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Upper Cheslatta River
Fish Stranding Hydrologic Assessment

Prepared for: Cheslatta Carrier Nation and the Nechako Environmental Enhancement Fund
Attn: Cody Reid – Interim Natural Resources Manager
Board of Directors – Nechako Environmental Enhancement Fund

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Signature Page

Noot'senay Consulting LP is pleased to submit this report for your review. This report has been prepared using sound technical and professional judgement, based on our knowledge and experience, applicable regulatory framework, industry best management practices, and current understanding of project conditions, design, and project setting.

Report Title:	Upper Cheslatta River, Fish Stranding Hydrologic Assessment
Prepared For:	Cheslatta Carrier Nation and the Nechako Environmental Enhancement Fund
Revision:	0

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[1] Editorial Review: Reviewed for formatting, grammar, spelling, etc.
Professional Review: Reviewed for content and professional signoff
Client Review: Reviewed by client
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We do not represent, warrant, undertake or guarantee:

- That all project environmental-related information has been received.
- That regulations and standards of practices shall remain constant through the duration of the project.
- That the use of guidance in the report will lead to any particular outcome or result; or, in particular,
- That by using the guidance in the report, the client will be approved by the contract holder for the applied works.
- That site conditions will remain constant or true to survey data. Rivers, side channels and gravel bars are dynamic systems that undergo regular change.

Special Thanks

Noot'senay Consulting Limited Partnership gratefully acknowledges this project was made possible through the financial support provided by the Cheslatta Carrier Nation and the Nechako Environmental Enhancement Fund, including the program supporters Rio Tinto and the Province of British Columbia.

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1.0 INTRODUCTION

1.1 BACKGROUND

DWB Consulting Services Ltd. (DWB) was engaged by the Cheslatta Carrier Nation to assess fish stranding incidents along Cheslatta River, located between Skins Lake and Cheslatta Lake (Figure 1). Previous works and environmental assessments by DWB identified four key locations presently at the highest risk of recurring fish stranding. Detailed location information for the study sites is provided in Table 1.

The primary objective of this assessment is to qualitatively evaluate the extent of fish stranding caused by the fluctuations of discharge from the Skins Lake Spillway (SLS). This study aims to investigate and document areas within the specified river section that have been identified as high-risk to fish stranding. It also seeks to assess the current fish stranding conditions under the existing reservoir operations and explore potential mitigation measures for the Nechako Reservoir.

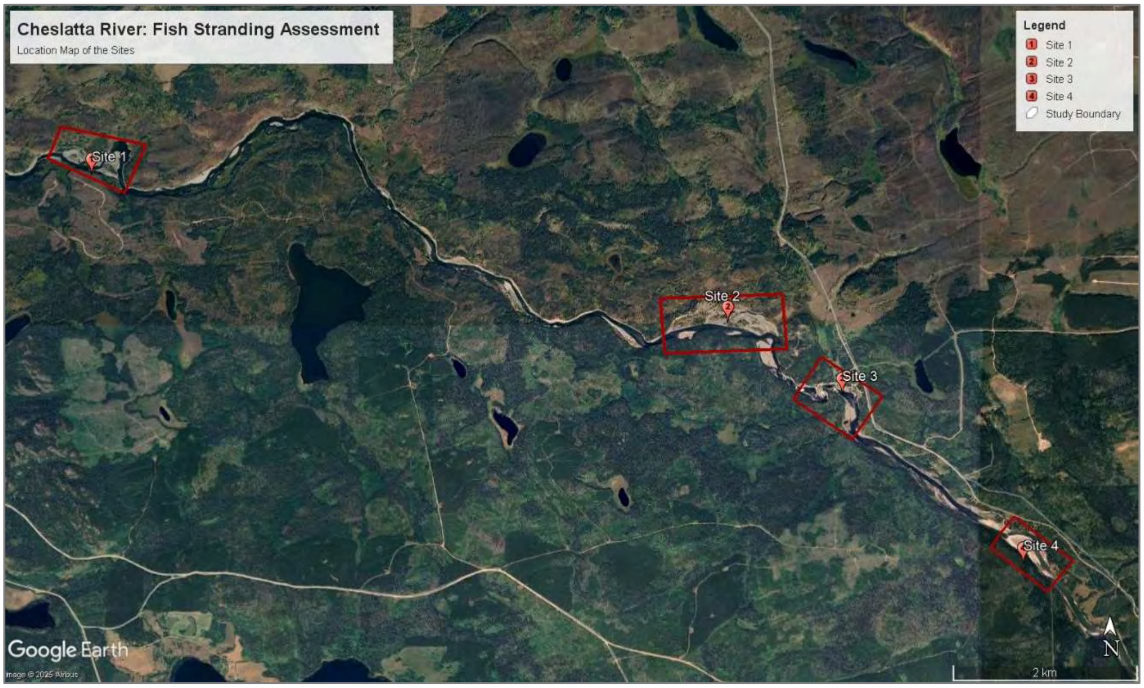

Figure 1: Study Sites' Locations (Google Earth, 2025)

Table 1: Location of the Cheslatta River Fish Stranding Study Sites

Site No.	Location		Drainage Area (km^2)	Approximate Elevation (m)
	Lat (N)	Long (W)		
1	53°46'58.4"	125°52'15.0"	4263	820
2	53°46'07.7"	125°46'04.0"	4330	820
3	53°45'43.0"	125°44'57.1"	4372	800
4	53°44'44.5"	125°43'11.6"	4390	800

The site topography surveys were collected throughout 2023 and 2024, covering the majority of the River section with a combination of ground RTK and UAV-based LiDAR. These surveys have been processed and corrected for vegetation and water, and used in the modelling presented in this report. Survey and ground assessment from the Engineering field staff both confirmed the findings presented in the *Upper Cheslatta River, Fish Stranding Assessment – Year 1* (DWB. Apr 2024). This biological assessment of the span of the river between Skins Lake and Cheslatta Lake identified 58 isolated pools of water, mostly throughout side channels, 75% of which had stranded fish present.

1.2 OBJECTIVE OF ASSESSMENT

The primary objective of the assessment is to provide a hydrotechnical analysis of the Upper Cheslatta River and qualitatively evaluate the extent of fish stranding caused by the annual high discharge periods from the Skins Lake Spillway (SLS). The specific objectives include:

- Conduct thorough hydrologic assessment and hydrology characterizing of the Cheslatta River between Skins Lake Spillway and Cheslatta Lake.
- Perform survey and assessment of identified key areas of concern for potential fish stranding in pools at sites along this reach of the Cheslatta River.
- Perform hydraulic modelling of key areas of concern, assessing impacts of high and low flow conditions, as well as impacts from Skins Lake Spillway.
- Assessing potential mitigation options and presenting initial concept-level steps for future consideration in restoring and protecting critical fish habitat and mitigating the risk of repeat stranding.
- Complement previous and tandem environmental reporting and studies with technical river engineering insights and inform subsequent design processes.

Key reports that this hydrologic assessment builds upon and references are:

- *Upper Cheslatta River, Ungulate Habitat Assessment – Fall 2024* (DWB. Feb 2025)
- *Upper Cheslatta River, Fish Stranding Assessment – Year 1* (DWB. Apr 2024)

2.0 HYDROLOGICAL ANALYSIS

2.1 CATCHMENT AREA AND HYDRO STATIONS

The location of the Cheslatta River Fish Stranding Study sites and the corresponding catchment areas are 4,263km^2, 4,330km^2, 4,372km^2, and 4,390 km^2 for Sites 1, 2, 3, and 4 respectively (as presented in Table 1). The catchment area of the sites (as shown in Figure 2) were delineated using iMapBC (iMapBC, 2025). The highest elevation of the catchment area reaches 2,080m, while the lowest point at the site is approximately 800m above mean sea level. The catchment has an average gradient of about 1.0% and is primarily covered by mature forest, water bodies and high mountains. According to the BC Soil Map (BC Soil Tool, 2025), the majority of the region is characterized by type A and B hydrologic group soils, indicating predominantly moderately to well-drained soil types within the catchment.

The regional hydrological analysis was conducted considering three regional stations: 08JA002 (Oosta River at Ootsa Lake), 08JA013 (Skins Lake Spillway, Nechako Reservoir), and 08JA017 (Nechako River below Cheslatta Falls). These stations are marked with red circles in Figure 2 and other details of these stations are presented in Table 2. The historical hydrological data for these stations is obtained from the Water Office, Government of Canada (WSC, 2025). Stations were selected for their relative location, catchment size and characteristics.

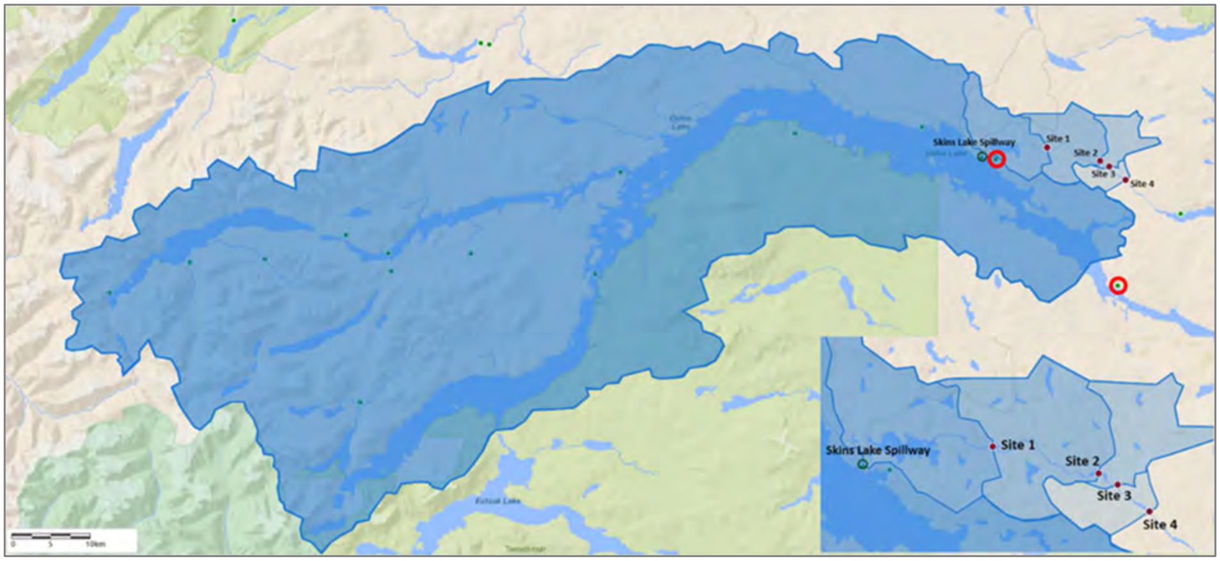

Figure 2: Catchment Area of the Cheslatta River Fish Stranding Study Sites (iMapBC, 2025)

Table 2: Location of the Regional Stations and Hydro Data Status

Station No.	Location			Drainage Area (km^2)	Data Period	Regulation Type
	River	Lat (N)	Long (W)			
08JA002	Cheslatta	53°37’30”	125°44’00”	4450	1929-1952	Natural
08JA013	Cheslatta	53°46’15”	125°58’14”	4187	1955-2019	Regulated
08JA017	Nechako	53°41’07”	124°50’21”	15500	1980-2024	Regulated

2.2 CLIMATE CHANGE ANALYSIS

According to IDF CC Tool 7.0 (UWO, 2025) for high flows distribution, the catchment areas are expected to experience an average increase of about 24% in precipitation and intensity duration frequency (IDF) from 2015 to 2100 under IPCC SSP5.85 scenarios. This analysis employs Gumbel distribution techniques, resulting in percentage increases of 18.0%, 20.9%, 23.0%, 24.2%, 24.5%, 25.3%, and 25.9% for return periods of 2, 5, 10, 20, 25, 50, and 100 years, respectively. Based on these findings, the increase in precipitation and IDF for the 200-year return period is extrapolated to estimate design flows. This was compared to and selected over the Plan2Adapt report (PCIC, 2025), which indicated an annual increase in precipitation of approximately 17.3% in the Bulkley-Nechako region. The seasonal changes in precipitation reported were approximately +21.1% in winter, +15.5% in spring, -2.4% in summer, and +23.3% in fall.

