead to more accidents.

Motor Vehicle Incident

An incident whenever a vehicle, be it a truck, passenger car, bus, farm vehicle or any other motor- or person-powered vehicle collides with another vehicle, train or other obstruction; or loses control and incurs damage (EMBC, 2019).

ELECTRICAL POWER OUTAGE

HAZARD	LIKELIHOOD		HUMAN & SOCIAL IMPACTS		PHYSICAL & ECONOMIC IMPACTS		RISK
Electrical Power Outage	5	x	(13	+	11)	=	120

With the increasing reliance on electrical power, any disruption in power could pose a serious risk to local residents and critical infrastructure. Electricity on Vancouver Island is provided to homes and businesses primarily by BC Hydro through four hydroelectric systems with six generating facilities (BC Hydro, 2019b). These facilities span the island in geographical extent from Jordan River in the south, to the John Hart facility in Campbell River. However, there are no generating facilities located directly within the region (BC Hydro, 2019b).

BC's land cover makes it particularly vulnerable to outages due to falling trees, as the overhead power lines have three times more trees per kilometer than any other region in North America (BC Hydro, 2018). Power outages often follow severe weather events such as wind and snow (Government of British Columbia, n.d.-g). Other causes of outages include "motor vehicle accidents, vandalism, and birds and animals interfering with electrical equipment" (BC Hydro, 2019a, p. 4).

A loss of power can affect individuals by restricting access to resources such as light, heat, running water and even food depending on the length of the incident. Within BC specifically, electrical power outages due to severe weather such as wind storms are becoming increasingly more common. BC Hydro (2017) reports residents of Vancouver Island experience 2.16 outages per year, per person, of which 44% occur during the winter storm season from mid-October to mid-February. The largest outage on record occurred in 2015, when a windstorm led to almost half of BC Hydro's customers, approximately 710,000 people, losing power across Vancouver's Mainland and Vancouver Island (CBC News, 2015). In 2018, a similar event resulted in over 300,000 BC Hydro customers losing power (Wadhwani, 2018). Of those customers, 110,000 were Vancouver Island residents with 67,000 located in the southern region of Vancouver Island and 43,000 in the northern region (Wadhwani, 2018).

Following a power outage event, BC Hydro works to restore power as soon as possible. BC Hydro prioritizes safety and will address any immediate concerns such as downed lines first (BC Hydro, 2019a). Once safety concerns have been addressed, BC Hydro works to restore power to critical services (fire, hospital, etc.) and areas with high concentrations of customers (BC Hydro, 2019a). As such, those who reside in more remote or rural communities may be without power for longer periods of time and ultimately be more vulnerable to the impacts of the outage.

The power grid is considered to be critical infrastructure and failures have the potential to greatly affected not only residents directly but also other critical infrastructure. The August 2003 blackout on the east coast of Canada and the US provides an example of the significant dependencies the critical infrastructure sectors have on electrical power as detailed below (Public Safety Canada, 2006).

- **Communications** – telecommunication companies experienced complications and cellular providers experienced increased volumes of calls causing the system to be overloaded
- **Banking and Finance** – due to the substantial dependence on technology including computer networks, telecommunications and wireless technology, this sector experienced an immediate degradation of services
- **Food Distribution** – difficulties with shipping and storage of inventory resulted in spoilage of product
- **Water Treatment, Supply and Distribution** – water supply was satisfactory during the event; however, some water treatment plants were said to have released partially treated waste back into waterways
- **Manufacturing** – during the power outage, commercial and industrial businesses closed or scaled back their manufacturing to conserve power
- **Transportation** – power loss led to difficulty for commuters as traffic lights and other electrical signs lost power, in addition buses, airport and rail transportation were delayed
- **Safety**
  - *Emergency Services* – received an increased number of calls and experienced transportation delays, along with communication difficulties and hospital delays
  - *Environmental Services* – chemical plants informed there were hydrocarbons that had been released into the air and boil water advisories were put in place after the release of partially treated waste in waterways

In addition to the above noted impacts to critical infrastructure sectors, the 2003 outage also hindered the ability of the oil and gas sector to manufacture or transport its products, and had substantial economic impacts with an estimated 26.4 million hours of work lost (Public Safety Canada, 2006). It was also reported that businesses saw an economic loss due to having to close their business or due to a decrease in sales following the outage.

Within the region itself, there have been some notable impacts to critical infrastructure resulting from electrical power outages. For example, a water treatment plant located in Nanaimo failed due to power loss following the significant 2018 windstorm (Migdal, 2018). During this event, Nanaimo residents were requested to restrict their non-essential water use and local businesses, such as restaurants, had to adapt or limit their services to deal with the water shortage (Migdal, 2018).

As adverse or severe weather is the leading causes of power outages, climate change could lead to an increase in outages. According to a report released by BC Hydro (2018), the number of individual storm events they responded to in the province tripled between 2013 and 2017. BC

Hydro customer outages resulting from a storm increased approximately 265% during this period – from 323,000 customers in 2013 to 1.18 million in 2017. With a trend for more frequent and destructive wind events the frequency of electrical power outages is expected to increase.

Electrical Power Outage

A power outage is a short or long-term loss of electric power to an area (Government of British Columbia, n.d.-f).

STRUCTURE FIRE

HAZARD	LIKELIHOOD		HUMAN & SOCIAL IMPACTS		PHYSICAL & ECONOMIC IMPACTS		RISK
Structure Fire	5	x	(14	+	10)	=	120

Structure fires include those fires burning in industrial, commercial or residential structures. Such structures include factories, storage facilities, office buildings, homes, schools, hotels, and retail outlets. Most structure fires are accidental and can occur at any time. In 2014, the top causes of residential and commercial structure fires in British Columbia were cooking equipment, matches and lighters (not for smoking use), smoker's material, and electrical equipment (Acada Consulting Inc., 2018). In 2013, a total of 35 structure fires were reported to have occurred within the region (excluding Nanaimo), which resulted in losses over $2.5 million (EMBC, 2013).

Structure fires can have different impacts due to the varying types of structures involved. Industrial and commercial fires can have serious implications for the community and tend to be more severe in nature than residential fires. These fires often result in significant costs to the companies involved, not only due to the damaged equipment, products or goods, and cost of repairs, but also the due to the lost revenue potential arising from lengthy closures and disruption of services. Depending on the recovery time, workers may experience impacts resulting from lost wages. Industrial fires can also pose complications for response and recovery due to the potential presence of hazardous materials and other on-site hazards.

In February 2019, a cement manufacturing facility located in Sooke, BC caught fire causing serious damage to the facility and the destruction of expensive equipment, with projected recovery costs of roughly half a million dollars (Gaetz, 2019). Because of the complex nature of the incident, mutual aid support was brought in from local fire detachments. The complexities included:

- Explosions,
- The presence of fuel and hydraulic fluids in the facility machinery,
- The involvement of heavy equipment,
- Compromised power lines, and
- Neighbouring trees on fire.

Residential fires have the potential to greatly impact individuals and families, destroying their belongings, leaving them without homes and in some cases, causing serious injury or fatality. A recent fire in an apartment building in Saanich, thought to have been caused by an electrical appliance failure, resulted in one fatality, two injuries and significant property damage from smoke and water (CTV News Vancouver Island, 2019a). Due to the extent of the damage, residents from over thirty units were left temporarily homeless, requiring support from Emergency Support Services and other agencies.

An engagement session participant shared details of a structure fire which occurred in July 2018 on Mudge Island as their most memorable hazard experience. Due to the extreme fire hazard at the time, the fire spread to the nearby trees and took 35 community members and fire fighters with helicopters to extinguish the blaze. In January 2019, four people were displaced after a fire destroyed their home in Bowser leaving the residents with few of their belongings (Blats, 2019). With a range of consequences from fatalities to property damage, it is likely that all of these incidents resulted in psychosocial impacts to those affected.

Structure fires can also affect buildings of high cultural importance such as churches, heritage buildings, as well as sites and facilities which are culturally significant to the region's First Nations. A recent example was the April 2019 fire at Notre-Dame Cathedral in Paris, described as "invaluable heritage", which affected thousands of people around the world. Such sites are often important contributors to the local economy, drawing visitors and tourists to the area.

Although structure fires can impact anyone, certain populations are more vulnerable to their impacts. Seniors, young children (under six years of age), as well as individuals with socio-economic disadvantages are thought to be at a higher risk of death from smoke inhalation or carbon monoxide poisoning (Garis, Hughan, & McCormick, 2016). While seniors, and young children, may not hear or be equipped to react to a smoke alarm, those with socio-economic disadvantages are more likely to not have functioning detectors on premise, making them more susceptible to the risks of fire. With a greater proportion of seniors in the region compared to the province, there may be a greater risk of injuries or fatalities due to structure fires. Additionally, with the largest proportion of low-income households in the region, Electoral Areas B, F and H could also be at a higher risk of impacts from structure fires. Those living in rural areas may be more vulnerable as a result of their limited access to firefighting resources such as fire hydrants. In 2018 a residential fire located near the Town of Qualicum Beach occurred and firefighters had to depend on water-tender shuttles for water to fight the blaze as there were no fire hydrants near the premises (Nanaimo News Bulletin, 2018).

Engagement session participants noted that structure fires may increase in frequency or severity in the future as a result of climate change. Increased storm frequency may lead to more or longer power outages, which can contribute to sources of fire ignition in structures. Additionally, dryer, hotter weather could act as a catalyst to fuel structure fires, causing them to spread to surrounding areas and/or making them more difficult to fight.

Structure Fire

A fire burning in industrial, commercial, or residential structures. Includes, but is not limited to, fires burning in factories, storage facilities, office buildings, homes and apartment buildings, schools, hotels, and retail outlets.

