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October 30, 2025

Keshni Nand
Registrar
British Columbia Utilities Commission
Suite 410, 900 Howe Street
Vancouver, BC V6Z 2N3

Dear Keshni Nand:

RE: British Columbia Utilities Commission (BCUC or Commission)
British Columbia Hydro and Power Authority (BC Hydro)
Site C Project
Lessons Learned Report to Inform Future Major Capital Projects

BC Hydro writes in response to the BCUC's letter dated May 6, 2025 to provide its Site C Lessons Learned Report.

BC Hydro is filing this report in two parts. The first part provides a comprehensive Executive Summary and the second part provides the full report.

For further information, please contact Joe Maloney at bchydroregulatorygroup@bchydro.com.

Yours sincerely,

Chris Sandve
Chief Regulatory Officer

wc/ma

Enclosure

BC Hydro
Power smart

BC Hydro Site C Project

Lessons Learned Report to Inform Future Major Capital Projects

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1 Project Overview

This section provides an overview of the Site C Project (**Project**) and its budget. Site C is the third dam and hydroelectric generating station on the Peace River in northeastern British Columbia. It is located approximately seven kilometres from Fort St. John in the Peace River Regional District. The area experiences significant seasonal weather variations with average temperatures ranging from -30 °C in the winter months to 30 °C in the summer months. Seasonal weather variations along with wildlife considerations (such as bird nesting and bear denning), significantly impact the timing and completion of key construction activities at site.

The Site C dam was built on what was once an ancient seabed, which was a mix of soft and hard ground. While the foundation had some strength challenges due to layers of clay, silt, and shale, it was generally stable and predictable, making it workable for construction. The left bank rises about 175 metres and is made up of glacial deposits, while the right bank features broad terraces of sand and gravel. The underlying bedrock, though weak in places, was well understood and carefully studied to ensure safe and reliable design.

The Project provides between 1,100 to 1,230 megawatts of capacity and produces about 5,100 gigawatt hours of energy per year on average, enough to power about 450,000 homes. By taking advantage of water already stored in the Williston Reservoir, it gains significant efficiencies, generating approximately 35% of the energy produced at the W.A.C. Bennett Dam with only 5% of the reservoir area. As the owner of this large-scale generating facility, BC Hydro will achieve greater flexibility to manage energy resources for both domestic use and trade, a key advantage over take-or-pay power acquisitions with third parties.[1]

[1] Take-or-pay refers to the standard practice of BC Hydro committing to purchase a minimum quantity of energy each year from Independent Power Producers, and to accept and pay for all energy delivered under that commitment.

In addition to generating supply and capacity benefits, the Project has significant economic benefits. During construction, the Project created about 13,000 person-years of direct employment and will have contributed approximately $40 million in tax revenues to local governments. During operation, Site C will employ approximately 30 full-time staff and will contribute about $2 million in payments to communities including grants and school taxes each year.[2]

The ambition and magnitude of Site C was considerable, and its completion is a substantial engineering and technical accomplishment that will benefit BC Hydro's ratepayers for decades to come. However, the Project was more complex and challenging than BC Hydro and its contractors anticipated, and it faced significant budget challenges. The Final Investment Decision budget for the Project, approved in December 2014, was $8.775 billion. This budget was increased twice: first, in February 2018, to $10.7 billion and again, in February 2021, to $16 billion.

The first budget increase in 2018 was primarily driven by higher costs for the main civil works and generating station and spillways contracts. This was due in part to additional work following two tension cracks on the left bank and the associated schedule delays and contractor claims, and the resulting one-year river diversion delay.[3]

The second budget increase in 2021 was driven by several factors including the COVID-19 pandemic, which led to the loss of approximately 60% of the summer 2020 construction season, delaying the Project's in-service date by one year. In addition, geotechnical challenges on the right bank required foundation enhancements for the stability of the spillways, dam core and powerhouse, and enhanced water tightness and drainage for the reservoir approach channel.

[2] https://www.sitecproject.com/why-site-c/project-benefits.

[3] A tension crack is a large surface crack that may form when there is ground movement.

The lessons learned discussed in this report under the six areas identified by the Commission should mitigate or reduce the potential for similar budget challenges from occurring on future major capital projects. In particular, BC Hydro should have ramped up its internal Project resources more proactively and sooner and going forward, BC Hydro should consider how to better communicate the breadth of low-probability, high-consequence risks on a project that have the potential to result in significant budget and schedule impacts, if they materialize.

This section is organized as follows:

- Section 1.1 describes the general Project components and provides a construction update;
- Section 1.2 discusses the Project budget approval history and the change from the Final Investment Decision Budget to the 2018 Approved Budget;
- Section 1.3 discusses the circumstances that led to the change from the 2018 Approved Budget to the 2021 Approved Budget and Schedule; and
- Section 1.4 explains that the Project is on track to meet the 2021 Approved Budget and Schedule.

1.1 Project Overview and Construction Update

Construction began on the Project on July 27, 2015, and as of October 30, 2025, it is substantially complete. Site C is fully operational with all six generating units in-service and is providing clean energy to British Columbia. The sixth and final generating unit was placed in-service on August 8, 2025.

Major civil works, including the earthfill dam, right bank foundation enhancements, approach channel to the powerhouse, the substation, generating station and spillways concrete structures, and tailrace areas are essentially complete. Additional infrastructure such as the Highway 29 realignment, reservoir clearing, and the

two 75 kilometre-long, transmission lines that connect the substation to the BC Hydro transmission system have also been completed.

With these milestones achieved, the transfer of operational responsibility of the assets to BC Hydro's operations group is underway.

Figure 1 below provides a high-level overview of the key Project components and Figure 2 below provides a more detailed view of the spillway, generating station and transmission lines.

Figure 1 Site C - Key Components

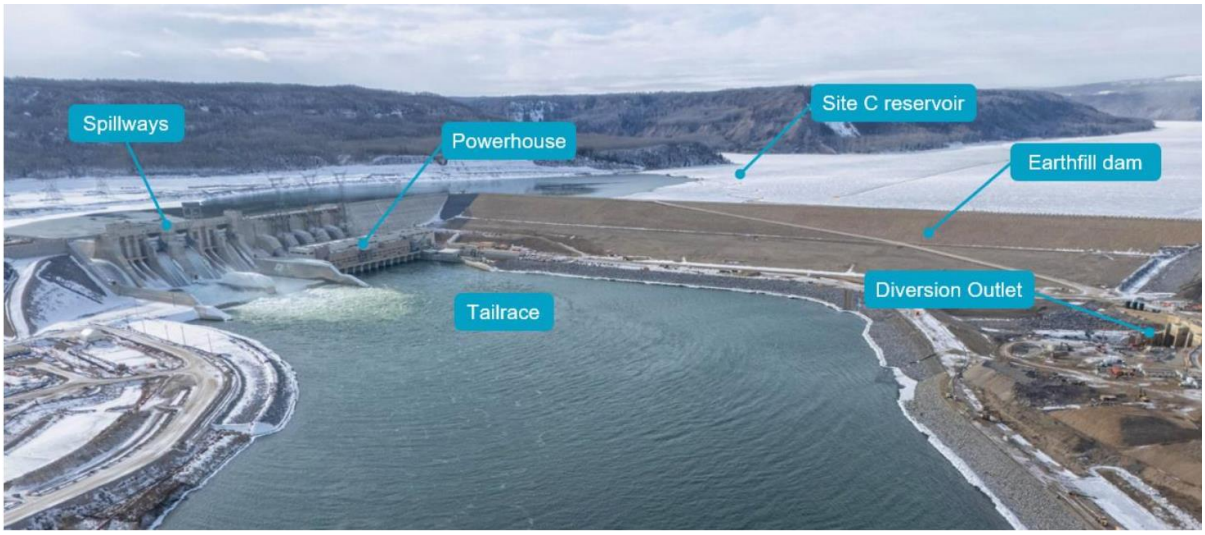


Figure 2 **Site C Dam - Spillway (Centre Left), Generating Station (Centre Right) and Transmission Lines (Above the Generating Station).**

The key components of the Project include:

- An earthfill dam, approximately 1,050 metres long and 60 metres high above the riverbed;
- A generating station with six generating units, each capable of producing up to 205 megawatts;[4]
- An 83-kilometre-long reservoir that will be, on average, two to three times the width of the Peace River;
- Two new 500 kilovolt AC transmission lines that will connect the Site C facilities to the existing Peace Canyon Substation, along an existing right-of-way;
- A new Site C substation;
- An 800 metre roller-compacted-concrete buttress to enhance seismic protection of the spillways and generating station;
- Access roads in the vicinity of the site and a temporary construction access bridge across the Peace River at the dam site;

[4] The installed capacity of the Site C generating station is between 1,100 and 1,230 megawatts.

- Two large diversion tunnels, each approximately 750 metres long and 11 metres in diameter, used to temporarily reroute the Peace River around the dam site;
- Construction of two temporary cofferdams across the main river channel to allow for construction of the earthfill dam;
- Worker accommodation at the dam site;
- The realignment of six segments of Highway 29 over an approximate total distance of 30 kilometres; and
- Shoreline protection at Hudson's Hope.

1.2 Budget Approval History

The Project's budget was increased twice from the initial Final Investment Decision budget approved in December 2014. The two budget increases were largely driven by low-probability and high-consequence Project risks that materialized related to two tension cracks that occurred on the left bank and related to foundation enhancements that were required on the right bank during construction of the powerhouse, generating station and spillways and earth fill dam. The impacts of these events were compounded due to the COVID-19 pandemic that occurred during the planned peak construction period of the Project.

In December 2014, the Project received approval from the Government of B.C. to proceed to construction. The approved Final Investment Decision budget was $8.775 billion which included a Treasury Board held Project reserve of $440 million.

In 2017, the Government of B.C. requested that the British Columbia Utilities Commission (**BCUC** or **Commission**) undertake an inquiry into certain aspects of the Project. The Commission was to report on the implications of three scenarios for the Project: continuing, terminating, or suspending construction with the option to resume by 2024. The Commission provided a report to the Government of B.C. on

November 1, 2017, which led to a government decision announced on December 11, 2017, to continue with the construction of the Project. In February 2018, a revised Project budget of $10.7 billion was approved (**2018 Approved Budget**), an increase of $1.925 billion over the 2014 Final Investment Decision budget and included a Treasury Board held Project reserve of $708 million.

Table 1 below outlines the key cost drivers of the $1.925 billion budget increase from the Final Investment Decision Budget to the 2018 Approved Budget. Final actual costs will be known upon full project completion. BC Hydro expects to complete the project within the 2021 Approved Budget.

Table 1 Description of Key Budget Drivers – Final Investment Decision Budget to 2018 Approved Budget

Description	Drivers	Total Increase ($ million)	Portion of Increase due to River Diversion Postponement ($ million)
Main Civil Works	Amendments to the contract for schedule delays – particularly, additional work related to left bank tension cracks and river diversion delay. Also, claim settlements, schedule recovery, equipment investments, and other commercial matters.	267	130
Generating Station & Spillway	Higher than expected contract bid values for the work and additional work related to left bank tension cracks and river diversion delay.	615	132
Transmission	Tower design changes, additional geotechnical work, and changes to the substation design.	117	-
Highways	Realignment away from a burial site and areas of cultural significance to several Indigenous Nations, difficult building conditions, and material and scope changes.	170	-
Indirect Costs (i.e., labour)	Additional labour resource requirements such as engineering, project management and construction management due to river diversion delay and for monitoring and executing construction.	386	85
Other	Increased costs associated with early works, worker accommodation, reservoir and turbines and generators expenditures.	160	50

Description	Drivers	Total Increase ($ million)	Portion of Increase due to River Diversion Postponement ($ million)
Interest During Construction	Overall lower interest rates than planned in previous budget. However, river diversion delay resulted in additional interest costs.	(122)	162
Contingency	Risk re-assessment updates including scope changes.	64	51
Project Reserve	Risk re-assessment updates including scope changes.	268	-
Total		1,925	610

As shown in Table 1 above, the $1.925 billion budget increase was primarily driven by higher costs for the Main Civil Works and Generating Station and Spillways contracts and by higher indirect costs for additional engineering, project management, and construction management resources to support the Project. These increases were driven in part by additional work following the two tension cracks on the left bank and the resulting one-year river diversion delay. The one-year river diversion delay increased the Project budget by $610 million, accounting for approximately 30% of the budget increase.

1.3 2021 Approved Budget and Schedule

On February 26, 2021, the Government of B.C. announced a revised cost estimate of $16 billion, an increase of $5.3 billion over the 2018 Approved Budget, and a new projected in-service date of 2025 (**2021 Approved Budget** and **2021 Approved Schedule**).

Table 2 below outlines the key cost drivers of the $5.3 billion budget increase. Final actual costs will be known upon full project completion. BC Hydro expects to complete the project within the 2021 Approved Budget.

Table 2 Description of Key Budget Drivers – 2018 Approved Budget to 2021 Approved Budget

Description	Drivers	Amount ($ million)
COVID-19	The global COVID-19 pandemic caused slowdowns in construction due to workforce reductions and resulted in a one-year delay of the Project. 60% of the 2020 summer construction season was missed including work on the earthfill dam, core buttress, generating station and spillways. Includes associated incremental interest during construction costs.	1,606
Right Bank Foundation Enhancements	Foundation enhancements were required to improve the stability for the powerhouse, spillways, and dam core areas. Enhancements included installing 96 large piles (concrete filled pipes) to further extend the foundation deeper into the bedrock and enhancements to the design of the approach channel above the powerhouse and spillways. This includes direct construction costs, indirect costs, and the related incremental interest during construction costs.	1,141
Main Civil Works	Schedule delays, claim settlements, schedule recovery, equipment investments, and other commercial matters.	1,110
Indirect Costs	Additional internal Project labour resource requirements such as engineering, project management and construction management due to schedule delays, and for monitoring and executing construction.	658
Balance of Plant	Scope (e.g., Heating, ventilation and air conditioning, and fire protection) and design changes.	319
Generating Station and Spillways	Scope changes, claims, and quantity increases.	233
Highways	Includes updated designs from feasibility to final design for remaining highway segments driven by geotechnical testing results and updated unit rates.	211
Worker Accommodation	Additional contractor bed night requirements and expansion and extended duration of the camp and office space.	189
Infrastructure Work	Additional work for stilling basins, security services and infrastructure, medical centre extension, debris boom operation, and remediation of permanent access road slopes on the right bank.	146
Incremental Mitigation and Compensation Work	Additional work to meet environmental requirements.	128
Turbines and Generators	Schedule delays, claim settlements, and other commercial matters.	47
Other	Other indirect costs including additional interest during construction not included in the COVID-19 pandemic amount and right bank foundation enhancement increases above.	220
Project Reserve	A project reserve was not included in the 2021 Approved Budget.	(708)
Total		5,300

As shown in Table 2 above, the $5.3 billion budget increase was driven by several factors including the COVID-19 pandemic, which accounted for $1.6 billion of the

increase, due to the loss of approximately 60% of the summer 2020 construction season, which delayed the Project's in-service date by one year. Additionally, geotechnical challenges on the right bank, which required foundational enhancements for the stability of the spillways, dam core and powerhouse and enhancements to the approach channel to reduce the risk of leakage, contributed $1.1 billion to the increase. Main civil works claims, schedule recovery, and equipment investments resulted in a further $1.1 billion increase.

An additional $0.7 billion was required for increases to Project resources, including engineering, project management and construction management resources; and the remaining $0.8 billion included increases due to design changes for the balance of plant and generating station and spillways contracts, higher costs associated with the Highway 29 realignment, expansion and extended duration of worker accommodation, and changes related to other infrastructure work.

While the 2021 Approved Budget did not include a project reserve, due to the ongoing implementation of recommendations from the 2021 Milburn Report, including four related to risk management, it did retain a contingency of $737 million.[5]

1.4 Project is on Track to Meet the 2021 Approved Budget and Schedule

As of October 30, 2025, the Project is substantially complete. The latest Project Status Dashboard dated September 30, 2025, indicates that the Project's health, scope, schedule, and cost remain "green" due to the substantial construction and commissioning progress achieved.

BC Hydro met the 2014 Final Investment Decision completion schedule for the transmission lines and substation components of the Project. All six generating units are now in full operation and generating electricity, ahead of the 2021 Approved

[5] Refer to sections on Contract Management, Risk Management and Project Governance for more details on the 2021 Milburn Report.

Schedule. However, river diversion was delayed a year from 2019 to 2020, and the units were placed into service later than the 2014 Final Investment Decision completion schedule, with the sixth unit entering service approximately nine months later. Table 3 below provides a comparison of the in-service dates under the Final Investment Decision completion schedule and the actual in-service dates.

Table 3 Comparison of Key Milestone In-Service Dates

Description/Status	Planned In-Service Date per Final Investment Decision[6]	Actual In-Service Date
Peace Canyon Gas Insulated Switchgear	February 2019	July 2019
5L5 500 kV Transmission Line	October 2020	October 2020
Project Substation	November 2020	October 2020
5L6 500 kV Transmission Line	July 2023	October 2020 (completed) October 2024 (ISD)
Unit 1 (First Power)	December 2023	October 2024
Unit 2	February 2024	December 2024
Unit 3	May 2024	February 2025
Unit 4	July 2024	March 2025
Unit 5	September 2024	July 2025
Unit 6	November 2024	August 2025

BC Hydro is on track to complete the Project within the 2021 Approved Budget. As of June 30, 2025, actual life-to-date Project costs are $14.5 billion which is $768 million below the budget for the corresponding as at date. This variance is due to changes in the timing of work, lower contingency requirements, cost savings for unrealized risks, lower property acquisition costs and lower interest during construction with the six generating units going into service earlier than the 2021 Approved Schedule.

In November 2024, the reservoir reached its normal operating range of 460 metres to 461.8 metres. The generating facility and supporting structures are performing in line with design specifications, demonstrating high construction quality and effective

[6] Based on plan at Final Investment Decision, December 2014.

quality management. The main dam, approach channel, associated structures and hydromechanical equipment have performed well during reservoir filling and early operations. Since November 2024, instruments such as flumes and piezometers, have stabilized or show declining readings within expected ranges. Instruments monitoring potential underground movements (i.e., inclinometers and extensometers) all show readings within expectations. All changes observed to the slopes around the reservoir are within the range of expected performance.

2 Project Successes and Challenges

This section provides a discussion of key successes and challenges on the Project during the development and construction phases to provide context for the lessons learned that follow.

2.1 BC Hydro Achieved Several Key Successes on the Site C Project

The completion of Site C is a substantial engineering and technical accomplishment. Many of the key successes on the Project are related to the completion of major infrastructure, the quality of design and construction and the performance achieved during the first year of operation. In addition, during the earlier construction years of the Project, opportunities were identified to improve governance and oversight.

BC Hydro is proud of the Project's safety record and its record on environmental permitting and compliance. The Project also provided important economic benefits to communities and Indigenous Nations and had strong levels of labour attraction, retention, and apprenticeships.

A key reason for the successes achieved on the Project was its integrated leadership approach. The Project was structured as a separate business unit with its own dedicated functional groups such as Safety, Environment, Engineering, Indigenous Relations, Project Management Office, Contracts and Construction Management, with a direct reporting relationship to the President and CEO. This structure helped to drive the necessary tone and approach across a broad range of organizational challenges. Every day involved substantial expenditures and swift removal of obstacles, which was facilitated efficiently by the Project's integrated leadership team.

2.1.1 Major Infrastructure Completion

The Project successfully installed six generating units adding between 1,100 MW to 1,230 MW of capacity, with sufficient energy to power approximately

450,000 homes annually. The units were commissioned progressively from October 2024 through August 2025, each ahead of the 2021 Approved Schedule. This was a major accomplishment given the scale and complexity of the Project.

Major assets now in-service include:

- The earthfill dam, completed over three years, involved placing about 15.5 million cubic meters of material with extensive instrumentation to monitor performance and safety. The dam reached the elevation needed to proceed with reservoir filling on July 27, 2023. It is 60 metres tall, more than one kilometre across and about 500 metres wide at its base;
- The powerhouse civil structure and intake civil structure collectively include approximately 255,000 cubic metres of concrete and 17.6 million kilograms of rebar;
- Six 10.2 metre diameter penstocks were installed;
- Six turbines and generators were manufactured through an integrated approach across three locations (on-site, Quebec, and Sao Paulo) and were fully commissioned with the final unit coming online in August 2025. BC Hydro conducted a competitive model test for turbine design to award the contract to the supplier with the broadest operating range and highest efficiency. Type tests were successfully completed for each unit, which have been reliably operating with output higher than their design specifications;
- The spillways required approximately 390,000 cubic metres of concrete and included the installation of three spillway gates and six low-level gates;
- Nearly 1.7 million cubic metres of roller-compacted concrete were placed to create a stable foundation for the powerhouse, spillways, and earthfill dam abutment;

- The approach channel required approximately 6.7 million cubic metres of excavation, and included necessary right bank foundation enhancements to address geotechnical concerns;
- The diversion tunnels, enabling the rerouting of the Peace River in October 2020, were completed, and safely operated for four years until reservoir filling. Tunnel No. 1 is 700 metres in length and Tunnel No. 2 is 790 metres in length;
- Transmission infrastructure, including a new Site C substation and two new 500kV lines, were energized between 2020 and 2022, to connect Site C to the BC Hydro system. This transmission infrastructure included the expansion of the existing Peace Canyon 500kV gas insulated switchgear and enhancements to the Peace Canyon substation to accommodate two new 500kV transmission line terminals, the construction of a new 500kV substation, the installation of two 75 kilometre-long 500kV transmission lines connecting the Site C substation to the Peace Canyon generating station, and three one-kilometre long 500kV transmission lines linking the Site C Generating Station to the substation. Construction involved clearing land, building roads, removing timber, installing 405 towers, setting insulators and stringing conductors;
- Approximately 30 km of Highway 29 was relocated, and the construction included five major bridges, including the Halfway River bridge, which is over one kilometre in length and included redesign of the realignment at Cache Creek – Bear Flat to reduce the effects on potential burial sites and areas of cultural significance in the area; and
- Reservoir clearing which included the construction of access roads, installation of wildlife buffers, the completion of the logging activities, the removal of the merchantable timber, the disposal of non-merchantable timber, and access

road deactivation. Most of the reservoir clearing work was completed by Indigenous Nation designated businesses.

2.1.2 Project Governance

BC Hydro and the Government of B.C. made substantial efforts to ensure that effective governance, oversight, and independent review were in place for the Project. Governance structures evolved over time to meet the needs of each project phase.[7]

Since 2004, the BC Hydro Board of Directors has provided overall governance to the Project, which included the responsibility for approving all Project contracts over $75 million. The Project team has been supported by several oversight bodies, beginning with the Site C Technical Advisory Board. The Technical Advisory Board consists of an independent global panel of engineering and construction experts who are internationally recognized for their breadth and depth of technical knowledge and experience with hydroelectric projects around the world. They have provided technical guidance and advice on design, construction, risks, and delivery since the feasibility phase.

In 2013, BC Hydro formed the Site C Project Board to enhance oversight and approvals, which was later replaced in 2018 by the Site C Project Assurance Board, tasked with ensuring the Project was completed safely, on schedule, and within budget.

Ernst & Young was appointed as Independent Oversight Advisor in 2017, with expanding scope over time including the review of BC Hydro's management of claims, schedule, cost, and risks. Ernst & Young's scope of independent oversight, included guidance and advice to BC Hydro management and independent reporting to the Project Assurance Board and the Government of B.C.

[7] The following discussion is only a summary; additional insights related to governance, including lessons learned, are provided in section 7.

In 2021, the Project Assurance Board established the Commercial Sub-Committee to focus on construction, schedule, cost reporting, and claims, while also engaging external experts to support and provide advice on critical milestones and technical solutions.

These governance structures were important to the Project's successful completion. For example, the Technical Advisory Board provided advice, feedback, and oversight of the solution to improve the stability of the right bank structures and two international dam experts provided an independent review of the solution design.

2.1.3 Quality Management Approach

BC Hydro's quality management approach was governed by the Site C Quality Management Plan. The Site C Quality Management Plan described the processes and activities by which BC Hydro would ensure that the quality requirements were achieved for design, equipment manufacturing and construction. Each contractor is responsible for quality control, and BC Hydro is responsible for quality assurance. Quality management processes and activities included:

- Regular meetings with the Technical Advisory Board to discuss and resolve design and construction issues and obtain advice on complex technical solutions;
- Partnering with specialized and globally located quality assurance inspection agencies to conduct surveillance and participate in quality witness and hold points at manufacturers' facilities on behalf of BC Hydro;[8]
- Establishment of a site-based Resident Engineering Team and a Quality Management Team to conduct surveillance and participate in quality witness and hold points for construction activities;

[8] A hold point is a mandatory inspection or verification step in the process where work must stop until the required inspection or approval is completed.

- Conducting regular quality audits of manufacturers and Project contractors;
- Participating in regular meetings with the quality management teams from key manufacturers and site contractors to resolve any quality issues;
- Active raising of non-conformity reports when quality issues were identified to formally track the non-conformity from identification to resolution; and
- Establishing a quality performance indicator process, by which key design, manufacturing and construction activities were assessed and reported monthly to confirm if the Project quality requirements were being met or if corrective actions were required.

2.1.4 Quality of Design and Construction

For the design of the Project, BC Hydro established a world-class integrated engineering design team, including BC Hydro, Atkins Réalis (formerly SNC Lavalin Inc.) and Klohn Crippen Berger Limited. The team had the required detailed knowledge and experience with large civil, hydroelectric projects, the ability to respond to peaks in workload, and a structure for assigning delivery accountability and liability to the appropriate engineering entity.

Atkins Réalis and Klohn Crippen Berger Limited were assigned Engineer of Record for the final design of key components such as the diversion works, generating station and spillways, and the earthfill dam. BC Hydro led the engineering specification development for critical generating station and spillway equipment, including the turbines and generators, hydromechanical equipment, large cranes, AC and DC station service equipment, and the 13.8kV to 500kV generator step up transformers. BC Hydro also led the design and are the Professionals of Record for the station’s protection, control, and telecommunications systems. Atkins Réalis and Klohn Crippen Berger Limited had an overall responsibility for the integration of the components and equipment designed by the equipment suppliers within the generating station and spillways and earthfill dam.

Extensive physical modelling was completed during the early design phase of the Project to establish the main geometric and hydraulic characteristics of the structures, including the approach channel, power intakes, the spillways and stilling basin. Additional physical modelling and testing was completed to validate the performance of the diversion tunnels and orifice rings, the spillway hydromechanical equipment and the turbines. This extensive modelling and testing program, in advance of detailed design, allowed the Project to confirm the performance of these structures and equipment prior to proceeding with detailed design, manufacturing and construction.

Specific features were included in the design to ensure the long-term operational reliability of the facility. For example, the penstocks and turbine spiral casings included upper and lower flexible couplers (joints) able to accommodate movement. This was important because the intake headworks and generating station concrete structures are subject to deflections from foundation movement, hydrostatic loading, and seasonal thermal expansion and contraction.[9]

When geotechnical issues regarding the right bank foundation were discovered during construction, BC Hydro identified a two-part solution to improve the stability of the right bank structures.[10] The updated design met the recommendations of the Canadian Dam Association and had input and feedback from independent engineers, globally recognized for their technical knowledge and experience with hydroelectric projects around the world.

During the construction phase of the project, BC Hydro worked with its contractors to implement specific methods to ensure the quality of the work met the specification requirements. This was challenging work due to the complex geology of the site as well as the requirement to progress work during the winter when temperatures would routinely drop well below 0°C, and frequently reaching below -30°C. For example,

[9] The Project's approach to overcoming these challenges is discussed further in section 2.2.8 below.
[10] This is discussed further in sections 2.2.2 and 6.3.3 below.

during the earthfill dam and approach channel construction, measures such as heated enclaves and thermal blankets, along with installation of thermistors to monitor the rock temperature were implemented, making it possible to perform the grout activities in cold temperatures. Placement of granular material also had to continue during winter to achieve timely completion of the dam. Measures such as heated trucks and heating the material stockpiles, as well as working continuously in smaller areas were implemented to make it possible to place materials at very cold temperatures.

Finally, construction of the generating station and spillways structures involved large and complex concrete placements. For specific areas of challenging geometry, trial placements were conducted to demonstrate the methodology for placement and finishing of the concrete on vertical, curved, or inclined surfaces. The size of the concrete placements across the generating station and spillways required detailed thermal modelling of each placement and the implementation of control measures so that the thermal limits of the placement were maintained during the curing process. These measures included careful cooling pipe layout and post-placement cooling. The schedule also required winter placements, which required heating and hoarding of the placements during the curing process. Temperature-sensing devices were included in each placement, and the thermal performance was monitored daily so that the specified temperature limits were not exceeded.

2.1.5 Performance During First Year of Operation

The Project has been in service for approximately one year and has successfully achieved important milestones including completion of reservoir filling, continuous operation of the spillway throughout winter 2024-2025, a winter-freeze and spring-thaw cycle, and bringing all six generating units in-service. During this time, the performance of the Project has been validated by:

- Visual observations of the reservoir and shorelines;

- Extensive instrumentation in the earthfill dam, dam abutments, right bank foundation and the generating station and spillways structures; and
- Extensive instrumentation and protection systems on the generating station and spillways equipment including the turbines and generators, exciters, circuit breakers and generator step-up transformers.

To-date, the performance of the Project has met or exceeded the design expectations, validating the quality of the design and construction.

For the reservoir shorelines and slopes, BC Hydro implemented a comprehensive monitoring program to verify the slope stability and the shoreline erosion processes to manage public safety and risks to infrastructure. During reservoir filling, BC Hydro's geotechnical specialists (BGC Engineering) performed twice-weekly aerial inspections of the reservoir, and weekly ground inspections of key site areas. Additionally, there were manual instrument readings (varying in frequency from weekly to monthly) and daily review of 50 instruments connected to a real-time monitoring system. Following the reservoir filling process and 2025 spring-thaw, the frequency of inspections has been reduced to monthly and will continue at this frequency into 2026 to further understand the stability and erosion impacts and to inform decisions on opening the reservoir boat launches to the public. To-date, the performance of the reservoir shoreline and slopes has been within BC Hydro's expectations with only minor erosion and sloughing observed at locations of historical landslides already identified within the preliminary stability impact lines.

For the earthfill dam, approach channel, right bank foundation and right bank structures, BC Hydro has implemented an extensive suite of instrumentation, including piezometers, inclinometers, extensometers, thermistors, and pendulums, to monitor movements and deformations of the structures and the pore-pressure development under the structures and within the bedding planes and earthfill dam. During reservoir filling, the engineering team met twice per week to discuss the data

collected from the instrumentation and trends.[11] To-date, the visual monitoring and instrument data collected indicates that the performance of the right bank foundation enhancements, the approach channel and the earthfill dam has equalled or exceeded design expectations. Movements and deformations of the concrete structures have primarily been driven by thermal cycling and are within expectations. This performance demonstrates the quality of design and construction.

During reservoir filling and early operation of the facility, continuous operation of the spillways was required to balance flows with the upstream Peace Canyon Dam until at least four units were in service. This was complicated by the need to spill throughout winter 2024-2025 when temperatures dropped as low as -30°C Special heating systems were incorporated into the design of the spillway gates, and this, coupled with regular monitoring and daily movements of the gates, prevented ice-bridging between the gates and concrete piers.

For the turbines and generators, all six generating units are in-service and key components of the station electrical system, including the 13.8kV to 500kV generator step-up transformers, the 1.8kV iso-phase bus and circuit breaker, and the 13.8kV and 600V AC station service, are commissioned and operating reliably.

2.1.6 Safety and Workforce Achievements

BC Hydro is proud of the Project's safety record. Over 65.6 million work hours were completed from July 2015 to July 2025 with no fatalities and a lost time injury frequency of 0.17.[12] This rate is well below WorkSafeBC's lost-time injury frequency rate of 2.32 for heavy construction projects in B.C., and equates to one lost-time injury at Site C for every 14 reported on similar projects. However, it is important to recognize that despite this strong record, serious safety incidents still did occur during construction. These incidents were included in progress reports submitted to

[11] The frequency of these meetings has now been reduced to monthly.

[12] Site C and WSBC – Heavy Construction, Lost Time Injury data is the average for the period of 2016 to 2024.

the Commission and, in some cases, resulted in WorkSafeBC inspections and administrative penalties, largely directed at contractors on the Project.

Proactive measures to mitigate safety risks included thousands of planned safety verifications, tracking of safety incidents and near miss events to develop risk mitigation strategies, thousands of safety incident reviews to encourage a safety learning culture, third-party experts retained to undertake risk-based reviews, workshops on various safety risks, and working closely with WorkSafeBC to monitor safety and respond to identified safety issues and WorkSafeBC orders.

2.1.7 Environmental Compliance and Permitting

The Project successfully secured both the Environmental Assessment Certificate and Federal Decision Statement, meeting over 170 conditions, designed to uphold rigorous environmental standards. As of March 31, 2025, all required conditions and submissions have been fulfilled, with approximately 650 provincial and federal permits, water licences, and construction authorizations obtained. These approvals encompass critical areas such as air and water quality, wildlife, heritage, health and safety, environmental management, and Indigenous consultation. Compliance is maintained through a comprehensive Construction Environmental Management Plan and regular audits, with over 100,000 environmental inspections completed to date.

While environmental compliance remains consistently high and there have been no environmental noncompliance orders that materially impacted the Project's cost or schedule, the Project did have some instances of noncompliance.[13] For example, in September 2018, a significant rain event at the Site C dam site led to the controlled release of approximately four million litres of rainwater, collected in holding ponds and flowing over potentially acid-generating rock, into the Peace River. Although the discharged volume was small relative to the river's flow and no impacts to aquatic life were observed, BC Hydro reported the incident to regulatory agencies.

[13] BC Hydro publicly publishes all environmental enforcement orders on the Site C website: https://www.sitecproject.com/document-library/environmental-and-socio-economic-plans-and-reports.

Environment and Climate Change Canada later investigated potential noncompliance with the federal *Fisheries Act*, resulting in charges against the main civil works contractor and BC Hydro. As a result of this investigation, the main civil works contractor was fined and charges against BC Hydro were stayed.

Throughout construction, BC Hydro refined its permitting strategy to enhance coordination with regulators and deepened engagement with Indigenous communities. This included strategic permit scheduling aligned with the construction schedule, centralized management by a dedicated permitting team, and increased direct engagement with Indigenous communities. Regular Environment and Permitting Forums, launched in 2018, further supported communication and inclusive participation.[14] These successful approaches are now being adapted for other BC Hydro initiatives, including the North Coast Transmission Line.

2.1.8 Community Engagement and Mitigation of Impacts

BC Hydro recognizes that the Project has had a material effect on the surrounding communities during construction and that impacts will continue throughout Site C's operational life.

Measures to reduce the impacts of the Project on local communities included implementation of five community agreements,[15] construction of worker accommodation to reduce local housing pressures, an on-site medical clinic to reduce pressure on the local medical system, and funding for affordable housing through a Contribution Agreement with BC Housing.[16] Other measures included a $1.8 million contribution to School District 60 for 37 childcare spaces, establishment

[14] Environment and Permitting forums are regular meetings with Indigenous communities potentially affected by the project to discuss topics such as project construction, permitting requirements, and environmental and Indigenous Nations issues and concerns. The forums are attended by BC Hydro subject matter experts and Federal and Provincial regulatory agency staff. These forums allow direct communication and feedback to occur on a regular basis, which is then incorporated into permit applications and environmental mitigation and management programs.

[15] The District of Chetwynd (2013), the District of Taylor (2014), the City of Fort St. John (2016), the District of Hudson's Hope (2017), and the Peace River Regional District (2024).

[16] The Agreement structured the financial contribution from BC Hydro to enable financially viable operation of ten affordable housing units in the near-term and 50 units over the longer term.

of agricultural and community support funds totaling over $20 million,[17] creation of a $100,000 annual fund to support non-profit organizations,[18] implementation of a trades bursary fund,[19] and several donations totalling $250,000.[20]

2.1.9 Indigenous Relations and Economic Opportunities

Significant efforts were made to advance Indigenous economic opportunities, with over $876 million awarded in procurement to Indigenous-designated companies and a peak workforce of 539 Indigenous employees. Site C achieved a 23% Indigenous affiliated participation rate by vendor count, compared to a 2.4% average in the forestry, natural gas and mining sectors, and a 9.2% participation rate by supply chain expenditures, compared to an 8.5% average in those same sectors.[21] Capacity-building initiatives included pre-skills training, employment sessions, and Indigenous awareness training.

Impact mitigation for Indigenous Nations included eight Impact Benefit Agreements, the establishment of the Indigenous Traditional Use Fund to support cultural and research projects, and progress on a Cultural Centre scheduled for completion in 2027 to showcase Indigenous history and artifacts.

[17] As of September 30, 2025, the BC Hydro Peace Agricultural Compensation Fund had approved more than $4.7 million in funding to 126 projects.

[18] As of March 31, 2025, a total of 118 projects had received over $1,000,000 since the BC Hydro Generate Opportunities Fund was launched.

[19] As of March 31, 2025, a total of 295 students had received bursaries, including 137 Indigenous students.

[20] Donations include: $25,000 to Skye's Place, a second stage housing program for women with children who are leaving abusive relationships; $25,000 to the Meaope Transition House for Women that provides a 24-hour safe and secure shelter for women who are victims of violence or abuse, and their children; and $200,000 to the Salvation Army Northern Centre of Hope to support shelter and transitional beds.

[21] The participation rates in the forestry, natural gas, and mining industries were derived from three reports:

- Our Communities Care: British Columbia's natural Gas and Oil Supply Chain and Community Investment Study, 2018 – 2021, by Canadian Association of Petroleum Producers, available here: https://www.capp.ca/wp-content/uploads/2024/02/BC-Natural-Gas-and-Oil-Supply-Chain-Community-and-Investment-Study.pdf;
- Timber trust: British Columbia's Forest Products Sector Supply Chain and Community Investment Study, 2020-2022, by Council of Forest Industries, available here: https://cofi.org/wp-content/uploads/COFI-2024-Supply-Chain-Study-Technical-Report.pdf; and
- One Province, One Economy: British Columbia's Mining and Smelting Supply Chain and Community Investment Study, 2021–2022, by the mining association of British Columbia, available here: https://mining.bc.ca/wp-content/uploads/2024/01/OPOE-Report-2022-Web-Version-2.pdf.

2.1.10 Labour Attraction and Retention

A significant risk to the Project was the attraction and retention of skilled workers and key management personnel by project contractors.

To address these risks, BC Hydro implemented several measures including: providing industry-leading worker accommodation; establishing commercial contract terms aimed at labour stability; establishing a Contract Labor Committee and requiring contractor participation for the major contracts; and reviewing contractor labour turnover and rehire data to identify potential attraction and retention concerns.

Industry data on labour market supply and demand was monitored, and policies supporting a safe and productive work environment were maintained. Collaboration with unions and contractors helped monitor labour risks, while contractors developed labour sourcing and supply plans, provided notice regarding hiring foreign workers, and took part in local job fairs. BC Hydro also supported capacity-building initiatives and tracked turnover rates and labour conditions on comparable projects.

An on-site medical clinic was also established in 2016 and provided over 53,500 patient interactions, including more than 5,000 COVID-19 tests and vaccinations, contributing to workforce health, safety, and retention.

