



Perseverance Creek Flood Risk Assessment

Options Analysis and Class 1 Risk Assessment

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September 17, 2026

Final Report, Rev. 1

Prepared for:

Village of Cumberland

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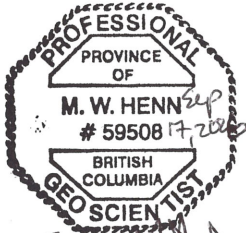
Cumberland, BC V0R 1S0

NHC Reference No. 3010841

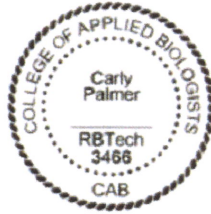
DOCUMENT TRACKING

Date	Revision No.	Reviewer	Issued For
August 29, 2026	0	M. Gellis	Draft
September 17, 2026	1	M. Henn	Final

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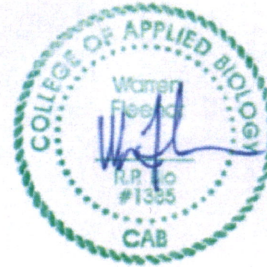


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CREDITS AND ACKNOWLEDGEMENTS

The authors would like to thank the Ministry of Emergency Management and Climate Readiness for funding through Emergency Response and Short Term Recovery and Village of Cumberland for initiating this study and for the support provided during the project, in particular:

- Kevin McPhedran Director of Community Services, Village of Cumberland
- David Dougherty Director of Engineering and Public Works, Village of Cumberland

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NHC would also like to thank the following individuals for their support during the project:

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- Dawn Copeman Educator and Historian
- Hamish Murray Perseverance Creek Stream Keeper
- Heather Mathers Perseverance Creek Stream Keeper
- Meaghan Cursons Executive Director, Cumberland Community Forest Society
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EXECUTIVE SUMMARY

In January 2026, a large rainstorm fell over the Comox Valley, on Vancouver Island, BC. The increase in streamflow on allowed a log jam to build up on an existing trail bridge across Perseverance Creek, causing a portion of the creek to avulse to the river right and flow north through an area with several elements of concern:

- a drinking water supply well and its associated linear infrastructure: water supply main, power and communications line, and access road
- recreational trails
- a disc golf course
- Coal Creek Historic Park
- environmental considerations

As usual with decreasing seasonal flows, Perseverance Creek dried up and stopped flowing through this area between April and May, though the avulsion channel remains and is expected to activate again once creek discharge increases.

In May 2026, NHC was retained by the Village of Cumberland (VoC) to assess what Risks the avulsion poses to the elements listed above, as well as elements further downstream that may also be affected by the new alignment. NHC teamed with Current Environmental, Bloom Landscape Architecture, and K'ómoks First Nation (KFN) to complete the study as a Class 1 Risk Assessment, according to EGBC guidelines.

The geomorphic processes at the avulsion and downstream of it are complex and this results in significant uncertainty in exactly how and when the avulsion channel will evolve. The assessment is therefore mostly qualitative and compares the relative Risks posed to each element, rather than estimating Risk based on statistics or modelling.

The assessment evaluates the baseline Risk posed to each element, and how it changes for different mitigation scenarios. Short-term (before this year's fall rains) and mid-term (after this year's fall rains) mitigation options are considered.

In the short-term, NHC recommends removing the trail bridge and log jam to reduce the chance of an outburst-type event potentially causing damage to the well and associated linear infrastructure, as well as posing a Risk to public safety in the area. This may carry an increased Risk of surface water flooding this winter during low and medium flows, but the amount of damage from an outburst type event is more uncertain and potentially more severe. We have therefore assigned it a greater Risk.

In the mid-term, the recommended option is to construct a set-back berm in the disc golf area that would allow the channel to migrate naturally in a portion of the alluvial fan, but keep flows away from the well and its associated linear infrastructure. This option, as well as the other mid-term options, require additional assessment before proceeding.

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GLOSSARY

Term	Definition
Aggradation	The net vertical raising of a channel bed, fan, or floodplain surface through sediment deposition over time
Alluvial fan	A convex, cone-shaped accumulation of sediment deposited at the mouth of a stream where it enters a wider and flatter area.
Avulsion	The relatively abrupt relocation of flow from an established channel to a new course across the adjacent floodplain or fan surface.
Consequence	The outcomes or potential outcomes arising from the occurrence of a flood.
Element at Risk	The people, buildings and engineering works, economic activities, public services, utilities, infrastructure, and environmental features situated within the area that could be affected by a flood or landslide. (EGBC 2018, Defined Terms)
Flood Hazard	The potential for loss of life, injury, or property damage arising from flooding.
Hazard Scenario	distinct outcomes from a given Hazard that result in some direct Consequence (EGBC 2018, Defined Terms)
Risk	A measure of the probability and severity of an adverse effect to health, property, or the environment. Risk is commonly estimated as the product of probability and Consequence, although a more general treatment compares probability and Consequence in non-product form.

1 INTRODUCTION

In January 2026, a large rainstorm fell over the Comox Valley, on Vancouver Island, BC. The increase in streamflow allowed a log jam to build up on an existing trail bridge across Perseverance Creek, causing a portion of the creek to avulse to the river right¹ and flow north through an area with several elements of concern (Figure 1.1, Figure 1.2, Figure 1.3, Figure 1.4):

- a drinking water supply well and its associated water supply main, power and communications line, and access road
- recreational trails
- a disc golf course
- Coal Creek Historic Park

As usual, with decreasing seasonal flows Perseverance Creek dried up and stopped flowing through this area between April and May, though the avulsion channel remains and is expected to activate again once creek discharge increases.

In May 2026, NHC was retained by the Village of Cumberland (VoC) to assess what Risks the avulsion poses to the elements listed above, as well as elements further downstream that may also be affected by the new alignment.

Additionally, this assessment will help inform the Cumberland Forest Land Strategy, a parks planning project currently underway and led by VoC. The strategy considers approximately 400 hectares of land, encompassing the scope area for this Risk Assessment. The strategy will establish a long-term vision and identify management goals that support the protection of the land's ecological values, cultural values, recreational values, and social values. Understanding more about the potential long-term functionality of Perseverance Creek will provide a critical layer in decision-making related to future park programming and ecological protection and stewardship initiatives.

NHC teamed with Current Environmental, Bloom Landscape Architecture, and K'ómoks First Nation (KFN) to complete the study as a Class 1 Risk Assessment, according to EGBC guidelines.

¹ References to river right, river left, and right and left banks are downstream-facing.



Figure 1.1 Looking at log jam on upstream side of Hai Gai trail bridge. Left photo taken from river left on April 7, 2026. Right photo taken from river right on June 10, 2026.



Figure 1.2 Looking upstream at avulsion channel and Perseverance Creek main channel on February 1, 2026. Photo courtesy of Adam Silverstein.



Figure 1.3 Looking downstream along avulsion channel in disc golf course on February 1, 2026, showing groundwater drinking water supply well and flooded access road for it. Photo courtesy of Adam Silverstein.

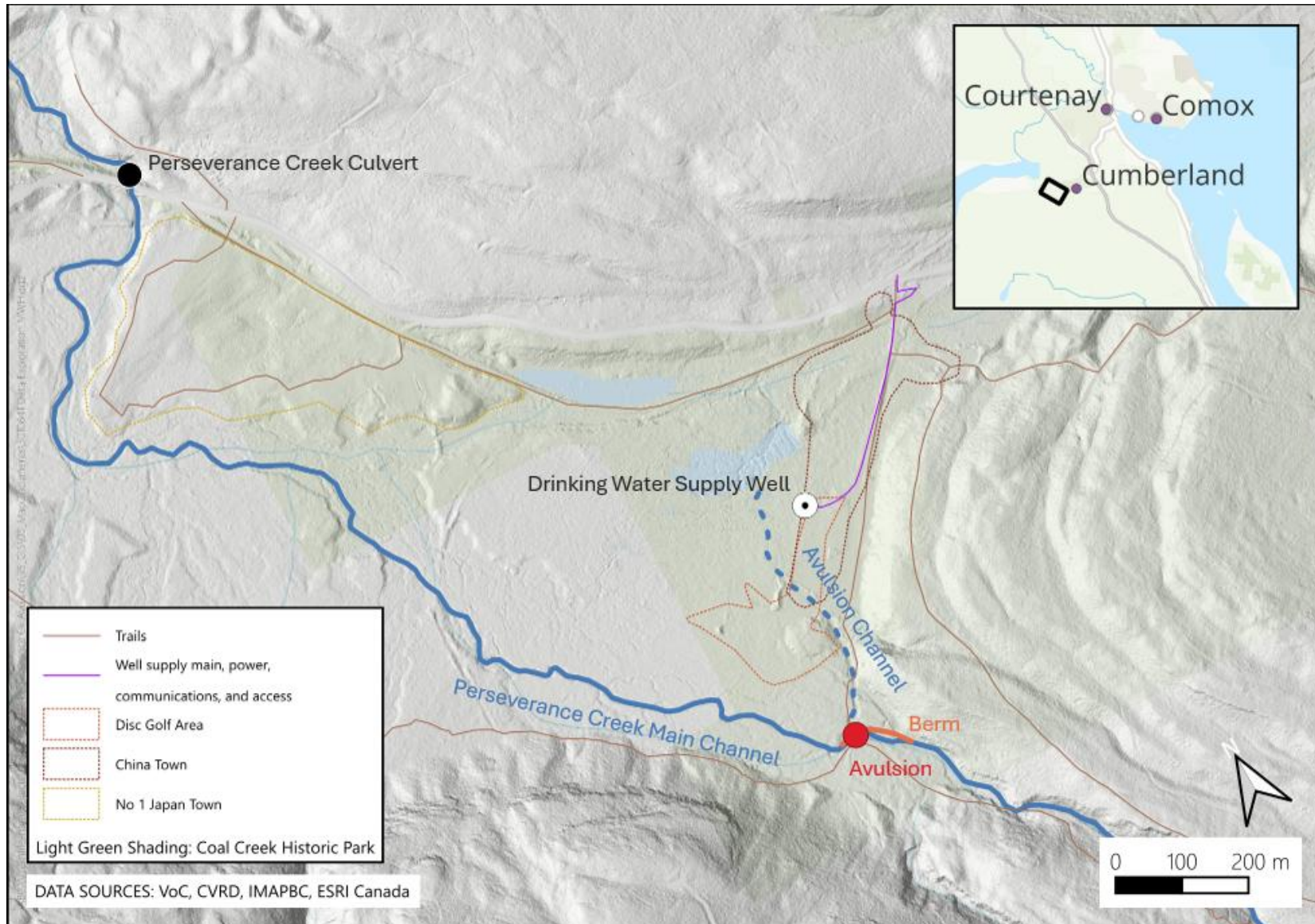


Figure 1.4 Map showing avulsion location and nearby infrastructure.

1.1 Project Background

The Perseverance Creek watershed has been subject to a range of anthropogenic development since at least the 1890s. Table 1.1 summarizes known elements of this development along with floods of note to better understand the range of conditions to which the current avulsion should be compared. While this list is not exhaustive, it is complete enough to show that since the 1890s, the area immediately downstream of the current avulsion path has been influenced more by anthropogenic development than by natural creek processes. The watershed as a whole has been significantly influenced by humans over a similar time period.

The long-term process most relevant to the January 30 avulsion is sediment aggradation at the avulsion site and reaches downstream of it. This aggradation is caused by increased sediment contributions to the upper reaches of the creek being transported downstream and deposited in the lower gradient areas at the avulsion site and further downstream. The increased sediment contributions are from a combination of logging and forest service road development, rerouting of No. 2 Dam outflows down Perseverance Creek away from their natural course down Cumberland Creek, a 1972 failure of the No. 2 Dam, and periodic landslides in the upper reaches of Perseverance Creek.

Table 1.1 Timeline of previous known land use and flood events in Perseverance Creek Watershed.

Decade	Land Use and Development	Flood Events of Note
1880s	<ul style="list-style-type: none"> First coal mines open in Cumberland 1888: Chinatown established near No. 2 mine, draining wetlands for the town and supporting agriculture. Mine closed by 1899, but Chinatown remains until 1960s 	
1890s	<ul style="list-style-type: none"> 1891: No 1. Japanese Town established next to No. 1 mine Wellington Colliery Railway completed 1897: Piping commenced from Hamilton Creek 1890s-1930s: No. 2 Dam constructed (Tetra Tech EBA, 2015) 	
1900s	<ul style="list-style-type: none"> Flume constructed from Perseverance Creek to flood No 6 mine after explosion (pers. comm. Dawn Copeman July 28, 2026) 	
1910s		

Decade	Land Use and Development	Flood Events of Note
1920s	<ul style="list-style-type: none"> Logging road constructed across mainstem Perseverance at confluence with Lookout Creek. High-lead logging removed timber in the area surrounding the confluence. 	
1930s	<ul style="list-style-type: none"> 1931-1950: Forest service road construction and clearcut logging carried out over much of Cumberland Creek watershed, including riparian areas (Tetra Tech EBA, 2015) 	
1940s	<ul style="list-style-type: none"> 1942: Japantown deserted as Japanese residents forced into internment in BC Interior during WWII 	
1950s		
1960s	<ul style="list-style-type: none"> 1964 (estimated): No. 2 Dam raised, flow redirected down Perseverance Creek (Tetra Tech EBA, 2015) 1968: Remaining buildings in Chinatown burned to ground. Chinatown land area leased to Cumberland Rod and Gun Club 	
1970s	<ul style="list-style-type: none"> Flow diverted to spillway channel during repairs to No. 2 Dam after Dec 1972 failure (Tetra Tech EBA, 2015) 1972-1973 (estimated): berm constructed at present day avulsion site to direct Perseverance Creek flow west instead of North into the rod and gun club area (Ellefson, 2003) 	<ul style="list-style-type: none"> Dec 1972: No. 2 Dam Failure during large rain on snow event (Tetra Tech EBA, 2015)
1980s		
1990s		
2000s	<ul style="list-style-type: none"> 2001: Rod and Gun club land lease released 2002: Weldwood Canada gifts 104 acres including Chinatown and No 1 Japantown to VoC with restrictive covenant 2006: CCFS purchases 23.8ha of land, including area with current avulsion 	<ul style="list-style-type: none"> 2002: Erosion observed in No. 2 Dam spillway channel (Tetra Tech EBA, 2015) 2003: Erosion in spillway channel during high flow event (Tetra Tech EBA, 2015) November 2009: <ul style="list-style-type: none"> Original trail bridge at current avulsion site washed out from debris buildup on it Road shoulder fails and concrete lock blocks displaced at Perseverance Creek culvert on Comox Lake Road
2010s		<ul style="list-style-type: none"> Boil water advisory for Comox Lake Water Supply area from Dec 11, 2014 to January 27, 2015 due in

Decade	Land Use and Development	Flood Events of Note
		part to high sediment loads from Perseverance Creek
2020s	<ul style="list-style-type: none"> 2020: CCFS purchases 90.5ha of land along Perseverance Creek, both upstream and downstream of 2006 purchase. Sep 2021: Deeper water intake in Comox Lake fully commissioned and put into operation. 2022: CCFS purchases 17.8ha of land along lower Perseverance Creek, from Comox Lake Road culvert to Comox Lake March 2025: planting and restoration at Perseverance Creek Trail Bridge 	<ul style="list-style-type: none"> Jan 2021: high turbidity noticed by Perseverance Creek Streamkeepers (PCSK); boil water notice issued for Courtenay Jun 2021: Trail flooding noted by PCSK Oct 2023: Beaver dam failure noted by PCSK Nov 2023: Colliery trail flooding noted by PCSK Dec 2023: Colliery trail flooded Jan 30, 2026: Avulsion and log jam at trail bridge

2 METHODOLOGY

This section outlines the guidelines and information relevant to the study, and describes how they were applied in conducting the Risk Assessment.

2.1 Guidelines and Standards

Appendix E of EGBC's *Legislated Flood Assessments in a Changing Climate* outlines procedures for conducting a Flood Risk Assessment based on the "value of developments and vulnerable populations exposed to Flood Hazards" (EGBC, 2018). Because this area is largely undeveloped and no one is living in it, NHC undertook this study as a Class 1 Risk Assessment. Below is a brief description of EGBC's five steps of conducting a Risk Assessment, and the resulting estimation of risk.

1. Identify Flood Hazard Scenarios. A Hazard Scenario is defined as "a specific scenario that could lead to an undesirable Consequence" (EGBC, 2018). A Consequence is "the outcomes or potential outcomes arising from the occurrence of a flood" (EGBC, 2018).
2. Estimate the probability of each Flood Hazard Scenario resulting in an undesirable outcome.
3. Estimate the Consequences of unwanted outcomes. Consequences can fall into several categories, including economic losses, human health and loss of life, environmental, cultural/historic losses, and intangibles such as psychological distress.
4. Define Tolerable Risk criteria.
5. Prioritize Risk reduction strategies.

The Risk (R) is then expressed as:

$$R = P_H * P_{S:H} * P_{T:S} * V * E, \text{ where}$$

- P_H = exceedance probability, i.e. the probability that the flood magnitude will be exceeded in any given year.
- $P_{S:H}$ = spatial probability that flood will reach the element at Risk
- $P_{T:S}$ = temporal probability that the element at Risk will be present when flood occurs
- V = vulnerability, i.e. the probability of loss of life, or the proportion of an asset loss compared to total loss
- E = exposure, i.e. the number of people at Risk or the homes and infrastructure at Risk

P_H , $P_{S:H}$, and $P_{T:S}$ together form the Hazard, and V and E together form the Consequence. The project team's application of this framework is described in 2.3.

2.2 Data and Information

The assessment was based on the following data and information:

- Spatial data
 - Light Detection and Ranging (LiDAR) elevation data of watershed (2024)
 - Historical imagery available from the BC Online Air Photo Portal – 1968, 1972, 1975, 1980, 1982, 1984, 1991, 1992, 1994, 1996, 2014, 2017
 - Infrastructure (provided from iMap BC and VoC)
 - Recreational trails (provided by Open Street Map (OSM))
 - Basemaps provided by OSM and ESRI Canada
 - Field mapped locations of hydraulic structures
 - Berm and avulsion site recorded during June 10 field assessment
 - Beaver dams from Current Environmental
- Hydroclimate data
 - 2020-2026 Perseverance Creek hydrometric data (Comox Valley Regional District (CVRD))
 - Precipitation data:
 - Comox Airport (ECCC)
 - Comox Dam Forebay (BCH)
- Background reports:
 - KFN Cultural Values Report (Morin, 2025)

- Wetland and Stream Restoration Assessment of Perseverance Creek and Boundary Wetlands (Annschild, 2020)
- No. 2 Dam and North Branch Perseverance Creek Rehabilitation Design Memo – Hydrology Assessment (Tetra Tech EBA, 2026)
- Perseverance Creek Fish Habitat and Proper Functioning Condition Assessment (EcoFish Research Ltd., 2019)
- Perseverance Creek Mapping and Inventory Project: Sensitive Habitat Inventory and Mapping (SHIM) Survey (Ellefson, 2003)
- Village of Cumberland Well Head Protection Plan: Water Supply Well – PW1 – MOE #36425 (Guiton Environmental Consulting, Ltd., 2013)
- Hazard Abatement Order Report (Tetra Tech EBA, 2015)
- Field Assessments on June 10 and July 16, 2026
- Informational interviews with the following local knowledge keepers:
 - Steve Morgan (Perseverance Creek Stream Keeper, July 8)
 - Hamish Murray (Perseverance Creek Stream Keeper, July 14)
 - Dawn Copeman (Perseverance Creek Stream Keeper, July 16)
 - Heather Mathers (Perseverance Creek Stream Keeper, July 23)
 - Meaghan Cursons (Cumberland Community Forest Society (CCFS), July 23)

2.3 Risk Assessment

This section describes how NHC and the project team applied the EGBC guidelines to this Risk Assessment.

