Syilx Okanagan Flood and Debris Flow Risk Assessment

Report 2 of 4 – Basis of Study (R2) Appendices

R2 List of Appendices

Syilx Okanagan Flood and Debris Flow Risk Assessment

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Appendix A: External Steering Committee Terms of Reference

<u>**Syilx Flood Adaptation Initiative Steering Committee:**</u>
<u>**Terms of Reference**</u>

Background

The *Syilx* Flood Risk Steering Committee is a volunteer committee created to guide the flood adaptation initiative until a fulsome planning process is completed, including risk assessments, floodplain mapping, data analysis and structural and non-structural mitigation planning. The Steering Committee's role is to direct and advise on technical and political aspects of a Flood Risk Analysis and future region-wide flood mitigation initiatives for both Okanagan and Similkameen Basins. Specifically, the Steering Committee will review each stage of the National Disaster Mitigation Program (NDMP) project reports and discuss priorities for the upcoming streams in the process. The Terms of Reference for this committee may change in order to accommodate the needs of the committee in achieving its stated goals. The committee will ensure the interests of all members, as well as the broader public interest, are considered in its work.

Principles of Engagement

The Steering Committee will respect the following principles of engagement:

- Recognition and respect. Acknowledging that the world views and values held by *Syilx* (Okanagan) Nation and Regional Districts are each unique
- Having consistent, meaningful dialogue about activities from the earliest stage of projects (the point of conceptualization) and iteratively through to implementation
- Working together to achieve mutual objectives to maximize the outcomes of the *Syilx* Flood Risk Assessment
- Commit to work together for consensus decision-making to find solutions that everyone actively supports, or to support the common goal.

Responsibilities of the Steering Committee and Decision Making

The Steering Committee is responsible to work collaboratively to:

- develop, implement, and evaluate the *Syilx* Flood Risk Assessment work plan or roadmap that aligns with identified priorities;
- to engage with the flood risk assessment process, such that the priorities identified in the flood risk assessment reflect the values and priorities of the committee members;
- engage in communications to share information on Okanagan and Similkameen priorities, achievements, and pressures;
- provide oversight to project delivery team (Ebbwater and Okanagan Nation staff);
- provide recommendations to each respective leadership (i.e. Chiefs Executive Council, Mayors and Councilors and Board of Directors) to advance shared priorities; and

- The group will work together to achieve consensus but will accept majority agreement for decision-making.

Composition

The Steering Committee will strive to have representation from all of the local governments in the study area. Technical representatives are welcome to attend with political representatives.

i. **Chair:** To be appointed by Steering Committee
    a. Lisa Wilson, shall serve as Chair. In the absence of the Chair, Karla Kozakevich will serve as Vice-Chair.

ii. **External non-Syilx Members**
    a. City of Kelowna
    b. City of Penticton
    c. Village of Keremeos
    d. Town of Princeton
    e. Village of Lumby
    f. Regional District of Central Okanagan (RDCO)
    g. Regional District of South Okanagan (RDOS)
    h. Regional District of North Okanagan (RDNO)
    i. Okanagan Basin Water Board (OBWB)

iii. **Three Syilx (Okanagan) Members**
    a. Okanagan Nation Political Representative:
        i. Councilor Janet Terbasket, with Chief Chad Eneas as her alternative.
    b. Two Okanagan Nation Technical Representatives:
        i. Okanagan Indian Band (OKIB), Colleen Marchand and
        ii. Penticton Indian Band (PIB), Dale Kronebusch

Tenure

- Designated technical support staff are invited to join meetings when deemed necessary to provide comments on the data-oriented aspects of flood planning.
- Committee meetings will be held at project milestones.
- The above meetings will be supplemented potentially by teleconferences, emails, webinars and other means as needed.

Roles of Steering Committee Members

- Select a Chair or Co-chair yearly, with the ability to opt out if external circumstances arise.
- Members may change when boards and elected officials change.
- Actively participate in committee meetings, activities and decisions.

- Assist in acquiring data, reports and other information as relevant, particularly where sourced from within their own organizations.
- Provide advice to the committee.
- Provide two-way liaison and communication between the committee and the member's organization (if applicable).
- All members are encouraged to participate in all tasks regardless of previous experience, skills or other commitments; no limits are to be placed on sub-committees – everyone is welcome to participate in all committees, sub-committees and tasks.

Roles of Chair or Co-Chairs

- Chair committee meetings.
- Liaise with committee members and the Secretariat as needed.
- Report on progress to the Syilx Flood Risk Assessment Steering Committee
- The Chair or Co-chairs will serve until the work of the Steering Committee and associated environmental projects are completed).
- Role as media liaison, with briefing notes/media advisories provided through e-mails and on ONA website.

Roles of Secretariat

- Organize and provide notices for all meetings, in collaboration with the Chair(s).
- Document meeting minutes/actions/communications.
- Undertake committee actions as needed and as appropriate (in collaboration with committee members, contractor(s), and other organizations).
- Assist in acquiring data, reports and other information where relevant, particularly where sourced from organizations outside of the committee membership.
- Communicate and coordinate committee work with Steering Committee members, funders and other organizations as appropriate.
- Provide overall program management, project management, contract management, and other administrative functions, including, but not limited to budget tracking and management, request for proposals process(es), retaining and liaising with contractors, preparing progress reports and briefing notes, etc.
- Development of talking points and briefing notes to the Steering Committee.

Membership

The Steering Committee will strive to have one representative attend each meeting from each Regional District, Municipality, *Syilx* member community and the Okanagan Nation Alliance (ONA)

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Appendix B: Risk Assessment Information Template

The following risk assessment information template (RAIT) was initially completed in August 2018 for an NDMP Stream 2 application. The form presented has been updated with results from this risk assessment project. Note that the RAIT format is currently being updated by Federal agencies; in its current form it limits how the information obtained from this project can be presented. Also, the form's PDF layout is cumbersome and limits the information that can be input into certain spaces. Ebbwater Consulting Inc. completed the form to the best of its abilities considering these constraints. The original PDF file may be provided upon request.

National Disaster Mitigation Program (NDMP)
Risk Assessment Information Template

Risk Event Details			
Start and End Date	Provide the start and end dates of the selected event, based on historical data.	Start Date: 05/05/2017	End Date: 29/07/2017
Severity of the Risk Event	Provide details about the risk, including: • Speed of onset and duration of event; • Level and type of damaged caused; • Insurable and non-insurable losses; and • Other details, as appropriate.	The Syilx Okanagan Flood and Debris flow risk project (the Project) was completed by the Okanagan Nation Alliance (ONA) and Ebbwater Consulting Inc. from September 2018 to December 2019. The driver for the project was the 2017 and 2018 freshet flood events in the Okanagan-Similkameen region. The Project was led by the perspective of Syilx Okanagan people. The ONA sought to disrupt western society's path dependency whereby decision-makers remain "locked in" to past policies and actions that favour engineered (e.g., structural mitigation) approaches to flood management (Parsons et al., 2019). This path dependency stands in the way of efforts to address changing hazard risks linked to climate change and other cumulative pressures. The Syilx Okanagan Nation maintains that existing institutional arrangements and frameworks do not adequately facilitate the implementation of wise environmental management that supports Indigenous communities to adapt to changing natural phenomena. In response, a new perspective and approach more closely aligned with a Syilx Okanagan worldview was adopted to guide this project. The risk assessment considered multiple flood magnitude events and and a single debris flow event. In this way, a range of natural hazard likelihoods were assessed as opposed to focusing specifically on one event. Some of the detailed information on specific events for this application are reported for the 2017 flood event, but this is complemented with information from the 2018 event, and flood and debris flows in the area as a result of the risk assessment project. The project focused on understanding risk, and not response and recovery. Therefore, much of the information relating to response and recovery stems from data that was obtained in the lead up to this project, based on stories about response and recovery following the 2017 and 2018 floods. The results from this project found that risk to floods is generally high, especially when considering the consequences from low magnitude events reoccurring over time. Risk due to debris flows is also high.	

Response During the Risk Event	Provide details on how the defined geographic area continued its essential operations while responding to the event.	- The Regional District of Okanangan Similkameen (RDOS) and the Regional District of the Central Okaganan (RDCO) Emergency Operations centers were activated to coordinate and monitor the emergency response. - 160 BC Wildfire Service crews worked to deploy over a period of six weeks 2 Million sandbags, 5 km of bladder dams and 1.3 km of gabion baskets. - A boil water advisory was issued due to increased turbidity in Okanagan Lake - Several roads were impassable and were closed. - Evacuation alerts and orders were issued. - In the RDCO, orders were first issued for Provincial Park and areas in Kelowna and West Kelowna. - Local states of emergency declared for the City of West Kelowna, the City of Kelowna and for the Fintry Delta due to flooding (May 6, 2017). - Rising water levels on May 9, 2017, due to warm temperatures and rain, melted snowpack and saturated soils causing flooding. - Okanagan Lake levels increased above the flood mark (343 m) on May 28, up to the highest record level of 343.22 m on June 3. - Wind gusts on Okanagan Lake created additional hazards.
Recovery Method for the Risk Event	Provide details on how the defined geographic area recovered.	- Where infrastructure was lost, individuals in ONA member communities have adapted their lifestyles, sometimes increasing their risk to health and safety. For example, one elderly couple belonging to the Penticton Indian Band was reported to be crossing a creek where a bridge was lost. - In some communities little has been done to plan for recovery, due to lack of capacity and a perceived lack of government willingness to assist. - Some of the flood recovery activities in the broader area included: - Removal of sandbags. - Removal of unnatural debris from public land and private property. - Repairs of boat decks. - Repair of properties. - Review of water management operations to make recommendations to mitigate lake flooding by optimizing lake storage.
Recovery Costs Related to the Risk Event	Provide details on the costs, in dollars, associated with implementing recovery strategies following the event.	At the provincial level, EMBC provided financial relief for uninsurable losses following the events through the Disaster Financial Assistance (DFA) program. As of June 27, 2019, the costs that the Government of BC expended through EMBC associated with the 2017 and 2018 flood events in the project area were as follows : • Private sector costs paid to date: $2,69,6532. • Public sector estimated and paid: $15,638,849. For confidentiality reaons, further details on the breakdown of the above costs could not easily be provided within this project's timeline (e.g. specific activities funded, and local governments or First Nations who were awarded funds).

Recovery Time Related to the Risk Event	Provide details on the recovery time needed to return to normal operations following the event.	-Starting mid-July, full demobilization of sandbags and other flood protection measures began. - Recovery time was approximately 6 months; however, some areas are still not fully recovered. - Okanagan Indian Band - "weeks to recover". - WFN Fire Services helped for 8 weeks following floods. - As of August 10, 2018, parks in RDCO were still closed and were undergoing restoration. Their closure is a lost ammenity.

Risk Event Identification and Overview	
Provide a qualitative description of the defined geographic area, including: • Watershed/community/region name(s); • Province/Territory; • Area type (i.e., city, township, watershed, organization, etc.); • Population size; • Population variances (e.g., significant change in population between summer and winter months); • Main economic areas of interest; • Special consideration areas (e.g., historical, cultural and natural resource areas); and an • Estimate of the annual operating budget of the area.	This project has a broad geographic scope. The spatial study area is approximately 15,400 km2 and includes those portions of the Okanagan and Similkameen watersheds located north of the Canada-US border. The study area makes up only a small part of unceded Syilx Okanagan territory. Syilx Okanagan territory is a large, diverse and beautiful landscape with the highest concentration of rare and threatened species in British Columbia (Okanagan Nation Alliance). The project area includes the Okanagan River watershed including kłúsx̌nítkw (Okanagan Lake) and the nməlqaytkw (Similkameen River) tributary watershed (Figure 2). The Similkameen is a river system, while the Okanagan is characterized by valley-bottom lakes. Elevations of the surrounding mountains vary from approximately 1600 m to 2600 m, with the highest peaks located in the southern portions of the Similkameen watershed. Each watershed consists of over 20 sub-watersheds. Both rivers join a few kilometres south of the project area in the United States. The Syilx Okanagan people have inhabited the interior plateau and applied knowledge systems here since the beginning of time. Archaeological records place Syilx Okanagan people here approximately 10,000 years ago with the last glacial retreat (Sam, 2013). Syilx Okanagan people are self-reliant and well provided for through ingenuity and use of the land and resources. The estimated number of Syilx Okanagan people who inhabited the territory prior to 1811 varies from approximately 2,000 to 10,000 (Sam, 2013). They travelled the breadth and depth of the territory, hunting, fishing, growing, harvesting, and trading. The Syilx Okanagan Nation is a sovereign Nation which never signed treaties with European settlers and holds Title and Rights to the lands and waters within the territory. The Syilx Okanagan people's way of life was dramatically disrupted with first European contact in 1811. The subsequent influx of immigrants upset the equilibrium in the region, resulting in the social marginalization of the Syilx Okanagan people and ongoing impacts on their sovereign territory including ecosystem degradation, severe water quality deterioration, and extreme stress on local ecologies and species loss at a scale and rate that is unprecedented.
Methodolgies, processes and analyses	

Provide the year in which the following processes/analyses were last completed and state the methodology(ies) used: • Hazard identification; • Vulnerability analysis; • Likelihood assessment; • Impact assessment; • Risk assessment; • Resiliency assessment; and/or • Climate change impact and/or adaptation assessment. *Note:* It is recognized that many of the processes/analyses mentioned above may be included within one methodology.	

