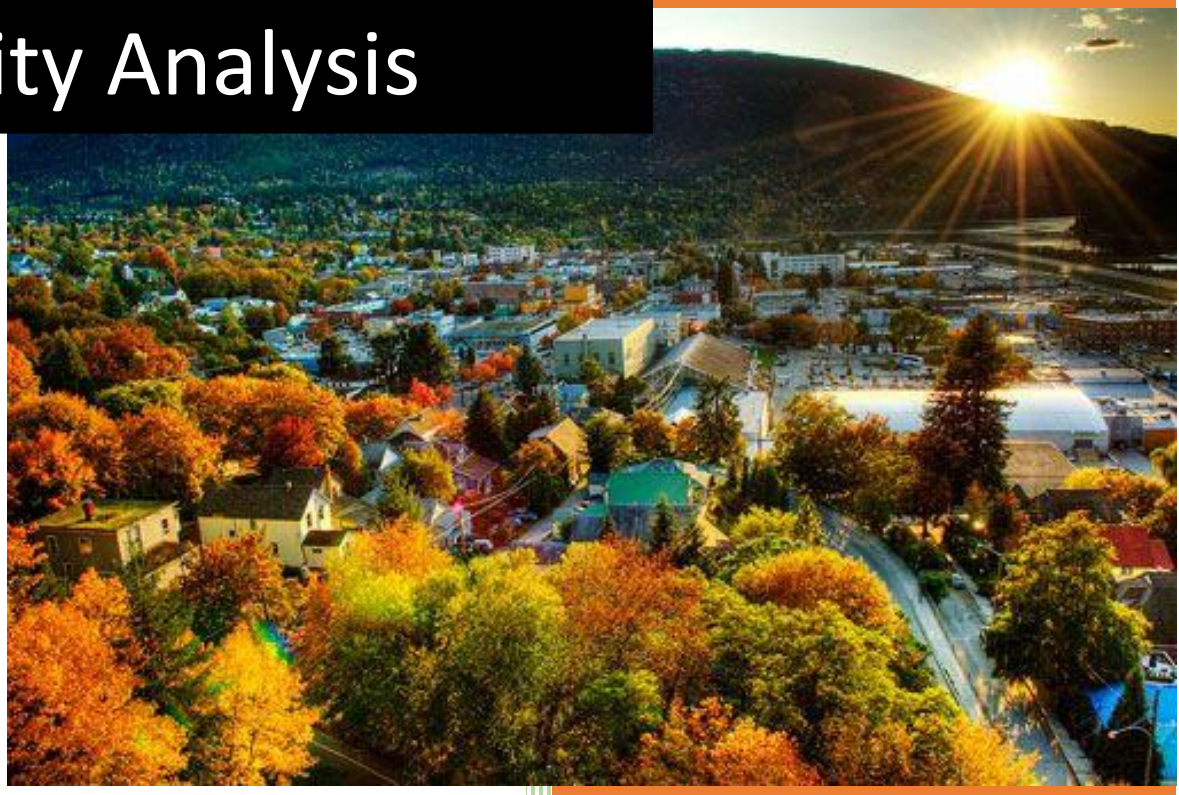
City of NELSON
EMERGENCY MANAGEMENT

2019

Hazard, Risk, and Vulnerability Analysis



Len MacCharles
Director of Emergency Management
10/29/2019

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RECORD OF CHANGES

Date	Summary of Changes
29 October 2019	Completion of 2019 HRVA (target for update in 2020 with new EMBC risk assessment tool)

Executive Summary

The Hazard, Risk and Vulnerability Analysis (HRVA) is intended to inform the City of Nelson regarding the hazards and related risks from which the community can make risk-based decisions related to the identified vulnerabilities. These decisions may include ways to prevent or mitigate the hazards as well as identify actions to appropriately prepare for, respond to, and recover from disasters and emergencies and maintain continuity of municipal operations. In essence, the HRVA forms the foundation of the Emergency Management Program.

The Nelson HRVA was conducted in collaboration with City of Nelson senior staff and selected members of the community who represented key stakeholders. The HRVA Working Group utilized EMBC's hazard, risk and vulnerability analysis (2004) online toolkit to identify risks, and assess their likelihood and consequence. It is recognized that the 2019 HRVA work was essentially a new beginning to the Nelson Emergency Management Program. Another HRVA will be conducted in 2020 using the new EMBC web-based risk assessment tool. The HRVA will be reviewed annually with updates added when new information is obtained and a complete HRVA process every three to four years.

The 2019 HRVA identified the principal risk events for the City of Nelson as:

- **Wildfire/Interface Fire**
- **Severe/Extreme weather**
- **Flood due to high lake levels**
- **Dangerous goods spill**
- **Human epidemic**
- **Critical facility failure**
- **Explosion/Emissions**

1 Purpose

The Hazard, Risk and Vulnerability Analysis (HRVA) is a fundamental component of emergency management planning that is intended to provide the basis from which Nelson can make risk-based decisions regarding its emergency planning. Hazard and vulnerability identification is the first step in the process where potential hazards and vulnerabilities are identified and the characteristics of each are defined. The risk analysis is the systematic use of the hazard information to estimate the chance or likelihood of the hazard occurring and the severity or consequence of the event.

Although the HRVA is a high-level risk assessment, it should have sufficient rigor applied to provide a reasonable assessment of the potential hazard along with the likelihood of occurrence and associated consequences. By better understanding the risks the community faces and determining which are

acceptable or unacceptable will inform potential mitigation opportunities and the need to prepare for, respond to and recovery from these risks.

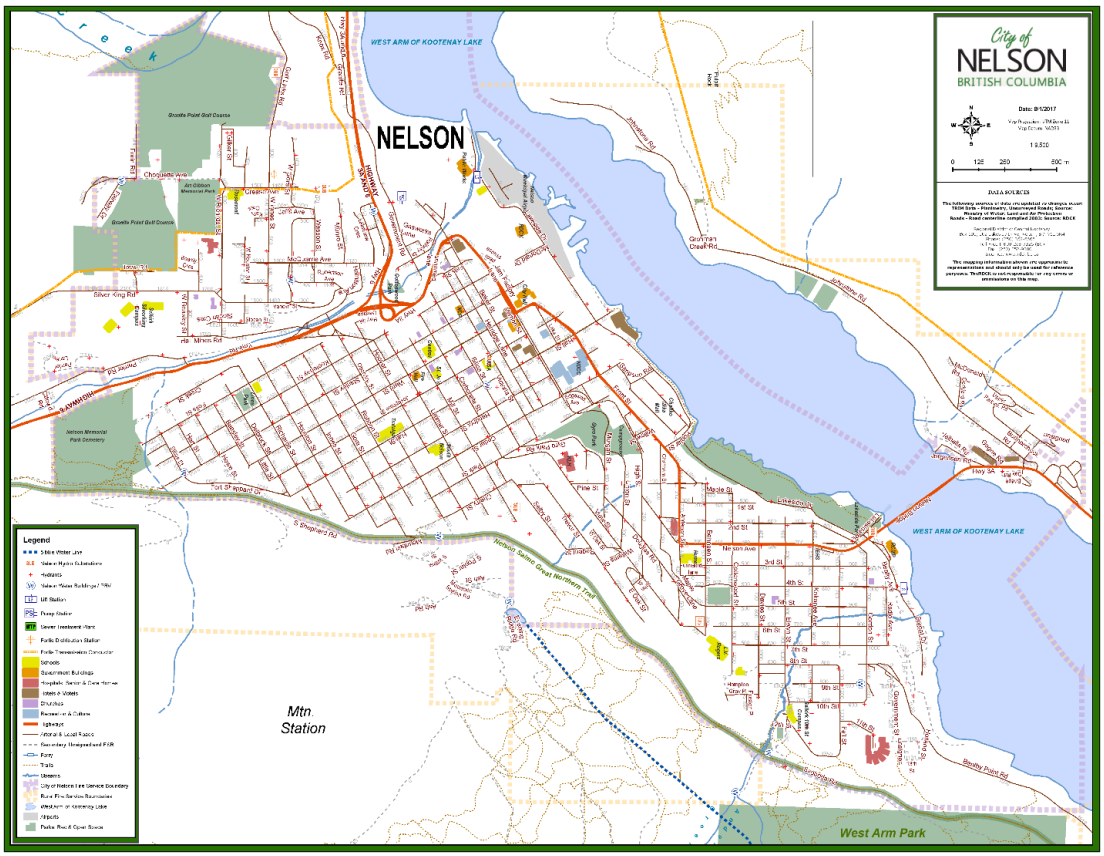
2 OBJECTIVES

The objectives of the HRVA are to credibly anticipate potential hazards, assess their likelihood of occurring and the impact or consequence of their occurrence. As well, it is hopeful that where possible, action steps may be identified to prevent or mitigate the hazards to help save lives, reduce property losses, and bring the City back to operation in as timely a manner as possible. Specifically the HRVA:

- Identifies the hazards and risk events that threaten Nelson;
- Determines how, where and why the City is particularly vulnerable;
- Assesses the likelihood and consequence of each risk event and prioritizes risk events; and
- Recommends priority measures that can be taken to prevent or mitigate the impact of the identified risk events.

3 SCOPE

The area covered under the HRVA is the municipal boundary of the City of Nelson (outline map reproduced below).



4 HRVA Working Group

The HRVA working group was comprised of:

- Len MacCharles, Fire Chief & Director of Emergency Management (Chair)
- Rik Logtenberg, City Councilor
- Kevin Cormack, City Manager
- Colin Innes, Director of Public Works
- Paul Burkart, Chief of Police
- Sue Adam, Community Member at Large
- Tom Thompson, Nelson Chamber of Commerce
- Callie Chatten, Nelson Search & Rescue
- Michelle Laurie, School District 8
- Jane Cusden, BC Interior Health
- Jenny Robinson, Nelson Cares Society
- Sam Cowen, RHC Insurance
- Glenda George, Nelson SPCA
- Ryall Giuliano, Nelson Street Culture

5 HRVA Process

The Nelson HRVA was conducted in collaboration with members of the City's Emergency Management Planning Committee and members of the community representing various stakeholders. The HRVA Working Group utilized EMBC's 2004 HRVA online toolkit to identify and assess risks.