2.3 HYDROLOGY OF SKINS LAKE SPILLWAY (SLS) AND FLOW RAMPING STRATEGY

2.3.1 Mean Monthly Spillway Discharge

The Skins Lake Spillway, located along Ootsa Lake Road in British Columbia, Canada, is a critical component of the Skins Lake Hydroelectric Project. Managed by Rio Tinto, the spillway regulates the water flow from Skins Lake, also known as the Nechako or Ootsa Lake Reservoir, which is impounded by the Skins Lake Dam. According to the delineation from iMapBC (iMapBC, 2025), the catchment area upstream of the Skins Lake Spillway encompasses approximately 4,188km^2.

Data regarding the spillway discharge, encompassing both actual and planned figures, was sourced from Rio Tinto BC Works (RioTinto, 2025). This dataset spans a comprehensive 35-year period from 1990 to 2024. To ensure the accuracy of this information, a comparison was made with the spillway data from the Water Office’s hydro station 08JA013 (WSC, 2025), revealing identical results. However, the Water Office's data is only accessible up to 2019. Consequently, the analysis of the spillway relied on the Rio Tinto data to incorporate the most up-to-date information.

Based on the daily data received the planned minimum releases that must be maintained are as follows: 14.2m^3/s from August 20th to September 1st, 32m^3/s from September 2nd to April 21st, 49m^3/s from April 22nd to July 10th, and 170m^3/s from July 11th to August 19th each year. Table 3 and Figure 3 illustrate the mean monthly actual and planned spillway discharges from the dam. Notably, the data highlights that the actual release from the dam surpasses the planned minimum release required to be maintained throughout the year. This may reflect adjustments made to manage seasonal inflows, reservoir levels, or downstream ecological requirements.

Table 3: Mean Monthly Spillway Discharge from the Skins Lake Dam

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Skins Lake Spillway Discharge (m^3/s)	Actual	41	39	41	63	83	113	209	138	39	60	48	43	76
	Planned	32	32	32	37	49	49	131	110	31	32	32	32	50

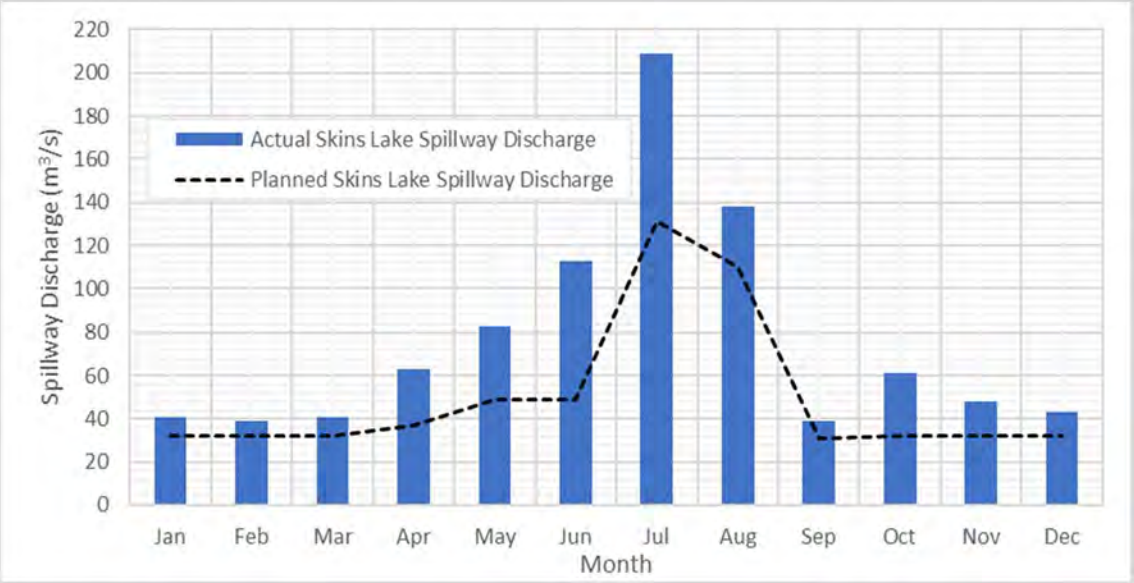

Figure 3: Mean Monthly Spillway Discharge from the Skins Lake Dam

2.3.2 Mean Daily Spillway Discharge

The analysis of Skins Lake Spillway flows (RioTinto, 2025) from 1990 to 2024 highlights the variability in discharge relative to the planned flow release (Figure 4), which is an integral component of the ramping plan for the Kenney Dam operation. The ramping plan aims to manage flow changes gradually, ensuring ecological stability downstream, particularly in the Nechako River system.

During the analyzed period, actual daily flows often exceeded the planned flow release. The daily maximum flow reached 599.7m³/s (equivalent to a ~Q50 discharge event), significantly surpassing the planned maximum of 170m³/s. The average actual flow was 76.9m³/s compared to the planned average of 50.2m³/s. This indicates that spillway releases were generally higher, likely influenced by operational decisions to manage excess water during high inflow periods, mitigate flood risks, or meet downstream ecological or hydrological needs.

However, there were 183 days during which actual flows dropped below the minimum planned flow of 14.2m³/s. Such deviations could disrupt downstream ecosystems, particularly during critical periods for fish habitats, as low flows can increase the risk of fish stranding or reduce habitat availability. These deviations highlight potential challenges in aligning operational needs, such as reservoir filling, level management and hydropower requirements, with ecological objectives outlined in the ramping plan.

This data emphasizes the importance of refining the ramping plan to better balance water releases with natural flow patterns, minimizing abrupt fluctuations and maintaining a stable flow regime. Improvements could include stricter adherence to minimum flow thresholds, enhanced forecasting models for inflow management, and collaboration with stakeholders to address ecological and operational priorities.

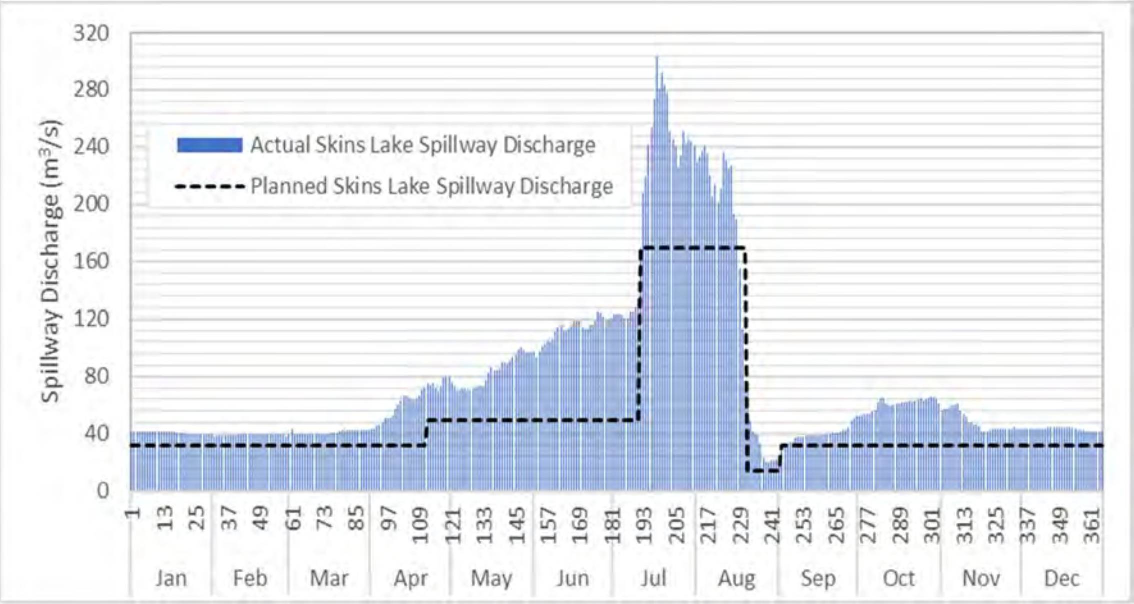

Figure 4: Mean Daily Spillway Discharge from the Skins Lake Dam

2.3.3 Mean Daily Natural Discharge at the Spillway

The mean daily natural discharge at the Skins Lake Spillway location was estimated using the catchment correlation method, based on historical daily flow records from 1930 to 1952 obtained from the regional hydrometric station 08JA002 (WSC, 2025). Data collection at this station was discontinued after 1952 due to the commencement of operations at the Skins Lake Spillway, which subsequently altered the natural flow regime downstream.

A comparative analysis between the estimated natural daily mean discharge and the actual (regulated) measured discharge following spillway operations is presented in Figure 5. The figure also includes the upper and lower bounds of the natural discharge, corresponding to the 75th and 25th percentiles. As this graph is a representative comparison of natural vs regulated flow regimes, it does not include climate change factors or predictive models.