HUMAN DISEASE

	HAZARD	LIKELIHOOD		HUMAN & SOCIAL IMPACTS		PHYSICAL & ECONOMIC IMPACTS		RISK
	Human Disease	3	x	(21	+	12)	=	99

Human diseases are not new occurrences, however, with modern science and vaccines, they have become more preventable and manageable than they have been historically. Infectious human diseases spread via person to person contact, either directly or indirectly, and have the potential to lead to epidemics at the local level, and pandemics at the global level. Epidemics and pandemics can impact the functioning of critical infrastructure, businesses, and industry through above-normal employee absenteeism caused by the disease itself, caring for the ill, and/or by measures to contain the spread of the disease (quarantines, school and public building closures). Infectious human diseases can place extraordinary demands on the health care system and health care workers.

Infectious human diseases can originate from:

- Newly detected or unknown sources;
- Known sources that have spread to new populations and/or new geographic locations;
- Existing sources whose role in disease transmission was unknown in the past; and
- Infectious diseases once thought to have been eliminated and/or controlled but are now re-emerging.

Infectious human diseases cause serious illness and deaths every year. Although infectious diseases can affect anyone at any time, those with weak immune systems, those with pre-existing medical conditions, or those without access to appropriate vaccinations are particularly susceptible.

As a result of successful immunization, several diseases were considered ‘diseases of the past'. However, with some people declining to be vaccinated, or have their children vaccinated, the risk of contracting or spreading many of these diseases has risen. Measles, for example, is considered to be rare disease within Canada due to the success of the existing measles vaccine (Health Link BC, 2019). However, as measles is still prevalent in other regions around the world, Canadians who are not vaccinated can still be susceptible to the disease if they are exposed to the virus.

Prior to the measles vaccination being introduced in 1960, approximately 300,000 to 400,000 Canadians were diagnosed with the disease each year. In 1926, nearly 900 Canadians succumbed to measles and those who survived were at risk of living with permeant health complications, such as brain damage or loss of hearing (Government of Canada, 2019). In 2019, there were 29 patients in BC with confirmed measles diagnoses, eight of these cases were documented on Vancouver Island (Grossman, 2019). Though Canada's vaccination rate is high, the eight confirmed cases of measles that occurred on the Island were all associated with travel outside of the country and stresses the importance of vaccines as a tool to mitigate disease outbreaks.

Some other notable incidents of infectious human disease outbreak include:

- 1862 – Smallpox. Death toll in the thousands amongst BC's Indigenous population.
- 1918 to 1920 – Spanish Flu. 55,000 Canadians die. 4,000 in BC.
- 1957 to 1958 – Asian Flu. 2,000 Canadians die.
- 1968 to 1969 – Hong Kong Flu. 4,000 Canadians die.
- 2003 – SARS. 44 Canadians die.
- 2009 – H1N1. 428 Canadians die.

Human Disease

Diseases that are caused by pathogenic microorganisms and are spread directly, or indirectly, from one person to another.

> **Epidemic:** *refers to an increase, often sudden, in the number of cases of a disease above what is normally expected in that population in that area* (Center for Disease Control and Prevention, 2012, para. 3).
>
> **Pandemic:** *is the worldwide spread of a new disease. The total number of people who get severely ill can vary. However, the impact or severity tends to be higher in pandemics in part because of the much larger number of people in the population who lack pre-existing immunity to the new virus* (World Health Organization, 2010).

INTENTIONAL ACTS OF CBRNE

	HAZARD	LIKELIHOOD		HUMAN & SOCIAL IMPACTS		PHYSICAL & ECONOMIC IMPACTS		RISK
	Intentional Acts of CBRNE	2	x	(18	+	17)	=	70

CBRNE events are intentional criminal acts, often classified as acts of terrorism, involving chemical, biological, radiological, nuclear, or explosive materials. Public Safety Canada's (2019a) *2018 Public Report on the Terrorism Threat to Canada*, notes that Canada's National Terrorism Threat Level remains at medium (set early October 2014) – meaning a violent act of terrorism could occur. While the likelihood of a CBRNE event occurring is relatively low, the impacts such an event would have are significant.

An explosive CBRNE event is considered the most likely to occur due to the relative ease in producing an explosive device without specialized training and the abundance of materials to create one (Ontario Office of the Fire Marshal & Emergency Management, 2019). Chemical and biological agents require some degree of expertise due to the difficulty in dispersing them effectively. The least likely type of CBRNE event is a radiological or nuclear event. These events require a specialized device and a large amount of nuclear or radiological material.

The impact of a CBRNE event is dependent on a number of variables such as the type and quantity of material used, the delivery system and dispersal method, location, population density and exposure to the device contaminants, and environmental conditions at the time of the attack.

Consequences arising from a CBRNE event can include mass casualties, fatalities or illness; the need for a large medical response, decontamination systems and specialized medical intervention and equipment; negative psychosocial impacts and chronic health impacts for survivors (Ontario Office of the Fire Marshal & Emergency Management, 2019). Damage or other impacts to critical infrastructure, such as water, energy, and transportation can occur, as they are often the focus of the attack. Additionally, the creation of a hazardous environment associated with some CBRNE events, can influence not only the response but the recovery from a CBRNE event.

There has been a number of notable CBRNE events impacting infrastructure in Canada, primarily of an explosive nature. In May 1983, a bombing occurred damaging the Cheekeye-Dunsmuir Hydro substation on Vancouver Island which was under construction. The bombing was said to be the result activity by a radical environmental group, Direct Action, who were protesting the development of the substation (United Press International, 1982). The substation was near completion at the time of the attack; four transformers were significantly damaged, to a cost of

$6 million dollars (United Press International, 1982). Following the incident, police speculated nearly 200lbs of dynamite had been secured to the four transformers (Campbell, 2000). There were no injuries or fatalities.

In another instance in British Columbia, six bombs were set off at various locations along the EnCanada Gas Pipeline over a ten-month period in 2008/2009, causing property damage but no injuries (CBC News, 2011).

The past decade has seen a slow but steady rise in the use of chemical agents to carry out attacks abroad (Public Safety Canada, 2019a), and there are several international examples of events involving explosives, from which impacts have been severe. Conflicts and the evolving global security environment continue to influence the risk of CBRNE events locally.

Intentional Acts of CRBNE

An event that involves a potential, perceived, or actual act with chemical or biological, radiological, nuclear or explosive materials that are, or are suspected to be, used in a deliberate or intentional way to cause harm (Public Safety Canada, 2015b).

ACTIVE THREAT

HAZARD	LIKELIHOOD		HUMAN & SOCIAL IMPACTS		PHYSICAL & ECONOMIC IMPACTS		RISK
Active Threat	2	x	(19	+	14)	=	66

An active threat involves an individual who is actively killing or trying to kill people in an enclosed or populated area (U.S. Department of Homeland Security, 2008). While the likelihood of an active threat event occurring in the region is low, the consequences of such an event should it occur are very high. An active threat event can occur in a public area, or at locations specifically chosen for social, cultural, symbolic, or political significance (Ontario Office of the Fire Marshal & Emergency Management, 2019). Active threat events are typically dramatic, fear-provoking, and distressing for both those involved and those who observe the event, ultimately negatively impacting the social well-being of the entire community (Ontario Office of the Fire Marshal & Emergency Management, 2019).

Types of active threats may include:

- Active Shooter: an event involving multiple victims of firearms-related violence perpetrated by a single or multiple shooter;
- Vehicle Ramming Attack: an event where a perpetrator deliberately rams a motor vehicle into a building, crowd of people, or another vehicle;
- Stabbing Attack: an event where a perpetrator uses an edged weapon to deliberately harm people; and
- Improvised Explosive Device (IED): an event where a perpetrator makes a "homemade" bomb from non-conventional materials but excludes radiological or nuclear devices (Ontario Office of the Fire Marshal & Emergency Management, 2019, para. 13).

The types of weapons that are utilized in these types of situations are easy to acquire and thus challenging to prevent from being used for an active threat event (Ontario Office of the Fire Marshal & Emergency Management, 2019). Perpetrators of such events typically try to find 'soft targets' where people gather, generally with the goal of causing as much damage or injury as possible. Furthermore, active threat events typically progress rapidly and are therefore unpredictable with regard to who may be at risk. As such, active threat events are nearly impossible to defend against.

Possible impacts of an active threat event include:

- Human harm (psychological and/or physical) or fatality;
- Stress placed on support systems such as hospitals and emergency services;

- Missing persons;
- Interruption in various sectors such as government, business or financial;
- Individuals being displaced;
- Damage to property such as buildings or critical infrastructure; and
- Traffic delays (Ontario Office of the Fire Marshal & Emergency Management, 2019).

Locally, an active shooting took place in 2014 in a Nanaimo sawmill. A disgruntled former employee of the mill opened fire, killing two people and injuring two others who were taken to hospital with gunshot wounds (DeRosa, 2014). The victims, victim's families and mill employees were all offered counselling to support them as they processed the incident.

In April 2018, an active vehicle ramming event occurred in Toronto, Ontario, which resulted in 10 fatalities and 16 injuries (Westoll, 2019). Testimony from the victims, witnesses and families clearly express that this was an event that has changed their lives forever. The incident overwhelmed emergency services and healthcare facilities, and caused serious traffic disruptions in the city, with closures of several major roads and subway stations (Westoll, 2019).

Active threat events cause psychological and stress injuries, which can impact not only the responders and individuals directly involved with the incident, but others who hear about and see the incident through various media channels (Ontario Office of the Fire Marshal & Emergency Management, 2019).

It is evident through tragedies such as these that active threats have the potential for physical and psychological consequences, impacting those directly and indirectly involved. With the ease and accessibility of active threat weapons, it is likely these events will continue to occur; however, they will remain difficult to prepare for and thus will require a strong response and support services in the aftermath.

Active Threat

An active threat is when an individual is actively engaged in killing or attempting to kill people in a confined and populated area. This is inclusive of active shooters in both public and industrial spaces (U.S. Department of Homeland Security, 2008, p. 2).