Table 2.1 outlines who undertook each step of the assessment. Table 2.2 and Table 2.3 list the criteria used to establish the Hazard and Consequence ratings for each element. Table 2.4 shows how the Hazard and Consequence ratings are combined to determine a Risk rating, with definitions for each Risk provided in Table 2.5.

Note that while the EGBC Risk Assessment methodology presents the results in a quantitative format, this is a qualitative Risk Assessment. In practice, each value depends considerably on judgement. We have therefore estimated Hazards and Consequences without separating out the individual components of each term, and determined Risk based on Table 2.4 rather than multiplying individual terms of the equation presented in 2.1. We have assigned Consequences based on conversations with VoC and other key interest parties, though these may be subject to change based on follow up conversations and additional input prior to this report being finalized. The purpose of this Risk Assessment is to provide a structured way to evaluate the relative Risks to each element, and a way of ranking and prioritizing mitigation strategies. Risk

values should be interpreted more as a decision-making tool than a scientific analysis. Specific limitations for various aspects of the analysis are described throughout Section 3.

Table 2.1 Information and analysis undertaken for Risk Assessment.

Risk Assessment Step	Risk Equation Variables	Assessment process
Identify Flood Hazard Scenarios	$P_{S:H}, P_{T:S}$	NHC, Current (for environmental components), and KFN (for cultural components):
Estimate probability of Flood Hazard scenario resulting in undesirable outcome	$P_H, P_{T:S}$	<ul style="list-style-type: none"> Map out channel and elements at Risk (LiDAR), as well as elements that pose hazard Review of previous reports and hazards Review of land use in the area and how it has affected natural creek function and hazards Field assessment, both with and without stakeholders Interviews with local knowledge holders For each element, qualitative assessment of probability of Flood Hazard Scenario resulting in an undesirable outcome
Estimate Consequences of unwanted outcome	V, E	<ul style="list-style-type: none"> Infrastructure (NHC and VoC) Environmental (Current) Cultural and Social developed during group workshop with NHC, VoC, Current, Comox Valley Land Trust (CVLT), CCFS, and United Riders of Cumberland (UROC)
Define tolerable Risk criteria	All	<ul style="list-style-type: none"> Group workshop between NHC, VoC, Current, CVLT, CCFS and UROC Follow up communication between NHC and VoC
Prioritize Risk reduction strategies		

Table 2.2 Hazard criteria

Hazard level (numeric)	Hazard level (descriptive)	Definition
1	Negligible	Scenario is extremely unlikely to occur
2	Low	Scenario is unlikely to occur
3	Medium	Scenario is moderately likely to occur
4	High	Scenario is likely to occur
5	Extreme	Scenario is very likely to occur

Table 2.3 Consequence criteria.

INDICES	1 Negligible	2 Minor	3 Moderate	4 Major	5 Severe
Infrastructure	No discernible impact	Affects few individuals; alternative or backup systems exist and can be used; may incur damage that is easily repaired	Affects tens of people; requires operational changes; may incur damage with moderate costs and timelines for repair	Affects tens to hundreds of people; requires large operational changes; incurs damage with high costs or long timelines for repair	Affects most or all of the community; requires emergency measures; incurs damage with very high costs and long timelines for repair or replacement
Ecological (Flora And Fauna)	No discernible impact	Slight impact; recoverable within days	Moderate impact; recoverable within weeks	Recoverable within months	Severe species loss
Social and Cultural	No discernible impact	Slight impact; recoverable within days	Moderate impact; recoverable within weeks	Recoverable within months	Long-term (years) loss of social and cultural values
Public Safety	Minor injuries of a few individuals	Major injury of 1 person	Major injury of several persons	Single fatality	<10 fatalities

Notes:

- Public safety criteria from (EGBC, 2018). As described in 3.3.4, this study has provided high level comments about the Hazards and Consequences for social elements and public safety, but has not assessed the Risk for them.

Table 2.4 Risk determination from Hazards and Consequences

		Consequence				
		Negligible	Minor	Moderate	Major	Severe
Hazard	Extreme	M	H	H	VH	VH
	High	L	M	H	H	VH
	Medium	L	L	M	H	H
	Low	VL	L	L	M	H
	Negligible	VL	VL	L	L	M

Table 2.5 Risk criteria

Abbreviation	Classification	Description
VH	Very High	Risk is unacceptable short-term; Risk reduction required; long-term Risk reduction plan must be developed and implemented
H	High	Risk is unacceptable; medium-term Risk reduction plan must be developed and implemented in a reasonable time frame; planning should begin as soon as feasible
M	Medium	Risk may be tolerable; more detailed review required; reduce Risk to low where reasonably practicable
L	Low	Risk is tolerable; continue to monitor if resources allow
VL	Very Low	Risk is broadly acceptable; no further review or Risk reduction required

2.4 Ecological Assessment

2.4.1 Assessment Area

The environmental assessment focused on both the avulsion channel and main channel alignments, together with their adjacent riparian areas. The upstream extent of the study area was located immediately upstream of the avulsion initiation point, while the downstream extent was located immediately downstream of the confluence of the main channel and avulsion alignments.

2.4.2 Data and Information

The environmental assessment was informed by the data sources summarized in Section 1.1. Additional information sources included:

- Habitat Wizard (Government of British Columbia, 2024)
- CVRD iMap (Province of British Columbia, 2026)
- Archival materials (e.g., historical maps, photographs, and personal accounts).
- iNaturalist research-grade observations (iNaturalist contributors, 2026)
- BC Species and Ecosystem Explorer (BC Government, 2025)

These sources were reviewed to support interpretation of present and historical fish and wildlife habitat conditions, riparian and wetland function, channel evolution, habitat connectivity, and changes associated with the 2026 avulsion event.

2.4.3 Assessment Methods

Ecological field assessments were conducted independently of the combined-team site visits (Section 2.2), on June 5 and July 2, 2026 within the main channel and avulsion channel alignments and associated riparian areas. Field assessments were completed using methods generally consistent with those applied by Ecofish (2019) to facilitate comparison of fish habitat and hydro-riparian function over time.

Fish habitat assessments were completed using methods adapted from the *Reconnaissance (1:20,000) Fish and Fish Habitat Inventory Standards and Procedures* (RISC 2001). Field assessments documented channel morphology, substrate composition, hydraulic conditions, habitat complexity, riparian conditions, and other indicators of fish habitat value. Additional consideration was given to the complex wetland habitats associated with the post-avulsion alignment, which are not readily characterized using standard stream inventory metrics for fish habitat. Habitat suitability for key life-history functions (spawning, rearing, overwintering, and migration) was subsequently evaluated using professional judgement informed by field observations. Proper Functioning Condition (PFC) assessments were completed following the general approach described by Dickard et al. (U.S. Department of the Interior, 2015) and Gonzalez and Smith (U.S. Department of the Interior, 2020). Assessments considered hydrologic,

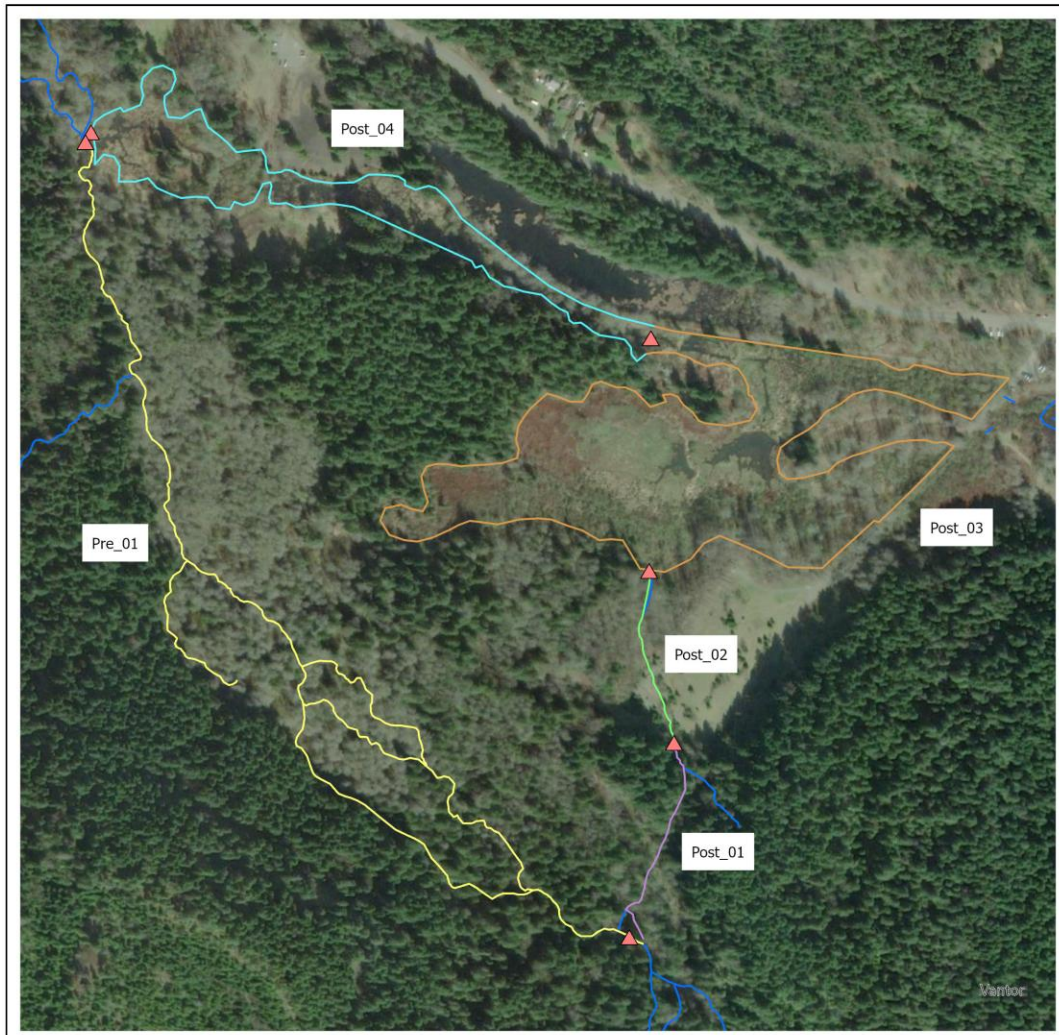
vegetative, and geomorphic indicators of hydro-riparian function and were used to evaluate current condition and functional trends.

Alignment-scale ratings for fish habitat and PFC were based on professional judgement informed by reach-level assessments and the relative contribution of each reach to habitat and hydro-riparian function across the alignment.

Wildlife habitat observations were recorded opportunistically throughout field assessments, including observations of amphibian habitat, bird habitat, mammal sign, and other indicators of wildlife use.

Minnow trapping was conducted within the wetland complex associated with the post-avulsion alignment between July 2 and 4, 2026. Ten minnow traps were deployed and fished over two sampling periods comprising an overnight (~12-hour) soak and a subsequent ~24-hour soak. Captured organisms were identified, recorded, and released at the point of capture.

Perseverance Creek Flood Risk Assessment - Reach Breaks



Legend

- | | |
|-------------|---------|
| Reach Break | Post_03 |
| Post_01 | Post_04 |
| Post_02 | Pre_01 |



0 100 200 m

Author: C.Palmer
Date: July 2026
CRS: UTM NAD83 Zn 10N
Scale: 1:5 000
All linework approximate.
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without consent of author.

current
ENVIRONMENTAL

Figure 2.1 Map of the study area showing reach breaks used for PFC and fish habitat assessments

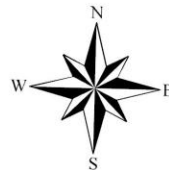
Perseverance Creek Flood Risk Assessment - Trap Locations



Legend

- Wetland
- Trap location

0 50 100 m



Author: C. Palmer
Date: July 2026
CRS: UTM NAD83 Zn 10N
Scale: 1:3 000
All linework approximate.
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current
ENVIRONMENTAL

Figure 2.2 Minnow trap locations in wetland complex on avulsion alignment.

3 RESULTS

This section summarizes the results of the Risk Assessment. Interpretation, Risk Assessment tables, and discussion of potential mitigation options are provided in Section 4.

3.1 Flood Hazard Scenarios

Step 1 of the EGBC Risk Assessment Process is to define Flood Hazard scenarios, described as "distinct outcomes from a given Hazard that result in some direct Consequence" (EGBC, 2018). The following section identifies the elements that may be impacted by a Flood Hazard Scenario, the general processes that could drive these Flood Hazard Scenarios, and the specific Flood Hazard Scenario currently at site.

3.1.1 Elements considered

For Perseverance Creek, we have considered Flood Hazard Scenarios that may cause damage to the following elements:

- Infrastructure
 - drinking water well
 - drinking water well access road, supply line, power, communications
 - Perseverance Creek culvert under Comox Lake Road
 - Comox Lake water intake
- Environment
 - Damage to environmental elements is better characterized as a trade-off than as a loss, with each scenario carrying both benefits and drawbacks. These are outlined in 3.3.2.
- Cultural elements
 - KFN Values
 - Certain plant species and plant communities found in the confluence zone of Cumberland Creek and Perseverance Creek are of importance to the K'omoks First Nation such as: Devil's club, mature cedar groves, and yew trees.
 - Chinatown
 - A historic walking tour with markers at areas of historical significance such as homesteads.

- A picnic pavilion that was constructed in 2010 holds significant cultural significance for descendants of Chinatown and a former resident. Seasonal flooding may impact this area.
- Japantown
 - Part of the historic No. 1 Japanese Town walking tour runs along Perseverance Creek downstream of the wetlands.
- Social elements and public safety
 - The trail bridge crossing and trail network adjacent to it is a popular access and egress point for hiking, walking, mountain biking, environmental education, and a generally more accessible way to experience a high value ecosystem than elsewhere in the Comox Valley. It also allows for a loop trail that connects Chinatown to Japanese town along the China Creek Trail and Colliery Trail.
 - The disc golf course downstream of the avulsion is the only 18-hole course in the Comox Valley and is highly popular during many months of the year by people of all ages.

Figure 3.1, Figure 3.2 and Figure 3.3 show these elements in relation to the January 30, 2026 avulsion site at sequentially finer scales. Figure 3.2 and Figure 3.3 include structures that control water levels or direct the creek (hydraulic control structures).

3.1.2 Geomorphic setting

The area downstream and north of the January 30, 2026 avulsion site is an alluvial fan. Alluvial fans form where a stream exits a confined, high-gradient channel into an unconfined, lower-gradient area. As the stream widens and flattens it deposits sediment it no longer has the energy to transport. Over time this material aggrades on the bed, reduces the cross-sectional area of the channel, and causes the stream to migrate laterally back and forth, resulting in a convex, cone-shaped landform referred to as a fan.

The implication of this is that over a long enough timescale, the creek could occupy anywhere within the fan. In the short term, it is likely to be constrained by existing channels and local areas of higher elevation. However, the mechanisms described below (particularly tree fall and wood transport) could change the creek alignment within a single storm event, or as soon as a tree falls in the right place. Every element on the fan is therefore exposed to the creek to some degree. What differs between elements is the likelihood of being affected in the near to medium term and the mechanism by which damage would occur. Elements downstream of the fan are not directly exposed the fan dynamics, though they may still be influenced by secondary affects associated with them.

3.1.3 Hazard Scenarios and Driving Mechanisms

All scenarios below share a common chain of events:

1. A large precipitation event raises water levels and potentially mobilizes wood and sediment.
2. Continued or renewed avulsion directs a greater share of that water, wood and/or sediment toward an element.
3. The element is damaged by the water itself, by localized erosion or deposition at the element, or by wood transported into it or trees falling onto it.

We have organized scenarios into clearwater, wood and vegetation, and sediment categories, though in practice they are all related and there could be multiple scenarios at once.

Clearwater scenarios

- Surface water from Perseverance Creek and Cumberland Creek flooding elements. This is part of the present scenario discussed in 3.1.4.
- High water tables in the wetland area, potentially compounded by storm flows, flooding elements

Wood and vegetation scenarios

- Wood mobilizing or depositing within channel and being transported into elements or redirecting surface water towards elements. This is the controlling mechanism of the January 30, 2026 avulsion.
 - Can occur very quickly: within a single high-flow event for a log jam, or the moment a tree falls in the right place.
 - very difficult to predict
 - The January 2026 avulsion channel is susceptible to additional change as its banks continue to erode and potentially deliver more wood to the channel.
- Beaver dams and reed canary grass play a large role in the hydrology of the wetlands to the north of Perseverance Creek. Until January 30, 2026, these wetlands had only very brief surface water connections to Perseverance Creek during the largest storms (pers. comm. Hamish Murray July 14, 2026). Increased surface water inflows to the wetlands could mobilize material that would otherwise remain in place.
 - Beaver dam collapse could deliver a pulse of water, wood, and sediment into the channel downstream of the dam. This could be caused by high inflows exceeding the strength of the dam, or by trees being transported into or falling onto the dam.
 - Reed canary grass could reduce the capacity of the wetlands to attenuate high flows, resulting in higher peak instantaneous flows at downstream elements.

Sediment scenarios

- Sediment transport changing the capacity and geometry of the channel. This could be sediment transport within Perseverance Creek, or entering Perseverance Creek from Cumberland Creek.
- Breach of a constructed dam or of a landslide dam further up the watershed.
 - A landslide and subsequent breach upstream on Perseverance Creek contributed significantly to elevated turbidity in Comox Lake and the resulting boil water advisories in 2014–2015 (Tetra Tech EBA, 2015, pers. comm. Warren Fleenor July 10, 2026). There are large eroding banks in the upper reaches of Perseverance Creek, so it is possible that this could happen again.
 - Dam outflow hydrology and associated upgrade options have been examined in previous studies and are not treated in detail here (Tetra Tech EBA, 2026). Debris flows fall in this category as well, though a full debris flow hazard assessment is also outside the scope of this assessment.
 - A landslide dam breach, constructed dam breach, or debris flow would all contribute a large and sudden pulse of sediment and water to Perseverance Creek, which could cause significant channel changes downstream.
- Legacy impacts from forestry and water supply development in the upper watershed.
 - Forestry increases runoff and reduces the capacity of the landscape to absorb precipitation, and road networks alter drainage patterns. This can deliver higher sediment loads to the creek than would otherwise occur. Tetra Tech reported clear cut logging through riparian areas of the watershed from 1931–1950 (Tetra Tech EBA, 2015).
 - Rerouting of flow east from the No. 2 Dam has delivered more flow to the upper reaches of Perseverance Creek than it would have carried naturally. In combination with the 1972 dam failure, this has caused more bank erosion and sediment inputs to the creek than would have otherwise occurred.
 - Wildfire is a plausible future change in this category. Wildfires remove vegetation and forest floor cover and can create hydrophobic soils, increasing runoff and hillslope erosion. This would increase the sediment supply to the channel in the years after the fire. Combined with increased runoff, this would promote aggradation and increase the likelihood of avulsion downstream.
- Sediment scenarios may take place over a large range of timescales from nearly instantaneous (such as sediment mobilized along the entire channel from the sudden pulse of water and sediment released during a landslide dam breach), to centuries (such as the channel slowly adjusting its dimensions during each large winter storm to match a larger effective drainage area created by rerouting the No. 2 Dam outflows).