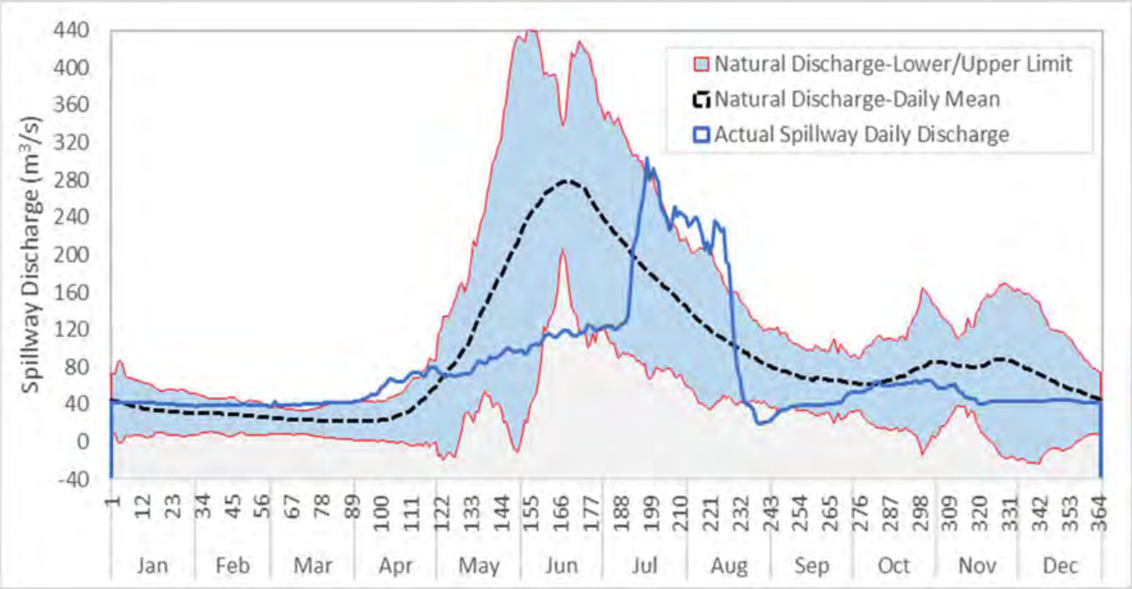

Figure 5: Actual/Regulated and Natural Daily Mean Discharge at the Spillway Location

The comparison indicates that peak natural flows typically occur between mid-May and mid-July, whereas maximum spillway discharges are observed between mid-July and mid-August. This shift suggests that high natural inflows are retained within the reservoir during the early high-flow season, with releases occurring later once the reservoir has reached its maximum or desired operational storage capacity.

Along with the shift in peak timing, there is also a considerable alteration in the average spring and fall ramping periods. The historic flows, as well as current flow from other systems compared have an average 4-week long spring ramp up and an 8-week ramp down after freshet. This is in direct contrast to regulated flows which ramp up and down within 1-2 week periods. The planned discharge does not include fall increases to flow, however, discharge records show that increased discharge does occur in the fall

It should be noted, however, that the time periods for the natural and regulated discharge analyses differ. As described earlier, the natural discharge estimates are based on the 1930–1952 period, while the actual (regulated) discharge data covers the 1990–2024 period.

2.3.4 Frequency Analysis of Spillway Flows

The analysis of high and low flow events at the Skins Lake Spillway was conducted using annual maximum and minimum spillway flow data, recorded daily from 1991 to 2024 (RioTinto, 2025). This extensive dataset provides a solid foundation for estimating the frequency and magnitude of both high and low flows. The findings, which include high-flow events for various return periods summarized in Table 4 and low-flow events in Table 5, offer valuable insights for effective water resource management and infrastructure resilience planning. The flow rates for different recurrence intervals are essential for understanding and mitigating the impacts of extreme hydrological events.

Table 4: High Spillway Flows from the Skins Lake Dam

	Return Period (Year)							
	200	100	50	25	20	10	5	2
High Flows (m³/s)	623	600	577	553	543	518	489	437

Table 5: Low Spillway Flows from the Skins Lake Dam

Return Period (Year)	**Low Flows (m³/s)**						
	1 day	**3 days**	**5 days**	**7 days**	**10 days**	**15 days**	**30 days**
200	9.30	9.39	9.58	9.53	9.51	9.73	17.24
100	9.68	9.69	9.88	9.84	9.83	10.14	17.70
50	10.11	10.06	10.25	10.22	10.22	10.65	18.25
20	10.79	10.70	10.90	10.88	10.90	11.56	19.19
10	11.47	11.38	11.59	11.60	11.65	12.54	20.17
2	14.75	15.37	15.59	15.75	15.94	17.97	25.25

2.4 EXTREME FLOW EVENTS

2.4.1 High Flow Events

The catchment correlation method was used to transfer flows from regional stations to the study sites. Due to the lack of reliable sources directly accounting for the impact of climate change on river flows, the percentage change in precipitation and IDF is directly applied to estimate flows at the site. Considering the flow regulation at the Skins Lake Dam (RioTinto, 2025), high flows were determined separately for the downstream locations of the dam and then added to the Skins Lake Spillway high flows to obtain total high flows at the study sites. Table 6 and Table 7 present the estimated extreme and peak flows at the study sites under historical and predictive climate change scenarios, with corresponding plots in Figure 6 and Figure 7 respectively.

Table 6: Historic High Flows at the Cheslatta River Fish Stranding Study Sites

Return Period (Year)	Historic Extreme Flows (m³/s)				Historic Peak Flows (m³/s)			
	Site 1	Site 2	Site 3	Site 4	Site 1	Site 2	Site 3	Site 4
200	648	663	672	675	661	687	702	709
100	623	637	645	649	635	659	672	678
50	598	611	619	622	609	630	642	647
20	563	574	581	583	571	589	599	603
10	536	547	553	555	543	559	568	571
2	451	458	462	464	454	464	469	471

Table 7: Predicted High Flows at the Cheslatta River Fish Stranding Study Sites

Return Period (Year)	Predictive Extreme Flows (m^3/s)				Predictive Peak Flows (m^3/s)			
	Site 1	Site 2	Site 3	Site 4	Site 1	Site 2	Site 3	Site 4
200	654	673	684	689	671	704	723	731
100	629	647	657	661	644	674	691	698
50	604	620	629	633	617	643	658	665
20	567	582	590	593	578	600	613	618
10	541	553	560	563	549	568	579	583
2	454	462	466	468	457	469	475	478

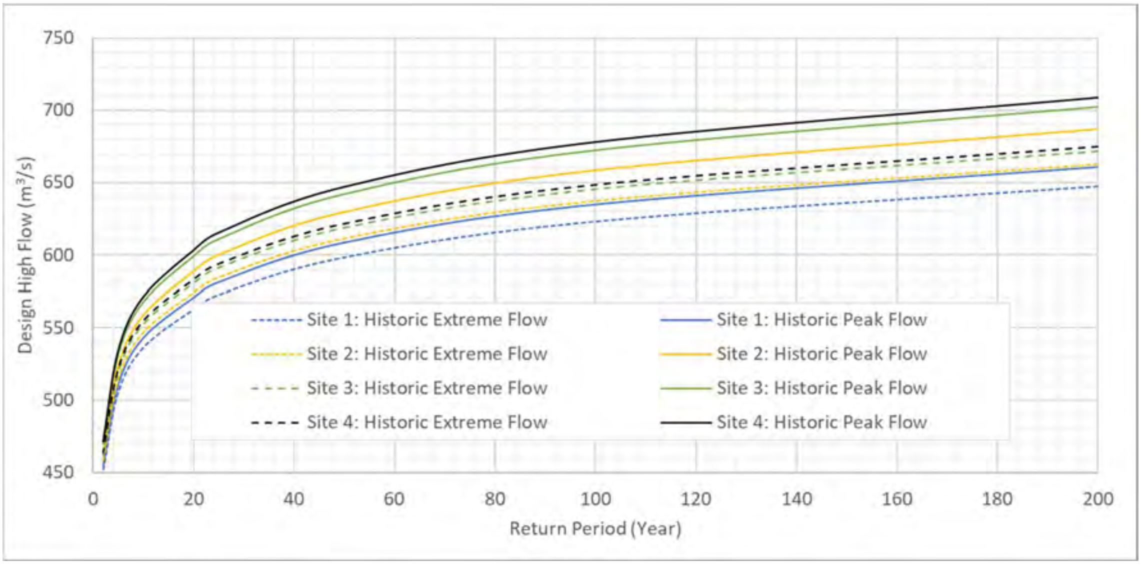

Figure 6: Comparison of Historic Flows at Cheslatta River Fish Stranding Sites

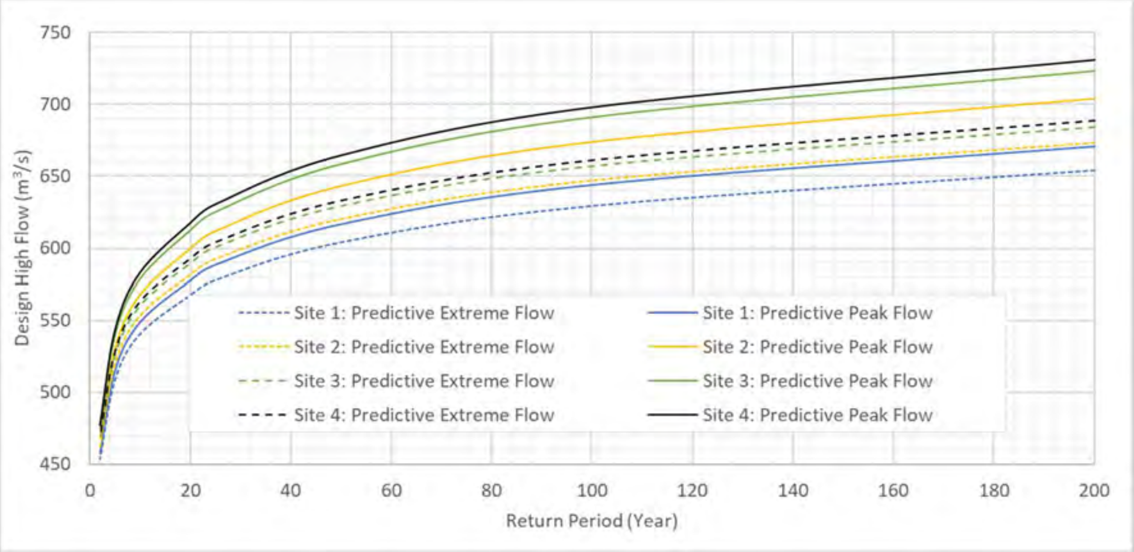

Figure 7: Comparison of Predictive Flows at Cheslatta River Fish Stranding Sites

2.4.2 Low Flow Events

Extreme low flow data for all sites was derived from daily flow records at nearby stations. These historical records provided essential information for analyzing and estimating extreme low flow conditions in the region. Statistical methods, including Log Pearson III and Log-Normal distributions, were applied to the observed daily flows using the Hydrologic Engineering Center's Statistical Software Program (HecSSP). Low flow analysis was conducted for accumulated flow periods ranging from 1 to 30 days, with return periods from 2 to 200 years (see Table 8 and Figure 8).

To validate the HECSSP results, 1-day accumulated low flows were graphically derived from observed extreme flow data at regional stations. Because there was limited peak low flow data available, these values were estimated to be 99% of the corresponding extreme low flows. This estimation was based on the ratio of recorded extreme low flows to peak low flows at the regional stations.