The HRVA was completed using a four step process:

- **Hazard and vulnerability identification**: identify potential hazards, along with the characteristics of those hazards as well as known current vulnerabilities in the community
- **Risk analysis**: the systematic use of the hazard information to estimate the chance or likelihood of the hazard occurring and the severity or consequence of the event.
- **Risk evaluation**: compare risk events collectively, and make manual adjustments to risk events as necessary; the process of determining whether a risk is acceptable or unacceptable in terms of a cost/benefit analysis. This step should place all risk event scores (likelihood and consequence) on a risk rating matrix for evaluation.
- **Risk mitigation opportunities**: identify and prioritize risk mitigation opportunities that may exist for all risks – in particular for those deemed to be unacceptable (high and very high risks).

As noted, at the time of developing Nelson's HRVA, the EMBC online risk assessment tool available for use was the 2004 version that has been the standard throughout the province. EMBC has informed emergency managers that a new tool is being developed for anticipated use in 2020. It is expected the 2020 EMBC assessment tool will identify new types of hazards, assist with scenario building, and provide a more thorough vulnerability and analysis process. However, in order to ensure the Nelson Emergency Management Program continues to move forward, the current risk assessment tool (2004) was used for

the 2019 HRVA with the expectation that the Nelson HRVA will be re-evaluated in the spring of 2020 using the new assessment tool for hazards that represented higher risks.

The Emergency Management Director for the City of Nelson prepared materials in advance of meetings with the HRVA Working Group to facilitate efficient and effective meetings. The Working Group met over three 3-hour meetings utilizing the EMBC Assessment Tool (2004) as the guide to identify potential hazards, identify plausible worst case scenarios, identify our community's vulnerabilities and score overall likelihood and consequence of the risk.

For each hazard listed in the EMBC Assessment Tool, the Working Group discussed and decided upon a worst plausible case the city could face. These are listed in the Risk Matrix and Hazard Chart below. The objective was not to identify absolute worst case scenarios, but rather to land on ones that were seen as worst case, yet remained realistic. It does little good to build emergency plans around hazard scenarios that do not go beyond what might be expected but equally, using scenarios that are extreme and remote do not offer the community much help in developing meaningful plans.

Each listed hazard was discussed by the Working Group to determine the scenario and assess the impacts to our community that included various perspectives and potential vulnerabilities. This included considering specific impacts to seniors, children, vulnerable populations, pets and so on. The City of Nelson Hazard, Risk & Vulnerabilities Matrix below illustrates the relative risks presented by the hazards and the Hazard Chart further on lists the hazards, the scenarios established by the HRVA Working Group and some of the identified mitigation strategies that are either in place or will need to be developed as part of the emergency planning process.

5.1 EMBC HRVA Risk Events Considered

The EMBC HRVA process lists a comprehensive set of risks applicable for British Columbia as a whole; not all elements are relevant for each community in the province. Below are the EMBC assessment tool list of hazards (✓ indicates formed part of the Nelson HRVA):

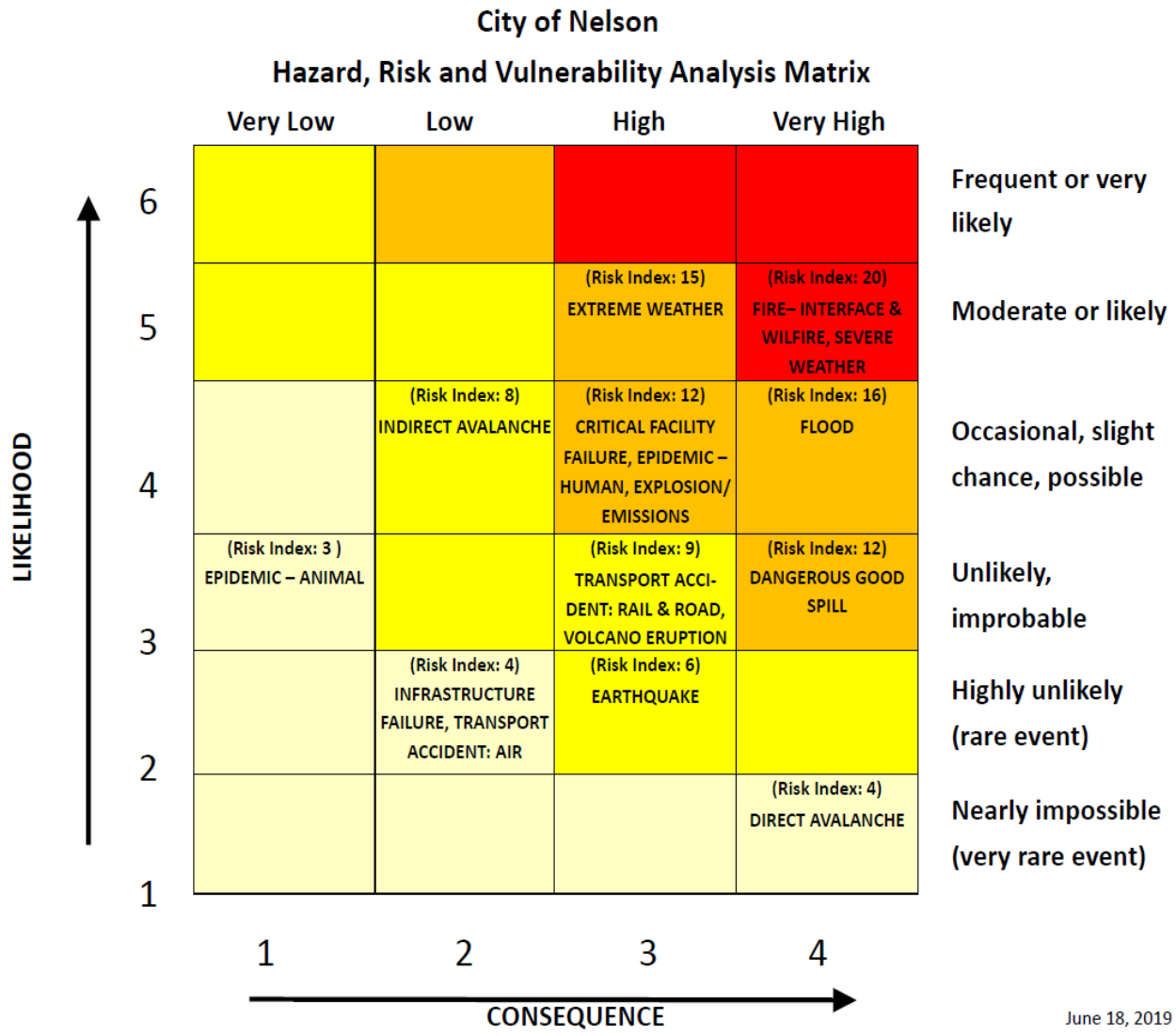
- ✓ **Avalanche** (considered direct and indirect avalanche)
- ✓ **Critical Facility Failure**
  Dam Failure
- ✓ **Dangerous Goods Spill**
- ✓ **Earthquake**
  Epidemic –Animal
- ✓ **Epidemic – Human**
- ✓ **Explosion or Emissions**
- ✓ **Fire – Industrial**
- ✓ **Fire – Interface & Wildfire**

- ✓ **Flood**
- ✓ **Infrastructure Failure**
- ✓ **Landslide, Debris Flow or Subsidence**
  Mine Accident
- ✓ **Severe Weather**
  Storm Surge
  Terrorism
- ✓ **Transport – Air**
  Transport – Marine
  Transport – Rail (formed part of Dangerous Goods scenario)
- ✓ **Transport – Road**
  Tsunami
- ✓ **Volcano Eruptions**

6 FINDINGS

The HRVA Working Group, using the EMBC Assessment Tool, identified nineteen potential hazards to be assessed with four them requiring subject matter experts to effectively assess. Of the remaining fifteen, Wildfire and Severe Weather rated 'Likely' to occur with 'Very High' consequences. Extreme Weather, meaning prolonged extremes such as heat/cold waves or drought, fell into a 'Moderate' chance of occurring and with 'High' consequences. Critical Facility Failure, Human Epidemic and Explosions/Emissions had a 'Slight Chance' of occurring and with 'High' consequences. Dangerous goods Spill was 'Unlikely' to occur but had 'Very High' potential consequences. Transport Accident: Rail & Road, were deemed 'Unlikely' to occur but was rated as having 'High' consequences. The remaining hazards ranged from 'Highly Unlikely' to occur or represented 'Low' to 'Very Low consequences.

6.1 HRVA Findings Matrix



For details on how 'likelihood' and 'consequence' are defined and rated by EMBC, please see Annex B.