3.1.4 Present Flood Hazard Scenario

The present Flood Hazard Scenario to be considered is continued avulsion at the January 30, 2026 site or immediately adjacent to it, directing surface water toward the elements identified above. The avulsion initiated where a log jam formed on a pedestrian bridge crossing Perseverance Creek. The bridge is founded on a apparently constructed berm that confines the creek along the river right bank. Backwater from the log jam overtopped the berm on the river right side of the bridge during the January 30 event, forming the avulsion channel entrance (Figure 3.4). The avulsion channel runs approximately 20 m before entering an historically excavated channel that carries flow north into the cleared area occupied by the disc golf course. The channel continues through the cleared area to a wetland west of the access road, though this section is smaller and does not appear to have been excavated. The berm and excavated channel are assumed to have been constructed in the aftermath of the 1972 dam failure, though it is possible some amount of construction took place earlier to direct creek flow away from Chinatown and the No 2 Mine.

Photos from January 30 show water flowing over the berm into the avulsion channel (Figure 3.4). There is also a small entrance to the avulsion channel under the river right bridge abutment that diverts a portion of the flow from Perseverance Creek (Figure 3.5, Figure 3.6, Figure 3.7). This entrance is at a lower elevation than the main channel bed, has a smaller cross-sectional area than the main channel, and has a log jam between it and the main channel. While the lower entrance means water will flow into the avulsion channel before the mainstem, its small cross-sectional area suggests that as flows increase, an increasing proportion of the water will flow down the main Perseverance Creek channel, until flows become high enough where water can flow over the berm again. This presents trade-offs when considering whether to remove the jam, which are discussed in 4.2.1.

In addition to surface water, there is also potential for wood and sediment to be transported through the avulsion channel to downstream elements. The timing and volume of this transport, and the resulting channel response, are difficult to predict, but may be a primary control on how the avulsion channel evolves.

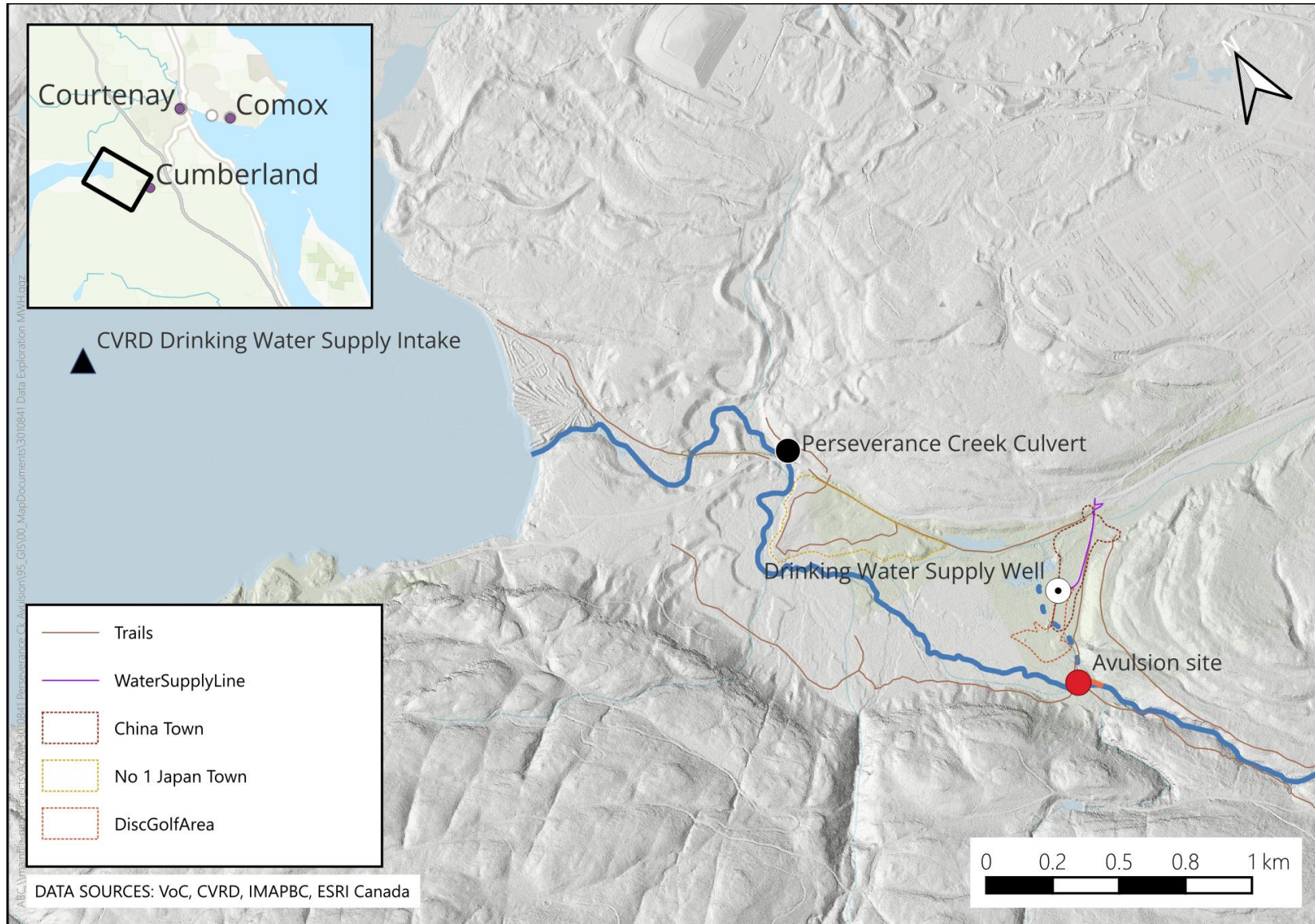


Figure 3.1 Overview map showing elements considered in risk assessment.

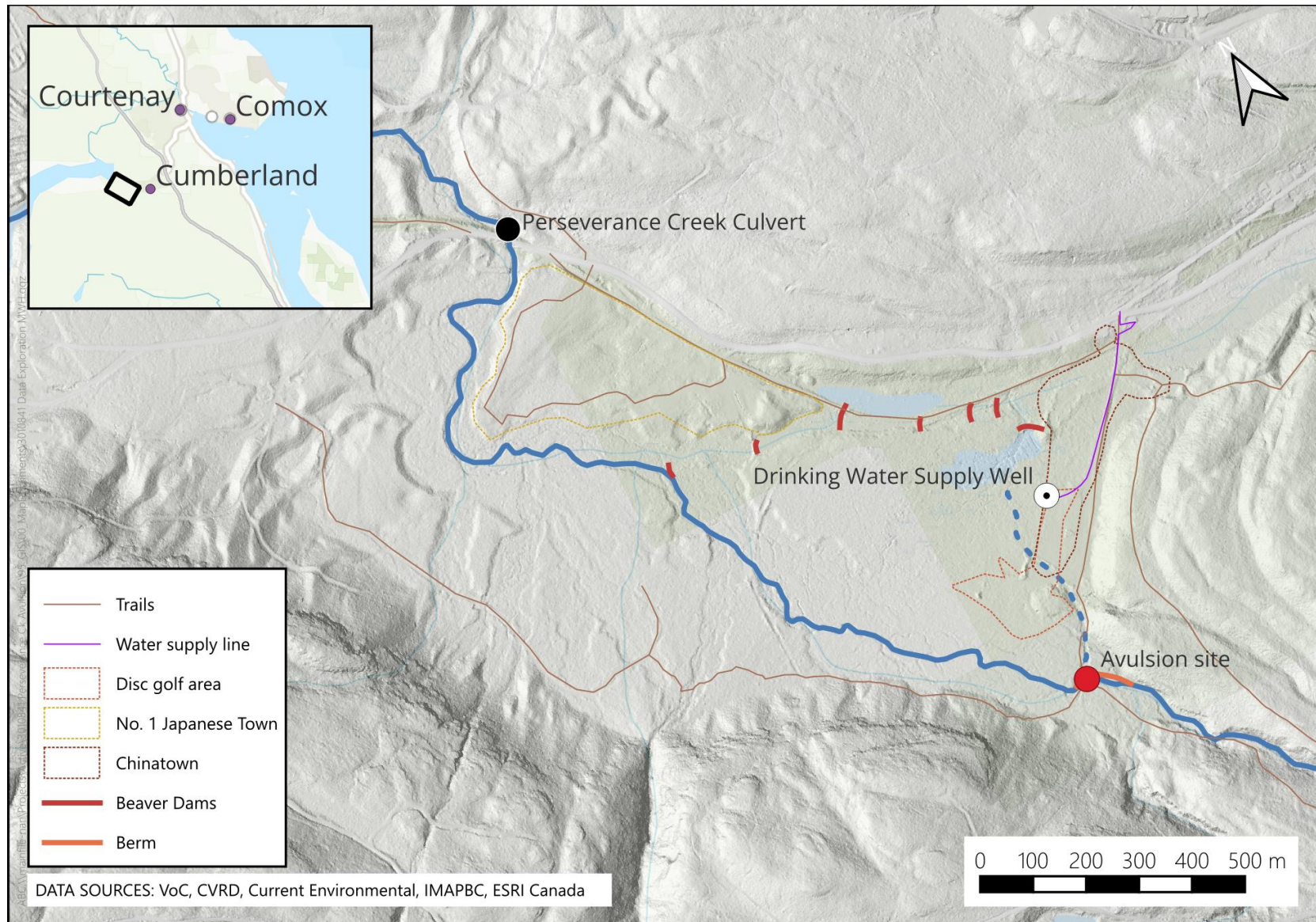


Figure 3.2 Closer view of avulsion site, elements, and hydraulic control structures in study area.

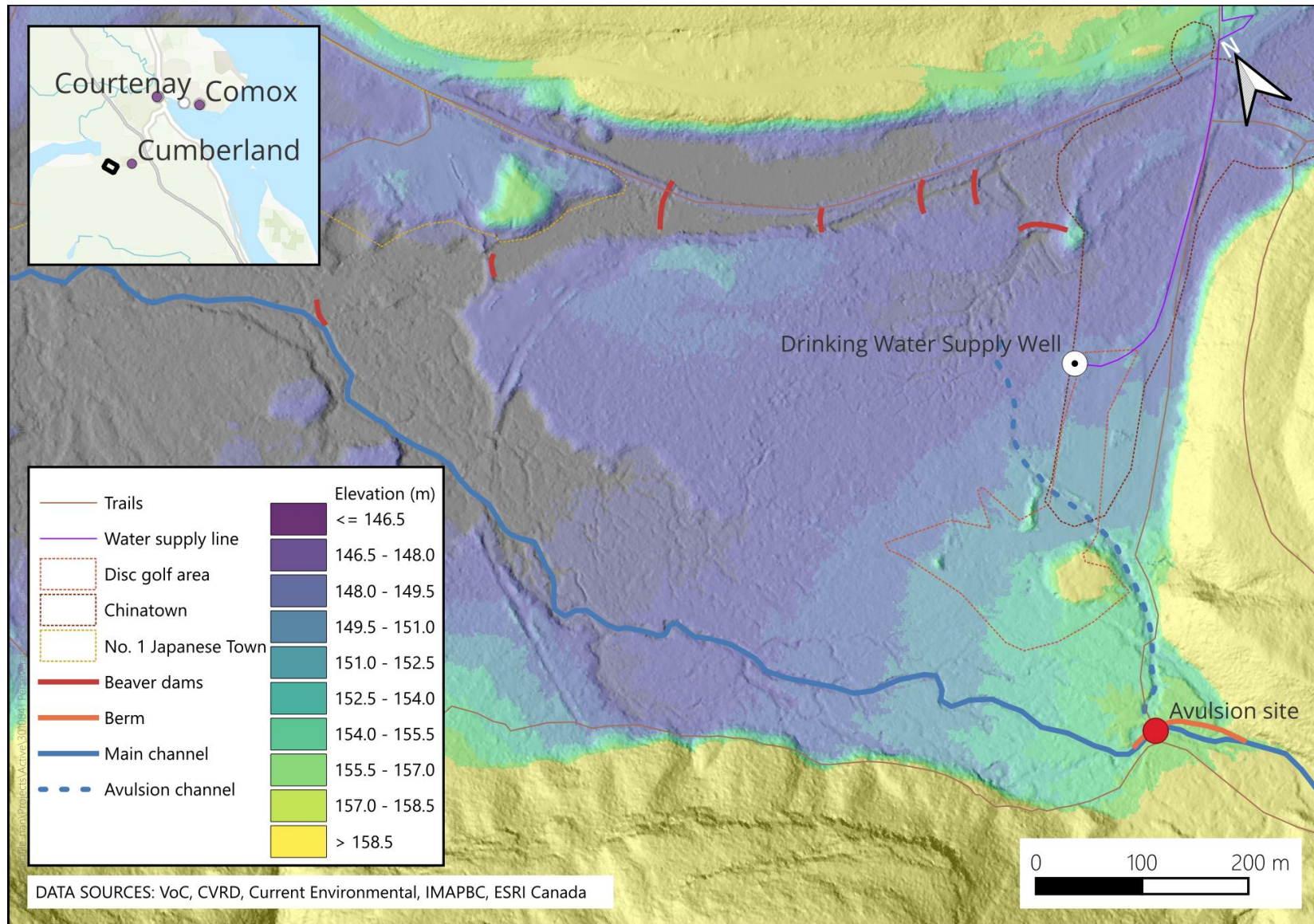


Figure 3.3 Map showing avulsion site and elements within alluvial fan, illustrated by elevations based on CVRD Lidar.



Figure 3.4 Looking upstream at avulsion channel entrance on January 30, 2026. Photo by Heather Mathers (Perseverance Creek Streamkeeper).



Figure 3.5 Photograph looking downstream at the avulsion channel on April 7, 2026, showing water flowing into the channel from below the bridge.



Figure 3.6 Looking upstream at the downstream side of trail bridge. Log jam on upstream side of bridge. Avulsion channel entrance as annotated. Photo taken July 16, 2026.



Figure 3.7 Looking downstream at trail bridge and log jam accumulated on it. Photo taken June 10, 2026.

3.2 Probability of Undesirable Outcomes from Flood Hazard Scenarios

This section examines the January 30, 2026 storm event relative to previous events and qualitatively assesses the probability of each Hazard scenario resulting in an undesirable outcome. We have kept this part of the assessment qualitative instead of providing return intervals for several reasons:

- The system is non-stationary
 - While the precipitation and streamflow data provide context of the conditions that caused the avulsion, the avulsion changed the channel, and it will now respond differently to all flow conditions.
 - The precipitation and hydrometric data show that similar size storms have occurred 2-3 times in the past 10 years, with no known avulsion events taking place in the earlier storms. This implies that the avulsion was not a simple function of precipitation and discharge.
- There will be large uncertainty associated with any prediction for the processes that most strongly affect the Risks to downstream elements:
 - *Avulsion progress:* The channel is currently split at the avulsion site. Residents estimated half the flow was flowing through the avulsion (north) path this winter, and half was flowing through the main (west) path. However, these proportions will change as the creek continues to erode, transport, and deposit sediment and wood in both channels. This will change the proportions of water, sediment, and debris flowing towards downstream elements.
 - *Sediment transport and aggradation:* Elevated sediment supply from historical forestry, the 1972 dam failure, the 2014 Bear Buns slope failure, and continued flow routing from the No. 2 Dam reservoir is driving aggradation at and downstream of the avulsion site, progressively reducing channel capacity and increasing avulsion potential. This process continues on multiple time scales ranging from single storm events to centuries, and is difficult to quantitatively predict.
 - *Wood transport:* The avulsion was initiated by wood accumulating at the trail bridge, and water eroding the berm of the river right bank. Ongoing supply of wood to the channel from upstream transport and danger trees along both channels is expected, but the timing and location of future jams cannot be predicted.
 - *Planned No. 2 Dam upgrades.* Rerouting reservoir outflows to Cumberland Creek will reduce the amount of water, sediment and wood transported in Perseverance Creek, but the resulting loads in Cumberland Creek, which flows into Perseverance Creek immediately upstream of the avulsion, are unknown.
- Risk to downstream elements is low enough to consider an adaptive management approach.

3.2.1 January 30, 2026 Storm Context

This section reviews precipitation and streamflow data during the January 30, 2026 storm event within the recent historic record.

Precipitation

This study looked at precipitation records during the January 30, 2026 storm event from two precipitation stations in the region:

1. Environment and Climate Change Canada (ECCC) Comox Airport Station
2. BC Hydro Comox Dam Forebay Station

ECCC has published precipitation Intensity-Duration-Frequency curves for the Comox Airport Station for durations up to 24 hours, though does not have hourly data available for download. We therefore excluded it from this analysis and only examined precipitation from the BC Hydro Comox Dam Forebay station (CMX), from September 15, 2016 to July 28, 2026. Storm totals at CMX during the January 28-31, 2026 event are summarized in Table 3.1.

Table 3.1 Measured and statistical precipitation at Comox Dam Forebay (BCH).

Measured and Statistical Precipitation (mm)	Jan 28	Jan 29	Jan 30	Jan 31
Daily precipitation	35.5	43.4	49.5	25.9
Highest 12hr precipitation	55.8			
Highest 24hr precipitation	67.8			
Highest 36hr precipitation	94.0			
Highest 48hr precipitation	115.0			
Highest 72hr precipitation	137.8			

Comparison of the values in Table 3.1 with 12, 24, 36, 48, and 72 hr precipitation totals at CMX since the winter of 2016-2017 provides context for how the January 30 storm event compared to historic storms (Figure 3.8). The 12 and 24 hr totals observed during the January 30 event have been observed in at least half of the years since the winter of 2016-2017. The longer duration totals stood out more, but have still been observed several times: twice for the 36 and 48 hr totals, and three times for the 72 hr total². This suggests that the January 30 storm was significant but not unprecedented; it is within the range of expected winter conditions.

² We have considered storms to be equivalent if precipitation is within 3 mm between events

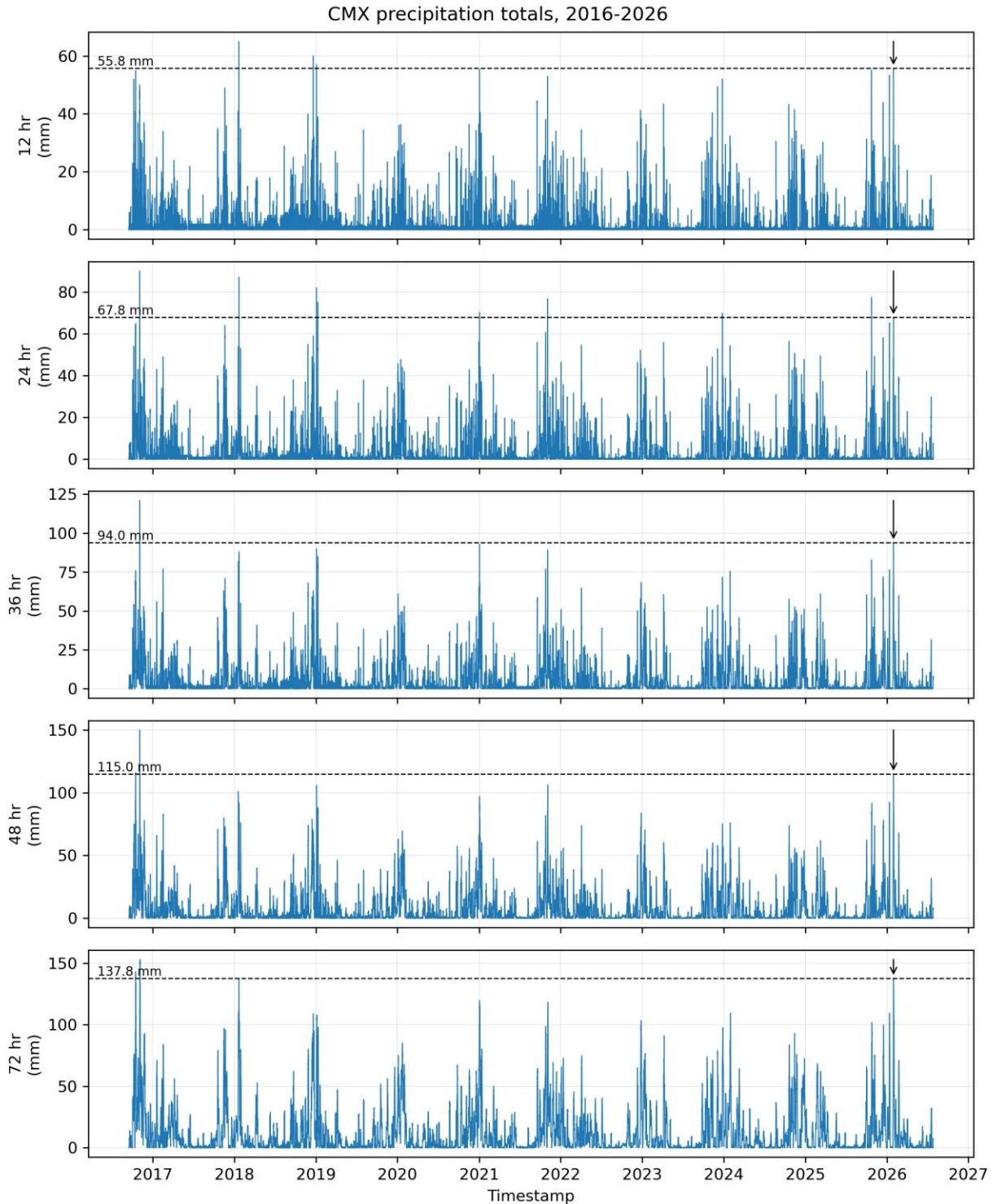


Figure 3.8 12, 24, 36, and 48 hour precipitation totals at BC Hydro's Comox Dam Forebay station. Arrows indicate the January 30, 2026 avulsion, with the dashed lines indicating the precipitation totals from that event.