Table 8: Estimated Low Flows for Four Sites

Site	Return Period (Year)	Peak Low Flows (m^{3}s)						
		1 day	3 days	5 days	7 days	10 days	15 days	30 days
1	20	13.0	13.3	12.9	12.8	13.1	13.1	14.4
	10	14.0	14.2	13.9	13.8	14.0	14.1	15.2
	2	18.3	18.5	18.6	18.8	18.6	18.9	19.5
2	20	12.8	13.1	12.9	12.7	13.2	13.8	22.8
	10	13.9	14.0	13.9	13.9	14.1	15.1	24.0
	2	18.3	19.2	19.5	19.9	19.9	22.3	30.3
3	20	12.8	13.0	12.9	12.7	13.1	13.8	22.8
	10	13.9	14.0	13.9	13.8	14.1	15.1	24.0
	2	18.3	19.2	19.5	19.9	19.9	22.3	30.4
4	20	12.8	13.0	12.8	12.7	13.1	13.8	22.8
	10	13.9	14.0	13.9	13.8	14.1	15.1	24.0
	2	18.4	19.2	19.5	19.9	19.9	22.3	30.4

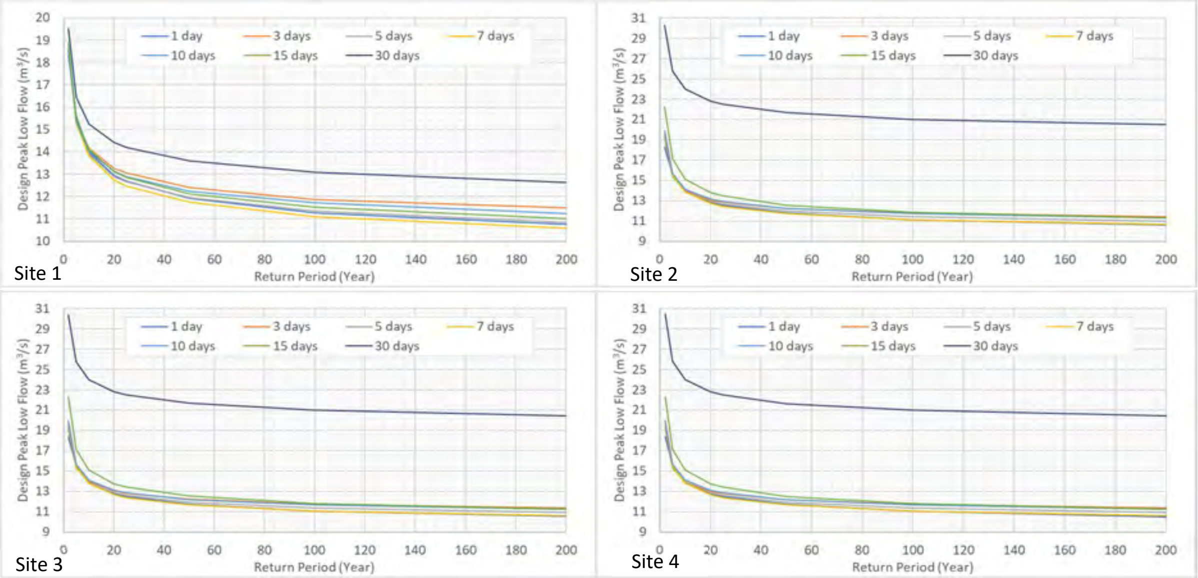

Figure 8: Plot of Estimated Low Flows for Four Sites

3.0 FLOOD AND DROUGHT MAPPING

3.1 FLOOD MAPPING RESULTS

The HECRAS model simulations (USACE, 2025) provided critical insights into the inundation characteristics for four study sites under a 200-year return period, with the analyses accounting for potential climate change impacts. The results highlight variations in flow velocities and inundation depths influenced by channel gradients, which are key parameters affecting hydraulic behaviour and floodplain dynamics.

3.1.1 Site 1: Flood Mapping

The simulations for Site 1, characterized by a channel gradient of ~0.21%, revealed flow velocities ranging from 0.72 to 11.15m/s, with an average velocity of 2.74m/s. Inundation depths varied between 1.36m and 4.19m, averaging 3.45m. These results suggest that the site experiences a moderate gradient that facilitates a wide range of velocities. The relatively shallow average inundation depth combined with significant variations in velocity indicates areas of potential erosion or localized flooding. The inundation extent for the 200-year return period is illustrated in Figure 9, while summary results for additional return periods are provided in Table 9.

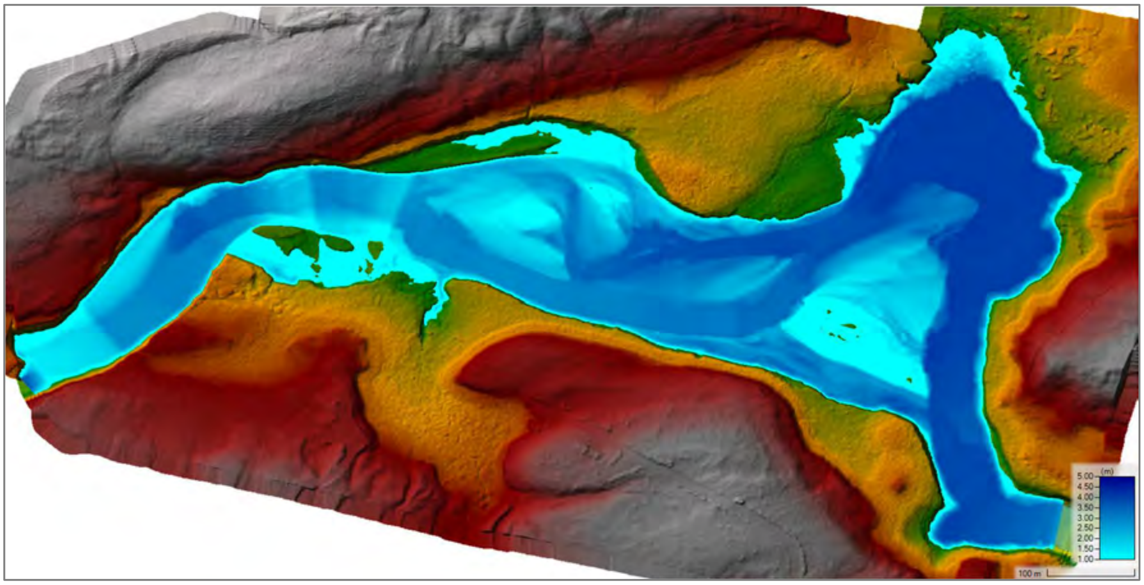

Figure 9: Modelled Flow Depth for 200-Year High Flows at Site 1, Cheslatta River

Table 9: Modelled Results for High Flows at Site 1, Cheslatta River

Return Period (Year)	Flood Velocity (m/s)			Inundation Depth (m)		
	Average	Minimum	Maximum	Average	Minimum	Maximum
200	2.74	0.72	11.15	3.45	1.36	4.19
100	2.68	0.71	10.97	3.38	1.33	4.09
50	2.67	0.71	10.79	3.28	1.30	3.99
20	2.62	0.71	10.52	3.16	1.26	3.84
10	2.59	0.71	10.31	3.07	1.23	3.72
2	2.44	0.68	9.60	2.76	1.12	3.35

3.1.2 Site 2: Flood Mapping

For Site 2, with a slightly gentler channel gradient of ~0.20%, flow velocities ranged from 1.28 to 5.36m/s, with an average of 2.42m/s. Inundation depths were between 2.28m and 4.45m, averaging 3.06m. The narrower velocity range compared to Site 1 reflects the gentler gradient, which reduces variability in flow energy. The deeper average inundation depth points to a more sustained floodplain engagement, impacting riparian areas and vegetation. The inundation extent for the 200-year return period is illustrated in Figure 10 while summary results for additional return periods are provided in Table 10.

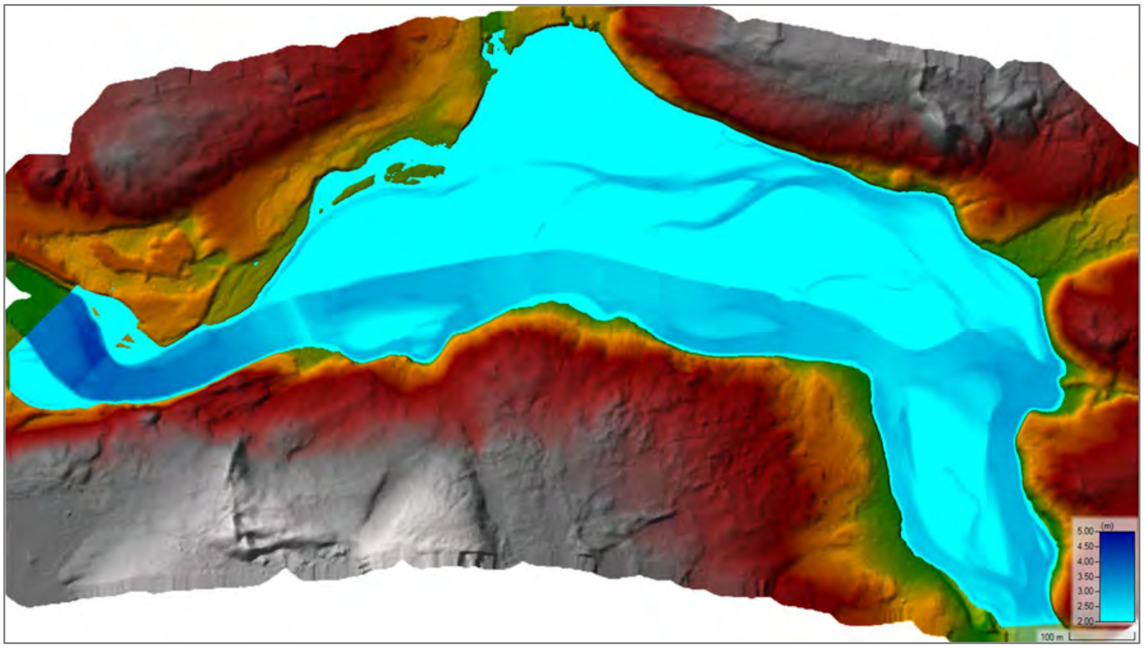

Figure 10: Modelled Flow Depth for 200-Year High Flows at Site 2, Cheslatta River

Table 10: Modelled Results for High Flows at Site 2, Cheslatta River

Return Period (Year)	Flood Velocity (m/s)			Inundation Depth (m)		
	Average	Minimum	Maximum	Average	Minimum	Maximum
200	2.42	1.28	5.36	3.06	2.28	4.45
100	2.39	1.26	5.21	3.00	2.26	4.37
50	2.36	1.24	5.12	2.93	2.20	4.25
20	2.32	1.21	4.98	2.83	2.12	4.10
10	2.28	1.18	4.90	2.76	2.06	3.99
2	2.15	1.10	4.07	2.54	1.87	3.62

3.1.3 Site 3: Flood Mapping

Site 3, with a steeper channel gradient of ~0.83%, exhibited the highest average flow velocity among the sites at 5.53m/s, ranging from 2.28 to 10.18m/s. Inundation depths varied from 1.65m to 8.89m, with an average depth of 3.20m. As this site includes a variety of cascading and braided waterfalls, results were only considered below the main falls, as modelling of such complex fall systems requires greater channel data and is outside the scope and intent of this study. The high velocities and broad depth range are indicative of a dynamic flow regime, where the steep gradient amplifies hydraulic energy. This suggests that Site 3 is particularly susceptible to erosion, sediment transport, and potential structural impacts during high-flow events. The inundation extent for the 200-year return period is illustrated in Figure 11 while summary results for additional return periods are provided in Table 11.