The Project reached its peak employment in June 2023 with a workforce of 6,069. Throughout the construction of the project, approximately 70% of the workforce resided in BC, approximately 6% - 10% were Indigenous workers and approximately 10% - 12% were women.

2.2 The Project Faced Challenges that Impacted Cost and Schedule

There were several factors that made the Project challenging to execute including the geological conditions at the site, the major seasonal variations in weather (from - 30°C in the winter to 30°C in the summer), wildlife considerations (such as bird nesting and bear denning) and the need to attract a large workforce to a non-urban location.

BC Hydro conducted significant studies, analysis, investigations, consultation, and planning activities before the Project commenced construction in July 2015 to understand and account for these challenges. However, even with this preparation, the Project was more complex and challenging than anticipated by BC Hydro and its contractors. Initially, both BC Hydro and its contractors faced difficulties in scaling up resources and commencing construction activities across multiple work fronts following the Final Investment Decision. This led to budget increases for project resourcing, schedule changes and contractor claims. While the performance and capacity of BC Hydro and its contractors improved as the Project progressed, these resources should have been scaled up more proactively and sooner.

The cost to complete the Project is significantly higher than the Final Investment Decision Budget of $8.775 billion, approved in December 2014. This budget was increased twice: first, in February 2018, to $10.7 billion and again, in February 2021, to $16 billion. While BC Hydro is proud of the ingenuity and determination of the Project team to resolve the challenges that led to these budget increases, we recognize the important responsibility we hold on behalf of our customers and the province to learn from this experience and apply any lessons to future major capital projects.

The first budget increase in 2018 was primarily driven by higher costs for the main civil works and generating station and spillways contracts. This was due in part to additional work following two tension cracks on the left bank slopes being excavated,

the associated contractor delays and claims and the resulting one-year river diversion delay.

The second budget increase in 2021 was driven by several factors including the COVID-19 pandemic, which led to the loss of approximately 60% of the summer 2020 construction season, delaying the Project's in-service date by one year. In addition, geotechnical challenges on the right bank required foundational enhancements for the stability of the spillways, dam core and powerhouse and enhanced water tightness for the reservoir approach channel.

While the potential for geotechnical challenges on the left bank and right bank was understood, the probability that these high-consequence geotechnical challenges would occur was considered low and the full cost if these risks were to materialize was not included in the approved Project budgets.

Extensive geotechnical studies and investigations had been completed from 1975 to 2014, prior to the start of Project construction. These activities informed the development of a detailed geotechnical model, choices on the location, design and schedule of major Project assets, and the implementation of an observational approach.

Adopting an observational approach meant that any actual geotechnical differences from the pre-construction geotechnical investigations would be addressed through design changes during Project construction. While this is an accepted approach for similar projects, and was supported by a Technical Advisory Board of international dam engineering and construction experts, it carries an inherent risk that budget amounts may not be sufficient for low-probability, high-consequence major geotechnical challenges and consequential design changes, if they materialize. These risks did materialize and were compounded by the impacts of the COVID-19 pandemic, which occurred at the peak of planned construction, maximizing cost and schedule impacts.

The lessons learned from this experience are not straightforward. Requiring future major capital projects to advance designs further prior to final Project approval and/or have project contingency and reserve amounts augmented based on low-probability, high-consequence events or contain arbitrary amounts for unforeseen risks would likely be speculative, cost prohibitive and against accepted industry best practices for cost estimating. However, the 29 lessons learned discussed in this Report across the six areas identified by the Commission should mitigate or reduce similar budget challenges on future major capital projects.

2.2.1 COVID-19 Pandemic

The global COVID-19 pandemic had significant implications for the Project schedule and cost, despite several effective mitigation measures.

2.2.1.1 Missed Construction Season, Reduced Workforce and Lower Productivity

The COVID-19 pandemic resulted in a one-year delay to the Project's in-service date from 2024 to 2025 and an estimated budget increase of $1.606 billion.

The pandemic caused workforce reductions and construction slowdowns at site, followed by several months of below-planned workforce levels. This led to about 60% of the 2020 summer construction season being missed for work on the earthfill dam, core buttress, generating station, and spillways.

Prior to the pandemic, BC Hydro expected 2020 to be one of the Project's peak workforce years. For the period of April to October 2020, BC Hydro forecasted a total workforce of about 5,000 people each month. However, due to the initial reduction in the workforce in response to the pandemic, and the subsequent gradual restart, it was not possible to meet these forecasts. For example, in April 2020, the Project's workforce was only 3,029, which was the lowest workforce level on the Project since June 2018. The Project did not reach a monthly workforce of 5,000 until October 2020 – approximately six months later than forecasted.

In 2021, the COVID-19 pandemic continued to have a significant impact on safety, schedule, scope, and cost. In particular, to reduce the risk of increased post-winter holiday transmission of COVID-19 in the north, B.C.'s Provincial Health Officer issued several public health orders in late December 2020 and early January 2021 resulting in a reduced number of on-site workers. BC Hydro was able to ramp up the number of workers on-site gradually throughout the first few months of 2021. Later in 2021, Northern Health declared two COVID-19 outbreaks on the Project. Due to the extensive COVID-19 protocols in place, the Project was not required to stop construction, and work was able to continue.

2.2.1.2 BC Hydro Adopted Effective Protocols to Advance Construction While Keeping Employees Safe

BC Hydro and its contractors took steps to allow construction work to proceed during the COVID-19 pandemic while keeping workers safe. In 2020, during the pandemic, the Project successfully and safely completed diversion of the Peace River, completed the temporary fish passage facility, completed and energized the Project substation, and placed the first of two new transmission lines into service.

To facilitate the planned river diversion, BC Hydro successfully reprioritized activities and reached agreements with contractors to accelerate work and meet schedule milestones once conditions were deemed safe.

In spring 2020, extensive measures were adopted on-site to reduce transmission risk for COVID-19. These included travel controls, health self-assessments before departure, infectious disease sanitization protocols, strict physical distancing in all areas, and mandatory temperature screenings at entry and exits to the worker accommodation lodge to detect fever. Masks were required throughout the Project site.

BC Hydro worked closely with the on-site medical clinic and the operator of the worker accommodation lodge to implement isolation and quarantine facilities and services. BC Hydro also worked with the Northern Health Authority on key initiatives

including transportation protocols to safely drive a worker home under isolation, an international travel protocol for essential workers, and a positive test protocol that assigned all positive cases to the care and oversight of the on-site medical clinic.

2.2.2 Right Bank Foundation Enhancements

During construction, BC Hydro encountered a significant geotechnical issue on the Project's right bank, which led to an estimated $1.141 billion budget increase to ensure structural stability beneath the powerhouse, spillways, and dam core areas.

The right bank had been extensively investigated prior to Project construction. During construction, instruments were installed to monitor the response of the right bank foundation. In 2018, small displacements began to occur on a bedding plane below the roller compacted concrete buttress, leading BC Hydro to reassess the expected strength of the bedrock at this depth. Further analysis confirmed the need for foundation enhancements to achieve the required structural stability. In consultation with the Technical Advisory Board, BC Hydro implemented a two-part solution: (1) installing 96 deep vertical steel and concrete piles to anchor the compacted concrete buttresses into stronger bedrock, extending the shear key function by 15–25 metres; and (2) improving the water tightness of the approach channel to prevent seepage into the foundation. These measures were supported by advanced engineering studies and validated by independent third-party dam experts in 2021, confirming the design met international safety standards.[22]

2.2.3 Tension Cracks on the Left Bank and River Diversion Delay

In February 2017, a significant tension crack developed on the left bank excavation while constructing a haul road. This was followed by a second and smaller tension crack in May 2017. The tension cracks resulted in an estimated $610 million budget increase.

[22] Additional details on the right bank foundation enhancement are provided in section 6.3.3 below.

The first tension crack, in early 2017, halted excavation work, prompting BC Hydro and Peace River Hydro Partners (the main civil works contractor) to stabilize the slope through staged construction. Although initial remediation was successful, a second crack in May 2017 led to a disagreement over schedule, remediation options and cost allocation, resulting in contractor claims and a one-year delay to the river diversion. In fall 2017, to address these challenges, BC Hydro redesigned the left bank and accelerated winter construction efforts to maintain the revised river diversion timeline.

The left bank had been extensively investigated and studied prior to project construction. It was known to contain many ancient slides with weak bedding planes, which were planned to be removed during excavation. When the tension cracks occurred, it was discovered that these weak planes extended beyond the area BC Hydro initially identified.

2.2.4 Reservoir Filling in 2024

While river diversion was achieved in October 2020, the impact of the COVID-19 pandemic and uncertainty regarding whether delayed work could be accelerated to recover lost schedule meant that the final Project in-service date was delayed to 2025. To achieve the final in-service date in 2025, reservoir filling was required to begin in fall 2024.

BC Hydro and its contractors worked to develop and agree to contractual schedules that could have resulted in an opportunity for earlier reservoir filling in fall 2023 and achieving first power earlier than planned. However, the Project's ability to meet this earlier schedule remained uncertain and as of early November 2023, there continued to be some critical work areas that needed to be completed before reservoir filling could begin, including the approach channel, spillway gates and powerhouse intake gates. With winter weather and colder conditions setting in, the window to safely begin reservoir filling was closing and in mid-November 2023, BC Hydro made the decision to maintain the planned reservoir filling for fall 2024.

2.2.5 Unit 4 Nonconforming Concrete

On December 14, 2022, the second of three concrete placements was made as part of the Unit 4 turbine spiral case embedment. Subsequent testing and observations indicated nonconforming concrete was laid during the placement. A review of the concrete batch tickets and compressive test results was performed. The review concluded that during the batching process, a delivery of fly ash was erroneously loaded into the batch plant cement silo, resulting in approximately 100 cubic metres of concrete with low cement content being produced and placed into the 1,500 cubic metre placement.

Over the course of six months, the contractor accessed the nonconforming concrete from the top of the placement and through cut-outs in the servomotor pockets and turbine pit steel liner to remove all the nonconforming concrete. In June 2023, following comprehensive inspections, BC Hydro approved the concrete replacement, and work was completed in late August 2023.

This additional work resulted in delays to the turbines and generators work, and subsequent impacts to the integration of other work with the generating station and spillways. As BC Hydro is responsible for the interfaces between contractors, these delays and impacts resulted in claims and commercial issues against BC Hydro, which were subsequently closed and addressed through settlement agreements.

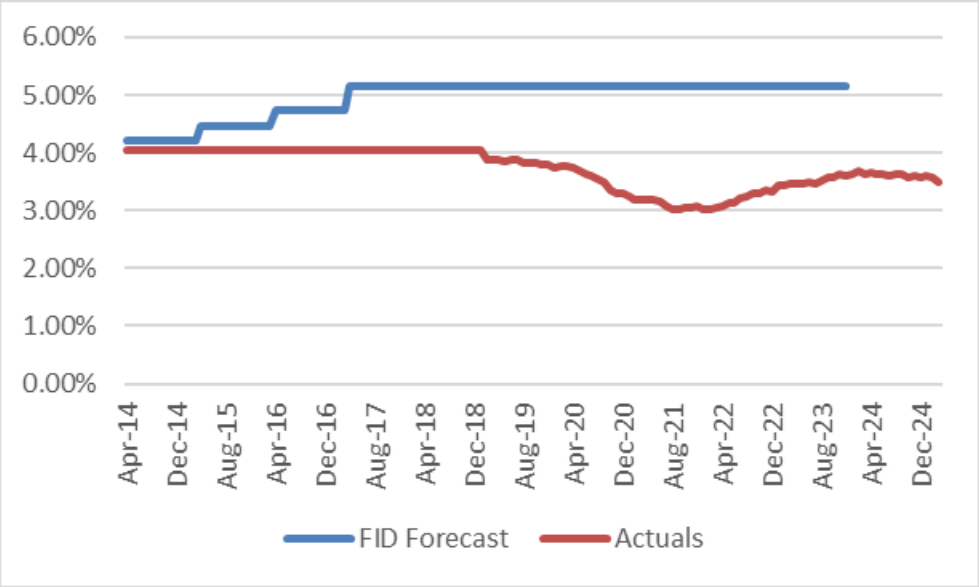
These impacts were partially mitigated by resequencing work in other areas. While the required rework did not impact the Project's critical path and the achievement of major schedule milestones, schedule adjustments and other impacts resulted in claims for time extension and additional costs.

2.2.6 Increased Interest During Construction

Budget increases and schedule delays resulted in higher overall interest costs; however, the actual interest rate during construction was lower than the rate

projected in the 2014 Final Investment Decision budget. This is shown in Figure 3 below.

Figure 3 Comparison of Interest During Construction Rates Between the Final Investment Decision and Actuals



In addition, BC Hydro undertook debt hedging to manage the risk of interest rate fluctuations.

However, despite lower-than forecast interest rates and a debt hedging program, the Project's contingency and reserve were insufficient to fully address the compounded impact of rising construction costs and the one-year schedule delay on Interest During Construction. Consequently, the Interest During Construction increased from the approved Final Investment Decision budget of $1.4 billion to $2.0 billion in the 2021 Approved Budget.[23]

[23] Budget increase includes impacts from COVID-19 and Right Bank Foundation Enhancements.

2.2.7 Increased Requirements for Internal Resourcing

The Project was more complex and challenging than anticipated by BC Hydro and its contractors. In response, BC Hydro significantly increased its internal resourcing to effectively support delivery of the Project. This led to cost increases of $368 million between the Final Investment Decision Budget and the 2018 Approved Budget and $658 million between the 2018 Approved Budget and the 2021 Approved Budget.

Increased internal resources were required to support design and scope modifications as well as emerging challenges such as tension cracks on the left bank and geotechnical issues on the right bank. Contract claims, risk management complexities, the execution of thousands of contracts, and the coordination of interdependencies among them also contributed to the need for increased internal resourcing.

While the performance and capacity of BC Hydro and its contractors improved as the Project progressed, these resources should have been scaled up more proactively and sooner.

2.2.8 Redesign of Penstock Upper Flexible Couplers

A significant challenge arose during construction of the penstocks with the penstock's upper flexible coupling. In June 2021, during the field-testing and verification process for the Unit 1 penstock upper flexible coupling, the coupling failed its hydrostatic pressure test. The contractor proceeded with a series of modifications and re-tests to the coupling between October 2021 and November 2022. During this time, it became apparent to BC Hydro that the root cause of the issue was the contractor's design of the coupling, which was initially accepted by BC Hydro, and it was unlikely that the original coupling could be successfully modified to achieve the specification requirements for accommodating structural movements and seasonal temperature changes while remaining watertight.

In September 2022, BC Hydro directed the contractor to initiate a new design in parallel with remaining tests on the original design. In November 2022, the new design was completed, and the contractor fast-tracked multiple activities including procurement of materials, securing a manufacturing location, designing, and building the requisite tooling and equipment to manufacture the couplings, proceeding with manufacturing, and developing a plan to remove the existing coupling on the Unit 1 penstock and to install the replacement upper couplings on all six penstocks.

The first upper coupler was completed, delivered to site, and installed in February 2024, with the final upper coupler installed in October 2024. To date, the replacement couplings have performed in accordance with the design requirements for leakage and have accommodated structural movements.

The delay and impacts caused by the rework were partially mitigated by resequencing work in other areas. Since BC Hydro had accepted the original design, the redesign of the upper flexible couplers resulted in BC Hydro contributing an estimated incremental cost of $55 million, which covered redesign, supply, installation, schedule delays, interface coordination, and additional Project resources.

Costs contributed by BC Hydro were funded from the generating station and spillways budget, with no draw on Project contingency. Completion was delayed 16 months, from June 2023 to October 2024. The work did not impact the Project's critical path and therefore did not impact the major schedule milestones of reservoir filling or the Unit 1 in-service date. However, schedule adjustments and other impacts resulted in claims for time extension and additional costs.[24]

[24] This issue is further discussed in Table 19 in section 5.3 below.

3 BC Hydro's Project and Portfolio Management Framework and Lessons Learned Practice

This section outlines BC Hydro's Project and Portfolio Management framework, which is an industry-leading corporate framework for project management. This framework was applied to the Project and includes, among other components, the Lessons Learned Practice that BC Hydro has incorporated into the preparation of this Report.

A significant number of data points were collected during the Project's construction phase to inform potential lessons learned. Following BC Hydro's Project and Portfolio Management process, these data points could be entered by any team member. Lessons learned were then further developed, validated, and refined through a series of workshops over the past year, including with the Project Assurance Board. These lessons build upon earlier recommendations and guidance from oversight bodies and feedback obtained through engagement with Indigenous Nations and local communities.

This section is organized as follows:

- Section 3.1 explains that BC Hydro's Project and Portfolio Management framework is mature and can be tailored to specific project circumstances;
- Section 3.2 describes BC Hydro's mature Lessons Learned Practice;
- Section 3.3 sets out how BC Hydro has tailored its Lessons Learned Practice to the Project; and
- Section 3.4 describes how the lessons learned on the Site C Project will be available as a resource for future projects but will need to be adapted as appropriate, based on the circumstances.

3.1 Project and Portfolio Management Is a Mature Framework that Can Be Tailored as Needed

Project and Portfolio Management is BC Hydro's corporate framework for managing engineering, construction, and other types of projects, and includes the project lifecycle, practices, processes, procedures, job aids, and software tools.[25] As discussed further below, independent experts have found BC Hydro's Project and Portfolio Management framework to be mature and industry leading. The framework was adapted to meet the scale and complexity of the Project and contributed significantly to its success.

The main components of Project and Portfolio Management are a single standard set of defined practices with additional sub-practices, a suite of tools used to manage different elements of a project, and a learning component which involves people development and sharing knowledge and experiences. The single standard set of practices lay out the framework of Project and Portfolio Management, covering the requirements, rationale, and responsibilities in each area of project delivery. This promotes quality, accuracy, efficiency, and consistency, while minimizing risk.

Project and Portfolio Management has 17 practice areas, including: project management (which includes the project governance and project risk management sub-practices, amongst other sub-practices); design (which addresses geotechnical design considerations); construction and contract management; procurement; stakeholder engagement; and Indigenous relations. Each of the six areas identified by the Commission in its May 6, 2025, letter requesting this Report is included in one of the practices or sub-practices within Project and Portfolio Management.

In 2016, BC Hydro's Project Management Office and Project and Portfolio Management framework were assessed by the Project Management Institute's

[25] Project and Portfolio Management is based on standard project management principles and is consistent with industry standards such as the Project Management Institute's Project Management Book of Knowledge and the Association for the Advancement of Cost Engineering International Recommended Practices. PPM is structured as a Quality Management System, consistent with the principles of ISO 9001, 2008 Quality Management Systems - Requirements.

certified auditor based on the institute's Organizational Project Management Maturity Model Assessment. BC Hydro received a maturity rating of 91%, which was the highest score ever given, globally, by a certified auditor. Later that year, BC Hydro won the institute's Project Management Office of the Year award for demonstrating superior organizational project management abilities.

BC Hydro regularly engages third-party assessments of our Project and Portfolio Management framework to identify opportunities for improvement. In 2021, BC Hydro completed a third Organizational Project Management Maturity Model assessment and achieved a 100% maturity score in all four categories: Organizational, Project Management, Program Management, and Portfolio Management.

3.2 BC Hydro Has a Mature Lessons Learned Practice

BC Hydro's Lessons Learned Practice is in place to support project teams in identifying, analyzing, and applying insights to improve the delivery of current and future projects. It consists of the following four key features:

- **Lessons Learned Database:** BC Hydro stores lessons learned in the Lessons Learned Database that can be queried by project team members at any time. Best practice requires teams to regularly search for lessons learned in the Lessons Learned Database so that newly raised and specific lessons learned can be applied to a project, generally during key project milestones and activities (e.g., at the start of the Identification Phase, when the project is newly initiated, before a major procurement event, etc.).

  When relevant lessons learned are identified from the Lessons Learned Database, the project manager ensures they are discussed with the project team and considered and incorporated into project processes and documentation such as the Risk Register, Supply Chain Strategy, Contracting Plan, Project Plan or Quality Assurance Plan.

- **Sharing of Lessons Learned:** Lessons learned are shared with project teams and across the organization through various means such as project team meetings, newsletters, training sessions, project manager presentations, and lunch and learn sessions.
- **Ongoing Collection of Data:** Lessons learned are collected in the Lessons Learned Database in a timely manner throughout the project lifecycle. Key opportunities for collection include major design milestone completions, safety or reliability incidents, risk assessments, asset commissioning, and final project evaluations.
- **Continuous Improvement:** To support continuous improvement of both the Lessons Learned Database and BC Hydro's Project and Portfolio Management practice areas, BC Hydro conducts periodic audits with Project and Portfolio Management practice leads who are responsible for developing and maintaining the standard practice for their respective practice areas. These reviews validate all existing and new lessons learned and may lead to updates to the practice or new training to close knowledge gaps.

3.3 BC Hydro Tailored the Lessons Learned Practice for the Project

The Project adopted BC Hydro's Lessons Learned Practice and tailored it to meet the specific needs of the Project.

As BC Hydro's largest capital project, Site C maintains its own dedicated lessons learned database. Throughout the Project, various teams contributed data points identified as potential lessons learned.

In 2024 and 2025, BC Hydro conducted workshops to gather additional lessons learned on the Project. Workshops have been held and are planned with functional groups (such as engineering, legal, procurement, etc.) and from subproject areas

(such as main civil works, generating station and spillways, turbines and generators, etc.). These workshops will continue as the Project progresses toward completion.

3.4 Lessons Learned Will be a Resource for Future Projects but Must be Adapted to Particular Circumstances

The lessons learned outlined in this Report will be a valuable resource for future capital projects. To support effective planning and delivery, BC Hydro teams are encouraged to tailor lessons learned to the specific scale and complexity of each project. The standard Lessons Learned Practice framework described above enables teams to individually review the full Lessons Learned Database, apply relevant insights appropriately, and benefit from ongoing refinement of both the Lessons Learned Database and Project and Portfolio Management practices. This adaptive approach ensures that lessons learned are meaningfully integrated into future projects, supporting continuous improvements across BC Hydro's portfolio of capital projects.

The Project stands out within BC Hydro's capital portfolio due to its unique scale and complexity, as the largest project undertaken since the 1980s and significantly larger than any project within BC Hydro's current 10-Year-Capital Plan. Therefore, while lessons learned from the Project are valuable, the extent to which they apply to future BC Hydro major capital projects will vary depending on project-specific circumstances.

4 Contract Management

This section addresses Contract Management. It describes how potential contractors are vetted and awarded, how the work delivered corresponds to contract obligations, the claims management process, including how claims are raised, evaluated, tracked, and settled with contract counterparties, as well as lessons learned.

Over 2,000 contracts were awarded over the life of the Project, ranging in size from major (> $500 million) to small (< $10,000).

A key contract management challenge on the Project was the use of consortiums with limited Canadian experience and minimal experience working together. Proponents often form consortiums when bidding on scopes of work for major projects because of the broad expertise and capabilities required. This introduces several complexities that must be considered in the evaluation criteria such as financial and liability requirements, the experience of the consortium team members working together, their experience working in British Columbia or Canada, their experience working on major projects, and the ability of the consortium to ramp up their activities at the pace required for multiple active work fronts. For future major projects, where applicable, evaluation criteria must be defined for these considerations, and procurement submissions should include and be evaluated on an entity integration plan outlining roles and responsibilities, interdependencies between entities, authority limits, and labour attraction and retention strategies.

A key challenge from these design and schedule changes was the capacity required to assess and address contractor claims and other commercial issues. While the Project ramped up resources and implemented several actions to proactively manage claims over time, including a dedicated commercial management team, these resources should have been scaled up more proactively and sooner. Going forward, it will be critical for BC Hydro to continue to build its commercial capacity and to plan to ramp up dedicated contract and commercial management resources, with representation on the project leadership team, earlier in the project lifecycle to

effectively manage the commercial impact of contractor claims. Where applicable, future major capital projects should ramp up these resources from the outset.

This section is organized as follows:

- Section 4.1 explains how potential contractors were vetted and how contracts were awarded;
- Section 4.2 explains that the Project employed several measures to facilitate contractual oversight and compliance so that contractors met their obligations;
- Section 4.3 explains that the Project's claims management process was successful in resolving claims early, before contract completion, and benefited from the implementation of the recommendations from the Site C Review Report completed by Mr. Peter Milburn (**2021 Milburn Report**); and
- Section 4.4 describes the six lessons learned from the Project regarding Contract Management:
  - **Lesson CM1:** Establish criteria for the evaluation of consortium bidders on major contracts with special consideration to the capacity and capabilities of parties to be able to ramp up to delivery across all required work fronts;
  - **Lesson CM2:** Assess and manage the impact of numerous work front interfaces among contractors to optimize performance and minimize potential claims;
  - **Lesson CM3:** Implement processes and have senior leadership involved early to set the tone and expectations to assess and address contractor claims in a timely manner to avoid significant cost claims at contract completion;
  - **Lesson CM4:** Develop and provide project teams with the training, tools, and processes, including production tracking, to support consistent contract management across the scope and duration of the project. The project team

needs to know and understand the contract and schedule prior to starting work;

- **Lesson CM5:** Establish and maintain an integrated project schedule across all contracts to evaluate schedule variances and changes across a large complex project. The overall schedule and cascading interface risks are difficult to transfer and need to be managed by the project team with oversight by senior leadership; and
- **Lesson CM6:** Establish processes to support early and continuous engagement with contractors (including planned, proactive, and responsive engagement). Facilitate early contractor and owner relationship expectations and manage the relationship through the lifecycle of the project.

4.1 Vetting of Contractors and Awarding of Contracts

This section describes the procurement approach for the Project, including how potential contractors are vetted and how contracts are awarded.

4.1.1 Procurement Approach Was Tailored for the Project

The procurement approach for the Project was designed to support project objectives, including providing economic opportunities for Indigenous groups, northern communities, and the Province. The Project developed this approach through the following three-step process:

- **Step 1 – Component Definition:** This step involved breaking down the project scope into major components based on scope, geography, and construction logistics. Major components included:
  - Major earthworks (the earthfill dam);
  - Generating station and spillways and turbines and generators; and
  - Ancillary elements (transmission lines, reservoir clearing, highways, worker accommodation, and other infrastructure).

This classification guided work packaging for procurement, contracting, and construction interfaces.

- **Step 2 – Packaging:** This step involved evaluating combinations of components based on benefits, costs, and risks, and developing contract packaging options for each. Scheduling and sequencing requirements informed procurement timing and site access needs as well as logistics and material supply.
- **Step 3 – Model Selection:** This step involved screening and evaluating procurement models for each component package. Key considerations included scheduling and sequencing, procurement risks and associated mitigation measures, economic conditions, Indigenous opportunities, and project timing. The evaluation assessed factors such as interface risk, design complexity, cost certainty, owner control, risk allocation, and the potential for disputes. This step also identified how the engineering, supply, installation, and commissioning would be sourced. Various models were considered for construction contracts including design bid build, design build, and design build, finance, operate and maintain.

KPMG, as financial advisor to the Project, established a Due Diligence Advisory Team, and was available throughout the development of the procurement approach to provide strategic advice on procurement, commercial, and financial considerations.

The Project team developed contracting plans and conducted market soundings to evaluate industry capacity, interest, and feedback on delivery strategies. Contracting plans, created to secure approval before drafting procurement options, included risk assessments covering constructability, safety, permitting, environmental factors, and other project-specific concerns. Market sounding involved engaging potential contractors and interviewing Canadian utilities, Crown corporations, and developers of international hydroelectric projects to understand market conditions and improve

bidder quality. These steps informed contract packaging and procurement models, validated risk assumptions, aligned market capabilities with project needs, and supported the bidding, evaluation, negotiation, and awarding of contracts. The findings from this work were consolidated in the Project Procurement Options Report that was approved by BC Hydro's Board of Directors in 2012.

4.1.2 Procurement of Major Contracts

The standard procurement process for major contracts includes three phases - bidding, evaluation, and negotiation:[26]

- **Bidding Phase:** This phase involved coordinating site visits, information sessions, and a questions and answers process to support bid accessibility. Early collaboration through meetings and staged procurements promoted information exchange and issue clarification, improving commercial outcomes. An electronic data room was also used to share key data, such as geotechnical information for the Main Civil Works contract.
- **Evaluation Phase:** An evaluation team conducted comparative reviews, assigned interim rankings and points, and documented their rationale. Fairness monitors were also involved for some major contracts.

  The process involves three key roles:

  - Neutral facilitator, who oversees the evaluation, appoints evaluators, ensures conflict of interest clearance, and coordinates the final report;
  - Evaluators, who review bids using set criteria; and
  - Subject Matter Experts, who provide specialized input but do not participate in scoring or decision making. Standard evaluation criteria for construction bids included cost, methodology, safety, environment, financials, and company experience.

[26] There are exceptions to this standard procurement process such as direct awards to Indigenous Nations.

The evaluation team reviewed interim findings, reached consensus on final rankings and scores, and sought clarification, reference checks, or additional Subject Matter Expert input, as required. Points were assigned based on bid merit, with cost evaluations considering total costs and risk adjustments. BC Hydro's Treasury Department assessed the bidder's financial capacity and risk using financial data. The Evaluation Report, documenting all decisions and inputs, was signed by the evaluators and final awards were based on the evaluation recommendation and management approval.

- **Negotiation Phase:** As appropriate, BC Hydro would negotiate with the preferred bidder on price and contract terms. If negotiations failed, BC Hydro either approached another bidder, terminated the bid, or sought alternative solutions. Some contracts did not require a negotiations phase due to fixed commercial terms or full bidder acceptance of BC Hydro's terms and conditions.

4.1.3 Contract Awards and Exceptions

After successful negotiation, a recommendation to award memo was prepared. Contract financial commitments greater than $50 million (this was subsequently updated to $75 million) were approved by the BC Hydro Board of Directors. Unsuccessful bidders received regret letters and could request debriefings.

Some contracts followed exceptions to the standard bidding, evaluation, and negotiation phases, as contemplated under BC Hydro Procurement guidelines. These exceptions are summarized in Table 4 below.

Table 4 Exceptions Allowed Under BC Hydro Procurement Guidelines

Procurement Type		Description
1	Direct Procurement to Indigenous Nations	Procurement opportunity provided by BC Hydro to designated Indigenous Nations businesses.
	1a – Indigenous Nations Direct Award	Non-competitive. Used when a single Indigenous Nations Designated Business is identified by an Indigenous group with an agreement.
	1b - Indigenous Nations Select Competition	Competitive. Used when two or more Indigenous Nations Designated Businesses are identified by one or more Indigenous groups with agreements. Requires recommendation from BC Hydro's Indigenous Relations Key Business Unit.
2	Ministry of Transportation and Transit	Coordination agreement for Highway 29 realignment.
3	Other Direct Awards	Direct contract awards outside of Indigenous Nations (e.g., contracts for legal services, contracts to address an emergency), or specialty contractors.
4	Work Order via Master Service Agreement	Procurement through existing Master Service Agreement work orders.

Table 5 below provides a summary of the construction contracts over $100 million awarded for the Project.

Table 5 Summary of the Contracts Awarded Over $100 Million

Contract	Contractor	Procurement Model	Contract Award Date
Main Civil Works	Peace River Hydro Partners	Design Bid Build with Design Build elements	December 2015
Generating Stations and Spillways - Civil	Aecon-Flatiron-Dragados-EBC	Design Bid Build with Design Build elements	December 2017
Balance of Plant– Electrical, Fire Protection, Architecture, and Heating and Ventilation	F&M Installations Ltd.	Design Bid Build / Design Build	September 2021
Balance of Plant – Mechanical	Mitchell Installations Ltd.	Design Bid Build	July 2021
Balance of Plant – Permanent Upstream Fishway and Other Out Structures	Aecon-Flatiron-Dragados-EBC	Design Bid Build	January 2022
Hydromechanical equipment	ATB Riva Calzoni Hydro Canada Inc.	Design Build (Supply)	April 2018

Contract	Contractor	Procurement Model	Contract Award Date
Turbines & Generators	Voith Hydro Inc.	Design Build	March 2016
Worker Accommodation	ATCO	Design Build, Finance, Operate and Maintain	September 2015
Highway 29 Realignment	Ministry of Transportation and Transit	Design Bid Build	April 2011 (Coordination Agreement)

4.2 Contract Oversight and Compliance

This section explains the measures employed by the Project to facilitate contractual oversight and compliance so that contractors met their obligations.

Contracts on the Project included terms that defined performance, set reporting requirements, and mandated adherence to regulatory requirements. The contracts generally adopted the BC Hydro standard templates, but larger contracts were often tailored depending on size or scope.

Each contract detailed how the contractor was required to carry out the work, its obligations with respect to scope, schedule and costs, and the way in which the work would be managed. Most of the obligations were assigned to the contractors, but the contracts also detailed the obligations for BC Hydro in interacting with the contractor such as review timelines, approvals, and acceptance criteria. The Project scope and regulatory requirements were incorporated into each of the contracts as required. For example, the Environmental Impact Statement and Environmental Assessment Certificate for the Project required the inclusion of some obligations related to matters such as regulatory and permitting requirements, consultation, and community engagement.

Contractors were required to provide evidence that work had been completed in accordance with the contract terms and provisions. Once the Project team determined that the contractor obligations had been met, the contractor was paid for

that particular scope of work. The contractor was obligated to fulfill all the contractual requirements to achieve full payment within the contract.

4.2.1 Key Contract Provisions

Major contract templates contained the following key contract provisions:

- **Work Program and Schedule:** The contractor was required to plan, update, and report work progress through a detailed, resource-loaded schedule using specialized tools. A qualified scheduler was required to create and maintain this schedule, which served as the baseline for all updates. Monthly progress reports and weekly three-week look-ahead schedules were required to forecast work, detect delays, and propose corrective actions.
- **Submittals Procedure:** These provisions set out the documents and data (e.g., plans, reports, and test results) that would be prepared and submitted by the contractor to BC Hydro to demonstrate how the contractor was fulfilling their contractual obligations.
- **Specifications and Drawings:** These provisions defined the work scope, technical standards, materials, and methods so that the completed work met the contractual requirements.
- **Environmental Obligations:** Contractors were required to comply with all environmental laws, regulations, and project-specific requirements. Contractors were required to appoint a qualified Environmental Manager with knowledge of the specific environmental requirements. Contractors were responsible for ensuring all personnel, including subcontractors, understood and followed environmental requirements and were required to implement preventative and corrective actions and cooperate with BC Hydro to adjust plans, as needed. In addition, collaboration with BC Hydro on mitigation design and participation in environmental audits was required.

Contractors were also required to develop a comprehensive Environmental Management Plan by qualified environmental professionals, detailing roles and management strategies. Detailed, site-specific Environmental Protection Plans had to be prepared and approved by a qualified environmental professional to confirm compliance.

- **Quality Management:** Quality management provisions set out how the contractor demonstrates compliance with technical requirements through a Quality Management System. This includes obligations for Inspection and Test Plans, handling non-conformities, and conducting audits as well as the processes and controls in place to maintain quality during work execution and the documentation requirements to provide transparency and accountability.
- **Safety:** Contractors were required to ensure the health and safety of all on-site personnel and in certain cases, were designated as the Prime Contractor for specific areas, requiring appropriate knowledge, training, and capability to perform that role. If assigned to that role, the contractor was required to manage safety in those areas, coordinate with other contractors, and comply with all safety laws including the reporting on safety incidents and near miss events.

  Contractors were required to prepare and regularly update a Site Safety Management Plan that aligned with BC Hydro's standards, covering hazard identification, emergency response, training, and coordination. Safe Work Procedures had to be developed by qualified personnel for each activity, complying with WorkSafeBC and other regulations. Noncompliance could lead to stop work orders and potential liability for the contractor and/or BC Hydro.
- **Prices and Payment:** The prices and payments provisions explained how the performance of the work performed by the contractor would be measured for the purposes of payment against the price items that were set out in the contract.

Contractors are required to submit monthly payment requests showing how much work has been performed, and the request must follow a specific format and include forecasts. Once received, BC Hydro reviewed the request and either approved it or explained any disagreements. Once approved, the contractor sent an invoice for the agreed amount.

Prices and payment provisions may also include provisions for advance payments designed to support the contractor's cash flow, particularly at the start of the contract, so that they have adequate funds to mobilize and commence work in a timely manner.

Payment is a key motivator for contractors to fulfill their contractual obligations. Specific payments were tied to pre-mobilization requirements such as obtaining performance security and appropriate insurance, as defined in the contract. Similarly, de-mobilization payments were structured so that all deficiencies were addressed and all recorded and marked up 'Issued For Construction' drawings were endorsed as "accepted" before the contractor fully de-mobilized from site.

Amounts were held back to complete or correct any deficiencies. Additionally, payments were tied to interface milestones, which are critical dates when one contractor must hand over an area or system to another contractor. This approach helped ensure that interface milestone dates were met, reducing delays, and improving coordination between contractors.

Lastly, provisions related to performance securities (performance bonds, letters of credit, or parent company guarantees) were included to provide financial and legal safeguards so that the obligations of the contractor could be fulfilled in accordance with the terms of the agreement.

- **Changes:** Change provisions govern how modifications to scope, schedule, or cost are managed. When a change is considered, BC Hydro may issue a Preliminary Change instruction. The contractor must then submit a Change

Report detailing the scope, schedule impact, cost estimates, potential savings, mitigation, required actions, and subcontractor input. If the report is not accepted, only approved third-party costs would be reimbursed.

If the contractor believed an undocumented change had occurred, they could submit a claim with supporting records and a Change Report within a set timeframe. Failure to complete these steps in the required timeframe could invalidate the claim if it limited BC Hydro's ability to respond. BC Hydro could accept, reject, or seek clarification of such claims. If rejected, the contractor could issue a Dispute Notice within the required period. Finalized changes were documented in a Change Order signed by both parties.

- **Dispute Resolution Procedure:** The dispute resolution procedure begins with a Dispute Notice, detailing the nature of the dispute, the relief sought, and relevant contractual provisions. If the matter remained unresolved, it proceeded to settlement meetings between senior representatives. If no resolution was reached within specified timeframes, either party could issue a Referee Notice to appoint an independent Referee.

  The Referee conducts an impartial, confidential review, possibly involving site visits and expert consultations and issues a decision. The decision may be challenged within the contractually defined period. If the Referee does not render a decision, or the dispute is unresolved after a certain timeframe, the matter may proceed to final resolution by binding arbitration. Related disputes may be consolidated, and contractors were required to include similar dispute resolution terms in any subcontracts.

4.2.2 Project Plans

A comprehensive set of internal project plans were developed to support the delivery of the Project. Plans related to contract management included:

- **Contract Management Plan:** Provides guidance for managing contracts on the Project so that all activities are conducted in a consistent, transparent, and accountable manner. In addition, each major contract team developed a contract specific contract management plan at the time of contract award;
- **Project Quality Plan:** Outlines the requirements, principles, and processes necessary so that materials, equipment, and constructed works meet contract technical specifications and quality standards, while also providing guidance on best practices to support successful project delivery; and
- **Project Deficiency Management Plan:** Details the processes, procedures, tools, and systems used to identify, record, track, manage, and resolve contract and project deficiencies.

BC Hydro worked hard to support effective relationships and communications with contractors throughout the Project. This included frequent meetings between representatives, joint scorecard development and reporting and joint safety walkdowns of the site.