Creek Discharge

The Comox Valley Regional District (CVRD) has operated a hydrometric station on Perseverance Creek at the Davis Lake Main Forest Service Road crossing since 2020. Preliminary stage data (water level relative to an arbitrary reference datum) are shown in Figure 3.9, with the January 30 event annotated. While the data are preliminary and uncorrected, there are two takeaways:

1. Water levels in the creek associated with the January 30 event were higher than most of the data record but not unprecedented. Water levels on the rising limb of the January 2, 2021 event reached within 12 cm of the January 30 water levels, though data gaps prevent a complete comparison – it is possible they were closer or exceeded the January 30, 2026 avulsion. We are not aware of an avulsion during the 2021 event, though Perseverance Creek Stream keepers noted significant turbidity and flow through the wetlands.
 - i. Because data are preliminary, we have compared water levels rather than discharge, and assumed that stage data has been collected in a consistent manner for the entire data record. Discharge is calculated based on an empirical relationship between stage and field measurements of discharge. This relationship is subject to change as the channel geometry changes due to sediment transport. Hydrometric data requires review from a Qualified Hydrometric Reviewer before being used for assessment or design.
2. Stage values during summer low flow conditions were approximately 0.1 m lower in 2021 and 2022 than they have been since. Hydrometric reports made available for this assessment state the creek dries up each summer. Stage values during summer low flow conditions are therefore measuring the channel bed elevation. The 0.1 m rise over the data record suggests 0.1 m of aggradation under the water level sensor, illustrating that sediment transport occurring in Perseverance Creek.

While the hydrometric data are preliminary, they support the same general conclusion as the precipitation data: the January 30 event was large, but within the range of observed recent historical conditions.

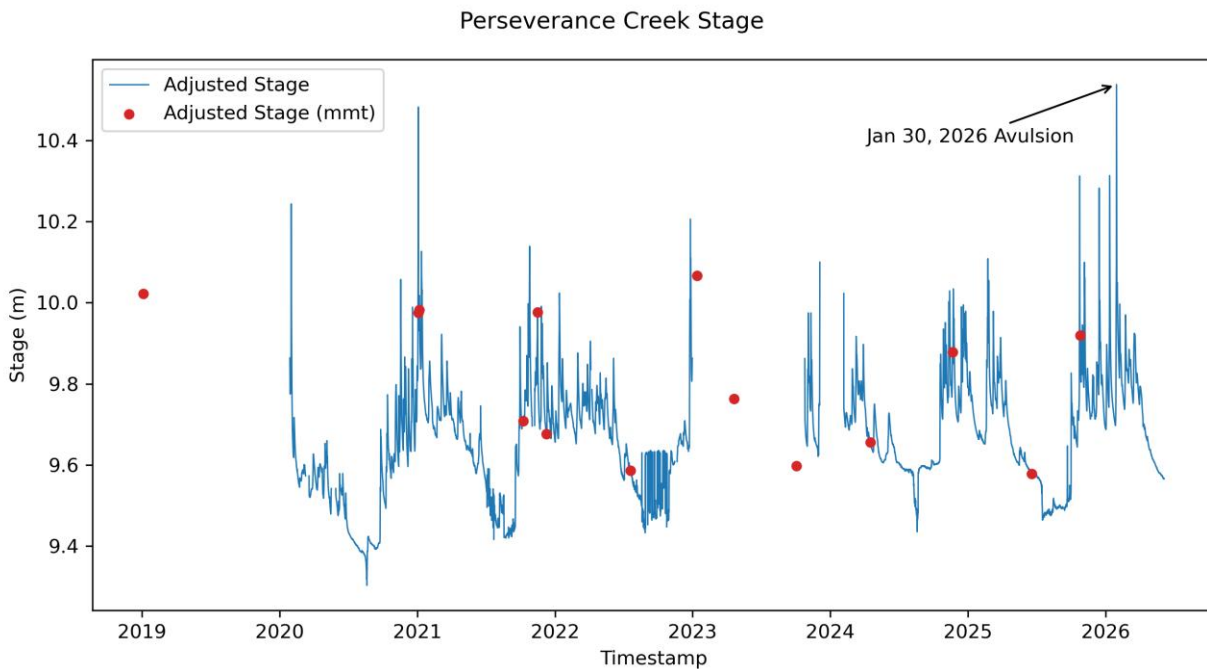


Figure 3.9 Stage data at the Perseverance Creek hydrometric station, from 2020-2026

3.3 Element-Specific Baseline Risk Results

This section reviews each element of the Risk Assessment, summarizing the available information, associated Hazards, potential Consequences, estimated Risk, and limitations of the analysis. Results are only presented for the do-nothing option in this section. Mitigation options and how they change the Risk for each element are discussed in 4.

3.3.1 Infrastructure

Infrastructure elements include the drinking water well and its associated linear infrastructure: the supply main, power and communications cables, and access; the Perseverance Creek culvert under Comox Lake Road, and the drinking water intake in Comox Lake.

Groundwater Supply Well

- The following information was used to assess the Risk to the well and its associated linear infrastructure:
 - Village of Cumberland Well Head Protection Plan: Water Supply Well – PW1 – MOE#36425, Coal Creek Heritage Park, Cumberland, BC (Guiton Environmental Consulting, Ltd., 2013)

- Groundwater At Risk of Containing Pathogens (GARP) Determination Field Form (Crisfield, 2017)
- In person and email communication with VoC (David Dougherty): June 10, June 24, July 10, August 10, August 12
- June 10 and July 16 field assessments
- LiDAR data
- Photographs of the area surrounding the well from February 1, 2026, courtesy of Adam Silverstein.
- Hazards: medium (3) in winter, low (2) in summer
 - The Hazard scenario of direct damage to the well via surface water flooding is low in summer and medium in winter:
 - The ground surface at the well is raised 1 m above the surrounding ground surface, reducing the chances of surface water, sediment, and wood coming into direct contact with the well.
 - The alluvial fan on which the well is located is a net depositional environment. While localized scour is possible, it is more likely for sediment to deposit in the area around the well, than for the sediment around it to erode and damage the well itself.
 - The low-lying area around the well is much wider than the Perseverance Creek channel. Any sediment deposition that might occur around the well is more likely to cause water to flow into adjacent lower lying areas, than to bring water, sediment, or wood into contact with the well.
 - The Hazard is driven by a potential outburst-type event resulting from additional wood and sediment accumulation upstream of the existing log jam, which will eventually result in flow overtopping the berm and causing a larger release in water, wood and sediment towards the well. This poses a larger Hazard than clearwater flooding scenarios.
 - The Hazard scenario of surface water contamination (SWC) to the well is low in summer and winter, though there is much more uncertainty associated with this Hazard:
 - The top of the well screen is greater than 21 m below the surrounding ground surface (22 m below the raised surface at the well). The well screen is located in a gravel and cobble aquifer overlain by over 15 m of fine-grained low permeability strata and has been assessed as not under the direct influence of surface water (Guiton Environmental Consulting, Ltd., 2013).
 - There is a bentonite seal surrounding the well from the ground surface to 2.85 m below ground, reducing the chances of water running down the outside of the well into the aquifer.
 - It is very likely that surface water will flow around both sides of the raised well pad in the winter, but the information above suggests it is unlikely to reach the well intake.

- The Hazard is less likely to occur in the summer when both the wetlands and Perseverance Creek dry out, though this could change if the wetland backwaters to the well in response to the additional surface water inputs.
 - Limitations and uncertainty for this Hazard are described below.
- Consequences: moderate (3) in winter, major (4) in summer
 - Consequences of the well being damaged vary seasonally:
 - While this well is used year-round for water supply, VoC can rely on surface water to meet municipal demand in the winter, if needed.
 - Consequence in the summer (or for damage that occurs in winter but remains unresolved by summer) is major since the well is relied upon to meet municipal demand during the dry months.
 - The Consequence of SWC to the well is that the well water would have to be treated as if it were surface water.
 - SWC would be more likely to occur during wetter months when the well is relied upon less. However, the duration of potential SWC effects is unknown, and effects that extend into drier months would have increasing Consequences as the well plays a larger role in meeting municipal water demands.
- Limitations and uncertainties
 - The characteristics of the aquifer in which the well is located have been determined based on the well's drill log, air photo and topographic map reviews, and several site reconnaissance inspections (Guiton Environmental Consulting, Ltd., 2013). It is possible that the degree to which the aquifer is confined varies spatially. This would not change the Risk of damage to the well from surface water, sediment, or wood processes, but it would change the Risk of SWC to the well.
 - While the Well Head Protection Plan assessed the wetland area to the north and west of the well as posing a low Risk of contaminating the well, this was based on the wetland's location and extent in 2013 (Guiton Environmental Consulting, Ltd., 2013). It is possible that the author would assess this likelihood differently if the wetland area surrounded the well, as may be caused by the January 30 avulsion.
- Risk: medium in both winter and summer, though by different pathways
 - In winter, a medium Hazard and moderate Consequence result in a medium Risk (M).
 - In summer, a low Hazard and a major Consequence result in a medium Risk (M).

Groundwater supply well power, comms, and supply main

- The same information used to assess Risk to the well was used to assess Risk to these elements
- Hazards: Medium (3) winter, low (2) in summer

- The well supply main, power, and communications lines are all 1.2 m below ground, reducing the likelihood of surface water, sediment, and wood coming into direct contact with them.
- The alluvial fan on which these elements are located is a net depositional environment. While localized scour is possible, it is more likely for sediment to deposit over these elements, than for the sediment surrounding them to erode and expose them to damage.
- The low-lying area around these elements is much wider than the Perseverance Creek channel. Any sediment deposition that might occur over them is more likely to cause water to flow into adjacent lower lying areas, than to direct water, sediment, or wood into contact with them.
- It is unknown how the wetland complexes on either side of the access road will handle surface water flow from Perseverance Creek – whether water will flow west out of the wetlands at the same rate as it enters from the creek, or backwater over the elements, and how long that would last if it were to occur. The potential Hazard this relates to is scour over these elements where water flows between the wetlands, at the entrance to Chinatown in Coal Creek Historic Park.
 - Our understanding is that water flowed from east to west at this location before the January 30, 2026 avulsion. Post avulsion, we see a low likelihood of scour in either direction since water levels will increase on both sides of the crossing, reducing the water slope and velocity from one side to the other.
- Like the well itself, the Hazard is driven by a potential outburst-type event resulting from additional wood and sediment accumulation upstream of the existing log jam, which will eventually result in flow overtopping the berm and causing a larger release in water, wood and sediment towards the well. This poses a larger Hazard than clearwater flooding scenarios.
- Consequences: moderate (3) in winter, major (4) in summer
 - Consequences to these elements match the Consequences of damage to the well itself:
 - Consequence in winter is moderate since VoC could rely on surface water to meet municipal demand.
 - Consequence in the summer (or for damage that occurs in winter but remains unresolved by summer) is major because the well is relied upon during those months to meet municipal demand.
- Limitations
 - We are not aware of any air release valves or access to this infrastructure extending upwards through the ground surface. Such components would change the Risk posed to these elements, and mitigation measures for them would have to be considered.

- If repairs or temporary bypass solutions for this infrastructure are possible to implement within the residence time of municipal storage facilities, the Consequences of damage in the summer would be lower.
- Risk: medium in both winter and summer, though by different pathways
 - In winter, a medium Hazard and moderate Consequence result in a medium (M) Risk.
 - In summer, a low Hazard and major Consequence result in a medium (M) Risk.

Groundwater Supply Well Access

- The same information used to assess Risk to the well was used to assess Risk to the well access.
- Hazards: high (4) in winter, low (2) in summer
 - Water was observed flowing along access during January 30 event (Figure 1.3, pers. comm. David Dougherty June 10, 2026). There have been no mitigation measures put in place for this yet, so there is nothing from preventing it from occurring again once flows increase.
 - Increased water levels in the wetlands on either side of the access road may saturate the road fill and damage the road.
 - The exact timing and duration of how long water would be present along the access road, and how much damage it might cause to the road, is unknown. It is more likely to occur during winter than summer due to increased precipitation and stream flows. The duration of flooding after any given storm event is likely to be determined by beaver dam construction in the wetlands controlling the rate at which water flows out of the wetlands, though it is likely that the access road will dry up each summer.
- Consequences: minor (2) in winter, moderate (3) in summer
 - The Consequence of flooding or damage to the access road is reduced access to the well infrastructure, as well as cultural and social elements in the area.
 - From solely an infrastructure perspective, this Consequence is minor in both winter and summer.
 - However, the well access is also the access and egress for a disc golf course, recreational trails, the trail bridge, Chinatown interpretive infrastructure, and some of the KFN-valued plant species. This has increased the Consequence in the summer from minor to moderate, when these elements are most utilized. Consequence in the winter remains minor due to lower usage.
- Limitations

- The avulsion and fan dynamics between the avulsion site and the well access road are complex and likely to change over time, making it difficult to predict the level of Hazard posed to the well access road.
- Similarly, the wetland dynamics to the east and west of the access road are complex and likely to change over time, making it difficult to predict if and how water will backwater over the access road and drain away it.
- Risk (medium in winter, low in summer)
 - In the winter, a high Hazard and minor Consequence result in a medium (M) Risk.
 - In the summer, a low Hazard and moderate Consequence result in a low (L) Risk.
 - There is uncertainty in the Hazard because the duration of flooding depends on stream flows, the avulsion evolution, and wetland response. All of these are unknown.
 - Damage to the access road would affect elements in several categories. This increases the Consequence of damage.

Comox Lake Road – Perseverance Creek Culvert

- The following information was used to assess the Risk to the Perseverance Creek culvert under Comox Lake Road:
 - June 10 field assessment
 - Photographs of November 16, 2009 road failure, provided by Hamish Murray
 - LiDAR data
- Hazards: medium (3)
 - The November 2009 crossing failure appeared to be caused by wood buildup on the upstream side of the crossing, which raised water levels and saturated the road embankment, causing concrete lock blocks on the downstream side of the crossing to dislodge and part of the road shoulder to slump. This Hazard is still present.
 - The current avulsion does not clearly increase or decrease the Hazard posed to the culvert by the 2009 failure mechanism:
 - Reduced flow through the Perseverance Creek main channel as the result of flow being diverted into the wetlands will likely reduce the amount of wood transported to the culvert via the main channel. This would decrease the Hazard posed to the culvert.
 - Beaver dam failure within the wetland complex, or wood input into the channel between the wetland complex and the culvert as the result of additional flow through the wetland complex, would increase the amount of wood transported to the culvert. This would increase the Hazard posed to the culvert.
 - Wood transport through either flow path is difficult to predict and we do not see either flow path posing a greater Hazard than the other.
- Consequence: major (4)

- This crossing is the only road access and egress for residents living west of it on Comox Lake Road and Horbury Road.
- Limitations
 - Wetland and wood transport dynamics are complex and difficult to predict.
- Risk: high (4)
 - A medium Hazard and major Consequence result in a high Risk to this element.
 - Neither the avulsion or any of the mitigation options considered here clearly change this Risk.

Comox Lake – Drinking Water Supply

- Available Information
 - Hazard Abatement Order Report (Tetra Tech EBA, 2015)
 - Photos of upper Perseverance Creek from November 9 and 10, 2014, provided by Hamish Murray
 - CVRD Water Treatment Project Backgrounder (Comox Valley Regional District, 2021)
- Hazards: Medium (3)
 - On numerous occasions before 2021, high reservoir turbidity in Comox Lake resulted in boil water advisories being issued for the Comox Valley. Some of these events were attributed to sediment entering the reservoir from Perseverance Creek, including a 47-day advisory in 2014-2015, when multiple landslides occurred in the reach below the No. 2 Dam. Other boil water advisories coinciding with high turbidity events in Perseverance Creek did not have known landslide events upstream.
 - Similar to the Perseverance Creek culvert under Comox Lake Road, the avulsion does not clearly increase or decrease the Hazard posed to the Comox Lake Water Intake:
 - Routing a portion of the Perseverance Creek flow through the wetland complex is likely to reduce the amount of sediment transported into the lake, since the wetlands provide a low energy environment for sediment to deposit. This will reduce the Hazard posed to the drinking water intake.
 - Beaver dam failure within the wetland complex, or sediment input into the channel between the wetland complex and the lake as the result of additional flow through the wetland complex, may increase the amount of sediment transported to the lake. This would increase the Hazard posed to drinking water intake.
 - The avulsion does not have any effect on whether future landslides upstream in Perseverance Creek are likely to occur. Upstream landslides would contribute sediment to Perseverance Creek that would increase the Hazard posed to the drinking water intake.
- Consequences: negligible (1)

- The Consequences of previous turbidity events were high (boil-water advisories for approximately 50,000 people), but this has since been mitigated by a new deep-water intake and treatment plant designed to eliminate the need for turbidity-related boil water advisories. This has reduced the Consequence of high reservoir turbidity to negligible.
- Limitations
 - Wetland and sediment transport dynamics are difficult to predict.
 - We have not undertaken a detailed review of the water treatment facility, though are not aware of any boil water advisories being issued since the upgrades were completed.
- Risk: low (1)
 - A medium Hazard and negligible Consequence results in a low Risk.

Summary of Risks posed to infrastructure

Table 3.2 and Table 3.3 summarize the Risk posed to each infrastructure element considered in this assessment.

Table 3.2 Baseline Risk Assessment for groundwater well and associated linear infrastructure. Risk is seasonally dependent.

	Winter			Summer		
Element	Hazard	Consequence	Risk	Hazard	Consequence	Risk
Groundwater supply well	Medium (3)	Moderate (3)	Medium	Low (2)	Major (4)	Medium
GW well power, communications, and supply main	Medium (3)	Moderate (3)	Medium	Low (2)	Major (4)	Medium
GW well access	High (4)	Minor (2)	Medium	Low (2)	Moderate (3)	Low

Table 3.3 Baseline Risk Assessment for downstream infrastructure.