	Hazard Mapping: - 1982: MOE (1982) mapped 1:200 yr return period (0.5% annual exceedance probability) floodplain for west shore of Okanagan Lake, from Peachland to West Kelowna - this map was never designated through the FDRP. Flood construction level designated for Okanagan Lake is 343.66 m (including freeboard). -1984: MOE mapped 0.5% AEP floodplain for reach of Mission Creek from Gallaghers Canyon to the mouth. - 1993: Ministry of the Environment Okanagan River: Osoyoos to Penticton (including Skaha Lake). 0.5% AEP. - 2010: Mill Creek floodplain based on the greater of: Okanagan Lake 0.5% AEP water level + 60 cm freeboard, Mill Creek 0.5% AEP max daily water level plus freeboard, Mill Creek 0.5% AEP instantaneous peak waterlevel plus 30 cm freeboard, AE (2010). ---> Old floodplain mapping in the regional district is 24 to 30 years old (therefore, does likely not represent the current (and future) situation), and it does not cover all the floodplains. ---> Flood hazard assessments have not been completed for the majority of watercourses and waterbodies within the RDCO and only limited floodplain mapping on Mission Creek, Kelowna (Mill) Creek and a portion of Okanagan Lake (AE 2016). Peak Streamflows: - Okanagan Water Supply and Demand Project (Summit 2010), model to estimate net and naturalized streamflows for many of the watersheds within the Okanagan. Risk Assessment: - 2008: RDOS assessment based on Hazard Risk and Vulnerability Assessment (HRVA), conducted by EmergeX Planning Inc. This methodology uses an all hazards approach. This was reviewed and updated in 2015 for urban centres. - 2016: RDCO vulnerability assessment and preliminary flood risk screening, conducted by Associated Environmental. The method used the Critical Infrastructure Rating Workbook. (AE 2016). Climate Change: - The Okanagan Water Supply and Demand Project (OWSDP) completed climate and hydrologic modeling. future scenario modeling using climate data from CGCM2 (A2) climate model, HadCM3 (A2), CGCM3(B1), for 2011-2040. - University of Victoria Pacific Climate Impacts Consortium - Plan2Adapt Tool provides outputs for the area. - Columbia Basin Climate Change Scenarios (University of Washington's Climate Impacts group). - Cannon and Innocenti (2018) provided projections in changes in precipitation intensity for the project area.

Hazard Mapping	
To complete this section: • Obtain a map of the area that clearly indicates general land uses, neighbourhoods, landmarks, etc. For clarity throughout this exercise, it may be beneficial to omit any non-essential information from the map intended for use. Controlled photographs (e.g. aerial photography) can be used in place of or in addition to existing maps to avoid the cost of producing new maps. • Place a grid over the maps/photographs of the area and assign row and column identifiers. This will help identify the specific area(s) that may be impacted, as well as additional information on the characteristics within and affecting the area. • Identify where and how flood hazards may affect the defined geographic area. • Identify the mapped areas that are most likely to be impacted by the identified flood hazard. Map(s)/photograph(s) can also be used, where appropriate, to visually represent the information/prioritization being provided as part of this template.	
Hazard identification and prioritization	
List known or likely flood hazards to the defined geographic area in order of proposed priority. For example: (1) dyke breach overland flooding; (2) urban storm surge flooding ; and so on.	See Syilx Okanagan flood and debris flow risk assessment project Map Book for maps of interest. The maps contain hazard delineations of 3 flood magnitude areas, and 1 debris flow area, based on high-level modelling completed for each hazard (see project's Quantitative Study for details). The general hazards driving flooding in the region are as follows: (1) Snowmelt (2) Heavy rainfalls (3) Rain on snow events (4) Debris flows (5) Groundwater-induced flooding (6) High lake levels (7) Storm surge, wave setup from lakes
Provide a rationale for each prioritization and the key information sources supporting this rationale.	(1) Historical snow-melt events resulting in floods (e.g. 2017 floods) (2) In particular problematic in combination with snow-melt events (3) Historically led to flooding (4) Debris flows often occur during heavy rainfall events. They cause bank scouring, erosion, and sediment deposition. Hydrogeomorphic assessments will be complemented by local knowledge. (5) Often in combination / as a result of high streamflows due to (1) snowmelt and (2) heavy rainfalls (6) Often as a result of heavy rainfalls, high lake levels and high streamflows (7) High winds and associated storm surge was an issue during the 2017 floods, with lake levels already been very high.
Risk Event Title	

Identify the name/title of the risk. An example of a risk event name or title is: "A one-in-one hundred year flood following an extreme rain event."	In the Okanagan watershed in 2017, most areas experienced flows that approximated the 5% annual exceedance probability (AEP; 20-year indicative return period), but some areas such as Vernon and Penticton experienced flows that exceeded the 1% AEP (100-year indicative return period). In May 2017 in Okanagan Lake, water levels were approximately 0.20 m above the estimated 0.5% AEP (200-year indicative return period) (Associated Environmental, 2017b). In 2018, the hazard levels were in the range of 2%-5% AEP (20 to 50-year indicative return period), with impacts that included combined flood and debris flow events (Figure 4). In the Similkameen watershed, hazard levels in 2017 were in the range of 10%-50% AEP (2 to 10-year indicative return period), which resulted in debris blockages (Figure 5). Larger events occurred downstream in the Hedley and Ashnola region. In 2018, there were hazard levels in the range of 20%-50% AEP (2 to 5-year indicative return period) in the Princeton area, and higher levels in the range of 2%-10% (10 to 50-year indicative return period) in the Hedley and Ashnola region.
Type of Flood Hazard	
Identify the type of flood hazard being described (e.g., riverine flooding, coastal inundation, urban run-off, etc.)	For the Syilx Okanagan flood and debris flow risk assessment project, flooding was described as follows: "t̓ik̓t is the word for flood. There are also words for flood land... but t̓ik̓t talks about the water… it almost sounds like t’ik’wt, which is the word for lake. t̓ik̓t is shallower and not still like the lake…" Richard Armstrong, Syilx Okanagan Elder, Traditional Ecological Knowledge Keeper and Syilx language instructor. Personal communication, February 14, 2019. From a western science perspective, flood and debris flow may be summarized as follows: Flood: Main types in the area are pluvial, riverine, dam and dike breach, and high water table. Debris flow (used in this project as representative of a variety geohazards ranging from rockfalls, landslides, to debris torrents): Rapid mass movements of saturated surface materials that move rapidly through channels to their outlets (debris flow fans). For the 2017 flood event, multiple factors played a role, including heavy spring rains from thunderstorms combined with snowmelt from warmer temperatures. - Riverine flooding occurred from creeks and rivers, as well as flooding due to rising levels of the Okanagan Lake, and groundwater induced flooding (in basements of properties) - Flooding continued over almost two months, with increasing water levels due to continued warming temperatures, melting snowpack, heavy rainfalls and saturated ground. Kelowna experienced the fourth-highest precipitation for the period of March to May, inclusive, on record. Vernon experienced the second-highest record for those three months while Penticton experienced the highest precipitation ever in that period. As a result of the high snowpack and spring precipitation, the inflows to Okanagan Lake during May 2017 were the highest on record, which caused the lake to rise to its highest level since the dam was built.

Secondary hazards	
Describe any secondary effects resulting from the risk event (e.g., flooding that occurs following a hurricane).	Cumulative pressures on the land are causing hazards to worsen. There are tangible connections between the need to respect water and activities occurring on the tmxwulaxw (land). Based on project feedback (see Qualitative Study) and a literature review of scientific research (see Basis of Study), watershed-scale cumulative pressures on flood and debris flows were identified. These include climate change (changing hydrologic regimes and increasing precipitation intensity and frequency), landuse change (loss of wetlands and riparian habitats), ecological disturbances (wildfire, infestations and invasive species, animal and habitat removal, recreational land use), industrial activity (non-renewable resource extraction, logging), flood defence structures, urban development, and surface-subsurface interactions. A range of geohazards have been noticed following flood events across the project area. Eg. Landslides due to erosion on Nk'Mip (e.g., this has occurred in 2018 affecting the Osoyoos Indian Band), as well as on Similkameen River near Allenby Rd. in 2018), and rockfall on Hwy 97 near Summerland in February 2019.
Primary and secondary organizations for response	
Identify the primary organization(s) with a mandate related to a key element of a natural disaster emergency, and any supporting organization(s) that provide general or specialized assistance in response to a natural disaster emergency.	RDOS, RDCO, and RDNO Emergency Operations Centres, and Emergency Management BC, ONA

Risk Event Description	
Description of risk event, including risk statement and cause(s) of the event	
Provide a baseline description of the risk event, including: • Risk statement; • Context of the risk event; • Nature and scale of the risk event; • Lead-up to the risk event, including underlying cause and trigger/stimulus of the risk event; and • Any factors that could affect future events. *Note:* The description entered here must be plausible in that factual information would support such a risk event.	

Risk Statement: Risk from flood and debris flows is a concern as the hazards are increasing, as well as the exposure to the hazards. Having said this, one of the key project findings is that not all flooding is bad, as it brings ecosystem benefits. We cannot continue down our path-dependency of looking at flood risk without applying an ecosystem-based perspective.

- See "Risk Event Title" section for details on the AEPs that were assessed qualitatively and the "Likelihood Assessment" section for details on the AEPs that were assessed quantitatively.
- Similar events are likely to occur increasingly in the future, with climate change (changing hydrologic regime and increasing precipitatoin intensity and frequency, and other cumulative pressures discussed in the "Secondary Hazard" section.

The results from the Syilx Okanagan flood and debris flow risk assessment may be summarized as follows:
Flood Risk:
o Extreme in the Okanagan watershed for the low scenario for the environment, affected people, and economy indicators.
o High for many indicators including environment, affected people, and economy in both watersheds.
o Medium for indicators such as culture and disruption in the Similkameen watershed.
o Generally higher in the Okanagan compared to the Similkameen watershed.
Debris Flow Risk:
o Extreme in the Okanagan watershed for all indicators.
o High in the Similkameen watershed for all indicators.

Location	
Provide details regarding the area impacted by the risk event such as: • Province(s)/territory(ies); • Region(s) or watershed(s); • Municipality(ies); • Community(ies); and so on.	

For the Syilx Okanagan flood and debris flow risk assessment, detailed qualitative impacts and quantitative consequence maps were produced for the 15,400 km2 project area. Almost all communities have been affected in recent years by flood and debris flows, either directly or indirectly. The project area currently likely exceeds 360,000 people, with approximately 95% of this population in the Okanagan watershed.

Following is an overview of the consequences summarized by watershed and hazard.

General Remarks:
• Consequences across all exposure indicators (i.e., environment, culture, mortality, affected people, eocnomy, and disruption) for flood and debris flow hazards generally range from catastrophic to moderate.
• When considered in absolute terms, the level of consequences is higher in the Okanagan watershed, compared to the Similkameen watershed. However, when considered in terms of proportion of consequences on a watershed basis, the consequences in the Similkameen are similar or higher to those in the Okanagan.

Okanagan Watershed:
• Consequences are typically concentrated within 10-20 km of the lakes that run through the centre of the watershed, and around the major population centres. However, culture and disruption indicator consequences are more widespread across the landscape.
• Compared to the Similkameen watershed, consequences are higher due to a larger population, properties, etc.—and more shoreline—in that watershed.

Similkameen Watershed:
• Consequences are typically concentrated in the major population centres near Princeton, Keremeos, Tulameen, and Hedley. There are also consequences along the main highways.

Flood:
• As expected, consequences are larger for the high flood hazard scenario, and smaller for the low hazard scenario.
• Generally, consequences affect highly populated areas near large rivers and lakes.
• Compared to debris flow, consequences are higher for the economy indicator, since economic assets tend to be close to water.

Debris Flow:
• Consequence levels are typically between the medium and high flood scenario.
• Compared to flood, debris flow consequences are more widely distributed and include hillslope areas.
• Debris flows have a greater influence on indicators that are more prevalent in rural areas (e.g., culture, disruption).