6.2 EMBC Listed Hazards, Potential Scenarios, and Community Vulnerabilities

HAZARD (EMBC CLASSIFICATION)	SCENARIO: POTENTIAL IMPACTS & VULNERABILITIES	LIKELIHOOD	CONSEQUENCE SEVERITY	HRVA TOOL SCORE	MITIGATION MEASURES (IN PLACE OR TO BE DEVELOPED)
MITIGATION MEASURES IN COMMON • **EMERGENCY RESPONSE PLAN** • **EVACUATION PLAN** • **BUSINESS CONTINUITY PLAN (TBD)** • **EMERGENCY OPERATIONS CENTRE** • **EMERGENCY NOTIFICATION PLAN (TBD)** • **FULL-TIME EMERGENCY SERVICES** • **ESS PLAN (WITH RDCK)**					
WILDFIRE	AN INTERFACE /SPOTTING WILDFIRE REQUIRING A PARTIAL OR FULL EVACUATION—MULTIPLE HOMES AND BUSINESSES BEING IMPACTED; HOSPITAL AND CARE HOMES EVACUATED. VULNERABILITIES: VULNERABLE POPULATION; BUILDINGS AND INFRASTRUCTURE; ECONOMIC LOSSES; LOSS OF RESOURCES	**MODERATE/ LIKELY**	**VERY HIGH**	**20**	- COMMUNITY WILDFIRE PROTECTION PLAN - WILDFIRE INTERFACE DESIGN GUIDELINES & 2019 ZONING BYLAW UPDATE RE: NO NEW CONIFEROUS PLANTS WITHIN 1.5M OF STRUCTURES - FIRESMART ACTIVITIES & HOME ASSESSMENTS - COMMUNITY AWARENESS & PREPAREDNESS
SEVERE WEATHER	WINDSTORM: HIGH WINDS, POWER OUTAGE, AFFECTING TRANSPORT ROUTES, DAMAGING VEHICLES AND PROPERTY, HEAVY RAIN WITH OVERLAND FLOODING VULNERABILITIES: VULNERABLE POPULATION, PROPERTY LOSS, INFRASTRUCTURE DAMAGE	**MODERATE/ LIKELY**	**VERY HIGH**	**20**	- SEVERE WEATHER RESPONSE PLAN (TBD) - COMMUNITY PREPAREDNESS
EXTREME WEATHER	PROLONGED EXTREME HEAT AND DROUGHT (2 WEEKS ADDED ON BOTH SHOULDER SEASONS) LITTLE TO NO PRECIPITATION, DRY CONDITIONS AND RISK OF WILDFIRE VULNERABILITIES: WATER AND POWER SHORTAGES; VULNERABLE POPULATION; PETS	**MODERATE/ LIKELY**	**HIGH**	**15**	- ALTERNATIVE WATER SUPPLY PLAN (PW) - EXTREME WEATHER RESPONSE PLAN (TBD) - COMMUNITY PREPAREDNESS
FLOOD	LIBBY DAM ISN'T HOLDING BACK AND WITH HEAVY SPRING FRESHET, KOOTENAY LAKE RISES TO A METER HIGHER THAN WE EXPERIENCED IN 2018 VULNERABILITIES: AIRPORT; LAKESIDE DRIVE COMMERCIAL PROPERTIES; CPRAIL LANDS; LIFT STATIONS; RCMP OFFICE; RDCK OFFICE; SD#8 OFFICE; PUBLIC WORKS YARD; LAKESIDE PARK	**OCCASIONAL**	**VERY HIGH**	**16**	- EXISTING FLOOD MITIGATION MEASURES - NATURAL ENVIRONMENT DEVELOPMENT PERMIT GUIDELINES - BC HYDRO INNUNDATION MAPPING & EMERGENCY PLANNING GUIDE - FLOODING EMERGENCY RESPONSE PLAN (TBD)
EPIDEMIC - HUMAN	OUTBREAK OF PANDEMIC, SIMILAR TO H1N1 OR SARS VULNERABILITIES: VULNERABLE POPULATION, SENIORS; CHILDREN; UNPREPARED/OVERCROWDED HOSPITAL	**OCCASIONAL**	**HIGH**	**12**	- TBD BY INTERIOR HEALTH - EMERGENCY RESPONDERS OPERATING GUIDLINES
EXPLOSION/ EMISSIONS	EXPLOSION FROM COMMERCIAL BUSINESS OR NATURAL GAS EXPLOSION OF MULTI-UNIT DWELLING VULNERABILITIES: BUILDINGS; INFRASTRUCTURE; PEOPLE, PETS	**OCCASIONAL**	**HIGH**	**12**	- EMERGENCY RESPONDER OPERATIONAL GUIDELINES - EXPLOSION/EMISSION RESPONSE PLAN (TBD)

HAZARD (EMBC CLASSIFICA-TION)	IMPACTS & VULNERABILITIES	LIKELIHOOD	CONSEQUENCE SEVERITY	HRVA TOOL SCORE	MITIGATION MEASURES (IN PLACE OR TO BE DEVELOPED)
CRITICAL FACILITY FAILURE	E.G. LARGE FIRE AT HOSPITAL, CAUSING A COMPLETE HOSPITAL EVACUATION, DAMAGING EQUIPMENT AND LONG-TERM SHUT DOWN VULNERABILITIES: HEALTH CRITICAL PATIENTS, VULNERABLE POPULATION, SENIORS DEPENDING ON DIAGNOSTICS	**UNLIKELY/ IMPROBABLE**	**HIGH**	**12**	- IHS & KLH EMERGENCY REPONSE PLAN - EOC PLANNING WITH KLH/EMBC
DANGEROUS GOODS SPILL	RAIL ACCIDENT RELEASING AMMONIA, SULPHURIC ACID OR SIMILAR FROM ONE OR MORE RAIL CARS BEING DAMAGED BY DERAILMENT, RELEASING ITS PRODUCT UNCONTROLLABLY VULNERABILITIES: VULNERABLE POPULATION; KOOTENAY LAKE; WILDLIFE AND GRASS LANDS; PROPERTY DAMAGE	**UNLIKELY/ IMPROBABLE**	**HIGH**	**12**	- HAZARDOUS MATERIALS RELEASE RESPONSE PLAN
AVALANCHE	*Indirect:* AVALANCHE THAT IMPACTS TRANSPORTATION ROUTES TO AND FROM THE CITY, POWER TAKEN OUT, WATER AND FOOD & FUEL SUPPLIES POSSIBLY IMPACTED. VULNERABILITIES: VULNERABLE POP.; PROPERTY DAMAGE; ECONOMIC LOSS; TRANSPORT FLOW; ENVIRONMENT	**OCCASIONAL**	**LOW**	**8**	- MOTI ALTERNATE ROUTE PLANNING - EOC PLANNING WITH EMBC
TRANSPORT ACCIDENT-ROAD	BUS CRASH IN OR NEAR NELSON WITH MULTIPLE CASUALTIES. VULNERABILITIES: LOSS OF LIFE; TRANSPORT ROUTES IMPACTED; SOCIAL & EMOTIONAL EFFECTS	**UNLIKELY/ IMPROBABLE**	**HIGH**	**9**	- EMERGENCY RESPONDER OPERATIONAL GUIDELINES - EHS & IHS MASS CASUALTY PLAN - JOINT RESPONDER EXERCISES
VOLCANIC ERUPTIONS	VOLCANIC ERUPTION SOMEWHERE NEAR (250KM) OF NELSON ; HEAVY ASH FALLING ON CITY VULNERABILITY: VULNERABLE POP.; PROPERTY DAMAGE; ENVIRONMENTAL DAMAGE; VISIBILITY; SAFETY; HEALTH	**UNLIKELY/ IMPROBABLE**	**HIGH**	**9**	- INTERIOR HEALTH EMERGENCY RESPONSE PLANS (TBD)
EPIDEMIC - ANIMAL	FOREIGN ANIMAL DISEASE - EX. BIRD FLU	**UNLIKELY/ IMPROBABLE**	**VERY LOW**	**3**	
EARTHQUAKE	A MODERATE (5-5.9 ON THE RICHTER SCALE) OCCURRING - IMPACTING THE CITY. MULTIPLE PROPERTIES WITH RUBBLE BASEMENTS, STACKED ROCK WALLS AFFECTED. VULNERABILITIES: OLD BRICK BUILDINGS; SCHOOLS; AGING UTILITY LINES & ROADS; PEOPLE; VULNERABLE POP.	**HIGHLY UNLIKELY**	**HIGH**	**6**	- EARTHQUAKE EMERGENCY RESPONSE PLAN (TBD)
INFRA-STRUCTURE FAILURE	LOSS OF WATER - THE 5 MILE SUPPLY LINE GOES DOWN FOR MORE THAN 2 DAYS DURING THE WINTER; LOSS OF POWER FOR MORE THAN 2 DAYS IN THE WINTER VULNERABILITIES: VULNERABLE POPULATION; BUILDINGS AND INFRASTRUCTURE; LOSS OF BUSINESS; LOSS OF RESOURCES	**HIGHLY UNLIKELY**	**LOW**	**4**	- MASTER WATER PLAN WITH ALTERNATIVE SUPPLIES (PUBLIC WORKS) - NELSON HYDRO EMERGENCY RESPONSE PLAN - MAJOR POWER OUTAGE EMERGENCY RESPONSE PLAN

HAZARD (EMBC CLASSIFICA-TION)	DETAILS INCLUDING IMPACTS & VULNERABILITIES	LIKELIHOOD	CONSEQUENCE SEVERITY	HRVA TOOL SCORE	MITIGATION MEASURES (IN PLACE OR TO BE DEVELOPED)
TRANSPORT ACCIDENT - AIR	AIR CRAFT CRASHING INTO TO OCCUPANCY ADJACENT TO THE AIRPORT CAUSING LOSS OF LIFE AND DAMAGE TO THE PROPERTY, LOSS OF BUSINESS, FIRE/EXPLOSION VULNERABILITIES: LOSS OF LIFE; DAMAGE TO PROPERTY	**HIGHLY UNLIKELY**	**LOW**	**4**	- EMERGENCY RESPONDER OPERATIONAL GUIDELINES - EHS &HIS MASS CASUALTY PLAN
AVALANCHE	*Direct:* HIT UPPER PORTIONS OF THE CITY CAUSING MULTIPLE HOMES TO BE IMPACTED, LOSS OF LIFE, INJURY. VULNERABILITIES: 5 MILE RESERVOIR/INTAKE; SELKIRK COLLEGE; SENIOR CARE FACILITIES; HIGH SCHOOL	**VERY RARE**	**VERY HIGH**	**4**	- NO SPECIFIC PLAN
DAM FAILURE	TBD	**UNKNOWN**	**NEED SME**		- EXISTING FLOOD MITIGATION MEASURES - NATURAL ENVIRONMENT DEVELOPMENT PERMIT GUIDELINES - FLOOD RESPONSE PLAN
LANDSLIDE, DEBRIS FLOW OR SUBSIDENCE	WE HAVE SOME REPORTS FROM PUBLIC WORKS, SNC STUDY ETC, HOWEVER WE AGREED THAT THE AUTHOR OF THOSE REPORTS AND EXPERTS INPUT IS NEEDED	**UNKNOWN**	**NEED SME**		- NDMP PROJECT TO INFORM NELSON (TBD)
TERRORISM	TBD	**UNKNOWN**	**NEED SME**		

7 REVIEWING AND UPDATING THE HRVA

The HRVA, along with hazard specific guidelines in the Emergency Response Plan, should be reviewed annually and updated every three to four years. A full or partial HRVA should also be updated as follows:

- Once mitigation opportunities have been implement and their effectiveness in reducing risk are determined;
- New major development occurs, including new large residential subdivisions, commercial or industrial complexes;
- An emergency or disaster occurs, and new lessons are learned;
- Significant changes occur to critical infrastructure components, including the water and sanitary system, the power grid;
- To reflect shifts in risk perceptions resulting from new elections, major emergencies and disasters that occur outside Nelson, etc.; or
- As new risk information becomes available. This includes new climate and hydrological information such as updated climate projections, vulnerability studies, and other reports that may provide new information on the likelihood or consequent of risk events.