4.2.3 Contractual Oversight and Contractor Compliance

Several measures were implemented to support contractual oversight and contractor compliance:

- **Oversight:** A BC Hydro Representative from the Construction Management team would oversee on-site implementation, including contract administration, progress payments, and change orders, working closely with Resident Engineers and Quality Managers to ensure installations met design specifications and contractual standards.

  Supporting teams would include Environmental Management, Safety Management, and Contract Management. Environmental Managers ensure compliance with mitigation measures and coordinate with other teams to prevent incidents. The Safety team, in conjunction with Construction

Management, ensure that WorkSafeBC requirements and project safety protocols are integrated into the work schedule. Contract Managers assist with daily contract activities such as payments and change management.

In some cases, Interface Managers would be appointed to coordinate across contracts and disciplines, align timelines, clarify responsibilities, and manage handovers by resolving deficiencies and maintaining project continuity.

- **Contract Templates:** Standard Project and Portfolio Management Contract Management templates are available for all stages of the contract lifecycle – from the kick-off meeting to contractor performance evaluation to contract closeout. Given the size and complexity of some of the Project contracts, templates were customized as required.

  These templates improved workflow efficiency and ensured that contractual obligations were clearly defined, consistently applied, and actively monitored. By standardizing language and format, they reduced ambiguity and made it easier to verify that deliverables, timelines, and performance standards aligned with agreed-upon terms. They also facilitated accurate documentation and traceability, helping to confirm that work completed corresponded to contractual requirements.

- **Quality Management Program:** Alongside standardized contract administration tools, BC Hydro's Quality Management Program provided a structured framework so that work met design and regulatory standards.

  Contractors were responsible for quality control, including testing, monitoring, documentation, and managing non-conformance with design. BC Hydro oversaw quality assurance through witness and hold points, quality audits, and discussing quality issues with contractors.

  BC Hydro's Engineering Design Team was responsible for the quality of the engineering design, including design features for safety and environmental protection, and reviewed contractor designs, field changes, and

non-conformances. The Resident Engineering team, which included BC Hydro staff, consultants, and specialists, was responsible for on-site quality surveillance and followed a detailed plan to ensure compliance with technical, safety, and environmental requirements. Specialists from independents labs were engaged, as necessary, to validate contractor testing. In 2018, a dedicated Lead Auditor was retained to conduct audits under the Project Quality Plan and Audit Program Guideline.

In addition, a Non-Conformance Reporting process was put in place to address quality issues. It contained six-steps: submission, review, disposition, root cause analysis, corrective/preventative actions, and verified closure. Monthly logs of any non-conformances were submitted for each contract.

4.3 Claims and Commercial Management Process

This section discusses the Project's claims and commercial management process, including how claims are raised, evaluated, tracked, and settled with contract counterparties.

The Project's claims management process was successful in resolving claims early, before contract completion, and benefited from the implementation of the recommendations from the 2021 Milburn Report.

Claims management is part of the BC Hydro Project and Portfolio Management Contract Management practice. This work is typically carried out within the project management and contracts and construction teams as part of their duties as the contract owners and BC Hydro representatives. The scope, scale, and complexity of the Project, and resulting claims, required significant commercial support.

4.3.1 2021 Milburn Report Recommendations Improved the Project's Commercial Management

In July 2020, the Minister of Finance and the Minister of Energy, Mines and Low Carbon Innovation commissioned Mr. Peter Milburn to provide a report (**2021 Milburn Report**). Among other things, the report reviewed and assessed the governance and reporting structure in place for the Project, examined the latest identified cost, schedule, geotechnical and scope risks and assumptions associated with the Project, examined how and when actual and forecast assumptions and risks changed, and reviewed and assessed risk management for the Project, as well as contract supervision.

In response to recommendations from the 2021 Milburn Report,[27] the Project formed a dedicated, centralized Project Commercial Management team and developed a Project-specific Commercial Management Plan.

The Commercial Management team had two focus areas: Commercial Governance and Compliance, and Commercial Claims and Disputes Management. The key objectives of the team included:

- Continuing to assert the Project's contractual rights to resolve contract disputes;
- Minimizing cost and schedule impacts to the Project for the resolution of disputes;
- Identifying areas of potential contractor leverage and developing strategies to advance the Project's interests; and
- Minimizing interface issues and disputes from one contractor to the other contractors.

The Commercial Management team sought timely resolution of commercial issues before they escalated into major claims or disputes. This team included a

[27] https://www2.gov.bc.ca/assets/gov/farming natural resources and industry/electricity alternative energy/electricity/site_c_milburn_report_final_redacted.pdf.

Commercial Governance sub-team which led practice improvements, facilitated lessons learned workshops and facilitated the development and delivery of contracts and commercial training across the Project team. The team also included a Claims and Dispute Management sub-team which led major claims and supported large claim resolution.

In-depth claims oversight workshops were held regularly with Ernst & Young, as the Project's Independent Oversight Advisor. These workshops focused on reviewing claims and assessing impacts of claims on project cost, schedule, and risk. Supporting documentation such as change reports, estimating analyses, change orders, and settlement agreements were provided in advance to facilitate review. Ernst & Young also met with Commercial Management Senior Managers regularly to identify opportunities to improve commercial management processes and practices on the Project.

4.3.2 Claims Management Process

Claims commonly arise during major infrastructure projects due to work changes, delays, contract interpretations, payment disputes, and performance issues. Force majeure events and third-party interference can further complicate contract execution. The Project managed claims through the following key processes:

- **Identification:** All claims required applicable notices under contract provisions to enable BC Hydro to conduct further investigation. All contracts included a provision outlining the process for managing changes throughout the project lifecycle. The contractor could submit a Claim for Change if they alleged that a Change to the work had occurred which was not already captured in the contract scope including any applicable change orders. In accordance with the contract, each Claim for Change had to be submitted in the form of a Change Report. The Change Report was required to include all information necessary for BC Hydro to evaluate and analyze the claim.

A database application was used to support the Project in managing cost and changes for construction contracts that were over $1 million. Contract pay items, payments, adjustments, and change orders were tracked in the application along with contemplated changes, claims, and disputes. Claim information was continuously updated to provide quick visibility on current commitments, contract amounts, remaining contingency, and estimate at completion.

A claims management dashboard was developed using claims data and was used to track all commercial risks including Claims for Change, Notices of Delays, and Dispute Notices. This dashboard provided metrics and detailed information for all claims received. This information was summarized and reported to the Project Assurance Board and Commercial Sub-Committee and included in the monthly Project Report.[28]

- **Evaluation and Resolution:** The Project team worked proactively to address claims in a timely manner. If BC Hydro could not determine what a contractor was entitled to receive based on the claim as submitted, the contractor would be asked to either withdraw the claim or provide additional information to support the claim.

  If further assessment confirmed that the claim had entitlement or merit, it would be resolved under the Contract Change process with a change order. If BC Hydro and the contractor were unable to agree, a Mandate document could be used to seek management approval to negotiate a resolution of the claim with the contractor. The Mandate document outlined the potential risks, strategic approach, and rationale for the proposed resolution, and the financial impact and status of the contract.

  The Project's Commercial Governance team would conduct compliance reviews of all negotiation and settlement documents to ensure accuracy,

[28] Further discussion is provided in section 4.4.4.

completeness, and consistency before they were shared with the contractor. A governance memorandum would also be prepared outlining key financial, scheduling, and interface considerations of the new agreement to support management's review and approval.

For events that impacted multiple contractors, such as the COVID-19 pandemic, the Commercial Governance team developed a project-wide plan to provide a consistent and coordinated response in alignment with contractual obligations across all affected contractors.

If the parties reached an agreement, a change order could be executed. The claim could also be consolidated with other unresolved issues into a broader settlement agreement. Settlement provisions would include an appropriate release of the claim and issues, and associated documents such as contract amendments or change orders were executed.

If the parties were unable to reach an agreement on a disputed claim, contracts included a tiered escalation process, including senior management engagement, referral to a Referee and, if necessary, ultimate resolution through arbitration.[29]

- **Monitoring, Reporting and Oversight:** Claims were actively monitored through a structured and ongoing set of meetings and reports.

  During peak construction, weekly meetings were held between the Project leadership team, Commercial Management, Finance, Legal, Project Managers, Construction Management, and Ernst & Young, as the Independent Oversight Advisor. Status updates on key commercial risks and planned mitigation activities for each subproject were prepared for each meeting.[30]

[29] Refer to section 4.3.21 above for more information on the dispute resolution process.
[30] As construction activity reduced, the frequency of the meetings was also reduced.

In addition, an internal monthly meeting summarizing all open claims, including their assessed values, and statuses, was held with Contract Owners providing updates on open claims and commercial risks to the Project leadership team.

In addition to these meetings, the Project governance structure included two key oversight bodies regarding claims: the Project Assurance Board, formed in 2018, and the Commercial Sub-Committee, formed in 2021. The Project Assurance Board provided independent due diligence and oversight of the Project. The Commercial Sub-Committee is a sub-committee of the Project Assurance Board and provided oversight of the various commercial issues related to the construction of the Project. It also reviewed and formulated endorsements to the Project Assurance Board with respect to contractual claims and negotiations, commercial strategies, settlement agreements, and related matters.[31] Updates on commercial issues and a summary of claim metrics were included in the monthly Project reporting to the Project Assurance Board and were discussed during monthly meetings. In addition, a claims trend chart was included in the monthly Project Accountability report.

Feedback from Ernst & Young, the Project Assurance Board, and the Commercial Sub-Committee led to several enhancements to the contract management application, claims dashboards and reports over time, improving visibility into commercial risks and traceability of claims-related activities.

[31] The roles of the Project Assurance Board and the Commercial Sub-Committee and their terms of reference are discussed further in section 7.1 below.

4.4 Lessons Learned – Contract Management

This section describes the six lessons learned from the Project regarding Contract Management.

4.4.1 Lesson CM1: Establish Criteria for the Evaluation of Consortium Bidders on Major Contracts with Special Consideration to the Capacity and Capabilities of Parties to be Able to Ramp up Delivery Across all Required Work Fronts

Lesson CM1 is to establish criteria for the evaluation of consortium bidders on Major Contracts with special consideration to the capacity and capabilities of parties to be able to ramp up to delivery across all required work fronts. The choice of consortium can have significant impacts on project outcomes, particularly the cost and schedule. In the early stages, the Project experienced challenges with consortiums who did not fully understand and appreciate the local conditions and regulations, resulting in delays to the work. These challenges were compounded because the consortium team members had minimal experience working together which led to inefficiencies and delays as the team mobilized and commenced work at site. Over time, these issues improved, and those contracts were successfully completed.

In large-scale infrastructure projects that involve high-value and complex scopes, it is common for bidders to form consortiums or partnerships to deliver the work. These consortiums allow for the pooling of specialized expertise, financial resources, and operational capacity, which are often necessary to meet the demanding requirements of such projects.

BC Hydro entered into agreements on the Project with consortiums or partnerships for the major contracts associated with Main Civil Works, Generating Stations and Spillways, and Balance of Plant - Permanent Upstream Fishway and Other Out Structures. However, BC Hydro’s expectations were not always realized after the contract was awarded. For example:

- One of the local partners under the Main Civil Works contract consortium had to withdraw after the contract award because of insolvency that was not caused by BC Hydro; and
- Multinational parties often relied on local entities and approaches. It also took awhile for multinational contractors to fully appreciate the complexity of the Project and the challenges of working in northern British Columbia. Some examples include: a lack of understanding of detailed requirements for plans submission at the start of the project to address Environmental Assessment Certificate obligations and a lack of understanding of working with WorkSafeBC and other regulatory agencies especially on environmental and safety issues.

The financial procurement evaluation for the Project included:

- Bidders must identify the legal entities forming the consortium along with their respective responsibilities. This included providing corporate-level and project-specific organizational charts, illustrating the relationships among consortium members and their reporting lines to the Project. Bidders also had to describe the legal structure of the consortium, whether a joint venture, partnership, or other arrangement, and confirm that the relationship would be joint and several with respect to contractual obligations.
- To assess capability and experience, bidders were required to submit several nominated reference projects completed, along with verified contact information for references. These projects were to demonstrate relevant experience in similar scopes, climates, and regulatory environments. Bidders were also required to provide a listing of all major construction projects completed or underway in Western Canada within the last five years.
- Evidence of financial capability of each consortium member was required including three years of audited consolidated financial statements, interim financials, and disclosures of any material off-balance sheet financing, credit

rating changes, or insolvency proceedings. Where financial support was to be provided by an affiliated entity, a formal letter of guarantee was required. The evaluation also considered each member's ability to meet financial obligations under the contract, including access to financing, ability to provide performance security, and overall financial stability.

- Bidders were required to describe how decision making would be allocated among consortium members; the roles, and responsibilities of key individuals; and how these individuals would manage their teams. This included outlining interdependencies between entities, authority limits, and strategies for retaining key personnel throughout the contract term. Bidders were required to identify key subcontractors, including their roles, contract values, and whether work would be self-performed or subcontracted.
- The Project required that a jointly signed letter of each consortium member be submitted, confirming the accuracy of submitted information and providing updates or affirmations of previously submitted due diligence data. These criteria were in place so that consortium bidders were evaluated on their ability to function as a cohesive, accountable, and financially stable team, in addition to their individual qualifications.

Despite these requirements, there are opportunities for improvement on future projects.

Table 6 below provides some specific considerations which are intended to support future project teams as part of this lesson learned.

Table 6 Lesson CM1 - Specific Considerations

#	Consideration
CM 1.1	Require a consortium's submission to provide more detail on experience working on large projects in Canada or British Columbia, particularly with respect to labour agreements, permitting, WorkSafeBC regulations and other government regulations as well as weather conditions. This could also include potentially assigning a risk premium for consortiums with limited Canadian experience or for consortiums whose members have limited experience working together.
CM 1.2	Require a consortium integration plan as part of the submission requirements to assess how entities will collaborate, contribute key strengths, and resolve internal disagreements. This could include requirements such as if one of the consortium members is deemed weak in an area, a plan for how the other consortium members will address this weakness and what mitigation plans they have in place. Projects should also consider adding financial penalties if consortium teams switch out their team members early.

4.4.2 Lesson CM2: Assess and Manage the Impact of Numerous Work Front Interfaces Among Contractors to Optimize Performance and Minimize Potential Claims

Lesson CM2 is to assess and manage the impact of numerous work front interfaces among contractors to optimize performance and minimize potential claims. During the Project, contractor delays had knock-on affects to other contractors which led to claims that needed to be resolved.

The Project is comprised of dam site subprojects, off-dam site subprojects, and functional groups, with approximately 700 work packages and over 2,000 contracts across multiple disciplines. Given this scale and complexity, the contracts were developed to minimize the number of interface risks to mitigate the likelihood of potential claims. An internal Interface Management Plan supported by structured processes, tools, and governance was developed to support this approach. Under this Plan, information was exchanged between subproject internal teams and contractors, particularly during interface handovers and Interface Management Items were tracked so that unresolved issues could be escalated.

BC Hydro bore the risk of interface risks between contractors, and these risk items were identified and managed in the Project risk register. Several interface risks were realized during the Project including river diversion delay impacts and right bank

foundation enhancement impacts. These impacts resulted in claims from affected contractors which were eventually closed through settlement agreements.

As part of the procurement process on the Project, the number and size of the large contract scope packages were reviewed and optimized. This is a complex balance that projects need to manage. A greater number of contract packages creates more interfaces to manage; however, having less contract packages potentially requires contractors to externally source some of their expertise, which can add markups that result in higher bid prices. On Site C, the contract packaging options were tested through market sounding and included review with KPMG (financial advisor for the Project), and Partnerships BC. As projects continue to grow in complexity this is something that needs to be carefully considered.

To monitor and manage Interface Management Items, the Project team created an interface management dashboard and report to track the status, highlight upcoming handovers, and provide estimated transition dates. Internal Work Package Managers collaborate closely with affected contractors to re-sequence work activities as needed to mitigate schedule disruptions and reduce the potential for claims. This collaborative effort manages delays constructively and minimizes downstream impacts through early intervention and planning.

The Project team also developed an online Prime Contractor Web Map to coordinate contractor responsibilities. Each construction contract defines the contractor’s obligations for working cooperatively and sharing workspaces with other contractors on the Project. It also identifies the responsible and affected parties for each interface milestone and outlines protocols for managing delays, inspections, and handovers. It is a GIS-based tool that allows users to zoom into zone boundaries, view site-wide notices, and receive real-time updates.

Interface handovers are planned well in advance. Months prior to a milestone, work package managers from both the responsible and affected subproject review their contracts and collaboratively develop a milestone completion checklist. Weeks

before interface handovers, the responsible contractor begins executing and submitting deliverables identified on the checklist. These are reviewed by the affected contractor and a walkdown is conducted to identify deficiencies. The responsible contractor then provides a timeline for resolving identified deficiencies. If the affected contractor accepts the handover with outstanding deficiencies, arrangements are made for the responsible contractor to return and complete the work. Alternatively, both parties may agree to transfer the deficiency scope to the affected contractor.

The Project team established an escalation process to address challenges that occasionally arose related to complex interface matters where multiple contractors and work fronts were impacted, and the decision-making authority was unclear. For example, the Project used this process to determine when contractors could mobilize into or demobilize from a work area.

The resolution of interfaces needs to achieve the best outcome for the Project. This means that there may be negative consequences on some subprojects to support the needs of the Project overall. Project decision makers were given the appropriate level of authority to make these types of decisions and analysis was completed to support the best decision on both cost and schedule.

Table 7 below provides some specific considerations which are intended to support future project teams as part of this lesson learned.

Table 7 Lesson CM2 - Specific Considerations

#	Consideration
CM 2.1	Consider consolidating walkdowns and using standardized milestone handover memos to streamline communication and accountability.
CM 2.2	Consider using enhanced planning tools like laydown maps and GIS boundary mapping to prevent space conflicts and improve coordination. Addressing handover deficiencies proactively, either by adjusting timelines or assigning scope to incoming contractors, may reduce delays and claims. Clearly defining prime contractor transfer processes and site access protocols early would help avoid disputes and inefficiencies.
CM 2.3	Consider assigning the Project as prime contractor in shared areas and scaling review periods based on package complexity to support smoother operations. Consider also how the owner communicates with WorkSafeBC in shared areas and who WorkSafeBC ultimately holds responsible for corrective action.
CM 2.4	Consider establishing an escalation process for complex interface issues to ensure timely, authoritative decision making throughout the project lifecycle.

4.4.3 Lesson CM3: Implement Processes and Have Senior Leadership Involved Early to Set the Tone and Expectations to Assess and Address Contract Claims in a Timely Manner to Avoid Significant Cost Claims Remaining Open at Contract Completion

Lesson CM3 is to implement processes and have senior leadership involved early to set the tone and expectations to assess and address contractor claims in a timely manner to avoid significant cost claims remaining open at contract completion. The Project had limited claims and commercial management resources when construction started. Over time, the Project ramped up resources and worked through the backlog of claims which then limited exposure at contract completion.

The Project implemented a proactive approach to manage claims so that their resolution was not left until contract completion. This approach has several benefits including: access to full project resources and subject matter experts; timely and informed analysis and negotiation; preservation of working relationships with contractors by fostering collaboration and trust; reduction of administrative burden at the end of the project, allowing for a smoother and faster close-out process; improved cost control and risk management, as issues are addressed before they escalate; and improved documentation and record keeping since claims are evaluated while the details are still relevant and accessible.

This proactive approach was particularly effective during the close-out of the Main Civil Works Contract earlier this year. At the present time, the number of open claims remaining on the Project is low and the degree of exposure is limited due to the release language and limited exclusions used in prior agreements.

The number and complexity of the claims was challenging at times for the Project team to manage in addition to their daily responsibilities of managing the contract. As discussed above, in response to these challenges and recommendations from the 2021 Milburn Report, claims and commercial management resources were ramped up and a dedicated and centralized Commercial Management team was established, supported by additional specialist resources as required.

These resources should have been scaled up more proactively and sooner. Going forward, it will be critical for BC Hydro to continue to build its commercial capacity and to plan to ramp up dedicated contract and commercial management resources, with representation from the project leadership team, earlier in the project lifecycle to effectively manage the commercial impact of contractor claims. Where applicable, future major capital projects should proactively incorporate these improvements from the outset.

Table 8 below provides some specific considerations which are intended to support future project teams as part of this lesson learned.

Table 8 Lesson CM3 - Specific Considerations

#	Consideration
CM 3.1	Consider integrating practices to monitor contracts to ensure continuous alignment with project goals (e.g., safety, quality, schedule) and resolve claims in a timely manner. These practices could include incorporating processes such as daily field reports, field instructions, change processes (including preliminary change instructions, change directions, interim directions, change orders), dispute resolution procedures, negotiation strategies (including incentives and penalties) and amendments settlements. By integrating these practices, project teams can better manage complexity, reduce risk, and maintain alignment with evolving project goals.
CM 3.2	Consider ramping up a contract and commercial management team earlier in the project lifecycle and with representation on the project leadership team for supporting claims administration and managing contractor relationships, mitigating disputes, and ensuring timely resolution of issues. Consider having this team both at the head office and on-site.
CM 3.3	Add strategic resources to support claims avoidance, especially in large-scale projects, as they can enhance communication, reduce, and mitigate risks, and improve overall project performance. For example, consider creating a dedicated Labor Relations Support team and having specialized, on-site resources to manage complex project elements and ensure contractor accountability. This should help to minimize labour impacts and claims on the project. Consider ramping up engagement of specialist quality control personnel early to establish robust quality assurance and quality control systems and proactively build internal capacity. Consider assigning dedicated project legal resources to allow for efficient legal support, with in depth knowledge and familiarity with the project.
CM 3.4	Consider addressing claims as quickly as possible and not leaving them to the end of the project close-out. Consider seeking settlement, and release of disputes and claims up to the date of settlement, with limited exclusions remaining for the future.

4.4.4 Lesson CM4: Develop and Provide Project Teams with the Training, Tools and Processes, Including Production Tracking, to Support Consistent Contract Management Across the Scope and Duration of the Project

Lesson CM4 is to develop and provide project teams with the training, tools, and processes, including production tracking, to support consistent contract management across the scope and duration of the project. The project team needs to know and understand the contract and schedule prior to starting work. The Project continuously evolved its tools and training program to scale with the long duration and complexity of the Project. The tools enabled timely reporting, transparency, and issue resolution.

To support consistent contract management across the Project, the team actively developed internal expertise and capacity including the use of document management systems and reporting tools. The Project team also supported

mentorship and succession planning so that team members could grow into roles on the Project, and gain experience that could be brought back to BC Hydro once the Project was complete.

The Project required a significant amount of document management and reporting to internal (e.g., Project team, management, and oversight bodies) and external stakeholders (e.g., local communities, and government). Initially, the Project relied on external consultants to develop systems such as Tableau dashboards to report on project statuses and targets for certain areas. While these dashboards provided the Project team with a better understanding of project needs and data, the team initially lacked the technical skills to manage the dashboards independently. This highlighted the need for knowledge transfer and in-house capability development to support timely and relevant reporting. Accordingly, the Project provided training sessions to team members and reduced the need for external contractors.

Contractual and legal training also emerged as a development opportunity for the Project team. The contract and commercial management team, along with the legal team, created training modules focused on contract management, dispute resolution process, change management, submittals, legal privilege, and substantial and total completion within contracts. These proactive training sessions helped team members identify potential issues early, improve preparedness and reduce risk.

Training was also important for workforce development and knowledge retention. For example, the Highway 29 subproject demonstrated the value of mentorship by giving workers leadership opportunities under experienced guidance. This approach supported individual growth and contributed to succession planning.

Training and process improvement support was also provided to team members for contract templates, digital tools, documentation standards, digital platforms, and workforce reporting.

Table 9 below provides some specific considerations which are intended to support future project teams as part of this lesson learned.

Table 9 Lesson CM4 - Specific Considerations

#	Consideration
CM 4.1	Prioritize early and implement ongoing training programs. Some key areas to consider include document management systems and tools (e.g., Tableau and SharePoint). This ensures staff can independently manage and update these systems. Reporting systems such as Tableau are also useful for reporting on project statuses to internal and external stakeholders (e.g., executive management). Contract and commercial management and legal awareness training should be embedded into onboarding processes and refreshed regularly, with a focus on standardized templates, the strategic use of contract mechanisms including dispute resolution protocols, and confidentiality and sensitive information handling. These efforts will reduce reliance on external consultants, improve compliance, and enhance the team's ability to manage complex projects.
CM 4.2	Invest in mentorship and leadership development for younger staff to support long-term organizational resilience. Creating pathways for junior team members to take on increasing responsibilities under the guidance of experienced mentors fosters a culture of learning and prepares the next generation of project leaders. This was especially critical for a multi-year project such as Site C where the project construction period was over 10 years. These combined efforts will help ensure that internal teams are better equipped to manage current and future projects with greater autonomy, efficiency, and strategic foresight.
CM 4.3	Consider contract management best practices early in the project lifecycle, to outline roles, responsibilities, workflows, and templates for such things as Change Orders, Change Directives and Field Instructions.
CM 4.4	Consider training that is tailored to different roles with a focus on key contract management areas regarding contract interpretation, milestone tracking, interface coordination, and issue resolution. Training should be considered for all personnel on-site and at head office and should run frequently as more personnel join the project and be used as a reset to ensure all personnel are on the same page.
CM 4.5	Consider providing digital tools such as GIS mapping for boundary management (to support Prime Contractor's tracking), standardized handover memos, and production tracking dashboards.
CM 4.6	Consider establishing consistent documentation standards and escalation protocols to ensure decisions are made efficiently and transparently. Regular refreshers and feedback loops help maintain alignment and adapt processes as the project evolves, fostering a culture of continuous improvement and collaboration.
CM 4.7	Consider cross collaboration among other internal project delivery entities (e.g., Engineering) outside the construction and contracts and commercial teams so the entire project team is aligned on contracts and change and claims management.
CM 4.8	Ensure the integration of digital platforms is well understood at the outset of the project between the owner and contractor for items such as document/records management software. In particular, the type of platform should be detailed in the contract's terms and conditions. Internally, the owner should consider maintaining live contracts to capture changes within the main contract, and adopting digital signatures to help streamline documentation, approvals, and archiving.
CM 4.9	Consider integrating digital tools and technologies for 3D modeling, drones, and surveillance cameras to improve project tracking, site monitoring, and safety, enabling real-time updates and better field supervision.

#	Consideration
CM 4.10	Consider tailoring contract templates to the complexity of the work. Continuous improvements help to streamline processes and reduce inefficiencies.
CM 4.11	Consider whether the use of multiple contractor specific Environmental Protection Plans is better for each contractor's methods and responsibilities than a standard site wide plan.
CM 4.12	Consider incorporating standard workforce reporting requirements for contractors at the start of the project. Workforce reporting was an important part of the communication requirements on the Project. Early alignment across project teams and ensuring IT systems are in place before contract finalization are recommended to improve communication flow and ensure consistency in reporting across the contracts so metrics can be consolidated.

4.4.5 Lesson CM5: Establish and Maintain an Integrated Project Schedule Across All Contracts to Evaluate Schedule Variances and Changes Across a Large Complex Project

Lesson CM5 is to establish and maintain an integrated project schedule across all contracts to evaluate schedule variances and changes across a large complex project. The overall schedule and cascading interface risks are difficult to transfer and need to be managed by the project team with oversight by senior leadership. The use of an integrated schedule allowed the Project to manage and report on its schedule milestones.

The Project adopted BC Hydro's Project and Portfolio Management practices for scheduling, with tailored modifications to suit its unique governance and oversight requirements. A work breakdown structure was developed in SAP, BC Hydro's financial system, and transferred to Primavera P6, forming the foundation for integrated scheduling.

An Integrated Site Construction Schedule provided the strategy for all construction activities at site. This schedule was developed during the pre-construction stage, with input from all contractors. It operated as a high-level planning tool to review major work activities for interdependencies and to sequence them in a way that clearly indicated the critical path for the Project.

Based on this integrated framework, individual contractors then developed their own detailed schedules. Upon contract award, each contractor was required to submit a

Primavera P6 Based Work Program and Schedule which, once accepted by BC Hydro, became the contractual baseline. These contractor schedules were then merged into the Integrated Construction Schedule to form a more advanced and comprehensive view of site-wide activities. Major contractors also provided monthly updates and weekly three-week look-ahead schedules detailing progress, critical path activities, and any anticipated delays. Additionally, major contractors were required to submit an updated schedule to reflect revised scope and timing of work whenever major commercial claims were resolved. However, in some cases, it was challenging to secure compliant schedules from the major contractors. Future projects should take steps to actively manage the submission of these compliant schedules so that there is an updated baseline to analyze changes against.

The scheduling methodology for the Project was based on the Critical Path Method, which calculated float and determined the minimum project duration. The Project tracked the critical path and activities on the near critical path to ensure those activities did not become part of the critical path. Careful attention should be paid to the additive affects of small issues that when combined together can impact the schedule even if not on the critical path. As with all planning, addressing these issues early and effectively is important. Primavera P6 served as the central scheduling tool, and customized calendars were used to reflect work periods, including statutory holidays and seasonal constraints. The project team implemented a monthly progression cycle, beginning with the transfer of actual costs from SAP to Primavera P6. Progress data was collected from Work Package Managers, including estimates for cost, duration, and resources, as well as percentage completion and forecasted milestone dates. This data was then used to update the schedule, and the revised cost values were transferred back to SAP. Progression meetings were held with contractors and internally, at both the subproject and leadership levels, to validate forecasts and inform baseline updates.

Multiple baselines were maintained throughout the Project, including the First Full Funding Baseline, Performance Measurement Baseline, Prior Month Forecast

Baseline, and seasonal baselines aligned with construction periods. Changes to baselines followed a formal change control procedure, ensuring transparency and accountability. A summary schedule showing the progress of key work activities compared to the approved reservoir fill and first power schedule was provided to the Project Assurance Board monthly.

Table 10 below provides some specific considerations which are intended to support future project teams as part of this lesson learned.

Table 10 Lesson CM5 - Specific Considerations

#	Consideration
CM 5.1	Consider using an integrated site construction schedule during the pre-construction phase. This would provide a high-level planning tool to review major work activities for interdependencies and to sequence them in a way that clearly indicates the critical path for the project. Based on this integrated framework, individual contractors can then develop their respective detailed schedules.
CM 5.2	Consider merging individual detailed contractor schedules into the Integrated Construction Schedule upon contract award to form a more advanced and comprehensive view of site-wide activities. This allows for detailed critical path analysis as well as float and other variance analysis.
CM 5.3	In addition to routine schedule monitoring, consider conducting other schedule sensitivity analyses and schedule updates for critical project milestones and events. These analyses assess the impact of unforeseen developments such as major contractor commercial delay claims and evaluate the probability of achieving key milestones. They also provide valuable insights into schedule risks and support strategic decision making. Consider the use of Schedule Risk Analysis for managing uncertainty.[32]
CM 5.4	Consider conducting regular quality assurance and control checks before establishing Performance Measurement Baselines and Prior Month Forecast Baselines. Issues, such negative float, should be tracked and resolved to maintain schedule integrity. Consider monthly reporting to include one-month lookahead reports, critical and near-critical path analyses, Schedule Performance Index evaluations, and schedule contingency reviews. Define roles and responsibilities, with Schedulers leading schedule management and variance analysis, Work Package Managers overseeing scope and cost within their packages, and Project Managers and the Leadership Team providing oversight and approvals.
CM 5.5	Ensure that the contractor provides a detailed and resource loaded schedule at the start of the contract. It is essential that the original contractor's baseline schedule has complete resourcing details, as this will be the baseline from which contractor claims or changes are managed for impact analysis. In other words, avoid accepting a less detailed schedule at the start, assuming it will be augmented later. Ensure that the contractor continues to submit compliant schedules along the project lifecycle, as this is the updated baseline to compare changes against.as the project progresses.

[32] Schedule Risk Analysis is used to determine the probability of achieving the Project schedule objectives using risk analysis software and a simulation model.

4.4.6 Lesson CM6: Establish Processes Early to Support Early and Continuous Engagement with Contractors and Facilitate Early Contractor and Owner Relationship Expectations and Manage the Relationship Through the Lifecycle of the Project

Lesson CM6 is to establish processes to support early and continuous engagement with contractors (including planned, proactive, and responsive engagement). Facilitate early contractor and owner relationship expectations and manage the relationship through the lifecycle of the project.

In the early stages, the Project experienced challenges with contractor relationships that were more adversarial than collaborative. This delayed the work while issues were being resolved. Over time, relationships improved as teams worked together to solve issues.

Large-scale capital projects that involve high-value and complex scopes and multi-year schedules require specialized expertise, financial resources, and operational capacity from the contractors. The project team can increase the prospect of successful project delivery by helping the contractor be successful. Effective collaboration with contractors was critical to the success of the Project. For example, the Project:

- Used external facilitators to encourage collaboration between the Project team and contractors to develop zipper charts so that each team member was aware of their counterpart to be able to attempt to resolve issues at their level before escalating upwards; [33]
- Conducted joint safety walkdowns where senior members of both teams were present;
- Created the Labour Committee which served as an open forum where parties could engage in meaningful dialogue, share perspectives, and raise concerns.

[33] A zipper chart is a side-by-side visual comparison of two related datasets (e.g., Project organization roles versus contactor organization roles).

By actively listening to contractor input, the Project was able to gain valuable insight into the challenges occurring on site, which helped inform more responsive and practical decision making. The Committee also provided a structured space to build mutual understanding and trust, allowing both sides to work together to identify issues and advance improvement;

- Facilitated the early involvement of the Ministry of Transportation and Infrastructure (**MOTI**) to ensure alignment with provincial standards and help streamline subsequent phases of the Project with respect to the highways related works;[34] and
- Used schedule recovery strategies to motivate timely completion of work.

Table 11 below provides some specific considerations which are intended to support future project teams as part of this lesson learned.

Table 11 Lesson CM6 - Specific Considerations

#	Consideration
CM 6.1	Encourage early contractor involvement during the procurement process.
CM 6.2	During construction, encourage collaboration on aggregate, quarry and materials management, monitoring and planning to ensure there are no surprises during construction and that materials are not depleted faster than expected.
CM 6.3	Encourage the owner and contractor teams to have joint relationship building sessions where teams meet each other, and work collaboratively towards meeting metrics for safety, quality, production targets, etc.
CM 6.4	Ensure that representative to representative meetings (Management meetings between the Contractor and the BC Hydro Project team) are held regularly, often and in-person, if possible, to ensure that communication channels are kept open, especially in times of challenge.
CM 6.5	Ensure collaborative efforts at the beginning of the contract to jointly work toward getting critical submittals prepared and approved. Time lost at the early part of the project going back and forth on documents and plans is hard to recover, and setting expectations early is critical to the success of the project.
CM 6.6	Consider creating a Labour Committee to support collaboration between the BC Hydro Project team and its contractors.

[34] The Ministry name was subsequently updated to Ministry of Transportation and Transit (**MOTT**)

#	Consideration
CM 6.7	Encourage understanding and alignment of the goals of BC Hydro with the motivations of each contractor. By taking the time to explore what motivates the contractors, the project team can find common ground and create shared objectives. Alignment fosters a more cooperative environment, where parties work toward mutually beneficial outcomes. This facilitates the efficient achievement of key milestones.
CM 6.8	Foster effective collaboration with contractors by prioritizing relationship building at the outset of the project. Project teams should invest time in getting to know the contractor. Establishing trust early through consistent communication, transparency, and follow-through on commitments lays the foundation for a productive partnership and smoother project execution.
CM 6.9	For partners who are delivering highways components on behalf of the project (e.g., the Ministry of Transportation and Transit), consider the mutual benefits of a cooperative approach and co-operation/co-ordination agreement.
CM 6.10	Consider the use of additional financial instruments for contractor management. Often the clause in the contract with respect to liquidated damages may not keep the contractor engaged if they think they have missed the milestone and have no chance to recover it. Financial instruments could include, for example, performance incentives and advance payments (secured with letter of credit or other financial security) to help manage the contractor's cash flow.
CM 6.11	Consider the number (%) of specific overhead payment line items in the Progress Payment Estimate, versus payment line items that have overhead type costs embedded in them. Having numerous overhead payment line items sometimes creates administrative burden and potential disincentives. Where possible, ensure that payment for any overhead line items mirrors the work profile cashflow.

5 Risk Management

This section addresses Risk Management. It provides a discussion of the framework employed for risk management and mitigation, the evolution of risk management practices, and the major changes to risk management that have occurred during the Project. It also describes challenges and inefficiencies that were realized and the effectiveness of the process, and provides a discussion of all major risks realized, including risks not identified that were realized over the course of the Project and the resulting impacts to cost and schedule.

The Project followed BC Hydro's existing risk management framework and practices. As of August 2025, there were over 1,100 active or closed risks in the Project Risk Register. Risk management on the Project, including the implementation of mitigation plans, either reduced the cost and schedule impacts of risks that materialized or successfully mitigated the risk altogether. For example, despite the COVID-19 pandemic which led to the loss of approximately 60% from the initial scheduled plan for summer 2020, the Project successfully reprioritized activities to ensure diversion of the Peace River was still achieved by October 2020, avoiding additional delays and cost.

Improvements were made to risk management throughout the Project lifecycle, including in 2019 in response to a report by Ernst & Young, and in 2020 and 2021 in response to the Site C Project Review by Mr. Peter Milburn. These improvements included: combining various risk registers into a single central risk register and increasing the visibility and reporting of identified risks; improved mapping of identified risks to the Cost and Schedule Risk Analyses; increasing the frequency of Cost and Schedule Risk Analyses; better applications and systems; adding more experienced resources to the central risk management team; and a greater role for the Project Assurance Board and the Independent Oversight Advisor. Future major capital projects should consider implementing these improvements early, when appropriate.

This section is organized as follows:

- Section 5.1 explains that the Project followed BC Hydro's existing well established and mature risk management framework, scaled to the needs of the Project, and describes the Project's Risk Management processes and program;
- Section 5.2 describes the evolution of the Project's Risk Management Program and Process;
- Section 5.3 describes identified Project risks, how these risks were mitigated and their impacts on the Project budget and schedule;
- Section 5.4 describes major risks that were successfully mitigated on the Project; and
- Section 5.5 describes the seven lessons learned from the Project regarding Risk Management:
  - **Lesson RM1:** Consolidate and enhance risk registers to improve cost risk estimates and provide more consistent analysis. The use of a central risk register allows for better availability across the project and reporting to governing bodies;
  - **Lesson RM2:** For very large complex projects, implement cost risk analysis and schedule risk analysis processes that are complete and transparent and include effective methods to quantify risks;
  - **Lesson RM3:** Organize and size the project risk team for the complexity of the project, and ensure it includes qualified resources with the appropriate knowledge, experience, and expertise;
  - **Lesson RM4:** Ensure risk reporting is clear and timely and provides early visibility to the potential for low-probability, high-consequence events;

- **Lesson RM5:** Ensure governing bodies are aware of the low-probability, high-consequence risks for the project, and that they fully understand budget and schedule impacts if these risks materialize;
- **Lesson RM6:** Capitalize on the opportunities provided by large capital projects to develop internal and external knowledge, and expertise for future projects; and
- **Lesson RM7:** Implement effective early project planning to mitigate or reduce project cost and schedule impacts.

5.1 Site C Risk Management Program Follows BC Hydro's General Risk Management Framework and Practices

The Project follows the same general risk management framework and practices of BC Hydro's Enterprise Risk Management Department and BC Hydro's Project and Portfolio Management Sub-Practice for Risk Management, scaled to the needs of the Project.