Natural environment considerations	
Document relevant physical or environmental characteristics of the defined geographic area.	The Okanagan River watershed has an area of approximately 7,900 km2. From north to south, the river flows through a series of “mainstem” lakes (Kalamalka, Wood, Okanagan, Skaha, Vaseux, and Osoyoos) whose flows are regulated to manage various services such as flood control; water supply; fisheries, aquatic, riparian, and environmental values; and recreation and tourism (Symonds, 2000). The natural lake systems are an important factor in the mainstem river’s flood flows due to their attenuating effect. Flow regulation adds another layer of complexity to the attenuation effect. The nmǝlqaytkw (Similkameen River) watershed within the study area is approximately 7,500 km2 in size. In contrast to the Okanagan River, the Similkameen River on the Canadian side has no dams and is unregulated. Compared to regulated flows in the Okanagan River, average annual peak yield in the Similkameen River is approximately ten times higher than flows within the Okanagan River (Table 1). This is due to the lack of the attenuation from natural lakes and flow regulation. As well, the region contains more higher-elevation areas receiving greater amounts of precipitation, which generate larger spring runoff volumes.
Meteorological conditions	
Identify the relevant meteorological conditions that may influence the outcome of the risk event.	The region has a dry, continental climate due to its location in the rain shadow of the Coast and Cascade Mountain ranges. Precipitation is approximately distributed throughout the year with peaks around June and November (see Quantitative Study). Winter precipitation is driven by the atmospheric jet stream and summer precipitation is typically caused by surface heating of local lakes and streams. The southern extents of the study area (e.g. Keremeos, Osoyoos) are warmer and drier than more northern areas (e.g. Vernon). Precipitation also ranges depending on elevation, from just under 300 mm at lower elevations in southern regions, to approximately 770 mm in sub-alpine regions (Duke et al., 2008). Due to the region’s dry conditions, water availability is sensitive to evapotranspiration loss as well as groundwater recharge and extraction . Both watersheds are snowmelt-dominated, which means that the majority of annual streamflow is generated by spring snowmelt, occurring between May to July. Year-to-year flow variability reflects variations in snow accumulation and melt, precipitation, evapotranspiration, and groundwater storage patterns. As a result of these varying patterns within the project area’s sub-watersheds, varying flood levels were experienced in the region in 2017 and 2018. Changing temperature, precipitation patterns are changing hydrologic regimes, with considerable implications to flood and debris flows. These changing meteorological conditions have overarching impacts on other cumulative pressures, which are leading to an increased hazard.

Seasonal conditions	
Identify the relevant seasonal changes that may influence the outcome of the risk assessment of a particular risk event.	The main seasonal changes that are relevant for the generation of the high streamflows that led to the 2017 flood eventg event are the warming temperatures in spring and related snowmelt and early and heavy freshet. Furthermore, high spring rainfalls coincided with the freshet, increasing the total streamflow and contributing to saturated ground, that in turn increased surface runoff. Debris flows could occur during or following intense fall rainfall events.
Nature and vulnerability	
Document key elements related to the affected population, including: • Population density; • Vulnerable populations (identify these on the hazard map from step 7); • Degree of urbanization; • Key local infrastructure in the defined geographic area; • Economic and political considerations; and • Other elements, as deemed pertinent to the defined geographic area.	

Many of the ONA member communities experienced flood, but there is little or no capacity to document the affected areas and people. The information has been collated based on findings for the regional districts. It was out of the scope of this risk assessment to analyze this data in detail.

Population Density and degree of urbanization:
Population density and degree of urbanization varies throughout the regional district. It is higher in the centres of Kelowna (pop. ~125,000) and Penticton (pop. ~34,000). But there are also many smaller communities with lower population density.

Vulnerable populations:
- A major geographical issue facing response groups in the area during an emergency is that there are many isolated communities, including ONA member communities, where notification and evacuation is difficult.
- A percentage of the population is unable to understand or speak English, where interpretation of emergency operations is necessary. Cultural values have to be considered.
- The region has a large proportion of senior or elderly residents (e.g., 25% of total population in RDOS, Statistics Canada, 2001). In particular, Osoyoos and Oliver have a high percentage of elderly residents. Elderly residents are in particular vulnerable during a flood event, as they are not as mobile, might live alone, have limiting conditions, need appropriate health services and may experience transfer traumas (e.g. from residential school experiences).
- In the RDOS, 20.6% of the population is under 6 years old and also requires special consideration.
- Low income groups are also vulnerable. In the RDOS, low income ranges from 15.9% for residents in private households to 37.8% for unattached individuals. The state of emergency requires funds and resources that low-income people might have no access to.

Economic and political considerations:
- Tourism and fisheries are economic drivers on the order of multiple millions of dollars for the ONA member communities. Flooding disrupts fish habitat, with potential long-term effects on fish populations and the fishing industry. The Penticton Indian Band lost a riding stable, and associated revenues, due to flooding.
- The top industries in the RDOS are retail trade, health care/social assistance, agriculture, forestry, fishing and hunting. Tourism contributes a significant share of revenues in the region. Further, the large share of retired and elderly residents in the region has propagated the need for more health services and facilities.
- In the RDCO, the flooding affected the downtown core and cultural district of the City of Kelowna, a major economic and administrative hub in the region.
- Population density is high along the lake shore in Kelowna and the downtown core, as well as in the Mill Creek floodplain. There is further population and urbanisation on the lakeshores of the tributary lakes.
- City of Kelowna acts as a major provincial hub, retail services, government, health care, education, aerospace and tourism. Agriculture, viticulture and forestry are important employers in rural areas.
- Economic considerations: tourism is an important component of the regional economy and can be largely impacted by flooding events that lead to extended road closure, closures of beaches

Asset inventory	
Identify the asset inventory of the defined geographic area, including: • Critical assets; • Cultural or historical assets; • Commercial assets; and • Other area assets, as applicable to the defined geographic area. Key asset-related information should also be provided, including: • Location on the hazard map (from step 7); • Size; • Structure replacement cost; • Content value; • Displacement costs; • Importance rating and rationale; • Vulnerability rating and reason; and • Average daily cost to operate. A total estimated value of physical assets in the area should also be provided.	There is very little or no capacity for the ONA to complete asset inventories. Due to the nature of the study, a detailed asset inventory was not completed. What follows is an integrated summary of qualitative impacts and quantitative consequences for each exposure category assessed. Environment: The largest number of impacts recorded related to this indicator with a focus on fish and fish habitat, and water quality. There were numerous mentions of recent changes to flow paths as a result of cumulative pressures such as climate change, ecological disturbance (i.e., wildfire), and urban development. There was an emphasis on the negative impacts of flood defence infrastructure on riparian ecosystems such as cottonwoods; these are ecosystems that depend on flooding and they can provide natural flood storage. Their destruction has impacted cultural use of such ecosystems. Human encroachment on wildlife habitat or animal removal (i.e. beavers) was cited as a problem for flood and ecosystem management. Concern was also expressed over the mismanagement of industrial waste (e.g. mine tailings), and contamination sources such as pleasure boat fuel tanks stored on lakeshore docks, and the disposal of sandbags used for flood protection. For consequences, the source-pathway-receptor model was applied, and there is a high potential for septic systems to contaminate drinking water wells and high biodiversity areas. Consequence scores were assigned qualitatively and ranged from moderate to catastrophic (i.e., minor to permanent or severe destruction of ecosystems). Culture: There are numerous overlaps between the impacts for this indicator and the environment indicator. An important link is due to the high value placed primarily by Syilx Okanagan people on fish and fish habitat. Mapped impacts relate to Syilx landmarks, harvesting sites, and places of cultural and spiritual significance. Many places of cultural significance to the Syilx were pointed out in general terms, but there was hesitation in identifying specific areas. Respect for these areas and lack of communication between responsible organizations were widely cited as key issues that have led to their destruction. For consequences, there are high proportions of Syilx Okanagan and non-Syilx archaeology sites (i.e. approximately 30%-60%), and cultural buildings (i.e. approximately 40%-60%) that overlap the hazard areas. Consequence scores were assigned qualitatively and range from minor to catastrophic (i.e., widespread permanent loss, to damage to objects of identified cultural significance). Please consult the Synthesis and Recommendations report for further details on other indicators. The information could not be included within the space provided in this document format.
Other assumptions, variability and/or relevant information	

Identify any assumptions made in describing the risk event; define details regarding any areas of uncertainty or unpredictability around the risk event; and supply any supplemental information, as applicable.	There are important uncertainties associated with the Syilx Okanagan flood and debris flow risk assessment. The main ones are summarized below: 1. Qualitative Study: The study is limited by the people who provided input, and their interests including the locations with which they were familiar. Therefore, there are gaps in this study's findings on a local basis. Different findings would potentially arise if the same process were followed with different participants. Also, past experiences, data sensitivity, and trust need to be addressed to obtain a more comprehensive understanding of specific indicators, such as culture. 2. Quantitative Study: The study is limited by the quality and quantity of hazard and exposure data, the proxies developed to represent exposure indicators, the quantitative measures applied to determine consequence, and the tables used for likelihood and consequence scoring. In terms of the delineation of hazard magnitudes, for example, there is low confidence in the definition of the low magnitude flood scenario. This is due to a lack of flood mapping in the project area to calibrate this hazard magnitude. Furthermore, the concept of risk needs to be understood from the Syilx perspective. "If people can't understand that we are water; they have missed the point." – Arnie Baptiste, Syilx Representative The Syilx Okanagan worldview is holistic and complex. It cannot be fully summarized in this report format; however, in the community discussions and engagement that laid the foundation for this project, a number of themes emerged that have been employed in this report as ways of increasing the alignment of this project with Syilx Okanagan perspectives. These themes are: 1) Be Responsible for Water. 2) Apply Syilx Okanagan knowledge. 3) Connect to place. 4) Value tmixw (all living things). 5) Collaborate and develop Water Partnerships. An overarching understanding that ties all these themes together is: "Water is connection".
Existing Risk Treatment Measures	
Identify existing risk treatment measures that are currently in place within the defined geographic area to mitigate the risk event, and describe the sufficiency of these risk treatment measures.	

By weaving multi-disciplinary western science and the Syilx perspective, ecosystem-based ideas to guide adaptation actions were developed. These ideas centre around 1) respect water, and 2) recognize cumulative pressures. In terms of (1), water is powerful, water is life, and water is connected. Details on adaptation actions and recommendations are found in the Synthesis and Recommendations report. Generally, risk treatment measures have relied on engineering approaches (e.g., construction of dams and dikes). However, considering soft path approaches that include landuse planning are gaining interest in the region. Understanding risk, including better defining where and how flood and debris flow phenomena occur as well as their positive ecosystem benefits, is a key step to implementing risk treatmetn through sustainable risk reduction.	

Likelihood Assessment	
Return Period	
Identify the time period during which the risk event might occur. For example, the risk event described is expected to occur once every X number of years. Applicants are asked to provide the X value for the risk event.	This project assessed consequences associated with multiple likelihood of events (i.e., risk is a function of likelihood and consequence. For flood, three magnitudes were assessed. The moderate flood scenario approximately corresponded to a 1% annual exceedance probability (AEP) event (100-year indicative return period). The high flood scenario approximately corresponded to an event that was worse than a 0.2% AEP (500-year indicative return period). The low flood scenario had no AEP associated with it, and was defined using the Geomorphic Flood Area tool, based on parameter calibrations of the moderate and high flood scenarios. The debris flow extents were based on susceptibility and generalized flow paths modelling. While a likelihood score of "moderate" was assigned to the extents, an AEP was not assigned. In the likelihood assessment below, we use the 0.5% AEP event (moderate) flood hazard scenario for rating purposes.

Period of interest

Applicants are asked to determine and identify the likelihood rating (i.e. period of interest) for the risk event described by using the likelihood rating scale within the table below.

Likelihood Rating	Definition	
5	The event is expected and may be triggered by conditions expected over a 30 year period.	3
4	The event is expected and may be triggered by conditions expected over a 30 - 50 year period.	
3	The event is expected and may be triggered by conditions expected over a 50 - 500 year period.	
2	The event is expected and may be triggered by conditions expected over a 500 - 5000 year period.	
1	The event is possible and may be triggered by conditions exceeding a period of 5000 years.	

Provide any other relevant information, notes or comments relating to the likelihood assessment, as applicable.	