MEGATHRUST EARTHQUAKE

HAZARD	LIKELIHOOD		HUMAN & SOCIAL IMPACTS		PHYSICAL & ECONOMIC IMPACTS		RISK
Megathrust Earthquake	1	x	(30	+	25)	=	55

Despite having a low frequency of occurrence, the megathrust earthquake hazard event was assigned the highest possible score for potential consequence. When a megathrust earthquake hits western Canada, it is expected to impact all communities within the region.

Megathrust earthquakes are huge “subduction” earthquakes that occur when the build-up of strain between two tectonic plates, one of which is being thrust under the other, is suddenly released (Natural Resources Canada, 2019). The subduction zone that would specifically affect the region is the Cascadia subduction zone which is found off the west coast of Vancouver Island and extends seven hundred miles south along the Pacific Northwest coast to California. Within the Cascadia subduction zone is the Juan de Fuca Plate and the North American Plate. The much smaller Juan de Fuca Plate is subducting underneath the much larger North American Plate, causing both plates to constantly converge. Due to the growing tension and friction where the plates are “stuck” together, when released, the result will be a megathrust earthquake.

Results of extensive research, including analysis of geological evidence, have revealed that the Pacific Northwest has experienced 41 subduction zone earthquakes in the past 10,000 years – a recurrence interval of 243 years (Schulz, 2015). Experts state there is a 12 per cent probability a Cascadia megathrust earthquake will occur in the next 50 years (Dangerfield, 2018).The last megathrust earthquake along the Cascadia subduction zone occurred on January 26, 1700. The earthquake caused intense shaking and also resulted in a massive tsunami that swept west, across the Pacific Ocean (Natural Resources Canada, 2019c). Oral history from the First Nations people of Vancouver Island noted that as a result of the shaking, houses belonging to the Cowichan people collapsed and several landslides were triggered. The effects of the shaking have been described as extremely intense and for such a lengthy period of time that people could not stand and felt sick as a result.

It is predicted that a megathrust earthquake will cause damage to buildings, infrastructure, and the environment, which will result in people being trapped, killed or injured from falling debris and associated secondary hazards such as tsunami, landslides or fires. Experts in B.C. and the U.S. estimate that the number of deaths could reach 10,000 with another 26,000 injured across the Cascadia subduction zone (Schulz, 2015). After the initial megathrust earthquake, additional casualties may occur from aftershocks or secondary hazards.

A study conducted by The Conference Board of Canada, which focused on the economic impacts 10 years after a significant earthquake occurred off the coast of BC, reported there are significant economic risks associated with disastrous events such as the megathrust earthquake (McIntyre & Desormeaux, 2016). Any impacts to the economy could directly affect both the efforts to rebuild and recover from a catastrophic incident; much of it being borne by the taxpayer, both for infrastructure/assets as well as some private losses (McIntyre & Desormeaux, 2016). This in turn can place significant stress on individuals and communities as they seek support to both overcome and move forward from the aftermath of a megathrust earthquake.

Due to the significant magnitude of a megathrust earthquake, the potential consequences to critical infrastructure would be unprecedented. Professor Saeed Mirza suggests, the current state of Canada's critical infrastructure is "very dire" (Kovacs, 2010, p. 17). Based on megathrust earthquakes that have occurred in other regions around the world, there are some ideas of what these consequences might be, as detailed below (Kovacs, 2010).

- **Electrical power and communication services** – due to the size and potential impact zone of a megathrust earthquake occurring in the Cascadia subduction zone, electric and communication infrastructure are expected to be compromised, not just locally on Vancouver Island but also extending into Vancouver's mainland and the United States. This would greatly restrict the accessibility of neighboring resources that contribute to bringing infrastructure and services back on line as quickly as possible. A prolonged lack of power and/or communication services has the potential to significantly impact a community's ability to recover.
- **Transportation** – a megathrust earthquake would result in serious interruptions to transportation services, with the potential to last for several weeks or even months. Within the region, transportation infrastructure at risk includes roads, bridges, ports, and airports. If significant damage to this infrastructure were to occur, the region would be extremely vulnerable as the provision of critical resources to enable the region and communities to recover, would be limited.
- **Water and underground utilities** – if underground utilities such as sewers and water lines are impacted, it is probable there would be extensive failure. This could lead to sewage back up, contamination of groundwater, and coupled with limited water availability, could result in a sizeable evacuation as communities are forced to relocate. Not only would a loss of water directly impact individuals as a critical resource to sustain life, but there is the potential that fires will result as a secondary hazard to the earthquake. Without the necessary water supply to contain these fires, further damage and lives could be put at risk.

Strong inter-dependencies between the various critical infrastructure sectors mean impacts to one sector may have cascading effects. Additionally, different levels of government and public and private agencies have responsibility over various critical infrastructure and assets, making the efforts to plan for, and respond to, significant earthquakes challenging. A coordinated approach to mitigation, preparedness, response and recovery will be essential to manage the risk.

Due to the scale of the megathrust earthquake that is likely to occur in the Cascadia subduction zone, it is certain there will be tremendous consequences directly impacting the physical and mental health of communities, critical infrastructure, the economy, the environment along with emergency and support services.

Megathrust Earthquake

A megathrust earthquake is a very large earthquake that occurs in a subduction zone, a region where one of the earth's tectonic plates is thrust under another. For the purposes of this definition, megathrust earthquakes have a magnitude of 8.5 or greater (Natural Resources Canada, 2019c).

09 Resiliency

Both vulnerability and resiliency are important, and closely related, concepts for evaluating a community's ability to cope with the impacts of a hazard event. While vulnerability looks at the factors that increase a community's susceptibility to damage from a hazard, resiliency is a measure of a community's ability to resist or recover from damage (SOPAC, 2002). Typically, the most vulnerable communities tend to be the least resilient (Bergstrand, Mayer, & Zhang, 2015).

UN Office for Disaster Risk Reduction (UNDRR) defines resilience as:

"The ability of a system, community or society exposed to hazards to resist, absorb, accommodate, adapt to, transform and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions through risk management."

(UN Office for Disaster Risk Reduction, 2017).

Just as social systems play a key role in human vulnerability to hazards, social systems also underpin many aspects of community resilience (Bergstrand, Mayer, & Zhang, 2015). Paton and Johnston (2001) identified a sense of community, or feelings of belonging, as being an important component of a community's ability to "bounce back".

The sense of connectedness and strong support networks in the region were highlighted by engagement session participants as an important aspect of current resiliency levels within the region. This sense of belonging was also emphasized by the results of the 2015–16 Canadian Community Health Survey (Provincial Health Services Authority, 2019). Almost three-quarters of the Central Vancouver Island HSDA[8] population (aged 12 and up) reported a somewhat strong or very strong sense of belonging to their local community. This sense of belonging may increase resident's involvement in community disaster response strategies (Bergstrand, Mayer, & Zhang, 2015). Several engagement session participants commented on the willingness of community members to collaborate on emergency preparedness initiatives across communities and organizations/agencies and their interest in taking a proactive approach.

Efforts to build resiliency and recovery capacity are most effective when undertaken at the regional and community level. Engagement session participants were asked to share their knowledge of current strategies that are contributing to resiliency within the region. These community and regional resiliency strategies were taken into consideration by the project team during the hazard consequence rating portion of this assessment.

[8] The Regional District of Nanaimo is included in the Central Vancouver Island Health Service Delivery Area (HSDA) along with the Alberni-Clayquot and Cowichan Valley regional districts

A selection of current resilience resources and strategies are captured below, grouped under the themes of “Prevention & Mitigation Activities” and “Preparedness & Response Resources”:

PREVENTION & MITIGATION ACTIVITIES

Non-Structural Mitigation

i.e. Strategies for encouraging safer and more sustainable development.

- Strategic Plans:
    - *City of Parksville 2019–2022 Strategic Plan* – includes actions for providing diverse housing options and development, support improved access to health care, and economic development.
    - *Town of Qualicum Beach 2019–2022 Strategic Plan* – includes actions for supporting a diversity of housing, implementing the Town’s Official Community Plan, improve transportation networks, and enhance alternative opportunities, and fostering economic opportunities.
    - RDN *2019–2022 Strategic Plan* – includes actions for climate change adaptation and mitigation, affordable housing, asset management, and economic diversification.
    - The *Regional Growth Strateg*y (RGS) – adopted by the RDN in 2011, it sets out a long-term strategic plan for sustainable population growth and development.
    - Official Community Plans (OCPs) – long-term strategies for land use, development, and servicing adopted by Electoral Areas and Municipalities within the region. The OCPs align with the goals of the RGS and are implemented primarily through zoning bylaws.
- Asset management programs to replace aging and existing infrastructure:
    - RDN *Asset Management Review and Implementation Report* (2019) – recently produced with a plan to develop an overall *Asset Management Plan Implementation Framework* in 2020 to operationalize the RDN’s asset management program.
    - The Town of Qualicum Beach has been in the process of developing a comprehensive asset management program since 2015.
    - The City of Parksville is currently working towards the adoption of an Asset Management Strategy.
- RDN *Sea Level Rise Adaptation Program* – The RDN recently commenced the first phase of an assessment of coastal areas that may be impacted by sea level rise within the Electoral Areas, Parksville and Lantzville. When complete, the entire coastal region from Electoral Area ‘H’ to ‘A’, including Area ‘B’ and member municipalities will have floodplain mapping, which will be used to better inform decision-making.

- Floodplain Management Bylaw (No. 1469) – Applies within the boundaries of the Regional District of Nanaimo Electoral Areas A, C, E, F, G and H. Bylaw updated December 2018 to incorporate sea level rise.
- Parksville Development Permit Areas (DPAs) – DPAs have been established for the City of Parksville to manage the development in hazardous areas, e.g. DPA No. 10 – Wildfire Interface Management Area, DPA No. 11 – Coastal Protection Development Area, and DPA No. 12 – Flood Plan Development Area.
- *Drinking Water and Watershed Protection (DWWP) Action Plan* – details regional initiatives to protect watersheds and drinking water. 10-year Plan updated in 2019.
- *Qualicum Beach Waterfront Master Plan* (2016) which includes goals for establishing a beach profile that will protect against future damage.