The risk management framework applies to all work on the Project. It is not a stand-alone or time-bound function. Rather, it involves members from across the Project team, and is an ongoing activity. It includes the Risk Management Program, which sets out the risk management criteria developed for the Project, and the Risk Management Process, which describes how the Risk Management Program should be implemented.

The Project's Risk Management Program:

- Sets out the risk management objectives;
- Identifies roles, accountabilities, and responsibilities;
- Implements the suite of risk management tools and systems;
- Produces, updates, and controls the risk management deliverables; and

- Implements the set of work processes to manage risks over the life of the Project.

5.2 Site C Risk Management Program and Process

The Risk Management Process for the Project, which supported the implementation of the Risk Management Program, is shown in Figure 4 below.

Figure 4 Site C Risk Management Process Flowchart

The steps include:

- **Step 1 - Risk Management Program Planning:** defines the objectives, roles, processes, and tools for managing risk;
- **Step 2 - Risk Identification:** develops and regularly updates a comprehensive list of Project risks and opportunities;
- **Step 3 - Risk Analysis and Evaluation:** assesses the likelihood and impact of risks to determine exposure and the need for mitigation plans;
- **Step 4 - Risk Response Planning:** creates strategies to reduce risks and enhance opportunities; and

- **Step 5 - Risk Monitoring and Control:** tracks risk factors, manages mitigation plans, and communicates updates.

5.2.1 Step 1 - Risk Management Program Planning

The key deliverables of Risk Management Program planning are the preparation, implementation, and ongoing maintenance of the program objectives; the Project Risk Register and associated structure; the Project Risk Matrix; and the identification of risk management roles, accountabilities, and responsibilities. Each of these deliverables are described further below:

- **Objectives:** The Risk Management Program objectives for the Project are consistent with those of other BC Hydro capital projects. These include applying a unified and consistent risk management approach throughout the Project's lifecycle; maintaining a single, centralized Project Risk Register accessible to all team members; aligning the Project's risk framework with BC Hydro's Enterprise Risk Management standards, policies and Project and Portfolio Management practices; and ensuring compliance with the BC Hydro Risk Management Policy.
- **Risk Register:** All Project risks are documented in Microsoft SharePoint in a single, central Project Risk Register. As of August 2025, there were over 1,100 active or closed risks in the Project Risk Register.[35] For each risk in the Risk Register, there are approximately 50 fields that are populated on an ongoing and regular basis. Examples of fields include risk description, risk owner, mitigation plan, risk start date, risk end date, probability of consequence, consequence severity, and schedule information.

  The Project Risk Register aligns with the BC Hydro Project and Portfolio Management risk register standard, with additional data fields to capture unique

[35] SharePoint is a web-based platform developed by Microsoft that enables organizations to store, organize, share, and access information securely.

Project-specific information. Project data was added to align with the Project's structure, risk reporting requirements, and Monte Carlo risk analysis that are used on the Project.[36] The Risk Register is accessible to all Project team members and is reviewed and updated on at least a monthly basis.

The Project Risk Register classifies all risks based on the Project's schedule work breakdown structure which is periodically updated as the Project progresses.[37] Risks are also classified by functional group.[38]

- **Project Risk Matrix:** The Project Risk Matrix is used to identify and evaluate the "risk zone" for a given risk based on a comparison of the risk's probability and the type and level of consequence. The risk zone determines the level of management discussion required to inform decision making, with higher risk zone risks requiring Executive and Project Assurance Board discussion.

  The Project Risk Matrix also provides a consistent way to evaluate all risks both before and after mitigation. It is based on the BC Hydro Project Delivery Risk Matrix, with adjustments for additional Consequence Severity categories to provide a more granular range of Risk Levels and an additional Project Risk Zone (for the Executive Team and Project Assurance Board). The Project Risk Matrix is shown in Figure 5 below.

[36] Monte Carlo analysis is a statistical technique that uses random sampling and simulation to estimate the probability of different outcomes that cannot be easily predicted due to uncertainty.

[37] Work breakdown structure is generally categorized by subprojects such as Main Civil Works, Reservoir Clearing, or Turbines and Generators.

[38] This classification helps to link risks to the schedule used in the Schedule Risk Analysis discussed in section 5.2.3 below.

1 **Figure 5 Site C Project Risk Matrix**

PROBABILITY OF CONSEQUENCE (Duration of Project through Implementation)		BC Hydro SITE C PROJECT Risk Matrix							
60%	**Likely** More than even chance to occur	**L7**	8	9	10	11	12	12.5	13	13.5
30%	**Fairly Likely** Often occurs	**L6.5**	7.5	8.5	9.5	10.5	11.5	12	12.5	13
10%	**Possible** Could well occur	**L6**	7	8	9	10	11	11.5	12	12.5
1%	**Remote** May occur	**L5**	6	7	8	9	10	10.5	11	11.5
0.1%	**Very Unlikely** Not expected to occur	**L4**	5	6	7	8	9	9.5	10	10.5

CONSEQUENCE TYPE		CONSEQUENCE SEVERITY							
		S1	**S2**	**S3**	**S4**	**S5**	**S5.5**	**S6**	**S6.5**
Safety	**Worker**	First Aid	Treatment by Medical Professional	Temporary Disability	Permanent Disability	Fatality		Multiple Fatalities	
	Public	Near Miss	First Aid	Treatment by Medical Professional	Temporary Disability	Permanent Disability		Fatality	
Environmental *		Minor	Low	Moderate	High	Extreme		Catastrophic	
Financial Loss		$10K to $100K	$100K to $1M	$1M to $10M	$10M to $100M	$100M to $300M	$300M to $1B	$1B to $3B	$3B to $10B
Reputational *		Limited complaints to company or shareholder	Negative local profile	Small but vocal minority of customers critical	Many customers critical	Loss of trust- strategic change imposed by regulator and/or shareholder		Loss of consent to operate	
Reliability	**Supply**	N/A	N/A	Require voluntary load reduction	Localized load shedding	Significant load shedding required		BC load shedding spreads to WECC	
	Customer (hours lost per event)	< 5K	5K to 50K	50K to 500K	500K to 5M	5M to 50M		50M to 500M	

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Risk Zone	Risk Communication Guidelines
3-A) Executive and PAB	Detailed analysis and discussion at Project EVP, President, COO and Project Assurance Board (PAB) level with input from Site C Leadership and/or BC Hydro Executive Team members.
3-B) Executive	Detailed analysis and discussion at the Project EVP level, with engagement of business group EVP or SVP, and /or Site C Leadership Team. Input from Executive Team generally should be sought.
2) Initiator	Analysis & discussion between Site C Leadership Team Director, Project Manager and Functional Manager about the risk and appropriate course of action.
1) Project Manager	Risk generally analysed and discussed with PM at project team level. Safety Risks should be reviewed with Project Safety Lead and Site C Leadership Team Director.

Purpose of the Risk Matrix

1. To provide a standard representation of the results of risk analyses for use in the evaluation and communication of risks.

2. As a risk governance tool. The Risk Zone relates to the level of management discussion to aid in decision-making.

3. Not used to describe risk tolerance.

4. A comparison of differing risks may also be conducted based on the Risk Levels.

To use the Risk Matrix

1. Select the Consequence Type.

2. Select the highest appropriate Consequence Severity.

3. Select the Frequency level of the Consequence Type and Severity.

4. Plot the Consequence severity and Frequency level pair to determine the Risk Level and associated Risk Zone.

5. Based on the Risk Zone, review Risk Communication Guidelines to determine action.

NOTE: The rigour of analysis in analyzing consequence and frequency should be commensurate with the Risk Zone. This may be an iterative process.

- **Roles, Accountabilities and Responsibilities:** The Project has a centralized Risk Management Team that is generally responsible for reviewing all risk entries for accuracy and completeness. This team also supports a standardized risk management approach across the Project, offers guidance and training, and seeks ways to improve the Risk Management Program. While the team is centralized, risk management on the Project involves individuals from across the whole Project team. The primary risk management roles on the Project, and their associated responsibilities and accountabilities are set out in Table 12 below.

Table 12 Project Risk Management Responsibilities and Accountabilities

Role	Responsibility
Project Executive	• Has overall accountability for all Project risks. • Acts as a risk owner for Project-wide risks.
Risk Manager	• Leads the Site C Risk Management Program, including: – Establishment of processes and procedures. – Development and maintenance of the Risk Register and Risk Matrix. – Publishing risk management statistics and reporting including for the Project Assurance Board and the Quarterly and Annual reports. – Project-wide staff training on risk management. – Ensuring alignment with BC Hydro's policies. – Providing governance oversight for and chairing the Risk Review Committee. • The Risk Manager is not responsible for managing specific risks and must remain an independent reviewer.
Risk Review Committee	• Established in mid-2018 to provide governance for the Risk Management Program. • A decision-making body for program wide and risk-specific decisions.

Role	Responsibility
Risk Professionals (Analyst, Advisor, Specialist)	• Supporting and coordinating risk management activities including challenging risk reviews with risk owners. • Developing and maintaining risk management tools. • Attending risk management meetings, and leading or performing quantitative risk management. • Risk Professionals are not responsible for managing specific risks and must remain independent reviewers.
Site C Leadership Team Directors	• Accountable for risks and the mitigation plans for risks that span two or more subprojects within their area of responsibility.
Risk Owners[39]	• Accountable for a risk and its approved mitigation plan(s). • Reports either directly or indirectly to a Site C Leadership team member for the Project work they are performing.
Risk Delegate[40]	• Support the Risk Owners with day-to-day risk management. • Typically, a subject matter expert. • If no delegate is assigned, the Risk Owner handles all responsibilities.

5.2.2 Step 2 - Risk Identification

The risk identification step involves identifying the key risks that can impact or benefit the delivery of the Project, resulting in a comprehensive list of the major Project risks in the Risk Register.

The following sources are used on the Project to identify possible risks:

- Project documentation such as Construction Management Reports by contract or work area (e.g., Main Civil Works contract), Project Management Reports, Technical Advisory Board Reports, Claims Reports, the Safety Incident Tracking System, and media articles on the Project for potential public or local community issues;

[39] Examples: BC Hydro Project Manager, Engineering Manager, Construction Manager, Environmental Manager, Regulatory Manager, etc.

[40] Examples: BC Hydro Engineer, Construction Officer, Specialist, Professional, Consultant.

- Interviews with experts who have specific knowledge or with key stakeholders in the Project; and
- Facilitated meetings, sessions, and brainstorming with Project staff and subject matter experts.

5.2.3 Step 3 - Risk Analysis and Evaluation

This step involves assessing the probability and consequence of the risk event occurring to calculate the risk exposure (risk level score from the risk matrix) and the risk zone (which determines level of management discussion). To measure the effectiveness of risk mitigation plans, two risk assessments are completed for each risk: one before mitigation and one after mitigation.

All risks are initially reviewed on a qualitative basis and, where a significant impact is identified, risks may also be included in a Project-wide quantitative analysis. This is consistent with both BC Hydro's internal Project and Portfolio Management practices and external standards such as the International Standards Association 31000 Risk Management and the Project Management Institute Standard for Risk Management in Portfolio, Programs and Projects.

Qualitative risk analysis evaluates the importance of each risk and allows the Project team to focus its efforts and resources on those risks that can most significantly impact the achievement of the Project objectives. This is typically a subjective judgement based on the consequence type, severity, and associated probability of a risk and is informed by the experience of the Project team and third parties on related past projects.

The qualitative risk analyses performed for the Project are typically undertaken by performing a "Bow-Tie Analysis" to identify the potential risk event, risk threat or opportunity, conditions or triggers, and the consequences or benefits if the risk

materializes.[41] Additionally, the analysis identifies ways to prevent the risk and mitigate risk effects if it does materialize. Once information related to the risk is determined, the Site C Project Risk Matrix is used to determine the risk level and risk zone.[42]

Quantitative risk analysis provides insight into the combined effect of individual risks. It considers probabilistic effects and provides a numerical estimate of the overall effect of the risk on the ability to achieve the Project cost and schedule objectives. The quantitative risk analyses performed for the Project are the Cost Risk Analysis and the Schedule Risk Analysis.

The Cost Risk Analysis is a structured process used to evaluate financial risks by analyzing all open risks in the Risk Register that have a financial loss consequence if they were to occur. The Cost Risk Analysis is conducted by the Risk Management Team, with input from Risk Owners and the Estimating Team through the completion of risk documents which include the risk event description, scope, risk assumptions, three-point cost estimate, risk probability, and a justification statement.[43]

Once the Risk Management Team has identified all relevant risks from the Risk Register, and all necessary data has been captured and reviewed for quality, the team performs a Monte Carlo analysis using risk management software to quantify the potential cost impacts. The results are then fed back into the Risk Register for informational purposes. This methodology aligns with BC Hydro's Project and Portfolio Management practices, as well as the Association for the Advancement of Cost Engineering standards.

[41] Bow-tie analysis is a structured risk assessment methodology that visually represents the relationship between potential threats, a central hazardous event, and its possible consequences. It identifies and evaluates both preventative controls and mitigative controls.

[42] Refer to Figure 5 above.

[43] A three-point cost estimate includes one of the following options: optimistic, most likely, and pessimistic.

The Schedule Risk Analysis is used to determine the probability of achieving the Project schedule objectives using risk analysis software and a simulation model.

As part of developing risk mitigation plans, the Risk Owner may perform a Cost Benefit Analysis by weighing the potential cost impact of the unmitigated risk against the cost of the risk mitigation plan and the residual impact of the risk.

5.2.4 Step 4 - Risk Response Planning

The purpose of this step is to decrease the probability and consequence of risks and increase the probability and consequence of opportunities by selecting a preferred mitigation option for each risk item. The general deliverables of risk mitigation planning are:

- An up-to-date Risk Register outlining the proposed mitigation options for each risk; and
- An approved work plan that describes the execution of active mitigation for each risk.

There are four general categories of risk mitigation as set out in Table 13 below.

Table 13 Risk Mitigation Categories

Action	Description	Rationale
Avoid	Scope or plan for the Project is altered to avoid the risk event.	• Avoiding the risk is the simplest approach. • The associated activity may not be worth taking the risk.
Mitigate	Take steps to reduce the consequence and/or likelihood of the risk occurring. This may also include reactive mitigations (e.g., contingency plans) if proactive mitigations are unsuccessful.	• The consequence(s) arising from the risk event is(are) not tolerable, and their probability and/or magnitude must be reduced. • The mitigation comes at no cost, or the cost is worth the potential benefit.
Transfer	Include language in contracts that assign the risk to another party and review for potential residual risk that BC Hydro retains.	• The other party is in the best position to control this risk. • It is less costly to have the other party manage the risk.
Accept	Accept the risk with existing controls. Project contingency should be budgeted to address the risk should the risk event occur.	• No cost-effective option exists to avoid, mitigate, or transfer the risk. • The consequence if it occurs is not critical to the Project success.

Once a risk is identified, analyzed, and categorized, mitigation options are evaluated and documented in a mitigation plan. The plan is then implemented and reviewed regularly.

Major risks are those risks that could impact BC Hydro's ability to meet the Project's objectives. The criteria are as follows:

- For non-financial loss consequence risks, a residual risk level of 10.5 or greater; and
- For financial loss consequence risks, the same criteria as non-financial loss risks plus an expected risk value of greater than or equal to $50 million.

For major risks, a formal and detailed Risk Mitigation Action Plan is created. This plan outlines specific actions, timelines, costs, resources, and performance measures. The Risk Owner is responsible for ensuring the plan is executed and effective. The plan must be actively managed and reported on a regular basis. The plan addresses the speed of risk onset and includes actions to reduce both the likelihood and impact of the risk, as well as contingency actions if the risk occurs. All activities are tracked in the Risk Register.

Once the mitigation plan is in place, the residual risk is assessed and recorded. Risks remain active in the Risk Register unless they are closed.

5.2.5 Step 5 - Risk Monitoring and Control

This step includes monitoring the factors that can influence the occurrence of a risk, managing the risk mitigation plans, and communications and reporting of the risks. Risk monitoring procedures have the following deliverables:

- Updating the probability, consequence, and exposure for each identified risk in the Project Risk Register;

- Preparing a risk monitoring plan with ongoing monitoring of the factors that can influence the occurrence of a risk and managing the risk mitigation plans;
- Preparing ongoing risk communications and reporting;
- Preparing a list of personnel responsible for managing each risk;
- Including risks with a risk score of 10.5 or higher in the Risk Matrix, in the monthly risk reporting to the Project Assurance Board and the BC Hydro Board of Directors and in the quarterly reporting to the Project Assurance Board, BC Hydro Board of Directors, Government of B.C., and the Commission.

The Project's risk management reporting includes:

- **Monthly Site C Project Assurance Board Risk Report:** This report was provided to the Project Assurance Board, including the Government of B.C. representatives, and to the BC Hydro Board of Directors. The report sought to capture all the significant or potentially significant risks that could impact the Project's objectives. The intent was to balance a broad view of risks while maintaining a manageable number of risks being identified.
  - Risks are reported in this report if:
    - They have a $50 million or greater value based on the quantitative Cost Risk Analysis; or
    - They have a risk level of 10.5 or higher based on the Project Risk Matrix; or
    - They do not meet the above criteria but may in the future.
  - The report also includes the following information:
    - Risk Velocity;[44]

[44] Risk velocity is an indication of how quickly the risk impact is felt, categorized as High (within one month), Medium (one to six months), or Low (over six months).

- Quantitative financial risk data (probability of occurrence, three-point cost estimates);
- P50 Base Budget: value of the base budget funds to address the risk;[45]
- Mitigation Status: objective reporting criteria based on the risk mitigation plan;
- Risk exposure trend;[46] and
- Comments: update of activities and events since the last quarter.

▶ A comprehensive listing of all open risks in the Project Risk Register was also provided to the Project Assurance Board on a semi-annual basis.

- **Site C Quarterly and Annual Progress Reports:** These reports are provided to the Project Assurance Board, including Government of B.C. representatives, the BC Hydro Board of Directors, and the Commission. The risk information in these reports is based on the monthly Project Assurance Board risk reports.
- **Risk Information to Management and the Project Team:** This risk information is included in the Project Risk Register, accessible to all Project team members, and numerous risk dashboards which enable the review and analysis of all Project risks.

5.2.6 BC Hydro Has Continually Improved the Site C Risk Management Framework

The Risk Management Framework for the Project has been improved over time. Specifically:

- **2018 Consolidation of Risk Registers:** In the early stages of the Project, risks were tracked in benefit and risk lists, which later evolved into Microsoft Excel

[45] A P50 base budget means that the actual cost is expected to be higher 50% of the time and lower 50% of the time.

[46] Indicated by a visual (directional arrow) representation of how the risk profile is trending from the previous quarter.

spreadsheets. By 2013, three separate risk registers were maintained for strategic, contract, and transmission risks, and each were housed in different systems. In 2018, BC Hydro consolidated these separate registers into a single, comprehensive Project Risk Register on SharePoint. This streamlined risk management across the Project enabled a Project-wide view of risks, consistent risk management practices and processes and improved support for quantitative analysis and reporting.[47]

- **2019 Ernst & Young Assessment:** In 2019, Ernst & Young issued a report titled *Current State Assessment BC Hydro Site C Project Controls and Risk*, which recommended several improvements to the Project's risk management framework. The Project adopted all the recommendations, including the following changes:[48]
  - All risks with a risk level greater than or equal to 10.5 are to be reported in the Project Assurance Board risk reports;
  - The risk number from the Risk Register will be included in the risk change log;
  - The milestone name and number will be included in the Risk Register field along with the risk exposure start and end dates;
  - Access permissions in the SharePoint settings was changed to provide improved access to the risk register for the Project team;
  - A new alert field "My Risk" was created in SharePoint to help Risk Owners manage the risks they are responsible for;
  - A risk dashboard was developed and made available to the Project team; and

[47] This has been identified as a lesson learned and is described in section 5.5.1 below.

[48] These enhancements have been identified as lessons learned and are described in sections 5.5.2, 5.5.4, and 5.5.5.

- The Risk Committee was established in mid-2018, with meetings held monthly. The Risk Committee consisted of Project Directors, the Dam Site Vice President, the Site C Executive Vice President, members of the Risk Management Team and the Independent Oversight Advisor, Ernst & Young.

- **2020-2021 Enhancements to Cost Risk Analysis and Schedule Risk Analysis:** Throughout 2020, BC Hydro, in collaboration with Ernst & Young, completed the following enhancements to the Cost Risk Analysis and Schedule Risk Analysis processes, in response to early feedback prior to the public release of the 2021 Milburn Report in January 2021:

  - Enhanced mapping of risks between the Project Risk Register and the Cost Risk Analysis;
  - Improved documentation of cost estimates used as an input into the Cost Risk Analysis;
  - Improved documentation of risks used in the Schedule Risk Analysis;
  - Additional and regular reviews with Ernst & Young as part of the Cost Risk Analysis process;
  - New Risk Register fields:
    - "Optimistic," "Most Likely," and "Pessimistic" cost estimate fields to allow for the calculation of the Cost Risk Analysis directly from the Risk Register; and
    - Additional schedule impact fields to support the Schedule Risk Analysis; and

- Increased the frequency of the Cost Risk Analysis and the Schedule Risk Analysis to quarterly.[49]

- **2021 Risk Management Enhancement Plan:** As a result of close collaboration with Ernst & Young and Mr. Peter Milburn, the Project authored a Risk Management Enhancement Plan, which was substantially complete in June 2021 and fully implemented by September 2021. The Plan enhanced the organization's risk management framework through process improvements, updated documentation, and strengthened governance.

  Standardized templates, guidance materials, and quantitative tools were developed. Comprehensive training programs and orientations were delivered to build capability across all levels. Governance was reinforced through committee reviews, maturity assessments, and the creation of a risk management community of practice. System enhancements addressed software needs and approvals, and advanced analytics evaluated modeling requirements, mitigation effectiveness, and scenario impacts to support informed decision making.

- **2021 Enhancements to Project Assurance Board Risk Reporting Process:** In response to the 2021 Milburn Report, improvements were made to the Project Assurance Board risk reporting processes.

  Specifically, the criteria to determine whether a risk was reported to the Project Assurance Board was updated so that, in addition to risks with a risk level of 10.5 or higher from the Risk Matrix, the following risks would also be reported:

[49] Beginning in mid-2022, the frequency of the Cost Risk and Schedule Risk analyses began to reduce based on direction from the Project Assurance Board. These analyses are now performed two to three times per year.

- All financial loss risks that have an expected value of greater than or equal to $50 million;
- Any new or emerging risks identified by Project Assurance Board or Project team members that do not currently meet the Risk Matrix or financial loss criteria but may in the future; and
- Any risks that have been closed or that have become active during the reporting period.

In addition, a risk velocity measure was added with risks categorized as High (impact is felt within one month), Medium (impact is felt between one and six months), and Low (impact is felt in greater than six months).

BC Hydro and the Independent Oversight Advisor, Ernst & Young held regular meetings regarding the Project Risk Register, and any changing or new risks. The frequency of dedicated risk discussion sessions at Project Assurance Board meetings was increased, supplemented by detailed background information to enable deeper discussion and expert input.

- **2021 Resource Increases:** As of mid-2021, risk management on the Project was performed by Risk Owners, the Risk Management team and the Estimating, Scheduling and Cost team. Given the overall impact that realized risks had on the Project, and in response to the 2021 Milburn Report, BC Hydro reviewed the staffing levels of the centralized Risk Management Team and added four additional resources to increase the team to six members. The new resources were dedicated to the centralized Risk Management Team and were separate and independent from the team members responsible for the delivery of the Project.[50]

[50] This has been identified as a lesson learned and is described in section 5.5.3.

5.3 Overview of Major Risks that Materialized and Impacted Cost and Schedule

This section describes identified major Project risks, how these major risks were mitigated and their impacts on the Project budget and schedule. These major risks were compiled from the Major Project Risk sections from the Quarterly Progress and Annual reports filed with the Commission.

As discussed in section 1.2 above, since the Final Investment Decision budget of $8.775 billion was approved in December 2014, there have been two budget increases. The 2018 Approved Budget was $10.7 billion, and the 2021 Approved Budget is $16 billion. These budget increases and the one-year delay to the approved final in-service date, from November 2024 to November 2025, were largely driven by major risks that materialized on the Project.

Two of the most critical milestones on the Project were river diversion and reservoir filling. Both these milestones could only take place during a narrow window in the fall of each year due to BC Hydro system constraints during the winter, excessive inflows during the spring freshet, and environmental constraints (such as bird nesting and bear denning). Missing either milestone would require the activities associated with the milestone, and all the other construction activities that depended on the completion of the milestone, to take place approximately one year later. As a result, there were significant cost and schedule implications related to when these milestones were achieved. In addition, to achieve each of these milestones, substantial planning, scheduling, and effort was required to coordinate the safe completion of all the work activities that were required.

As discussed further in section 2.2 above, in 2017, various construction challenges were encountered on the Project, including the development of two tension cracks on the left bank. Consequently, BC Hydro determined that the timeline for river diversion in 2019 could not be met. While this set some of the Project activities back a year, including moving river diversion to the fall of 2020, BC Hydro had one year of

float planned into the schedule, and accordingly, the final Project in-service date was not delayed at that time. However, the impacts of the two tension cracks and the one-year delay in river diversion contributed to the increase from the Final Investment Decision budget of $8.775 billion to the 2018 Approved Budget of $10.7 billion.

In March 2020, the impact of the global COVID-19 pandemic began. As BC Hydro worked with contractors to gradually restart work that was stopped due to the pandemic, the work required to meet major Project milestones, including river diversion in fall 2020, was prioritized. Between January 2020 and October 2020, the Project completed all the required steps to prepare for river diversion, and the Peace River was successfully diverted around the Site C damsite on October 3, 2020.

While river diversion was achieved in October 2020, there was uncertainty with the Project's budget, schedule, and in-service date in part due to the COVID-19 pandemic and whether the resulting delays in work could be recovered. In addition, there were geotechnical challenges on the right bank, which required foundational enhancements for the stability of the spillways, dam core and powerhouse and enhancements to the approach channel to reduce the risk of leakage. As a result, in February 2021, the Approved Budget was increased to $16 billion, and the final Project in-service date was changed from November 2024 to November 2025.

With the completion of diversion tunnel conversion in September 2023, there was a possibility that reservoir filling could start in late fall 2023, one year earlier than the 2021 Approved Schedule. However, as of early November 2023, there continued to be some critical work areas that needed to be completed before reservoir filling could begin safely, including the approach channel, spillway gates and powerhouse intake gates. With the winter weather and colder conditions setting in, the window to safely begin reservoir filling was ending and in mid-November 2023, BC Hydro decided to maintain the approved reservoir filling schedule of fall 2024.

However, all the planning and critical work that was completed in 2023, reduced the risks to commence and complete reservoir filling in fall 2024. In late August 2024, reservoir filling commenced ahead of the 2021 Approved Schedule and reached its normal operating range on November 7, 2024. As a result of the earlier reservoir filling, the first generating unit was able to be placed in-service on October 27, 2024, approximately six weeks ahead of the 2021 Approved Schedule, and all six generating units were in-service by August 8, 2025, approximately three months ahead of the Approved Schedule.

The following tables describe the major risks identified that materialized and had a significant impact to the Project's budget and/or schedule. The tables provide a description of each major risk identified on the Project, including examples of specific risks from the Risk Register, a qualitative description of impacts if the risk materializes, BC Hydro's response and mitigation actions, and where possible, the estimated effects on the Project's budget and schedule.

Table 14 Major Risk 1: Increased Costs, Schedule Delays, and Potential Safety Issues Associated with the Tension Cracks on the Left Bank

Identified Risks	Unknown geotechnical ground conditions causing cost increases or schedule delays. Required redesign due to differing geotechnical conditions, leading to higher costs or delays.
Description	In February 2017, a tension crack developed on the left bank excavation while constructing a haul road resulting in the temporary stoppage of some construction excavation activities. In May 2017, a second and smaller tension crack was first observed in the temporary access road excavations above the future diversion tunnel portal. This smaller tension crack extended locally into the final slope, requiring a solution that integrated with the final slope. Following the May 2017 tension crack, BC Hydro identified that the weak surfaces extended within the Project's final design slope, providing new information to be considered for the existing design of the final slope.

Mitigating Actions	The first tension crack resulted in the need to redesign the slope excavation and to redesign and move the construction roads to ensure the safety and the long-term stability of the slope. The Project and the contractor worked collaboratively and agreed on a plan to stabilize the slope. Construction recommenced in April 2017. In response to the second tension crack, the Project developed a new design for the contractor's haul roads and a new design for the left bank final slope that included the removal of the preexisting ancient slides to mitigate various construction challenges. To mitigate the delays, efforts were made to enable work to continue over the winter months. The activities over the winter were in support of future work which included the start of diversion tunnel excavation in summer 2018 to support the achievement of the 2020 river diversion milestone.
Impacts	The two tension cracks were major contributors to the $1.925 billion increase from the Final Investment Decision budget to the 2018 Approved Budget. The schedule delay resulted in additional Project engineering, project management, and construction management resources and costs, and increased the costs for the Main Civil Works contractor due to the additional work required to address the two tension cracks and the resulting schedule changes. Safety risks from unstable slopes on the right bank caused delays, reduced productivity, and contractor interface issues. Additional geotechnical investigations, design changes, and work scope adjustments were required. The Project completed detailed geotechnical investigations prior to construction and implemented mitigating actions through collaborating with contractors, adjusting work plans, resolving claims, and closely monitoring progress. The pre-construction geotechnical investigations and ongoing monitoring and oversight also helped mitigate further geotechnical issues. A successful insurance claim resulted in the Project receiving $97 million in net proceeds which was returned to Project contingency.

Table 15 Major Risk 2: Cost and Schedule Increases on the Project up to 2018

Identified Risks	Increased costs due to Highway 29 geotechnical conditions and market rates. Highway 29 costs exceeding budget. Higher costs from progressed reservoir clearing designs and market conditions. Elevated reservoir clearing costs. Transmission design issues not resolved.
Description	Prior to the 2018 Approved Budget, the Project re-examined each component of the Project budget. The budget review included the impact of the two tension cracks and the one-year river diversion delay, and identified other budget increases required for other major scope items including: • The Generating Station and Spillway bid costs were significantly higher than initial budgets. • Higher transmission costs due to design changes, geotechnical work, and road upgrades and maintenance. • Increased Highway 29 realignment costs driven by culturally sensitive area concerns by Indigenous Nations and higher fill material quantities and unit prices. • Higher reservoir clearing and infrastructure costs from expanded reservoir clearing areas, additional environmental compliance, and more roads, bridges, and crossings than initially budgeted. • Increased costs for early works and turbine and generator work. • Higher indirect costs for Project engineering, project management, and construction management due to the river diversion delay and greater effort required to support construction activities.
Mitigating Actions	The Project took several mitigation actions to reduce the impacts of the various risks materializing and the associated budget increases including: • Conducting value engineering and constructability reviews to optimize designs and using competitive tendering on contracts, where appropriate. • Commencing procurement processes early and utilizing collaborative procurement and contracting approaches with contractors. • Closely monitoring contractor schedule and productivity during construction and working with contractors to address schedule and productivity issues. • Providing sufficient time for effective procurement processes and negotiating competitive pricing for contracts. • Collaborating with BC Hydro's Indigenous Relations Key Business Unit for direct award contracts with Indigenous Nations designated businesses. • Adopting an ongoing collaborative approach with contractors during construction to manage issues as they arose. • Providing a safe work environment for all Project workers. • Providing industry-leading on-site worker accommodation to mitigate contractor risks related to the availability of labour. • Providing commercial management resources to proactively resolve claims as they were received and ensure effective commercial management procedures were in place and being followed. • Capturing and reporting on-site physical work progression on a weekly basis for key work fronts including monitoring key interface milestones and holding work progression reviews with contractors on a regular basis. • Facilitating integration between the original equipment manufacturers and the installation contractors to resolve any differences.
Impacts	These increased costs were major contributors to the $1.925 billion increase from the Final Investment Decision budget to the 2018 Approved Budget.

Table 16 Major Risk 3: Communicable Diseases Impact on Construction Activities at Site C

Identified Risks	Risk that communicable diseases impact construction activities at Site C. Risk that reoccurrence of COVID-19 impacts continuation of construction activities. Risk that contractors do not complete scope on schedule. Risk that productivity for roller-compacted concrete is lower than planned.
Description	The COVID-19 pandemic, which began in December 2019 and was declared a global pandemic by the World Health Organization in March 2020, had far-reaching public health and societal impacts. Governments across the world, including in Canada and British Columbia, implemented numerous public health measures in response. These measures resulted in travel restrictions, supply chain disruptions, strict workplace and social distancing protocols and the controlled rollout of vaccinations when they became available in late 2020 and early 2021. The pandemic had a significant impact on the Project's cost and schedule.
Mitigating Actions	In response to the global COVID-19 pandemic, BC Hydro and the Government of B.C. decided to continue to advance the critical path work on the Project. The Project focused on activities critical to achieving river diversion and essential services, such as keeping the site safe and secure and meeting the Project's regulatory and environmental commitments. The Project complied with public health measures to keep workers safe and advance work which included: • Reducing the number of workers in the worker accommodation, which resulted in fewer workers travelling to and from Fort St. John and the Peace Region; • Gradual ramp up of workers at site in early 2021; • Implementing travel restrictions and the Ministry of Health self-assessment and confirmation practices before travel; and • Implementing infectious disease sanitation protocols and daily temperature screening, rigorous physical distancing compliance, mandatory masks at site, and isolation/quarantine facilities and services. Despite these preventative measures and protocols, Northern Health declared two COVID-19 outbreaks on the Project in 2021. However, due to effective safety measures, on-site work continued, and BC Hydro was not directed to stop construction at any time.
Impacts	The COVID-19 pandemic resulted in a budget impact of $1.6 billion. Impacts included schedule delays because of contractor work stoppages in March 2020 and work restarting slowly over the remainder of 2020 and 2021; interface issues with other contractors due to delayed schedules; contractor cost increases due to the schedule delays and productivity impacts; and additional costs to implement safety systems, practices, and protocols in worker accommodation and across all work areas. Specific impacts included: • A large portion of the 2020 summer construction season for the earthfill dam, the core buttress and the generating station and spillways, was missed (i.e., approximately 60% of the summer 2020 construction season was lost); • The generating station and spillways civil works, the powerhouse intakes and penstocks, and the spillway headworks construction activities were also significantly impacted and by the end of December 2020 had not recovered to the original 2020 plan; and • In May 2020, the Main Civil Works contractor initiated a gradual phased approach to restarting the remaining non-critical river diversion works. As of December 2020, most of the key planned main civil work activities had restarted except for the earthfill dam fill placements. Since the placement of these materials required warmer temperatures, the restart of that work was delayed until 2021.

	Despite the challenges and lower productivity at site, between January 2020 and October 2020, the Project completed all required steps in the process to prepare for river diversion, and the Peace River was successfully diverted around the damsite in October 2020.

Table 17 Major Risk 4: Increased Costs and Schedule Delays Associated with the Right Bank Foundation Enhancements

Identified Risks	Risk of additional work to meet approach channel, powerhouse, and spillway roller-compacted concrete stability buttress requirements. Risk of geotechnical issues on work fronts other than the left bank diversion tunnel. Right bank foundation enhancements at approach channel require additional work. Risk of right bank foundation enhancements interface conflicts. Risk of procurement uncertainty for the right bank foundation enhancement work. Risk of additional work for the Main Civil Works contractor to meet powerhouse, dam, and spillway roller-compacted concrete buttress requirements. Risk of differing geotechnical conditions resulting in design changes to the earthfill dam.
Description	In late 2018, small movements were measured on a bedding plane beneath the roller compacted concrete buttress on the right bank. By January 2020, ongoing investigations and analysis of geological mapping and monitoring activities completed during construction identified that foundation enhancements would be required to increase the stability below the powerhouse, spillways, and future dam core areas. The Project, in agreement with the Technical Advisory Board, determined that significant foundation enhancements were required, and the cost of those enhancements would be significantly higher than previously expected.
Mitigating Actions	A two-part solution was developed to improve the stability of the right bank structures. The first part of the solution was to improve the strength of the concrete buttresses beneath the right bank structures by anchoring the buttresses deeper into the rock below. 96 vertical steel and concrete piles, each up to 2 metres in diameter, extended the function of the shear key by drilling through the deeper bedding plane into the even stronger rock below it. The piles extend the function of the shear key a further 15 metres to 25 metres into the bedrock, below the deepest bedding plane where movements have been measured. The second part of the solution was to improve the water tightness of the approach channel. The approach channel is located adjacent to the spillways and powerhouse and directs water from the reservoir, around the earthfill dam and into the generating station. The approach channel's original design included features to make it watertight, which prevents water from seeping out of the channel and into the underlying and surrounding bedrock. The improvements enhanced the approach channel liner and increased drainage to prevent water from seeping into the foundation when the reservoir is filled. In February 2021, the Government of B.C. released a due-diligence geotechnical review by two independent international dam experts which confirmed the solutions met the highest safety standards and international best practices. The experts were retained to provide oversight while construction was completed. All the planned work was substantially complete as of the end of March 2024.
Impacts	The right bank foundation enhancements resulted in a budget impact of $1.1 billion. Additional impacts included schedule delays for contractors; lower productivity for contractors resulting in further schedule delays and interface issues with other contractors; additional geotechnical investigations resulting in required design changes; and changes in work requirements.

Table 18 Major Risk 5: Cost and Schedule Increases Related to Major Scopes of Work on the Project After 2018

Identified Risks	Risk of earthfill dam construction delays due to instrumentation installations. Risk of dam construction delay. Risk that spillway costs increase materially due to required design changes. Risk of powerhouse, intakes, and spillway completion delays. Risk of Highway 29 geotechnical conditions and market rates increasing costs. Risk of Highway 29 costs exceeding the approved budget. Risk that reservoir clearing designs and market conditions increase costs. Risk that reservoir clearing costs are higher than budget.
Description	In addition to the COVID-19 pandemic and the right bank foundation enhancements, there were several other contributors to the increase between the 2018 Approved Budget and the 2021 Approved Budget including higher cost associated with the Main Civil Works contract (dam construction), higher costs for the Generating Station and Spillways and Balance of Plant, higher costs associated with the Highway 29 realignment and higher costs for reservoir clearing.
Mitigating Actions	The Project took several mitigation actions to reduce the impacts of the various risks materializing and the associated budget increases. These actions were similar to the actions described in Table 16 above.
Impacts	The cost impacts of these risks are included in the $5.3 billion increase between the 2018 Approved Budget and the 2021 Approved Budget. Specific impacts included: • Amendments to the Main Civil Works contract due to schedule delays, claims settlements, schedule recovery, equipment investments, and other items. • Additional Project labour resource requirements for engineering, project management and construction management due to schedule delays and for monitoring and executing the construction activities. • Cost increases and schedule delays related to the Balance of Plant work activities. These were required for design changes and scope changes involving heating, ventilation, and air conditioning and fire protection. • Cost increases and schedule delays related to the Generating Station and Spillways civil work activities These were required for scope changes, resolution of claims related to contract interface impacts, and material quantity increases. • Cost increases and schedule delays related to the Highway 29 Realignment. These were required for updated designs for remaining highway segments driven by geotechnical testing results and updated material unit rates. • Other cost increases and schedule delays related to other scopes of work, including site infrastructure such as roads, temporary site power, and worker accommodation, turbines and generators, mitigation and compensation works such as reservoir boat launches and fish habitat, and the clearing of the reservoir.