To estimate the flood hazard extents for the low, moderate and high magnitude flood scenario, we used the Geomorphic Flood Analysis tool. The geomorphology of a landscape is shaped by many factors (e.g., climate drivers, water flows, geology, sediment transport, landcover, and landuse (Samela, Troy and Manfreda, 2017). Over a long time (many thousands of years), hydrological extremes can shape geomorphological features through erosion, sediment transport, and deposition (Samela, Troy and Manfreda, 2017). This is the underlying assumption for using geomorphological (landscape) features in determining potentially flood prone areas. In hydrology, many methods have been developed that relate topographic descriptors (topographic indices) to potential floodplain extent (Samela, Troy and Manfreda, 2017; Samela et al., 2018). The basis for these analyses is typically a digital elevation model (DEM), from which geomorphological landscape characteristics can be deduced. The GFA tool is plugin to the open-source GIS software QGIS (Albano et al., 2018) that allows users to conduct the above DEM analyses. However, it is important to highlight here that a geomorphological analysis does not account for rainfall-runoff processes and interaction with infrastructure (such as flood defences). Thus, the tool can only identify potentially flood prone areas.

The moderate magnitude scenario represented our calibrated GFA flood prone area layer, which was approximately equivalent to the 0.5% AEP, plus a 0.6 m freeboard (the freeboard was included within the Federal Disasster Reduction Program [FDRP] maps used for calibration).

Impacts/Consequences Assessment			
There are 12 impacts categories within 5 impact classes rated on a scale of 1 (least impacts) to 5 (greatest impact). Conduct an assessment of the impacts associated with the risk event, and assign one risk rating for each category. Additional information may be provided for each of the categories in the supplemental fields provided.			
A) People and societal impacts			
	Risk Rating	**Definition**	**Assigned risk rating**
Fatalities	5	Could result in more than 50 fatalities	1
	4	Could result in 10 - 49 fatalities	
	3	Could result in 5 - 9 fatalities	
	2	Could result in 1 - 4 fatalities	
	1	Not likely to result in fatalities	
Supplemental information (optional)	No fatalities were reported in 2017 nor 2018 events; however, the health and safety of vulnerable individuals (e.g. elderly people having to walk through creeks where bridges no longer exist) is at risk		
Injuries	5	Injuries, illness and/or psychological disablements cannot be addressed by local, regional, or provincial/territorial healthcare resources; federal support or intervention is required	2
	4	Injuries, illnesses and/or psychological disablements cannot be addressed by local or regional healthcare resources; provincial/territorial healthcare support or intervention is required.	
	3	Injuries, illnesses and/or psychological disablements cannot be addressed by local or regional healthcare resources additional healthcare support or intervention is required from other regions, and supplementary support could be required from the province/territory	
	2	Injuries, illnesses and/or psychological disablements cannot be addressed by local resources through local facilities; healthcare support is required from other areas such as an adjacent area(ies)/municipality(ies) within the region	
	1	Any injuries, illnesses, and/or psychological disablements can be addressed by local resources through local facilities; available resources can meet the demand for care	
Supplemental information (optional)	Injuries were not specifically assessed; therefore, this score is a high-level approximation. Syilx Nation communities do not have adequate resources to address injuries and illnesses, including chronic stress, that is being experienced by individuals.		

	Risk Rating	**Definition**	**Assigned risk rating**

Displacement	Percentage of displaced individuals	5	> 15% of total local population	4
		4	10 - 14.9% of total local population	
		3	5 - 9.9% of total local population	
		2	2 - 4.9% of total local population	
		1	0 - 1.9% of total local population	
	Duration of displacement	5	> 26 weeks (6 months)	3
		4	4 weeks - 26 weeks (6 months)	
		3	1 week - 4 weeks	
		2	72 hours - 168 hours (1 week)	
		1	Less than 72 hours	
Supplemental information (optional)				
B) Environmental impacts				
		5	> 75% of flora or fauna impacted or 1 or more ecosystems significantly impaired; Air quality has significantly deteriorated; Water quality is significantly lower than normal or water level is > 3 meters above highest natural level; Soil quality or quantity is significantly lower (i.e., significant soil loss, evidence of lethal soil contamination) than normal; > 15% of local area is affected	4
		4	40 - 74.9% of flora or fauna impacted or 1 or more ecosystems considerably impaired; Air quality has considerably deteriorated; Water quality is considerably lower than normal or water level is 2 - 2.9 meters above highest natural level; Soil quality or quantity is moderately lower than normal; 10 - 14.9% of local area is affected	
		3	10 - 39.9% of flora or fauna impacted or 1 1 or more ecosystems moderately impaired; Air quality has moderately deteriorated; Water quality is moderately lower than normal or water level is 1 - 2 meters above highest natural level; Soil quality is moderately lower than normal; 6 - 9.9 % of area affected	

	2	< 10 % of flora or fauna impacted or little or no impact to any ecosystems; Little to no impact to air quality and/or soil quality or quantity; Water quality is slightly lower than normal, or water level is less than 0.9 meters above highest natural level and increased for less than 24 hours; 3 – 5.9 % of local area is affected	
	1	Little to no impact to flora or fauna, any ecosystems, air quality, water quality or quantity, or to soil quality or quantity; 0 – 2.9 % of local area is affected	
Supplemental information (optional)			

C) Local economic impacts

	Risk Rating	Definition	Assigned risk rating
	5	> 15 % of local economy impacted	
	4	10 – 14.9 % of local economy impacted	
	3	6 – 9.9 % of local economy impacted	5
	2	3 – 5.9 % of local economy impacted	
	1	0 – 2.9 % of local economy impacted	
Supplemental information (optional)	The Project determined quantitative consequences for the environment indicator. There is a large potential for environmental consequences in the Okanagan watershed, including contamination of drinking water wells and high biodiversity areas. In particular, 80% of locations are potentially affected in even the low flood scenario . This is due to the high number of potential contaminants within the hazard area. This is a conservative estimate and does not take into account the release and transport of these contaminants, or local protection measures (such as storing potential contaminating materials above flood levels). In terms of environmental receptors (also referred to as environmental assets), they are concentrated at the bottom of valleys, within the floodplain. Consequences in the Similkameen are similar in relative magnitude to those in the Okanagan with a very high percentage of environmental assets potentially affected.		

D) Local infrastructure impacts			
	Risk Rating	**Definition**	**Assigned risk rating**
Transportation	5	Local activity stopped for more than 72 hours; > 20% of local population affected; lost access to local area and/or delivery of crucial service or product; or having an international level impact	4
	4	Local activity stopped for 48 - 71 hours; 10 - 19.9% of local population affected; significantly reduced access to local area and/or delivery of crucial service or product; or having a national level impact	
	3	Local activity stopped for 25 - 47 hours; 5 - 9.9% of local population affected; moderately reduced access to local area and/or delivery of crucial service or product; or having a provincial/territorial level impact	
	2	Local activity stopped for 13 - 24 hours; 2 - 4.9% of local population affected; minor reduction in access to local area and/or delivery of crucial service or product; or having a regional level impact	
	1	Local activity stopped for 0 - 12 hours; 0 - 1.9% of local population affected; little to no reduction in access to local area and/or delivery of crucial service or product	
Supplemental information (optional)		Risk to transportation was quantitatively assessed with the Project, and it is relatively high. This is as expected as many of the major transportation routes follow the lakes at the base of the mountains. As While the infrastructure sections of consequence usually cover short distances, in some areas there are few routes without any consequences. This means that flooding is likely to have a larger relative effect in the Similkameen. A large proportion of the consequences are along Highways 3, which runs parallel to the Similkameen River between Princeton and Keremeos; and Old Hedley Road, which runs parallel to the river between Princeton and Hedley.	
Energy and Utilities	5	Duration of impacts > 72 hours; > 20% of local population without service or product; or having an international level impact	3
	4	Duration of impact 48 - 71 hours; 10 - 19.9% of local population without service or product; or having a national impact	
	3	Duration of impact 25 - 47 hours; 5 - 9.9% of local population without service or product; or having a provincial/territorial level impact	
	2	Duration of impact 13 - 24 hours; 2 - 4.9% of local population without service or product; or having a regional level impact	
	1	Local activity stopped for 0 - 12 hours; 0 - 1.9% of local population affected; little to no reduction in access to local area and/or delivery of crucial service or product	

Supplemental information (optional)	In the Okanagan, the consequences on utilities is also high. A large number of structures are affected, which represents a major disruption to the network. It is important to note that the moderate flood hazard area affects two electrical substations, and the high scenario flood area includes three substations. Any consequences to these structures are likely to have far reaching implications for the network. Consequences in the Similkameen are of a similar order to the Okanagan. Although the number of assets affected is lower, the percentage of the network affected is higher.		
Information and Communications Technology	5	Service unavailable for > 72 hours; > 20 % of local population without service; or having an international level impact	3
	4	Service unavailable for 48 □ 71 hours; 10 □ 19.9 % of local population without service; or having a national level impact	
	3	Service unavailable for 25 □ 47 hours; 5 □ 9.9 % of local population without service; or having a provincial/territorial level impact	
	2	Service unavailable for 13 □ 24 hours; 2 □ 4.9 % of local population without service; or having a regional level impact	
	1	Service unavailable for 0 □ 12 hours; 0 □ 1.9 % of local population without service	
Supplemental information (optional)	These were assessed qualitatively by mapping, but no quantitative analysis was completed. Therefore, the score is a high-level approximation.		
Health, Food, and Water	5	Inability to access potable water, food, sanitation services, or healthcare services for > 72 hours; non□essential services cancelled; > 20 % of local population impacted; or having an international level impact	5
	4	Inability to access potable water, food, sanitation services, or healthcare services for 48□72 hours; major delays for nonessential services; 10 □ 19.9 % of local population impacted; or having a national level impact	
	3	Inability to access potable water, food, sanitation services, or healthcare services for 25□48 hours; moderate delays for nonessential services; 5 □ 9.9 % of local population impacted; or having a provincial/territorial level impact	
	2	Inability to access potable water, food, sanitation services, or healthcare services for 13□24 hours; minor delays for nonessential; 2 □ 4.9 % of local population impacted; or having a regional level impact	
	1	Inability to access potable water, food, sanitation services, or healthcare services for 0□12 hours; 0 □ 1.9 % of local population impacted	

Supplemental information (optional)	This indicator was not assessed quantitatively. Therefore, the score is a high-level approximation and oral accounts. During the recent flood events, boil water advisories had to be issued in several communities due to high turbidity of Okanagan Lake, and lasted for weeks. This included ONA member communities such as Westbank First Nation, who experience and advisory for multiple weeks due to increased turbidity. Other communities included those in West Kelowna who were connected to the Sunnyside and Pritchard Water Systems).		
Safety and Security	5	> 20 % of local population impacted; loss of intelligence or defence assets or systems for > 72 hours; or having an international level impact	1
	4	10 19.9 % of local population impacted; loss of intelligence or defence assets or systems for 48 – 71 hours; or having a national level impact	
	3	5 9.9 % of local population impacted; loss of intelligence or defence assets or systems for 25 – 47 hours; or having a provincial/territorial level impact	
	2	2 4.9 % of local population impacted; loss of intelligence or defence assets or systems for 13 – 24 hours; or having a regional level impact	
	1	0 1.9 % of local population impacted; loss of intelligence or defence assets or systems for 0 – 12 hours	
Supplemental information (optional)	This indicator was not assessed quantitatively. Therefore, the score is a high-level approximation and oral accounts. As a result of infrastructure damage and loss resulting from flooding, the health and safety of elderly individuals is at risk. For example an elderly members of the Penticton Indian Band are forced to cross a creek where a bridge has been destroyed and not replaced. There is a hazard of encountering wildlife such as grizzly bears in such areas, where safe egress would be very difficult.		

E) Public sensitivity impacts			
	Risk Rating	Definition	Assigned risk rating
	5	Sustained, long term loss in reputation/public perception of public institutions and/or sustained, long term loss of trust and confidence in public institutions; or having an international level impact	4
	4	Significant loss in reputation/public perception of public institutions and/or significant loss of trust and confidence in public institutions; significant resistance; or having a national level impact	
	3	Some loss in reputation/public perception of public institutions and/or some loss of trust and confidence in public institutions; escalating resistance	
	2	Isolated/minor, recoverable set□back in reputation, public perception, trust, and/or confidence of public institutions	
	1	No impact on reputation, public perception, trust, and/or confidence of public institutions	
Supplemental information (optional)	Based on qualitative information gathered, there is little trust among Syilx people that public institutions are working for them to reduce flood impacts and implement adaptation options. With this project, the ONA sought to disrupt western society's path dependency whereby decision-makers remain "locked in" to past policies and actions that favour engineered (e.g., structural mitigation) approaches to flood management (Parsons et al., 2019). This path dependency stands in the way of efforts to address changing hazard risks linked to climate change and other cumulative pressures. The Syilx Okanagan Nation maintains that existing institutional arrangements and frameworks do not adequately facilitate the implementation of wise environmental management that supports Indigenous communities to adapt to changing natural phenomena. In response, a new perspective and approach more closely aligned with a Syilx Okanagan worldview was adopted to guide this project.		