8 ACTION STEPS

The HRVA provides valuable insight to the risks residents, businesses, local government and others face in Nelson. It confirms that wildfire presents the greatest potential risk to Nelson that is further supported by the Community Wildfire Protection Plan. Wildfire mitigation work has been a priority for the City with additional work planned for 2020. The HRVA provides additional insights that will lead to specific actions being undertaken to mitigate and prepare for other risks. Going forward from this HRVA, and forming part of the Emergency Management Program, action steps will include:

- Share risk information with Council and public
- Develop Mitigation Plans (note: various mitigation activities are already part of City work plans)
- Develop Emergency Response Plans where required
- Conduct training and exercises
- Conduct 2020 HRVA using new EMBC Assessment Tools

9 SUMMARY

The 2019 HRVA was the first risk assessment completed for the City of Nelson in recent memory. It was developed by a working group composed of the Emergency Management Planning Committee together with stakeholders from the community such as School District 8, BC Interior Health, the business community, and concerned citizens. Amongst the principal hazards facing the community the working group identified were wildfire, severe weather, flood, and hazardous materials release; the working group further identified mitigation measures already in place and action steps to mitigate the identified hazards further. Emergency Management BC will be releasing new guidelines and a new tool for developing Hazard, Risk, and Vulnerability analyses in early 2020. Upon release of those guidelines, Nelson Emergency Management will complete a new HRVA, and will update the analysis as required to ensure the City of Nelson is best prepared to face the most significant hazards the community may face.

ANNEX A – POTENTIAL HAZARDS

The following is a list of hazards that are listed in Schedule 1 of the Emergency Program Management Regulation[1], the EMBC HRVA Toolkit, or have been added to meet the needs of Nelson. For the purposes of this analysis, some listed risks are not analyzed as part of the HRVA, such as tsunamis which normally occur along the coastal regions, or plant and animal diseases that are not something a municipality would normally address. Some risks have been combined under one heading such as atmosphere and hazardous materials releases.

HAZARD GROUPS	HAZARD
Accidents	• air crashes • marine accidents • motor vehicle crashes
Atmosphere	• snow storms • blizzards • ice storms and fog • hailstorms • lightning • hurricanes • tornadoes • heat waves
Cyber Attack	• denial of service • website hijack • data theft or destruction • ransomware
Dam Failure	• dam failure (includes foundations and abutments)
Disease and Epidemics	• human diseases • animal diseases • plant diseases • pest infestations
Explosions and Emissions	• gas and gas leaks (pipeline) • gas and gas leaks (gas wells) • mine • other explosions
Fire — Urban and Rural	• fire (urban and rural — excludes interface fire)
General	• General — non-specific or not identified
Geological	• avalanches: • debris avalanches and debris flows • landslides:

[1] http://www.bclaws.ca/civix/document/id/complete/statreg/477_94#Schedule1

	• submarine slides • land subsidence
Hazardous materials	• hazardous spills • radiation • infectious materials
Hydrologic	• drought • erosion and accretion • flooding • ice jams • storm surges
Power outage	• electrical power outage
Riots	• riots/public disorder
Seismic	• ground motion effects • Tsunamis
Space object	• space object crash
Structural	• structural collapse
Terrorism	• terrorism (hostile act against state)
Volcanic	• ash falls • pyroclastic flows • lava flows • mudflows
Wildfire	• wildfire (includes interface fire)

Risk Events for the City of Nelson

Hazards form the foundation of risk events which outline a potential scenario and impact to the City of Nelson. Risk event descriptions, for which the consequence and likelihood are assessed in step two, are listed below. Risk events constitute potential emergency or disaster scenarios whereby there is potential for the activation of the Emergency Response Plan, opening of the Emergency Operations Centre or declaring a State of Local Emergency.

Aviation Incident

An aviation incident or crash is an incident involving one or more aircraft resulting in damage to aircraft or property, or injury or death. The incident could occur at or near the Nelson airport or anywhere in or around the city. The Nelson municipal airport landings has hundreds of takeoffs and landings each year of small private and commercial planes and helicopters. The runway parallels the waterfront with a flight path that is in relative alignment with the Chahko Mika Mall, the Prestige Hotel and Conference centre as well as other commercial occupancies. An incident during take-off or landing, the most vulnerable times for aircraft operations, could result in an aircraft crash on land or in the water but

could also involve occupied properties along or near the flightpath. There is also the possibility of an aircraft crash in or near the city that could impact others or start a wildfire.

Gaining a recorded history of aviation incidents in or near Nelson is difficult to obtain. There was a crash landing at Nelson Airport October, 2008 of twin engine plane where a plane was damaged but did not result in injuries. There are also a few anecdotal accounts of incidents where small planes have crashed into Kootenay Lake outside of Nelson and one where a small plane attempting to take off crashed into the lake. It is worth noting that there has been increased use of the airport over the past few wildfire seasons due to wildfire suppression activities near Nelson.

AVALANCHE

An avalanche is generally a cohesive slab of snow lying upon a weaker layer of snow in the snowpack that fractures and slides down a steep slope when triggered. Avalanches are typically triggered in a starting zone from a weakening within the snowpack. After initiation, avalanches usually accelerate rapidly and grow in mass and volume as they entrain more snow. If the avalanche moves fast enough, some of the snow may mix with the air forming a powder snow avalanche.

For the purposes of the HRVA, avalanches were considered from a 'direct' and 'indirect' perspective. The risk of an avalanche directly impacting Nelson is very low due to the treed slopes above the city with few clearings for snow to accumulate. While the terrain is mountainous there are no chutes, bowls or large un-treed areas above the city where significant snow could accumulate to present avalanche potential. There is a greater likelihood of an avalanche indirectly impacting Nelson due to road closures and power and telephone outages within the city.

CYBER ATTACK

(This hazard was not included in the 2004 EMBC HRVA tool, and as such was not evaluated. It will form part of the EMBC HRVA tool that will be released in 2020, and will be included in the next iteration of the HRVA.) The Government of BC defines[2] cyber attack as: "An attack, via cyberspace, targeting an enterprise's use of cyberspace for the purpose of disrupting, disabling, destroying, or maliciously controlling a computing environment/infrastructure; or destroying the integrity of the data or stealing controlled information."

Common cyber attacks include:

- Theft of employee, citizen, or Corporate data, including financial data. This can result in extortion, identity theft, theft of money from bank accounts, and reputational damage.
- Denial of service (including distributed denial of service, or DDoS), in which an attacker floods a website or other internet-connected service with large amounts of data, making it unavailable to legitimate users.
- Website hijack. Often the result of social engineering, which is tricking an employee into voluntarily providing user or administrator account details, website hijacks typically involve replacing approved Corporate information with illegitimate information for the purpose of causing embarrassment or stealing information from legitimate users.

[2] https://www2.gov.bc.ca/gov/content/governments/services-for-government/information-management-technology/information-security/information-security-awareness/information-security-definitions

- Ransomware. Ransomware attacks involve gaining sufficient control of a computer system to encrypt valuable data, then demanding a ransom in order for the entity attacked to regain access to the data. Once the ransom is paid (normally through a cryptocurrency like Bitcoin), the attacker often disappears with the money and leaves the data encrypted. This form of attack has become extremely common in recent years.

Failure of Duncan Dam

Duncan Dam, an earthfill dam at the north end of Kootenay Lake impounding a major storage reservoir, is managed by BC Hydro. There is no powerhouse at the dam and it is operated under the Columbia River Treaty. BC Hydro has provided Nelson Emergency Management with its *Emergency Planning Guide – Columbia River Basin*[3](EPG), which provides detail on the expected consequences of failure of its dams in the area. The reservoir area contained by the dam is 7,150 hectares, and the EPG's *Downstream Consequences Classification Guide* classifies the dam as 'Extreme' in terms of consequences related to a dam failure. BC Hydro rates the likelihood of failure of its dams as "unlikely"; the consequences of such a failure, however, would be significant. See Annex C for an extract from the BC Hydro Duncan Dam breach inundation mapping for the Nelson area.

Earthquake

An earthquake is a sudden release of energy in the earth's crust or upper mantle, usually caused by movement along a fault plane or by volcanic activity and resulting in the generation of seismic waves which can be destructive. These waves can range in intensity from very weak to very violent shaking causing extreme damage.

Natural Resources Canada hosts the National Building Code of Canada's seismic hazard maps (2010) that show the Nelson area to be in a relatively low seismic hazard zone[4]. Natural Resources Canada also maintains a National Earthquake database that provides earthquake history throughout Canada since 1985. A search of the database shows that there have been 79 earthquakes within 100 kilometers of Nelson since 1985. The majority range between magnitude 2 and 3 with highest occurring in 1985 with a magnitude of 4.0[5].

The institute for Catastrophic Loss Reduction (ICLR) is a not for profit research institute founded by the insurance industry and affiliated with Western University, London Ontario. The ICLR organization has an online earthquake risk tool developed with the Corelogic Canada Earthquake Model that is reflective of the seismic hazard described by the Geological Survey of Canada (GSC) and the US Geological Survey

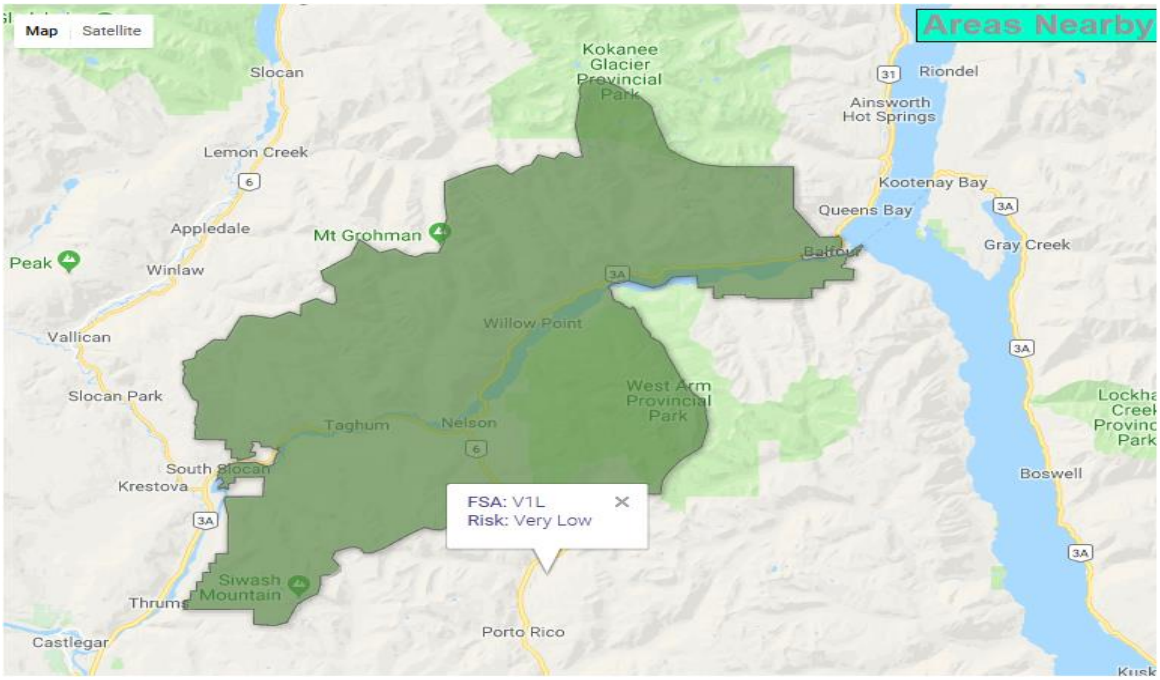
BC Hydro
Emergency Planning

[3]Embedded for ease of reference.