Table 19 Major Risk 6: Penstock Flexible Couplings Do Not Perform as Expected

Identified Risks	Penstock flexible couplings do not perform as expected.
Description	The construction of the generating station included the design, manufacturing, delivery to site, and construction of six penstocks that are used to convey water between the intake structure and the powerhouse. On each of the six penstocks, there is an upper flexible coupling that allows the penstock to expand and contract. The design, supply, installation, and corrosion protection of the six upper flexible couplings on the six steel penstocks was within the scope and responsibility of the Generating Station and Spillways contractor. The design for the upper flexible couplings did not fully meet the Project's specifications and needed to be redesigned. The installation of all six upper flexible couplers was completed in October 2024.
Mitigating Actions	The Project team worked closely with the contractor to ensure the Project's specifications and requirements were met. This resulted in numerous discussions and project interface planning efforts when the upper flexible couplers were ready to be installed at site.
Impacts	Since BC Hydro had accepted the original design, the Project contributed approximately $55 million for the estimated incremental cost impacts associated with the redesign of the upper flexible couplers. This included: the costs the Project was contractually responsible for related to the redesign, supply, and installation of the final upper flexible couplers; schedule prolongation; interface management; requirements and issues with other scopes of work at the penstock locations; schedule recovery costs; and additional Project resource costs. The cost impacts were funded from the generating station and spillways work package budgets. No draw on Project contingency was required. There was a 16-month delay in the completion date for the upper flexible couplers from June 2023 to October 2024. The upper flexible couplers have been performing well since the generating units were placed into service with minimal leakage. The minimal leakage to date was anticipated and is a result of the heating and cooling associated with varying weather cycles. Adjustments will continue to be made to the seals in the upper flexible couplers once they have gone through a couple of varying weather cycles to address any further minor leakage.

Table 20 Major Risk 7: Cost and Schedule Impacts from Enhancements to the Right Bank Drainage Tunnel and Left Bank Drainage Adit

Identified Risks	Adits[51] or right bank drainage tunnel may need additional structural support post reservoir filling.
Description	The primary function of the right bank drainage tunnel is to prevent groundwater from accumulating behind the roller-compacted concrete buttresses on the right bank. Flooding in the right bank drainage tunnel is prevented by collecting water in the tunnel sumps and actively pumping it via piping outside the tunnel and back into the Peace River. With a similar function to the right bank drainage tunnel, the left bank drainage adit prevents the accumulation of groundwater on the left bank adjacent to the earthfill dam. These features ensure groundwater is managed to an acceptable level in the left and right abutments. The civil construction of these features was completed by the Main Civil Works contractor, consistent with their contractual requirements and the base design. This work included the installation of instrumentation, drain holes, the structural lining, and the concrete floor slabs.[52] After this work was completed, the Project's engineering team, the Technical Advisory Board, and an external tunneling consultant concluded that enhancements were required to both tunnels to ensure the tunnels would meet the Project requirements for the life of the facility. The scopes of work for the enhancements include an enhanced tunnel lining and upgrades to the permanent electrical and mechanical systems and portal structures.
Mitigating Actions	BC Hydro completed a commercial analysis and developed a commercial supply chain strategy for the tunnel enhancement scopes of work. The analysis and strategy considered the delayed schedule to complete the permanent works, and which contractor could complete the work in the most cost-effective manner, including availability of the required equipment and facilities such as a crusher, on-site concrete batch plant, and qualified personnel to complete the work. The Generating Station and Spillways contractor was determined to be the best contractor to complete this work, utilizing one of the existing contracts that were in place for the Project with this contractor.
Impacts	Impacts include the additional ongoing operation, maintenance, and management of the tunnels before the permanent works commence, the enhanced lining including the welded wire mesh reinforced shotcrete lining and tensioned rock bolts, the permanent electrical and mechanical systems, and the portal structures. Most of the cost to complete the enhancements will be funded by a draw on Project contingency with a minor amount being funded from existing budgets. The work to complete the enhancements is currently in progress and is expected to be complete by fall 2026.

[51] A horizontal or near-horizontal tunnel into a hillside or mountain for drainage.

[52] The flat concrete surface at the bottom of an underground structure.

Table 21 Major Risk 8: BC Hydro's Estimate for the Diversion Tunnel Backfill May Be Below Current Market Rates

Identified Risks	Estimate for Tunnel Backfill may be below current market rates.
Description	The original scope of work for the construction of the two river diversion tunnels, the conversion of the one diversion tunnel to facilitate reservoir filling (tunnel conversion), and the backfilling of the two tunnels once reservoir filling was complete (tunnel backfill), was within the Main Civil Works contract. In August 2022, after the construction of the two diversion tunnels was completed, the Project completed a commercial analysis and developed a commercial supply chain strategy to review the available options to complete the tunnel conversion and tunnel backfill scopes of work. The Generating Station and Spillways contractor was determined to be the best contractor to complete this work, utilizing one of the existing contracts that were in place for the Project with this contractor. The tunnel conversion, which involved installing four orifices in diversion tunnel 2 for reservoir filling, was completed in 2023 for $32 million, below the initial estimate. However, the cost estimate for the tunnel backfill scope, which includes multiple structural and electrical components, increased due to changes in scope directed by the Project and increases in market pricing.
Mitigating Actions	The Project held numerous discussions and negotiations with the Generating Station and Spillways contractor in 2023 and 2024 to mitigate the estimated cost increases for the tunnel backfill work. These discussions included scope changes, delivery of work practices and estimated material quantities. The Project requested that the contractor resubmit updated pricing based on the updated scope of work and updated subcontractor costs. This updated pricing was significantly lower than the original updated pricing submitted by the contractor.
Impacts	The estimated costs to complete the tunnel backfill scopes of work was higher than the initial estimates provided in August 2022, mainly due to required design changes and higher costs for ventilation, water management and subcontractor resource costs. The funding for the incremental cost was mainly from a draw from Project contingency with the remaining sourced from existing work package budgets. The work to complete the tunnel backfill is currently in progress and is expected to be complete by spring 2026. The completion of this work did not impact the Project's key milestones.

Table 22 Major Risk 9: Borrowing Costs Increase Because of Higher Interest Rates or Changes to Expenditure Timing

Identified Risks	Risk that increased interest rates, changes in expenditure timing or cost escalations increase borrowing costs.
Description	Interest During Construction is applied to eligible capital expenditures as it represents the cost of borrowing to BC Hydro and is included in the total Project cost. The Project faced the risk of higher Interest During Construction costs than budgeted, especially due to the long construction period, fluctuations in short-term interest rates on debt that was not hedged, regulatory accounting for realized gains / losses on hedges, changes in capital expenditure timing, changes in the in-service dates for key assets (e.g., first power), and cost escalations.
Mitigating Actions	To mitigate the impact of increasing or high interest rates, BC Hydro hedges debt based on BC Hydro's approved debt hedging strategy. BC Hydro hedged approximately 75% of the Project's debt. In addition, BC Hydro closely managed the annual capital expenditures on the Project and the schedule for first power in-service, which is when most of the Interest During Construction ceased on the Project.
Impacts	The 2018 Approved Budget included a reduction in the expected Interest During Construction costs of $122 million due to lower-than-expected interest rates, which was partially offset by higher Interest During Construction costs due to higher capital expenditures. The 2021 Approved Budget included an increase in Interest During Construction costs of $743 million mainly due to higher capital expenditures and the delayed in-service date.[53]

Table 23 Major Risk 10: Cost and Schedule Impacts Because of Need to Increase Project Resources

Identified Risks	Risk of increased BC Hydro Construction Management resources required for contractor oversight. Risk of additional expenditures required for Engineering support for the Project. Risk of additional Engineering costs to complete the design, and support construction and staff supervision in the field. Risk of increased BC Hydro Site Resident Engineers required to review contractors' work.
Description	The number of Project resources required increased above the amount that was originally budgeted due to the numerous challenges the Project faced including the delay to river diversion by one year and the delay to the final in-service date by one year. Most of the additional Project resources were for engineering, project management and construction management resources that completed specific Project scopes of work, or managed and monitored the work being completed by contractors. The 2021 Milburn Report recommended additional commercial and claims management resources, and risk management resources to manage contractor claims and commercial activities more effectively, to more closely monitor on-site construction activities, and to enhance risk management practices and processes. These recommendations for additional resources were subsequently implemented on the Project.

[53] Includes interest included in the COVID-19 pandemic amount and the right bank foundation enhancement amount shown above in Table 2.

Mitigating Actions	To mitigate the risk of increased Project resource costs, BC Hydro took several actions including: • Performing regular and ongoing forecasting of the required internal resource requirements. • Filling open positions in a timely manner to align with design, manufacturing, and construction activities. • Working with contractors to increase their quality control staffing levels to reduce the requirement for the Project to add additional quality assurance resources.
Impacts	$386 million in cost increases for additional Project resources were included in the 2018 Approved Budget. $658 million in cost increases for additional Project resources were included in the 2021 Approved Budget.

Table 24 Major Risk 11: Unit 4 Nonconforming Concrete

Identified Risks	Risk that the powerhouse, spillway, and intakes don't conform to construction drawings and design specifications. Risk of Balance of Plant contractor claims. Risk of Turbines and Generators contractor claims.
Description	In December 2022, the second of three concrete placements in the Unit 4 turbine spiral case embedment were found to contain nonconforming concrete due to fly ash erroneously unloaded into the batch plant cement silo. After extensive mapping and coring, the nonconforming concrete was assessed, identified, removed, and replaced.
Mitigating Actions	The early identification of the nonconforming concrete demonstrated that detailed testing could identify the impacted concrete and initiate plans to remove it in a timely manner. The Project worked closely with the Generating Station and Spillways contractor responsible for the nonconforming concrete to mitigate the cost and schedule impacts of the delays, including by resequencing work in other areas.
Impacts	The work to identify, remove and replace the nonconforming concrete did not impact the Project's critical path and therefore did not impact the major schedule milestones. However, schedule adjustments to other parts of the Project and other impacts resulted in claims for time extension and additional costs. The claims were resolved through negotiations and in conjunction with other delays and commercial issues. Revised contract schedules with impacted contractors were established and cost adjustments were funded by existing budgets and Project contingency. The nonconforming concrete in Unit 4 was identified in December 2022, was fully removed by June 2023, and was fully replaced by late August 2023. Overall, there was approximately a six-month schedule delay for the Turbine and Generator contractor as the nonconforming concrete was removed and replaced. These delays also impacted the integration of other work, resulting in subsequent delays.

5.4 Many Major Project Risks Were Successfully Mitigated

This section describes major risks that were successfully mitigated on the Project including safety, labour attraction and retention, potentially acid generating rock, insufficient aggregate supply, insufficient worker accommodation, wildfire impacts to cost and schedule, noncompliance with environmental requirements, and cost and schedule impacts from inflation, exchange rates or supply chain issues. Specifically:

- **Safety:** BC Hydro is proud of the Project's strong safety record. From July 2015 through to July 2025, more than 65 million work hours were completed across the Project, with no fatalities and one permanent partial disabling injury in August 2017 when a worker injured their arm as a result from a fall from the back of a flatbed truck. Key Project safety metrics tracked over the duration of the Project consistently outperformed WorkSafeBC comparators.

  BC Hydro took many proactive measures to mitigate safety risks across the Project including completing thousands of planned safety verifications, continuous safety management programs and analytics, extensive safety training, regular sharing of safety learnings and detailed tracking and reporting of safety incidents. The team fostered a strong safety culture across all work fronts and contractors, working collaboratively with WorkSafeBC to monitor and respond to identified safety issues and retaining third-party experts to undertake risk-based safety reviews.

- **Labour Attraction and Retention:** One of the most significant risks to the Project over the duration of the lengthy construction period was that Project contractors would be unable to attract and retain sufficient skilled craft workers and key management personnel.

  To mitigate these risks on the Project, BC Hydro provided industry-leading worker accommodation, implemented commercial contract terms to increase labour stability, and built labour capacity in the Peace River Regional District.

Significant contracts included a requirement for Contractor Labour Committee participation. BC Hydro also reviewed contactor craft labour turnover and rehire data for attraction and retention issues, monitored industry data to determine labour market supply and demand, and ensured policies were in place for a safe and productive site. Contractors also provided labour sourcing and supply plans, advance notice of foreign worker hiring, and participated in local job fairs.

As a result of all these proactive mitigation measures by BC Hydro and contractors, the Project was able to consistently attract and retain skilled craft workers and key management personnel.

- **Potentially Acid Generating Rock:** The bedrock at the Site C damsite and the surrounding areas contains potentially acid generating rock. When the construction activities associated with the Project expose potentially acid generating rock, these locations must be treated to mitigate the potential environmental impacts of contaminated runoff.

To mitigate the risks of potentially acid generating rock, the Project developed a potentially acid generating rock management plan that employed a variety of recognized techniques to identify, test, monitor and treat any potentially acid generating rock during construction. The Project constructed several temporary care of water infrastructures across the site to collect and appropriately treat potentially acid generating contact water run-off. Any potentially acid generating rock sites located within the reservoir are rendered inert now that the reservoir is filled as inundation neutralizes the submerged rock by preventing oxidation. Any potentially acid generating rock sites remaining outside the reservoir post-construction will be addressed through location-specific prescriptions including on-going monitoring and testing by qualified environmental professionals.

In April 2022, an Environmental Assessment Office order related to potentially acid generating rock exposures required revisions to the Project's Construction

Environmental Management Plan. In October 2023, BC Hydro published the revised plan, which accelerated potential mitigation options for exposed potentially acid generating rock at the damsite not covered by the reservoir.

- **Insufficient Aggregate Supply:** A significant risk during construction of the Project was securing a sufficient supply of aggregate to meet construction requirements, including the earthfill dam, approach channel, the roller-compacted concrete foundations, the civil construction of the powerhouse and spillways, the diversion works, and other construction activities.

  To mitigate the risk of insufficient aggregate, BC Hydro increased aggregate stockpiles, worked with contractors to minimize waste and maximize aggregate production, released BC Hydro's on-site contingency aggregate excavation sites, investigated and implemented additional on-site aggregate sources, and identified off-site aggregates sources and options to haul it to site.

  For example, the Project secured approval for, and implemented, the Area E aggregate source and completed an upgrade to the haul road from Area E to the damsite in June 2022.

  As a result of all these proactive mitigation measures undertaken by BC Hydro and contractors, sufficient aggregate sources to meet Project requirements were identified and implemented.

- **Insufficient Worker Accommodation:** Sufficient on-site worker accommodation was required to mitigate the cost, schedule, and reputational risks associated with housing the number of workers required for the Project. This included cost and schedule impacts if workers were required to stay off-site and had to be transported daily to and from site as well as reputational risks from impacts to the available rental housing market in local communities.

  BC Hydro regularly forecasted on-site accommodation needs and expanded the worker accommodation lodge in stages to meet labour demands, ultimately

adding 700 additional rooms over the course of the Project. The lodge included a large dining area which supported social distancing during the COVID-19 pandemic. Successful contingency plans included short-term use of local accommodation, with ongoing cost comparisons between lodge expansion and off-site options.

Due to the mitigation actions that were implemented, the risk of the worker accommodation being insufficient to meet the construction schedule did not materialize. However, the worker accommodation budget did increase from the 2014 Final Investment Decision budget of $394 million to $486 million in the 2018 Approved Budget and to $736 million in the 2021 Approved Budget. These budget increases were mainly a result of the COVID-19 pandemic and the right bank foundation enhancements which required workers to spend additional time in the lodge and required the expansion of the lodge and higher operating costs.

- **Wildfires:** The threat of wildfires to the construction schedule and the safety of workers is a major risk in the summer season. BC Hydro prepared and implemented wildfire plans at site, conducted fire safety assessments, and implemented recommendations and mitigation measures to allow construction to continue when wildfires threatened the site. These measures included the monitoring of air quality and mitigation measures when air quality was low due to smoke. For example, when particulate levels were sustained well above provincial guidelines, BC Hydro required workers to wear respiratory protection when working outdoors, stay in pressurized vehicles with windows closed when possible, and minimize time spent outside.

- **Noncompliance with Environmental Requirements:** The Project must comply with the requirements of the Environmental Assessment Certificate and the Federal Decision Statement, as well as conditions in licenses, permits and authorizations. To address challenges contractors were experiencing to adapt

their construction methodologies to these requirements, BC Hydro added additional environmental specialists and worked with contractors on solutions.

While the Project did receive several enforcement orders from regulators during construction, through early identification of potential risks and the early preparation of mitigation plans, BC Hydro was able to quickly and effectively respond to environmental incidents that occurred.[54]

- **Inflation, Exchange Rates and Supply Chain:** The construction phase of the Project occurred over an extended period which meant prolonged exposure to inflation, exchange rate and supply chain risks. In particular;
  - the rate of inflation in Canada hit a 40-year high in 2022 at 6.8%. This included increased costs for labour, fuel, and materials and equipment;
  - Supply chain challenges, especially during and after the COVID-19 pandemic, also resulted in impacts to the schedule as contractors found it more difficult to source materials and equipment, and the time between placing an order and delivery to site increased; and
  - Since approximately 20% of the initial overall direct construction costs were based in foreign currencies, the total cost for the Project was also affected by fluctuations in the exchange rates. The Canadian dollar weakened significantly compared to the U.S. dollar following the Final Investment Decision in 2014.

To mitigate these risks, BC Hydro transferred inflation, exchange rate, and supply chain risks to contractors, where possible, conducted early procurement of the contracted work, materials, and equipment, worked with contractors to develop contract specifications that mitigated exchange rate and supply chain risks, and worked with contractors to increase their flexibility around sourcing

[54] Site C environmental enforcement orders can be found at: https://www.sitecproject.com/document-library/environmental-and-socio-economic-plans-and-reports.

materials. Once the major contracts were awarded, BC Hydro's exposure to currency fluctuations was reduced and this exchange rate risk was transferred to the contractors.

5.5 Lessons Learned – Risk Management

This section describes the seven lessons learned from the Project regarding Risk Management.

5.5.1 Lesson RM1: Consolidate and Enhance Risk Registers to Improve Cost Risk Estimates and Provide More Consistent Analysis

Lesson RM1 is to consolidate and enhance risk registers to improve cost risk estimates and provide more consistent analysis. The use of a central Risk Register allows for better availability and accessibility across the project and supports transparent and consistent risk reporting to the governing bodies. The single Risk Register should be available to all project team members.

The Project consolidated its three risk registers into a comprehensive single risk register in 2018. Subsequent enhancements to the Risk Register based on recommendations from the Independent Oversight Advisor and the 2021 Milburn Report, resulted in improved identification, tracking, and reporting of the Project's major risks to governing bodies.

Table 25 below provides some specific considerations which are intended to support future project teams as part of this lesson learned.

Table 25 Lesson RM1 - Specific Considerations

#	Consideration
RM 1.1	Adopt a single and central Risk Register across the project.
RM 1.2	Make the Risk Register available to all project team members.
RM 1.3	Ensure the Risk Register contains appropriate fields to support complete, transparent, and effective risk categorization, quantification, and reporting to governing bodies.

5.5.2 Lesson RM2: For Very Large Complex Projects, Implement Cost Risk Analysis and Schedule Risk Analysis Processes That Are Complete and Transparent and Include Effective Methods to Quantify Risks

Lesson RM2 is, for very large complex projects, to implement Cost Risk Analysis and Schedule Risk Analysis processes that are complete and transparent and include effective methods to quantify risks.

Implementing the enhancements to the Cost and Schedule Risk Analyses as recommended by the 2021 Milburn Report, strengthened the timeliness, completeness, and transparency of reporting on the quantification of the Project's risks and provided important insights into the Project's ability to achieve the cost and schedule objectives.

Table 26 below provides some specific considerations which are intended to support future project teams as part of this lesson learned.

Table 26 Lesson RM2 - Specific Considerations

#	Consideration
RM 2.1	Implement Cost Risk Analysis and Schedule Risk Analysis processes that are complete, transparent, and include effective methods to quantify risks. The frequency of these quantitative analyses should be determined based on the specific requirements and phase of the project.
RM 2.2	The Risk Register should include the required input and output information for the Cost Risk Analysis and the Schedule Risk Analysis to increase traceability, efficiency, and consistency.
RM 2.3	If the project governance includes an Independent Oversight Advisor, the advisor should be included as part of these analyses to ensure independent review of the processes and to provide more effective governance and oversight.

5.5.3 Lesson RM3: Organize and Size the Project Risk Team for the Complexity of the Project and Ensure it Includes Qualified Resources with the Appropriate Knowledge, Experience, and Expertise

Lesson RM3 is to organize and size the project's dedicated risk team for the complexity of the project and ensure it includes qualified resources with the appropriate knowledge, experience, and expertise. The Risk Management Team's ability to implement the Project's risk management practices and Project and Portfolio Management practices was improved after more resources were added in response to the 2021 Milburn Report.

It is important to have sufficient and qualified risk management resources, especially early in the project. Establishing the Site C Project Risk Committee in mid-2018, further strengthened the Project's risk management governance and served as a key decision-making body for risk related issues. Attendance at these meetings by the Independent Oversight Advisor, Ernst & Young, provided expert input and feedback to Management on risk discussions and issues.

Table 27 below provides some specific considerations which are intended to support future project teams as part of this lesson learned.

Table 27 Lesson RM3 - Specific Considerations

#	Consideration
RM 3.1	In early project planning, assess the size, complexity, and risk management requirements for the project.
RM 3.2	Consider and ensure sufficient, qualified risk management resources are available including Risk Owners and Risk Delegates, and the resources in the centralized Risk Management Team.
RM 3.3	Implement effective Project and Portfolio Management risk management processes, procedures, and supporting systems, scaled to the needs of the project, and consider establishing a Project Risk Committee.

5.5.4 Lesson RM4: Ensure Risk Reporting is Clear and Timely and Provides Early Visibility to the Potential for Low-Probability, High-Consequence Events

Lesson RM4 is to ensure risk reporting is clear and timely and provides early visibility to the potential for low-probability, high-consequence events. Risk reporting to governing bodies was improved following the implementation of recommendations from the 2021 Milburn Report and from the Independent Oversight Advisor, Ernst & Young. Risk reporting to the governing bodies was extensive and captured all major or potentially major risks that could impact the Project's cost and schedule objectives. Future major capital projects should consider implementing these enhancements early in construction.

Table 28 below provides some specific considerations which are intended to support future project teams as part of this lesson learned.

Table 28 Lesson RM4 - Specific Considerations

#	Consideration
RM 4.1	Ensure that the project risk reporting is clear and timely and balances a broad view of risks while maintaining a manageable number of risks being identified to governing bodies.
RM 4.2	Ensure risk reporting is effective in providing early visibility to the potential for low-probability but high impact events.
RM 4.3	Risk reporting should include risks based on criteria that are both objective (e.g., cost and risk level) and subjective (e.g., potential to become a major risk).

5.5.5 Lesson RM5: Ensure Governing Bodies are Aware of the Low-Probability, High-Consequence Risks for the Project, and That They Fully Understand Budget and Schedule Impacts if These Risks Materialize

Lesson RM5 is to ensure governing bodies are aware of the low-probability, high-consequence risks for the project, and that they fully understand budget and schedule impacts if these risks materialize. Although a wide range of low-probability, high-consequence risks were included in the Project Risk Register and quantified in the Cost Risk Analysis, future projects should consider how to better

communicate the breadth of these risks and their potential to result in significant budget and schedule impacts, if they occur.

Table 29 below provides some specific considerations which are intended to support future project teams as part of this lesson learned.

Table 29 Lesson RM5 - Specific Considerations

#	Consideration
RM5.1	Ensure that project governing bodies are aware of the potential low-probability, high-consequence risks in the Risk Register.
RM5.2	Ensure that project governing bodies fully understand that even though these risks are included in the Risk Register, the full impacts to the project's cost and schedule if the risks materialize are not included in the approved project budget and schedule.

5.5.6 Lesson RM6: Capitalize on the Opportunities Provided by Large Capital Projects to Develop Internal and External Knowledge and Expertise for Future Projects

Lesson RM6 is to capitalize on the opportunities provided by large capital projects to develop internal and external knowledge, and expertise for future projects. The Project was successful in developing knowledge and experience through mentorships and training. This increased knowledge and experience will be beneficial for future major capital projects.

Large and complex projects, like Site C, provide unique and important opportunities to develop and enhance the knowledge, skills, and experience of BC Hydro resources and the consultants and contractors that BC Hydro works with to implement projects.

Prior to the start of construction, BC Hydro undertook a detailed assessment of the number of resources required, and the required qualifications for those resources. Over the duration of the Project, BC Hydro continued to update these resource forecasts and look for opportunities to enhance the knowledge and experience of those working on the Project. This included opportunities for BC Hydro staff to work

with, and learn from, external engineering consulting firms with experience on similar major projects. Notably, effective succession planning supported a smooth transition with minimal impacts between five different individuals who held the executive leadership position for the Project over the course of construction. In each instance, this role was filled by an internal candidate from the Project team.

Table 30 below provides some specific considerations which are intended to support future project teams as part of this lesson learned.

Table 30 Lesson RM6 - Specific Considerations

#	Consideration
RM 6.1	Ensure that future major capital projects capitalize on the enhanced knowledge, skills, and experience of BC Hydro resources and the consultants and contractors that BC Hydro works with.
RM 6.2	Ensure that future projects draw on more knowledgeable and experienced consultants and contractors when additional external resources are required, particularly during peak workload periods.

5.5.7 Lesson RM7: Implement Effective Early Project Planning to Mitigate or Reduce Project Cost and Schedule Impacts

Lesson RM7 is to implement effective early project planning to mitigate or reduce project cost and schedule impacts. Adopting BC Hydro's risk management framework and Project and Portfolio Management practices enabled the Project to successfully manage and mitigate several safety and compliance risks. In particular, BC Hydro is proud of the Project's strong safety record.

An important learning during the Project was the need to identify and plan for North American Electric Reliability Corporation (**NERC**) requirements early and ensure that the cost and time to complete this work was included in the Project budget and schedule. NERC requirements must be clearly defined and communicated to the project team and contractors delivering the work. The Project experienced resourcing and scheduling challenges during the commissioning of the Site C substation when a NERC audit was required to be completed and would have benefitted from more detailed planning and additional time to complete this work in

the schedule. Subsequently, the Project developed the NERC Requirements subproject, which will help future projects appropriately plan and schedule for NERC requirements.

Table 31 below provides some specific considerations which are intended to support future project teams as part of this lesson learned.

Table 31 Lesson RM7 - Specific Considerations

#	Consideration
RM 7.1	Provide effective safety training and clear and detailed safety procedures to mitigate safety risks.
RM 7.2	Consider, when appropriate, if BC Hydro should take the role as Prime Contractor to manage complex interfaces in work areas that include several contractors.
RM 7.3	Develop clear guidelines and plan early for NERC requirements in the delivery of work.

6 Geotechnical Risk

This section addresses Geotechnical Risk. It includes a discussion of the approach to the initial evaluation of geotechnical risk for the Project and how these risks informed the project contingency estimate. It also discusses assessments of the geotechnical risks from project inception to completion and how this changing assessment influenced project planning, design, and execution. It provides lessons learned and explains how each lesson will inform identification, management, and budgeting for geotechnical risks in future projects.

Extensive geotechnical studies and investigations were completed from 1975 to 2014, prior to the Final Investment Decision. These activities informed the development of a detailed geotechnical model, choices on the location, design and schedule of major Project assets, and implementation of an observational approach. They also informed the procurement approach by leveraging the capabilities of the consortiums with a design-build procurement model for the temporary works on the Project and a design-bid-build procurement model for the permanent works, including unit prices for the two largest civil contracts. Both approaches provided flexibility to adapt the Project design as geotechnical conditions were uncovered through Project construction.

The left bank had been extensively investigated and studied prior to project construction. It was known to contain many ancient slides with weak bedding planes, which were planned to be removed during excavation. After the two tension cracks occurred on the left bank, it was determined that these weak planes extended beyond the area BC Hydro initially identified. This required a redesign of the slope excavation and planned construction roads.

The right bank had also been extensively investigated prior to Project construction. During construction, instruments were installed to monitor the response of the right bank foundation. In 2018, small displacements began to occur on a bedding plane

below the roller compacted concrete buttress, prompting BC Hydro to re-assess the expected strength of the bedrock at this depth. Ultimately, BC Hydro concluded that more significant foundation enhancements would be required. BC Hydro and the Technical Advisory Board considered several solutions and decided to implement structural enhancements within the foundation of the spillways and powerhouse and an enhancement to the approach channel to reduce the risk of leakage.

Throughout these challenges, the Project benefited greatly from a large and varied group of external independent experts from around the world, who provided advice, knowledge, and guidance on complex technical investigations, designs, and construction solutions. Future major capital projects should consider retaining third-party experts early in the project development cycle and major projects with geotechnical risks should consider establishing a Technical Advisory Board. In addition, thorough investigations should be conducted early to inform design considerations and to develop strong geotechnical models to evaluate performance and inform required design enhancements.

While the Project implemented these activities, significant geotechnical challenges still occurred, with substantial cost and schedule impacts. This emphasizes the importance of future project teams taking steps to ensure that project governing bodies are aware of low-probability, high-consequence risks that are not fully reflected in the project budget. The budget and schedule impacts of these high-consequence, low-probability risks materializing must be clearly communicated so that potential budget and schedule impacts are better understood.

This section is organized as follows:

- Section 6.1 describes how the Project used detailed geological modelling to inform layout and design, employed extensive monitoring instrumentation, adjusted its design based on as-found conditions, and engaged independent experts to validate those designs;

- Section 6.2 describes how the Project's assessment of geotechnical risks affected all aspects of the Project;
- Section 6.3 describes the Project's assessment of three key geotechnical risks - the tension cracks on the left bank, the different ground conditions for the two transmission lines, and the right bank foundation enhancements - and their impact throughout planning, design, and execution of the Project; and
- Section 6.4 describes the four lessons learned from the Project regarding Geotechnical Risks:
  - **Lesson GR1:** Identify and engage geotechnical experts early, particularly on complex issues, and maintain involvement throughout design and major change processes;
  - **Lesson GR2:** Conduct thorough investigations to inform design considerations early and to frame baseline information;
  - **Lesson GR3:** Develop robust geotechnical models to evaluate performance and proactively support required enhancements; and
  - **Lesson GR4:** Foster communication and collaboration with the Technical Advisory Board, engineering, geotechnical specialists, and contractors to resolve issues in a timely manner.

6.1 BC Hydro Developed a Multi-Component Approach and Response to the Initial Evaluation of Geotechnical Risks

Extensive geotechnical studies and investigations were completed over many years prior to the start of construction of the Project. BC Hydro developed a comprehensive approach and response to the initial evaluation of geotechnical risks consisting of the following seven components:

- **Component 1:** Complete comprehensive studies and site investigations to develop a detailed geological model;

- **Component 2:** Use the detailed geological model to develop the layout and design for the major project assets;
- **Component 3:** Use BC Hydro's Project and Portfolio Management estimating practices to estimate the Project's cost, including contingency;
- **Component 4:** Install geotechnical monitoring instrumentation and complete geological mapping during excavation and construction;
- **Component 5:** Take an observational approach to adapt the construction activities to the as-found geotechnical conditions in the field;
- **Component 6:** Obtain input and advice from a broad team of qualified geotechnical experts; and
- **Component 7:** Follow the established risk management processes based on the detailed geological model.

6.1.1 Component 1: Complete Comprehensive Studies and Site Investigations to Develop a Detailed Geological Model

The Site C dam was built on what was once an ancient seabed, which was a mix of soft and hard ground. While the foundation had some strength challenges due to layers of clay, silt, and shale, it was generally stable and predictable, making it workable for construction.

Extensive geotechnical studies and investigations were completed around the Site C damsite over many years prior to the start of construction. Most of these studies and investigations were completed in three main periods: 1975 to 1983, 1989 to 1991, and 2008 to 2014. At the time of the 2014 Final Investment Decision, these site investigations were considered state-of-the-art and extensive.

The studies and site investigations focused on:

- The engineering geology characteristics of the site to identify geological units, bedding planes, relaxation joints and shears;
- Laboratory and field strength and stiffness testing of the bedding planes, shale, relaxation joints and shears; and
- Development of the design parameters for rock strengths, including the operational strength of the bedding planes.

The studies and site investigations included:

- The physiography and topography of the Site C damsite;
- The regional geology;
- The seismicity around the damsite area which is considered to have moderate seismicity;
- The topography of the damsite based on Light Detection and Ranging surveys, bathymetry surveys (i.e., measurement of the depth of water), conventional surveys, and aerial photographs;
- Extensive field investigations at the damsite including:
  - more than 1,100 bore holes and test pits. The bore holes included thirty large diameter holes, each 0.9 metres in diameter. The information gathering and testing completed in the bore holes included the examination of core samples by a qualified geologist, geophysical testing, bore hole cameras, and acoustic and optical televiewers;
  - the excavation of five exploratory adits;
  - 12 exploratory trenches with a total length of 1,220 metres;
  - 13,000 metres of seismic lines tested around the damsite; and

- over 12,000 laboratory tests and extensive in-situ (in place) tests. The testing included hydraulic conductivity testing, bore hole tests, piezometer tests, large scale pump tests, adit seepage flow tests, in-situ overburden testing, becker penetration testing, standard penetration tests, in-situ rock testing, static modulus tests, dynamic modulus tests, and stress measurements.

- Geological mapping of bedrock on natural bedrock exposures, and on bedrock exposed in the exploratory trenches;
- Investigations to assess the rock mass foundation modulus values at the damsite; and
- Investigations to assess the shear strength of various bedding planes.

Based on these extensive studies and site investigations, a detailed geological model was developed for the Project.

The left bank of the Peace River is about 175 metres high above the riverbed and consists of glacial and interglacial deposits of clay, silt, sand, and gravel over bedrock.

The overburden on the right bank of the Peace River at the damsite is composed of broad terraces that consist of alluvial silts, sands and gravels that overlie bedrock on the terraces, with isolated pockets of silts and clays. A thick deposit of clay, silt, and sand underlies the plateau from the valley crest, which overlies a layer of sand and gravel about 10 metres thick on top of the bedrock. The slope is covered with a variable thickness of overburden colluvium.

The Peace River flows in a wide channel mainly infilled with up to 10 metres of medium dense to dense alluvial sands and gravels, overlying bedrock. In some areas adjacent to the left bank, clayey colluvium occurred above bedrock and was interlayered with the granular materials. The overburden-bedrock interface was

smooth in some areas and irregular in others. The bedrock at the interface is slightly weathered, with very weak rock to a depth of 1 metre to 3 metres, below which is fresh, weak to medium strong rock.

The bedrock at the damsite is part of the Shaftesbury Formation and consists of weak to medium strong, flaky to fissile, silty shale interbedded with siltstone, sandstone, and shale. The rock is of marine origin and is in an intermediate stage of diagenesis.[55] The stratigraphy is uniform throughout the site. Numerous marker beds, as little as a few millimetres in thickness, can be traced throughout the site and from one side of the river to the other. The bedding dips very slightly to the north, and as a result, the beds on the right bank are about 10 metres higher than on the left bank. The bedrock is cut by three sets of fractures which are characteristic of valleys eroded in flat-lying, weaker, sedimentary rocks and includes fractures or softened zones parallel to bedding, steep relaxation factures parallel to the valley slopes, and low angle shear zones of limited displacement.

These structural features are the result of general rebound effects of the valley erosion in reducing the horizontal and vertical stresses. These stress changes have resulted in inward movement of the valley walls, sprung bedding planes and formed shear zones due to displacements along the weaker beds and local thrust faults in the abutments.

The interfaces between the different bedding planes in the bedrock at the Site C damsite were investigated in detail to identify discontinuities and potential locations with a lower shear strength where movement could occur along the surface. When investigating these discontinuities, the frictional resistance along the surface is

[55] Diagenesis is the process by which sediment is transformed into sedimentary rock through physical, chemical, and biological changes after its initial deposition, and includes compaction, cementation, recrystallization, and mineral alteration.

estimated, along with an assessment of how continuous the surface is in the bedrock across the damsite.

In the geological model for Site C, seven bedding planes were considered in the design of the Project. Four of these (Bedding Plane 8, Bedding Plane 12, Bedding Plane 18, and Bedding Plane 25) were estimated to have low frictional resistance and were continuous throughout the site. It was considered possible that Bedding Plane 28 would be continuous beneath the earthfill dam. The remaining two bedding planes, Bedding Plane 31 and Bedding Plane 33, which would be encountered in the deeper excavations for the buttress on the right bank, were believed to not be continuous and were typically hairline discontinuities with little to no infill.

6.1.2 Component 2: Use the Detailed Geological Model to Develop the Layout and Design for the Major Project Assets

The detailed geological model that was developed for the Project informed the location, layout, and design of major project assets.

In the 1970s, three alternative designs for the Project's earthfill dam were studied. All these designs incorporated a spillway on the right bank terrace. An earthfill dam across the river valley was selected as the basis of the site arrangement because of its ductility and ability to provide a wide base with low angle slopes.

Earthfill dams are well-suited to the foundation conditions at Site C; however, the powerhouse and spillways, which are rigid structures, are generally less tolerant of movements and the swelling response in the foundation rock. Based on the geotechnical investigations and studies done in the 1970s, the Project decided to conduct further study on the option to locate the power intakes adjacent to the spillway headworks on the right bank terrace and the powerhouse in the river channel next to the right bank. However, when the Project was deferred in 1983, there remained unresolved issues with this design, particularly regarding the

potential for differential rebound of the foundation to negatively impact the concrete structures on the right bank.

In 2010, the layout and design of the right bank structures were reviewed and revised. The updated layout reduced the impact of the bedding plane shears and stress release fractures on the stability of the right bank structures. Under this updated layout and design, the rock containing the open stress release fractures and bedding plane shears was to be excavated and replaced with roller-compacted concrete, referred to as the roller-compacted concrete buttress. This roller-compacted concrete buttress was intended to prevent sliding movements along the horizontal continuous bedding plane shears and provide a competent concrete foundation for the powerhouse, spillways, and headworks structures. Based on the geotechnical studies and investigations that had been conducted, the deepest identified bedding plane below the roller-compacted concrete buttress was determined to be Bedding Plane 33. As a result, the shear key (i.e., a structural feature that creates a mechanical interlock between two parts of a structure) incorporated into the roller-compacted concrete buttress was designed to a depth below Bedding Plane 33.

The Project then undertook stability and deformation analyses of the structures following the U.S. Army Corps of Engineers rigid block methodology, which was then checked with a finite difference deformation model. These analyses provided an assessment of the stability of the structures based on the adopted strength parameters for the bedding planes, relaxation joints and shears.

Although the design of the right bank buttress foundation assumed that no continuous bedding plane shears existed below the bottom of the shear key of the roller-compacted concrete buttress, a stability check was carried out during the design to confirm whether, based on the design parameters, the roller-compacted concrete buttress would remain stable if a bedding plane shear was identified during

construction at a critical depth below the bottom of the shear key of the roller-compacted concrete buttress. The analysis determined that the roller-compacted concrete buttress would remain stable under such conditions.

6.1.3 Component 3: Use BC Hydro's Project and Portfolio Management Estimating Practices to Estimate the Project Cost Including Contingency

The methodology used to estimate the cost for the Project, and the required Project contingency, was based on BC Hydro's Project and Portfolio Management estimating practice, which is consistent with the Association for the Advancement of Cost Engineering International (**AACEI**) standards.