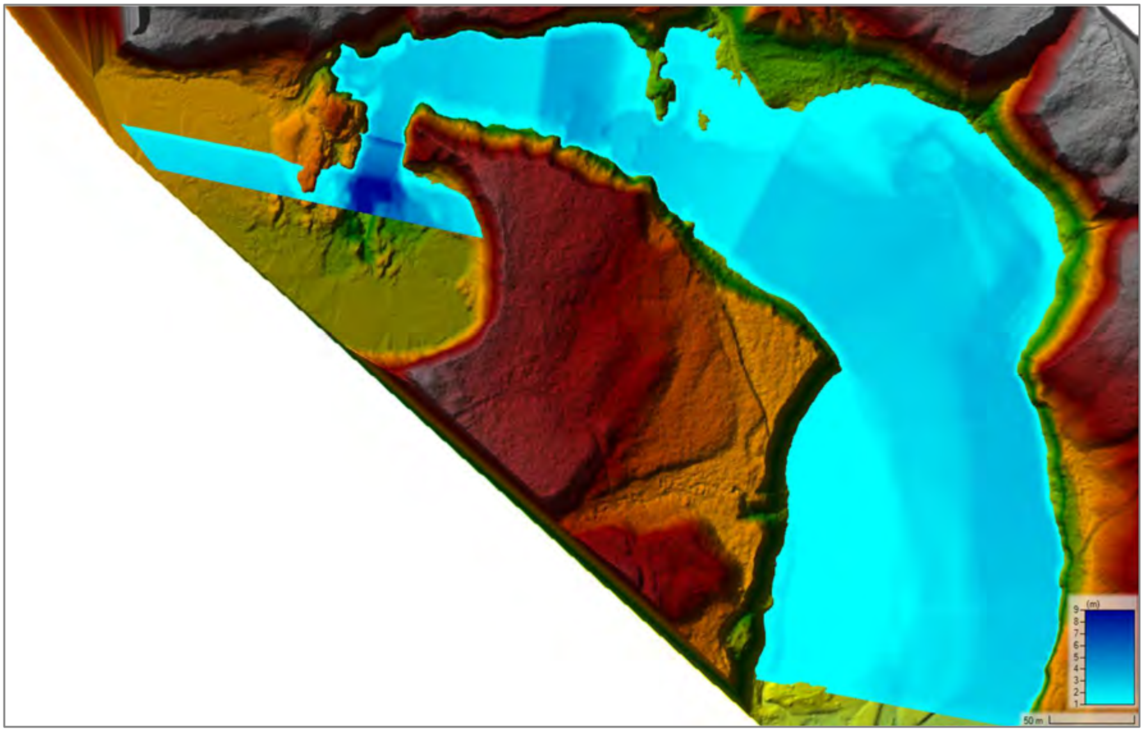

Figure 11: Modelled Flow Depth for 200-Year High Flows at Site 3, Cheslatta River

Table 11: Modelled Results for High Flows at Site 3, Cheslatta River

Return Period (Year)	Flood Velocity (m/s)			Inundation Depth (m)		
	Average	Minimum	Maximum	Average	Minimum	Maximum
200	5.53	2.28	10.18	3.20	8.89	1.65
100	5.48	2.25	9.99	3.11	8.64	1.61
50	5.61	2.17	10.61	2.94	9.01	1.58
20	5.47	2.17	10.37	2.83	8.61	1.53
10	5.35	2.11	10.18	2.76	8.31	1.50
2	5.05	1.96	9.82	2.46	7.68	1.39

3.1.4 Site 4: Flood Mapping

Site 4, with the gentlest channel gradient of ~0.11%, had flow velocities ranging from 1.56 to 4.93m/s, with an average velocity of 2.41m/s. Inundation depths ranged from 2.35m to 4.38m, averaging 3.90m. The lower velocities and consistent depth profile reflect the reduced energy of the flow, which may lead to sediment deposition in the floodplain. The deeper average inundation depth also underscores the site's potential for prolonged flooding, which could impact nearby land use and ecosystems. The inundation extent for the 200-year return period is illustrated in Figure 12, while summary results for additional return periods are provided in Table 12.

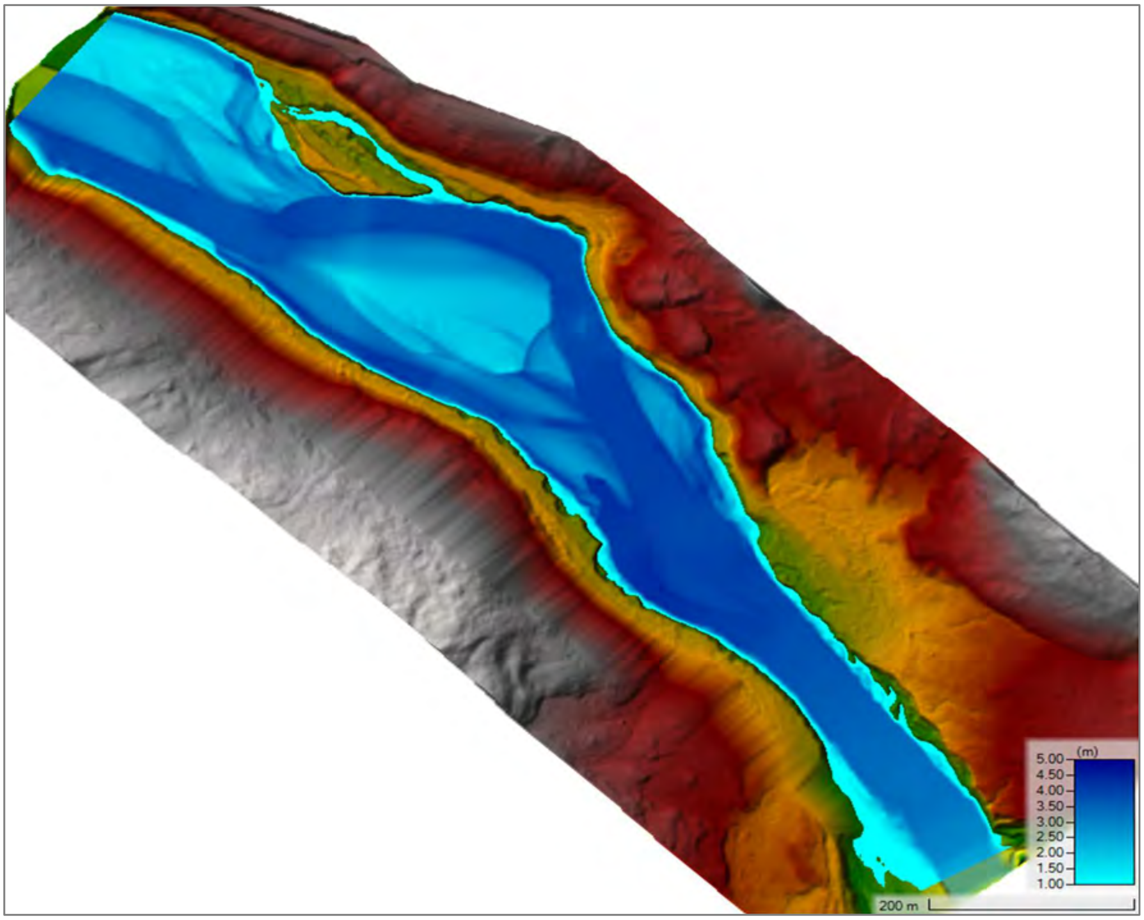

Figure 12: Modelled Flow Depth for 200-Year High Flows at Site 4, Cheslatta River

Table 12: Modelled Results for High Flows at Site 4, Cheslatta River

Return Period (Year)	Flood Velocity (m/s)			Inundation Depth (m)		
	Average	Minimum	Maximum	Average	Minimum	Maximum
200	2.41	1.56	4.93	3.90	2.35	4.38
100	2.39	1.55	4.82	3.79	2.30	4.26
50	2.34	1.52	4.62	3.70	2.34	4.16
20	2.30	1.49	4.51	3.56	2.24	4.01
10	2.26	1.46	4.50	3.46	2.11	3.89
2	2.13	1.37	4.23	3.12	1.87	3.53

3.1.5 Flood Mapping Conclusions

The variation in results across the four sites underscores the site-specific significant influence of channel gradient on flow dynamics and its potential impact on fish stranding. Steeper gradients, as observed at Site 3, result in higher velocities and dynamic flow regimes, which may increase the risk of fish displacement and reduce suitable habitat availability during high flows. In contrast, gentler gradients, such as at Site 4, produce more stable flow conditions with deeper average inundation, potentially creating refuges, but are also prone to sediment deposition and potential stranding as water levels recede. Moderate gradients at Sites 1 and 2 reflect transitional behaviour, offering a mix of habitat variability that may either support or challenge fish movement and survival depending on flow conditions.

Impacts of extreme flood events may be mitigated by the presence of the dam and the spillway operation. The full design extent of Rio Tinto’s dam infrastructure to mitigate flood flows and expected emergency spillway rates was not included in the background information reviewed for the study. Catastrophic Dam Breach modelling was not included in the scope of this study as it would not typically be considered in the river habitat design. Flows from a dam breach would be expected to exceed the feasible or economic ability to protect the immediate river systems.

These findings are critical for assessing fish stranding risks and guiding habitat conservation strategies. Areas with high velocities (e.g., Site 3) may require mitigation measures such as flow regulation or habitat modification to provide safe refuges for fish. In contrast, sites with deeper inundation (e.g., Site 4) may benefit from monitoring and adaptive management to prevent fish from becoming isolated in shallow areas as water recedes. Incorporating these insights into hydrological modelling and ecological planning can enhance fish habitat resilience and ensure sustainable aquatic ecosystem management under future climatic scenarios.

3.2 DROUGHT MAPPING RESULTS

The HECRAS model simulations for low flow conditions provide valuable insights into flow dynamics and inundation characteristics at the four sites, particularly under a 20-year return period. These findings are essential for assessing fish stranding risks and understanding habitat availability during periods of reduced water flow.

As modelling results for extreme low-flows across the large river sections and waterfall features can produce unreliable/unpredictable results in terms of flow distribution, analysis is also based on site observations and witnessed isolated pools identified by survey teams and environmental staff assessments.

3.2.1 Site 1: Drought Mapping

Under low flow conditions, Site 1 exhibited flow velocities ranging from 0.18 to 2.71m/s, with an average velocity of 0.73m/s. Inundation depths varied between 0.24m and 0.72m, averaging 0.49m. The relatively low velocities and moderate depths suggest this site could offer suitable habitats for fish during low flow periods. However, the limited depth range raises concerns about potential stranding, particularly in shallower areas where receding water levels may isolate fish in pools or reduce connectivity to main channels. Figure 13 presents the low flow depth distribution for the 20-year return period, with results for additional return periods summarized in Table 13.