[4] Natural Resources Canada – National Building Codes of Canada seismic hazard values: http://www.earthquakescanada.nrcan.gc.ca/hazard-alea/interpolat/index_2010-en.php.

[5] Natural Resource Canada – National Earthquake Database: http://www.earthquakescanada.nrcan.gc.ca/stndon/NEDB-BNDS/bull-eng.php. Records search within a 100km radius of 49.4928°lattitude & -117.2948°longitude.

(USGS) for regions along the US border. Below is the ICLR's Quake Smart Program showing the rating for the Nelson area as Very Low[6].



Map Legend

Extreme	Very High	High	Moderate	Low	Very Low	Extremely Low	High Hazard, Low Population

In the unlikely event a significant earthquake did occur in the region, it would have the potential to cause widespread destruction that could result in numerous injuries, deaths, loss of critical infrastructure, etc. An earthquake may increase the potential for a breach of the earthen Duncan Dam that could result in a sudden inflow or possibly a surge of water into Kootenay Lake and the West Arm. Such an event could have devastating impact on Nelson. There are no warning systems in place for such an event.

Electrical Power Outage (> 1 day)

Electrical power outages are the loss of electricity delivery to homes and businesses. Power outages can be caused by mechanical failure, but most are due to adverse weather or environmental conditions such as lightning, wind, snow, flood or falling trees. Short-term power outages occur occasionally in Nelson with minimal impact. Nelson Hydro staff are well versed in restoring power quickly and are usually able to restore power within a few hours. However, prolonged outages lasting more than 12 hours or

[6] Source: Institute for Catastrophic Loss Reduction. https://www.iclr.org/earthquake-risk/. Area searched utilizing postal codes beginning with V1L.

certainly greater than 24 hours will start to have more significant consequences. For residences this may include:

- compromised food storage in refrigerators and freezers
- loss of lights – may turn to unsafe alternatives such as candles, fuel lanterns, etc.
- loss of heat – may use unsafe heating sources such as fuel heaters designed for outdoors
- loss of ability to cook – may use unsafe cooking appliances such as BBQ, fuel stoves
- loss of communication devices such as radios, TV's, computers and cell phones
- loss of street and public lighting
- loss of fire and security alarms due to battery back-up becoming drained
- potential of freezing water pipes leading to extensive water damage
- inability to run health homecare devices such as dialysis machines, nebulizers and oxygen concentrators

For businesses, commercial and healthcare facilities the extended loss of power may result in the same as above with the addition of:

- loss of retail, inability to provide services; grocery stores, fuel dispensing, banks
- loss of income for workers unable to work
- inability to provide medical services; closed doctor/dentist offices, clinics
- loss of business data, loss of economic opportunity

Kootenay Lake Hospital has two 750 kW back-up generators that will support all hospital functions with a fuel tank capacity to last for 5 days, but an extended power outage will impact the ability to run some of the normal hospital functions.

Overall, the extent of the consequences due to power outages depends on the length of the outage and the time of year. However power outages greater than 24 hours at any time of year pose a significant risk.

As part of the City's Critical Infrastructure planning, there are a number of important facilities that have generator back-up power, listed along with capacity (where known). These are:

- City Hall – 100 kW
- Fire Hall – 17 kW
- Nelson Police/PSAP
- Public Works Yard
- Mountain Station Water Treatment
- Waste Water Treatment Plant

Other facilities within Nelson that have generator back-up power:

- Kootenay Lake Hospital
- RDCK EOC

HIGHWAY CLOSURE (> 1 DAY OR DURING EVACUATION)

Nelson has three routes into or out of the city, each heading in different directions leading to municipalities, 40 to 90 minutes away. Each route is susceptible to motor vehicle incidents, downed

trees or powerlines, avalanches, landslides, rock fall, wildfire or severe weather such as storms, wind or blizzards. These routes are single lane secondary highways maintained by a private contractor on behalf of the Ministry of Transportation and Infrastructure. MOTI works hard to keep the highways open and are quick to share closure information however, as noted, there are circumstances where prolonged closures could occur. Closures on any of these highways could cause economic and personal hardship on residents, businesses as well as commercial and private transportation companies. Prolonged closures could result in limited goods and services reaching Nelson such as food, fuel and medical supplies. During an evacuation the closure of any of these routes would be significant and add to the many challenges associated with an evacuation. It is reasonable to anticipate that a wildfire could result in a closure of at least one of the highways out of Nelson.

Fire and Explosions

As in any city, various types of fires occur and Nelson Fire & Rescue Services has operational procedures and resources to manage the majority of fires when they occur. However there are times when larger or complex fires occur that may displace many residents and/or business owners and disrupt usual day-to-day operations within the city. This may include large structure fires, large vehicle fires such as fuel trucks, urban bush fires or wildland fires. Fires of any nature have the potential to spread quickly causing significant property damage or result in injury or loss of life.

Flooding and Freshet

The most likely flooding scenarios are Kootenay Lake levels rising significantly, overflowing streams that travel through the city or from sudden heavy rainfalls. Freshet is the annual spring snow melt from mid to high level elevations resulting in higher stream and river flows and rising lake levels. A freshet with a heavy snow pack followed by a late warm and wet spring can cause unusually high and rapid flow in streams and rivers causing flooding and result in rapid uncontrollable rise in lake levels. Both high stream flows and significantly high lake levels can result in damage to property and the environment. The risks that could be experienced during a freshet include a debris jam that can result in water backing up that may suddenly release causing water and/or debris to flow outside of the normal stream channel.

As part of the Columbia River Treaty between the US and Canada, Duncan Dam was built in 1967 and the Libby Dam in Montana in 1975. The dam operators regulate flow into and out of Kootenay Lake to the extent they can, however one of the goals of the dam system on the Kootenay River is to retain water upstream of each dam during the spring melt to ensure high water levels for use throughout the year. As such, if the snow experiences a sudden rapid melt there is limited ability to lower lake levels.

The highest level on record since the Duncan Dam was built occurred in 1974 that reached 1754.24’ (534.73m) measured at Queen’s Bay. The next highest level, 1753.78’ (534.54m) was in 2012 that resulted in flooding along Lakeside Park and the Sports fields In 2018, there were estimates of meeting or exceeding the 1974 record, but due to dam operations and favorable weather it a peak at 1752.1’ (534.04m). Emergency modeling and preparations in 2018 showed that if the lake had reached its 1974 levels, there would have been extensive damage to infrastructure and to commercial occupancies along Lakeside Drive and other locations. Between 1973 and 2005, (32 years) lake levels exceeded 1750’ (533.4m) four times while between 2006 and 2018 (12 years), lake levels have exceeded 1750’ (533.4m) seven times. Freshet can also result in rapid increase in stream flow.

Extreme rainfall events can overwhelm the City's drainage system and lead to localized flooding which can damage infrastructure, private property and lead to transportation and access delays. Nelson receives about 800 mm of precipitation annually with the highest amount in the form of snow during the winter months. Like most locations in Canada, there can be extreme rainfall days as there was in July 2012, where a heavy downpour caused a flash flood along Baker Street and low elevations streets. Since that time, the City has upgraded the storm system which should lessen the impact of a rainfall of that magnitude. Given the topography of Nelson, a heavy downpour results in much water running downhill over land as well as entering and potentially overwhelming the storm system.

HAZARDOUS MATERIALS RELEASE

A hazardous materials incident involves the uncontrolled release of a hazardous material. A hazardous materials incident can result in a gaseous, solid or liquid release that can pose serious health and/or environmental impacts. Health risks may be acute or chronic that can include burns, blindness, asphyxiation, cancer or other serious health impacts. Depending on the scope of a release, incidents could result in evacuations, road closures and major disruptions within the community. A variety of dangerous goods are transported through Nelson via road and rail. Businesses along or near the transportation routes are most at risk however, depending on the circumstances of the release, the impacts could well exceed those areas. Other risks are presented by commercial operations and

ROAD

Highway 3A travels through the centre of Nelson with a junction to Highway 6 near the west side of the city. Transport vehicles of all sizes and configurations including tanker trucks regularly travel through Nelson with various dangerous goods. Most common hazardous materials on these roads are various types of fuels and chemical trucks. Depending on the circumstances of a release such as product type, volume, weather, location, etc., Nelson Fire & Rescue Services may or may not be able to effective contain and manage the release. A release of product by a transport vehicle is likely to result in some level of evacuation.

RAIL

Canadian Pacific has an average of two trains per day travelling through Nelson with a maximum of 4 per day. The trains are usually carrying products to and from Teck in Trail carrying various goods including hazardous materials. Based on Canadian Pacific's 2017 Dangerous Goods Density Study for Nelson, the most frequent hazardous materials on these trains are Sulfuric Acid, Anhydrous Ammonia, Sodium Hydroxide Solution, Sodium Chlorate, Sulfur Dioxide, Molten Sulphur, Methanol, Refrigerated Liquid Argon, Flourosilicic Acid and Hydrogen Peroxide. Any of these could represent a serious release, especially if due to derailment or a deliberate act that resulted in more than one chemical being released at the same time or were on fire. Such a release would be beyond the scope of Nelson Fire & Rescue Services other than initial emergency actions related to incident command and evacuations. Command would take steps to initiate response by external hazardous materials expertise and resources. As required, either the product manufacturer or transporter of the product must have an emergency response team to respond to incidents where the product has been released. However, it is very likely that the product emergency response team could take up to 24 hours to arrive on scene with the necessary resources and able to intervene effectively.

The rail line leading into Nelson from both directions runs along Kootenay Lake or River following a winding line with steep rocky terrain above the tracks. There are land slide or rail wash out risks however, CP engineers typically keep speeds quite low along this portion of the line including when traveling through Nelson. A spill could result in serious water and environmental contamination. The likelihood of a hazardous materials release due to a rail incident is low but the consequences could be quite significant involving injury or death, mass evacuations, toxic fumes, fire and extensive environmental damage.