During planning of the Project, the entire scope was broken down into separate work packages with scope, schedule, and cost developed for each work package. The sum of the costs for all work packages, along with the Project contingency, overheads, interest during construction, and Project reserve formed the basis of the Project budget. The 2014 Final Investment Decision budget for Site C was based on the P50[56] expected cost for the Project. The geotechnical conditions and risks for the Project informed the estimated cost for many of the work packages, and the estimated Project contingency based on the following assumptions:

- That the geology of the site would generally be consistent with the extensive geotechnical investigations undertaken of the site and that no significant issues would arise that would affect the means, methods, and schedule of the work;
- That the identified sources of granular material would be sufficient to complete the construction of the dam structure; and
- That geotechnical conditions would not be significantly worse than contemplated by the design and construction contracts that were issued.

[56] A P50 expected cost means that the actual cost is expected to be higher 50% of the time and lower 50% of the time.

The Project contingency and Project reserve did not include provisions for these assumptions being incorrect. Rather, they only included provisions for typical and expected items such as increases in excavation quantities to find suitable bedrock, and minor alterations in the work.

6.1.4 Component 4: Install Geotechnical Monitoring Instrumentation and Complete Geological Mapping During Excavation and Construction

An extensive state-of-the-art instrumentation system was installed to monitor the behavior of the bedrock foundations during both the excavation stage and the construction stage of the major civil structures, including the earthfill dam, powerhouse, and spillways. This instrumentation system allowed the Project to observe the performance of the foundations and excavations during construction and confirm geotechnical design assumptions.

The instrumentation to monitor the excavations and the completed structures was installed before the start of each excavation and consisted primarily of inclinometers (to monitor sliding on bedding planes), extensometers (to measure opening of relaxation joints or any extension in the rock) and piezometers (to measure water pressures in the rock).

Extensive geological mapping of all excavated bedrock surfaces was also undertaken immediately after excavation and cleaning of the excavated surface. Geological mapping provides detailed information on the bedrock including a description of the rock, the orientation and extent of any joints in the rock, any bedding planes and the infill in the bedding planes, any shears in the rock and the infill in the shears, any offsets, the presence of water, and other geological features of interest.

The information obtained from the instrumentation and geological mapping during construction was used to update and validate the geological model over the life of the Project.

6.1.5 Component 5: Take an Observational Approach to Adapt the Construction Activities to the As-Found Geotechnical Conditions in the Field.

The Project followed an observational approach, which means that the designs and construction were meant to be adapted based on as-found geotechnical conditions as the Project progressed.

This approach allowed construction activities such as rock support, ground improvements, stability requirements, and foundation preparations and designs, to be optimized based on best available geological information from the instrumentation and detailed geological mapping once excavations had fully exposed the foundations and bedrock conditions.

In general, the four main steps followed in the observational approach are:

- **Establish a Design:** The process begins with an initial design based on the best available information, including studies, site investigations and assumptions;
- **Prepare for Deviations:** The design team anticipates potential deviations between the predicted and actual site conditions and develops mitigation plans to address these scenarios;
- **Monitor During Construction:** Observations and measurements are made during the execution of the Project (e.g., instrumentation and geological mapping) to verify the design and assess the behavior of the ground and structures; and
- **Modify and Adapt:** If observations indicate that the actual conditions are deviating from the assumptions, the design or the construction methods are adjusted accordingly.

6.1.6 Component 6: Obtain Input and Advice from a Broad Team of Qualified Geotechnical Experts.

The Project had access to qualified geotechnical experts for the design and construction of the Project. This included members of the Project team (both employees and external consultants), members of the Technical Advisory Board, and independent geotechnical experts retained by the Project Assurance Board.

External consultants working on the dedicated Project team were sourced from external engineering and construction firms through partnership agreements and through short-term or long-term consultancy contracts. The Project employees, along with these external consultants, had knowledge and experience in geotechnical engineering, geology, hydrogeology, engineering geology, hydraulics, dam engineering, civil engineering, and the planning, engineering, design, and construction of hydroelectric facilities.

From 2010 to 2025, the Technical Advisory Board provided expert technical advice to the Project related to the design, construction, risks, and delivery of the Project. The Technical Advisory Board consisted of internationally recognized experts, with extensive experience in hydroelectric projects from around the world. Their core expertise included hydroelectric projects, geotechnical design, geology, hydrology, and the hydraulic design of spillways, tunnels, and reservoir landslides.

In addition, in 2020, the Project Assurance Board retained two independent, internationally recognized dam experts, specifically chosen because they were both recognized globally for their expertise in hydroelectric dams, and they did not have prior involvement with the Project. The Project Assurance Board commissioned these experts to complete an independent due-diligence review of the proposed right bank foundation enhancement measures. The experts then continued to be retained to provide oversight while the construction of the foundation enhancements was completed.

6.1.7 Component 7: Based on the Detailed Geological Model, Follow the Established Risk Management Processes

Section 5.2 above provides a detailed explanation of the risk management processes followed on the Project. These processes include creating and maintaining a comprehensive Risk Register that included approximately 200 identified geotechnical risks, assessing the probability and consequence of risk events occurring, determining how to decrease the probability and consequence of risks by developing detailed treatment plans, and monitoring and communicating these risks and managing the risk response plans should the risk occur.

6.1.8 Geotechnical Risks Outside the Damsite

The preceding subsections primarily focussed on the damsite, and the works carried out on the dam, powerhouse, spillways, approach channel and diversion tunnels. This subsection focuses on geotechnical risks outside the dam site including the reservoir, Highway 29 realignment and transmission components.

To manage the risk of slope movements along the reservoir, the Project undertook detailed geotechnical assessments to characterize the potential for groundwater changes, flooding, shoreline erosion, slope instability and landslide-generated waves resulting from the impoundment and operation of the reservoir.

An extensive network of instrumentation was also installed and continues to be monitored. The results of these assessments were used to generate preliminary reservoir impact lines that delineated areas of potential hazard. These reservoir impact lines were developed based on the framework outlined by the International Commission on Large Dams (**ICOLD**), and they provided information on the expected likelihood and nature of the hazards around the reservoir. The four types of impact lines that were developed for the reservoir included:

- Flood Impact Lines (i.e., potential impact of floods, wind-generated waves, and/or waves caused by boats and small landslides);

- Erosion Impact Lines (i.e., potential impacts of wind-generated waves and resulting shoreline erosion, dependent on the potential wave action and the geological materials at the shoreline);
- Stability Impact Lines (i.e., potential impacts of reservoir creation on slope stability, governed by the present slope conditions, predicted shoreline erosion, and geological materials present); and
- Landslide-Generated Wave Impact Lines (i.e., rapid landslides originating from the reservoir slopes have the potential to generate waves that could impact public safety and infrastructure and apply to sections of the shoreline where landslide-generated waves could temporarily exceed the elevation of the Flood Impact Lines).

In total, more than 9,000 acres of land were acquired for the Project, including almost 4,600 acres for impact line statutory rights-of-way due to geotechnical conditions and risks around the Site C reservoir. In addition, significant additional work was required for the realignment of Highway 29 to address geotechnical conditions such as historic landslides and instability in the slopes adjacent to the Highway.

For the transmission components, two new 500 kV transmission lines were constructed, to connect the Site C Substation to the BC Hydro transmission system. The first line had 200 tower foundations, and the second line had 205 tower foundations, with a combined total of 3,800 helical piles to support the foundations. During foundation construction, the contractor encountered ground conditions that were different, and more challenging, than planned. As a result, the tower foundation design needed to be changed at 47 locations, which extended the completion of the

foundations work in both the eastern and western segments of the transmission line.[57]

6.2 Continuing Assessment of Geotechnical Risks Influenced Project Planning, Design and Execution

The Project continued to complete geotechnical studies and investigations throughout its lifecycle to improve understanding of the geological model and the associated geotechnical risks. The assessment of specific geotechnical risks evolved as new information was obtained and this evolving assessment informed Project planning, design, and construction. Specifically:

- **Project Planning**: As discussed in section 6.1, the planning for the Project was heavily influenced by geotechnical conditions and risks. A geological model of the damsite and surrounding area was developed, and this model was used to determine the layout for the earthfill dam, powerhouse, spillways, approach channel, diversion tunnels, and other major Project assets. Based on this layout, and the geological model, the design for each of these components was completed. The geological model was then updated and validated during construction, allowing the Project to use an observational approach to adapt the construction activities to the as-found geotechnical conditions in the field. The instrumentation to monitor how the foundations responded to construction were installed well before the start of construction so that the Project to collect baseline data to assess any deviations in the measurements.
- **Layout and Design**: The layout and design of all the civil structures was significantly influenced by geotechnical conditions and risks. The final design of locating the powerhouse and spillways on the right bank, constructed on top of a large roller-compacted concrete buttress, was selected based on

[57] This particular risk is discussed in more detail later in this section 6.3.2.

geotechnical considerations obtained through extensive study and investigation.

- **Implications for Schedule**: The Project schedule and sequence of work was also heavily influenced by the geotechnical conditions and risks. Due to geotechnical conditions, some of the construction activities could only take place during the summer construction period. The placement of the entire roller-compacted concrete buttresses, which occurred over three years, was limited to summer construction due to the geotechnical conditions at site. Since the foundations for the civil structures, and the excavations for the portals for the diversion tunnels needed to be completed first, much of this work was typically on the critical path for the Project schedule.
- **Supply Chain Strategies, Contracting Plans, Contracts**: Geotechnical conditions and risks were also a major consideration for the development of the supply chain strategies, contracting plans, and contracts for construction. The Project team selected procurement options that could accommodate the geotechnical conditions and risks at site and provide the flexibility to respond to variations in the as-found geotechnical conditions. Specifically:
  - The Project selected a design-bid-build model for the delivery of most civil scopes of work due to the limited ability to transfer geotechnical risks associated with the design of the earthfill dam and other components of the contract scope to contractors. Under this model, the Project retained design responsibility for most of the scope of work that was to be performed. The Project also retained responsibility for variations to quantities associated with the evolution of the Project design, and the contract interfaces with other contractors.
  - For scopes of work where it was practical to transfer some of the geotechnical risks to the contractor, and where the work was dominated by

constructability considerations and risks that are best transferred to the contractor, the Project used a design-build model, where the design and construction of the scopes of work were priced using fixed lump sum amounts.

- Based on the Project's plan to utilize the observational method to adapt the construction activities to the as-found geotechnical conditions in the field, the two largest civil contracts for the Project were designed as unit price contracts, which are commonly used for large civil projects. For unit price pay items, the contract included estimated quantities, although actual quantities were expected to vary from the initial estimates. The estimated quantities were established from the geotechnical information available at contract award, and the contract provided the flexibility for the quantities to vary using existing unit contract rates, within the quantity variation thresholds defined in the contract, assuming no changes to the existing work shown on the drawings. The additional geotechnical information that was obtained during construction was expected to result in a higher or lower number of units, based on a predefined unit rate.

- Even with the use of unit price contracts, the Project retained risks related to required design changes. During construction, the Project identified required design changes and opportunities for improvement that differed from the original contractual scopes of work. When these changes were implemented, the contractor had the opportunity to claim for change, consistent with the contract terms, and the price included in these claims had to be negotiated and was not constrained to the use of the unit prices in the unit price contract.

- **Contract Interfaces**: One of the geotechnical cost and schedule risks that was more challenging to address through the procurement processes was related to interfaces between the contracts. Due to size, complexity, and variations in

scopes of work and timing of the work, the site civil work was not contained within one contract. Since there were multiple contracts, the Project retained the interface risks between those contracts. As a result, there were cost and schedule risks to the Project if geotechnical issues impacted one contract and delayed the completion of a scope of work or handover milestone. These cost and schedule risks were amplified due to the seasonal aspect of many of the Project scopes of work where a small delay could result in moving a handover milestone to the following year.

- **Governance**: Due to the significant role that geotechnical conditions and risks would play in the design and construction of the Project, the Project team made considerable efforts to include individuals with geotechnical knowledge and experience in various governing roles for the Project. Individuals with extensive geotechnical knowledge and experience were included on the Project Assurance Board, the Commercial Sub-committee, the Independent Oversight Advisor, and the Technical Advisory Board. In addition, two international dam experts were retained to oversee enhancements to the right bank foundation and expert geotechnical advisors were retained for the 2017 Site C Inquiry and the 2021 Milburn Report.
- **Estimated Project Cost and Contingency**: The approved budgets for the Project were estimated as the sum of the costs for all work packages, along with the Project contingency, overheads, and interest during construction. The geotechnical conditions and risks for the Project informed the estimated cost of many of the work packages and the Project contingency. However, as discussed above, the potential full cost if a low-probability, high-consequence geotechnical risk materialized was not included in the approved budgets.
- **Project Resourcing**: The resource planning and recruitment strategies for the Project were focused on attracting and retaining sufficient geologists, geotechnical engineers, geotechnical resident engineers, and construction

managers and officers with geotechnical knowledge and experience. This experience was essential to complete the required geotechnical studies and investigations, geological mapping and to identify and monitor geotechnical risks. Since the internal Project team had only a fraction of the total geotechnical resources that were required, agreements were established with various engineering consulting firms and construction contractors to source additional geotechnical resources.

- **Safety**: As geotechnical risks were potential safety concerns, detailed safety plans were prepared so that work activities were completed safely.
- **Quality Assurance and Control**: The quality control and quality assurance plans, procedures, and resources were informed by identified geotechnical conditions and risks. Each contractor was responsible for Quality Control, which included detailed quality control processes and procedures for the foundation grouting for the earthfill dam, and the testing of material to be used for the earthfill dam. The Project was responsible for Quality Assurance, which included onsite construction quality assurance and monitoring of the contractor's material testing laboratory, and quality resources and independent material testing.
- **Risk Management Processes**: The Project implemented a comprehensive risk management framework, which was consistent with the risk management framework and practices of BC Hydro's Enterprise Risk Management Department and BC Hydro's Project and Portfolio Management practices.[58]

[58] A detailed description of the risk management framework is included in section 5.2 of this Report.

6.3 Three Key Geotechnical Risks Impacted Project Planning, Design and Execution

This section describes the Project's assessment of three key geotechnical risks - the tension cracks on the left bank, the different ground conditions for the two transmission lines, and the right bank foundation enhancements - and their impact throughout planning, design, and execution of the Project.

6.3.1 Tension Cracks on the Left Bank

In February 2017, a tension crack developed on the left bank excavation while constructing a haul road resulting in the temporary stoppage of some construction excavation activities. In May 2017, a second and smaller tension crack was first observed in the temporary access road excavations above the future diversion tunnel portal. This smaller tension crack extended locally into the final slope, requiring a solution that integrated with the final slope.

The left bank had been investigated extensively prior to construction. It contained many ancient slides with weak sliding planes which were planned to be removed during the excavation to provide a final stable slope. BC Hydro provided the design of the final stable slope but not the intermediate excavation stages or the design of the temporary construction haul roads. These intermediate excavation stages and the construction haul roads were critical to the construction schedule. The temporary haul roads needed to be constructed across the slope on the left bank of the Peace River to complete the excavations for the diversion tunnel inlet and outlet portals and the final design slope.

The first tension crack in February 2017 resulted in the need to redesign the slope excavation and to redesign and move the construction roads to ensure the safety and the long-term stability of the slope. BC Hydro and the contractor worked collaboratively and agreed on a plan to stabilize the slope and construction recommenced in April 2017.

In May 2017, following the second tension crack, the Project developed a new design for the contractor's haul roads and a new design for the left bank final slope that included the removal of the pre-existing ancient slides to mitigate various construction challenges. To mitigate the associated delays, efforts were made to enable work to continue over the winter months. The activities over the winter were in support of future work, which included the start of diversion tunnel excavation in summer 2018 to enable river diversion to be achieved by 2020.

Even though the contractor was contractually responsible for the intermediate excavation stages and the design of the construction haul roads, the Project continued to retain cost and schedule risks related to this work due to interfaces with other contracts, any required design changes, and for any changes in the conditions included in the contract.

6.3.2 Different Ground Conditions for the Two Transmission Lines

To connect the Site C Substation to the transmission system, two new 500 kV transmission lines were constructed. The first line had 200 tower foundations, and the second line had 205 tower foundations, with a combined total of 3,800 helical piles to support the foundations.

In October 2018, the contractor mobilized to the transmission right-of-way and began tower assembly and in November 2018, installation of the helical pile foundations began. However, different and more challenging ground conditions were encountered and as a result, the tower foundation design needed to be changed at 47 locations, which extended the completion of the foundations work in both the eastern and western segments of the transmission line.

Construction of the foundations continued until March 2019, when road access restrictions started due to the spring thaw period. To mitigate the delay to the overall schedule, the transmission line contractor continued to work on foundations and tower assemblies during the summer from July 2019 to September 2019. However,

working during this period was more challenging due to unseasonable wet conditions in the summer and colder temperatures later in the year. As a result, access to some of the eastern foundation sites that were within the wetter areas of the transmission line was not possible until December 2019.

In January 2020, the transmission right-of-way experienced an unstable slide. This impacted one of the access roads and required vehicles to be rerouted. The access road was repaired in June 2020. In March 2020, transmission line construction activities were halted for the planned spring break-up and were scheduled to resume in the summer of 2020, when access roads would reopen. Transmission foundations construction activities were then completed at the end of March 2021.

6.3.3 Right Bank Foundation Enhancements

During construction of the Project, instruments were installed to monitor the response of the foundation, and geological mapping was completed during the excavations of the foundations.

In 2018, small displacements began to occur below Bedding Plane 33, which indicated that the shear strength was potentially lower than initially assumed in the Project design. These small displacements, other instrument data, and the results of geological mapping led to a reassessment of the expected strength of the bedrock at this depth.

Before the start of construction, the shear key incorporated into the roller-compacted concrete buttress was designed to a depth below Bedding Plane 33. As a result of the additional information that was obtained from the instrumentation and mapping during construction, another potentially continuous bedding plane was identified below the base of the buttress shear key.

In 2018 and 2019, BC Hydro conducted analysis of the interlock of the foundation, the strength of the bedding planes below the base of the roller-compacted concrete

buttress and other aspects of the foundation rock, as well as the expected water pressures in the foundations resulting from the future reservoir. The analyses and additional data indicated that these other aspects of the foundation did not provide enough resistance to compensate for the lower strength of the bedding plane.

Ultimately, BC Hydro, in agreement with the Technical Advisory Board, determined that significant foundation enhancements were required, and the cost of those enhancements would be significantly higher than previously expected.

After considering all the alternatives that were developed to address this geotechnical risk, the Project identified a two-part solution to improve the stability of the right bank structures:

- Structural enhancements located within the foundation of the spillways and powerhouse; and
- Enhancement of the drainage for and water-tightness of the approach channel.

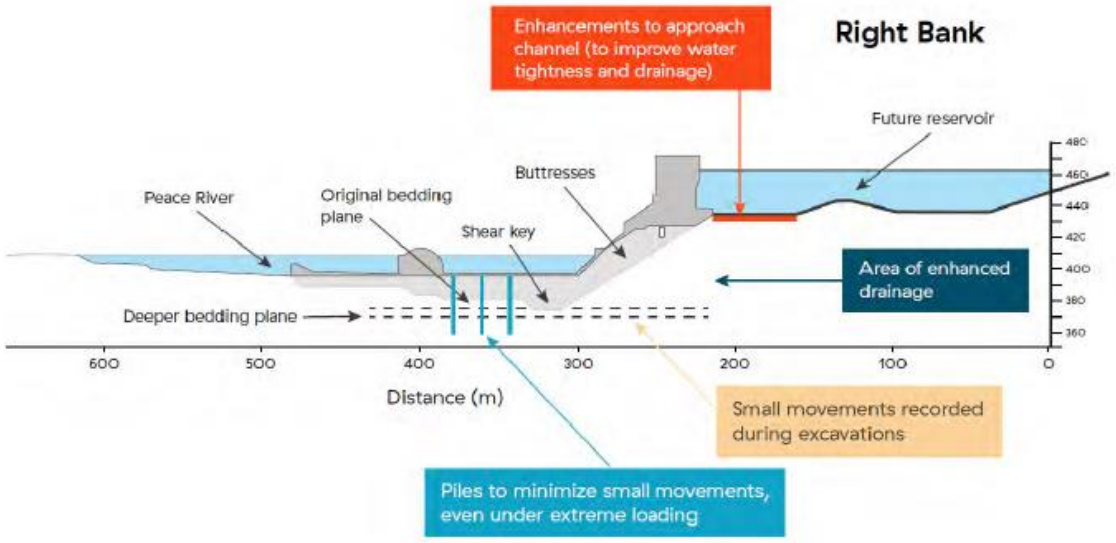
The first part of the solution was to improve the strength of the concrete buttresses beneath the right bank structures by anchoring the buttresses deeper into the rock below. 96 vertical steel and concrete piles, each up to 2 metres in diameter, extended the function of the shear key by drilling through the deeper bedding plane into the even stronger rock below it. The piles extend the function of the shear key a further 15 metres to 25 metres into the bedrock, below the deepest bedding plane where movements had been measured. The depth of the piles was intended to provide adequate stability even if weaker planes existed below the level identified. The fixed nature of the piles provides added resistance to both the spillways and the powerhouse.

The second part of the solution was to improve the water tightness of the approach channel. The approach channel is located adjacent to the spillways and powerhouse and directs water from the reservoir, around the earthfill dam and into the generating

station. The approach channel's original design included features to make it water-tight, which prevents water from seeping out of the channel and into the underlying and surrounding bedrock. The enhancements improved the approach channel liner and increased drainage to prevent water from seeping into the foundation when the reservoir is filled.

Figure 6 below shows a cross section of the spillways and approach channel including the right bank foundation enhancements.

Figure 6 Right Bank Foundation Enhancements



Given the scope, cost and schedule implications of the proposed solution, the Project Assurance Board commissioned a further independent due-diligence review conducted by two internationally recognized dam experts to assist its evaluation of the technical integrity of the solution and to ensure it met the safety and reliability standards of the Canadian Dam Association.

In February 2021, the Government of B.C. released the due-diligence geotechnical review by these two experts and confirmed the foundation enhancements developed to address geotechnical issues on the Project's right bank would meet the highest

safety standards and international best practices. The experts were retained to provide oversight while construction of the foundation enhancements were completed and all planned work for stabilizing the bedrock foundations for the dam, powerhouse, approach channel and spillways was substantially complete as of the end of March 2024.

Table 32 below provides a summary of the chronology regarding the right bank foundation enhancements.

Table 32 Summary of Chronology Regarding Right Bank Foundation Enhancements

Time Period	Event
Pre-July 2015 and Start of Construction	Engineering studies were completed that formed the design basis for the powerhouse, spillways, and dam and core buttress. Project risks were identified and documented, including geotechnical risks
June 2016 to October 2016	Installation of instruments to monitor excavations.
October 2018	Technical Advisory Board Report No. 19. Completion and presentation of geotechnical engineering studies and analyses of mapping and monitoring activities to date. Discussion on the new observation of movement on the right bank in mid-August 2018 and the recommended evaluation for next steps and studies. Further displacements on Bedding Plane 33 in response to the excavation of spillways. The Technical Advisory Board recommended that a 3D stability analysis with the same inputs as used in the conservative 2D analysis be completed and that undisturbed samples of core be obtained to evaluate the shear strength on the bedding planes.
May 2019	Technical Advisory Board Report No. 20. The Technical Advisory Board recommended that a hydrogeological model be developed to facilitate a re-evaluation of the drainage measures and the effectiveness of the planned grout curtain.
January 2020	Technical Advisory Board Report No. 21. Indications that structural measures were likely required to improve the foundation. At that time, neither the preferred solution nor the magnitude of the forecast costs for the remediation was known and the potential forecast progressively increased after the initial concepts were developed and evaluated.
March 2020	The Project determined that significant foundation enhancements were required, and the cost of those enhancements would be significantly higher than originally estimated.
June 2020	Technical Advisory Board Report No. 22. Several alternative stabilizing measures were evaluated and the two favourable solutions that emerged were large diameter concrete filled steel pipe piles and concrete shear walls. The final depth of the shear walls or piles would depend on the findings of the ongoing geological investigations.

Time Period	Event
October 2020	Technical Advisory Board Report No. 23. The Technical Advisory Board supported recommendations for the laterally loaded piles for both the powerhouse buttress and spillways buttress and conceptual modifications to the approach channel. A report was provided to the Project Assurance Board and meetings were held to discuss the content and respond to questions. Mobilization for a full-size field trial for the large diameter laterally loaded piles was underway. The Project Assurance Board approved recommended mitigation measures to address additional stability. The Project Assurance Board retained two internationally recognized dam experts to assist it in its evaluation of the technical integrity of the proposed mitigation measures and ensure they met the safety and reliability standards of the Canadian Dam Association
February 2021	The due-diligence geotechnical review from the two independent, world-leading dam experts was released. Their review confirmed the foundation enhancements developed to address geotechnical issues on the Project's right bank indicate the Project design continues to meet the highest safety standards and international best practices.
March 2024	All the planned work for stabilizing the bedrock foundations for the dam, powerhouse and spillways was substantially complete as of the end of March 2024.

6.4 Lessons Learned – Geotechnical Risks

This section describes the four lessons learned from the Project regarding Geotechnical Risks.

6.4.1 Lesson GR1: Identify and Engage Geotechnical Experts Early, Particularly on Complex Issues, and Maintain Their Involvement Throughout the Design and Major Change Processes

Lesson GR1 is to identify and engage geotechnical experts early, particularly on complex issues, and maintain their involvement throughout design and major change processes. The Project was successful in engaging geotechnical experts early and continuously throughout the long duration project lifecycle.

The Project benefitted greatly from a large and varied group of internal and external experts who provided guidance and advice throughout the Project from investigations and through the construction period.

The Project formed a dedicated team of knowledgeable and experienced engineering, construction and project management employees and external consultants, and established a Technical Advisory Board early in the project lifecycle consisting of individuals who were internationally recognized for their experience in hydroelectric projects. The Project team also utilized a vast network of external geotechnical experts.

Experts are best retained early in the project development cycle to provide ongoing advice. In larger more complex projects, teams should consider whether it would be beneficial to establish a Technical Advisory Board that the project can work with. Any experts or expert bodies should be informed of progress through regular meetings and status updates and there should be clear governance structures in place to ensure independence.[59] It is also important to consider that a range of qualified experts may be required in areas such as geotechnical engineering, geology, hydrogeology, engineering geology, hydraulics, dam engineering, civil engineering, and the planning, engineering, design, and construction of hydroelectric facilities.

Table 33 below provides some specific considerations which are intended to support future project teams as part of this lesson learned.

Table 33 Lesson GR1 - Specific Considerations

#	Consideration
GR 1.1	Engage geotechnical experts early, long before construction starts.
GR 1.2	Ensure that experts have relevant experience with the geology of the site.

[59] Refer to section 7 below on project governance, which discusses this in more detail.

6.4.2 Lesson GR2: Conduct Thorough Investigations to Inform Design Considerations Early and to Frame Baseline Information

Lesson GR2 is to conduct thorough investigations to inform design considerations early and to frame baseline information. The Project developed a robust model and undertook extensive investigations, but geotechnical risks can still arise with the potential for significant impacts on the project budget and schedule.

Table 34 below provides some specific considerations which are intended to support future project teams as part of this lesson learned.

Table 34 Lesson GR2 - Specific Considerations

#	Consideration
GR 2.1	Complete comprehensive studies and site investigations long before design and construction to allow development of a detailed geological model.
GR 2.2	Consider a wide variety of investigation types.

6.4.3 Lesson GR3: Develop Robust Geotechnical Models to Evaluate Performance and Proactively Support Required Enhancements

Lesson GR3 is to develop robust geotechnical models to evaluate performance and proactively support required enhancements. Site C was able to proactively address the geotechnical risks during construction based on the model outputs.

As a result of the detailed studies and investigations undertaken, the Project team was able to develop a detailed geological model, which informed the evolving design needs of the Project. Continuously gathering data and updating the geotechnical model ensured that any required design changes were undertaken with the most current and relevant information.

In addition to the detailed studies and site investigations, the Project undertook extensive geological mapping of all excavated bedrock surfaces immediately after excavation and cleaning of the excavated surface. Geological mapping provides detailed information on the bedrock including a description of the rock, the

orientation and extent of any joints in the rock, any bedding planes and the infill in the bedding planes, any shears in the rock and the infill in the shears, any offsets, the presence of water, and other geological features of interest.

The Project installed an extensive state-of-the-art instrumentation system to monitor the behavior of the bedrock foundations during both the excavation stage and the construction stage of the major civil structures, including the earthfill dam, powerhouse, and spillways. This instrumentation system allowed the Project to observe the performance of the foundations and excavations during construction and confirm geotechnical design assumptions.

In addition, to manage the risk of slope movements along the reservoir rim, an extensive network of instrumentation was installed and monitored. Detailed geotechnical assessments were also undertaken to characterize the potential for groundwater changes, flooding, shoreline erosion, slope instability and landslide-generated waves resulting from the impoundment and operation of the proposed reservoir. The results of these assessments were used to generate preliminary reservoir impact lines that delineate areas of potential hazard. These reservoir impact lines provided information on the expected likelihood and nature of the hazards around the reservoir.

Table 35 below provides some specific considerations which are intended to support future project teams as part of this lesson learned.

Table 35 Lesson GR3 - Specific Considerations

#	Consideration
GR 3.1	Use a detailed geological model to develop the layout and design based on the known geotechnical conditions, and to minimize geotechnical risks to the Project.
GR 3.2	Prior to and during the construction of the Project, install extensive instrumentation to monitor the geotechnical conditions at the damsite, and complete detailed geological mapping during the excavations and construction activities, to update and validate the geotechnical model over the life of the Project.
GR 3.3	Ensure a variety of instrumentation is used during construction (e.g., inclinometers, extensometers, and piezometers) to provide data on bedding plane slippage, opening of relaxation joints, and water pressure.

#	Consideration
GR 3.4	Use information obtained from the instrumentation and geological mapping during construction to update and validate the geotechnical model over the life of the Project.
GR 3.5	Identify interfaces and inherent impacts on design and construction resulting from geotechnical considerations from model updates.
GR 3.6	Allow sufficient time for consultation with the Indigenous Nations and stakeholders (e.g., local communities) on the construction impacts that occur from changes in the geotechnical model.

6.4.4 Lesson GR4: Foster Communication and Collaboration with Technical Advisory Board, Engineering, Geotechnical Specialists and Contractors to Resolve Issues in a Timely Manner

Lesson GR4 is to foster communication and collaboration with the Technical Advisory Board, engineering, geotechnical specialists, and contractors to resolve issues in a timely manner. The Project was successful in engaging the Technical Advisory Board and other specialised technical experts for timely advice when addressing key geotechnical risks.

For large and complex projects, it is unlikely that BC Hydro will have all the required geotechnical expertise. Additional resources with specialized knowledge will need to be engaged through external consulting companies. For example, on the Project, the Engineering team was augmented with resources from Klohn Crippen and Atkins Realis, two Canadian companies with extensive geotechnical expertise.

Ensuring the independence of the Technical Advisory Board, through a governance structure where advice from the Technical Advisory Board is provided directly to the governing bodies on the project supports transparency and builds trust.

Table 36 below provides some specific considerations which are intended to support future project teams as part of this lesson learned.

1 **Table 36 Lesson GR4 - Specific Considerations**

#	Consideration
GR 4.1	Establish agreements with various engineering consulting firms and construction contractors to source additional geotechnical resources when needed.
GR 4.2	Include individuals in the various Project governing roles that have geotechnical knowledge and experience.
GR 4.3	Create visualization tools to aid in the communication and transparency of information.
GR 4.4	Create a governance structure that allows any Technical Advisory Board to present independently to other governing bodies rather than through the Engineering Design Team.

7 Project Governance

This section addresses Project Governance. It describes the history and effectiveness of project governance and oversight, including the Project Assurance Board, Technical Advisory Board, and the Independent Oversight Advisor. It describes lessons learned related to the individuals selected, method of selection, expertise represented, scope of oversight and the communication protocols for each group, as well as their interactions with BC Hydro staff, executive and board.

The Project Assurance Board, Ernst & Young's role as an Independent Oversight Advisor, and the Technical Advisory Board all contributed valuable advice, and guidance to the Project. This included oversight and feedback on critical Project decisions such as the selected solution for the right bank foundation enhancements, as well as guidance and input on high-priority risks and mitigation strategies monitored in the Project risk register. Effective governance supported the Project by enhancing due diligence in decision making, rigorously evaluating and validating management plans, ensuring clarity in decisions, and providing continuous oversight of schedule and cost risk analyses.

The mandate, expertise, and independence of the Project's governing bodies were improved over time and future major capital projects should take steps to implement these improvements from the beginning, where appropriate. These improvements included: developing and updating a skills matrix for the Project's governing bodies so that the expertise matches the Project's needs as it advances through construction; providing sufficient time for the governing bodies to consider the matters on which their advice is sought; establishing sub-committees where additional advice and oversight is required; and, ensuring the independence of the Project Board from other governance bodies (such as the BC Hydro Board of Directors and Executive Team) and making independent external advice available to them.

This section is organized as follows:

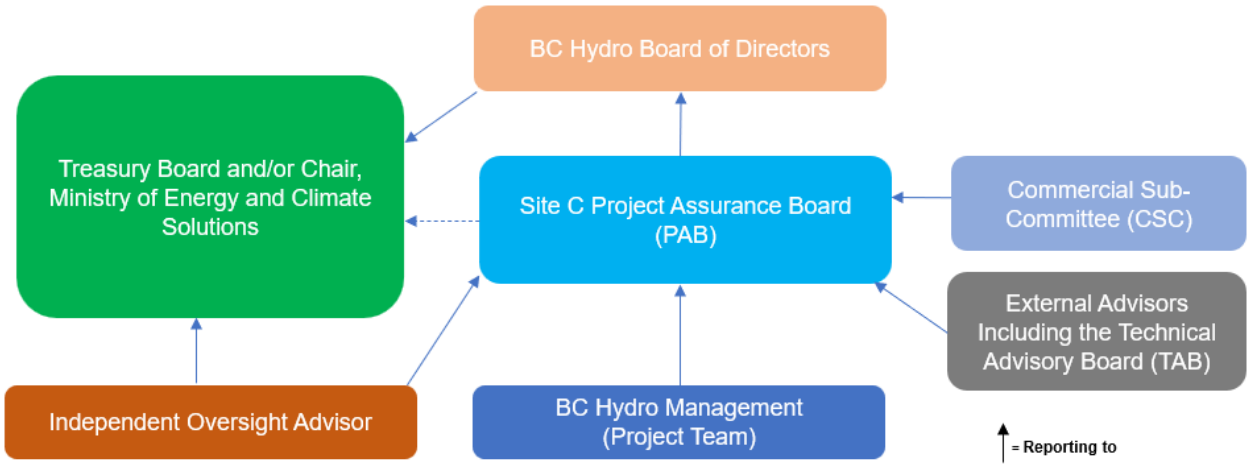
- Section 7.1 describes the current Project governance framework, which includes multiple governing bodies and independent third-party advisors with detailed terms of reference or statements of work and communication protocols;
- Section 7.2 describes the independent third-party reviews conducted for the Project; and
- Section 7.3 describes the four lessons learned from the Project regarding Project Governance:
  - **Lesson PG1:** for large complex projects, evaluate project complexity and risk early, and consider the role of an independent project board, including members with applicable skills and knowledge;
  - **Lesson PG2:** establish governance sub-committee(s) and engage special advisors or experts, as needed, to supplement governing bodies' knowledge and experience;
  - **Lesson PG3:** ensure clear and detailed terms of reference and communication protocols are established for all governance bodies, and if applicable, with any external advisors and the independent oversight advisor; and
  - **Lesson PG4:** establish processes, tools and reporting to ensure governing bodies obtain effective and timely information.

7.1 Site C Governing Bodies and Independent Third-Party Advisors

The Project governance framework includes multiple governing bodies and third-party independent advisors with detailed terms of reference or statements of work and communication protocols. It reflects BC Hydro's implementation of the recommendations from the 2021 Milburn Report.

Figure 7 below provides a high-level overview of the governance and oversight for the Project as of August 2025.[60]

Figure 7 Current Project Governance and Oversight



7.1.1 BC Hydro Board of Directors

The BC Hydro Board of Directors provides governance, strategic direction, and oversight of BC Hydro in accordance with its authority under the *Hydro and Power Authority Act*. As the primary governing body for BC Hydro, members of the Board of Directors consider a broad range of interests including those of the Government of B.C. (as BC Hydro's shareholder), customers, employees, Indigenous rights holders,

[60] Certain aspects of the governance structure detailed in this section have been changed since August 2025, as the Project has achieved all six generating units in service and has begun Project completion activities. The Project Assurance Board has been dissolved and oversight has transferred to the Capital Projects and Programs Committee of the BC Hydro Board of Directors.

and stakeholders such as regulators, contractors and the communities in which BC Hydro operates. The BC Hydro Board of Directors also appoints various standing sub-committees to consider specific areas of focus.

The BC Hydro Board of Directors has provided overall project governance, oversight, and approvals for the Project since its early feasibility stage. Specifically, the BC Hydro Board of Directors approves:

- The Project budget and any updates;
- Financial commitments greater than $75 million and expenditures, consistent with BC Hydro's Management and Accounting Policies and Procedures;
- Draws on the Project contingency;
- The Project schedule;
- All major Project strategies and plans, including key procurement plans, activities, decisions, and contract awards;
- Key Project communication plans and reports including the Quarterly and Annual Progress Reports to the Commission;
- Reports to the Government of B.C.'s Treasury Board;
- Key commercial strategies and claims resolutions;
- Cost Risk Analyses and Schedule Risk Analyses;
- Other key Project plans and documents, as appropriate; and
- Recommendations to the Government of B.C. regarding any requests to establish a Project reserve.

The Chair of the BC Hydro Board of Directors also advises the Minister responsible for BC Hydro with respect to key issues and developments on the Project, as appropriate.

The BC Hydro Board of Directors are appointed by the Lieutenant-Governor in Council. They are selected to reflect the industrial, economic, social, ethnic, and regional diversity of the British Columbia. Appointees include persons with business, utility, construction, Indigenous Nations, and energy industry experience to provide an appropriate balance of expertise.

The primary communications protocol between the Project and the BC Hydro Board of Directors is through Project documents and information updates from the Project Assurance Board and the Project Team.

The BC Hydro Board of Directors also receive updates related to the Project through the President and CEO and through the BC Hydro Board members who are members of the Project Assurance Board.

7.1.2 Project Assurance Board

The Site C Project Assurance Board was created by the BC Hydro Board of Directors in January 2018. It replaced the Site C Project Board (which had been made up of a subset of BC Hydro Board members).[61] The Project Assurance Board meets at least monthly. Its current Terms of Reference includes the following:[62]

- Providing independent due diligence and oversight of the Project to enable the Project to be fit for purpose and to be completed safely, on time, and on budget;
- Overseeing the Schedule Risk Analysis and Cost Risk Analysis over the life of the Project, including assessing and testing Management's plans for completing the Project;

[61] The Site C Project Board, a sub-committee of the BC Hydro Board of Directors, was formed in early 2013 and operated until it was replaced by the Project Assurance Board in 2018. It was formed to provide more focused Project oversight, guidance, and approvals to the Project team. It functioned at a strategic level, offering advice and direction to Management during the development and early execution and construction of the Project.