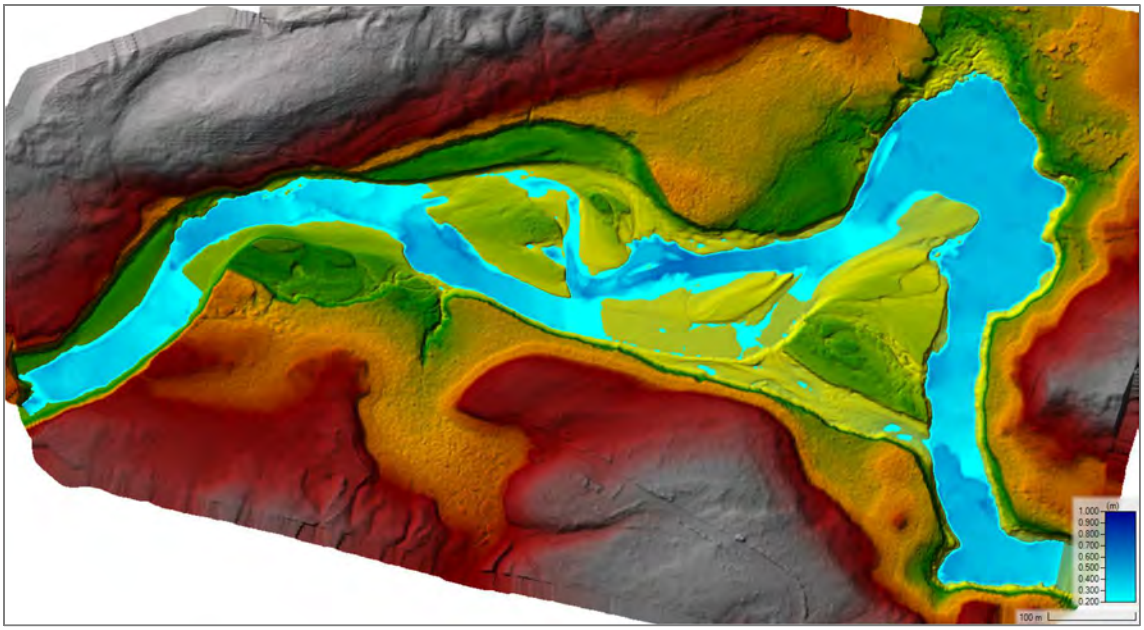

Figure 13: Modelled Flow Depth for 20-Year Low Flows at Site 1, Cheslatta River

Table 13: Modelled Results for Low Flows at Site 1, Cheslatta River

Return Period (Year)	Low Flow Velocity (m/s)			Inundation Depth (m)		
	Average	Minimum	Maximum	Average	Minimum	Maximum
20	0.73	0.18	2.71	0.49	0.24	0.72
10	0.73	0.18	2.71	0.49	0.24	0.72
2	0.79	0.21	2.94	0.55	0.26	0.81

3.2.2 Site 2: Drought Mapping

For Site 2, velocities ranged from 0.31 to 1.29 m/s, with an average of 0.66 m/s, while depths varied between 0.32 m and 0.69 m, averaging 0.51 m. The slightly narrower velocity range and consistent depth profile indicate relatively stable flow conditions. While these conditions may reduce the likelihood of stranding compared to Site 1, the limited depth variation could still pose risks during sudden water level changes, particularly for smaller or less mobile fish species. Figure 14 presents the low flow depth distribution for the 20-year return period, with results for additional return periods summarized in Table 14.

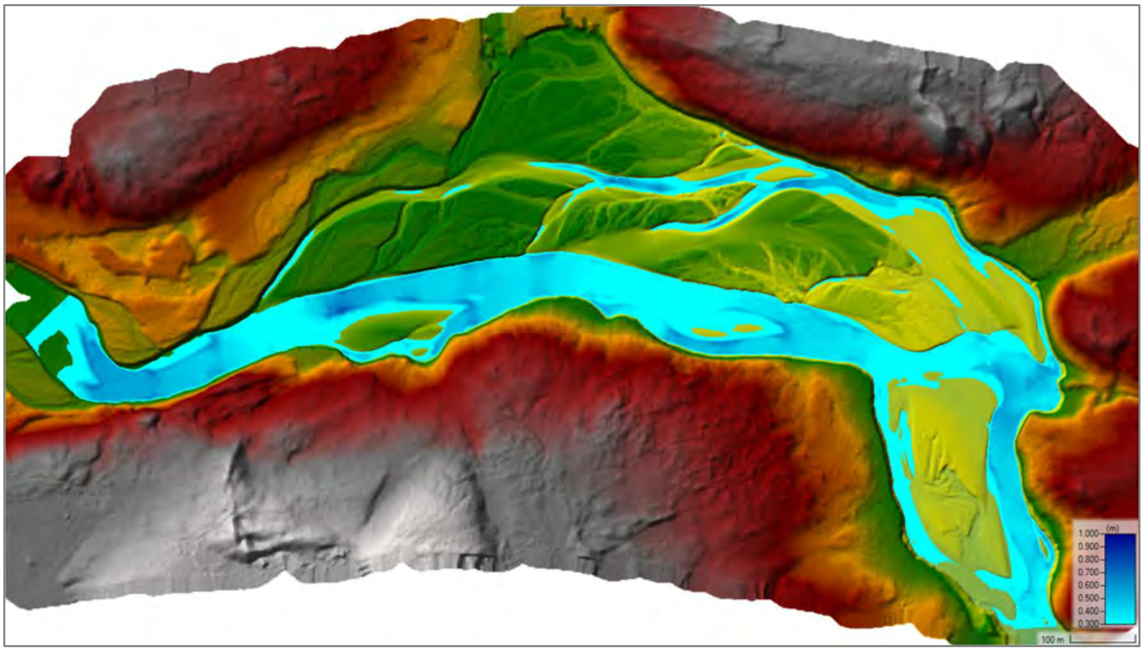

Figure 14: Modelled Flow Depth for 20-Year Low Flows at Site 2, Cheslatta River

Table 14: Modelled Results for Low Flows at Site 2, Cheslatta River

Return Period (Year)	Low Flow Velocity (m/s)			Inundation Depth (m)		
	Average	Minimum	Maximum	Average	Minimum	Maximum
20	0.66	0.31	1.29	0.51	0.32	0.69
10	0.66	0.31	1.29	0.51	0.32	0.69
2	0.73	0.35	1.28	0.58	0.37	0.78

3.2.3 Site 3: Drought Mapping

Site 3 displayed the highest average velocity among the sites during low flow conditions, ranging from 0.65 to 2.83m/s, with an average of 1.18m/s. Depths varied between 0.19m and 0.77m, averaging 0.44m. The combination of higher velocities and shallower depths suggests a challenging environment for fish, where the risk of stranding may be compounded by limited refuge areas. This site may require targeted measures, such as creating deeper pools or low-flow refuges, to mitigate stranding risks. Figure 15 illustrates the low flow depth distribution for the 20-year return period, with results for additional return periods provided in Table 15.

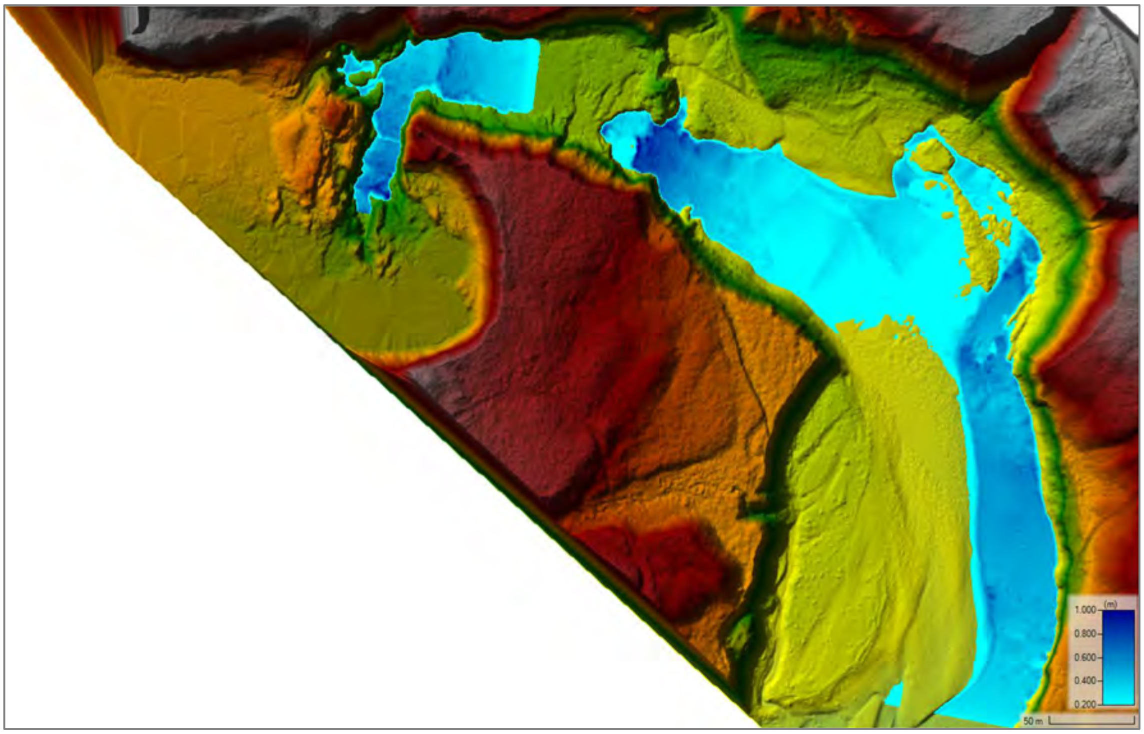

Figure 15: Modelled Flow Depth for 20-Year Low Flows at Site 3, Cheslatta River

Table 15: Modelled Results for Low Flows at Site 3, Cheslatta River

Return Period (Year)	Low Flow Velocity (m/s)			Inundation Depth (m)		
	Average	Minimum	Maximum	Average	Minimum	Maximum
20	1.18	0.65	2.83	0.44	0.19	0.77
10	1.22	0.67	2.93	0.46	0.20	0.80
2	1.37	0.73	3.24	0.52	0.24	0.94

3.2.4 Site 4: Drought Mapping

Site 4, with the gentlest flow conditions, had velocities ranging from 0.37 to 1.03m/s, with an average velocity of 0.59m/s. Depths ranged from 0.28m to 0.94m, averaging 0.55m. The gentler velocities and slightly greater average depth make this site potentially favourable for fish during low flows. However, areas with minimal depth variability might still experience localized stranding if connectivity is disrupted due to receding water levels. Figure 16 illustrates the low flow depth distribution for the 20-year return period, with additional return period results summarized in Table 16.