Element	Hazard	Consequence	Risk
Comox Lake Road Perseverance Creek Culvert	Medium (3)	Major (4)	High
Comox Lake Drinking Water Intake	Medium (3)	Negligible (1)	Low

3.3.2 Environmental

Unlike the Infrastructure, Cultural, and Social/Public Safety elements, Environmental elements are not assigned a single Hazard, Consequence, and Risk rating in Section 3. Ecological outcomes associated with the avulsion and associated management options carry both risks and benefits; a single risk rating would obscure this trade-off. Section 3.3.2.5 summarizes ecological risks and benefits qualitatively, and qualitative Hazard/Consequence/Risk language is applied contextually within the management options discussion in Section 4.

This section provides a general ecological context for the area at and downstream of the avulsion site, followed by a summary of the ecological risks and benefits associated with the current avulsion condition.

3.3.2.1 Previous Findings

Aquatic Habitat

Documented fish species in the Perseverance Creek watershed include:

- Coho salmon (*Oncorhynchus kisutch*)
- Coastal Cutthroat trout (*Oncorhynchus clarkii clarkii*)
- Rainbow trout, resident and anadromous (*Oncorhynchus mykiss*)
- Dolly Varden (*Salvelinus malma*)
- Coastrange sculpin (*Cottus aleuticus*)
- Three-spined stickleback (*Gasterosteus aculeatus*)

Previous assessments of lower Perseverance Creek (Ellefson 2003; Ecofish 2019) and information provided by PCSK consistently identified altered hydrology as the primary factor influencing aquatic and riparian function within the watershed. Low summer flows, high winter flows, and substantial seasonal discharge variability caused by development upstream (e.g., water supply system, timber harvesting) were identified as limiting factors for fish habitat, contributing to channel instability, sediment transport, habitat simplification, reduced connectivity between aquatic habitats, and annual fish strandings.

The lower watershed contains an extensive wetland complex that has been recognized as an important component of ecological function, providing water storage, sediment retention, flood attenuation, groundwater recharge, wildlife habitat, and off-channel fish habitat (Ellefson 2003; Ecofish 2019). Previous studies documented hydrologic connections between Perseverance Creek and adjacent wetlands, while also identifying constraints associated with seasonal connectivity, water quality, and historical wetland alterations including drainage works and ditch construction (Ellefson 2003; Ecofish 2019).

Ecofish's (2019) Proper Functioning Condition assessment concluded that the lower watershed was generally Functional-at-Risk and trending downward due to hydrologic and geomorphic instability associated with altered flow regimes, channel aggradation, and sediment transport. Despite these limitations, riparian vegetation remained relatively intact and continued to provide important ecological functions including bank stability, temperature moderation, and large woody debris recruitment.

Species of Conservation Concern and Focal Species

No Critical Habitat for species at risk has been identified within the study area; however, several provincially and federally listed species have been documented within or adjacent to the lower Perseverance Creek watershed (Table 3.4). Species of conservation concern associated with the study area include Northern red-legged frog, Western toad, band-tailed pigeon, and little brown bat.

In addition to species of conservation concern, focal species and species groups were identified based on their ecological importance within the study area. Beaver are considered a primary focal species due to their role as ecosystem engineers and their influence on wetland function throughout the post-avulsion alignment. Wetland-associated birds were also considered a focal group given the diversity of marsh, shrub swamp, open-water, and forested wetland habitats present within the study area. A full list of species recorded within the study area is provided in Appendix A.

Table 3.4 Listed species within or adjacent to the Perseverance Creek watershed.

Common Name	Scientific Name	BC List	SARA Status	Comments
Northern red-legged frog	<i>Rana aurora</i>	Blue	Special Concern	No breeding documented within the study area but suitable habitat (sunny, open water ponds >40 cm deep) is present in the Perseverance wetlands.
Western toad	<i>Anaxyrus boreas</i>	Yellow	Special Concern	Breeding sites located in the upper Perseverance watershed, study area likely used for foraging and overwintering.
Band-tailed pigeon	<i>Patagioenas fasciata</i>	Blue	Special Concern	Documented within the Perseverance wetlands.
Little brown bat	<i>Myotis lucifugus</i>	Red	Endangered	Not recorded within the study area, but has been recorded nearby and is likely present. Forages over open water and along forest edges.

3.3.2.2 Current Aquatic Habitat Conditions and Function

The assessment of aquatic habitat naturally focuses on salmonid species due to their importance from a cultural and regulatory perspective. Furthermore, salmonid species are well known to be keystone species for their critical influence on ecosystem function and health. Habitat conditions and

function for other wildlife species - also an important consideration for this study - have been contemplated and discussed where relevant.

The 2026 avulsion redirected flow from the mainstem channel into a pre-existing network of constructed channels and a large wetland complex within the lower Perseverance Creek watershed. While the habitat features present within both alignments predate the avulsion event, the redistribution of flow has altered hydrologic connectivity and may influence future ecological condition. However, given the limited time elapsed between the avulsion and field assessment, it is too soon to definitively predict how aquatic habitats and associated ecological functions will respond to these changes.

Both alignments remain strongly influenced by watershed-scale stressors, including altered hydrology associated with municipal water withdrawals and industrial forestry leading to excessive peak flows and elevated sediment inputs. The lack of summer baseflows remains the primary factor limiting habitat quality and function throughout the study area, while excess sediment supply and peak flows that exceed channel capacity further degrade conditions. These issues will persist with any of the management options presented in this report if the upstream causes are not addressed.

The mainstem channel is highly aggraded and unstable, with extensive summer dewatering/subsurface flows, multi-threading channels, bank erosion and burial/harm of riparian vegetation. However, mature mixed forest along the length of the alignment provides excellent shade, nutrient, and LWD inputs to the channel. In contrast, the post-avulsion alignment contains extensive wetland habitat and perennial water in some areas, but summer water quality is frequently poor due to low dissolved oxygen concentrations and elevated temperatures resulting from a lack of riparian shading. Past agricultural activities associated with historic Chinatown (ditching, land clearing), have altered wetland hydrology and riparian condition. Water levels are currently controlled by a series of beaver dams, but wetlands are vulnerable to drainage should beaver dams fail due to the presence of remnant ditches.

Invasive American bullfrogs present in the wetlands also pose a predation risk to juvenile salmon and native amphibians. Overview descriptions of assessed reaches are provided in Table 3.5.

Fish habitat quality was generally low throughout the entire study area, with some variation among reaches and life-history stages. Spawning and rearing habitat were generally poor throughout, while overwintering and migration habitat showed greater variation, particularly within the beaver-influenced wetland reaches of the post-avulsion alignment.

Table 3.6 summarizes fish habitat quality by life history stage and key limiting factors for each reach.

PFC assessments identified functional limitations throughout both alignments, although the nature of these limitations varied among reaches. The pre-avulsion alignment remains affected by aggradation, channel instability, and altered hydrology, while reaches within the post-avulsion alignment are primarily constrained by channel simplification, historical land-use disturbances, and reduced riparian function that significantly impair water quality. Table 3.7 summarizes PFC determinations, apparent trends, and key factors affecting hydro-riparian function within each reach.

Table 3.5 Habitat descriptions of each assessed reach. 'Post' refers to reaches along the post-avulsion alignment while 'Pre' refers to the pre-avulsion mainstem channel

Reach Name	Description	Overview
Post-01	Excavated channel through forest below berm	<ul style="list-style-type: none"> • Straight, anthropogenic channel likely associated with 1972 avulsion works • Uniform width (~5.8 m) and simple channelized morphology • Cobble-dominated substrate • Limited habitat complexity and instream cover • Well-shaded by maturing mixed forest
Post-02	Excavated channel through disturbed open floodplain/disc golf area	<ul style="list-style-type: none"> • Straight, potentially excavated channel through disc golf area • Uniform width (~4.8 m) with poorly defined banks • Gravel-dominated substrate • Transitions downstream into a more complex multi-thread floodplain channel • Sparse, heavily disturbed riparian vegetation through disc golf area; mature cottonwood floodplain forest downstream
Post-03	Reed canary grass-dominated wetland	<ul style="list-style-type: none"> • Open wetland heavily modified by historical drainage and land clearing associated with historic Chinatown • Water levels controlled by active beaver dams • Dominated by reed canary grass, with willow and hardhack present on elevated microsites • Limited structural diversity • Deep pools present but water quality poor (high temperature, low dissolved oxygen) • Wetland-type habitat supports a diversity of species that include amphibian, waterfowl, beavers,, etc.
Post-04	Linear ditch/canal wetland	<ul style="list-style-type: none"> • Deep, linear wetland channel transitioning to forested and shrub swamp wetlands • Hydrology strongly influenced by beaver dams • Abundant large woody debris and good structural complexity • Perennially wetted deep pools and beaver canals present • Small areas of spawning-sized gravel present • Poor summer water quality (high temperature, low dissolved oxygen) • Wetland-type habitat supports a diversity of species that include amphibians, waterfowl, beavers, etc. • Adjacent to historic coal slag heaps associated with the former No. 1 Mine site, riparian area highly disturbed by past development in some areas

		<ul style="list-style-type: none"> Wetland is constricted downstream by an historic road alignment and a large beaver dam located near the Japantown parking area
Pre-01	Pre-avulsion mainstem channel	<ul style="list-style-type: none"> Severely aggraded, over-widened and unstable mainstem channel Multiple flow paths and ongoing floodplain avulsion processes Gravel-dominated substrate with localized woody debris-associated pools scoured to hardpan or bedrock Abundant woody debris, forming unstable debris jams that may mobilize during high flows Functional woody debris pieces often act as sediment traps rather than habitat-forming structures Mature riparian forest provides excellent shading, nutrient and wood inputs to the channel, but is at risk from ongoing aggradation and excessive peak flows. Bank erosion and tree burial is evident throughout the reach Extensive summer dewatering with isolated refuge pools and recurring fish rescue efforts Importantly, some surface flow was observed in the lowest portion of the reach during the July assessment, indicating localized groundwater or spring inputs that have also been documented by the PCSK and CEL field staff

Table 3.6 Fish habitat quality for each life history stage summarized by reach.

Reach Name	Summer Rearing	Spawning	Overwintering	Migration
Post-01	Poor. Dries seasonally, no pool habitat, extremely low in stream cover. Lacking riffles or other features to oxygenate water.	Poor – Moderate. Suitable gravels present but high flows may cause redd scour. No riffle features to promote upwelling and redd aeration.	Poor. Extremely low in stream cover present, no off-channel habitat to provide refuge during high flow events.	Moderate. No barriers but at high flows velocities would likely be high given small channel size. Dries seasonally.
Post-02	Poor. Dries seasonally, no pool habitat, extremely low in stream cover except in short section running through cottonwood forest.	Poor – Moderate. Suitable gravels present but high flows may cause redd scour. No riffle features to promote upwelling and redd aeration.	Poor. Extremely low in stream cover present, no off-channel habitat to provide refuge during high flow events outside of cottonwood forest.	Moderate. No barriers but at high flows velocities would likely be high given small channel size. Dries seasonally.
Post-03	Poor. Dries seasonally, water quality in remaining small pools is poor due to lack of flow and shading. Bullfrogs present and may predate on trapped juveniles. Lacking riffles or other features to oxygenate water. High invertebrate production.	Poor. No suitable gravels present for spawning.	Moderate. Extensive deep pool habitat present, but instream cover is limited.	Poor. Beaver dams may pose a barrier for adults during some flow conditions and may be permanent juvenile barriers. Flow velocities low and resting areas present. Limited cover for migrating adults.
Post-04	Poor. Deep pools are present in old ditches and beaver canals, but water quality is poor due to lack of flow and shading. Bullfrogs present and may predate on trapped juveniles. Lacking riffles or other features to oxygenate water. High invertebrate production.	Poor. Spawning habitat limited to some very small gravel pockets present in braided channels behind Japan Town.	High. Extensive deep pool habitat present, cover present in the form of LWD and dense overhanging vegetation.	Poor-moderate. Beaver dams may pose a barrier for adults during some flow conditions and are likely permanent juvenile barriers. Flow velocities low and resting areas present. Good cover for migrating adults. Deep ditches/canals provide opportunities for movement even in summer months.
Pre-01	Poor. Dries seasonally, remaining pool habitat limited to scour pools where fish become stranded, instream cover is limited. Some riffle-pool sequences present.	Poor - moderate. Suitable gravels present but high flows may cause redd scour. Limited riffle features to promote upwelling and redd aeration. Gravels appear to be highly mobile.	Poor – Moderate. High flow velocities for juveniles. Low frequency of pool habitat, some instream cover but features (e.g., LWD jams) unstable. Some off channel habitat present.	Moderate. No significant barriers, some debris jams may pose a partial barrier during some flow conditions. High flow velocities may limit movement during some flow conditions. Dries seasonally.

Table 3.7 PFC results and issues affecting PFC for each assessed reach.

Reach Name	Description	PFC Determination	Apparent Trend	Issues Affecting PFC
PFC-Post-01	Excavated channel through forest	Functional-at-risk	Unclear – avulsion likely to have significant effects but channel has not had sufficient time to respond.	<ul style="list-style-type: none"> Channel incised and disconnected from floodplain Banks at risk of erosion due to lack of stabilizing vegetation Channel lacks complexity needed to dissipate energy during high flows. channel size likely incapable of handling peak flows diverted from mainstem.
PFC-Post-02	Excavated channel through disturbed open floodplain/disc golf area	Non-functional	Unclear – avulsion likely to have significant effects but channel has not had sufficient time to respond.	<ul style="list-style-type: none"> Channel lacks defined banks and stabilizing riparian vegetation is heavily disturbed with minimal coverage. Peak flows overtop banks and spill into surrounding areas, Channel lacks complexity needed to dissipate energy during high flows. channel size possibly incapable of handling peak flows diverted from mainstem.
PFC-Post-03	Reed canary grass-dominated wetland	Functional-at-risk	Unclear – avulsion likely to have significant effects but wetlands have not had sufficient time to respond.	<ul style="list-style-type: none"> Wetland complex lacks microtopographic features to support diverse riparian vegetation. Previous site clearing and cultivation has removed large trees, and woody debris from the site, and colonization from reed canary grass is likely suppressing establishment of native vegetation. Ditches put complex at risk of dewatering should beaver dams fail.
PFC-Post-04	Linear ditch/canal wetland	Functional-at-risk	Unclear – avulsion likely to have significant effects but wetlands have not had sufficient time to respond.	<ul style="list-style-type: none"> Past industrial activity and residential development (coal mining, site clearing, etc.) impairing recovery of riparian vegetation. Coal slag heap is actively eroding and preventing establishment of riparian vegetation. Coal slag may pose a risk to water quality due to potential presence of heavy metals and other contaminants.
PFC-Pre-01	Pre-avulsion mainstem channel	Functional-at-risk	Downward – riparian forest continues to degrade due to erosion in peak flows and burial from excessive sediment supply. Channel unstable and braiding throughout floodplain.	<ul style="list-style-type: none"> Excessive aggradation, partially due to erosion in the upper watershed – most recently the ‘Bear Buns’ slide. Peak flows excessive for channel size Lack of summer base flows caused by changes in the upper watershed due to village water supply system and subsurface flows within aggraded substrates.

3.3.2.3 Comparison of Wetland and Mainstem Alignments

Fish Habitat

Fish habitat quality is generally poor throughout both alignments, although suitability varies by life-history stage and habitat type. Generally, the mainstem alignment provides somewhat better spawning and migration opportunities, while the wetland alignment provides greater water retention and more extensive overwintering habitat. Importantly, habitat function in both alignments is substantially constrained by seasonal dewatering, resulting in broadly similar overall habitat values.

Similarly, PFC assessments indicate that both alignments are currently Functional-at-Risk, although for different reasons (Table 3.8). The mainstem alignment is primarily affected by channel instability associated with excessive sediment deposition, elevated peak flows, and a lack of summer baseflows. In contrast, the wetland alignment is limited by channel simplification, historical land use impacts, reduced riparian function, and dependence on beaver dams to maintain hydrologic connectivity and water levels. Table 3.9 compares overall fish habitat function and PFC results for each alignment.

Note that these values are largely inferred; assessment of fish habitat performance over a full year would be required to definitively ascribe habitat quality.

Table 3.8 Fish habitat quality by life history stage for each alignment.

Life History Stage	Mainstem Alignment	Wetland Alignment	Description
Rearing	Poor	Poor	Rearing habitat in both alignments is limited by seasonal drying. Riffle-pool sequences along mainstem provide better oxygenation, wetland complex supports higher invertebrate production.
Spawning	Poor-moderate	Poor	Spawning habitat along mainstem alignment contains abundant suitable gravels, but peak flows may cause redd scour (harmful shifting of gravels containing eggs). Wetland alignment contains only small pockets of suitable gravels.
Overwintering	Moderate	Moderate-High	Wetland complex buffers peak flows and provides a much larger habitat area during the winter months. High peak flows and minimal cover in mainstem limit overwintering habitat quality, but some refuge provided by side channels and deeper pools.
Migration	Moderate	Poor-moderate	Beaver dams along wetland alignment may pose a barrier to spawners under some flow conditions, and

			could be a year-round barrier to juveniles. Debris jams and high flow velocities on mainstem alignment may pose a partial barrier during some flow conditions. Seasonal drying in both alignments limits summer movement.
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Table 3.9 Overall PFC results and trends for each alignment.

Alignment	PFC Assessment Result	Trend
Mainstem	Functional-at-risk	Downward
Wetland	Functional-at-risk (one short sectional of Non-functional)	Unable to determine

3.3.2.4 Trapping Results

Trapping was conducted in order to better understand fish distribution throughout the post-avulsion wetland complex. No salmonids were caught during trapping efforts. This could be due to the presence of barriers (beaver dams) preventing juvenile coho and resident trout from moving from mainstem Perseverance into the wetland complex, or could be the result of extremely poor dissolved oxygen levels and high temperatures precluding use. Trapping results are provided in Table 3.10, trap locations are shown in Figure 2.2. Note that the timing of the avulsion event precludes an accurate representation of fish distribution in the study area.

Table 3.10 Results from minnow trapping in post-avulsion wetland complex.

Trap Number	July 3	July 4
1	15 three-spined stickleback	7 three-spined stickleback 2 bullfrog tadpoles
2	25 three-spined stickleback	10 three-spined stickleback 2 bullfrog tadpoles
3	2 three-spined stickleback	1 three-spined stickleback
4	-	2 three-spined stickleback
5	-	17 three-spined stickleback
6	19 three-spined stickleback	30 three-spined stickleback
7	7 three-spined stickleback	2 three-spined stickleback
8	-	-
9	-	-
10	1 bullfrog tadpole	3 bullfrog tadpoles

Other Wildlife

It is important to note that the lentic (wetland) alignment provides different biophysical conditions that provide suitable habitat for different species than the lotic (stream) habitat of the pre-avulsion alignment. Generally, wetland habitats support higher overall species diversity and biological productivity than stream habitats due to their shallow, nutrient-rich, and standing waters.

Hydrologic Considerations

The effect of a more lentic environment on summer baseflows is not understood. It is possible that a larger area of inundation and longer retention of flows on the landscape may increase summer baseflows to downstream reaches of Perseverance Creek – a critically limiting factor of ecological function within the watershed.