[62] The Terms of Reference were established in January 2018 and were updated in May 2020 and in April 2021 to align the Project Assurance Board's responsibilities and accountabilities with the Project's needs.

- Making recommendations to the BC Hydro Board of Directors on any matters requiring BC Hydro Board of Directors approval;
- Providing Project updates to the BC Hydro Board of Directors, the Minister Responsible for BC Hydro, and the Government of B.C. (e.g., Treasury Board, Ministry staff, etc.);
- Meeting, deliberating, and formulating recommendations independently from the BC Hydro Board of Directors. Facilitating meaningful debate with Management and the Independent Oversight Advisor, Ernst & Young, to thoroughly assess and test Management's plans for completing the Project;
- The Chair of the Project Assurance Board is to report to the BC Hydro Board of Directors, the Minister Responsible, and the Government of B.C. on a timely basis in respect to changes to the Cost Risk Analysis and Schedule Risk Analysis, any major risk exposures, as well as the ongoing work of the Project Assurance Board and progress made on the Project;
- Meeting in-camera with the Independent Oversight Advisor;
- Meeting (in-person, by teleconference, or virtual) at least monthly, unless otherwise determined by the Chair of the Project Assurance Board. The Project Assurance Board may establish sub-committees to deliberate and form recommendations to the Project Assurance Board; and
- Meeting agendas are to be set by the Chair of the Project Assurance Board after consultation with Project Assurance Board members and should ensure sufficient time for thorough consideration of relevant strategic issues.

Project Assurance Board members are appointed by the BC Hydro Board of Directors, in consultation with the Minister Responsible for BC Hydro, and consist of:

- Two members from the BC Hydro Board of Directors;

- A senior staff member from the Ministry of Energy and Climate Solutions;
- A senior staff member from the Ministry of Finance;
- Four individuals with expertise in one or more of the following areas: capital project construction and management, delivery of major civil projects and experience in commercial negotiations and construction related claims settlement;
- The Independent Oversight Advisor (non-voting);
- A member of the Technical Advisory Board (non-voting); and
- Such other individuals with expertise as the Project Assurance Board determines it requires from time to time (non-voting).

The Chair of the Project Assurance Board is elected by the Project Assurance Board members, after consultation with the Minister Responsible for BC Hydro, and cannot be a member of the BC Hydro Board of Directors. Project Assurance Board members are appointed on terms which extend from the date of appointment until the completion of the Project.

The 2021 Milburn Report included seven recommendations to strengthen the Project's governance and oversight. BC Hydro accepted these recommendations and implemented all of them by May 2021. Specifically:

1. **Skills Matrix:** The 2021 Milburn Report recommended that a skills matrix be completed for the Project Assurance Board. It stated that the skills matrix should identify any gaps that exist between current Project Assurance Board skills and the desired Project Assurance Board skill level, specifically focusing on individuals with experience delivering major civil projects (as both owners and contractors) and individuals with experience in commercial negotiations and construction related claims settlement. This recommendation was

implemented by April 2021 and informed changes to the Project Assurance Board membership.

2. **Composition:** The 2021 Milburn Report recommended that consideration be given to having more external, independent, and skill-specific membership on the Project Assurance Board. This recommendation was implemented by April 2021. Consistent with this recommendation, the Project Assurance Board is currently comprised of 10 members and includes an independent Chair and three additional independent members. The number of members from the BC Hydro Board of Directors has been reduced to two. The current membership has enhanced the skillset of the Project Assurance Board and represents a greater level of independence from the BC Hydro Board of Directors.

3. **Independence:** The 2021 Milburn Report recommended that BC Hydro consider providing the Project Assurance Board with more autonomy to provide opportunities for independent due diligence and deliberations. The report concluded that due diligence and oversight require independent consideration and that governance at the time appeared to truncate the opportunity to properly explore problems and potential solutions. This recommendation was implemented by April 2021.The Project Assurance Board Terms of Reference were updated to address this recommendation by providing more time to independently consider and test the Project Team's approach to key issues, and by clarifying that the Project Assurance Board Chair cannot be a member of the BC Hydro Board of Directors.

4. **Orientation:** The 2021 Milburn Report recommended that the Project Assurance Board orientation process be formalized and include formal feedback on content, quality, and methodology. This recommendation was implemented by May 2021. The orientation process was enhanced with the development of an orientation book, which includes comprehensive information

about the Project. Two orientation sessions were held with the Project Assurance Board and supporting materials were provided.

5. **Time Commitments:** The 2021 Milburn Report stated that the Project Assurance Board would benefit from the dedication of additional time to conduct due diligence and oversight. It stated that consideration should be given to facilitating a more active and detailed review of key subjects by the Project Assurance Board using task assignments, workshops and/or sub-committees. It also recommended that the Project Assurance Board meetings should take place at least monthly, unless otherwise determined by the Project Assurance Board. This recommendation was implemented by May 2021. In addition, the Project Assurance Board established a Commercial Sub-Committee in May 2021 to deliberate and form consensus recommendations to the Project Assurance Board on commercial related issues.

6. **Meeting Structure:** The 2021 Milburn Report recommended that future meeting agendas should be reviewed by the Project Assurance Board in a detailed manner so that the topics that effect commercial strategy, quality, schedule, and costs are appropriately tabled with the Project Assurance Board. It also recommended that meeting materials requesting a significant decision or a recommendation by the Project Assurance Board to the BC Hydro Board of Directors for approval include a summary of the risks and risk mitigation methods relating to the subject matter. This recommendation was implemented by May 2021.

7. **Terms of Reference and Statement of Work:** The 2021 Milburn Report recommended that the Independent Oversight Advisor and Project Assurance Board functions be re-evaluated, and that their Terms of Reference or Statement of Work be updated and re-established to address the findings of the report. This recommendation was implemented by May 2021. A new Project

Assurance Board was formed, incorporating the recommendations from the report, and updated Terms of Reference and Statement of Work for both the Project Assurance Board and the Independent Oversight Advisor were established.

The primary communications protocol between the Project Assurance Board and the BC Hydro Board of Directors is through Project documents and updates that are received by the BC Hydro Board of Directors for approval or information from the Project Assurance Board. The Project Assurance Board makes recommendations to the BC Hydro Board of Directors regarding any proposed resolution for the Project. The Chair of the Project Assurance Board reports to the BC Hydro Board of Directors on a timely basis regarding changes to the Cost Risk Analyses and the Schedule Risk Analyses, and any material risk exposures identified by the Project Assurance Board. The Chair also regularly updates the BC Hydro Board of Directors on the Project Assurance Board's ongoing work and progress on the Project, typically monthly.

The primary communications protocol between the Project Assurance Board and the Project Team is through Project documents, approval requests, and updates provided by the Project Team at monthly (or more frequent, as necessary) Project Assurance Board meetings.

The Project Assurance Board has engaged external advisors, as needed, to provide expert advice and technical knowledge as the Project progressed through critical construction milestones. These external advisors included two independent, world-leading international dam experts that were commissioned to independently provide a due diligence review of the right bank foundation enhancements. The two experts were specifically chosen because they are both recognized globally for their expertise in hydroelectric dams and because neither had any prior involvement with

the Project. After their initial February 2021 report, the experts continued to be involved in the review of the design and construction for the Project.

7.1.3 Commercial Sub-Committee of the Project Assurance Board

In May 2021, the Commercial Sub-Committee of the Project Assurance Board was created to provide more focussed Project oversight related to key construction, schedule, cost reporting, claims management and other commercial matters.

The Commercial Sub-Committee is comprised of Project Assurance Board members. At least three members are to be independent Project Assurance Board members (i.e., not members of the BC Hydro Board of Directors). The Project Assurance Board Chair is a member of the committee in an *ex officio* capacity. The Commercial Sub-Committee elects a Chair from among its members.

The primary communications protocol between the Commercial Sub-Committee and the Project Assurance Board is through the Commercial Sub-Committee's review of any commercial Project-related resolutions proposed for approval by the Project Assurance Board. The Commercial Sub-Committee makes recommendations to the Project Assurance Board regarding the proposed resolution.

7.1.4 Technical Advisory Board

The Technical Advisory Board is a global panel of engineering and construction experts that report to the Project Assurance Board. They provide expert technical advice to BC Hydro related to the design, construction, risks, and project delivery for the Project. The mandate of the Technical Advisory Board includes:

- Advising the Project Assurance Board, the BC Hydro President and Chief Executive Officer, and the Executive Vice President, Site C, regarding the engineering and technical decisions related to Project design, consistent with current international best practices;

- Providing technical review of key design milestones and ongoing external advice to supplement existing engineering and design and procurement expertise;
- Reporting to the Project Assurance Board and Management on key findings and recommendations; and
- Preparing and submitting technical reports, as required, to the Project Assurance Board, Management, and the BC Hydro Board of Directors.

The Technical Advisory Board is comprised of a team of individuals internationally recognized for their breadth and depth of technical knowledge and experience with the design of hydroelectric projects around the world.[63] Their core areas of experience span hydroelectric projects, geotechnical design, geological and hydrological considerations, and the hydraulic design of spillways, tunnels, and reservoir landslides.

The primary communications protocol for the Technical Advisory Board is with the Project's Engineering Design Team related to the design, construction, risks, and project delivery. The Technical Advisory Board also communicates with the Project Assurance Board, Management, and the BC Hydro Board of Directors through technical reports and updates to the Project Assurance Board and Management on key findings and recommendations.

7.1.5 Independent Oversight Advisor - Ernst & Young Canada

In October 2017, the Project, in consultation with the Government of B.C., engaged Ernst & Young Canada to provide Independent Oversight to the Project Assurance Board. Ernst & Young's function is to assist the Project team with identifying and implementing effective mitigation strategies for key Project risks and to provide

[63] Technical Advisory Board membership since 2010 is as follows: Dr. Norbert Morgenstern (Chair) (2010 to present); Dr. Wynfrith Riemer (2010 to present); Dr. Peter Mason (2016 to present); Mr. Joseph Ehasz (2014 to 2025); Mr. Cassio Viotti (2010 to 2014); and Mr. Karl Rytters (2010 to 2016).

independent, external reporting to the Project Assurance Board, the BC Hydro Board of Directors, and the Government of B.C., as appropriate.

BC Hydro engaged Ernst & Young to provide independent oversight for the Project, specifically with respect to:

- **Risk Management:** Reviewing the Project risk management processes, attending Project risk committee meetings, attending Project risk update meetings, reviewing the Project risk register, and risk reporting;
- **Claims and Commercial Management:** Ongoing review of the Project's commercial team and its related processes, reviewing ongoing claims and related commercial strategies, and attending the monthly meetings of the Commercial Sub-Committee;
- **Schedule Management and Change Control:** Reviewing the schedule risk and opportunity management plans and the schedule risk analyses;
- **Engineering and Technical:** Includes, but is not limited to, attending the Technical Advisory Board meetings, and reviewing the value engineering analyses as it relates to the Project's cost, schedule, and risk impacts;
- **Cost Management and Change Control:** Includes, but is not limited to, attending budget management review meetings; review of cost reporting; and the review of the cost risk analyses;
- **Overall Project Oversight, Planning, Reporting and Monitoring:** Providing independent, external reporting to the Project Assurance Board, BC Hydro Board of Directors, and the Government of B.C., as appropriate. Attending monthly Project progress meetings, providing a monthly report to the Project Assurance Board, and attending monthly Project Assurance Board meetings. Reviewing processes and making recommendations (if applicable), and following up on previous recommendations; and

- Any other requests made by the Project Assurance Board.

Ernst & Young was embedded with the Project team to provide oversight services to Management. The Project team worked collaboratively with Ernst & Young on implementing identified opportunities for improvement. For example, a Risk Management Enhancement Plan was prepared collaboratively with Ernst & Young that documented all identified opportunities for improvement from the 2021 Milburn Report and Ernst & Young. The Plan was fully implemented by September 30, 2021.

The Ernst & Young resources that delivered the Independent Oversight Advisor role evolved over time with the increased focus on commercial management and the implementation of the identified opportunities for improvement following the approval of the 2021 Approved Budget.

The primary communications protocol for Ernst & Young was with the Project team and with the Project Assurance Board and Commercial Sub-Committee. Ernst & Young prepared a monthly report, and attended numerous Project, Commercial Sub-Committee, and Project Assurance Board meetings. Ernst & Young also provided independent, external reporting to the Project Assurance Board, the BC Hydro Board of Directors, and the Government of B.C., as appropriate.

7.2 History of Project Governance and Oversight

Table 37 below provides a chronology of the independent third-party reviews conducted for the Project.

Table 37 Independent Reviews Strengthened Governance and Oversight

July 2016 - Ernst & Young and BTY Group Review	
Description	• Independent, external review of the Project to ensure the appropriate risk and cost management processes were in place to build the Project on time and on budget. • The review focused on four areas: – Major contracts (over $50 million) awarded to date. – Risk management plans, processes, and risk registers. – Cost management plans and processes, with an assessment of overall cost controls. – Cost drivers and indicators compared to the estimate baseline.
Recommendations / Outcomes	• The report found that the Project was clearly defined and well-planned and had the appropriate processes and risk mitigation in place to meet major Project milestones and financial targets. [64] • The Report made a series of recommendations under each of the four key areas reviewed. BC Hydro developed and implemented an action plan to address these recommendations.

[64] https://www.sitecproject.com/sites/default/files/BC-Hydro-Site-C-Risk-Cost-Management-Report.PDF.

August 2017 – British Columbia Utilities Commission Site C Inquiry	
Description	• The Government of B.C. directed the BCUC to undertake an inquiry into certain aspects of the Project. • The inquiry was tasked with reporting on the implications of three scenarios for the Project – continuing, terminating, or suspending construction with the option to resume by 2024. • Deloitte was engaged by the Commission to perform an independent analysis of whether the Project was on time and on budget, what the anticipated costs would be to suspend or cancel construction, and what alternative sources of generation and demand-side management initiatives exist to replace the energy and capacity of Site C.
Recommendations / Outcomes	• The Commission provided a report to the Government of B.C. on November 1, 2017, which concluded that the suspension scenario would result in the highest cost to ratepayers, that the Project was not within the 2014 Final Investment Decision budget and that an illustrative alternative portfolio, if considered under the low load forecast case, had similar cost to ratepayers as Site C. [65] • On December 11, 2017, the Government of B.C. decided to continue with construction of the Project and announced the 2018 Approved Budget of $10.7 billion (including Project reserve of $708 million).
October 2017 - Ernst & Young Appointed Independent Oversight Advisor	
Description	• Following the Site C Inquiry, the Project, in consultation with the Government of B.C., engaged Ernst & Young to be the Independent Oversight Advisor for the Project.
Recommendations / Outcomes	• Refer to section 7.1.5 above.
January 2018 - Project Assurance Board	
Description	• The Site C Project Assurance Board was created, reporting to the BC Hydro Board of Directors, and replacing the previous Site C Project Board.

[65] https://docs.bcuc.com/documents/wp-content/11/11-01-2017_SiteC-Executive-Summary.pdf.

Recommendations / Outcomes	• Refer to section 7.1.2 above.
July 2020 - Site C Review by Mr. Peter Milburn	
Description	• The Government of B.C. appointed a special advisor, Mr. Peter Milburn, to complete a review of the Project.
Recommendations / Outcomes	Refer to section 7.1.2 above.

Numerous Provincial and Federal governing bodies also provided detailed and comprehensive review and oversight of the Project, particularly with respect to permitting and environmental monitoring.

7.3 Lessons Learned - Project Governance

This section describes the four lessons learned from the Project regarding Project Governance.

7.3.1 Lesson PG1: For Large Complex Projects, Evaluate Project Complexity and Risk Early, And Consider the Role of an Independent Project Board, Including Members with Applicable Skills and Knowledge

Lesson PG1 is, for large complex projects, to evaluate project complexity and risk early, and consider the role of an independent project board, including members with applicable skills and knowledge. The recommendations from the 2021 Milburn Report strengthened the Project Assurance Board with members with diverse skills and expertise more aligned to the needs of the Project and a greater independence from the BC Hydro Board of Directors. Engaging third-party expert advisors, as required, and having an Independent Oversight Advisor provided the Project Assurance Board with additional knowledge and experience to inform decisions.

Effective governance requires governing bodies with diverse expertise and the engagement of independent expert advisors, when appropriate, as well as sufficient time to understand the project's key strategic decisions and required approvals. The initial governance structure and enhancements made through the recommendations

of independent third-party expert reviews successfully integrated diverse expertise, enhanced the independence of the governing bodies, and implemented strong oversight processes for meaningful review and deliberation. Future major capital projects of similar size and complexity may benefit from adopting these principles.

Table 38 below provides some specific considerations which are intended to support future project teams as part of this lesson learned.

Table 38 Lesson PG1 - Specific Considerations

#	Consideration
PG 1.1	Early in the project life cycle, develop a skills matrix that identifies the beneficial skills for members on the Project Board. The skills should align with the specific needs of the project (e.g., construction, engineering, commercial, safety, environmental, Indigenous Nations, community engagement, etc.).
PG 1.2	Review the time required for the governing bodies to complete the appropriate due diligence and deliberations and to review the volume of governance related materials they will receive. Consider creating a dedicated Project Board to allow for specific project focus including sufficient dedicated time to fully understand the scope of the project and the issues and potential solutions that arise.
PG 1.3	Ensure the project governing bodies include members with the required skills, knowledge, and experience from the skills matrix. Consider establishing a dedicated Project Board with internal and/or external members with the desired skills that is independent, where possible, from other project governing bodies.
PG 1.4	Ensure the governing bodies have access to independent internal and external advisors to provide expert advice and opinions as the project progresses through construction or where specific expertise is required for a complex issue.
PG 1.5	For large and complex projects, consider if the project would benefit from engaging an independent oversight advisor, and if so, have this advisor report to the most appropriate project governing body. Develop a detailed Terms of Reference or Statement of Work for their role including roles and responsibilities and the required expertise they would bring to the project.

7.3.2 Lesson PG2: Establish Governance Sub-Committee(s) and Engage Special Advisors or Experts, as Needed, to Supplement Governing Bodies' Knowledge and Experience

Lesson PG2 is to establish governance sub-committee(s) and engage special advisors or experts, as needed, to supplement governing bodies' knowledge and experience. Establishing the Commercial Sub-Committee of the Project Assurance Board in 2021 provided greater oversight, advice, and support to the Project Assurance Board and Management on commercial and contractual issues including

negotiations and claim settlements. The Technical Advisory Board, engaging other third-party experts and the role of Ernst & Young as Independent Oversight Advisor also provided additional specialist technical knowledge and experience during critical phases of work on the Project. This helped facilitate understanding of issues and verify the Project's proposed solutions.

Table 39 below provides some specific considerations which are intended to support future project teams as part of this lesson learned.

Table 39 Lesson PG2 - Specific Considerations

#	Consideration
PG 2.1	Consider engaging external advisors, as required, to support the governing bodies and provide them with technical knowledge, expertise, guidance, and advice on complex and/or technical issues.
PG 2.2	Consider creating governance sub-committees during critical phases of the project, with members with the required skills and knowledge, to increase the effectiveness and efficiency of the project's governance and oversight.

7.3.3 Lesson PG3: Ensure Clear and Detailed Terms of Reference and Communication Protocols are Established for all Governance Bodies, and if Applicable, With External Advisors and the Independent Oversight Advisor

Lesson PG3 is to ensure clear and detailed terms of reference and communication protocols are established for all governance bodies, and if applicable, with any external advisors and the Independent Oversight Advisor. Clear terms of reference or statements of work that are updated with the needs of the project provide greater understanding and alignment between the project team and governing bodies.

Two good examples of how BC Hydro maintained and refined terms of reference on the Project are the Project Assurance Board and the role of Ernst & Young as an Independent Oversight Advisor.

Following the 2017 Site C Inquiry, the Project Assurance Board was formed and detailed Terms of Reference were developed and subsequently updated in May 2020 and in April 2021 to align with the Project's evolving needs.

BC Hydro, in consultation with the Government of B.C., engaged Ernst & Young in October 2017. The original Statement of Work was updated in 2021 to expand to areas such as: claims and commercial management; schedule management; engineering and technical considerations; cost management and change control; risk management; the review of the right bank foundation enhancements; the Project delivery and control framework; and the overall Project planning, delivery, and reporting. In addition, the updated Statement of Work provided additional clarity related to roles and responsibilities and resulted in greater collaboration and a more effective working relationship between Ernst & Young and Management.

Table 40 below provides some specific considerations which are intended to support future project teams as part of this lesson learned.

Table 40 Lesson PG3 - Specific Considerations

#	Consideration
PG3.1	Establish clear and detailed Terms of Reference or Statements of Work for all governing bodies, including external advisors and if applicable, any Independent Oversight Advisors. As the project progresses, periodically review and update the Terms of Reference or Statement of Work to ensure they continue to describe the current purpose, objectives, scope, roles and responsibilities, accountabilities, decision making, and communication channels.
PG3.2	Establish clear communication protocols for the governance bodies including the communication processes, agendas, and the meeting materials.
PG3.3	If the project has engaged an Independent Oversight Advisor, seek to establish a collaborative working relationship, have them regularly participate in relevant project team meetings, and hold regular meetings with them to seek advice, feedback and perspectives on key project decisions, approvals, and analyses.

7.3.4 Lesson PG4: Establish Processes, Tools and Reporting to Ensure Governing Bodies Obtain Effective and Timely Information

Lesson PG4 is to establish processes, tools and reporting to ensure governing bodies obtain effective and timely information, that the project team has a significant and visible presence at the construction site, and to source a diverse workforce to best meet the project requirements.

Complex and large projects, manage large volumes of data and information. Developing key project dashboards greatly improved the reporting for the Project and facilitated a more effective review of issues and decisions. A strong leadership presence at site allowed for more timely and effective decisions to resolve issues in the field.

To support effective governance on large projects, the processes, tools, and reporting need to be strong and comprehensive so that the governing bodies receive the information they need in a timely and effective way and can appropriately review, discuss, and make informed decisions on the Project. The Project implemented project dashboards across the major work fronts, established a monthly Project Accountability meeting, and had key leadership roles based at site. These measures enhanced reporting, ensured key issues were highlighted, discussed, and resolved in a timely manner and were effective at highlighting key issues or concerns to be raised to the governing bodies.

Although discussion of project governance is typically associated with the Project's governing bodies and the impact they had on supporting the Project to meet its objectives, it is also important to consider governance and oversight at the tactical work level. The Project benefitted from strong site management and leadership and a diverse workforce, both of which resulted in timely and efficient decision making at site and a broad range of perspectives when issues arose, and solutions were required. Strong leadership presence helped to foster clear communication channels and rapid identification of key issues, and diversity of thought and experience helped ensure critical insights were not overlooked and were informed by a wide array of perspectives. Clear communication channels also ensured that the Project's governing bodies received relevant, effective, and timely information.

The Project employed a very large and diverse workforce of internal and contractor resources with a wide range of skills and technical abilities. This diverse knowledge

and experience was used to design, manufacture, and construct the Project and to support decisions at site. For example, many of the contractors working on the Project had substantial global expertise and the Project benefitted from this diverse experience.

Table 41 below provides some specific considerations which are intended to support future major capital projects and the project teams as part of this lesson learned.

Table 41 Lesson PG4 - Specific Considerations

#	Consideration
PG 4.1	To support effective governance on large projects, the processes, tools, and reporting need to be strong and comprehensive to ensure the governing bodies receive the required information in a timely and effective way. One key tool to achieve this is to develop dashboards for key project information.
PG 4.2	Establish a monthly project wide "Accountability" meeting to review the progress and issues for each area of the project, provide opportunities for senior members of the project team to review the results, highlight issues, concerns, and risks, discuss interfaces between the different work activities, and consider future project work.
PG 4.3	Ensure the project team has a significant and visible presence at the construction site. To best meet the project requirements, source a diverse workforce of internal and contractor resources to deliver the Project.

8 Indigenous Consultation

This section addresses Indigenous consultation. It describes the consultation that occurred with Indigenous Nations prior to and during construction activities and explains how decisions made with respect to issues raised during construction were addressed throughout the Project lifecycle. It also explains lessons learned with respect to consultation with Indigenous Nations.

BC Hydro approached Indigenous consultation with an appreciation that the Project will have impacts to Treaty rights pertaining to the use of lands and resources for traditional purposes during both construction and operation. The Project benefited from early and extensive consultation, starting before the environmental review process began and continuing through construction. Several First Nations commenced court proceedings regarding the Project, all of which were resolved by agreement or court decisions. In their decisions, the courts concluded that consultation was deep, meaningful, and adequate. Currently, BC Hydro has entered into Impact Benefit Agreements with eight First Nations. We recognize the importance of continuing to work with Indigenous Nations as we advance future major projects in recognition of both historical and potential future major project impacts.

Consultation included direct engagement with Indigenous Nations, Project update meetings, multi-Nation forums, and at times, use of neutral facilitators. Environmental and cultural monitoring programs directly involving Indigenous Nations were established from the outset, with early engagement on culturally sensitive sites to inform Project planning and design. Early planning also helped to identify and support procurement opportunities for Indigenous Nations' businesses and businesses designated by Indigenous Nations.

In 2018, BC Hydro launched regular Environment and Permitting Forums with First Nations, to serve as a platform to discuss construction activities, permitting

requirements, and environmental and Indigenous concerns. Attended by BC Hydro subject matter experts and representatives from federal and provincial regulatory bodies, the forums enabled direct and ongoing dialogue and feedback. Input from these forums was actively integrated into permit applications and environmental mitigation and management programs and facilitated the timely issuance of permits. This approach is now being adapted for other BC Hydro initiatives, including the North Coast Transmission Line projects.

This section is organized as follows:

- Section 8.1 provides an overview of Indigenous Nations consultation on the Project;
- Section 8.2 provides an overview of key issues and concerns raised by Indigenous Nations and how they were addressed; and
- Section 8.3 describes the four lessons learned from the Project regarding Indigenous Consultation:
  - **Lesson IC1:** Enable early consultation and streamline ongoing engagements, including use of permitting and environmental forums;
  - **Lesson IC2:** Create environmental and cultural monitoring programs from the start of the project;
  - **Lesson IC3:** Plan for and build support for Indigenous procurement opportunities; and
  - **Lesson IC4:** Support training and employment opportunities for Indigenous workers and Indigenous awareness training for all project resources.

8.1 Overview of Indigenous Consultation

BC Hydro's consultation process involved working collaboratively and iteratively with Indigenous Nations throughout the project lifecycle and this work continues into project operations today. BC Hydro shares information with Indigenous Nations, provides opportunities for feedback, and took feedback into account in Project planning.[66]

8.1.1 Overview of Consultation Prior to Construction

Consultation with Indigenous Nations regarding the Project began in November 2007. In the early stages of Project planning, BC Hydro contacted approximately 60 Indigenous groups in B.C., Alberta, Saskatchewan, and the Northwest Territories.

Beginning in 2011, the Project underwent a cooperative federal-provincial environmental assessment that included a Joint Review Panel process. At the outset of the environmental assessment, the federal and provincial governments identified 29 Indigenous groups that may be affected by the Project.[67] Canada, British Columbia, and BC Hydro consulted with these 29 groups throughout the environmental assessment from 2011 to 2014.[68]

Consultation varied from group to group. In general, BC Hydro's consultation included offering capacity funding to facilitate participation in consultation, sharing

[66] BC Hydro and the Crown's consultation with Indigenous Nations regarding the Site C Project is described in numerous places including: the Environment Impact Statement (**EIS**) Volume 1 section 9 and Volume 5, Appendix A; the Federal/Provincial Consultation and Accommodation Report, September 7, 2014; BC Hydro's Submission to BCUC for Site C Inquiry, August 30, 2017, Appendix B; and BC Hydro's Aboriginal Group Communication Plan Annual Reports for the Project, as well as in several court decisions.

[67] Doig River First Nation, Halfway River First Nation, Prophet River First Nation, West Moberly First Nations, Saulteau First Nations, Blueberry River First Nations, McLeod Lake Indian Band, Kwadacha First Nation, Tsay Keh Dene First Nation, Duncan's First Nation*, Horse Lake First Nation*, Dene Tha' First Nation *, Woodland Cree First Nation, Sturgeon Lake Cree Nation, Beaver First Nation, Tallcree First Nation, Little Red River Cree Nation, Mikisew Cree First Nation, Athabasca Chipewyan First Nation.

[68] The Site C Environmental Impact Statement Volume 5 contains detailed information on consultation with Indigenous Nations that occurred ahead of the Joint Review Panel process, and is available on the Impact Assessment Agency of Canada website: https://iaac-aeic.gc.ca/050/evaluations/document/88727.

information on potential Project impacts, gathering data on traditional territories and the exercise of their rights, and creating space for dialogue, concerns, and discussion of mitigation strategies.

The environmental assessment process also provided Indigenous Nations with opportunities to:

- Join a working group and comment on the scope, procedures, and methods of the Environmental Impact Statement and other submissions by BC Hydro;
- Make oral and written submissions to the Joint Review Panel, which held hearings in six Indigenous Nation communities and one for the Métis community; and
- Provide written submissions directly to the provincial and federal Ministers responsible for the environmental assessment decisions.

In October 2014, BC Hydro received both provincial and federal environmental assessment approvals. At that time, a Federal/Provincial Consultation and Accommodation Report was issued by the Canadian Environmental Assessment Agency and the B.C. Environmental Assessment Office. The report concluded:

> The Agency and EAO are of the view that there has been meaningful consultation with the potentially affected Aboriginal groups, to understand the potential impacts of the proposed Project on Aboriginal Interests, and to develop substantive accommodation measures that are intended to reduce, mitigate or offset these impacts.

The provincial Environmental Assessment Certificate and the Federal Decision Statement collectively identified 13 Indigenous groups who were potentially affected by Site C and included conditions intended to mitigate the adverse impacts of the

Project on the exercise of rights by these groups.[69] Many of these conditions require ongoing consultation with these Indigenous groups related to fish, wildlife, heritage resources, and current use, among other matters.

8.1.2 Overview of Consultation During Construction

During construction, which began in July 2015, BC Hydro consulted with the 13 Indigenous groups identified in the Environmental Assessment Certificate and the Federal Decision Statement through several means, including committees, forums, and direct engagement. This extensive consultation included:

- Consultation on hundreds of permits and authorizations issued throughout construction, including under the *Water Act*, *Forestry Act*, *Wildlife Act*, *Land Act*, *Fisheries Act, and Canadian Navigable Waters Act*;
- Permitting and Environmental Forums, attended by Indigenous communities to discuss topics such as project construction, permitting requirements, environmental mitigation and monitoring programs, and other Indigenous Nations issues and concerns. The forums were attended by BC Hydro staff, and Federal and Provincial regulatory agency staff, allowing direct and frequent communication and feedback;
- Establishment of the Cultural and Heritage Resources committee to support initiatives such as identifying and naming key cultural sites, documenting historical land use, commemorating sites lost to inundation, promoting cultural awareness among workers, and providing financial or in-kind support for cultural camps;
- Focussed burial investigation and management work;

[69] Blueberry River First Nations; Doig River First Nation; Fort Nelson First Nation; Halfway River First Nation; McLeod Lake Indian Band; Prophet River First Nation; Saulteau First Nations; West Moberly First Nations; Dene Tha' First Nation; Duncan's First Nation; Horse Lake First Nation; Métis Nation British Columbia and Kelly Lake Métis Settlement Society.

- Focussed consultation on river diversion and inundation, in recognition of the potential trauma these activities may cause in part due to the filling of Williston reservoir in 1960s;
- Heritage inspections and artifact collection and preservation;
- Establishment of an Indigenous Traditional Use Fund to fund projects identified by Indigenous groups; and
- Relationship initiatives, with Indigenous Nations who have a Relationship Agreement with BC Hydro.

Table 42 below summarizes the consultation activities undertaken during construction.

Table 42 Summary of Consultation Activities During Site C Construction

Initiative	Activity	Detail
Forums and Committees	**Permitting and Environmental Forums**	Representatives from 13 Indigenous Nations work with BC Hydro to address environmental uncertainties, incorporate Indigenous values and interests into mitigation and monitoring programs, and discuss upcoming permitting requirements. The Forum has met 36 times since May 2018.
	Cultural & Heritage Resources Committee	Identification of potential impacts and mitigation measures, identification and naming of key cultural sites, documenting historical use of the area, and commemoration of sites lost to inundation. The Cultural and Heritage Resources Committee has met 35 times since July 2015.
	Site C Cultural Centre	Initiated by the Cultural and Heritage Resources Committee as a legacy project to further offset Project impacts to cultural resources. The vision is for the Centre to be a place where Indigenous people can gather and teach their culture, and where others can come to learn about it. Construction is scheduled to begin in 2025 and the Centre is expected to be open to visitors in 2027.
Project Updates	**Quarterly Project Update and Joint Working Group Meetings**	Quarterly Project Update meetings and regular Joint Working Group meetings.

Initiative	Activity	Detail
Field-Based Initiatives	**Cultural Monitoring**	Cultural monitors participated in several field work activities including archeological work and wildlife surveys. In advance of reservoir filling, cultural monitors were on-site at construction areas to observe, record, and report on impacts to vegetation, wildlife, traditional use features, archaeological sites, and other possible topics of concern. As of June 2024, members from seven Indigenous Nations participated and more than 7,317 person-days of monitoring have been undertaken since the program began. Monitors were also involved through the reservoir filing process.
	Ground-Truthing and Harvesting	Throughout construction, BC Hydro initiated ground truthing programs in advance of activities to engage Indigenous land users in verifying and accurately locating specific areas of use and interest and to identify any concerns related to specific features or sites that might be affected by the Project.
	Pre-Reservoir Filling Boat Tours	Halfway River First Nation (two tours), Saulteau First Nation (two tours), Blueberry River First Nation (three tours), Prophet River First Nation (one tour), McLeod Land Indian Band (one tour), Doig River First Nation (one tour, two site-specific boat visits), Site C Environmental Monitors (one tour), and Site C Cultural Monitors (one tour).
	Site C Highway 29 Tour	Halfway River First Nation (one tour), Blueberry River First Nation (four tours), Doig River First Nation (one tour), and Site C Environmental Forum (one tour).
	Site C Reservoir Filling Community Open Houses	Held in five Indigenous Nation communities.
	Site C Damsite Tours	In 2023-2024, prior to reservoir filling, several tours were conducted including: McLeod Lake Indian Band (one tour), Blueberry River First Nation (two tours), Saulteau First Nation (two tours), Doig River First Nation (two tours), Cultural Monitors, and Site C Environmental Forum (two tours).
Communication Initiatives	**Construction Bulletins**	Since 2015, BC Hydro has provided Indigenous Nations with a quarterly news bulletins of recent and upcoming Project work over the reporting period.
	Bi-Weekly Update	Email updates to Indigenous Nations that includes information on permitting and regulatory items, project schedule, and upcoming meetings. Since April 2016, 176 updates have been shared.[70]
	Indigenous Relations Site C	The Project website has a designated Indigenous Relations page providing information on consultation and engagement opportunities.

[70] In January 2024, reporting shifted from bi-weekly to monthly.

Initiative	Activity	Detail
	Community Meetings/Open Houses	In-community events tailored to the needs of each Indigenous Nation have been held or offered. At these meetings, Project information is shared through visuals, handouts, presentations, and one-on-one discussions.
	Video	Multiple video projects have been completed providing information on the Project and showcasing the history and rich culture of Indigenous Nations in the Peace Region.

In addition to these consultation and engagement activities, BC Hydro has provided directed procurement to Indigenous businesses, and training, education, and employment benefits to Indigenous individuals. Over $847 million in Site C directed procurement opportunities have been awarded to companies designated by Indigenous Nations since the beginning of the Project. This work has promoted the growth of Indigenous businesses, in some cases allowing them to expand the scale of their operations and develop new expertise to compete in the regional economy. Over 4.7 million hours of work were undertaken on the Project by people who self-identified as Indigenous, including 447,000 apprentice hours across 10 trades.

8.1.3 2017 Site C Inquiry

The Site C Inquiry, initiated in August 2017 and concluded in December 2017, was a review conducted by the Commission at the direction of the Government of B.C. to assess whether to continue the construction of the Project.[71] Indigenous Nations were invited to participate through written and oral submissions to the Commission. The Commission also held public hearings in Prince George, Vancouver, and Victoria. Several Indigenous Nations and individuals participated, including the West Moberly, Prophet River, McLeod Lake, and Mikisew Cree First Nations.[72]

[71] Order in Council No. 244 (**OIC**), section 2.
[72] Exhibit A-24, Site C Final Report, page 29.

8.1.4 Agreements with Indigenous Nations

BC Hydro has entered into Impact Benefit Agreements with eight Indigenous Nations, all of whom are signatories to Treaty 8. This includes six Nations located in B.C. and two in Alberta.[73] Through these agreements, these Nations have confirmed that, on a going forward basis, they do not oppose or object to the Project and that they have been adequately consulted and accommodated in relation to the impacts of the Project on their section 35 rights. These agreements were the result of extensive collaboration among BC Hydro staff and leadership, the Government of B.C., and Indigenous Nations.

With respect to the B.C. Nations, the agreements provide the Nations with lump sum payments, annual payment streams, and contracting opportunities. They also provide for the transfer of land in fee simple, as well as land protection measures intended to directly address concerns raised about the cumulative impacts to land available for the exercise of rights and preservation of way of life.

8.2 Issues Raised by Indigenous Nations and How BC Hydro Has Responded

The key issues raised by Indigenous Nations and BC Hydro's response to these issues are summarized in the sections below.[74]

8.2.1 Need and Alternatives

The need for, and alternatives to, the Project were significant topics throughout the environmental assessment process and various legal challenges, and the subject of

[73] BC Hydro has entered agreements with Doig River, Halfway River, McLeod Lake, Saulteau, Prophet River, West Moberly, Duncan's, and Dene Tha' First Nations.

[74] Given the length, depth, and breadth of consultation with respect to the Project, this summary is not intended to be exhaustive. The issues, concerns and interests identified by First Nations are described in various places, including an issues tracking table in the Environment Impact Statement (**EIS**) (EIS Volume 1, section 9, Appendix H), the EIS appendices on Indigenous Nations, the Joint Review Panel report, the Federal/Provincial Consultation and Accommodation Report, and the various court cases.

consultation throughout the Project lifecycle. These issues were also considered as part of the Commission's Site C Inquiry in 2017.[75]

Some Indigenous Nations raised questions about whether the Project was needed and would result in surplus power, or whether the need for power could be met through other alternative energy sources, such as wind, solar, geothermal, gas-fired generation, or upgrading existing generating facilities closer to the Lower Mainland.

BC Hydro provided capacity funding to Treaty 8 Nations interested in this issue to retain their own experts, and BC Hydro met with the Nations' expert on multiple occasions and responded to their reports. Indigenous Nations also presented to the Joint Review Panel and to the Commission on this issue.

8.2.2 Impacts to Wildlife

Hunting and trapping are important to Indigenous Nations in northeast British Columbia. The impact of the Project on ungulates and ungulate habitat were among the central issues raised by Indigenous Nations. There were also concerns raised around impacts to wildlife primarily related to flooding important habitat features such as calving grounds, dens, and nesting trees, and overall reduction of suitable habitat.