Confidence Assessment

Based on the table below, indicate the level of confidence regarding the information entered in the risk assessment information template in the “Confidence Level Assigned” column.
Confidence levels are language-based and range from A to E (A=most confident to E=least confident).

Confidence Level	Definition	Confidence Level Assigned
A	Very high degree of confidence Risk assessment used to inform the risk assessment information template was evidence-based on a thorough knowledge of the natural hazard risk event; leveraged a significant quantity of high-quality data that was quantitative and qualitative in nature; leveraged a wide variety of data and information including from historical records, geospatial and other information sources; and the risk assessment and analysis processes were completed by a multidisciplinary team with subject matter experts (i.e., a wide array of experts and knowledgeable individuals on the specific natural hazard and its consequences) Assessment of impacts considered a significant number of existing/known mitigation measures	
B	High degree of confidence Risk assessment used to inform the risk assessment information template was evidence-based on a thorough knowledge of the natural hazard risk event; leveraged a significant quantity of data that was quantitative and qualitative in nature; leveraged a wide variety of data and information including from historical records, geospatial and other information sources; and the risk assessment and analysis processes were completed by a multidisciplinary team with some subject matter expertise (i.e., a wide array of experts and knowledgeable individuals on the specific natural hazard and its consequences) Assessment of impacts considered a significant number of potential mitigation measures	
C	Moderate confidence Risk assessment used to inform the risk assessment information template was moderately evidence-based from a considerable amount of knowledge of the natural hazard risk event; leveraged a considerable quantity of data that was quantitative and/or qualitative in nature; leveraged a considerable amount of data and information including from historical records, geospatial and other information sources; and the risk assessment and analysis processes were completed by a moderately sized multidisciplinary team, incorporating some subject matter experts (i.e., a wide array of experts and knowledgeable individuals on the specific natural hazard and its consequences) Assessment of impacts considered a large number of potential mitigation measures	

D	Low confidence Risk assessment used to inform the risk assessment information template was based on a relatively small amount of knowledge of the natural hazard risk event; leveraged a relatively small quantity of quantitative and/or qualitative data that was largely historical in nature; may have leveraged some geospatial information or information from other sources (i.e., databases, key risk and resilience methodologies); and the risk assessment and analysis processes were completed by a small team that may or may not have incorporated subject matter experts (i.e., did not include a wide array of experts and knowledgeable individuals on the specific natural hazard and its consequences). Assessment of impacts considered a relatively small number of potential mitigation measures	C
E	Very low confidence Risk assessment used to inform the risk assessment information template was not evidence□based; leveraged a small quantity of information and/or data relating to the natural risk hazard and risk event; primary qualitative information used with little to no quantitative data or information; and the risk assessment and analysis processes were completed by an individual or small group of individuals little subject matter expertise (i.e., did not include a wide array of experts and knowledgeable individuals on the specific natural hazard and its consequences). Assessment of impacts did not consider existing or potential mitigation measures	

Rationale for level of confidence	
Provide the rationale for the selected confidence level, including any references or sources to support the level assigned.	

Ebbwater applied confidence levels to the final datasets that were used in this study. Confidence levels provide an indication of the robustness of a risk assessment (AIDR, 2015). This is essential, as risk assessment outputs inform decisions, and decision makers should be aware of potential uncertainties in data. Further, data availability is a limitation in most risk assessments, and often, simplified proxies have to be used to describe an indicator. Confidence levels communicate the different data quality levels in the risk assessment results. Confidence considers the reliability and relevance of the used data, and how up-to-date a dataset is (AIDR, 2015). Confidence can be assessed for consequence data and hazard/likelihood data separately, and combined to obtain an overall risk confidence level.
We used five confidence levels in our analysis, which were loosely based on the AIDR guidelines (AIDR, 2015) and simplified for the purposes of this risk assessment. The AIDR qualifiers for confidence are slightly different than those used in this RAIT; that is why the overall confidence score provided in this RAIT is slightly higher than those provided below.

Environment:
The confidence in this assessment is low. There may be other criteria that could be used to characterize potential environmental consequences due to flood a debris flow, both positive and negative, which could be included in the scope for future study. For example, a review of habitats which are dependant on these mechanisms could be conducted. In addition, a review of how potential contaminants are likely to spread and their likely consequence on sensitive ecosystems is important in building an understanding of this indicator. This could be done based on highly hazardous sites such as landfills or historic mining sites and/or areas with high concentrations of lesser contamination sources next to highly sensitive environments (for example, septic tanks near drinking water sources).

Culture:
The confidence in this assessment is low. More direct input from communities in the project area would be required to appropriately capture potential culture indicator consequences based on community values. This assessment does, however, provide a good starting point for discussion and should ensure that culture is considered in the development of mitigation and adaptation solutions.

Mortality:
The confidence in this assessment is low. This could be improved by more detailed investigations related to evacuation to link hazard and mortality rates. Investigations could improve understanding of the location of residential buildings, consider where people actually spend their time, evaluate hazard warning times and warning systems, and consider vulnerability factors such as demographics, accessibility, and evacuation routes.

Affected People:
Confidence in this assessment is moderate. This is largely because of the limitations in the census data and the lack of information on residential buildings. This could be improved with the completion of a specific study. This is particularly important for the Similkameen due to the discrepancy in the two data sources used to estimate consequences in this location.

Economy:
The confidence in this assessment is low. This is largely due to the lack of consideration of the degree of damage caused by these hazards. A more detailed review including depths and velocity in priority areas would improve this confidence.

Disruption:
Confidence in this assessment is moderate. This would be improved by a better understanding of the consequences of hazards on infrastructure in key locations and a thorough review of other critical infrastructure.

Key Information Sources	
Identify all supporting documentation and information sources for qualitative and quantitative data used to identify risk events, develop the risk event description, and assess impacts and likelihood. This ensures credibility and validity of risk information presented as well as enables referencing back to decision points at any point in time. Clearly identify unclassified and classified information.	A large range of qualitative and quantitative data sources were used, and the full list cannot be included in this space. Please consult the Synthesis and Recommendations report, as well as the risk assessment supporting documents, for detailed references of supporting documentation. Key qualitative information sources were participants in the workshops and watershed tours. Grey and scientific literature was also consulted. Key quantitative information sources included Ministry of Environment databases such as the Environmental Monitoring System (EMS) and Freshwater Atlas, the Integrated Cadastral Information (ICI) Society, BC Assessment, Interior Health, and the Remote Access to Archaeological Data (RAAD).

Description of the risk analysis team	
List and describe the type and level of experience of each individual who was involved with the completion of the risk assessment and risk analysis used to inform the information contained within this risk assessment information template.	The authors wish to acknowledge the support of ONA staff Tessa Terbasket and Kathy Holland, as well as Lisa Wilson. The ONA and its member communities led the watershed tours and contributed to the workshops planning and delivery. We also thank the many project participants that included Elders from Syilx Nation communities, as well as representatives from the region's local governments and agencies. The collaboration and data sharing were extremely valuable and appreciated. We would like to acknowledge that all the project events took place on unceded Territory of the Syilx (Okanagan) people, and that this report was written at the Ebbwater office, which is located on unceded Territory of the Coast Salish people. The consulting team was diverse and many individuals contributed to various aspects of the project. Writing was led by Robert Larson, M.Sc., who was supported on technical components by Dickon Wells, M. Eng., Silja Hund, Ph.D, and Nikoletta Stamatatou, M.Sc. (Ebbwater) for flood hazard and quantitative risk assessment. Cory McGregor, GIT and Derek Cronmiller, P.Geo. (Palmer Environmental Consulting Group; PECG) completed the debris flow hazard assessment. The report was reviewed by Tamsin Lyle, P.Eng of Ebbwater. The workshops planning and facilitation, as well as qualitative study review, were led by Erica Crawford (Shift Collaborative). For the workshops, Erica was supported by Kelly Terbasket (IndigenEYEZ) and Dallas Goodwater.

Syilx Okanagan Flood and Debris Flow Risk Assessment

Report 1 of 4 – Basis of Study

Appendix C: Climate Change Projections Science Primer

1.1 Introduction

The world is warming. Global mean temperatures have been rising steadily for decades, with an estimated average increase of 0.85°C since 1880 (Bush & Lemmen, 2019), the rate of change is intensifying over time, with the hottest years on record occurring in 2015, 2016 and 2017. This is a result of human interventions affecting the climate system in the form of greenhouse gas (GHG) emissions.

Climate and climate science are extremely complex with many different interacting components (e.g. the connections between the atmosphere, oceans, and land surface). Scientists of many different disciplines from around the world are studying climate to better understand these linkages so that they can make future climate projections. These projections underpin the understanding of our future risk, which inform adaptation decisions.

The following sections highlight the major components of climate science and projections. The concepts described here are necessary to understanding the available data to support a climate risk and resiliency assessments.

1.2 Weather Versus Climate

The short-term state of the atmosphere is termed weather. This describes the temperature, precipitation, humidity, cloudiness, wind, etc. Weather is extremely variable both in space and time. The Province of BC has particularly diverse weather on both temporal and spatial scales. On any given day, or over the course of the day, weather conditions can be quite different.

Climate describes the long-term patterns of weather at a given location, where the long-term is generally considered to be on the order of 30+ years. For somewhere like the Greater Vancouver area, climate can be described broadly as being an area with cold, cloudy and wet winters and warmer, dryer summers. Climate gives a sense of expected conditions in a given place and season.

1.2.1 Inter-annual Variability in Climate

The climate can be affected by processes that create inter-annual variability. In BC these include:

- El Niño-Southern Oscillation (ENSO). This is a recurring climate pattern involving the oscillation of temperatures in the central and eastern tropical Pacific Ocean. An El Niño condition exists when warmer than average ocean temperatures persist in the central and eastern tropical Pacific

Ocean. In British Columbia this creates warmer and drier than average conditions. In contrast, a La Niña condition, which exists when average ocean temperatures are colder than normal, generally creates colder and wetter conditions across the province.

- Pacific Decadal Oscillation (PDO). This describes a climate pattern associated with ocean temperature variation (or amplitude) from east to west in the Pacific Ocean. There have been reversals in the polarity of the ocean temperatures on a decadal scale in the past. A positive PDO describes a scenario when the western Pacific becomes cooler and the eastern Pacific becomes warmer, a negative PDO describes the reverse. When the PDO is in a positive phase, BC sees higher than average temperatures and precipitation.

The ENSO and PDO affect climate variability in the province under current conditions. Climate change may affect the timing and intensity of these phenomena in future.

1.3 Climate Projections

Climate is changing, and so past weather and climate data cannot be used as a predictor for the present or future. Given this non-stationary climate, there is an effort to understand future climate, led primarily by the Intergovernmental Panel on Climate Change (IPCC) at a global scale; the global data are then used to consider climate changes at smaller, regional scales. The following section provides a brief overview of the process that is followed to estimate regional-scale climate projections.

1.3.1 Climate Emission Scenarios

With the knowledge that human activities are affecting climate, the first step in climate projections is to develop plausible future emissions trajectories. These broadly describe scenarios where humans maintain, increase, or decrease current emission of GHGs. The IPCC currently uses Relative Concentration Pathways (RCPs) to describe these trajectories. These are represented as global emissions of carbon-dioxide equivalents over time (Figure 1). The RCP 2.6 scenario describes the best-case scenario, where emissions peak in the near future and then decrease over time. Conversely, RCP 8.5 describes the worse case, where a business-as-usual scenario perpetuates, and global society continues to emit GHGs at current rates. The other two scenarios (RCP 4.5 and RCP 6.0) describe trajectories that are somewhere in between the previous two described. Although the global community still has the ability for course corrections, some governments, including in BC (i.e. Metro Vancouver) have made an organizational level decision to assume the worse case of an RCP 8.5 scenario to support future planning.

The RCPs have replaced the previous SRES (Special Report on Emissions Scenarios) scenarios that were used in earlier IPCC assessments and reports. These described families of scenarios with different narratives of the future (from economic to environment and global to local). These are described using alphanumeric codes, for example the A1 family of scenarios describes a world with rapid economic growth and population growth by the mid-century.

The emission scenarios (both the current RCPs and previous SRES) are key inputs to climate projections. Models report climate for some or all scenarios. Additional information on available data for BC is found later in this report.