Structural Mitigation

i.e. Strategies for preventing damage to infrastructure and homes.

- Fire mitigation strategies to increase resilience in buildings in interface zone (FireSmart design standards). FireSmart infrastructure to provide safe access routes and adequate water supply for firefighting.
- Enforcing building codes.
- Stormwater mitigation features, e.g. storm sewers, culverts, ditches, overland flow on roadways, streams.
- Green infrastructure, e.g. bioswales, rainwater ponds, rain gardens, top soil retention, pervious pavers, to maintain hydrological function and resiliency.
- Dike mitigation to reduce flooding.
- Sandbag stocks around region.
- Improved existing dam infrastructure with new spillway. Fire suppression readiness – Initiatives underway to increase availability and maintenance of interface firewater and storage tanks to provide water sources closer to fire risk areas and provide enhanced fire protection. Preparedness & Response Resources

Education and Training

i.e. Strategies for enhancing public awareness and capabilities of response personnel.

- Emergency Preparedness Expo – Workshops and activities offered for residents to help improve preparedness and response
- Public presentations and other community outreach workshops
- Neighbourhood Emergency Preparedness Program (NEPP) – program designed to build neighbourhood level resiliency.
- Social media strategy – usage is being increased to deliver public education.
- Webpage developed for Emergency Preparedness
- Completion and dissemination of HRVA. Improved awareness of hazards within the region through engagement sessions and communication of report findings.

- FireSmart Communities Program and FireSmart Home Assessments – recommendations for property owners on how to mitigate fire hazards and implementing solutions for wildfire safety.

Emergency Response

i.e. Strategies for increasing response capacity and coordination.

- Emergency Plans – facilitates a collaborative and integrated approach to actions required to effectively coordinate a response to and recovery from an emergency or disaster within the region
- Regional Emergency Management Agreement – provides guidelines for coordinating an effective, multi-agency response when emergencies cannot be handled by local response agencies.
- Community Wildfire Protection Plans – identifies areas at high risk of wildfire; assigns planning priorities; and establishes a cooperative framework to improve community safety, reduce the risk of property damage, and protect natural resources.
- Emergency Management Oceanside (EMO) – partnership between Regional District of Nanaimo, City of Parksville, and Town of Qualicum Beach to increase efficiency and effectiveness of emergency management in the region.
- Emergency Operation Centre and Reception Centres pre-identified – yearly exercises and training for activation readiness and improvements
- Emergency Support Services (ESS) – organization of trained volunteers ready to assist residents in the event of an emergency.
- Emergency communications volunteers – volunteers, including operators licensed through Industry Canada as radio operators provide emergency communications within the region.
- Emergency Notification System – mass emergency notification system to deliver both text and voice calls to those signed up to receive notifications.
- Radio communication established between schools and administration centres and school busses.
- Emergency services inter-agency partnerships established with: RCMP, BC Ambulance Service (BCAS), Fire Departments (15 departments operating 23 fire halls), Search and Rescue (SAR), Canadian Coast Guard.

Additional response resources and services can be found in *Appendix 5*.

Resilience minimizes vulnerability by developing and fortifying the social and physical capacity to cope with, adapt to, respond to, recover, and learn from disasters (Public Safety Canada, 2019c).

As evidenced by the examples noted in the table above, significant efforts have been taken, or are underway, to enhance resiliency within the region. Many of these initiatives are being driven at the local level by individual communities and are not necessarily 'regional' initiatives.

Fundamental to recovery is the ability of communities to cooperate and join forces to overcome the many challenges when faced with an adverse event. Thus, community resilience takes a communal perspective to coping with disasters and encompasses ideas like problem-solving, efficiency, and adaptability (Bergstrand, Mayer, & Zhang, 2015). Consideration to coordinate and leverage the previous, current or planned efforts to enhance prevention, mitigation, preparedness, and response, by other communities and ideally at a regional level, will help to further the overall resiliency within the region.

010 Conclusion

> *"The reason one completes an HRVA is to set priorities for sustainable hazard mitigation – to develop an action plan towards becoming a disaster resilient community." (Pearce, 2011, p. 2)*

This HRVA is a foundational step towards enhancing regional resilience. Through the calculation and plotting of risk, the HRVA has provided local community members, stakeholders, and decision-makers with a view of the risks across all hazards. The findings can serve as a useful tool in promoting robust discussions, determining unacceptable levels of risk, and arriving at highest priority hazards for risk management, resiliency building, and emergency preparedness activities.

The HRVA process, through engagement with local stakeholders and Indigenous community leaders, served to strengthen relationships and build a shared understanding of risks posed to the region as a method to contribute to long-term resiliency. Several workshop participants shared the value the HRVA and engagement session offered to their member communities and agencies.

> *"We learned that familiarization with each other's methods and how you share information and what you're capable of doing and not capable of doing has benefited us now with subsequent incidents. There's more knowledge about how everybody can work together." (Engagement Session Participant)*
>
> *"The benefit of being connected together, understanding from the onset of an event what the possible scope would be, that way we can gauge how we need to be able to respond after the fact." (Engagement Session Participant)*

The results of the assessment reveal that natural hazards pose the greatest risk to the region, and that the risk from the majority of hazards locally is increasing, due to climate change and urbanization. Within British Columbia, climate change has already resulted in increased average temperatures, rising sea levels, as well as increased rates of severe weather events (BC Ministry of Environment and Climate Change Strategy, 2019). The BC Ministry of Environment and Climate Change anticipates that severe wildfire seasons and seasonal water shortages will be the greatest risks to all of British Columbia as a result of climate change by the year 2050 (BC Ministry of Environment and Climate Change Strategy, 2019).

While a detailed description of the top hazards was presented in this report, this selection represents a small portion of the hazards the region faces. With a total of *53 hazards* identified, the results of the HRVA can be leveraged by individual communities and stakeholder agencies to consider the likelihood of occurrence and consequences posed to them specifically.

With the identification of the high-risk hazards and acknowledgement of the evolving risk locally due to climate change and urbanization, the next step for the region is to specify approaches to manage and mitigate the risk.

Highest risk natural hazards

- Wildfire and Urban Interface Fire
- Overland Flooding
- Wind Event
- Drought

Highest risk technological hazards

- Motor Vehicle Incident
- Electrical Power Outage
- Structure Fire

Highest consequence hazards

- Megathrust Earthquake
- Intentional Acts of CBRNE
- Active Threat
- Human Disease

This report serves as a resource to support current and proposed projects, or the prioritization and initiation of new projects, to support resiliency building and risk mitigation, such as:

- Assessing the capacity of local critical assets and response resources to withstand and respond to an impactful hazardous event and maintain or resume services (business continuity planning);
- Collaborating with critical infrastructure owners/operators, and provincial and federal government agencies to understand the current and future strategies identified to protect their assets and property from potential hazards, and maintain their ability to deliver services during an incident;
- Identifying the applicability, and mapping, of the hazards to the specific electoral areas and communities in the region, such as preparing and updating flood and wildfire hazard maps;

As the local impacts of climate change transpire, and new information becomes available, the results of this hazard assessment should be re-evaluated, and the prioritization of associated mitigation and adaptation strategies reconsidered.

One of the key factors in developing a resilient community is to motivate and support residents in undertaking prevention and mitigation efforts and engaging in preparedness activities. Publicly sharing the HRVA, can enhance the awareness of the community to the existing and potential hazards in the region, and the corresponding risk. Educating the region's residents can increase the prioritization and support of initiatives that can move the region towards becoming a more disaster resilient community.

Future strategies to reduce the risk of disasters should aim at preventing the creation of risk; reducing existing risk; strengthening economic, social, health and environmental resilience; and enhancing preparedness for effective response and to "build back better" in recovery (UN Office for Disaster Risk Reduction, 2019). Alignment and prioritization of policies across local governments and communities within the region, as well as execution of an integrated and inclusive planning process, will be essential to manage the evolving risk and will contribute to a safer and more resilient region.

Through the efforts of the Production Team and the engagement session participants, the region has an assessment that can be confidently used in risk-based decision making, the setting of priorities for proactive hazard mitigation, and in developing an action plan towards becoming a disaster resilient community.

Appendices

APPENDIX 1. Glossary of Key Terms

Asset	Equipment or personnel used to deliver a service. People, structures, facilities, buildings, materials, and processes can all be considered Assets (EMBC, n.d.-a, p. 4).
Consequence/ Impact	The physical/environmental, social, economic, and political impact or adverse effects that may occur as the result of a hazardous event (EMBC, 2011, p. 3).
Critical Infrastructure	The processes, systems, facilities, technologies, networks, assets and services essential to the health, safety, security or economic well-being of a community. Critical infrastructure can be stand-alone or interconnected and interdependent within and across provinces, territories and national borders. Disruptions of critical infrastructure could result in catastrophic loss of life, adverse economic effects and significant harm to public confidence (Public Safety Canada, 2019b, para. 1).
Frequency	The number of occurrences of an event in a defined period of time (Public Safety Canada, 2018a).
Hazard	A source of potential harm, or a situation with a potential for causing harm, in terms of human injury; damage to health, property, the environment and other things of value; or some combination of these (EMBC, 2011, p. 3).
Likelihood	The chance of an event or an incident happening, whether defined, measured or determined objectively or subjectively (Public Safety Canada, 2012).
Mitigation	Mitigation measures are those that eliminate or reduce the impacts and risks of hazards through proactive measures taken before an emergency or disaster occurs (Public Safety Canada, 2015a, para. 1).
Preparedness	The phase of emergency management during which action is taken to ensure that individuals, businesses, and the jurisdiction/ organization are ready to undertake emergency response and recovery (EMBC, 2019, p. 98).
Recovery	The restoring or improving of livelihoods and health, as well as economic, physical, social, cultural and environmental assets, systems and activities, of a disaster-affected community or society, aligning with the principles of sustainable development and "build back better", to avoid or reduce future disaster risk (UN Office for Disaster Risk Reduction, 2017).