There are five at-grade railroad crossings within the city presenting risks for train-vehicle collisions. Three of the crossings are in relative close proximity to each other (Hall Street, Cedar Street, and Poplar Street) that separate Front Street from Lakeside Drive and Chahko Mika Mall. An incident could impact more than one crossing blocking evacuation routes. A long train has the potential to block all three crossings preventing evacuation from the lake side of the rail line.

Pipeline

The only pipelines located within the city of Nelson are natural gas lines. Natural gas is primarily composed of methane, a colourless, odourless gas to which a highly odorific chemical called 'mercaptan' is added to make it possible for humans to detect by smell. While natural gas is not toxic, in high concentrations it is considered asphyxiating because it replaces the oxygen in the air. Natural gas is highly flammable; however, it can only ignite when it is in a concentration between 5% (lower flammable limit, or LFL) and 15% (higher flammable limit, or HFL) in air. By law, mercaptan must be added to natural gas so that the mixture is detectable by humans at 10% of LFL (or 0.5% absolute concentration). FortisBC, however, odorizes natural gas so it is detectable at 5% of LFL (or 0.25% absolute concentration).

The release of natural gas from pipelines caused by excavating, drilling, mechanical failure, ground movement such as landslides or earthquakes or corrosion can result in significant amounts of natural gas being release into the air, into nearby structures or into underground voids. There is a high pressure gas line (1200 pounds per square inch or 'psi') entering the city from the west which travels diagonally between West Gore Street and West Innes Street through the Rosemont Trailer Park to a pressure reducing station located on the north side of West Inness Street in the 800 block, where the pressure is reduced to 60 psi. From the reducing station there are underground distribution lines throughout the city. Most natural gas releases do not ignite or cause explosions but the potential is always present and when they do occur they can be destructive. There are a relatively small number of gas line hits, generally 3 or 4, occurring every year.

Reported natural gas line hits in Nelson:

- 2015 – 4
- 2016 – 3
- 2017 – 4

COMMERCIAL OPERATIONS

There are two ammonia ice plants in Nelson. One at the RDCK managed Nelson & District Community Complex (NDCC) that provides ice making for the NDCC skating rink and the Civic Arena skating rink. The other plant is at the City owned and leased Nelson Curling Rink. Both plants use anhydrous ammonia to cool a calcium chloride brine that travels through underground pipes to the rink areas where it turns surface water into ice. There are brine pipes that run underground from the NDCC plant to the Civic rink. Risks include an ammonia releases occurring from the plant, ammonia piping, or from the storage tank located outside near the laneway between the Civic and the NDCC. There is 1500 lbs. charge of anhydrous ammonia in the refrigeration plant system, as well as two 300 lbs. spare cylinders. The NDCC ice plant has a well-constructed containment area to temporarily contain a release from traveling throughout the building. However, it would likely require an entry by the NFRS HAZMAT Team along with trained NDCC staff to stop the release of ammonia within the plant. A release that occurred from the ammonia storage tank that resulted in a significant amount of product being released directly into the air causing an ammonia plume that would be subject to wind and humidity conditions at the time. Nearby residences and businesses would likely be impacted. Nelson Fire & Rescue Services crews are trained and outfitted to manage many hazardous materials incidents such as an ammonia release, but an uncontrolled release of product from the storage tank has the potential to be very significant. Depending on the volume, wind and humidity, an ammonia release from any part of the system could result in the evacuation of the immediate area or could result in large-scale evacuations. Based on the circumstances at the time, Incident Command may determine a shelter-in-place tactic will provide the best outcome. This will require rapid and effective communications with residents and business owners.

The Nelson and District Community Complex also operates the community swimming pool that uses chlorine and hypochloric acid and calcium hypochlorite as part of the sanitizing process. The Chlorine is in gaseous form with a maximum of 6 - 150 lbs. cylinders on site. There are about 8 5-gallon carboys of hypochloric acid liquid (35%) and about 150 gallons of hypochloric acid at a 10% solution. There is also a 45 kg barrel of calcium hypochlorite (70%) in granular form. These hazardous materials, like anhydrous ammonia, under normal use and conditions present an acceptable risk. However, an uncontrolled release of the product, mechanical failure or exposure to fire could result in significant health and safety concerns. Similar to an ammonia release, response actions will depend on the volume, wind and humidity at the time.

- Chlorine Gas – up to 6 full 150 lbs. cylinders.
- Calcium Hypochlorite (70% granular) – 45 kg barrel.
- Hypochloric Acid (35% liquid) – 8 or more 5-gallon carboys.
- Hypochloric Acid (diluted) – approximately 150 gallons mixed in a storage tank at roughly 10% solution.
- Soda Ash (caustic) – one pallet for acidity control for city pools. Caustic or alkaline chemicals have the same effect on humans as acid when mixed in strong solution. They are in 50 lbs. bags and a pallet contains 50 or more bags.
- Sodium Bicarbonate (mildly caustic) – 50 or more 50 lbs. bags.
- Diatomaceous Earth (DE for main pool filtration) – up to 5000 lbs. It is not hazardous to the environment but it is carcinogenic in its dry form.

There are a number of commercial operations and services that use or distribute hazardous materials in Nelson. These include three service stations, large refrigerant operations such as local grocery stores, welding supply companies, paint shops, etc. These risks are similar to those found in most urban centres for release of hazardous materials and potential for fire.

Radiation / Nuclear Contamination

The Hanford Site is a decommissioned nuclear reactor facility which was operational from 1944 until 2008 and which lies in southeast Washington State approximately 366 km south-southwest of Nelson. Since beginning operation, it has been used to store nuclear waste. It is estimated to contain 60% of the US Department of Energy's high-level radioactive waste, and between 7-9% of all nuclear waste in the USA; because of its age and decay of the relatively primitive facilities originally used to store the waste, it is considered the most contaminated nuclear site in the nation[7]. Although no nuclear reactors are currently active at Hanford, the amount and lengthy half-life of the radioactive material on site means that a major release, due to explosion or other factors, could disperse radioactive fallout a significant distance downwind. The prevailing winds in the Hanford area are typically from the northwest, however winds from the southwest and south-southwest are common. After the Chernobyl disaster in 1986, small amounts of radioactive materials were detected hundreds of kilometres downwind of the reactor site. The health effects of this contamination are not clear, but some studies have indicated significant increases in the frequency of various types of cancer in the years following the incident in countries such as France, far away from (and not downwind of) the Chernobyl site. Thus, it is not possible to completely discount the possibility of ill effects to the people of Nelson from a major incident at the Hanford Site.

Landslides and Subsidence

Landslides are the down-slope movement of soil, rock and organic materials under the influence of gravity. Some areas of BC are more susceptible to landslides than others due to their unique geological conditions. Smaller, more frequent landslides contribute to personal and property losses than do less frequent large slides.

Landslide risk can be reduced through engineering and geoscience that leads to improved community safety.

Subsidence is the downward shift of the surface relative to a datum such as sea level. Subsidence can move very slowly over time or more rapidly.

Slope hazards are identified in the Official Community Plan - Hazard Lands Development Permit Area for steep slopes (Schedule J). Steep slopes, defined as those above 15%, are prevalent in several areas of Fernie exposing residential properties and other infrastructure, including the water and sewer trunk main down slope of Burma Road, to steep slopes and potential landslide hazard. Steep slopes also exist in the Fairy Creek watershed and could threaten the Fairy Creek water intake, chlorine and control room and reservoir.

[7] https://en.wikipedia.org/wiki/Hanford_Site

The City has completed two geotechnical studies, one for Burma Road and one for the Ridgemont area, which provide more details on specific landslide hazards. The City has installed slope meters to monitor slope stability in high risk areas.

Marine Incidents

Nelson has a moderately active boating environment with many boating visitors during the summer months. There tends to be a few boats used for transportation to and from Gohman throughout the year. Boating traffic increases every year and there are plans to increase the number of boat slips in and around Nelson. There have not been any recorded serious boating incidents on Kootenay Lake in or near the city for over 15 years. There have been a few anecdotal accounts of incidents where small planes have crashed into Kootenay Lake outside of Nelson and one case where a small plane was attempting to take off but crashed into the lake.

Mass Casualty Incident

To be developed in conjunction with Interior Health.

Natural Gas Release

See Hazardous Materials Release, Pipeline above.

Pandemic and Infectious Disease

A pandemic is classified as a global infectious disease outbreak generally determined to be a pandemic by the World Health Organization (WHO). An Influenza Pandemic occurs when a new influenza virus emerges for which people have little or no immunity and for which there is no vaccine. Pandemics can occur about every ten to forty years and have the potential to cause severe illness and death in large populations over large areas. Pandemics can have very serious wide spread impacts that can range from interruption of the supply chain including food and fuel supply to overwhelming hospitals and medical centres.

Infectious diseases are caused by pathogenic microorganisms such as bacteria, viruses, parasites or fungi and may be easily transmitted between people of which respiratory infections are the most serious. Infectious diseases are typically transmitted through human fluid exchange. The most recent notable infectious disease pandemic outbreak impacting Canada was the H1N1 influenza in 2009 that infected approximately 3.5 million people resulting in 428 confirmed deaths and thousands admitted to hospitals across the country. Impacts can include people not reporting to work to reduce their chance of becoming infected resulting in a dramatic drop in goods and services. Response and medical agencies need to communicate with staff and the public about the seriousness of an outbreak but that there is no need for panic. Managing infectious diseases requires a good plan that focuses on breaking the chain of transmission, managing the ill or deceased and effective communications.

SEVERE & EXTREME WEATHER

Severe or extreme weather events include unexpected, unusual, or unseasonal weather extremes. They have the potential to cause serious damage, social disruption and injury or death. Severe or extreme weather is often difficult to predict resulting in local authorities and communities being caught off guard when the event occurs. However, by understanding the types of severe or extreme weather Nelson may be subjected to can help to determine the likelihood and consequences of these events.

Nelson can eliminate two of the most common and devastating severe weather events, hurricanes and tornadoes. The east coast of Canada may be subject to hurricanes; however, there are no records of the west coast being hit with a confirmed hurricane. Accordingly, the Kootenays are not subject to the inland effects of hurricanes. Similarly, tornadoes present very serious risks to many Canadians but are quite rare in British Columbia. There were 4 confirmed tornadoes in British Columbia between 1926 and 2000 causing only minor damage. As such, tornados are excluded from the list of risks for the province by both the federal and provincial emergency preparedness programs.