3.3.2.5 Risks and Benefits of Current Avulsion Condition

- Risks of the current avulsion condition include:

- Potential flow-splitting of already limited base flows
 - Risk of peak flows causing blow out in constructed channel sections (Post_02 and Post_03)
 - Increased mortality of resident fish and juvenile salmonids due to:
 - Elevated summer water temperatures and extremely low DO in wetland complex
 - Increased predation on juvenile salmon from American bullfrogs and other species in wetland complex
 - Stranding in isolated pools when wetland complex dries
 - Limited riparian shading in wetland complex contributing to thermal stress
 - Earlier stranding in main channel if low flows are split between alignments
 - Potential loss of functional spawning habitat should channel fully avulse to wetland alignment
- Benefits
 - Additional water availability to wetland complex supports diversity (amphibians, beavers, and other wildlife)
 - Wetland complex may help to attenuate peak flows downstream
 - Allowing the channel to evolve without intervention may facilitate the re-establishment of natural channel processes
 - Expanded wetland footprint from increased flows contributes to wildfire resilience
 - Wetland complex is more productive than mainstem channel, leading to increased food production for fish
 - Connectivity to wetland complex may provide refuge for fish during peak flow events, improving overwintering habitat
 - Broader floodplain activation may increase infiltration and summer baseflows.

3.3.3 Cultural

Cultural elements include KFN, Chinatown, and Japanese Town elements.

KFN Values

- The following information was used to assess Risk to KFN cultural values in the area:
 - *Cultural Values Report – Cumberland Community Forest Park* (Morin, 2025)
 - June 10, 2026 Field Assessment, undertaken with KFN Guardians
- Hazards: Medium (3)

- KFN cultural elements identified in the Cultural Values Report near the avulsion site include patches of Devil's club above the avulsion site and along the avulsion channel, and mature cedar trees along the main channel.
 - The avulsion channel poses a Hazard to the Devil's Club adjacent to it, though the level of Hazard depends on the avulsion channel evolution, which is difficult to predict.
 - Access to the Devil's Club is likely to be seasonally compromised in the short term as the trail network around the avulsion channel is reestablished.
 - There are mature cedar trees along both banks of the Perseverance Creek main channel. The creek has scoured under some of these trees and currently poses a Hazard to them. The undercut trees also pose a Hazard to members of the public depending on how unstable they have become. There are fewer mature cedar trees along the avulsion channel path.
- Morin (2025) also mentions trailing blackberry, blackberry, thistle, salal, Oregon grape, sword fern, huckle berry, salmonberry and blueberry as existing throughout the Cumberland Community Forest, but doesn't mention specific patches of these plants in the immediate avulsion area. The Hazard posed to these elements is unknown.
- Morin (2025) estimates a low archaeological potential for the lands on either side of the creek, based on regular flood events, previous land modification, the ground being too damp to provide a good camp site, and better alternatives existing 10s of meters away.
 - The land adjacent to the avulsion channel has been subject to significant land modification (No 2. Mine and Chinatown), so the Hazard to potential archaeological sites is considered low.
- Consequences: moderate (3)
 - Morin (2025) identifies the Devil's Club patch and Cedar trees near the avulsion site as some of the largest in the Comox Valley area. Both species take many years to establish, though it is unlikely that the avulsion will damage every plant within the area. We therefore estimate the Consequence of damage to these elements as moderate.
 - The report describes the distribution of the other species listed above as shifting over time as some areas of the forest mature and others are disturbed, but it does not identify any specific areas supporting populations of particularly high value. Given the avulsion occupies a small area of the report's study area, we take this to mean that it will not pose a disproportionate Hazard to these species, and therefore the Consequence to them is negligible.
- Limitations
 - We have not undertaken a detailed study of the distribution of Devils Club or mature Cedar trees near the avulsion site. Coupled with the difficulty in predicting the avulsion channel evolution, this creates a significant uncertainty for the Risk posed to those two plant populations.

- While not immediately related to the January 30 avulsion, routing flows down Cumberland Creek as part of the No. 2 dam upgrade plan may pose a Risk to the Devil's Club at the confluence of Cumberland Creek and Perseverance Creek. Cumulative effects of the avulsion and No. 2 Dam upgrades on the Devil's Club patch in this area should be considered.
- Risk: medium (3)
 - A medium Hazard and moderate Consequence results in a medium Risk.
 - Risk to the Devil's Club along the avulsion channel depends on how the channel evolves and what proportion of the plants are damaged by this evolution. Plants upstream of the avulsion will not be damaged by the avulsion channel.
 - There is a Risk to mature Cedar trees immediately exposed to surface water flow, though the splitting of flow between the two channels reduces the peak flows in both channels, limiting the potential damage to any given tree.

Chinatown

The historic Chinatown site was mostly deserted by the 1950s and the remaining buildings were burned in 1968. The only elements related to Chinatown presently within the study area are a picnic table pavilion, wooden gate, and interpretive signs along the well access road within Coal Creek Historic Park. This assessment considers the Risk posed to these elements.

- The following information was used to assess the Risk posed to the cultural elements from Chinatown in the study area:
 - Cumberland Museum Archives (accessed in person July 16, 2026, as well as multiple times online over the study period).
 - Personal communication with Dawn Copeman (Educator and Historian, Cumberland Resident)
 - June 10, 2026 field assessment
 - Historical imagery available from the BC Online Air Photo Portal – 1968, 1972, 1975, 1980, 1982, 1984, 1991, 1992, 1994, 1996, 2014, 2017
 - Wetland and Stream Restoration Assessment of Perseverance Creek and Boundary Wetlands (Annschild, 2020)
- Hazards: high (4)
 - Because these elements are on the access road to the drinking water supply well, the Hazard posed to them by surface water flooding is high. The access road experienced surface water flooding during the January 30 avulsion and there is nothing to stop it from happening again during future large storms. Depending on the wetland response to additional surface water inflows, flooding may extend further down the access road towards these elements than it did in the aftermath of the January 30 avulsion.

- The avulsion response may cause the access road fill to become more saturated than it has been previously. This saturation may pose a Hazard to these elements, though the level of Hazard depends on the wetland response, road fill material and how the picnic area and signs are constructed (ie, if they are on piles), and is therefore hard to predict.
- Consequences: minor (2)
 - Consequence to the signs is negligible because they can be moved or adjusted if needed, and are replaceable if damaged.
 - Consequence to the picnic pavilion and gate is minor because there is a larger potential effort required to repair or replace this infrastructure relative to the interpretive signs.
 - Applying a waterproof coating to the bases of these elements may mitigate potential damage from surface water flooding.
 - The Consequence of seasonally reduced access applies to these elements as well as the other elements accessed on this road: the well, disc golf course, and recreational trails. This Consequence is minor in the winter and moderate in the summer.
- Limitations
 - The Hazard depends on avulsion and wetland dynamics which are hard to predict and likely to change over time.
 - We have formed this assessment based on the information listed above, but are not experts in this history or any current cultural connections to it. If new information about this area becomes available, it should be incorporated into the assessment.
 - This assessment considered surficial elements related to Chinatown. Future work involving ground disturbance at the site may have to consider the potential for uncovering archaeological artifacts.
- Risk: medium (M)
 - A high Hazard and minor Consequence result in a medium Risk (M). Although the Hazard is high, the Consequence of damage to the elements remaining within the study area is minor, and the Consequence of seasonally reduced access to the picnic area is low in the winter.
 - The Risk to these elements is at least partly shared with the Risk to the other elements along the access road.

No. 1 Japanese Town

The only element from the historic No. 1 Japanese Town area considered in this assessment is the part of Martha's trail closest to Perseverance Creek. The remainder of the No. 1 Japanese Town is situated at a higher elevation and will not be affected by Perseverance Creek.

- The following information was used to assess the Risk posed to the cultural elements from the No. 1 Japanese Town in the study area:

- Cumberland Museum Archives (accessed in person July 16, 2026, as well as multiple times online over the study period).
- Personal communication with Dawn Copeman (Educator and Historian, Cumberland Resident)
- June 10, 2026 Field Assessment
- Hazards: medium (3)
 - This area had flooding issues prior to the January 30 avulsion that VoC mitigated with trail maintenance. Because the avulsion is likely to deliver more surface water to the wetlands, this area may experience flooding again.
 - The January 30 avulsion caused an abandoned bridge at the upstream end of the No. 1 Japanese Town to wash out. As this continues to erode, it may deliver more wood and sediment to the channel that could deposit near the site and influence surface water levels in the area.
- Consequences: minor (2)
 - Consequences of surface water flooding are minor because it may require trailwork to mitigate.
- Limitations
 - Surface water flooding in this area depends on a chain of processes that are difficult to predict: avulsion evolution, wetland response, bridge washout progression and downstream wood transport and deposition.
- Risk: low (1)
 - A medium Hazard and minor Consequence result in a low Risk.
 - The level of Hazard is difficult to predict.

Summary of Risks posed to cultural elements

Table 3.11 summarizes the Risks posed to the cultural elements.

Table 3.11 Baseline Risk Assessment for cultural elements.

Element	Hazard	Consequence	Risk
KFN valued plant species	Medium (3)	Moderate (3)	Medium
Chinatown	High (4)	Minor (2)	Medium
No. 1 Japanese Town	Medium (3)	Minor (2)	Low

3.3.4 Social and Public Safety

Social elements include the trail bridge, trails adjacent to it, disc golf course, and ecological heritage and interpretation values in the area near the avulsion. Each element has a physical component (eg, the trail bridge structure) as well as a public safety component (eg, a person using the trail bridge). We have provided high-level comments about the Hazards and Consequences for these elements, though have left the element-specific evaluation to VoC and other key interest parties to establish as community leaders and experts in the social values and public use of the area, as well as being the parties in charge of balancing available funding with various mitigation options.

- The following information was used to assess the Risk posed to these elements:
 - All spatial data described in 2.2
 - June 10 and July 16, 2026 field assessments
 - Informational interviews with local knowledge holders described in 2.2
 - In person meeting between VoC, CVLT, CCFS, UROC, and Bloom Landscape Architecture (Aug 12)
- Hazard: variable
 - Hazard ranges from low to extreme, depending on what social element is looked at and at which time frame is considered. The Hazard is higher for elements closer to the avulsion, at lower elevations, and during the fall and winter. It is lower for elements at higher elevations and during the summer.
 - The Hazard posed to each element will change over time as the avulsion channel evolves.
 - The public safety component of the Hazard depends on human presence, which will vary over the course of a day, week, and year.
 - There is a Hazard posed to these social elements by danger trees potentially falling on the element or on people using it. This Hazard will also change over time as the avulsion channel evolves.
- Consequences
 - It may be helpful to think of Consequences as chains based on access and egress, with the main limiting factor being the well access road. For example, the Consequence of surface water flooding of the disc golf course in the winter is low if the access road to it is flooded and no one can access it anyway. Similarly, addressing the damaged trail bridge crossing is only relevant for times when people can access or egress from it along the access road and trail network adjacent to it.
 - The ongoing evolution of the avulsion channel presents a cost-benefit analysis for the key interest parties in the area regarding how much to spend on trails and bridges now, which may need to be adjusted or repaired again in the near future.

4 MITIGATION STRATEGIES, DISCUSSION AND RISK SUMMARY TABLES

This section outlines several high-level mitigation strategies, and summarizes how they change the Risk for each element relative to the baseline Risk described for it in Section 3.3. VoC and NHC have identified minimal environmental impact, maximum space for creek to migrate naturally, and minimal maintenance as the guiding principles for which mitigation option(s) to pursue.

4.1 Mitigation Strategies

We have identified short- and mid-term mitigation strategies, based on whether the mitigation would take place before or after the fall rains this year. Potential short-term mitigation options are to either leave the log jam and bridge in place or remove it. Potential mid-term mitigation options are:

- Option 1: Construct a buried grade-control at the avulsion channel entrance and an overflow berm in the main channel, to direct low and medium flows into the avulsion channel while allowing a portion of peak flows to spill into the main channel. This combination would limit the amount of water entering the avulsion channel, which would reduce the amount of erosion and flooding downstream of it.
- Option 2: Reinstate and upgrade the berm on the right bank at the avulsion to direct all creek flow through the mainstem. This would eliminate flow into the avulsion channel and areas downstream of it.
- Option 3: Construct a set back berm near the well. This would allow the channel to migrate naturally across a portion of the alluvial fan, while preventing direct contact with key elements on the fan.

4.2 Discussion

For some elements, there is no clear increase or decrease in Risk for different mitigation options. This is due to the complexity and resulting unpredictability of the avulsion evolution and wetland response, and the distance between the elements and the current avulsion site. This reduces the number of the elements that influence the decision on which mitigation strategy to pursue. These elements have been greyed out in Tables Table 4.1 through

Table 4.7.

4.2.1 Short-term mitigation discussion

The short-term decision of whether to leave or remove the wood bridge and log jam presents a trade-off in potential Hazards:

- Leaving the wood and bridge in place will allow additional wood and sediment to build up behind it and eventually produce a larger release, which could take the form of a sudden outburst-type event. Exact timing of this is difficult to predict: it could happen during the next large storm or several years from now. However, in the short term the jam may limit the proportion of surface water flowing into the avulsion channel during high flow events, which in turn would limit the amount and rate of geomorphic change in the avulsion channel and downstream of it.
 - No associated environmental permitting requirements if wood and bridge are left in place
- Removing the bridge and wood accumulated on it may give water easier access to the avulsion channel. In the short term, this may widen the channel entrance, accelerate erosion of the channel, and increase the amount of water flowing towards the downstream elements. However, this reduces the Risk of an outburst-type event at a future date that could cause more dramatic changes.
 - A Notification under the Provincial Water Sustainability Act will be required for removal of the wood and bridge. Provided work is done when the channel is dry, works can be completed under the Code of Practice for Bridge Maintenance and Repair, and will not require review by DFO.
- There is also a Hazard posed by berm failure upstream of the existing avulsion channel entrance. This is present regardless of whether the wood jam is removed, but may be increased if the bridge and jam are left in place.

The two most immediate Consequences associated with these Hazards are:

- Potential damage to the drinking water supply well and access to it access this winter
- Potential reduced access to social elements in the area. This may be seasonal or storm driven.

Recommendation: It is our opinion that the bridge and jam should be removed to reduce the Risk of an outburst-type event, due to the greater uncertainty and potential Consequence of such an event.

4.2.2 Mid-term options

Brief comments for each mid-term mitigation option are provided below. Any of the options will require an engineering approach including a more thorough review of existing streamflow data, survey data, and design before pursuing.

- Option 1: Construct buried grade control sills to direct low and mid flows into the avulsion channel and allow peak flows to spill into main channel
 - This will require instream work at the avulsion channel entrance.
 - It is likely that this system will require maintenance to maintain the relative inlet elevations due to the ongoing sediment aggradation at this site.
 - Construction would require a WSA Authorization or Water License. An Authorization would only cover construction, not maintenance, of the diversion structure. A License would allow for ongoing maintenance as needed.
 - Construction would require review by DFO and potential Authorization under the Fisheries Act. Should an Authorization be required, DFO may require offsetting for habitat impacted by the project.
- Option 2: Reinstate and upgrade the right bank berm and maintain flows in main channel
 - Maintaining creek flow in the main channel will require either raising the berm, dredging the channel, or a combination of the two approaches.
 - If the bridge is to be reinstated at the same location, it should be installed at a higher elevation above the channel bed. This could take the form of building the bridge higher, or removing sediment from the channel. Sediment removals from the channel would require regular maintenance as well as permitting.
 - An alternative option for reinstating the bridge would be to construct it further upstream where aggradation and channel migration are less of a concern. This would require additional assessment to determine a feasible location.
 - Construction would require a WSA Authorization or Water License. An Authorization would only cover construction, not maintenance, of the diversion structure. A License would allow for ongoing maintenance as needed.
 - Construction would require review by DFO and potential Authorization under the Fisheries Act. Given that berm construction would be maintaining pre-existing fish habitat conditions, offsetting is less likely to be required.
- Option 3: Construction of a set-back berm in the disc golf area near the well
 - This option allows the avulsion to evolve naturally and for the channel to migrate naturally within the portion of the floodplain to the west of the proposed set back berm.
 - Depending on how the wetlands respond to increased surface water inputs, this approach may require raising the access road and/or providing more drainage under it to allow water to spill into the wetland area east of it.

- Depending on design details (e.g., distance from existing aquatic habitat), permitting under the Fisheries Act and WSA may not be required.

Recommendation: We recommend pursuing mitigation Option 3. Additional details are provided in 0.

4.3 Risk Assessment Tables

Tables Table 4.1 through Table 4.10 summarize the Hazards, Consequences and Risks posed to each element for the baseline conditions, and the residual Hazards, Consequences, and Risks remaining for each mitigation option.

Table 4.1 Hazards table, short term options. Greyed out boxes correspond to infrastructure where the avulsion mitigation options do not affect the Hazard posed to those elements.

Scenario (short term mitigation options)	Infrastructure			Environmental ^a		Cultural	Social
	Groundwater Well, supply main, power and communication, access	Perseverance Creek Culvert under Comox Lake Road	Comox Lake Drinking Water Supply Intake	Hazards	Benefits	KFN Values, Chinatown, No. 1 Japanese Town	Trail Bridge, Trail Network, Disc Golf Course, Coal Creek Historic Park
Baseline (leave bridge and wood in place)	<ul style="list-style-type: none">The Hazards posed to the well, its power and communications cables, and supply main, vary seasonally:<ul style="list-style-type: none">The Hazard of direct damage to the well or its associated linear infrastructure is medium in winter and low in summer. Damage would be most likely to occur from an outburst-type event at the avulsion site.The Hazard of surface water contamination is low in winter and summer, though there is much greater uncertainty regarding this Hazard.In the winter, there is a high (4) Hazard posed to the access road and compromised access is likely, though the duration is unknown. There is a low (2) Hazard posed in the summer.<ul style="list-style-type: none">Note that the well access is also the access and egress for all social elements and some cultural elements.	<ul style="list-style-type: none">There is a medium (3) Hazard posed to the culvert, but the avulsion does not clearly increase or decrease it:<ul style="list-style-type: none">Flow split between main channel and wetland will likely reduce peak flows at culvert, reducing Hazard to crossing.Beaver dam collapse in wetland could result in larger pulse of material that builds up at culvert, increasing Hazard to crossing.	<ul style="list-style-type: none">There is a medium (3) Hazard of high turbidity occurring at the drinking water intake, but the avulsion does not affect this:<ul style="list-style-type: none">Perseverance Creek is one of several creeks entering Comox Lake that contributed to reservoir turbidity resulting in boil water advisories.Wetlands could reduce sediment transport to reservoir during low and mid flow conditions.Beaver dam collapse resulting from increased flow through wetland could increase turbidity in reservoir.	<ul style="list-style-type: none">The avulsion splits flow between the mainstem and wetland-complex alignments, reducing the volume of already-limited summer base flow reaching each channel.Peak flows may erode the constructed channel sections at Post-02 and Post-03, which are simple, straight, and lack the roughness to dissipate high flows without erosion.Predation on juvenile salmon by invasive American bullfrogs and other species within the wetland complexElevated water temperature and low dissolved oxygen in the wetland complex during summer low-flow periodsLimited riparian shading within the wetland complex, contributing to thermal stressStranding of fish in isolated pools as the wetland complex seasonally driesIf the avulsion channel captures most (or all) flows, existing functional spawning substrate in the main channel will be lost, as wetland reaches lack suitable gravels.Beaver dams present along the wetland alignment may pose barriers to fish passage at some life stages and under some flow conditions.	<ul style="list-style-type: none">Additional flows to wetland habitats.Flow splits into the wetland complex during high-flow events.The channel is allowed to evolve without intervention.Increased flows may expand the wetland footprint.Flow is directed through the more productive wetland complex rather than the mainstem.Fish gain connectivity to the wetland complex during peak flow events.Wetland areas will likely hold water for longer than the mainstem channel.	<ul style="list-style-type: none">There is a medium (3) Hazard posed to KFN valued plant species (Devil's Club, mature Cedar trees):<ul style="list-style-type: none">Extent of potential damage along avulsion channel unknown.Negligible Hazard (1) posed to plants upstream of avulsion site by the avulsion, though these plants may need to be considered in the No. 2 Dam upgrades if flow is to be routed down Cumberland Creek.Access to all plants could be seasonally compromised based on status of trail network and bridge.There is a high (4) Hazard posed to Chinatown elements.<ul style="list-style-type: none">All elements are along access road that flooded in January 30 event, and no mitigation steps have yet been taken to prevent it from occurring again.There is a medium (3) Hazard posed to the No. 1 Japanese Town elements.<ul style="list-style-type: none">Local observations noted occasional flooding of trails near Japan town, which was later mitigated with trail construction. Increasing flow into the wetland complex may result in future issues.A bridge washout upstream of the No. 1 Japanese Town site may introduce additional water, wood and sediment to the channel, which could influence flooding at downstream elements.	<ul style="list-style-type: none">There is an extreme (5) Hazard posed to the trail bridge, since it is already compromised. Previous bridge in same location was washed out in 2009.There is a high (4) Hazard posed to the trail network near avulsion site since it is likely to be affected by seasonal flooding in low lying areas.There is a medium (3) Hazard posed to the Disc golf course and Coal Creek Historic Park. They are likely to be affected, though uncertain to what extent.
Remove bridge and wood	<ul style="list-style-type: none">Removing the wood and bridge reduces the Hazard posed to the well from an outburst-type event, reducing the Hazard of direct damage from medium (3) to low (2).<ul style="list-style-type: none">Removing material may increase the amount of surface water accessing the avulsion channel and downstream elements in the short term, though clearwater scenarios pose a low (2) Hazard to the well.						