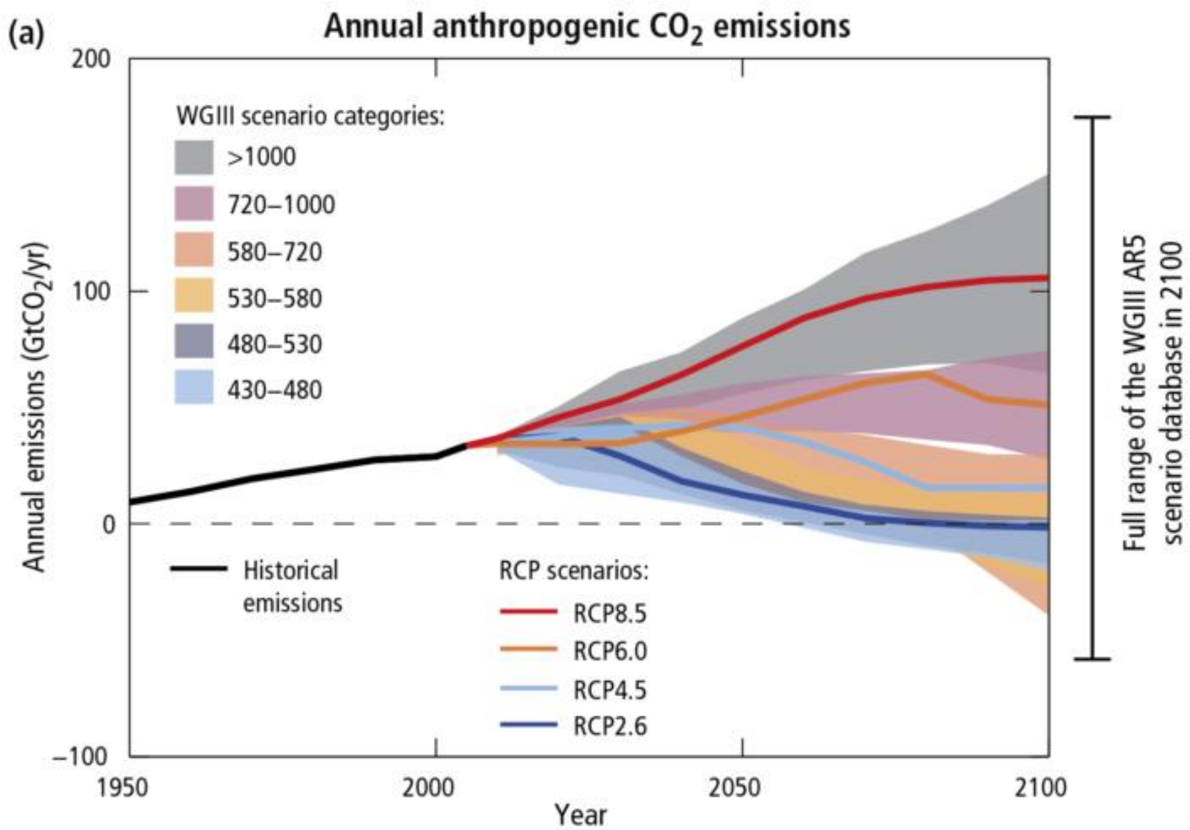

Figure 1: Representative concentration pathways (IPCC, 2014a).

1.3.2 General Circulation Models

A general (or global) circulation model (GCM) is a type of climate model that is used to simulate and understand global physical processes. These are used both for an understanding of historic conditions to predict weather, and to project future climate. GCMs used for climate projections include models that consider atmosphere, ocean, and land surface processes and are forced by emissions scenarios (see above).

There are many researchers around the world working with GCMs, each with a different focus. There is great variability in the outputs of the GCMs, and therefore an ensemble approach is generally used to understand overall trends. This means that many GCMs are run for the same forcing variables, and then their convergence (or conversely their variance, which is represented as uncertainty) is used to estimate future climate. Figure 2 shows a summary of global projections for temperature and sea level rise. RCPs are represented by colours, and the variation in the ensemble models is represented by the width of the projection.

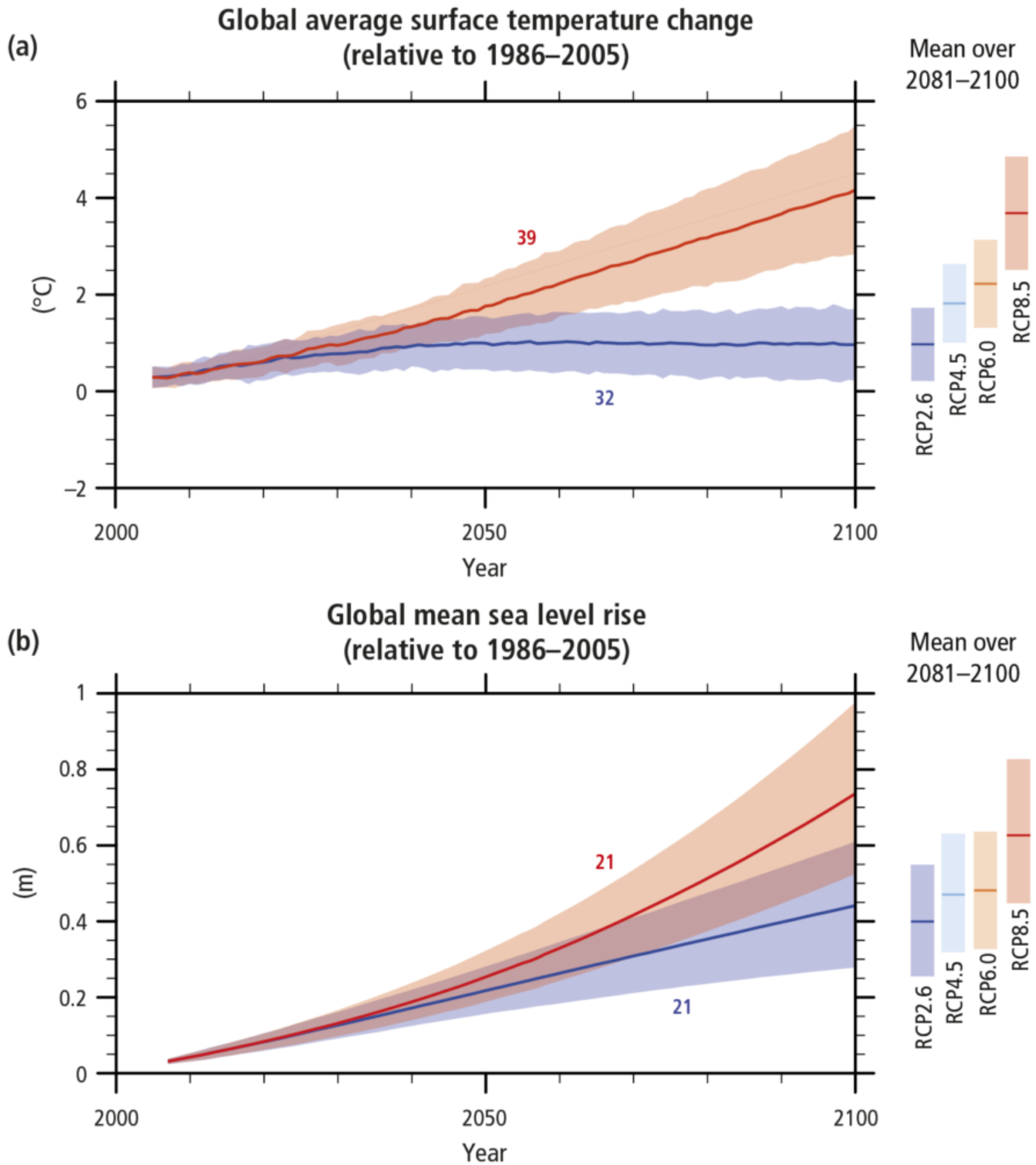

Figure 2: Climate projections for multiple RCPs showing ensemble variability (IPCC, 2014a)**.**

Ensemble models for the IPCC were selected based on the performance of the models at a global scale (when calibrating or validating to historic data). These collectively are called the Coupled Model Intercomparison Project (CMIP), are working collaboratively at a global scale and are used to project climate scenarios for each of the RCPs. The CMIP5 results represent a collective effort to estimate climate projections for the IPCC AR5 (Assessment Report), and work is now underway to prepare CMIP6. However, it is known that some models work better for different regions around the world, and therefore the selection of an appropriate ensemble of models is often undertaken when looking at a given region.

1.3.3 GCM Data Output

GCMs output various climate indicators. Air temperature is the primary and most robust indicator output by GCMs. Most also provide an indication of precipitation change. Other climate patterns (cloudiness, wind, etc.) are more difficult to project within a GCM because of the localised effects. There is much greater uncertainty in these outputs if they are produced at all.

Because of their spatial coverage, global models are coarse and their processes are resolved at resolutions of 100s or 1000s of kilometres. Given the variability in terrain, ecosystems, etc. across a province like BC, the model results from GCMs have to be refined before they can be applied as useful tools.

1.4 Downscaling

Downscaling describes the process of taking GCM outputs and estimating more localised impacts (at a scale of 10s to 100s of kilometres). There are two main methods of downscaling – statistical and dynamic – both of which are summarised below.

1.4.1 Statistical Downscaling

Statistical downscaling is commonly used, and is the primary approach used by the main regional climate service in BC (i.e., the Pacific Climate Impacts Consortium, PCIC). Statistical downscaling considers historic information from GCMs and locally-observed data to develop statistical relationships between the two sets of models. These relationships are then applied to future projections from GCMs to project local indicators (usually precipitation and temperature). The advantage of this approach is the relative simplicity of the process, which leads to reduced computational resources required. Statistical downscaling does, however, have the limitation that results tend to report at a relatively coarse scale and are they are tied to historic data. This leads to uncertainty in results for two reasons: 1) areas where climate data are sparse (like BC) are not well represented by the statistical relationships, and 2) statistical models cannot explicitly consider effects of increasing GHG emissions in local physical processes. Therefore, past statistical relationships are applied to the future and non-stationarity of the climate is not considered.

1.4.2 Dynamic Downscaling (Regional Climate Modelling)

Dynamic downscaling describes a process where a Regional Climate Model (RCM), which simulates local physical processes including climate, topography, and the landsurface, is forced at the boundaries of the spatial domain by the results of the GCM output for the same spatial domain. The advantage of this type of downscaling is that generally a finer resolution of results can be achieved. Since they are physically-based, RCMs do not rely on past statistical relationships and they can simulate localised effects of GHGs. The major disadvantage of regional climate modelling is that the computational resources required are high and the approach is not widely used.

1.5 Summary

Climate is changing and there are tools available to project what our future climate will look like. These in turn can be used to understand weather and trends in hazards (such as floods, wildfires, etc.). There is uncertainty in the projections related to future human GHGs, modelling error and downscaling tools. However, projections can indicate possible future trajectories and provide a range of potential future impacts. An understanding of the available information and its limitations is key to establishing what level of effort is relevant to a climate risk and resilience assessment.

Syilx Okanagan Flood and Debris Flow Risk Assessment

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Appendix D: Recently Funded Flood Initiatives

1.1 Introduction

Tracking project funding resulting from the various public programs is not a clear-cut task. The overlap between federal and provincial cost-shared programs can be confusing, and programs do not always make award information readily available. However, even a high-level understanding of recently-completed and on-going initiatives in the region can be valuable to practitioners in the project area in gaining awareness and enable collaborative innovation. The objective should be to reduce duplication of effort and to make the most use of the information obtained.

The list of projects reviewed does not include provincially-led projects. These include recently completed and on-going field investigations and risk assessments of regulated and "orphaned" dikes and appurtenant structures across BC, as well as dam safety reviews and other studies mentioned in the main body of the Basis of Study.

1.2 Funded Initiatives

Table 1 contains a list of the publicly funded flood-related initiatives in the project area, organized by Okanagan and Similkameen watersheds. The information in the table was obtained from a mix of on-line searches, as well as email and telephone conversations. There is high confidence that the list is close to complete, but the search was not exhaustive. The budget amounts in the "Approx. Amount" column and the information in the "Project Description and Status" should be considered high-level and is not necessarily updated as of the time of publishing this report in December of 2019.

Based on our research and some cross-checking including email and phone communications with awardees, at least $4.7M has been spent on flood-related projects in the Okanagan in the last 2 years, excluding this risk assessment project. Additionally, in March 2019, $22M was announced to help the City of Kelowna with a long-term mitigation plan and flood protection for Mill Creek; that project was the one exclusively awarded under the newly-formed Disaster Mitigation Adaptation Fund (DMAF). No projects were found to have been explicitly related to geohazards such as debris flow in the project area. The total awarded budget amount for the Similkameen watershed is $859,000.

Table 1: List of recent publicly funded flood-related initiatives in the project area.