Resilience	The ability of a system, community or society exposed to hazards to resist, absorb, accommodate, adapt to, transform and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions through risk management (UN Office for Disaster Risk Reduction, 2017).
Vulnerability	The conditions determined by physical, social, economic and environmental factors or processes which increase the susceptibility of an individual, a community, assets or systems to the impacts of hazards (UN Office for Disaster Risk Reduction, 2017).

APPENDIX 2. Hazard Definitions

The following list of hazards was compiled to capture hazards relevant to the region. The hazards are arranged alphabetically – first by hazard category (Conflict, Natural, Technological), then by sub-category (e.g. Security/Threat, Biological, Climatological, etc.).

In total, 53 hazards were identified that could affect the region, determined through the review of historical data, previous HRVAs, provincial (EMBC), federal (Public Safety Canada) and international hazard lists; and engagement of community members and subject matter experts.

A variety of emergency management and risk reduction standards, frameworks, and tools were surveyed to tailor the approach to classifying and grouping hazards, which resulted in the following broad hazard types, conflict, natural and technological, being defined. Within each category, hazards were further classified into sub-categories, as listed below.

Conflict Hazards	Natural Hazards	Technological Hazards
Human-caused hazards originating from intentional human actions.	*Environmental processes that have the potential to interact with humans and infrastructure.*	*Hazards that stem from technological or industrial conditions as well as the consequences of an event related to a natural hazard.*
• Security/Threat	• Biological • Climatological • Extraterrestrial • Geological • Hydrological – Flooding • Hydrological – Other • Meteorological	• Hazardous Materials • Infrastructure Failure • Communications • Energy • Food • Health • Water • Other Incidents • Transportation Incidents

CONFLICT HAZARDS

Security/Threat

A hazard originating from intentional human actions.

Active Threat	An active threat is when an individual is actively engaged in killing or attempting to kill people in a confined and populated area (U.S. Department of Homeland Security, 2008, p. 2). This is inclusive of active shooters in both public and industrial spaces.
Cyber Security Threat	A circumstance or event with the potential to interrupt or adversely impact organizational operations, assets, or individuals (including mission, functions, image or reputation). Cyber threats occur through information systems via unauthorized access, destruction, disclosure, modification of information, and/or denial of service.
Hijacking	The unexpected, unlawful and forceful seizure of control aboard an aircraft, boat or ship, wheeled or tracked vehicle by an individual or group of individuals resulting in passenger and crew endangerment, injury or death, and/or the redirection of flight destination (Public Safety Canada, 2015b). This definition also includes forceful seizure of control of public buildings resulting in endangerment, injury or death.
Intentional Acts of CBRNE	An event that involves a potential, perceived, or actual act with chemical or biological, radiological, nuclear or explosive materials that are, or are suspected to be, used in a deliberate or intentional way to cause harm (Public Safety Canada, 2015b).
Public Disturbance	An act or interruption that interferes with the operation of society and the ability of people to function efficiently. Examples include mass gatherings, riots and demonstrations.

NATURAL HAZARDS

Biological

A hazard caused by the exposure to living organisms and their toxic substances or diseases.

Animal Disease	Animal diseases or sicknesses can be spread from animals to animals and from animals to humans. They can be classified as: non-infectious diseases, infectious diseases, and diseases caused by parasites (Pearce, 1997).
Human Disease	Diseases that are caused by pathogenic microorganisms and are spread directly, or indirectly, from one person to another. **Epidemi**c refers to an increase, often sudden, in the number of cases of a disease above what is normally expected in that population in that area (Center for Disease Control and Prevention, 2012, para. 3). **Pandemic** is the worldwide spread of a new disease. The total number of people who get severely ill can vary. However, the impact or severity tends to be higher in pandemics in part because of the much larger number of people in the population who lack pre-existing immunity to the new virus (World Health Organization, 2010).
Insect Infestation and Plant Disease	An event involving invasive pests such as insects and mites or plant pathogens including fungi, bacteria and viruses.

Climatological

A hazard caused by long-lived atmospheric process and climate variability.

Air Quality	Air pollution occurs when the air contains gases, dust, fumes or odour in harmful amounts. Substances that cause air pollution are called pollutants and they can be liquid, solid, or gaseous. An air quality advisory is issued when pollutant concentrations approach or exceed predetermined limits, or when degraded-air-quality episodes are expected to continue or worsen (Government of British Columbia, n.d.-a). *British Columbia utilizes the Air Quality Health Index (AQHI) to issue advisories on a scale of 1 to 10. The higher the number, the greater the health risk associated with the air quality.* • 1-3: Low health risk • 4-6: Moderate health risk • 7-10: High health risk • 10 $^{+}$: Very high health risk (Government of Canada, 2019).
Drought	Drought is a recurrent feature of climate involving a deficiency of precipitation over an extended period, resulting in a water shortage for activities, communities or aquatic ecosystems. In British Columbia (BC), combinations of insufficient snow accumulation, hot and dry weather, or a delay in rainfall may cause drought (Government of British Columbia, 2018, p. 1).
Fires (Wildfire and Wildland Urban Interface)	**Wildfire:** An unplanned fire – including unauthorized human-caused fires – occurring on forest or range lands, burning forest vegetation, grass, brush, shrub, peat lands, or a prescribed fire set under a regulation which spreads beyond the area authorized for burning (EMBC, n.d.-b). **Wildland Urban Interface (WUI):** Any area where combustible forest fuel is found adjacent to homes, farm structures, or other outbuildings. This may occur at the interface, where development and forest fuel (vegetation) meet at a well-defined boundary, or in the intermix, where development and forest fuel intermingle with no clearly defined boundary (EMBC, n.d.-b).

Extraterrestrial

A hazard originating outside of the earth's atmosphere.

Extraterrestrial Debris	A type of extraterrestrial hazard caused by a natural object (e.g. meteoroid, asteroid, comet etc.) or human-made object (e.g. satellite, space vehicle etc.) entering the earth's atmosphere and the resulting debris colliding with the earth.
Geomagnetic Storm	A type of extraterrestrial hazard caused by solar wind shockwaves (solar flare) that temporarily disturb the Earth's magnetosphere.

Geological

A hazard originating from solid earth.

Avalanche	The movement of snow and ice in response to the force of gravity down a mountainside.
Coastal Erosion and Sedimentation	The temporary or permanent loss of sediments or landmass in coastal margins due to the action of waves, winds, tides or human activities (Integrated Research on Disaster Risk, 2014, p. 13).
Landslide	A landslide is any type of slope failure or downward movement of rock and/or sediment (includes rock-fall, debris flows, slumps and slides, etc.). Excessive rainfall, earthquakes and certain human activities are some of the factors that commonly trigger landslides (Natural Resources Canada, 2017, para. 1).
Earthquake	An earthquake is defined as the shaking of the ground due to movement along a fault rupture (EMBC, 2019). For the purposes of this definition, an earthquake is considered to have a magnitude of between a 5 to 8.4 (Note: "Megathrust earthquakes", those with a magnitude of 8.5 and above, are defined separately).
Land Subsidence and Sinkholes	The sinking or caving in of the ground due to groundwater removal, mining, dissolution of limestone (e.g., karst, sinkholes), extraction of natural gas, and earthquakes (Integrated Research on Disaster Risk, 2014, p. 17).
Megathrust Earthquake	A megathrust earthquake is a very large earthquake that occurs in a subduction zone, a region where one of the earth's tectonic plates is thrust under another. The Cascadia subduction zone is located off

	the west coast of North America. From mid Vancouver Island to northern California the Juan de Fuca Plate is subducting beneath the North American Plate. The two plates are continually moving towards one another yet become "stuck" where they are in contact. Eventually the build-up of strain exceeds the friction between the two plates and a huge megathrust earthquake occurs (Natural Resources Canada, 2019c, para. 1). For the purposes of this definition, megathrust earthquakes have a magnitude of 8.5 or greater.
Volcanic Ash Fallout	Ash falls occur where fine volcanic ash has been ejected out of a volcanic vent into the atmosphere, possibly transported by upper level winds, and deposited on the earth.

Hydrological – Flooding

A flood is a general term for the overflow of water from a lake, river, or stream channel onto normally dry land (rivers, lakes and stream flooding), higher-than normal levels along the coast (coastal flooding), as well as ponding of water at or near the point where the rain fell (overland flooding) (Integrated Research on Disaster Risk, 2014, p. 14).

Coastal Flooding	Higher-than-normal water levels along the coast caused by tidal changes or thunderstorms that result in flooding, which can last from days to weeks (Integrated Research on Disaster Risk, 2014, p. 13). High winds from tropical cyclones or other storms push water onshore to create a storm surge, which is the leading cause of coastal flooding and represents the greatest threat associated with such storms. Coastal flooding can be amplified or dampened by tides, both daily tides and periodic king tides, which are much larger tides that occur monthly or yearly due to the interaction of the earth, moon, and sun in their orbits (Resource and Environment Working, n.d., p. 7). **Storm Surge:** A storm surge consists of very high waves and high water levels caused by the wind and air pressure "pushing" the water onto the shore, often resulting in high waves and flooding. Storm surge can occur along all coastal areas of Canada. It can also occur in large lakes, such as the Great Lakes (Public Safety Canada, 2018c). **King Tide:** King Tides (also known as perigean spring tides) are extreme high tide events that occur when the sun and moon’s

	gravitation forces reinforce one another at times of the year when the moon is closest to the earth. They happen twice a year but are typically more dramatic during the winter (Government of British Columbia, 2015, para. 1).
Rivers, Lakes and Streams Flooding	A type of flooding resulting from the overflow of natural lake shorelines or water from a stream or river channel onto normally dry land in the floodplain adjacent to the channel (Integrated Research on Disaster Risk, 2014, p. 16). These floods can be caused by intense rainfall, rapid snowmelt (including **freshet** events), and **ice jams** blocking the rivers. **Freshet:** The movement of water associated with the thawing of ice and snow each spring. This runoff can result in high water levels in streams, lakes and other waterways (Abbott & Chapman, 2018, p. 17). **Ice Jams:** The accumulation of floating ice restricting or blocking a river's flow and drainage. Ice jams tend to develop near river bends and obstructions (e.g., bridges) (Integrated Research on Disaster Risk, 2014, p. 15).
Overland Flooding	Overland flooding (also known as "pluvial flooding") results from rainfall-generated overland flow. This type of flooding is usually associated with high intensity rainfall events (typically >30mm/h) but can also occur with lower intensity rainfall or melting snow where the ground is saturated, frozen, developed or otherwise has low permeability resulting in overland flow and ponding in depressions in the topography (Maksimovic, 2015). High intensity 'extreme' rainfall events in urban environments may cause sewerage/drainage systems to be completely overwhelmed and result in flooding.