However, it is reasonable to expect Nelson may be subjected to the following severe or extreme weather events that include:

- Winter Storms/Heavy snow falls
- Ice Storms
- High winds
- Heavy Rainfall
- Thunderstorms/Lightning
- Extreme Cold
- Extreme Heat

WINTER STORM / HEAVY SNOW FALL

Nelson has experienced numerous winter storms with heavy snow fall over the years. These storms have the potential to down trees and powerlines, to cause building collapses, block highways and roadways, restrict emergency response for police, fire and ambulance as well as for Hydro crews attempting to restore power. Most injuries or fatalities are associated with the effects of a winter storm or heavy snow fall, such as not being able to receive emergency assistance or get to the hospital due to the inability to travel, being without power for extended periods of time and the improper use of lighting, heating and cooking devices. Generally speaking, Nelson residents are accustomed to winter storms and heavy snowfalls.

ICE STORMS

An ice storm is a type of winter storm characterized by freezing rain forming a distinct ice layer on exposed surfaces. Ice storms are not usually violent storms and occur with temperatures just below freezing but can cause significant damage, particularly to electrical distribution systems. Heavy ice forming on trees, powerlines, transmission towers, etc. can result in excessive weight causing them to collapse. Travel can be paralyzed until the ice melts and the resulting impacts are similar to heavy snowfalls but due to the extent of damage that can be caused by ice storms, repair to electrical systems

can take days, weeks or longer to repair. This can dramatically increase the resulting hazards of improper lighting, heating and cooking dangers.

High Winds

Nelson has low to moderate winds on an annual basis but when associated with a storm, or a microburst such as occurred on 29 June 2016, the city can experience severe downdrafts and gale force winds. Generally these destructive winds only last for relatively short periods of time (10 – 60 mins) but they can cause significant damage to structures and topple large trees that can cause injuries or deaths. The falling trees also cause power outages. High winds are often accompanied with heavy rain, hail and lightning.

Heavy Rainfall

The average annual rainfall for Nelson is between 500 and 600 mm. However, there are times that Nelson experiences sudden heavy downpours in excess of 50 mm, such as on 17 July 2012 when 68.4 mm fell. In recent years there have been numerous sudden downpours causing localized flooding and road closures. With Nelson being largely sloped, rainfall quickly travels downhill through the storm drainage system and overland that during heavy downpours, in addition to erosion of laneways and streets, can result in an overwhelmed storm system with localized flooding along Front Street and other areas. The City has upgraded portions of the storm drainage system with the upgrades to the Hall Street Project.

Lightning

Lightning may accompany the rain and wind storms noted above but may also occur in dry conditions. Lightning causes about 70% of the wildfires in the Southeast Fire Centre area and certainly pose a threat to Nelson. Although lightning can strike anywhere, in general, it tends to strike on the top third of a mountain and depending on the wind conditions will usually move upwards. The greatest threat to Nelson would be lightning that strikes close to the city or if wind pushes a fire started by lightning towards the city. In both cases, there are scenarios that could provide Nelson with very little time to react to a wildfire started by lightning.

Extreme Cold / Heat

Nelson's average high temperature during summer months is about 28 degrees Celsius and average low of -3 degrees Celsius during the winter. There are recorded extreme temperatures of around 41 degrees in the summer and -35 in the winter. Typically these extremes are relatively short lived but if they become extended, they are cause for concern. Fortunately extreme summer temperatures are usually moderated by generally cooler nights with downdrafts from the surrounding treed mountains. However, prolonged hot and dry summers without sufficient precipitation dramatically increases the wildfire risks. Three of the years between 2015 and 2018 have produced drought or near drought conditions in and around Nelson. Prolonged cold extremes could result in cold related injuries, increased fires and freezing water pipes in older poorly insulated buildings.

STRUCTURAL COLLAPSE

Structural collapse occurs when a building or structure collapses due to engineering or construction reasons, metal fatigue, changes to the load bearing capacity of the structure, human errors or natural causes such as an earthquake, flood or excessive snow or ice buildup. Nelson receives large amounts of snowfall each year and structural collapses have occurred as a result. There are a number of bridges in Nelson that are the responsibility of the City or the Province. The city conducts regular inspections of city bridges as required.

VOLCANIC ERUPTION

While the City of Nelson is not located in an area of volcanic activity, it is plausible that the effects from a volcano eruption along the coastal region of BC or the US could impact Nelson. Significant amounts of volcanic ash and dust in the air has the potential to impact Nelson. Those impacts could range from health effects to economic losses. Volcanic ash can ground air travel near the volcano or depending on wind conditions and circumstances, could ground air travel in a large portion of the province.

WILDLAND URBAN INTERFACE FIRE

As set out in the updated Community Wildfire Protection Plan (CWPP) presented to City Council in 2017, Nelson is at high risk of experiencing a wildfire. The report explains that the forest surrounding Nelson is largely mixed coniferous second growth, resulting from early forest fires and forest management. Typical of the interior temperate rainforest, this forest is characterized on wet sites by dense western red cedar and western hemlock and on dry sites by Douglas Fir, Western Larch, and Lodgepole Pine. Several decades of fire suppression have resulted in patches of overstocked, high hazard forest. Bruce Blackwell, author of the Nelson CWPP stated to City Council and the local media that Nelson is one of the most at risk communities with a population over 10,000 in BC. This is based on the fuel types around Nelson, the extent of the ground fuels, the proximity of population and structures to the forest and the infrastructure at risk.

TOP 20 BC COMMUNITIES AT RISK – WITH >10,000 PEOPLE (2018)[8]

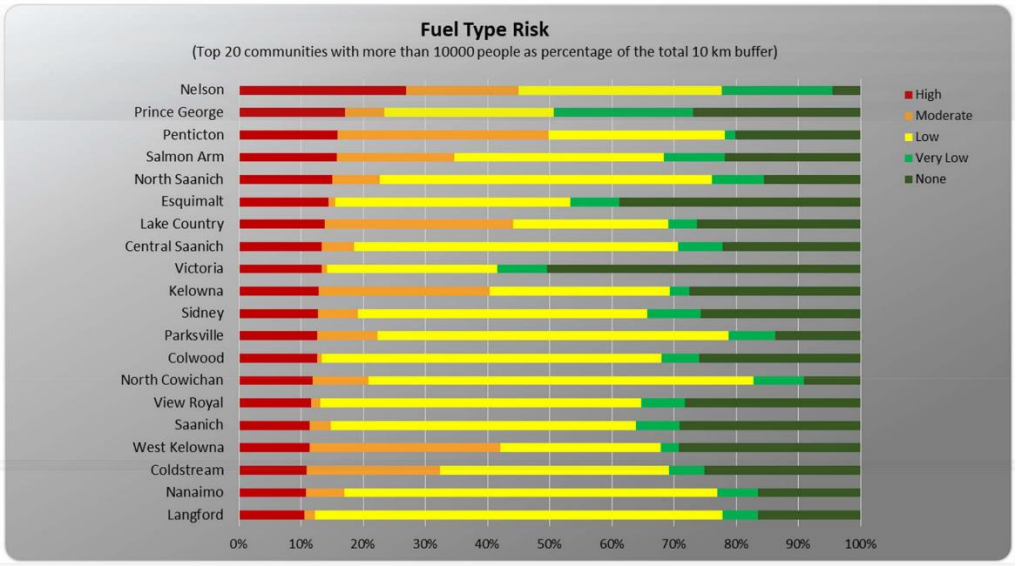
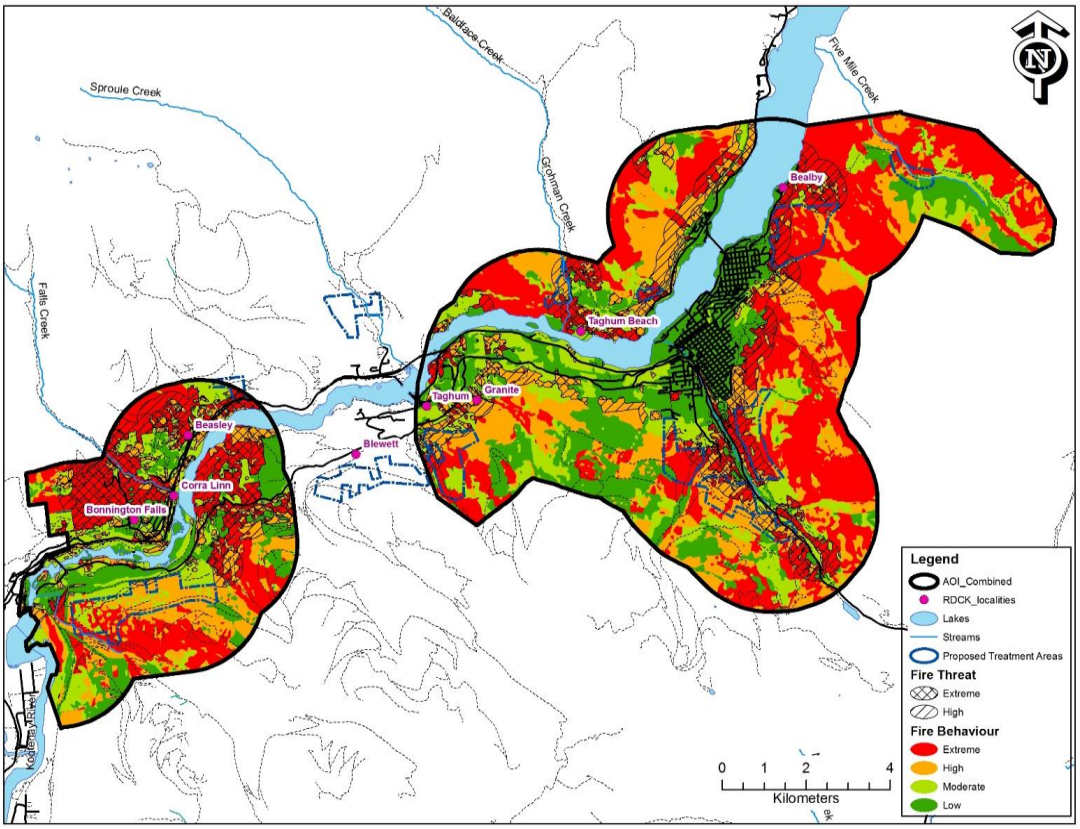


Figure 1. Updated CWPP Fire Threat and Fire Behaviour for the Study Area.



[8]Blackwell & Associates Ltd; slide from presentation at 2018 Wildfire and Climate Change Conference, "A Call to Action" June 26-28 at Nelson, BC.