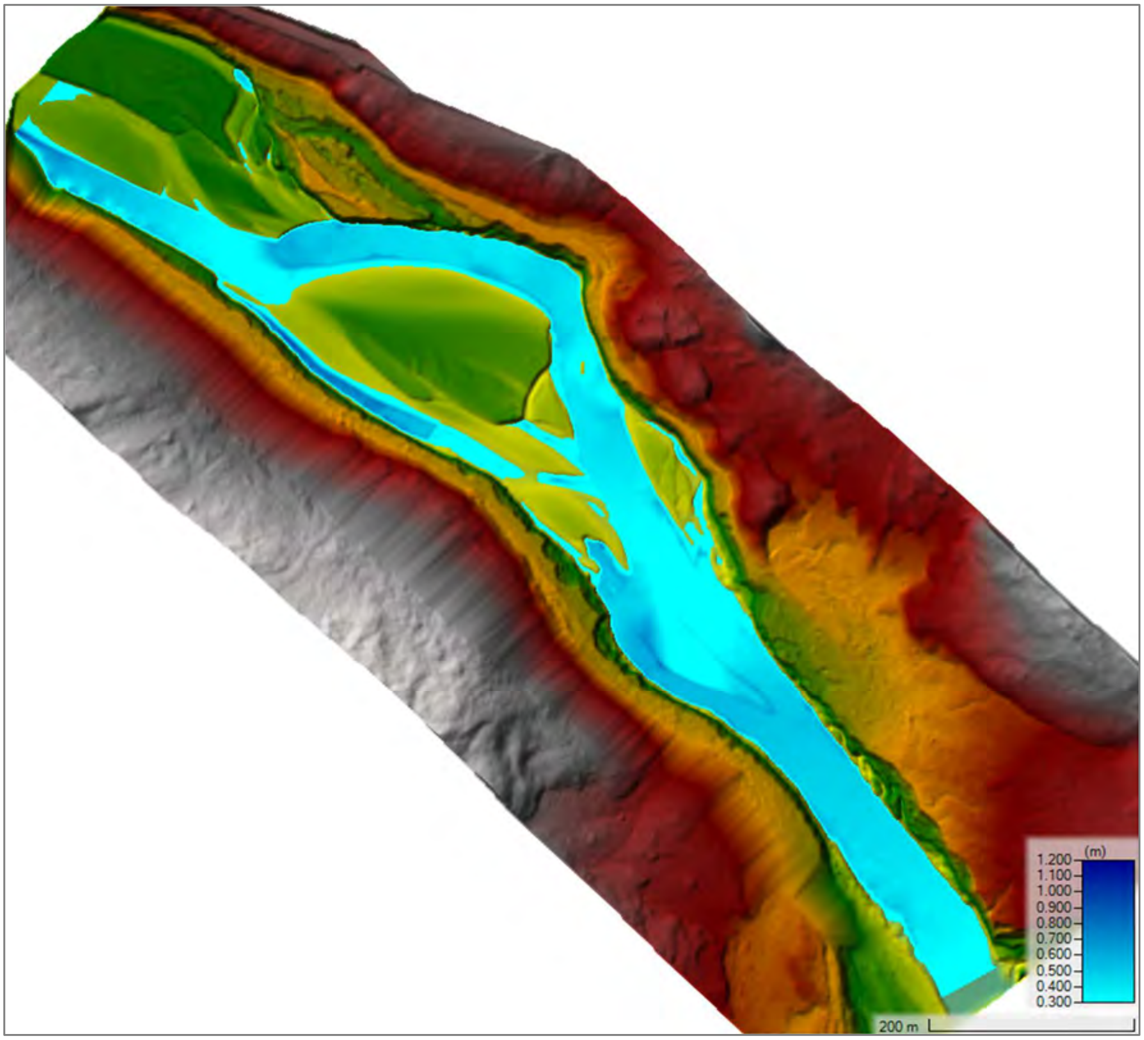

Figure 16: Modelled Flow Depth for 20-Year Low Flows at Site 4, Cheslatta River

Table 16: Modelled Results for Low Flows at Site 4, Cheslatta River

Return Period (Year)	Low Flow Velocity (m/s)			Inundation Depth (m)		
	Average	Minimum	Maximum	Average	Minimum	Maximum
20	0.59	0.37	1.03	0.55	0.28	0.94
10	0.61	0.39	1.06	0.57	0.29	0.95
2	0.68	0.44	1.19	0.64	0.33	1.00

3.2.5 Drought Mapping Conclusions

The simulation results highlight distinct flow and depth characteristics across the four sites, influenced by local topography and channel gradients. Site 3 stands out with its higher velocities and shallower depths, presenting the greatest stranding risk. In contrast, Sites 1, 2, and 4 exhibit relatively stable flow conditions, though shallow areas at these sites could still isolate fish during water level reductions.

These findings are crucial for developing site-specific mitigation strategies to minimize fish stranding risks:

- **Shallow Areas**: Sites with minimal depths (e.g., Site 1 and Site 3) may benefit from habitat modifications, such as the creation of deeper refuges.

- **Flow Connectivity**: Site connectivity is expected to vary year-over-year as sediment and gravel bars shift. Lower gradients at the downstream ends of back channels (as compared to the upstream end) present an increased risk of sediment deposition and isolation. Sites with variable depths (e.g., Site 4) require monitoring to ensure connectivity is maintained during low flows.

- **Velocity Management**: High-velocity areas (e.g., Site 3) may need flow regulation or additional refuges to support fish survival during low flows.

Integrating these insights into fish habitat management can enhance ecosystem resilience, ensuring fish populations are protected from the adverse effects of low-flow conditions under changing climatic scenarios.

4.0 FISH STRANDING ASSESSMENT

The Cheslatta River, between Skins Lake and Cheslatta Lake, experiences hydrological variability due to natural and human activities. Fish stranding that was identified in 44 isolated pools during the 2023 field assessments was caused by the erosion and deposition of sediments which results in the pools of isolated waters as flows recede. These sections of isolation and fish stranding were identified predominantly in side channels. This occurs naturally in most large river systems, however, sudden changes in river discharge can have an increased impact on fish stranding. The greater variability in flows results in greater sediment mobilization and deposition, as a river discharge (both flow rate and velocities) impacts the river's ability to carry sediments. A slow, natural decline in water levels in an area typically results in less isolated pools, as well as creates slower waters which prompt fish to leave before isolation occurs. Rapid river level decreases can deposit more sediments and debris creating unpredictable deposit patterns, also providing less time and indications for the fish to exit the area.

Sedimentation and altered flow patterns, influenced by the spillway's operations and past land-use activities like logging, have created shallow pools and sandbars. These features increase the risk of fish stranding during low-flow periods. Seasonal factors, such as ice formation in winter and rapid drainage after spring freshets, further contribute to fish being isolated in disconnected pools. For a full report of biological impacts and environmental assessment of fish stranding, refer to DWB's *Upper Cheslatta River Fish Stranding Assessment* (2023) and *Ungulate Habitat Assessment* (2024).

To address these risks, HECRAS modelling and inundation mapping at Q200 high flows and Q20 low flows, combined with Google Earth analysis, were used to identify potential fish stranding locations within the study area. Proactive water management and habitat restoration are essential to mitigate fish stranding and support healthy aquatic ecosystems.

4.1 SITE 1: FISH STRANDING ASSESSMENT

Figure 17 highlights the potential fish stranding locations identified at Site 1. These locations were determined using the September 2023 Google Earth imagery and confirmed by on-ground biologist assessments. Inundation maps are presented above for a 200-year return period high flow (Figure 9), and the inundation map for a 20-year return period low flow (Figure 13). Based on the assessment and modelling results, Figure 17 identifies areas of primary fish stranding locations were marked with red polygons, while secondary fish stranding areas are marked with blue polygons.

On the right bank, adjacent to a single island in the lower part of the site, a side channel approximately 30 meters wide was identified and is considered the primary fish stranding area. This channel contains six pools with varying sizes, where fish are at risk of stranding. The largest pool within this channel has an estimated surface area of approximately 250m², while the smallest measures approximately 12m².

On the left bank, two side channels were identified adjacent to two islands in the upper part of the site. This area is classified as a secondary fish stranding area. The side channels are approximately 20 meters and 12 meters wide, respectively, and each contains three distinct pools where the potential for fish stranding exists. The largest pool within this area covers an estimated surface area of 500m², while the smallest spans approximately 4m².

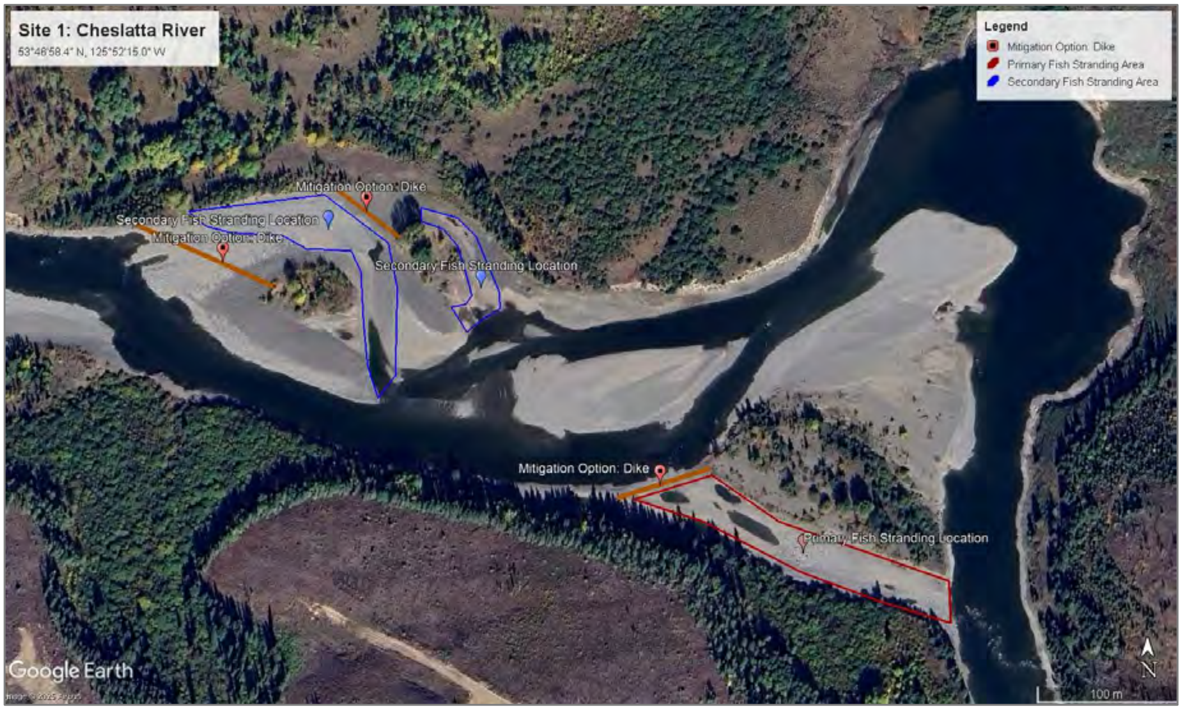

Figure 17: Annotated Map of Potential Fish Stranding Locations at Site 1 (Google Earth, 2025)

4.2 SITE 2: FISH STRANDING ASSESSMENT

Figure 18 illustrates the potential fish stranding locations at Site 2. These locations were determined using Google Earth imagery and field assessments. The inundation map for a 200-year return period high flow event (Figure 10), and the inundation map for a 20-year return period low flow event (Figure 14) were presented above. In Figure 18, areas identified as primary fish stranding locations are marked with red polygons, while secondary fish stranding areas are marked with blue polygons.