Jurisdiction	Funder	Project Name	Approx. Amount	Project Description and Status
Okanagan Watershed				
City of Armstrong	CEPF (approved December 2017)	Flood Mapping and Mitigation Planning	$79,000	• Using CEPF, Flood Mapping and Risk Assessment report was completed in December 2018. • Report scope Meighan and Deep creeks. • Scope was expanded to include risk assessment and public consultation process • RFP 2018016 for risk assessment was released in mid-September, but subsequently withdrawn in an addendum issued by the City on September 21, 2018.
City of Armstrong	NDMP Intake 3 (approved October 2017)	Flood Risk Assessment	$250,000	
Greater Vernon	NDMP Intake 3	Lakeshore Flood Mapping	$150,000	• E-mail from Alistair Crick of 29-Aug-2018: “Greater Vernon lakeshore project now has extra funding, and has extended, subject to approval from the province, into the Shuswap river flood areas of the RDNO, and has Enderby and additional electoral areas now as contributory partners.”
	Federal Gas Tax, Strategic Priorities Fund	Drainage Infrastructure Prioritization Study	$105,000	• E-mail from Geoff Mulligan of 10-Apr-2019: “Risk assessment study of stormwater (and critical) infrastructure taking into account climate change and using high density LiDAR to define overland flow routes specifically in the low-lying urban areas.”
	CEPF	Upper and Lower BX Creek Flood Risk Assessment, Mapping and Flood Mitigation Planning – Phase 1	$150,000	• From CEPF application: Project will bring together past work related to Upper and Lower BX Creek and update work with new hydrology and methodology related to changing climate to complete risk assessment and flood mapping to identify potential social, economic and environmental impacts that flood events.
RDNO	CEPF Stream 4	Structural Flood Mitigation for RDNO Drinking Water	$405,000	• E-mail response from Zee Marcolin (15-Oct-2018): Work was “awarded to KWL. The grant covers three separate projects for different water utilities owned and operated by RDNO. The work scopes cover structural and electrical floodproofing at three pumphouses.”

Jurisdiction	Funder	Project Name	Approx. Amount	Project Description and Status
Spallumcheen	NDMP (likely cycle 3?)	Spallumcheen Flood Hazard Risk Assessment	$100,000	Communications with Sasha Bird on 27-Mar-2019: • Open house was held on December 13, 2018, followed by on-line survey. • Second open house held at end of April, 2019. • Report with flood maps of various AEPs to be completed mid-May.
Kelowna	CEPF, Intake 1	Kelowna - LiDAR Acquisition and Mission Creek Floodplain Mapping and Dike Breach Analysis	$150,000	• E-mail response from Robinson Puche (26-Sep-2018): “LiDAR data expected to be available in December 2018, and will be used for Mission Creek flood modelling. Also considering incorporation of 2D flood modelling. Project deadline is August 2019.”
Kelowna	City of Kelowna and Province (EMBC), NDMP, Intake 4	Major Systems Flood Risk Assessment	$250,000	• Phase 2 of the Regional Floodplain Management Plan. • E-mail from Robinson Puche (City of Kelowna) on 26-Sep-2018: “With the lens of the 2017 freshet event and related flooding, the project will focus on property/infrastructure flood risk assessment” for flood prone reaches identified in Phase 1. • Focus on Gopher Creek, Brandt’s Creek, Bellevue Creek, Okanagan Lake foreshore area, and Mill Creek. • From RFP T19-063, work was awarded to Associated Engineering. • Scheduled for completion in August 2019. • Presentation of the draft results were presented to the ONA on 22-Nov-2019.
Kelowna	DMAF Intake 1	Long Term Mitigation Plan / Mill Creek Flood Protection	$22M	• Awarded in March 2019, and information obtained here. • Project will increase the creek’s capacity by rehabilitating creek riverbanks, integrating increased drainage solutions, and adding new off-stream water storage areas.
Kelowna (and RDCO)	CEPF, Intake 2	Flood Mapping and Mitigation Planning	$200,000	• Information obtained from RFQ T19-063, issued June 21, 2019 • Mill Creek flood hazard model update • Mission Creek flood hazard mapping and dike breach analysis
OBWB		Okanagan River and Lakes Flood	$1.5M	• Coordinated funding with regional districts. • As of 12-Dec-2019, OBWB “dealing with data share agreements between the

Jurisdiction	Funder	Project Name	Approx. Amount	Project Description and Status
		Mapping – LiDAR acquisition		Province and people accessing data. OBWB has data on hard drives and can share it that way now".
		Okanagan River and Lakes Flood Mapping	$500,000	• NHC is currently completing Okanagan mainstem modelling and mapping.
Peachland	CEPF Intake 2	Flood risk assessment and mitigation plan for Okanagan lakeshore	$145,000	• Obtained from Cheryl Wiebe (District of Peachland, 9-Dec-2019): • Work is being completed by Waters Edge Engineering • Expected completion date is February 2020.
Penticton	NDMP Intake 4	Flood Risk Assessment	$67,000	• Project awarded to TetraTech in July 2018. • 200-year flood maps produced were obtained for the Syilx Flood Risk project to compare with high-level flood-prone area delineation that we conducted.
	CEPF Intake 2	Flood Mitigation Plan	$59,000	• No details obtained.
RDCO	NDMP Intake 4	Lakeshore Flood Mapping	$270,000	• LiDAR data is expected in December 2018.
Greater Vernon	NDMP Intake 3	Lakeshore Flood Mapping	$150,000	• E-mail from Alistair Crick of 29-Aug-2018: "Greater Vernon lakeshore project now has extra funding, and has extended, subject to approval from the province, into the Shuswap river flood areas of the RDNO, and has Enderby and additional electoral areas now as contributory partners."
	Federal Gas Tax, Strategic Priorities Fund	Drainage Infrastructure Prioritization Study	$105,000	• E-mail from Geoff Mulligan of 10-Apr-2019: "Risk assessment study of stormwater (and critical) infrastructure taking into account climate change and using high density LiDAR to define overland flow routes specifically in the low-lying urban areas."
	CEPF Intake 2	Upper and Lower BX Creek Flood Risk Assessment, Mapping and Flood Mitigation	$150,000	• From CEPF application: "Project will bring together past work related to Upper and Lower BX Creek and update work with new hydrology and methodology related to changing climate to complete risk assessment and flood mapping to identify potential social,

Jurisdiction	Funder	Project Name	Approx. Amount	Project Description and Status
		Planning – Phase 1		economic and environmental impacts that flood events."
Similkameen Watershed				
Keremeos	CEPF Intake 2	Similkameen River regional flood risk assessment, flood mapping and flood mitigation plan	$150,000	• Being completed in conjunction with RDOS and Princeton CEPF Intake 2 projects (see below), by Ecora consultants. • From Barrett Van Vliet (Ecora, 9-Dec-2019): "Using 3-phase approach to complete modelling, flood mapping, and mitigation. Phase 1 is planned for completion in January 2020, and includes a desktop risk assessment. The timing of Phases 2 and 3 will be dependant on receipt of GeoBC LiDAR data, which is expected in February or later. • Sean Vaisler at RDOS is coordinating the work.
RDOS	CEPF Intake 2	Similkameen River regional flood risk assessment and flood mapping project	$139,000	• See details from above.
Princeton	CEPF Intake 2	Similkameen River regional flood risk assessment, flood mapping and flood mitigation plan	$150,000	• See details from above.
RDOS	NDMP Intake 4	Okanagan River and Lakes Flood Mapping	$570,000	• See project description under "OBWB", Okanagan Watershed section of table.

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Appendix E: Review of Relevant Regional Planning-Level Initiatives

1 Introduction

As identified in the main body of the Basis of Study, and other project reports, there is a variety of cumulative pressures on flood and debris flow hazards. These cumulative pressures arise in part due to land use policies. While the *Syilx* Nation is not governed by land use policies developed by the project area's local governments, *Syilx* people feel the effects of such policies through landscape changes.

The project area's Okanagan and Similkameen watersheds include three regional districts, and each has produced a high-level regional growth strategy (RGS) or similar planning document. These have been reviewed to provide a broad understanding of how local government level land use strategies and policies interact with flood and debris flows. It was out of the scope of this project to conduct such an analysis at lower levels of local governments such as municipalities.

According to Part 13 of the Local Government Act, the purpose of RGSs is "to promote human settlement that is socially, economically and environmentally healthy and that makes efficient use of public facilities and services, land and other resources." The objectives of this project therefore have important linkages with sections of the RGSs for each regional district.

Within the RGSs, the policies have three purposes:

- Give direction for implementing the RGS.
- Create a common strategic framework for planning at various levels within the regional district (including municipalities).
- Provide the vision for all levels of government to strive toward.

RGSs typically outline growth areas and guidance on land use planning. Therefore, the RGSs play a role in flood and debris flow adaptation. To highlight this role, the RGSs are summarized in the following sections with a focus on ideas with direct relevance to flood and debris flows, and collaboration with Indigenous People. The summary is not exhaustive, but is meant to identify how these issues converge or diverge in the two watersheds. This analysis can help the communities within the region identify gaps in policies and build on common goals.

There are a variety of indirect ways in which land use planning principles expressed in the RGSs link with flood management (e.g. through health impacts, food systems, etc.). However, identifying these more indirect linkages was considered out of the scope of this exercise.

2 Summary of Initiatives

2.1 Okanagan Watershed

While each of the three regional districts within the Okanagan watershed has produced a regional growth strategy (RGS), in matters related to water, the regional districts regularly work with the Okanagan Basin Water Board (OBWB) for watershed-scale coordination.

The OBWB has existed for approximately 50 years and was established under the *Municipalities Enabling and Validating Act*, and by supplementary letters patent. The Board of Directors is the main decision-making body and includes elected or appointed representatives from the Okanagan regional districts, the ONA, the Water Supply Association of BC, and the Okanagan Water Stewardship Council (OWSC). The OWSC was established in 2006 as a technical advisory body to the OBWB, and its membership includes a broad range of water sector, government, academic, and other stakeholder organizations.

2.1.1 Regional District Growth Strategies

The regional growth strategies reviewed were the following:

- Regional Growth Strategy (RDNO, 2011).
- Regional Growth Strategy (RDCO, 2013).
- South Okanagan Regional Growth Strategy (RDOS, 2009).

Generally, each of the strategies contain about 10 regional issues or policy areas, many of which relate to water. All of the strategies refer to policies or actions that pertain specifically to flood. While debris flows are not specifically mentioned, a few policies or actions refer to hazard management, which implicitly includes debris flows.

One of the strategies explicitly recognized that their land is on unceded territory and provided a statement to this effect at the beginning of the report. All strategies have some components related to community engagement and awareness, and working collaboratively with First Nations. However, it appears that in general the strategies were developed with limited input from the *Syilx* Nation.

Many aspects of the plans do not directly align with *Syilx* objectives that have been articulated through this project related to flood and debris flows. For example, the growth strategies do not mention the removal of exposed settlements in floodplains as a solution to reduce flood and debris flow risk. While most strategies *do* mention the need to work with external partners to address flood risk, specific plans to work with the *Syilx* Nation as partners in the process are not clear.

2.1.2 Okanagan Basin Water Board

The main initiative in the watershed related to flood is the Okanagan Lakeshore Mapping Project. For that project, the Okanagan Basin Water Board (OBWB) is working with the three regional districts and municipal partners to create flood maps for the valley-bottom lakeshores and the Okanagan River channel, using detailed topographic data (LiDAR) acquired in 2018. The *Syilx* Nation is a formal partner in the project, which is complementary to this risk assessment project.

The OBWB is also involved in much wider water-related initiatives across the watershed. One such initiative is the development of a Sustainable Water Strategy. The development of the strategy has included input from the *Syilx* Nation.

2.2 Similkameen Watershed

While there is no regional growth strategy that covers the Similkameen watershed, the Similkameen Valley Planning Society, with support from the RDOS, is in the process of developing the Similkameen Watershed Plan (SWP). The planning Society includes local government, parks, hamlets, and the *Syilx* Nation (via the Lower Similkameen Indian Band).

2.2.1 Similkameen Watershed Plan

The Similkameen Watershed Plan (SWP) has the overall objective of preserving and protecting the quality and health of the watershed. Version 1.1 of the SWP goals, strategies, and actions (drafted in September 2017) reflect understanding at the time of a draft agreement between the *Syilx* Nation and the RDOS, and the *Syilx* Water Declaration (AE, 2017). The plan is being informed by a series of technical studies, in addition to planning studies.

As part of the SWP, a governance survey was developed and feedback was obtained from a diversity of municipal, recreational, and industry groups within the watershed. From the responses received, a set of governing principles was defined.

The SWP makes several recommendations to address flood risk. For example, it contains five actions under the relevant strategy to "identify areas at high risk for flooding and undertake steps to reduce risk and mitigate impacts through planning", including "develop a floodplain management plan on a watershed scale…" (AE, 2017). Out of all the regional plans reviewed, the SWP is the one having the most content related to flood and debris flows; the process has also appeared to have involved the most effort to work with the *Syilx* Nation through its member communities.