According to the BC Wildfire Southeast Fire Centre, about 70 – 75% of the fires in the region are caused by lightning. Although lightning can strike anywhere, in general, it tends to strike on the top third of mountainous terrain and depending on the wind conditions will usually move upwards. The extreme fire threat to Nelson would be a fire that is started by lightning or human activity close to Nelson combined with winds directing the fire towards the city. This scenario would provide Nelson with very little time to react with response measures, to effectively notify residents, conduct evacuations, protect infrastructure and structures. Fires occurring further away but still threatening Nelson, especially if embers are falling in and around the city, will provide more time but still present serious challenges for response crews that are attempting to sprinkler structures, responding to spot fires occurring throughout the city, setting up strategic defensive positions to minimize fire spread and assist with evacuations.

As set out in the updated CWPP, to assess risk on treated and untreated polygons, the Provincial WUI Wildfire Threat Rating Worksheets (worksheet) were used, as required by UBCM in addition to professional judgment. The worksheet provides point ratings for four components that contribute to wildfire risk. These components include fuels, weather, topography and structural values at risk.

A total of 25 WUI threat plots were completed in the City of Nelson Combined Study Area, in conjunction with fieldwork for CWPP updates for the RDCK Areas E and F. The data collected and field observations recorded from the plots and field stops inform much of this document. The Study Area overall has 'high' fire behaviour threat class ratings, and a range of WUI threat ratings, demonstrated in the table below.

Wildland Urban Interface Threat Assessments completed in the combined Study Area

Plot Number	General Location	Fire Behaviour Score	Fire Behaviour Class	WUI Threat Score	WUI Threat Class
AC1	Anderson Creek	115	High	33	High
AC2	Anderson Creek	138	High	33	High
BL2	Blewett	131	High	14	Moderate
BO1	Bonnington	108	High	43	Extreme
GN2	Grohman Narrows	123	High	38	High
GN3	Grohman Narrows	131	High	28	Moderate
GO1	Giveout Creek	119	High	14	Moderate
GO2	Giveout Creek	127	High	23	Moderate
GO3	Giveout Creek	127	High	23	Moderate
GO4	Giveout Creek	145	High	28	High
GO5	Giveout Creek	134	High	32	High
GO6	Giveout Creek	122	High	14	Moderate
GO7	Giveout Creek	134	High	14	Moderate
MS1	Mountain Station	141	High	28	High
MS2	Mountain Station	121	High	25	Moderate
PR1	Pulpit Rock	134	High	28	High

Plot Number	General Location	Fire Behaviour Score	Fire Behaviour Class	WUI Threat Score	WUI Threat Class
ROV1	Rover FSR	128	High	20	Moderate
ROV2	Rover FSR	125	High	45	Extreme
SEL1	Selous Creek	139	High	16	Moderate
SEL2	Selous Creek	157	Extreme	16	Moderate
SVO1	Svoboda Road	121	High	40	Extreme
SW3	Smallwood FSR	122	High	48	Extreme
SW4	Smallwood FSR	156	Extreme	33	High
WA1	Waldorf School	119	High	32	High
WAPP1	West Arm Park	120	High	18	Moderate

Effective mitigation is fuel treatment that modifies forest vegetation by retaining large dominant trees but thinning from below by removing small trees, then pruning the retained trees from the ground up to remove ladder fuels to prevent crown fires. The result is a forest of large trees with little or no underbrush, small trees or ground debris. Forested lands around Nelson pose the most significant threat to the city but much of it is private land or crown land licensed to timber companies and fuel mitigation is challenging.

Water Supply

Supply

Nelson's primary water source is Five Mile Creek. Anderson and Selous Creeks are used to supplement supply as required during drought conditions but do not have the capacity to be a substitute for Five Mile. If Five Mile Creek is lost for any reason, the secondary creeks are unlikely to supply sufficient water for the entire city. The original intake and supply pipeline were constructed in 1925 with a concrete dam constructed in 1958.

The creek has been the primary source for many years. The intake point is located in West Arm Provincial Park where the City has a pump house and the water travels to the City's reservoir at Mountain Station. The reservoir holds up to 24,390 cubic metres of water..

At the time of this HRVA, other water sources have not been secured other than a connection to Kootenay Lake near the airport that will allow the City to draw from the lake into a portable water treatment appliance to assist with water in zone ##. The pipeline from the intake on Five Mile creek is susceptible to wildfire.

Fire Flow is the amount of water available in the supply system for firefighting purposes. A water system is considered fully adequate if it can deliver the necessary fire flow at any point in the distribution gridiron for the applicable time period required in the Fire Underwriters' "Required Duration of Fire Flow" with the consumption at the daily maximum rate (average rate on maximum day of a normal year). This is related to storage and since storage usually fluctuates, the normal daily minimums is the

amount that should be considered available for fire with a residual pressure of 150kpa at the point of use. The City of Nelson requires the following fire flows:

Building Type	Flow (l/min)
Single-family residential	3,600
Multi-family residential	5,400
Institutional	9,000
Commercial	9,000
Industrial	13,300

CONTAMINATION

Water contamination refers to both pathogenic bacteria found in drinking water as well as intentional contamination of the water supply, including groundwater. Common contaminants include Shigella Sonnei, Cryptosporidium, Escherichia Coli, Campylobacter, and the protozoa parasite Giardia lamblia. Water contamination can affect human health and lead to social and economic disruption.

Contamination can occur due to failure in the water treatment process, cross contamination of treated water in system or by deliberate actions.

The Nelson Water Master Plan Update was completed in 2017. It described[9] the disinfection and filtration system as follows:

> "The City currently practices sedimentation and disinfection by means of Ultra-Violet irradiation and chlorination. Interior Health has suggested that all surface water supplies should be filtered, but have also provided a set of criteria for exclusion of filtration. These criteria can be briefly stated as follows:
>
> 1. 4-log inactivation of viruses and 3-log inactivation of protozoa with a minimum of 2 disinfection processes.
> 2. Provision of background levels of Cryptosporidium and Giardia
> 3. Watershed control program expressly intended to minimize contamination (source-to-tap modules)
> 4. Not more than 10% of raw water E. Coli samples exceed 20/100mL in any 6-month period
> 5. Not more than 10% of raw water total coliform samples exceed 100/100 mL in any 6-month period
> 6. Turbidity (prior to disinfection) does not exceed 1 NTU for 95% of the time in any 30 day period
> 7. Peak turbidity does not exceed 5 NTU for more than 2 days in a 1-year period
> 8. Average annual total Trihalomethanes do not exceed 0.10 mg/L"

According to the Nelson Public Works Director, undetected contamination of the City's drinking water is highly unlikely.

DISTRIBUTION INTERRUPTION

[9] https://www.nelson.ca/DocumentCenter/View/2066/Water-Masterplan-Update-, p. 21

Distribution interruption or reduced flow can occur on a local or widespread scale due to a main break, a damaged valve or scheduled maintenance and replacement work. These issues are typically addressed quickly by city staff or contractors. In cases of prolonged interruption, the Public Works Department can provide water for consumption through above ground temporary water supply lines and/or a portable water supply plant.

Supply Interruption

Supply interruption can be as a result of a drought, blockage in the creek, damaged or blocked pipeline or a wildfire impacting the Five Mile drainage system that effects the quality of the water.

Drought

In addition to the recent experiences related to hot dry summers and water shortages leading to implemented water restrictions, climatologists have clearly demonstrated that climate change is currently impacting our environment. Extended hot dry periods or a drought is one of the serious consequences of climate change that can lead to short and long term water supply shortages. A long-term water shortage could have major social and economic impacts if water supply was not available for commercial, industrial, residential use and fire department use. In addition to the social and economic impacts, drought conditions create extreme wildfire risks and along with water shortages would seriously add to the city's vulnerability.

Creek Blockage

A snow avalanche, landslide or wind blowdown of trees could result in blocking Five Mile Creek causing it to back up and reroute itself that could severely limit the amount of water available for the city system.

ANNEX B – HRVA LIKELIHOOD AND CONSEQUENCE DEFINITIONS

HRVA LIKELIHOOD DEFINITIONS

'Likelihood' refers to how often a particular risk event can be expected to occur in each community. It is defined in terms of frequency or 'return period' – in other words, after what period of time the event can be expected to recur. EMBC defines likelihood rankings according to the following table.

Likelihood	Return period in years
Frequent or very likely	1-3 years
Moderate or likely	3-10 years
Occasional or slight chance	10-30 years
Unlikely or improbable	30-100 years
Highly unlikely or rare event	100-200 years
Very rare event	200-300 years

HRVA CONSEQUENCE DEFINITIONS

The severity of hazard consequences must be ranked according to seven categories:

- Fatality
- Injury
- Critical facilities
- Lifelines
- Property damage
- Environment
- Economic and social

When determining total consequence score, the **maximum** score of the seven categories should be used.

Fatality			
Rank	Description	Criteria	Example
1	Very low	0-4	No deaths
2	Low	5-10	Avalanche
3	High	11-50	Mine explosion
4	Very high	51+	Plane crash

Injury			
Rank	Description	Criteria	Example
1	Very low	0-4	No deaths
2	Low	5-50	Avalanche
3	High	51-2000	Mine explosion
4	Very high	2001+	Plane crash

Critical facilities (i.e. Critical Infrastructure)			
Rank	Description	Criteria	Example
1	Very low	Temporary relocation	Shelter evacuation
2	Low	Closure for a few days	Short-term school closure
3	High	Loss of 50% capability	Loss of 50% of emergency services
4	Very high	Long term disruption	Hospital destroyed

Lifelines (i.e. utilities and transportation)			
Rank	Description	Criteria	Example
1	Very low	Temporary interruption	Ferry service
2	Low	Interruption for a few days	2-3 day power outage
3	High	Interruption for a week	7 day water supply outage
4	Very high	Long term disruption	Bridge collapse

Property damage			
Rank	Description	Criteria	Example
1	Very low	Minimal damage	Flood damage – 1-2 homes
2	Low	Localized damage	Mud slide – several homes
3	High	Localized severe damage	Interface fire – community
4	Very high	Widespread severe damage	Dam breach

Environmental damage			
Rank	Description	Criteria	Example
1	Very low	Minimal damage	House fire
2	Low	Localized damage	Harbour oil spill
3	High	Localized severe damage	Toxic chemical spill
4	Very high	Widespread severe damage	Radiation contamination

Economic and social disruption			
Rank	Description	Criteria	Example
1	Very low	Temporary impact	Power outage
2	Low	Widespread but temporary	Lifeline loss
3	High	Widespread and extended	Pandemic disease
4	Very high	Long term disruption	Foot and mouth disease

ANNEX C – MAPS

DUNCAN DAM BREACH INUNDATION MAP (COURTESY BC HYDRO)