Notes:
a. Damage to environmental elements is better characterized as a trade-off than as a loss, with each mitigation scenario carrying both benefits and drawbacks.

Table 4.2 Hazards table, mid term option 1: direct creek into new alignment

Scenario (mid term mitigation options)	Infrastructure			Environmental		Cultural	Social
	Groundwater Well, supply main, power and communication, access	Perseverance Creek Culvert under Comox Lake Road	Comox Lake Drinking Water Supply Intake	Hazards	Benefits	KFN Values, Chinatown, Japantown	Trail Bridge, Trail Network, Disc Golf Course, Coal Creek Historic Park
Option 1: Direct creek into new alignment (follow avulsion), with overflow sill for additional water to spill peak flows into existing channel	<ul style="list-style-type: none">Relative elevations of the avulsion channel entrance sill and the overflow berm would be designed so that there would be a low (2) Hazard of direct damage posed to well elements.The Hazard of surface water contamination would remain unchanged from baseline. This Hazard is low (2) but uncertain.The berm and sill would still be vulnerable to sediment aggradation and wood transport. It would require regular sediment removals to reduce this vulnerability.	<ul style="list-style-type: none">Same considerations as short-term options: Avulsion does not present a clear increase in Hazard to culvert relative to pre-avulsion conditions.<ul style="list-style-type: none">Flow split between main channel and wetland will likely reduce peak flows at culvert, reducing Hazard to crossingBeaver dam collapse in wetland could result in larger pulse of material that builds up at culvert, increasing Hazard to crossing.	<ul style="list-style-type: none">Same considerations as short term options: Avulsion doesn't clearly increase or decrease the amount of sediment delivered to the drinking water intake:<ul style="list-style-type: none">Perseverance Creek one of several creeks entering Comox Lake that contributed to reservoir turbidity resulting in boil water advisories.Wetlands could reduce sediment transport to reservoir during low and mid flow conditions.Beaver dam collapse resulting from increased flow through wetland could increase turbidity in reservoir.Turbidity-related boil water advisories were mitigated by installation of new intake and treatment facility in September 2021.	<ul style="list-style-type: none">Similar risks as short-term options:<ul style="list-style-type: none">Peak flows may erode the constructed channel sections at Post-02 and Post-03, which are simple, straight, and lack the roughness to dissipate high flows without erosion.Predation on juvenile salmon by invasive American bullfrogs and other species within the wetland complexElevated water temperature and low dissolved oxygen in the wetland complex during summer low-flow periodsLimited riparian shading within the wetland complex, contributing to thermal stressStranding of fish in isolated pools as the wetland complex seasonally driesLoss of functional spawning habitat in mainstem in the short-to-mid termBeaver dams present along the wetland alignment may pose barriers to fish passage at some life stages and under some flow conditions.The proposed overflow sill would allow spillover from the avulsion channel into the existing channel during peak flows, but not to maintain connectivity as flows recede. Fish that move into the main channel via the spillway during a high-flow event may become isolated once flows drop back below the sill elevation.	<ul style="list-style-type: none">Similar benefits as short-term options:<ul style="list-style-type: none">Additional flows to wetland habitats.Flow splits into the wetland complex during high-flow events.Increased flows may expand the wetland footprint.Flow is directed through the more productive wetland complex rather than the mainstem.Fish gain connectivity to the wetland complex during peak flow events.Wetland areas will likely hold water for longer than the mainstem channel.Prevents issues with flow splitting between alignments during lower flowsLimits flows to degraded mainstem	<ul style="list-style-type: none">Relative elevations of the avulsion channel entrance sill and overflow berm would be designed to result in a low (2) Hazard posed to elements downstream in the avulsion channel.<ul style="list-style-type: none">These relative elevations may present a tradeoff in the Hazards posed to plants in the avulsion channel versus plants in the main channel.Reduced water into the avulsion channel would reduce the potential damage to the Chinatown elements along the access road, reducing the Hazard to low (2).The No. 1 Japanese Town is subject to several processes downstream of the avulsion. Mitigations at the avulsion do not have as clear of an effect on the Hazard posed to these elements. The Hazard would remain medium (3).	<ul style="list-style-type: none">Hazards posed to the trail bridge would be high (4) if it is in the same location and at the same elevation, since it would be subject to future log jams.Hazards to the trail network immediately adjacent to the bridge would be medium (3), since they would still be subject to wood transport, bank erosion, and sediment deposition, though at a reduced level due to reduced flow into the avulsion channel.Hazards to the disc golf course and Coal Creek Historic Park would be low (2), since they would be subject to surface water flooding if sediment or wood deposition at the avulsion location changed the flow split.

Table 4.3 Hazards table, mid term option 2: reinstate berm

Scenario (mid term mitigation options)	Infrastructure			Environmental		Cultural	Social
	Groundwater Well, supply main, power and communication, access	Perseverance Creek Culvert under Comox Lake Road	Comox Lake Drinking Water Supply Intake	Hazards	Benefits	KFN Values, Chinatown, Japantown	Trail Bridge, Trail Network, Disc Golf Course, Coal Creek Historic Park
Option 2: Reinstate berm (direct creek through mainstem)	<ul style="list-style-type: none">The height of the berm would have to be increased relative to the channel bed to reduce the Hazard posed to the well and associated infrastructure to low (2).<ul style="list-style-type: none">Maintaining this height would require regular sediment removals given the ongoing aggradation at site.The Hazard of surface water contamination would be reduced to pre-avulsion conditions (low (2)) with this option.	<ul style="list-style-type: none">Same considerations as short-term options: Avulsion does not present a clear increase in Hazard to culvert relative to pre-avulsion conditions. Directing the creek through mainstem maintains the Hazards that were present to it pre-avulsion.	<ul style="list-style-type: none">Same considerations as short term options: Avulsion doesn't clearly increase or decrease the amount of sediment delivered to the drinking water intake. This would reduce the potential for reservoir turbidity caused by Beaver dam collapse, but increase the chance of reservoir turbidity from sediment transport through the mainstem.	<ul style="list-style-type: none">Reinstates the pre-avulsion condition of the channel, which is prone to summer subsurface flow, leading to fish mortality.Returns flow to a channel already documented as excessively aggraded, with peak flows exceeding channel capacity. Continued aggradation leading to channel instability.Continues the riparian degradation trajectory already documented pre-avulsion; bank erosion and burial associated with excessive aggradation continue to damage the mature riparian forest along the channelInvasive, intensive intervention; maintenance requires ongoing, active intervention in the fan area (regular sediment removal and berm maintenance).Forgoes the expanded wetland footprint that the additional flows to the avulsion/wetland alignment may provide.Forgoes the higher productivity and habitat diversity currently associated with the wetland complex (increased food production, species diversity).	<ul style="list-style-type: none">Maintains existing (though degraded) spawning habitat.Channel flows through mature riparian forest with strong canopy cover.Reinstating flow through the mainstem avoids the numerous beaver dams present along the wetland alignment, which may pose barriers to fish at some life stages and under some flow conditions.	<ul style="list-style-type: none">The Hazard posed to KFN-valued plant species remains medium (3) overall, but this option would protect the Devil's Club along the avulsion channel while exposing the mature cedars along the main channel. The Hazard posed to plant species upstream of the avulsion remains negligible (1).The Hazard posed to Chinatown elements is reduced to low (2), with the Hazard scenario being another avulsion.The Hazard posed to No. 1 Japanese Town remains medium (3). This option might reduce it slightly, but it depends on complicated wetland and main channel dynamics and is therefore hard to predict.	<ul style="list-style-type: none">This option will reduce the Hazard posed to any social element, but will require regular sediment removals to maintain the reduced Hazard due to the ongoing channel aggradation at the avulsion location.

Table 4.4 Hazards table, mid term option 3: construct setback berm

Scenario (mid term mitigation options)	Infrastructure			Environmental		Cultural	Social
	Groundwater Well, supply main, power and communication, access	Perseverance Creek Culvert under Comox Lake Road	Comox Lake Drinking Water Supply Intake	Hazards	Benefits	KFN Values, Chinatown, Japantown	Trail Bridge, Trail Network, Disc Golf Course, Coal Creek Historic Park
Option 3: Set back berm near well	<ul style="list-style-type: none">A set back berm would result in a negligible (1) Hazard of direct damage posed to the well from surface water flooding or sediment or wood transport.The Hazard of surface water contamination would remain unchanged from baseline. This Hazard is low (2) but uncertain.	<ul style="list-style-type: none">Same considerations as other options: Avulsion and mitigation options considered here do not present a clear increase in Risk to culvert relative to pre-avulsion conditions.	<ul style="list-style-type: none">Same considerations as other options: avulsion and mitigation options here do not clearly increase or decrease the amount of sediment delivered to the drinking water intake.	<ul style="list-style-type: none">Same as short-term options:<ul style="list-style-type: none">The avulsion splits flow between the mainstem and wetland-complex alignments, reducing the volume of already-limited summer base flow reaching each channel.Peak flows may erode the constructed channel sections at Post-02 and Post-03, which are simple, straight, and lack the roughness to dissipate high flows without erosion.Predation on juvenile salmon by invasive American bullfrogs and other species within the wetland complexElevated water temperature and low dissolved oxygen in the wetland complex during summer low-flow periodsLimited riparian shading within the wetland complex, contributing to thermal stressStranding of fish in isolated pools as the wetland complex seasonally driesPotential loss of functional spawning habitat in mainstem channel in the short-to-mid-term.Beaver dams present along the wetland alignment may pose barriers to fish passage at some life stages and under some flow conditions.	<ul style="list-style-type: none">Similar to short-term options:<ul style="list-style-type: none">Additional flows to wetland habitats.Flow splits into the wetland complex during high-flow events.The channel is allowed to evolve with minimal intervention.Increased flows to wetland complex may expand the wetland footprint.Increased flows through more productive wetland complex rather than the mainstem.Fish gain connectivity to the wetland complex during peak flow events.Wetland areas will likely hold water for longer than the mainstem channel.Potential for incorporating restoration of wetland/riparian habitat with berm construction	<ul style="list-style-type: none">Same overall medium (3) Hazard and potential tradeoff to KFN-valued plant species posed by previous mitigation option, but reversed: Devil's Club along the avulsion channel may be damaged while mature cedars along the main channel will be less exposed to damage. The negligible (1) Hazard posed to plant species upstream of the avulsion remains unchanged.The Hazard posed to Chinatown elements is reduced to low (2), though wetland response will have to be monitored depending on what mitigation is applied to the access road.The Hazard posed to No 1 Japanese Town remains medium (3). It is perhaps slightly increased, but subject to complicated wetland and main channel dynamics so is hard to predict.	<ul style="list-style-type: none">There will remain a high (4) or extreme (5) Hazard posed to elements on the channel side (west) of the berm, depending on where the element is.There will be a negligible (1) or low (2) Hazard posed to elements on the berm or east of it, depending on where the element is.

Table 4.5 Consequences table (short term options)

Scenario (short term options)	Infrastructure			Environmental		Cultural	Social
	Groundwater Well, supply main, power and communication, access	Perseverance Creek Culvert under Comox Lake Road	Comox Lake Drinking Water Supply Intake	Hazards	Benefits	KFN Values, Chinatown, Japantown	Trail Bridge, Trail Network, Disc Golf Course, Coal Creek Historic Park
Do-nothing	<ul style="list-style-type: none">Consequence of damage to the well, supply main, power and communications, or surface water contamination (SWC) of the well varies seasonally.<ul style="list-style-type: none">Consequence in winter is moderate (3). VoC operates this well year round but there is redundancy from reservoirs upstream in the watershed.Consequence in the summer (or damage/SWC that occurs in winter but remains unresolved by summer) is major (4) since the well is relied upon during the dry months.	<ul style="list-style-type: none">Consequence of damage to culvert is major (4) since it is the only vehicle access for residents on Comox Lake Road and Horbury Road.	<ul style="list-style-type: none">The Consequence of increased reservoir turbidity at the drinking water intake is negligible (1) because it was mitigated by the installation of new intake and treatment facility in September 2021.	<ul style="list-style-type: none">Reduced base flow from flow-splitting lowers water depth and increases water temperature and low-DO conditions in both alignments, and increases the frequency/duration of seasonal dewatering - a primary contributor to the fish mortality and stranding.Erosion in Post-02 and Post-03 during peak flows could degrade habitat, mobilize additional sediment downstream, and damage remaining riparian vegetation along the disc golf area.Increased mortality of resident fish and juvenile salmonids, particularly during the summer low-flow window due to compounded effects of poor water quality, predation, and shrinking refuge habitat.Reduced availability of accessible spawning substrate for salmonids and dolly varden, contributing to lower juvenile recruitment for the watershed.Restricted passage around dams within the wetland complex, potentially limiting spawning access, juvenile rearing distribution, or movement to refuge habitat.	<ul style="list-style-type: none">Supports diversity of wetland-dependent wildlife (e.g., amphibians, beavers)Flow split to wetlands may attenuate peak flows and alleviate documented issues with excessive peak flows.Allowing the channel to evolve without intervention may facilitate the re-establishment of natural channel processes.A larger wetted area contributes to wildfire and drought resilience.Increased productivity supports fish growth and overall biodiversity.Connectivity to wetland complex may provide improved refuge and overwintering habitat availability.Increased water retention and gradual release may sustain baseflows to lower reaches for longer.	<ul style="list-style-type: none">KFN<ul style="list-style-type: none">Consequences of damage to Devils Club patch or mature cedar trees is moderate (3). This location is one of few accessible patches for both plants in the Comox Valley, and both plants take a long time to establish. However, not all plants will be damaged.Access to these elements depends on the access road.Chinatown<ul style="list-style-type: none">Consequences of damage to Chinatown elements is minor (2), since the infrastructure is easily moved, repaired, replaced, or mitigated by waterproofing the base of the picnic pavilion.No. 1 Japanese Town<ul style="list-style-type: none">Consequences of damage to the No. 1 Japanese Town elements are minor (2), since there are no known community members connected to the historic site, and infrastructure associated with it is minimal.	<ul style="list-style-type: none">Consequences of damage to social elements are lower in the winter than in the spring, summer, and fall, due to increased human presence.All social elements depend on the access road.Several elements depend on the trail bridge:<ul style="list-style-type: none">Access to some of the KFN-valued plant speciesRecreational (mountain biking and hiking) trailsEcological heritage and interpretation value of the Perseverance Creek main channel.
Remove bridge and wood	<ul style="list-style-type: none">Consequence of damage to the well access is minor (2) in the winter and moderate (3) in the summer, assuming the well itself remains functional.<ul style="list-style-type: none">Consequence is increased in the summer because the well access is also the access and egress for cultural and social elements in the area.						

Table 4.6 Consequences table (mid-long term options)

Scenario (mid-long term options)	Infrastructure			Environmental		Cultural	Social
	Groundwater Well, supply main, power and communication, access	Perseverance Creek Culvert under Comox Lake Road	Comox Lake Drinking Water Supply Intake	Hazards	Benefits	KFN Values, Chinatown, Japantown	Trail Bridge, Trail Network, Disc Golf Course, Coal Creek Historic Park
Direct creek into new alignment (follow avulsion), with overflow berm for additional water to spill peak flows into existing channel	All mitigation options address the Hazard component of the Risk, not the Consequence. Consequences remain the same as the short-term options presented in Table 4.5.						
Reinstate berm (direct creek through mainstem)							
Set back berm near well							

Table 4.7 Risk table, short term options

Scenario	Infrastructure			Environmental		Cultural	Social
	Groundwater Well, supply main, power and communication, access	Perseverance Creek Culvert under Comox Lake Road	Comox Lake Drinking Water Supply Intake	Hazards	Benefits	KFN Values, Chinatown, Japantown	Trail Bridge, Trail Network, Disc Golf Course, Coal Creek Historic Park
Do-Nothing	<ul style="list-style-type: none">Risk of damage to the well, its power and communications cables, or supply main, is medium in the winter and summer. The Risk is driven by the potential for an outburst-type event at the avulsion site.Risk of surface water contamination is low in the winter and summer. The Hazard component is uncertain.Risk of impaired access to the well is medium in the winter and low in the summer.	<ul style="list-style-type: none">Risk is medium, though unaffected by the avulsion or any mitigation options presented here.	<ul style="list-style-type: none">Risk is low and unaffected by the avulsion or any mitigation options presented here, due to the new drinking water intake and treatment facility installed in September 2021.	<ul style="list-style-type: none">Risk of flow-splitting is moderate. Flow-splitting affects the entire study area and compounds an already-limiting condition.Risk of habitat degradation in the constructed channel sections is moderate. Likelihood of erosion during peak flows is high, but the consequence is tempered by the already-low existing habitat quality in these reaches.Risk of increased fish mortality is high. These mechanisms are already observed in current field conditions (e.g., poor DO and elevated temperature are documented for the wetland reaches), and act concurrently during the same critical season.Risk of spawning habitat loss is moderate. Future channel evolution is uncertain, but if flows do become concentrated in the wetland-dominated reaches, loss of the spawning substrate in the main channel would be near-certain in the short-to-mid term.Risk of impaired fish passage is moderate. Likelihood is high given beaver dams are currently present, but barrier effects are life-stage- and flow-dependent rather than absolute.	<ul style="list-style-type: none">Benefits of additional water availability to wetland complex is moderate – wetlands will benefit from increased flows, but flows will still be limited during the critical summer window.Benefits of supporting wetland-dependent species diversity are moderate – wetlands are already present, but extending the hydroperiod may have some additional benefits.Flow attenuation benefits are uncertain – depends on capacity of wetlands to hold additional water during peak flow periods.Benefits of allowing channel to evolve naturally are uncertain.Benefits of expanded wetland footprint are uncertain – footprint may be limited by topographic controls.Increased productivity and food production benefits are moderate – food production is likely not a limiting factor for fish populations, but will support a range of species.Improved overwintering habitat benefits are moderate – providing high flow refuge will be beneficial but overwintering habitat is likely not a limiting factor for fish production.Benefits of increased water retention and supplementation of baseflow are uncertain – hydroperiod response is unknown.	<ul style="list-style-type: none">Risk to KFN valued plant species is medium (M). Damage to some plants is likely but damage to all plants is not.Risk to Chinatown elements is medium (M). It is likely they will experience flooding but the Consequences of this are minor. Waterproofing the base of structures may provide an effective mitigation of this Risk.Risk to No. 1 Japanese Town elements is low (L). The Hazard is considerable but hard to predict; the Consequence is low.	<ul style="list-style-type: none">Risk to the social elements in the area ranges from low to high, depending on the exact element and time frame considered.
Remove Jam	<ul style="list-style-type: none">Risk of damage to the well, its power and communications cables, or supply main is low in the winter and medium in the summer. This is due to mitigating the Risk of an outburst-type event.Risk of surface water contamination remains low in both the winter and summer. The Hazard component of this is uncertain.Risk of impaired access to the well remains medium in the winter and low in the summer.						