3 Review of Policies and Strategies

The following sections contain information that was pulled directly from the regional planning documents in the Okanagan and Similkameen watersheds, respectively, to provide readers with specific references.

3.1 Okanagan Watershed

3.1.1 RDCO RGS

The RDCOs RGS (RDCO, 2013) can be summarized as follows:

- Contains 10 'regional issues', each with defined goals, and sub-policies
- Outlines how monitoring and evaluation of the plan should be conducted
- Many of the regional issues of the RGS require cross jurisdictional collaboration in order to plan for the long-term
- First Nations are part of the RGS vision

A summary of relevant policies, organized in terms of regional issue and goal, follows. Underlined words have been added to emphasize content that relates more specifically to flood and debris flow risk.

Regional Issue	Water Resources
Goal	To manage and protect water resources.
Relevant Policies	
• Consider <u>water resources</u> in <u>land use planning</u> decisions. • Work with local governments, provincial agencies to <u>assess and mitigate the risks in floodplains.</u> • Continue in partnership with the Okanagan Basin Water Board (OBWB) and <u>regional partners</u> to encourage valley wide cooperation and coordination regarding the conservation of water and protection of all water sources. • Encourage cooperation and information sharing with regional partners to identify data and information necessary to improve hazard and resiliency planning.	

Regional Issue	Climate
Goal	To minimize regional greenhouse gas emissions and respond to the impacts of climate change.
Relevant Policies	
• Consider GHG reduction and climate adaptation/mitigation in decision-making as well as in planning policies and regulatory measures. • Encourage land use and transportation infrastructure that improves the ability to withstand climate change impacts and natural hazard risks.	

Regional Issue	Ecosystems
Goal	Be responsible stewards of natural ecosystems to protect, enhance and restore biodiversity in the region.
Relevant Policies	
- Manage growth to minimize disturbance to habitat, watershed and natural drainage areas and systems. - Protect natural environments, parks and water systems, as these systems are essential to the quality of life in the Okanagan that support active and healthy lifestyles. - Support the provisions of the Water Resources section to be considered in context of all discussions regarding the Region's ecosystems. - Encourage collaboration with regional partners, provincial ministries and stakeholders to consider regional conservation, watershed and other ecosystem-based plans and strategies that will update existing inventories. - Support cooperation on the maintenance and update of environmental mapping for terrestrial, foreshore and aquatic areas throughout the Region on a regular basis.	

Regional Issue	Economy
Goal	To develop and enhance a positive business environment in the region to achieve a dynamic, resilient and sustainable economy.
Relevant Policies	
Support a comprehensive regional approach to create an attractive investment climate for the Region by working in partnership with the province, local municipalities, First Nations and economic development agencies.	

Regional Issue	Land
Goal	To manage the land base effectively to protect natural resources and limit urban sprawl.
Relevant Policies	
- Support the continued exchange of information with provincial agencies on future land use decisions that impact the interface of the boundaries of crown land adjacent to municipalities and regional districts and best management practices for resource extraction to minimize negative impacts in the Region (e.g., truck traffic, environmental considerations, land use conflicts, nuisances). - Encourage cooperation and information sharing with regional partners on hazard identification and mapping programs to provide better and more information on hazard management.	

3.1.2 RDNO RGS

The RDNO RGSS (RDNO, 2011) can be summarized as follows:

- Contains 9 policy areas, each with goals, strategies, and indicators.
- Recognizes and shows the linkages between goals and the various policy areas.

- It is the first cooperative strategy of its kind for the region
- Supported by municipal councils with a bylaw
- Identifies actions that the communities of the RDNO agree to, as well as actions requested of other governments and agencies.
- Requires annual monitoring and review every 5 years.

A summary of relevant policies, organized in terms of policy area and goal, follows. Underlined words have been added to emphasize content that relates more specifically to flood and debris flow risk.

Policy Area	Water Stewardship
Goal	Protection of Our Groundwater
Relevant Policies	
• Develop policies, within the authority of local and regional government that will evaluate proposed developments based upon local <u>hydrological conditions</u>, access to long term water supply, an adherence to the precautionary principle and impact on supply to existing users. • Develop lot size policies that are based on local <u>groundwater</u> conditions so that the <u>cumulative effects</u> of development do not compromise the sustainability of the community. • Collaborate with the province and <u>appropriate agencies</u> to address regional and local watershed and source water protection and management issues.	

Policy Area	Water Stewardship
Goal	Consider the True Cost of Water
Relevant Policies	
• Collaborate on the development and implementation of a consistent full cost accounting framework (that includes the cost of construction, maintenance, operation, and replacement) for water and sewer infrastructure that reflects the true cost of delivering a long term sustainable service.	

Policy Area	Environment and Natural Lands
Goal	Protect our Watersheds
Relevant Policies	
• Develop consistent, integrated environmental policy that will protect water ecosystem function, our drinking water sources and conserve and enhance biodiversity and ecological services through the protection of ecological features and corridors, including <u>floodplains, shorelines, stream and river systems, aquifers, wetlands and forested watersheds</u>. • Create a Regional Foreshore Strategy, using <u>foreshore inventory mapping</u>, that will be incorporated into the application and permitting process for new and existing developments.	

Policy Area	Environment and Natural Lands
Goal	Protect our Parks, Natural Area and Open Spaces
Relevant Policies	
• Coordinate on the establishment of regionally significant open space networks and linkages across jurisdictional boundaries that will compliment local parks planning.	

Policy Area	Environment and Natural Lands
Goal	Reduce and Prevent Pollution
Relevant Policies	
• Encourage the development and adoption of policies that contribute to the reduction or prevention of air, land and water pollution. • Support the use of innovative approaches and technologies (i.e. green infrastructure) for water, energy, and waste and emissions management through the use of best management practices, local bylaws and incentives.	

Policy Area	Governance and Service Delivery
Goal	Support Regional Governance Based Upon a Foundation of Regional Cooperation
Relevant Policies	
• Support regional and municipal staff collaboration and coordination on matters of regional significance. • Recognize the need to engage First Nations in building mutual appreciation, understanding and respect for service delivery approaches across governments.	

3.1.3 RDOS RGS (South Okanagan)

A summary of relevant policies, organized in terms of policy area and goal, follows. Underlined words have been added to emphasize content that relates more specifically to flood and debris flow risk.

Policy Area	Housing and Development
Goal	Focus development in serviced areas in designated Primary Growth Areas and Rural Growth Areas.
Relevant Policies	
• It is recognized that land use decisions should take into account the broader values and needs of south Okanagan residents and the surrounding environment. The RGS recognizes that land use decisions can have long-term consequences on social health, ecosystem function, and the local economy. • Focusing development in Primary Growth Areas is a means of protecting rural and environmentally sensitive areas, and increasing service efficiency.	

Policy Area	Ecosystems, Natural Areas and Parks
Goal	Protect the health and biodiversity of ecosystems in the south Okanagan.
Relevant Policies	
• Conserve, protect and steward watersheds, wetlands, riparian areas, and open spaces. • Restore and manage prime habitat areas, including lakeshores. • Work with Syilx leaders to develop partnerships for regional ecosystem health.	

Policy Area	Infrastructure and Transportation
Goal	Support efficient, effective and affordable infrastructure services and an accessible multi-modal transportation network.
Relevant Policies	
• Consider guidelines and alternative development standards to reduce environmental impacts of hillside development. • Minimize infrastructure development impacts by avoiding hazard areas and environmentally sensitive areas. • Work with the Ministry of Transportation and Infrastructure to identify areas where limited access highways outside of urban centres are needed to ensure public safety and transportation efficiency.	

Policy Area	Energy Emissions and Climate Change
Goal	Reduce energy emissions and ensure the South Okanagan is prepared for a changing climate.
Relevant Policies	
• Consider climate change adaptation/resiliency measures in existing and proposed activities and development. • Support climate change adaptation and the mitigation of greenhouse gas emissions in existing and proposed activities and development.	

Policy Area	Engagement and Collaboration
Goal	Foster and support regional cooperation, collaboration and civic engagement.
Relevant Policies	
• Build and enhance communication and relationship with regional Syilx / Okanagan Nation communities. • Develop protocol agreements with Osoyoos Indian Band and Penticton Indian Band for communications, service delivery and joint services, and joint capacity building initiatives. • Support development of an indigenous cultural awareness program for local communities and governments.	

3.2 Similkameen Watershed

3.2.1 Similkameen Watershed Plan

A summary of relevant strategies, organized in terms of area and goal, follows. Underlined words have been added to emphasize content that relates more specifically to flood and debris flow risk.

Area	Water Contingency Planning
Goal	The Similkameen Valley will become more resilient to drought, floods, and environmental emergencies by developing appropriate risk management and response plans.

Relevant Strategies

- Identify areas at high risk for flooding and undertake steps to reduce risk and mitigate impacts through planning:
  - Action E2a: Update provincial floodplain mapping for the Similkameen Watershed, which was last completed in the 1980s by the Province. The update should make use of the most recent federal and provincial government guidelines and incorporate local and current climate change projections.
  - Action E2b: Develop a Floodplain Management Plan on a watershed scale. This can be done in a phased approach to first identify areas of higher risk before completing further assessments at a local scale. Include a communication strategy to identify a clear chain of communication under flood conditions, consistent with emergency response procedures.
  - Action E2c: Create a database on flood events, flood damage, and flood mitigation to capture information on historical and future flood events in the Similkameen Watershed. The database will identify or confirm watercourses and areas consistently subject to flooding, and help focus future flood hazard assessments and floodplain mapping exercises, and inform future land development decisions.
  - Action E2d: Within the same database (E2c), develop a list of dam owners and their emergency.
    contact information, as well as a list of unregistered dams. Compile all dam failure emergency preparedness plans into the database, and provide it to all emergency responders.
  - Action E2e: Confirm the number and ownership of dikes within the Similkameen Watershed (using Provincial information). For any dikes listed as having no Local Authority, confirm
    ownership with the Province to clarify maintenance responsibility and liability for a dike breach. [comment on how the province has completed a risk assessment of Orphaned and non-Orphan dikes and appurtenant structure. The purpose of those initiatives is to transfer ownership and liability from the province to local governments by identifying the work that would be required for structures to meet dike safety guidelines
- Flood and Drought Risk Reduction Strategies will include Wetland and Riparian Area Conservation and Restoration
  - Flood and drought risk reduction strategies will be coordinated with the ecosystem protection and restoration strategies (Section 3.3). Wetlands serve to retain water and promote groundwater recharge. Functional riparian areas contribute to the strength of stream banks and reduce the velocity of overbank flows.

Area	Water Supply
Goal	Long-term sustainability of water supply for human uses and economic development will be achieved by management of both water supply and water demand, considering Indigenous perspectives and the needs of aquatic ecosystems.
Relevant Strategies	

- Use scientific and traditional Indigenous information to make informed decisions for sustainable water management, and be at the forefront of new water supply information/policies.
- Monitor trends in streamflow and groundwater levels to support water management decision-making.

Area	Ecosystem Protection and Restoration
Goal	Protect and rehabilitate the aquatic, wetland, and riparian ecosystems in the Similkameen Watershed.
Relevant Strategies	

- Protect riparian and wetland areas.
- Restore high priority riparian areas and wetlands.
- Protect and enhance aquatic habitat.

Area	Climate Change Adaptation & Mitigation
Goal	Human and natural systems in the Similkameen Watershed will become more resilient to climate change, and climate change mitigation and adaptation policies and procedures will be used in land and water use decision-making.
Relevant Strategies	

- Mitigation: Implement policies and plans that reduce greenhouse gas emissions and promote carbon sequestration.
- Adaptation: Understand the risks (and the components of risk) to natural and built environments from climate change, and develop appropriate responses.

Area	Community Outreach and Consultation
Goal	Increase understanding and support for watershed management measures and encourage public engagement by providing important information to stakeholders, decision makers, and the public in an effective and timely manner.
Relevant Strategies	

- Build community awareness for the importance of watershed sustainability and improve understanding of the ecological functions of the watershed.
- Promote open and effective communication between agencies that are responsible for watershed and land use management.

4 Conclusion

A review of relevant regional planning-level initiatives, specifically at the regional district level or similar, the project area's two watersheds, was conducted. The review was completed to provide a broad understanding of how regional land use strategies and policies interact with flood and debris flows, specifically considering the *Syilx* perspective. This review may be used as a basis for a more thorough investigation of non-structural mitigation options to adapt to flood and debris flows in the region.

5 References

AE (2017) *Similkameen Watershed Plan (Version 1.1)*.

RDCO (2013) *Regional District of Central Okanagan Regional Growth Strategy: 'Our Home, Our Future'*.

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