On the left bank, four side channels were identified in proximity to three islands, with approximate widths of 9 meters, 40 meters, 20 meters, and 11 meters. These side channels are considered the primary fish stranding area for this site. Each channel contains multiple pools where fish stranding may occur. The largest of these pools covers an estimated surface area of approximately 1,700m², while the smallest measures about 100m².

On the right bank, no permanent side channels were observed; however, morphological changes in the river channel suggest the potential for side channel formation, which may increase the risk of fish stranding in this area.

Figure 18: Annotated Map of Potential Fish Stranding Locations at Site 2 (Google Earth, 2025)

4.3 SITE 3: FISH STRANDING ASSESSMENT

Figure 19 illustrates the potential fish stranding locations identified at Site 3. These locations were determined using Google Earth imagery and field assessments. The inundation map for a 200-year return period high flow event (Figure 11), and the inundation map for a 20-year return period low flow event (Figure 15) are presented in Section 3.

On the left bank, a side channel was found at the downstream end of the site, ranging in width from 6 to 10 meters. This channel contains four pools where fish stranding may occur. In addition, two isolated pools were observed adjacent to a waterfall at the left bank. The largest pool in the area spans an estimated surface area of approximately 250m², while the smallest measures around 30m².

On the right bank, a narrow side channel approximately 3 meters wide was identified, containing a single large pool with an estimated surface area of approximately 800m².

The presence of bedrock and the intricate nature of the channel downstream of the waterfalls increases the complexity and considerations required to develop an effective mitigation design for this site.

Figure 19: Annotated Map of Potential Fish Stranding Locations at Site 3 (Google Earth, 2025)

4.4 SITE 4: FISH STRANDING ASSESSMENT

Figure 20 illustrates the potential fish stranding locations identified at Site 4. These locations were determined using Google Earth imagery and field assessments. The inundation map for a 200-year return period high flow event (Figure 12), and the inundation map for a 20-year return period low flow event (Figure 16) are presented in Section 3. Figure 20 identifies primary fish stranding locations with red polygons, while secondary fish stranding areas are marked with blue polygons.

On the left bank, two side channels were identified- one located at the upstream part of the site and the other at the downstream end. These channels are approximately 7 meters and 9 meters wide, respectively. Each channel contains two discrete pools where fish stranding is likely to occur. The largest pool covers an estimated surface area of approximately 180m², while the smallest spans about 30m².

On the right bank, similar to the observations at Site 2, no permanent channels are currently present. However, morphological changes in the riverbed suggest the potential formation of two channels, thereby increasing the risk of fish stranding in this area. Based on the observed morphology, the area within the red polygon is considered a primary area of potential fish stranding due to its susceptibility to flow isolation during low flow conditions.

Figure 20: Annotated Map of Potential Fish Stranding Locations at Site 4 (Google Earth, 2025)

5.0 FISH STRANDING MITIGATIONS RECOMMENDATIONS

To reduce the risk of fish stranding along the Cheslatta River, a range of mitigation strategies should be considered, targeting both hydraulic and geomorphic contributors to stranding hazards.

5.1 OPERATIONAL MITIGATIONS

As discussed above, the system's rapid fluctuation in discharge associated with operations at the Skins Lake Spillway is suspected to be a contributor to the formation of stranding features observed in the side channels along this reach of the Cheslatta River. As such, a key recommendation is to regulate the rate of flow reductions during operational events. With consideration to the operational requirements of the reservoir, it is recommended that the ramping schedules be reviewed along with natural flow regimes to develop a discharge schedule that better follows natural flow patterns while maintaining the operability and timing of the reservoir. Based on the variation between the planned and the actual release, it is believed there is still room for improvement.

It is theorized that a return to a more naturally-timed flow regime will result in decreased impacts on channel characteristics, decreased channel bed scour and sediment mobilization, and lower formation of flow isolations. Slower decreases in flows will allow more natural sediment deposits as the river discharge loses its capacity to carry sediment as flows decrease, as well as providing more time and opportunity for potentially stranded fish to vacate areas of diminishing flow before isolation.

5.2 RIVER & HABITAT MITIGATIONS

Complementary to naturalizing flow regulation, structural interventions may be implemented in strategic locations to stabilize channel morphology and improve hydrologic connectivity.

For example, constructing berms (both solid and permeable), low dikes, armouring, and/or spurs at the upstream end of high-risk side channels—such as those illustrated in Figure 17 (Site 1), Figure 18 (Site 2), Figure 19 (Site 3), and Figure 20 (Site 4)—can limit inflow and sedimentation during mid-high flows while preserving a positive downstream gradient for water movement. Strategic designs would include bio-engineering to provide positive controlled flows and reduce the likelihood of side channel isolation during flow recession. Excavation, armouring, and training structures in the downstream sections of these side channels may also be required to establish initial connectivity and ensure sustained conditions to allow fish to exit unfavourable areas during flow reductions.

Stabilization of the channel bed and banks is another important mitigation measure. Engineered features such as grade control structures, flow deflectors, or strategic boulder placement, can be used to dissipate hydraulic energy, reduce localized scour, and provide improved fish habitat. These features not only protect channel integrity but also support more stable and predictable aquatic habitats. Other features can be used to alter flow characteristics such that fish present in side channels naturally leave for more desirable habitats and main channels as side channel flow safety recedes. The goal of these works would be to ensure that the bottom (downstream) end of a side channel remains open and connected to the river, once the top is no longer accepting flows.

Revegetation of disrupted riparian zones and exposed gravel bars should also be integrated into any future mitigation planning. Native plantings help stabilize soils, reduce erosion, and promote channel resilience to hydrologic changes. Moreover, well-vegetated riparian areas contribute to ecological complexity and improve habitat quality for aquatic and terrestrial animals.

5.3 MITIGATIONS CONCLUSION

The ultimate goal of any mitigation designs and works well is to encourage and expedite the River to reach a stable state where side channels are activated in a non-destructive manner during flood events (such as only during Q20 events or higher). Stable-state rivers provide better conveyance to their flow regimes with lower erosion rates and improved riparian vegetation survival/development. The state desired for this reach of the Cheslatta River will ideally include lower sediment mobilization, increased riparian revegetation, as well as resilient positive connectivity (via backwater effect) for the downstream ends of side channels, allowing fish to safely leave side channels as water levels decrease.

It is expected that a combination of operational improvements and physical channel works will be required to be implemented, possibly with multiple steps or iterations to achieve the ultimate desired level of channel restoration and habitat creation/protection.

To ensure the effectiveness of these proposed mitigation strategies, site-specific conceptual and detailed designs should be developed. Pilot-scale test sites are recommended to evaluate design performance under varying flow scenarios and to refine site-specific techniques based on observed river responses. As rivers are dynamic systems with highly variable conditions year-over-year, adaptive management supported by ongoing monitoring and data collection will be critical for improving design robustness and ensuring long-term success in mitigating fish stranding risks along the Cheslatta River.

6.0 RAMPING DISCUSSIONS AND RECCOMENDATIONS

Based on observations and modelling results, it is believed at this time that fish stranding in the Cheslatta River is tied to how flows are released from the Skins Lake Spillway. Currently, flows often increase or decrease rapidly during operational adjustments. These sudden shifts in water levels expose side channels, backwaters, and shallow bars—areas where fish can easily become stranded. Rapid changes in flow have higher severity and greater unpredictability to channel impacts. To reduce this risk, the current ramping strategy needs to be revisited and adjusted to more closely follow the natural, seasonal flow patterns that would have occurred in the river before the dam was built.

Before regulation, the Cheslatta River would have experienced gradual flow transitions in response to seasonal snowmelt and rainfall events. These natural signs allowed fish to move with the water, avoiding isolation in pools and shallow areas. By contrast, current rapid ramp-downs don’t give fish enough time to respond. One key recommendation is to slow down the rate of flow reduction, especially during sensitive periods, like late spring and early summer, when juvenile fish are moving through the system. For example, instead of reducing flow by $50m^3/s$ over a few hours, extending this reduction over several days or even weeks will help maintain water connections through side channels and give fish a better chance to move downstream safely.

Any changes to the ramping approach must still respect the operational needs of the Skins Lake Spillway and Nechako Reservoir, as well as river temperature control requirements. These include storage management, flood risk reduction, and downstream flow commitments for hydroelectric production. However, operational flexibility does exist—particularly outside of emergency spill conditions—and should be used to support more ecologically sensitive ramping rates. As discussed in various sections above, there appear to be allowances for ramping rate improvements to return toward a more naturalized annual flow regime.

7.0 SUMMARY

The Cheslatta River’s wide floodplain and dynamic channels make it highly responsive to changes in flow and sediment transport. Natural erosion and deposition processes continually reshape the riverbed, and when combined with regulated releases from the Skins Lake Spillway, they contribute to the formation of shallow pools and isolated side channels—areas where both mature and juvenile fish are at high risk of stranding. DWB’s 2023 field assessment and subsequent reporting identified at least 58 isolated pools with potential for fish strandings. 75% of all pools assessed had stranded fish present. This hydrologic study complements biological reports in providing river data and concept options to mitigate fish stranding.

The study identifies rapid flow ramp-downs following spillway releases as a major driver of fish stranding. Fast-declining water levels have greater impacts on side channel characteristics and leave fish with insufficient time to follow the receding flows, trapping them in drying habitats. To reduce this risk, the study recommends implementing slower, more gradual flow reductions—particularly during sensitive periods such as spawning and fry development. Aligning discharge patterns more closely with natural seasonal transitions will support fish movement and increase survival rates.

Alongside operational changes, the study recommends targeted physical interventions to improve habitat stability and maintain flow connectivity. Sites 1 and 4 stand out as ideal starting points due to their accessibility and manageable scale. These locations present immediate opportunities to implement mitigation measures such as low berms, subtle channel modifications, and reconstruction of natural features through bioengineering. Such features can effectively control water inflow during high-flow events, mitigate sediment mobilization, and sustain positive downstream gradients/connectivity as flows recede, reducing the likelihood of isolated pools where fish can become stranded. By improving flow-through conditions and stabilizing loose sediments, these interventions will create safer, more connected pathways for fish during changing water levels.

The Cheslatta River is a complex and dynamic system, shaped by both natural changes and the regulated flow from the dam. Because of this, the study highlights the importance of flexible and tailored solutions that can adapt to the river's unique needs. It suggests starting with a pilot approach, where mitigation design measures can be observed, refined and proven in a practical, cost-effective way. These locations are ideal for testing new ideas in a controlled environment. River response and results of test areas will provide invaluable information and refine methodology to improve results and efficiencies (material, time, footprint and cost) of further works.

Ultimately, this study, in tandem with DWB’s environmental assessments, advocates for a forward-thinking, balanced approach to managing the river that protects fish populations, respects the river's natural flow and ensures the ongoing efficient operation of the Skins Lake Spillway.

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