Hydrological – Other

A hazard originating from surface and/or subsurface freshwater or saltwater.

Saltwater Intrusion	When saline (salty) water is drawn in into a freshwater aquifer, making the water unpotable. This can affect one well or multiple wells in an aquifer and can occur either due to natural processes or human activities (Government of British Columbia, 2016a, p. 1).
Seiche	A standing wave of water in a large semi- or fully-enclosed body of water (lakes or bays) created by strong winds and /or a large difference in atmospheric pressure (UN Office for Disaster Risk Reduction, p. 3).
Tsunami	A series of waves (with long wavelengths when traveling across the deep ocean) that are generated by a displacement of massive amounts of water through underwater earthquakes, volcanic eruptions or landslides. Tsunamis travel at very high speed across the ocean but slow down and grow steeper as they begin to reach shallow water (Integrated Research on Disaster Risk, 2014, p. 17). This definition includes the effects caused by both remote source (telegenic) tsunamis and those caused by terrestrial and submarine landslides (terrestrial).

Meteorological

A hazard caused by short-lived extreme weather and atmospheric conditions.

Cold Event	A period of abnormally cold weather. Typically, a cold wave (-15°C) lasts two or more days and may be aggravated by high winds.
Fog	A cloud based at the earth's surface, consisting of tiny water droplets, or under very cold conditions, ice crystals or ice fog. It is generally found in calm or low wind conditions. Under foggy conditions, visibility is reduced to less than 1 kilometer (Environment and Climate Change Canada, 2017). A fog advisory is issued when fog is expected to persist and induce low visibility for at least 6 hours
Freeze Event *(Frost, Freezing Rain, Flash Freeze)*	An event involving the deposit or coating of ice on an object, e.g.: **Frost:** A deposit of ice crystals that forms through the process of sublimation (Environment and Climate Change Canada, 2017), which occurs when the temperature of surfaces is below freezing and water vapor from humid air forms solid deposits

	on the cold surface (Integrated Research on Disaster Risk, 2014, p. 15). **Freezing Rain:** Rain that freezes on impact to form a coating of clear ice (glaze) on the ground and on exposed objects. A freezing rain warning is issued when freezing rain is expected to pose a hazard to transportation or property or when freezing rain is expected for at least 2 hours. **Flash Freeze:** When significant ice is expected to form on roads, sidewalks or other surfaces over much of a region because of a rapid drop in temperature resulting in the freezing of residual water from either melted snow or falling/fallen rain.
Hail	Precipitation in the form of ice lumps which develop in the core of a thunderstorm. Hailstones have a minimum diameter of 5 mm and can grow larger than 10 cm (the size of a grapefruit). Hail can hit the ground at 130 kilometers per hour (Public Safety Canada, 2015d, para. 2).
Heat Event	A period of abnormally hot and/or unusually humid weather. Typically, a heat wave lasts two or more days (Integrated Research on Disaster Risk, 2014, p. 15). A heat warning is issued when 2 or more consecutive days of daytime maximum temperatures are expected to reach 29°C or warmer and nighttime minimum temperatures are expected to fall to 16°C or warmer.
Rainfall Event	Water vapor condenses in the atmosphere to form water droplets that fall to the Earth (Integrated Research on Disaster Risk, 2014, p. 16). Inland Vancouver Island will receive a rainfall warning when 100 mm or more of rain is expected within 24 hours. Coastal sections will receive a rainfall warning when 50 mm or more of rain is expected within 24 hours, or when 75 mm of rain is expected within 48 hours.
Snow Event	Meteorological disturbance giving rise to a heavy fall of snow, often accompanied by strong winds (also referred to as a blizzard or blowing snow event) (EMBC, 2019).

	A snowfall warning is issued when 10 cm or more of snow falls within 12 hours or less; or when 5 cm or more of snow falls within 6 hours or less (Government of Canada, 2019, table 18). A blowing snow advisory is issued when blowing snow, caused by winds of at least 30 km/h, is expected to reduce visibility to 800 m or less for at least 3 hours (Government of Canada, 2019, table 3).
Thunderstorm	A local storm, usually produced by a cumulonimbus cloud, and always accompanied by thunder and lightning (Environment and Climate Change Canada, 2017).
Wind Event	Differences in air pressure resulting in the horizontal motion of air. The greater the difference in pressure, the stronger the wind. Wind moves from high pressure toward low pressure (Integrated Research on Disaster Risk, 2014, p. 18). A wind warning is issued when there is 70 km/h or more sustained wind; and/or gusts to 90 km/h or more.

TECHNOLOGICAL HAZARDS

Hazardous Materials

A hazardous material is any agent which has the potential to cause harm either by itself or through the interaction with other factors.

Hazardous Materials Release – Land	A spill on site or transport route is any uncontrolled release of material posing a risk to health, safety, and property (Government of British Columbia, 2004, pp. 4-10). Includes all incidences whether they are in-transit or stationary, motor vehicle, rail, pipeline or industry related.
Hazardous Materials Release – Marine	An accidental leak, spill or release of a chemical into the marine environment which poses a danger to human or ecosystem health. Includes both tidal and non-tidal, in-transit and stationary incidences.

Infrastructure Failure – Communications

A hazard arising from the disruption of communication and technology services, including provision of networks, data lines, and internet service by the local government. Information and communications technology include providing voice-over-internet service, data services, first responder communications, etc.

Communications Interruption	The unavailability of services provided by the communications infrastructure caused by human error, equipment malfunction or breakdown (Public Safety Canada, 2015b). Included in this definition are interruptions to landlines, cellphones, internet, commercial radio, satellites etc.

Infrastructure Failure – Energy

A hazard arising from the inability to of the local government to provide energy to the community. Energy and utilities include electrical power provision and the municipally owned related infrastructure (power lines, transmission stations), natural gas provision and the externally owned related infrastructure, the supply and distribution of gasoline, etc.

Dam Failure	Dam failure is a breach in the dam itself, its foundations, abutments, or spillway, which results in large or rapidly increasing, uncontrolled releases of water from the reservoir (Government of British Columbia, 2004, pp. 4-8). **Dam:** A barrier constructed for the purpose of enabling the storage or diversion of water diverted from a stream or an aquifer, or both (Government of British Columbia, 2016c, para. 1). **Spillway:** Structures constructed to provide safe release of flood waters from a dam to a downstream area, normally the river on which the dam has been constructed (Jamal, 2017, para. 1).
Electrical Power Outage	A power outage is a short or long-term loss of electric power to an area (Government of British Columbia, n.d.-f).
Fuel Supply Interruption	A deficit, interruption or failure of fuel systems, services, supplies or resources (EMBC, 2019). Includes pipeline damage, transportation delays due to weather and/or shipping infrastructure damage or general shortages due to market supply problems, or panic fuel hoarding during emergencies.

Infrastructure Failure – Food

A hazard arising due to the inability to safely produce and distribute food.

Food Supply Chain Interruption	A disruption to the food supply or delivery system that may result in food shortages in a community.

Infrastructure Failure – Health

A hazard arising due to the interruption of health services that are provided and managed by the local government.

Health Interruption	An interruption to basic health services. Includes the reduction or loss of access to healthcare systems and/or medical resources e.g. prescription supply, health workers, health facilities and services, and specialized health technology.

Infrastructure Failure – Water

A hazard arising due to the failure of the provision of safe drinking water and removal & processing of wastewater by the local government. Examples include the provision of drinking water, removal and processing of sewer and wastewater, inspection and maintenance of wells and reservoirs, etc.

Potable Water Supply Interruption	A deficit, interruption or failure of water systems, services, supplies or resources. The types of water included in this definition are; well water, treatment facilities, storage, water supply contamination.
Waste Water Interruption	A deficit, interruption or failure of waste water or sewer systems, services, supplies, or resources. Facilities included in this definition are; Sanitary facilities, pump stations, septic fields, runoff, leaks and contamination.

Other Incidents

A category to capture other incidents such as an explosion, building collapse, etc.

Bridge Collapse	The failure of a bridge structure or component resulting in a loss of structural integrity or load-carrying capacity.
Building Collapse	The failure of a building structure or component resulting in a loss of structural integrity or load-carrying capacity. Structural collapse occurs when a building or structure collapses due to engineering or construction problems, metal fatigue, changes to the load bearing capacity of the structure, human operating error or any other cause such as earthquake, flood, fire, explosion, and snow or ice buildup (Government of British Columbia, 2004, pp. 4-11).
Incident at the Canadian Forces Maritime Experimental Test Range (CF-METR)	An incident involving the Canadian Forces Maritime Experimental and Test Ranges (CF-METR), which is a maritime test facility located at Nanoose Bay hosting nuclear-powered vessels and vessels carrying fissionable material.

Structure Fire	A fire burning in industrial, commercial, or residential structures. Includes, but is not limited to, fires burning in factories, storage facilities, office buildings, homes and apartment buildings, schools, hotels, and retail outlets.

Transportation Incidents

The category transportation incident can include incidents associated with motor vehicle, aircraft, marine, and/or rail.