Table 4.8 Risk table, mid term option 1: direct creek into new alignment

Scenario	Infrastructure			Environmental		Cultural	Social
	Groundwater Well, supply main, power and communication, access	Perseverance Creek Culvert under Comox Lake Road	Comox Lake Drinking Water Supply Intake	Hazards	Benefits	KFN Values, Chinatown, Japantown	Trail Bridge, Trail Network, Disc Golf Course, Coal Creek Historic Park
Direct creek into new alignment (follow avulsion), with overflow berm for additional water to spill peak flows into existing channel	<ul style="list-style-type: none">The Hazard of direct damage is reduced to low (2). The Consequence remains moderate (3) in winter and major (4) in summer. This results in a low Risk posed to the well and associated linear infrastructure in winter, and a medium Risk in summer.Maintaining this reduction in Risk requires maintaining the relative elevations of the sill and overflow berm, which will require regular sediment removals due to the ongoing aggradation at the site.This option leaves the Risk of surface water contamination unchanged (low)	<ul style="list-style-type: none">Risk is medium, though unaffected by the avulsion or any mitigation options presented here.	<ul style="list-style-type: none">Risk is low and unaffected by the avulsion or any mitigation options presented here, due to the new drinking water intake and treatment facility installed in September 2021.	<ul style="list-style-type: none">Risk of habitat degradation in the constructed channel sections is moderate. Likelihood of erosion during peak flows is high, but the consequence is tempered by the already-low existing habitat quality in these reaches.Risk of increased fish mortality is high. These mechanisms are already observed in current field conditions (e.g., poor DO and elevated temperature are documented for the wetland reaches), and act concurrently during the same critical season.Risk of spawning habitat loss is moderate. Future channel evolution is uncertain, but if flows do become concentrated in the wetland-dominated reaches, loss of the spawning substrate in the main channel would be near-certain in the short-to-mid term.Stranding risk due to the constructed berm creating a barrier is high, pending detailed design - fish may be cut off from upstream shale pools, which hold water longer than other parts of the channel. This risk would be reduced through fish passage considerations in detailed design of the berm. May be liability issues associated with constructing a potential fish barrier.Risk of impaired fish passage is moderate. Likelihood is high given beaver dams are currently present, but barrier effects are life-stage- and flow-dependent rather than absolute.	<ul style="list-style-type: none">Similar to Do-Nothing option, but channel will not be allowed to evolve naturallyAdditionally, this option will prevent issues caused by flow-splitting. This is of moderate benefit – low flows are a significant issue but if there continues to be no summer base flows extending the wetted period is of marginal benefit.	<ul style="list-style-type: none">Risk to KFN valued plant species is medium (M), though this option puts the Devil's Club more at Risk than the mature Cedar trees. Damage to some plants is possible but damage to all plants is not.Risk to Chinatown elements is reduced to low (L) by reducing the Hazard, though the avulsion site will require regular maintenance to maintain this lower Hazard. Waterproofing the base of structures may provide an effective mitigation of this Risk.Risk to No. 1 Japanese Town elements is low (L). The Hazard is considerable but hard to predict; the Consequence is low.	<ul style="list-style-type: none">This option reduces Risk to the social elements in the avulsion channel and downstream of it by controlling the flow split, though will require regular maintenance.If the trail bridge is reinstated upstream of the infrastructure, it will remain at high Risk because the Hazard posed to it remains unchanged. If it is located downstream the Hazard would be reduced.

Table 4.9 Risk table, mid term option 2: reinstate berm

Scenario	Infrastructure			Environmental		Cultural	Social
	Groundwater Well, supply main, power and communication, access	Perseverance Creek Culvert under Comox Lake Road	Comox Lake Drinking Water Supply Intake	Hazards	Benefits	KFN Values, Chinatown, Japantown	Trail Bridge, Trail Network, Disc Golf Course, Coal Creek Historic Park
Reinstate berm (direct creek through mainstem)	<ul style="list-style-type: none">Risk posed to the well and associated linear infrastructure is reduced to low by reducing the Hazard, though like the previous mitigation option will require regular sediment removals due to the ongoing aggradation at the site.This option would maintain a low Risk of surface water contamination, equivalent to pre-avulsion conditions. The Hazard for contamination associated with other mitigation options is very uncertain.	<ul style="list-style-type: none">Risk is medium, though unaffected by the avulsion or any mitigation options presented here.	<ul style="list-style-type: none">Risk is low and unaffected by the avulsion or any mitigation options presented here, due to the new drinking water intake and treatment facility installed in September 2021.	<ul style="list-style-type: none">Risk of fish stranding is high - this is not a new condition but a documented, recurring feature of the pre-avulsion channel, so likelihood is effectively certain based on prior observation.Risk of continued channel degradation is high. Likelihood is effectively certain given this reflects an already-documented, ongoing trajectory.Risks of continued riparian forest degradation is moderate. Likelihood is effectively certain, consistent with the same documented, ongoing aggradation and bank erosion trajectory noted above, but vegetation communities are resilient and will likely adapt.Risks of engaging in invasive intervention are high – sets a precedent for highly engineered approaches to environmental management in the Forest, Village takes on liability for the new berm if a Water License is obtained.Risk of habitat disturbance from ongoing maintenance is moderate - likelihood is certain, but impacts are limited to a confined area already impacted by recreational activity and past land use.Risk of reduced fire resiliency is low — reverting to the mainstem-only alignment may reduce wetland hydroperiod and/or extent relative to current conditions, but fire resiliency depends on broader watershed/regional fire risk factors beyond this reach alone.Risk of reduced species richness and productivity is low. Directly linking hydrological to diversity and productivity changes is challenging, and the existing wetland extent will continue to support biodiversity and productivity.	<ul style="list-style-type: none">Maintaining existing spawning habitat is of moderate benefit – existing habitat quality is poor-moderate and other suitable habitat is present in the lower watershed.Keeping channel alignment in existing riparian forest is of high benefit – excellent riparian habitat leads to better thermal regimes for fish when water is present.Fewer barriers to fish migration is of moderate-to-high benefit. Beaver dams are documented along the avulsion alignment, though their barrier effect is unknown. Native fish have coevolved with beavers and beaver dams often allow for passage during certain flow conditions.	<ul style="list-style-type: none">Risk to KFN valued plant species is medium (M), though this option puts the mature Cedars at greater Risk than the Devil’s Club. Damage to some plants is likely but damage to all plants is not.Risk to Chinatown elements is reduced to low (L) by reducing the Hazard, though the avulsion site will require regular maintenance to maintain this lower Hazard. Waterproofing bases of the structures would provide mitigation but is less important for this option compared to the previous one.Risk to No. 1 Japanese Town elements is low (L). The Hazard is considerable but hard to predict; the Consequence is low	<ul style="list-style-type: none">This option reduces Risk to the social elements in the avulsion channel and downstream of it by preventing flow towards them, though will require regular maintenance.Reducing the Risk posed to the trail bridge will also require regular sediment removals to maintain enough elevation between it and the channel bed for wood to pass under without jamming.

Table 4.10 Risk table, mid term option 3: setback berm

Scenario	Infrastructure			Environmental		Cultural	Social
	Groundwater Well, supply main, power and communication, access	Perseverance Creek Culvert under Comox Lake Road	Comox Lake Drinking Water Supply Intake	Hazards	Benefits	KFN Values, Chinatown, Japantown	Trail Bridge, Trail Network, Disc Golf Course, Coal Creek Historic Park
Set back berm near well	<ul style="list-style-type: none">Risk of direct damage is reduced to low (L) by reducing the Hazard to negligible (1). Regular maintenance is unlikely relative to the first two mid-term mitigation options.Risk of potential surface water contamination remains low (L) – the same as baseline conditions and mitigation option 1.	<ul style="list-style-type: none">Risk is medium, though unaffected by the avulsion or any mitigation options presented here.	<ul style="list-style-type: none">Risk is low and unaffected by the avulsion or any mitigation options presented here, due to the new drinking water intake and treatment facility installed in September 2021.	Same as do-nothing option	Same as do-nothing option, plus additional benefits associated with wetland/riparian restoration if incorporated	<ul style="list-style-type: none">Risk to KFN valued plant species is medium (M). Damage to some plants is likely but damage to all plants is not.Risk to Chinatown elements is reduced to low (L) by reducing the Hazard. Waterproofing bases of the structures would provide mitigation if the access road is not raised as part of the setback berm construction.Risk to No. 1 Japanese Town elements is low (L). The Hazard is considerable but hard to predict; the Consequence is low	<ul style="list-style-type: none">This option poses a Risk to the social elements in the avulsion channel and downstream of it because of the natural channel migration anticipated to occur on the fan. The extent of damage is hard to predict but some adjustment, repair, and maintenance will be necessary.If the trail bridge is replaced at the same elevation and location, the Hazard and reulsting Risk posed to it remains unchanged.

5 ASSUMPTIONS AND LIMITATIONS

Our assessment includes the following assumptions:

- LiDAR data show an accurate representation of relative elevations within the study area
- Hydrometric and precipitation data have been collected in a consistent manner over the period of record examined.
- Drawings of the drinking water supply well, supply main, and power and communications lines match the as-built conditions
- The aquifer the drinking water supply well pulls from is confined between the well and avulsion site.

Our assessment holds the following limitations:

- This assessment is mostly qualitative due to the complexity and resulting uncertainty of the avulsion channel processes. As such, we have estimated Hazard, Consequence, and Risk values for each element based on how they compare to other elements, rather than according to an absolute scale.
- This assessment is based on the hydrology and geomorphology of Perseverance Creek. However, the planned No. 2 Dam and Henderson Lake Dam upgrades may result in Cumberland Creek playing a larger role in the geomorphology and hydrology at the avulsion site and on the fan, which could change the Risk to downstream elements. This assessment did not investigate Cumberland Creek.
- From an environmental perspective, the abbreviated timeline precludes a fulsome assessment of conditions. The timing of the avulsion event (mid-winter) means specifics such as fish and other species distribution, habitat inundation, aquifer recharge, etc., does not represent a full seasonal cycle.
- If the new alignment of Perseverance Creek reduces the capacity of the wetlands or downstream reaches to attenuate additional flow from planned development north of Comox Lake Road, drainage plans for that development may need to be reconsidered. This possibility has not been assessed in the current Risk Assessment.

6 RECOMMENDATIONS

In the short term, we recommend the VoC:

- Remove the trail bridge and log jam
- Work with CCFS, UROC, and other key interest parties to determine what level of bridge repair and trail maintenance is appropriate given the available funding, uncertainty in the avulsion channel evolution, and fall and winter recreational use.
- Conduct a danger tree assessment in the area around the trail bridge, and where trail reconstruction may occur.
 - If culturally significant trees need to be felled, check with KFN if there is an appropriate time window for falling that allows for cultural use of the tree.
- Install water level sensors in the wetlands adjacent to the access road (one on each side) and survey them relative to the access road. This would measure the duration and depth of flooding on the access road, which would help establish whether raising the road is necessary, and if so, how high it should be raised. Installing one on each side of the road could help inform whether additional structures (culverts or boardwalks) should be installed under the road.
- Continue to support the CVRD's operation of the hydrometric gauge at Davis Lake Main, targeting high flow discharge measurements to better inform engineering design for structures downstream.
 - Once high flow discharge measurements have been obtained and before the design work commences, conduct a cumulative review of all hydrometric data from this station, so discharges are as accurate and consistent as possible.
 - Cross reference modelled discharges for the dam upgrades with corrected data from the hydrometric station to better inform engineering for both the dam upgrades and avulsion response construction.
- Collect photographs of the avulsion area during and after high flow events, to document how it evolves.

In the mid-term we recommend:

- Construct a set-back berm in the disc golf area to protect the well and access road while allowing the creek to migrate naturally across the rest of the fan.
 - Berm design would require hydraulic modelling based on the corrected hydrometric data. Topographic survey and additional Lidar survey may be required.
 - Consider combining this with a riparian and wetland restoration (e.g., converting the disc-golf gravel area back to a treed swamp), which could significantly improve shading,

water quality, and habitat complexity. This may also help contain and slow peak-flow events.

- Undertake a watershed geomorphology assessment to determine the potential effects of routing flow down Cumberland Creek instead of Perseverance Creek, if that remains the plan with the No. 2 Dam upgrades.
 - The main focus of this assessment would be to examine the relative sediment supply in Perseverance Creek versus Cumberland Creek, to determine what effects this would have on both the elements considered in this assessment as well as habitat further downstream in Perseverance Creek.
 - If routing flow down Cumberland Creek could reverse sediment aggradation in lower Perseverance Creek, this may favor mitigation options that maintain more flow in Perseverance Creek for long term ecological objectives.
 - This study would review any dam breach studies undertaken on the system and incorporate their results into the assessment as relevant.
- Complete targeted habitat assessment works through a full year.
 - Fish presence sampling in both reaches.
 - Water quality sampling in wetland areas.
 - Hydroperiod of wetted habitats in both reaches.
 - Monitor baseflows – compare to previous years if possible.
 - Collaborate with the Perseverance Creek Streamkeepers.

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CLOSURE

We appreciate this opportunity to study the January 30, 2026 avulsion on Perseverance Creek and its associated Risks. Please feel free to reach out to any of us with additional questions or concerns.

APPENDIX A

ANIMAL OCCURRENCES IN THE STUDY AREA

Common Name	Scientific Name	BC Status	SARA Status
Fish			
Coho salmon	<i>Oncorhynchus kisutch</i>	Yellow	N/a
Coastal cutthroat trout	<i>Oncorhynchus clarkii clarkii</i>	Yellow	N/a
Coastrange sculpin	<i>Cottus aleuticus</i>	Yellow	N/a
Dolly Varden	<i>Salvelinus malma</i>	Yellow	N/a
Rainbow trout (resident and anadromous)	<i>Oncorhynchus mykiss</i>	Yellow	N/a
Three-spined stickleback	<i>Gasterosteus aculeatus</i>	Yellow	N/a
Amphibians			
American bullfrog	<i>Lithobates catesbeianus</i>	Invasive	N/a
Northern red-legged frog	<i>Rana aurora</i>	Blue	Special Concern
Pacific tree frog	<i>Pseudacris regilla</i>	Yellow	N/a
Western toad	<i>Anaxyrus boreas</i>	Yellow	Special Concern
Mammals			
American beaver	<i>Castor canadensis</i>	Yellow	N/a
American black bear	<i>Ursus americanus</i>	Yellow	N/a
Common raccoon	<i>Procyon lotor</i>	Yellow	N/a
Reptiles			
Common garter snake	<i>Thamnophis sirtalis</i>	Yellow	N/a
Northwestern garter snake	<i>Thamnophis ordinoides</i>	Yellow	N/a
Puget Sound garter snake	<i>Thamnophis sirtalis pickeringii</i>	Yellow	N/a
Birds			
American Coot	<i>Fulica americana</i>	Yellow	N/a
American Goldfinch	<i>Spinus tristis</i>	Yellow	N/a
American Robin	<i>Turdus migratorius</i>	Yellow	N/a
Anna's Hummingbird	<i>Calypte anna</i>	Yellow	N/a
Audubon's Warbler	<i>Setophaga coronata auduboni</i>	Yellow	N/a
Bald Eagle	<i>Haliaeetus leucocephalus</i>	Yellow	N/a
Band-tailed Pigeon	<i>Patagioenas fasciata</i>	Blue	Special Concern
Barred Owl	<i>Strix varia</i>	Yellow	N/a
Belted Kingfisher	<i>Megasceryle alcyon</i>	Yellow	N/a

Black-headed Grosbeak	<i>Pheucticus melanocephalus</i>	Yellow	N/a
Black-throated Gray Warbler	<i>Setophaga nigrescens</i>	Yellow	N/a
Bufflehead	<i>Bucephala albeola</i>	Yellow	N/a
Canada Goose	<i>Branta canadensis</i>	Yellow	N/a
Common Goldeneye	<i>Bucephala clangula</i>	Yellow	N/a
Common Raven	<i>Corvus corax</i>	Yellow	N/a
Common Yellowthroat	<i>Geothlypis trichas</i>	Yellow	N/a
Dark-eyed Junco	<i>Junco hyemalis</i>	Yellow	N/a
Downy Woodpecker	<i>Dryobates pubescens</i>	Yellow	N/a
Fox Sparrow	<i>Passerella iliaca</i>	Yellow	N/a
Golden-crowned Kinglet	<i>Regulus satrapa</i>	Yellow	N/a
Hairy Woodpecker	<i>Dryobates villosus</i>	Yellow	N/a
Hammond's Flycatcher	<i>Empidonax hammondi</i>	Yellow	N/a
Hermit Thrush	<i>Catharus guttatus</i>	Yellow	N/a
Hooded Merganser	<i>Lophodytes cucullatus</i>	Yellow	N/a
Mallard	<i>Anas platyrhynchos</i>	Yellow	N/a
Northern Flicker	<i>Colaptes auratus</i>	Yellow	N/a
Northern Yellow Warbler	<i>Setophaga petechia</i>	Yellow	N/a
Orange-crowned Warbler	<i>Leiothlypis celata</i>	Yellow	N/a
Pacific Wren	<i>Troglodytes pacificus</i>	Yellow	N/a
Pine Siskin	<i>Spinus pinus</i>	Yellow	N/a
Purple Finch	<i>Haemorhous purpureus</i>	Yellow	N/a
Red Crossbill	<i>Loxia curvirostra</i>	Yellow	N/a
Red-breasted Nuthatch	<i>Sitta canadensis</i>	Yellow	N/a
Red-breasted Sapsucker	<i>Sphyrapicus ruber</i>	Yellow	N/a
Red-winged Blackbird	<i>Agelaius phoeniceus</i>	Yellow	N/a
Ring-necked Duck	<i>Aythya collaris</i>	Yellow	N/a
Ruby-crowned Kinglet	<i>Corthylio calendula</i>	Yellow	N/a
Song Sparrow	<i>Melospiza melodia</i>	Yellow	N/a
Spotted Towhee	<i>Pipilo maculatus</i>	Yellow	N/a
Turkey Vulture	<i>Cathartes aura</i>	Yellow	N/a
Varied Thrush	<i>Ixoreus naevius</i>	Yellow	N/a
Violet-green Swallow	<i>Tachycineta thalassina</i>	Yellow	N/a
Western Warbling Vireo	<i>Vireo gilvus</i>	Yellow	N/a
Wood Duck	<i>Aix sponsa</i>	Yellow	N/a
Yellow-rumped Warbler	<i>Setophaga coronata</i>	Yellow	N/a

APPENDIX B

HISTORICAL AIR PHOTOS

1929 Air Photo



1931 Air Photo



1946 Air Photo



1980 Air Photo



1991 Air Photo