Aircraft Incident	An air crash is an incident involving one or more aircrafts that results in damage to aircraft, property or human injury or death. Most crashes occur near airports; however, they can occur anywhere in the rugged terrain of British Columbia (Government of British Columbia, 2004, pp. 4-7).
Motor Vehicle Incident	An incident whenever a vehicle, be it a truck, passenger car, bus, farm vehicle or any other motor- or person-powered vehicle collides with another vehicle, train or other obstruction; or loses control and incurs damage (EMBC, 2019).
Marine Vessel Incident	An event involving a boat or ship that threaten human life, property and natural resources that may or may involve a vessel submerging, damage, bodily injury, death and/or the disruption of transportation service (Public Safety Canada, 2015b).
Rail Incident	When a train derails or collides with another train, motor vehicle, or obstruction on the rail tracks. Rail accidents have potential for a severe human or environmental impact (Government of British Columbia, 2004, pp. 4-7).

APPENDIX 3. Full Hazard Assessment Scores

Hazard Table with all Likelihood, Consequence and Risk Scores

Hazard	Likelihood (1-5)	*Human & Social Impacts*							*Physical & Economic Impacts*						Overall Consequence (11-55)	Risk	Confidence Rating
		Fatalities (1-5)	Injury/Illness (1-5)	Displacement (1-5)	Psychosocial (1-5)	Support System Impact (1-5)	Cultural Resource Impact (1-5)	Sub-Total (6-30)	Property Damage (1-5)	Critical Infrastructure (1-5)	Environmental (1-5)	Economic (1-5)	Reputational (1-5)	Sub-Total (5-25)			
Fires (Wildfire and Urban Interface)	5	2	2	4	3	4	4	19	3	4	4	4	3	18	37	185	Ⓐ
Overland Flooding	5	2	2	3	3	3	2	15	3	3	3	2	3	14	29	145	Ⓒ
Wind Event	4	2	3	3	2	3	3	16	4	4	4	4	3	19	35	140	Ⓐ
Drought	5	1	2	2	1	3	3	12	2	3	4	4	3	16	28	140	Ⓑ
Motor Vehicle Incident	4	4	4	2	4	4	1	19	3	2	2	2	3	12	31	124	Ⓑ
Electrical Power Outage	5	2	2	3	2	3	1	13	2	3	1	3	2	11	24	120	Ⓑ
Structure Fire	5	2	2	2	3	2	3	14	3	2	2	1	2	10	24	120	Ⓐ
Rivers, Lakes, and Stream Flooding	5	1	1	2	2	2	1	9	2	3	3	3	3	14	23	115	Ⓑ
Coastal Flooding	5	1	1	2	1	1	4	10	3	3	2	2	2	12	22	110	Ⓒ
Freeze Event	5	2	2	1	2	2	1	10	2	2	3	2	2	11	21	105	Ⓑ
Saltwater Intrusion	5	1	1	2	1	2	3	10	2	2	4	1	2	11	21	105	Ⓒ
Landslide	4	2	2	3	2	2	2	13	3	2	3	2	3	13	26	104	Ⓒ
Hazardous Material Release Land	4	1	2	3	2	2	3	13	2	3	4	2	2	13	26	104	Ⓒ
Insect Infestation & Plant Disease	4	1	1	1	3	2	4	12	4	1	4	3	2	14	26	104	Ⓓ
Air Quality	4	2	3	3	2	3	1	14	1	2	3	3	2	11	25	100	Ⓑ
Coastal Erosion and Sedimentation	5	1	1	2	1	1	2	8	2	2	2	2	4	12	20	100	Ⓒ
Human Disease	3	4	4	4	4	4	1	21	1	3	1	3	4	12	33	99	Ⓒ
Snow Event	4	2	2	2	2	3	2	13	2	2	1	2	3	10	23	92	Ⓑ
Animal Disease	4	1	1	1	3	2	1	9	4	1	3	3	2	13	22	88	Ⓓ
Food Supply Chain Interruption	3	2	2	3	4	4	1	16	2	2	2	3	4	13	29	87	Ⓓ
Marine Vessel Incident	3	3	4	2	4	2	1	16	3	2	3	2	3	13	29	87	Ⓒ
Land Subsidence and Sinkholes	5	1	2	2	2	1	1	9	2	2	2	1	1	8	17	85	Ⓒ
Hazardous Material Release Marine	3	1	2	2	1	2	4	12	2	3	4	2	4	15	27	81	Ⓒ
Potable Water Supply Interruption	3	2	3	2	3	3	3	16	1	2	2	3	3	11	27	81	Ⓒ
Fog	5	2	2	1	2	1	1	9	2	2	1	1	1	7	16	80	Ⓑ
Heat Event	5	2	2	2	2	2	1	11	1	1	1	1	1	5	16	80	Ⓑ
Fuel Supply Interruption	3	2	2	3	2	3	1	13	2	4	1	3	3	13	26	78	Ⓓ
Earthquake	3	1	2	2	2	2	2	11	3	3	2	2	3	13	24	72	Ⓑ
Intentional Acts of CBRNE	2	3	3	3	4	3	2	18	3	3	4	3	4	17	35	70	Ⓔ

Hazard Table with all Likelihood, Consequence and Risk Scores

Hazard	Likelihood (1-5)	*Human & Social Impacts*							*Physical & Economic Impacts*						Overall Consequence (11-55)	Risk	Confidence Rating
		Fatalities (1-5)	Injury/Illness (1-5)	Displacement (1-5)	Psychosocial (1-5)	Support System Impact (1-5)	Cultural Resource Impact (1-5)	Sub-Total (6-30)	Property Damage (1-5)	Critical Infrastructure (1-5)	Environmental (1-5)	Economic (1-5)	Reputational (1-5)	Sub-Total (5-25)			
Thunderstorm	5	1	1	1	1	1	1	6	2	2	2	1	1	8	14	70	Ⓒ
Cyber Security Threat	3	1	1	1	3	3	1	10	1	3	1	4	4	13	23	69	Ⓓ
Geomagnetic Storm	3	1	1	1	1	3	1	8	2	4	2	4	3	15	23	69	Ⓓ
Active Threat	2	4	4	2	5	3	1	19	2	2	2	4	4	14	33	66	Ⓓ
Cold Event	3	2	2	2	2	3	1	12	2	2	2	2	2	10	22	66	Ⓑ
Hail	5	1	2	1	1	1	1	7	2	1	1	1	1	6	13	65	Ⓒ
Aircraft Incident	2	4	4	2	4	3	1	18	3	2	2	3	4	14	32	64	Ⓒ
Dam Failure	2	3	3	2	3	2	3	16	3	4	3	3	3	16	32	64	Ⓑ
Rainfall Event	4	1	2	2	2	2	1	10	1	1	2	1	1	6	16	64	Ⓑ
Communications Interruption	3	2	1	1	2	3	1	10	1	3	1	3	3	11	21	63	Ⓑ
Bridge Collapse	2	3	3	2	3	3	1	15	3	2	3	2	4	14	29	58	Ⓓ
Megathrust Earthquake	1	5	5	5	5	5	5	30	5	5	5	5	5	25	55	55	Ⓒ
Building Collapse	2	3	3	2	3	3	1	15	3	1	2	3	2	11	26	52	Ⓒ
Public Disturbance	2	2	3	2	3	2	2	14	3	2	2	2	3	12	26	52	Ⓒ
Waste Water Interruption	2	2	2	2	2	2	2	12	3	3	3	2	2	13	25	50	Ⓒ
Volcanic Ash Fallout	2	1	2	2	1	2	2	10	2	3	4	3	1	13	23	46	Ⓒ
Hijacking	1	3	3	2	4	3	1	16	3	3	3	3	4	16	32	32	Ⓓ
Seiche	1	4	3	3	3	3	2	18	3	2	3	2	2	12	30	30	Ⓔ
Tsunami	1	2	3	4	3	3	2	17	3	2	2	2	4	13	30	30	Ⓑ
Health Interruption	1	2	2	2	3	3	1	13	1	3	1	2	3	10	23	23	Ⓑ
Incident at the CFM-ETR	1	2	2	3	2	1	1	11	2	1	3	1	2	9	20	20	Ⓓ
Rail Incident	1	2	2	1	2	2	1	10	3	1	2	2	2	10	20	20	Ⓒ
Avalanche	1	1	2	1	1	1	1	7	1	1	1	1	1	5	12	12	Ⓑ
Extraterrestrial Debris	1	1	1	1	1	1	1	6	1	1	1	1	1	5	11	11	Ⓔ

Legend

Hazard Category

- Natural Hazard
- Technological Hazard
- Conflict Hazard

Confidence Rating

- Ⓐ Very high degree of confidence
- Ⓑ High degree of confidence
- Ⓒ Moderate confidence
- Ⓓ Low confidence
- Ⓔ Very low confidence

APPENDIX 4. The Region's Critical Assets Owned/Operated by Local Government and First Nations

Critical assets are listed below by geographical location:

ELECTORAL AREA A

- Cassidy Fire Hall
- Cranberry Fire Hall (Cranberry Fire Improvement District)
- Decourcey Water System
- Duke Point Pollution Control Centre; SCADA software & equipment
- North Cedar Fire Hall (North Cedar Improvement District)
- Regional Landfill (RDN Solid Waste Department)

ELECTORAL AREA B

- Gabriola Emergency Wharfs
- Gabriola Fire Hall (Gabriola Fire Protection Improvement District)

ELECTORAL AREA C

- Arrowsmith Dam and Connections
- East Wellington Fire Hall (Mountain Improvement District)
- Extension Fire Hall

ELECTORAL AREA E

- Nanoose Fire Hall
- Nanoose Bay Peninsula
    (includes water treatment plant and SCADA software & equipment)
- Nanoose Pollution Control Centre

ELECTORAL AREA F

- Church Road Transfer Station (RDN Solid Waste Department)

- Coombs Fire Hall
- Errington Fire Hall
- Melrose Terrace Water System
- Westurne Heights Water System
- Whiskey Creek Water Service Area

ELECTORAL AREA G

- Dashwood Fire Hall
- Englishman River Water Service
- French Creek Sewer Treatment Plant
- French Creek Water System
- Meadowood Fire Hall
- San Pariel Water System with SCADA software & equipment
- Surfside Water System

ELECTORAL AREA H

- Bow Horn Bay Fire Hall
- Deep Bay Fire Hall (Deep Bay Waterworks Improvement District)
- Greater Nanaimo Pollution Control Centre; SCADA software & equipment

FIRST NATIONS

- Qualicum First Nation Office
- Snaw-Naw-As (Nanoose) First Nation Office
- Snuneymuxw First Nation Office

DISTRICT OF LANTZVILLE

- Lantzville Fire Hall
- Lantzville Town Hall
- Lantzville Costin Hall

CITY OF PARKSVILLE

- Parksville City Hall
- Parksville Civic and Technology Centre
- Parksville Public Works Yard

- SCADA software & equipment
- Water Treatment Facility
- Parksville Fire Department

TOWN OF QUALICUM BEACH

- Berwick Station: Communications tower (multiple services)
- Qualicum Beach Fire Hall
- Qualicum Beach Public Works Yard
- Qualicum Beach Town Hall
- Qualicum Beach water system
- Qualicum Beach Civic Centre
- SCADA software & equipment
- Sanitary lift stations (Hall road, Higson Crescent)
- Transfer/emergency reservoir (one) isolated from distribution system

REGIONAL DISTRICT OF NANAIMO ASSETS WITHIN THE CITY OF NANAIMO

- Main Administrative office & Transit Headquarters (Hammond Bay Rd, Nanaimo

APPENDIX 5. Response Services and Resources

An additional output from the population of the *Critical Infrastructure Assessment Tool* was a listing of response services and resources within the region.

A preliminary listing of response services and resources extracted from the *Critical Infrastructure Assessment Tool* is below. Additional efforts to continue to populate, and maintain the list, will assist the emergency management programs in the region to have a collated identification of response services and resources to support planning for restoration priorities, business continuity and resiliency initiatives.

PRIMARY RESPONSE SERVICES

Police

- Ladysmith RCMP
- Nanaimo RCMP
- Oceanside RCMP
- Gabriola RCMP

Ambulance

Ambulance Station

- Station 120 Nanaimo South
- Station 130 Parksville
- Station 138 Qualicum Beach
- Station 153 Gabriola Island
- Station 173 Bowser

Critical Care Transport Station

- Station 122/180 Nanaimo North

Fire Departments[9]

Bow Horn Bay Fire Department

- 21 Volunteer firefighters
- Nine (9) fire service vehicles
- Extraction equipment

City of Nanaimo Fire Department

- Five (5) fire halls

[9] Counts of firefighting resources were not available for all departments at the time of this report.

Coombs Fire Department

- 32 Volunteer firefighters
- Six (6) fire service vehicles
- Rescue pumper
- Two (2) fire halls

Cranberry Fire Department

- 35 Volunteer firefighters
- Two (2) fire halls

Dashwood Volunteer Fire Department

- 35 Volunteer firefighters
- Two (2) fire halls
- 12 fire service vehicles

Deep Bay Fire Department

East Wellington Fire Department

Errington Fire Department

- 40 Volunteer firefighters
- Seven (7) fire service vehicles
- Two (2) fire halls

Extension Fire Department

- 25 Volunteer firefighters

Gabriola Island Fire Department

- 40 Volunteer firefighters
- 12 fire service vehicles
- Two (2) fire halls

Lantzville Fire Department

- 28 Volunteer firefighters
- Six (6) fire service vehicles

Nanoose Fire Department

- 31 Volunteer firefighters
- Nine (9) fire service vehicles

North Cedar Fire Department

- 30 Volunteer firefighters
- 10 fire service vehicles

Parksville Fire Department

- Three (3) career firefighters
- 40 volunteer firefighters
- Eight (8) fire service vehicles
- Fire Special Operations Trailer for confined space and hazardous materials response

Qualicum Beach Fire Department

- 3 career firefighters
- 30 Volunteer firefighters
- One (1) fire hall
- 11 fire service vehicles

Other

- Canadian Coast Guard
- CFMETR Nanoose Naval Base
- Nanaimo Port Authority
- Western Canada Marine Response Corporation

Search and Rescue

- Arrowsmith Search and Rescue
- Nanaimo Search and Rescue
- Royal Canadian Marine Search and Rescue

SECONDARY RESPONSE SERVICES

Amateur Radio

- Emergency Communications Team (City of Parkville, Town of Qualicum, Electoral Areas E, F, G, H)
  - 15 trained volunteers
- Coast Emergency Communications Association (District of Lantzville, City of Nanaimo, Electoral Area A, B, C)
  - 40 trained volunteers

Emergency Management Programs

- Regional District of Nanaimo Emergency Management Program
- District of Lantzville Emergency Management Program (contract to RDN)
- Emergency Management Oceanside
  - City of Parksville

  - Town of Qualicum Beach
- Qualicum First Nation Emergency Program
- Snaw-Naw-As First Nation Emergency Program
- Snuneymuxw First Nation Emergency Program

Emergency Operations Centre (EOC)

- Parksville EOC
  - 45 trained staff
- Qualicum Beach EOC
  - Internally trained staff
- Regional District of Nanaimo EOC
  - 94 trained staff

Emergency Support Services

- Gabriola ESS
  - Trained volunteers
- Lantzville ESS
  - 12 trained volunteers
- Oceanside ESS (Parksville & Qualicum Beach)
  - 54 trained volunteers
- Southern Communities ESS
  - Nine (9) volunteers (undergoing training as of September 2019)
- Nanaimo ESS
  - 15 trained volunteers

Mutual Aid

- Bi-directional mutual aid agreements between Parksville, Qualicum Beach, RDN, City of Nanaimo, District of Lantzville, Qualicum First Nation, Snaw-Naw-As First Nation, and Snuneymuxw First Nation

Other Government

- Canadian Forces Base – Comox
- Emergency Management BC

Non-Government Organizations

- Canadian Red Cross
- Oceanside Community Safety Volunteers
- Salvation Army
- St. John Ambulance

APPENDIX 6. Engagement Sessions Participants

SESSION 1

Day 1, North Workshop (District 69)

Date: Wednesday October 10, 2018
Location: Eaglecrest Golf Club, Qualicum Beach, BC

Day 2, South Workshop (District 68)

Date: Thursday October 11, 2018
Location: Beban Park Social Centre, Nanaimo, BC

Participants

Total attendees: 66

• Alberni-Clayoquot Regional District	• Health Emergency Management BC
• Arrowsmith Search and Rescue	• Insurance Bureau of Canada
• BC Wildfire Service	• Lantzville Fire Department
• BC Ambulance Service	• Mudge Island Citizens Society
• Bow Horn Bay Fire Department	• Ministry of Transportation and Infrastructure
• CF Maritime Experimental Test Range	• Nanaimo Port Authority
• City of Parksville	• North Cedar Fire Department
• Comox Valley Emergency Program	• North Cedar Improvement District
• Comox Valley Regional District	• Oceanside Emergency Social Services
• Coombs-Hilliers Fire Department	• Oceanside RCMP
• Cowichan Valley Regional District	• Qualicum First Nation
• Provincial Dam Safety Officer	• Regional District of Nanaimo
• Department of Fisheries and Oceans	• Royal Bank of Canada
• Emergency Management BC	• School District 68
• Errington Fire Department	• Technical Safety BC
• Gabriola Emergency Social Services	• Town of Qualicum Beach
• Gabriola Fire Department	

SESSION 2

Day 1, South Workshop (District 68)

Date: Wednesday, February 20, 2019
Location: Beban Park Social Centre, Nanaimo, BC

Day 2, North Workshop (District 69)

Date: Thursday, February 21, 2019
Location: Eaglecrest Golf Club, Qualicum Beach, BC

Participants

Total attendees: 54

- Alberni-Clayoquot Regional District
- BC Hydro
- BC Parks
- BC Wildfire Service
- BC Ambulance Service
- Parksville Qualicum Beach Tourism Bureau
- City of Parksville
- Canadian Coast Guard
- Comox Valley Regional District
- Coombs-Hilliers Fire Department
- Cowichan Valley Regional District
- Cranberry Fire Department
- Provincial Dam Safety Officer
- Department of Fisheries and Oceans
- Emergency Management BC
- Gabriola Fire Department
- Health Emergency Management BC
- Island Radio
- Island Timberlands
- Mudge Island Citizens Society
- Nanaimo Port Authority
- Nanaimo RCMP
- Nanoose Fire Department
- Nanoose Naval Base
- Oceanside Emergency Social Services
- Canadian Red Cross
- Regional District of Nanaimo
- Royal Bank of Canada
- School District 68
- School District 69
- Snuneymuxw First Nation
- Technical Safety BC
- Town of Qualicum Beach

SESSION 3

Date: Wednesday June 12, 2019
Location: Tigh-Na-Mara Resort & Conference Centre, Parksville, BC

Participants

Total attendees: 43

• Arrowsmith Search and Rescue	• Mudge Island Citizens Society
• BC Hydro	• Nanaimo Port Authority
• BC Wildfire Service	• Nanoose Naval Base
• BC Ambulance Service	• Oceanside Emergency Social Services
• City of Parksville	• Parksville Qualicum Beach Tourism Bureau
• Comox Valley Regional District	• Provincial Dam Safety Officer
• Cowichan Valley Regional District	• Provincial Diking Authority
• Cranberry Fire Department	• Regional District of Nanaimo
• Emergency Management BC	• Royal Bank of Canada
• Environment & Climate Change Canada	• School District 69
• Fisheries & Oceans Canada	• School District 68
• Gabriola Fire Department	• Technical Safety BC
• Health Emergency Management BC	• Town of Qualicum Beach
• Island Radio	• Vancouver Island University

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