To avoid, reduce, or offset the potential impacts of the Project on wildlife, several enhancement programs are being implemented, including initiatives for eagles, bats, fishers, snakes, birds, and wildlife tree creation.[76] Enhancement sites have been visited through various tours. Ungulate movement monitoring is ongoing through the Indigenous Traditional Use Fund, a $13 million fund established to mitigate the impacts of the Project and help preserve land and resources for traditional use. A multi-Nation project, including habitat enhancement on an island in the reservoir, is

[75] Submissions from Indigenous Nations during the 2017 Site C Inquiry are available on the Commission website: https://www.bcuc.com/OurWork/SiteC

[76] More information on BC Hydro's Wildlife and Vegetation Mitigation Programs for Site C can be found here: https://www.sitecproject.com/wildlife-and-vegetation

also underway and an Indigenous Nation-led beaver harvest was implemented in spring 2023.

Targeted mitigation measures have also been implemented, such as establishing an ungulate winter range on BC Hydro lands and scheduling diversion and inundation activities to bird nesting and bear denning periods.

8.2.3 Impacts to Fish and Fish Habitat

The effect of the Project on fish and fish habitat arising from the damming of the Peace River and the conversion of riverine habitat to a reservoir were significant issues of concern for Indigenous Nations, and a focus of consultation.

The transformation of a stretch of the Peace River to a reservoir will affect the composition of fish populations. Indigenous Nations have expressed concerns about the viability of fish habitat in the reservoir for riverine species, and the continued ability to fish there.

BC Hydro undertook significant analysis of the change in fish habitat and is implementing mitigation measures including fish passage and creating fish habitat both upstream and downstream of the dam. This issue was thoroughly consulted on during both the environmental assessment and construction, in relation to the *Fisheries Act* authorization and associated offsetting and mitigation plans. An extensive fish monitoring and enhancement program covers the reservoir, tributaries, and downstream habitats. BC Hydro has organized field tours of the fish passage facilities, as well as fish habitat restoration and enhancement sites.

Starting with the installation of cofferdams for river diversion and continuing into operations with the permanent dam, the Project interferes with fish passage both upstream and downstream of the dam. This has the potential to adversely effect fish populations, particularly bull trout.

BC Hydro constructed a temporary fish passage facility for river diversion and a permanent facility for use in operations. Indigenous Nations were actively involved in the process, contributing to the development of the approach. BC Hydro's consultation also provided increased awareness of fish passage and its efficacy. BC Hydro also constructed fish habitat as part of its commitments under the *Fisheries Act* authorizations for the Project that offset residual impacts, in consultation with Indigenous Nations.

Indigenous Nations were also concerned about the potential for fish in the Site C reservoir to be contaminated with methylmercury and be unavailable for consumption.[77]

BC Hydro, on its own and through the Fish and Wildlife Compensation Program, undertook significant studies of the presence of methylmercury in fish in the existing reservoirs (Williston and Dinosaur), and retained independent experts to predict methylmercury levels in fish in the Site C reservoir, and any corresponding impacts on human health. BC Hydro also:

- Provided funding to Indigenous Nations to collect information on fish consumption and traditional foods;
- Established a Methylmercury Sub-Committee, focusing on education and community-led initiatives such as communication tools regarding safe fish consumption;
- Discussed methylmercury at the Environmental Forum, at community open houses,[78] and methylmercury-specific training sessions; and

[77] Methylmercury, an organic form of mercury, is created when microorganisms that live in aquatic environments react with the inorganic mercury that exists naturally in soil and plants. Once formed, methylmercury enters the food chain. More information about the Methylmercury Program is available on the Project's website: https://www.sitecproject.com/methylmercury-program.

[78] Doig River First Nation, and Saulteau First Nation

- Funded the training of “community champions” within each of the 13 Indigenous Nations affected by Site C, to provide expertise in fish sampling and preservation for methylmercury analysis.

Indigenous Nations also participate in decision making regarding monitoring plans and are actively engaged in community-based fish sampling programs.

8.2.4 Impacts to Heritage Resources Including Burials

Indigenous Nations expressed concern over the loss of heritage sites within the Project footprint and were particularly concerned that the Project footprint contained unmarked burials that would be inundated.

The Project area has been extensively studied for heritage resources. BC Hydro’s archaeological work began around 2008 and carried on throughout construction. Indigenous Nations were involved in the development of the archaeological model that guided the work and were invited to participate as cultural monitors from the outset. In addition, funding was provided to some Indigenous Nations so they could conduct their own studies.

BC Hydro also undertook extensive work with Indigenous Nations to identify potential burial sites. This work, which was funded by BC Hydro and was Indigenous-led, included Traditional Land Use Studies, community assessments, ground-truthing, and extensive engagement. Mitigation options for sites identified in or near the reservoir area were reviewed and approached collaboratively with Nations and included changes to the design of the Cache Creek Highway realignment to avoid an area of cultural sensitivity. Permits were issued based on the consultation undertaken.

The Cultural and Heritage Resources Committee also met regularly to identify measures for sites not covered by the *Heritage Conservation Act*. In total, 43 Site-Specific Mitigation Plans were developed by the Committee.

8.2.5 Cumulative Effects and Inundation of Land

One of the main concerns for Indigenous Nations was the cumulative effect of a third dam on the Peace River, as well as the effect of the Project in combination with other resource projects and developments in the region. There was also concern regarding the specific effects of inundation, due largely to the experience when the Williston reservoir was created.

The issue of cumulative effects was thoroughly canvassed in the environmental assessment process, including by the Joint Review Panel. BC Hydro's agreements with Indigenous Nations include both land and land protection measures intended to address, in part, cumulative effects of the Project. In relation to inundation, BC Hydro organized extensive consultation around both river diversion and inundation in recognition of the sensitivity of these events to Indigenous Nations. This work involved community meetings, technical sessions, and educational materials, aimed at building trust and transparency.

8.2.6 First Nations Court Challenges

Several First Nations commenced court proceedings regarding the Project, including challenges to the adequacy of the consultation process leading to the environmental assessment approvals, the Project Water Licences, and other proceedings, all of which were resolved by agreement or court decisions. In their decisions, the courts concluded that consultation was deep, meaningful, and adequate.

8.3 Lessons Learned – Indigenous Consultation

This section describes the four lessons learned from the Project regarding Indigenous Consultation.

8.3.1 Lesson IC1: Enable Early Consultation and Streamline Ongoing Engagements, Including Use of Permitting and Environmental Forums

Lesson IC1 is to enable early consultation and streamline ongoing engagements, including use of permitting and environmental forums. The Project engaged Indigenous Nations from a very early period and throughout construction of all elements of the Project. Permitting and Environmental forums were a helpful means of coordinating engagement among Indigenous Nations, project personnel and subject matter experts.

Structured, regular engagements played a key role in building strong relationships. Following issuance of the Environmental Assessment Certificate and the Federal Decision Statement, the Project team worked with 13 Indigenous Nations and invited them to quarterly meetings, which provided opportunities to engage on a range of topics and to receive project updates. These meetings enabled holistic dialogue and created a valuable forum for collective feedback, fostering relationships, and obtaining alignment on project activities. Opinions and feedback gathered during these sessions were shared with the Project team and incorporated into the Project.

Additional effective strategies included the use of multi-Nation forums with clear Terms of Reference to focus on specific subject areas such as environmental matters and culture and heritage initiatives. These forums created an opportunity to bring together multiple Nations to engage on important issues together. For example, Nations were able to provide ongoing input and participate in environmental programs designed to manage values important to them, such as wildlife measures and reclamation planning.

At one stage, the appointment of a neutral facilitator selected by Indigenous Nations further enhanced the effectiveness of meetings, and assisted in navigating sensitive topics, and supporting the development of governance structures and Terms of Reference. This approach contributed to building trust in a culturally sensitive

manner in circumstances where the Indigenous Nations had different perspectives. For future projects, the establishment of regular, structured engagement forums, and a neutral facilitator, when appropriate, can improve collaboration, strengthen relationships, and ensure more effective and respectful consultation with Indigenous Nations.

Early consultation with Indigenous communities was key to effective project planning. This included learning about culturally sensitive areas.

The use of rendered drawings was a valuable tool. Rendered drawings were used to help Indigenous Nations visualize what the area would look like after the reservoir was flooded. The use of such visual tools during consultations assisted in providing a better understanding of the Project and how it would look. This led to more informed discussions and input.

Timelines and scheduling for the Project required careful management. As part of consultation, BC Hydro actively communicated schedules early, clearly, and repeatedly. Specific timing requirements were explained at the outset to avoid misunderstanding and support more constructive discussion.

Table 43 below provides some specific considerations which are intended to support future project teams as part of this lesson learned.

Table 43 Lesson IC1 - Specific Considerations

#	Consideration
IC 1.1	Leverage project update meetings to streamline engagement.
IC 1.2	Use multi-Nation forums, with clear terms of reference, to engage on subject areas, such as environmental matters and culture and heritage initiatives.
IC 1.3	Support multi-Nation project engagement forums at times through use of a neutral facilitator.
IC 1.4	Engage early on culturally sensitive sites to inform planning and design.
IC 1.5	Facilitate a coordinated approach involving all relevant Project groups.
IC 1.6	Enhance communication through use of visual tools such as rendered drawings showing future states.
IC 1.7	Ensure frequent and transparent communication about project timelines.

8.3.2 Lesson IC2: Create Environmental and Cultural Monitoring Programs from the Start of the Project.

Lesson IC2 is to create environmental and cultural monitoring programs from the start of the project.

Environmental and cultural monitoring played a vital role throughout the Project. By actively involving Indigenous Nation community members in identifying potential risks and shaping culturally appropriate mitigation strategies, the environmental and cultural monitoring programs supported the protection of community health and the preservation of cultural traditions.

As a requirement of the Project and as part of the Environmental Assessment process, BC Hydro created a Culture and Heritage Resources Committee. This Committee brought together members from the 13 Indigenous Nations affected by Site C to discuss mitigation measures for impacts to culture and heritage resources. For future projects with similar committees, a dedicated budget should be established early on to enable proactive planning, transparency, trust, and implementation of initiatives in collaboration with Indigenous Nations.

The establishment of an Indigenous Traditional Use Fund was a successful tool in mitigating impacts to Indigenous Nations by enabling Nations to fund their own

initiatives. For example, a study was initiated to monitor for potential impacts to wildlife corridors from the reservoir in response to concerns of some Nations. The experience with an Indigenous Traditional Use Fund has been positive, creating an accessible program for Nation-led initiatives available to all Nations affected by the Project, with varying capacities, concerns, and interests.

Through the development phase of the Project, opportunities to involve Indigenous Nations in the planning and delivery of certain project components (particularly those most closely related to their interests) proved to be very meaningful and mutually beneficial. Two key examples include the cultural monitoring program and environmental forums.

BC Hydro employed Indigenous Nations on a full-time basis as part of a cultural monitoring program to observe and provide feedback on various aspects of Project construction. This program helped BC Hydro to gain real-time feedback, reflect Indigenous perspectives, build Indigenous awareness among project workers, and enhance transparency around BC Hydro's activities for Indigenous Nations. The cultural monitoring program for the Project was one of the largest ever implemented on a BC Hydro project and provides a model for future initiatives.

A notable aspect of the cultural monitoring program for the Project was to involve contractors in coordinating work with Cultural Monitors. For example, a contractor involved in road construction helped facilitate access for ceremonial activities, such as the removal of an eagle's nest. This coordination allowed for effective communication and cultural sensitivity. Cultural Monitors were welcomed as part of the operation, and their input was valued and considered in the Project's execution.

Cultural Monitors also played an important role in the discovery and respectful treatment of culturally significant materials on Site C. This included providing valuable insight and guidance regarding knowledge and practices. For example, when feathers were discovered in various work areas, they were initially stored with

the province following historic wildlife permit processes. Through engagement with Indigenous partners and Cultural Monitors, it was suggested that these feathers be offered to the local Indigenous Nations community after meeting documentation requirements in the permit. This initiative gave the feathers a meaningful cultural use and fostered stronger working relationships between the Project and Indigenous Nations. By respecting and integrating such practices, the Project strengthened its commitment to cultural collaboration and mutual respect. Future projects should be prepared for such discoveries and have clear, culturally appropriate plans in place.

Clear and timely communication was also critical to the cultural monitoring program. For example, integrating Cultural Monitors into construction planning and scheduling contributed to a respectful working environment and avoided disruptions. It was particularly important for Cultural Monitors to be aware of any changes in construction methods or schedule to assess potential implications for Indigenous Nations. Providing advance notice of site visits was also important to maintain safety and avoid overcrowding at active work zones.

Cultural monitoring programs should be established at the start of future projects and maintained throughout construction to support consistent, respectful engagement. Early involvement enables participation of cultural monitors that more closely aligns with the construction schedule, as well as affording time to explain the program’s intent to both project teams and contractors.

A multi-Nation forum was also established for information sharing and engagement on the Project’s environmental programs and practices. Through this venue, Indigenous Nations could provide ongoing input and participate in environmental programs designed to manage values most closely aligned with their rights and interests such as wildlife measures and reclamation planning.

An example at Site C was the development of a methylmercury program with input from Indigenous Nations. The initiative raised awareness, developed communication

tools, and supported a Nation-led sampling program with community training. This program enabled Nation representatives to gather data and better understand methylmercury levels, while also providing opportunities to build trust and strengthen relationships.

Table 44 below provides some specific considerations which are intended to support future project teams as part of this lesson learned.

Table 44 Lesson IC2 - Specific Considerations

#	Considerations
IC 2.1	Build early funding capacity to support elements such as the Indigenous Traditional Use Fund and fulfillment of Environmental Assessment Certificate conditions.
IC 2.2	Implement a cultural monitoring program (initiated at the outset of a project, clearly communicated to all teams, and actively supported by contractors).
IC 2.3	Involve cultural monitors to help identify and address culturally significant materials.
IC 2.4	Foster involvement and meaningful input into environmental programs and approaches. Implement environmental forums for information sharing and engagement on the project.

8.3.3 Lesson IC3: Plan for and Build Support for Indigenous Procurement Opportunities

Lesson IC3 is to plan for and build support for Indigenous procurement opportunities. Efforts to support Indigenous procurement opportunities evolved over the duration of the Project. As the Project progressed, BC Hydro recognized the need for a greater emphasis on planning and building support for Indigenous procurement opportunities as early as practicable.

Planning for and building support for Indigenous procurement opportunities proved to be a valuable aspect of BC Hydro's relationship with Indigenous Nations, and a manner of providing economic accommodation.

For many Indigenous Nation owned and designated businesses, the Project was the first opportunity to engage on a BC Hydro project. As a result, the procurement team, with support from BC Hydro's Indigenous Relations Key Business Unit had to

build relationships through discovery meetings and open dialogue with Indigenous Nations to walk through potential scopes of work and procurement processes. The approach enabled many Indigenous businesses to develop the awareness, skills, and experience necessary to participate in Site C contracts and to compete for work beyond BC Hydro projects.

Using targeted direct awards, Indigenous Nation businesses were able to secure contracts directly, build capacity, increase revenues, and as a result, take on more complex construction work as the Project progressed. The direct award process, which included detailed cost estimate comparisons, site visits, and collaborative scope discussions, allowed for transparent negotiations and competitive pricing.

Establishing a clear negotiation schedule and preparing a defensible estimate for the work were critical to reaching successful agreements with Indigenous businesses.

A dedicated Indigenous Relations lead and on-site coordinator helped to manage relationships and facilitate communication. Contractor resources were required to coordinate and implement Indigenous inclusion plans. For future projects, consideration should be given to strengthening contractual terms to improve fulfillment of such commitments.

Examples of successful tools used to enhance Indigenous procurement included:

- An Indigenous Nations business directory was created to help identify qualified vendors and promote Indigenous procurement. The tool provided a searchable view of services and equipment available from Indigenous businesses;
- Scoping documents were also developed to clearly communicate procurement opportunities, allowing Indigenous Nations to assess whether opportunities were suitable for their businesses; and

- A procurement dashboard was used to support quarterly reporting to Indigenous Nations on the status of procurement spending. This allowed Indigenous Nations to track progress and identify future opportunities.

Table 45 below provides some specific considerations which are intended to support future project teams as part of this lesson learned.

Table 45 Lesson IC3 - Specific Considerations

#	Consideration
IC 3.1	Initiate early planning for Indigenous procurement strategies, opportunities, and processes.
IC 3.2	Invest in key resources to work with Indigenous Nations and help support procurement opportunities.
IC 3.3	Strengthen contractual provisions to help enforce contractor procurement commitments.
IC 3.4	Develop tools to enhance communication and improve access to opportunities.
IC 3.5	Seek to align expectations and opportunities with capabilities and interests.

8.3.4 Lesson IC4: Support Training and Employment Opportunities for Indigenous Workers and Indigenous Awareness Training for all Project Resources

Lesson IC4 is to support training and employment opportunities for Indigenous workers and Indigenous awareness training for all project resources. Major capital projects present unique opportunities to support the training and engagement of Indigenous workers. In addition, fostering awareness of Indigenous concerns creates a supportive and respectful workplace.

The Project took steps to establish training and employment opportunities for Indigenous workers early in Project development and construction. For example, a $1 million investment into trades training at Northern Lights College helped support students from northern B.C., with half of the funding reserved for Indigenous students. The funding was provided over a five-year period to support the development of skilled workers and targeted those students who may otherwise not have access to post-secondary education. For future projects, such initiatives could be enhanced by helping to connect participants with potential job opportunities after

graduation. For example, a tracking system for training and scholarship recipients could be established to monitor progress, support ongoing communication, and increase employment outcomes.

A focus on mentorship programs for Indigenous apprentices was effective in helping new workers transition into the construction environment. This program contributed to a respectful workplace and promoted constructive working relationships.

Indigenous awareness training should be embedded as a core component of onboarding to the workplace from the beginning of future projects. The Project introduced an Indigenous Awareness Training module about midway during the Project and not all personnel, including contractors and subcontractors, were required to complete the training. In addition, site orientation for new workers had limited Indigenous Awareness Training. This knowledge gap sometimes led to misunderstandings and challenging conversations. BC Hydro should have done more to ensure workers received adequate Indigenous awareness training.

Providing early and ongoing Indigenous awareness sessions will help to create a shared understanding of the local Nations' histories, cultures, and values and build a more inclusive work environment that contributes to a respectful workplace where Indigenous workers and partners feel welcomed and better understood.

Table 46 below provides some specific considerations which are intended to support future project teams as part of this lesson learned.

1 **Table 46 Lesson IC4 - Specific Considerations**

#	Considerations
IC 4.1	Develop a communication and engagement plan to promote opportunities for scholarship or bursaries recipients.
IC 4.2	Promote mentorship opportunities to help introduce new workers to the workplace.
IC 4.3	Assign an on-site resource to help develop training and employment opportunities and support Indigenous workers.
IC 4.4	Provide mandatory Indigenous awareness training at the start of the project and for onboarding new workers.

9 Community Engagement

This section addresses Community Engagement. It describes the engagement activities that occurred with members of the public from impacted communities prior to and during construction activities and explains how decisions made with respect to issues raised by the public were addressed throughout the project lifecycle. This section also explains lessons learned with respect to community engagement.

The Project was responsive and proactive in response to stakeholder inquiries and concerns. A dedicated engagement team, with representation on the Project leadership team, supported the identification and resolution of issues raised through engagement. Future major projects should continue with these approaches.

This section is organized as follows:

- Section 9.1 explains BC Hydro's stakeholder engagement activities before construction began in 2015, and how these activities helped to inform and refine early Project design and studies;
- Section 9.2 explains that BC Hydro's stakeholder engagement activities during the construction period were undertaken with a principled approach that allowed BC Hydro to meaningfully respond to issues raised; and
- Section 9.3 describes the four lessons learned from the Project regarding Community Engagement:
  - **Lesson CE1:** Plan and implement responsive stakeholder engagement early and maintain throughout the project lifecycle;
  - **Lesson CE2:** Adapt organizational structures for stakeholder engagement to the evolving scale and duration of the project;
  - **Lesson CE3:** Adopt varied and responsive communications channels over the project lifecycle; and

- **Lesson CE4:** Use technology and tools to enhance stakeholder engagement.

9.1 Pre-Construction Public and Stakeholder Engagement

Prior to commencing Project construction, BC Hydro led an extensive public consultation process that included hosting or participating in more than 500 engagement events such as presentations, local government meetings, open houses, and other community events across the Peace Region and beyond. These sessions provided opportunities for residents, local organizations, and interest groups to learn about the Project, ask questions, and provide feedback on key aspects such as environmental impacts, land use, and community benefits.

The engagement also included targeted outreach to property owners and leaseholders in the Project area to address specific concerns and gather input on mitigation measures.

BC Hydro also maintained active communication with local and regional governments. This included regular updates, briefings, and consultations so that municipal and regional leaders were informed and had opportunities to provide input on Project planning and community impacts. Area-specific consultations were also held to address local issues as they arose so that the Project could consider and respond to the unique needs of different communities.

BC Hydro also responded to approximately 3,000 inquiries received via email, in-person at the consultation offices, or through written submissions.

Early feedback gathered through BC Hydro-led consultation was used, along with technical and financial input, to refine elements of Project's design and Project studies. This early public and stakeholder consultation input was also considered by BC Hydro to develop its Environmental Impact Statement.

9.2 Public and Stakeholder Engagement During Construction

BC Hydro's stakeholder engagement activities during the construction period were guided by the following principles:

- Upholding a safety-first culture for the people working on the Project and for people living and travelling near construction sites;
- Striving to minimize construction-related impacts to residents, businesses, property owners, communities, and Indigenous groups in the Project area;
- Informing and notifying Peace region residents, businesses, property owners, communities, and Indigenous groups about Site C construction activities and schedule;
- Fostering a two-way dialogue with Peace River region residents, businesses, property owners, communities, and Indigenous groups to ensure BC Hydro was aware of local interests, issues, and concerns; and
- Promoting business and job opportunities for local, regional, and Indigenous companies and workers during Site C construction.

These principles were implemented through various engagement methods, including through digital platforms, photos and videos, construction communications, business participation programs, and community measures agreements.

9.2.1 Digital Communication and Engagement Methods

In 2013, BC Hydro launched a stand-alone website for the Project (www.sitecproject.com). Web content included a Project overview, updates on construction activities, environmental management and monitoring, news, a photo and video gallery, and employment and contracting activities.

BC Hydro launched ***@sitecproject*** in 2013 as the official Twitter (now X) channel for the Project. As of October 15, 2025, ***@sitecproject*** had about 1,500 followers and

had issued a total of 1,350 posts on the channel. The account was used to share updates on a variety of Project related topics including public advisories and notifications related to safety, traffic disruptions, construction, upcoming open houses and meetings, procurement opportunities, and construction milestones.

The Site C Environmental Assessment Certificate required the implementation of construction communications and business participation programs throughout the construction period.[79] This helped inform the public, local governments, Indigenous groups, stakeholders and employees about upcoming construction activities and business and procurement opportunities.

The Project issued quarterly construction notification letters via email to local Indigenous Nations, local governments, and key stakeholders that provided updates on Project status and offered a three-month look ahead of significant upcoming construction activities. All quarterly construction notification letters are posted on the Site C website.[80]

BC Hydro issued bi-weekly construction updates and bulletins to voluntary Site C email subscribers and local media that provided an update on work currently taking place at different Project areas and notable upcoming activities. Updates were also shared on the Site C Twitter account and posted to the Site C website. All bi-weekly construction updates and bulletins since 2015 are posted on the Site C website.[81]

The Project team regularly issued notifications and advisories for any upcoming construction work taking place that would impact the local communities. Examples include advisories for reservoir debris burning, traffic disruptions, heavy equipment transportation, and localized work that may lead to increased noise or dust.

[79] The Site C Construction Communication Plan was developed in accordance with the Conditions 39, 43 and 72 of the Site C Environmental Assessment Certificate

[80] https://www.sitecproject.com/construction-activities/construction-bulletins.

[81] https://www.sitecproject.com/construction-activities/construction-bulletins.

Construction advisories are issued via targeted email, shared with local governments and media, and posted on social media and on the Site C website.

The section of Highway 29 between Fort St John and west to Hudson's Hope was a major Project construction area. Temporary road closures required notification via newspaper, radio, and social media for the construction of nearly 30 kilometres of realigned highway and five new bridges. In May 2023, to prepare residents in the region for reservoir filing, open houses were held in Fort St. John and in Hudson's Hope, followed by a virtual open house.

In May 2024, following the decision to maintain the original reservoir filling milestone date, two more open houses in Fort St. John and Hudson's Hope were held to ensure residents had a further opportunity to meet with BC Hydro staff to better understand the process and anticipated impacts of reservoir filling. In early August 2024, pre-reservoir filling emails were sent to landowners along the Peace River, elected officials, and media as the expected start of filling approached. On the day filling started, a notice was sent to the same list of stakeholders and a news release was issued for province-wide coverage. Further updates followed through an 11-week period and concluded when the reservoir was declared full on November 7, 2024.

Monthly employment figures were posted on the Project website and issued to the media. A high-level summary of employment statistics was also shared during quarterly Regional Community Liaison Committee meetings.[82]

[82] BC Hydro established the Regional Community Liaison Committee (RCLC) during Project construction to foster dialogue between BC Hydro, Peace region municipal and regional government officials, Peace region provincial government officials and Indigenous groups. The RCLC is an advisory forum for members to receive information about project construction, mitigation, and compliance reporting, and to bring forward community interests, issues, and concerns about the Project. The RCLC met, most often quarterly, from March 2016 to November 2024 holding 34 regular meetings both in-person and virtually. The RCLC was the successor to the pre-construction Regional and Local Government Liaison Committee.

9.2.2 Community Relations Team

The Project had a dedicated Community Relations team that fostered and maintained strong relationships with local communities, stakeholders, and the public throughout the planning and construction of the Project. Key responsibilities included organizing public engagement events, responding to community inquiries, hosting stakeholder site tours, delivering presentations, and managing media relations.

Throughout the Project, the majority of the Community Relations team was based in Fort St. John, operating out of the Site C Community Consultation Office, which served as a central hub for public engagement and information sharing.

The Fort St. John Site C Community Consultation Office was established in 2008, followed shortly by a second office in Hudson's Hope to provide direct, accessible points of contact for the public. The Fort St. John office has remained open throughout the planning and construction phases of the Project. The Hudson's Hope office was closed in 2017.

The Community Relations team received and logged approximately 15,000 public enquiries regarding employment and business opportunities, Project construction and general enquiries. Responses were sent within 24 hours when possible. Inquiries were tracked and reported to the Regional Community Liaison Committee.

During construction, local governments, regional Members of the Legislative Assembly, and Indigenous Nations were invited to send representatives to the Regional Community Liaison Committee. This committee met to provide regular two-way communications between the Project, local governments, and Indigenous Nations.

The Project also maintained a regular presence at the Peace River/Williston Reservoir Advisory Committee, a regional body that has reported to the BC Hydro Board of Directors since 1989. The Peace River/Williston Reservoir Advisory

Committee consists of local representatives from most of the incorporated communities in the Peace River region and Mackenzie, the largest community on the Williston Reservoir.

Interest in Site C throughout construction has been significant. Requests for site tours from Indigenous Nations and all levels of government and related agencies have numbered in the hundreds. To respond to local public interest, the Project provided dozens of presentations to local Chambers of Commerce, Rotary clubs, schools, and other organizations during construction.

Media requests for Project updates were routine, most often received in connection to milestone events, such as river diversion, completion of the dam, bridge replacements, and highway realignments. Natural events such as earthquakes, wildfires, or storms often prompted media calls seeking information on how the Project was managed under those conditions.

9.2.3 Community Measures Agreements

BC Hydro voluntarily entered into Community Measures Agreements with several municipalities and the Peace River Regional District as part of the Project. BC Hydro's objective in negotiating Community Measures Agreements was to develop mitigation approaches to address unique impacts arising from the Project in cases where there were no existing mitigation measures or Environmental Assessment Certificate or Federal Decision Statement conditions already in place.

Community measures agreements were entered into with:

- District of Chetwynd (2013);
- District of Taylor (2014);
- City of Fort St. John (2016);
- District of Hudson's Hope (2017); and

- Peace River Regional District (2024).

The Project also entered into the Regional Legacy Benefits Agreement between BC Hydro and the Peace River Regional District.

9.2.4 Key Issues Raised During Construction

Several key issues were raised during the construction of the Project including issues related to the COVID-19 pandemic, concerns from residents in Old Fort regarding dust from construction activities, woody debris management and the Hudson's Hope Water Treatment Plant.

BC Hydro began monitoring the emergence of COVID-19 in January 2020, and took proactive steps to respond as the virus spread. On March 18, 2020, BC Hydro announced modifications to on-site work activities at the Project to help limit the spread of the virus. BC Hydro also launched a dedicated COVID-19 information page on the Site C website.

Throughout the COVID-19 pandemic, BC Hydro maintained proactive communication with local elected officials and Indigenous Nations, sharing updates on each new positive case through direct outreach and the Project's website. This was in addition to the regular phone calls and weekly update emails being sent to the Regional Community Liaison Committee.

In late June 2022, BC Hydro started receiving complaints from residents in the community of Old Fort about dust from construction activities at the main dam site when work to complete the earthfill dam was at its peak. The community of Old Fort is a small, rural locality within the Peace River Regional District and is located about five kilometers downstream of the Site C dam site. There are about 50 residences in the community. BC Hydro responded to these concerns by increasing dust suppression activities around the dam site.

Old Fort residents also raised concerns about construction-related noise, traffic, road safety, and property value impacts following landslides in 2018, and 2020, that were not related to the Project. Dust issues stemmed mainly from dam site work, but nearby fish habitat enhancement activities also contributed. In response, BC Hydro held a community meeting in July 2022 to address concerns and committed to more transparent and frequent communication and to sending updates on dust control, traffic, and construction to residents.

As part of the reservoir tree and vegetation clearing program, BC Hydro burned non-merchantable wood and debris. BC Hydro communicated to residents in the region about these activities via advertising in newspapers, on radio, online platforms, and email. Links were provided to supporting materials regarding debris and smoke management.

In the early stages of the Project, BC Hydro committed to mitigating the effects of the Site C dam and reservoir on the District of Hudson's Hope infrastructure, including its water treatment plant.

The District of Hudson's Hope decided to build a well system instead of replacing the existing surface water system like-for-like. As part of the agreement, the District of Hudson's Hope took full responsibility for the design, procurement, and construction of the new plant. BC Hydro agreed to fund the construction, which amounted to approximately $5 million.

After the new well system became operational in March 2021, it faced several issues, including multiple failures in 2022, prompting BC Hydro to provide approximately $1 million to the District of Hudson's Hope for emergency response and a temporary water supply. In fall 2022, the District of Hudson's Hope launched a three-phase plan to switch its water source back to the Peace River, and by early 2023, BC Hydro agreed to fund the first two phases. A temporary surface water intake and treatment upgrades are now supplying potable water, and in

September 2024, BC Hydro committed to completing the permanent system and covering rental costs for a clarifier. A Memorandum of Understanding was signed in December 2024. Negotiations for a final agreement are ongoing.

9.3 Lessons Learned – Community Engagement

This section describes the four lessons learned from the Project regarding Community Engagement.

9.3.1 Lesson CE1: Plan and Implement Responsive Stakeholder Engagement Early and Maintain Throughout the Project Lifecycle

Lesson CE1 is to plan and implement responsive stakeholder engagement early and maintain throughout the project lifecycle.

BC Hydro's well-developed community engagement practice for capital projects provided a foundational framework for the expansive effort required for the Project, including the substantive environmental review process prior to construction.

BC Hydro's community engagement over the course of the Project was consistent with established guidelines and practices. However, the complexity and duration of the Project lifecycle was relatively unique and highlighted the benefit of planning and implementing stakeholder engagement early in the Project lifecycle that continues until the Project is completed.

The flow of information improved as work on the Project progressed. BC Hydro learned that it was important to be thoughtful to understand concerns, be fulsome in responses and to provide accurate information. These considerations, coupled with being proactive, likely served to reduce the number of public complaints and concerns. For example, prior to and during river diversion, BC Hydro received feedback from external stakeholders that the educational meetings, regular communications on Project status and identification of points of contact, were adequate and meaningful.

Engagement with property owners and residents that were impacted or in proximity to the Project also required early identification of potential impacts and extensive, well-organized engagement.

Early community engagement helped to identify and establish baseline conditions, including the meaningful placement of monitoring equipment for assessing information. For example, on highways design and construction, community engagement helped to inform baseline parameters, such as biological habitats, wildlife movement, noise levels, air quality, and water quality and drainage.

Future projects should consider integrating adaptable environmental monitoring systems (e.g., air quality, dust, noise, etc.) from the outset of the project and should consider that monitoring stations in fixed locations to meet regulatory requirements may not adequately capture localized impacts experienced by residents. Deploying adaptable monitoring solutions early on can provide more accurate data to address community concerns and demonstrate a proactive commitment. This approach was particularly helpful in better understanding dust concerns raised by residents of Old Fort.

Over time, BC Hydro recognized the value of targeted Project messaging to support effective and continuous engagement, particularly during construction. Generic notifications used early in the construction period led to confusion and negative feedback, since residents experience impacts differently depending on their location and contractor activity. BC Hydro responded by segmenting activities by zone and tailoring communications to more local areas, which reduced unnecessary outreach and frustration.

The Project team made it a priority to acknowledge receipt of each message and proactively follow up with stakeholders via email or phone to share an estimated timeline. This approach helped build trust with stakeholders and the public, and in many instances, effectively de-escalated potential concerns. Future projects should

consider establishing a clear response time goal, such as a 24-hour turnaround, and proactively following up with stakeholders when delays occur.

Finally, BC Hydro prioritized public and worker safety by implementing a comprehensive safety plan for engagement activities in the community. Prior to public engagement events, a member of the BC Hydro safety team held a safety briefing with employees, which included a safe exit strategy in the event of an incident.

Table 47 below provides some specific considerations which are intended to support future project teams as part of this lesson learned.

Table 47 Lesson CE1 - Specific Considerations

#	Consideration
CE 1.1	Develop and implement a proactive and adaptive communication plan.
CE 1.2	Create checklists of internal and external stakeholders for information sharing.
CE 1.3	Establish response time goals for queries.
CE 1.4	Create and understand limits of baseline data.
CE 1.5	Be open to adapting environmental monitoring locations to better understand local concerns.
CE 1.6	Use targeted and customized communication approaches.
CE 1.7	Identify subject matter experts and encourage collaboration with contractors to support sustained engagement efforts.
CE 1.8	Ensure a comprehensive safety protocol is in place for any public events.

9.3.2 Lesson CE2: Establish and Adapt Project Organization Structures for Stakeholder Engagement to the Evolving Scale and Duration of the Project

Lesson CE2 is to adapt organizational structures for stakeholder engagement to the evolving scale and duration of the project.

BC Hydro recognized that the Project's scope, construction phases, and long duration required dedicated community relations and social mitigation teams. These

teams played an important role in managing external communications, building relationships with local governments, and streamlining feedback processes.

A senior Communications Lead was part of the Site C Leadership Team. This fostered strong collaboration across Project delivery groups and supported proactive stakeholder engagement. Information was shared promptly with the Leadership Team, enabling timely and effective resolution of issues. Future major projects should consider including a communications lead as part of the project leadership team.

Response times for some subprojects declined as they were completed, and people transitioned off the Project. Future projects should consider that adequate engagement resourcing must account for the variety of subproject scopes and schedules across the duration of the project.

Table 48 below provides some specific considerations which are intended to support future project teams as part of this lesson learned.

Table 48 Lesson CE2 - Specific Considerations

#	Consideration
CE 2.1	Assess project needs and the scalability of required engagement resources to determine whether a dedicated team might be beneficial. Key considerations include the volume and complexity of public engagement, the need for specialized communication expertise, community mitigation efforts, and the benefits of integrating this function into the broader project organization.
CE 2.2	Include a communication lead in the leadership team for the project.
CE 2.3	Establish clear roles and responsibilities particularly when considering diverse stakeholder engagement and the need for significant community mitigation efforts.
CE 2.4	Proactively collaborate across project subgroups to ensure timely and consistent messaging.

9.3.3 Lesson CE3: Adopt Varied and Responsive Communications Channels Over the Project Lifecycle

Lesson CE3 is to adopt varied and responsive communications channels over the project lifecycle.

The Project adapted to evolving communication trends, including the increased use of social media following the COVID-19 pandemic, while also maintaining other more traditional communication methods.

Future large capital projects should consider establishing project community offices, or a strong community presence, to help build trust in local communities. The establishment of a regional office for the Project was generally well received and provided a forum for receiving, understanding, and addressing stakeholder feedback.

Another important communication channel for the Project was the establishment of the Regional Community Liaison Committee which provided a forum for transparent communications and issues resolution.

Table 49 below provides some specific considerations which are intended to support future project teams as part of this lesson learned.

Table 49 Lesson CE3 - Specific Considerations

#	Consideration
CE 3.1	Implement planning early in the project lifecycle to identify and use a variety of channels.
CE 3.2	Maintain awareness of existing channels to reach people as well as using new and emerging channels.
CE 3.3	Establish a local office to better engage and understand local interest and concerns.
CE 3.4	Facilitate a community engagement committee.

9.3.4 Lesson CE4: Use Technology and Tools to Enhance Stakeholder Engagement

Lesson CE4 is to use technology and tools to enhance stakeholder engagement.

The Project implemented a Customer Relationship Management System that helped to coordinate responses and build a useful knowledge base. The ability to track detailed requests and issues proved especially valuable for timely and consistent responses, particularly when addressing recurring or similar concerns. The tool also enabled the team to quickly access and provide accurate information for internal and external reporting requirements.

The Project was documented using a wide range of digital media technologies. Drone and aerial photography helped document construction progress, contractor activities, and field time lapses. Digital media was also widely used across the Project to create exhibits to provide residents with updates and to address inquiries. This was especially effective during the COVID-19 pandemic when the Project was not able to accommodate site tours for key stakeholders and other organizations to show how Project construction was progressing.

During the Project, community members occasionally reached out to BC Hydro with concerns about vehicle-related issues. Initially it was challenging to determine whether a vehicle was associated with the Project or not and identify the party involved. The Project introduced identifying decals for Project vehicles with the company name and number. This proactive step made it easier to identify and address concerns efficiently. Future projects should consider using decals or other appropriate tools, such as GPS tracking.

Table 50 below provides some specific considerations which are intended to support future project teams as part of this lesson learned.

1 **Table 50 Lesson CE4 - Specific Considerations**

#	Consideration
CE 3.1	Establish a customer relationship management system.
CE 3.2	Make use of new and emerging digital media technologies.
CE 3.3	Implement vehicle identification tools.

10 Looking Ahead to Future Projects

Overall, BC Hydro reflects on the Site C Project with pride and a commitment to learn and improve. Site C is an inspiring example of the transformative impact made possible through public infrastructure investment, but BC Hydro also has a responsibility to our customers and the Province to learn from the challenges and lessons discussed in this Report. We are committed to taking these lessons forward as we continue to advance important public infrastructure projects and deliver on our mandate to safely provide reliable, affordable, and clean electricity.

The Project was put into full operation on August 8, 2025, when the sixth and final generating unit was put into service. This achievement marks the culmination of a ten-year construction effort that safely delivered a high-quality facility, performing as expected, and delivering lasting value to BC Hydro ratepayers.

However, the Project was more complex and challenging than anticipated by BC Hydro and its contractors and it faced significant budget and schedule challenges. The lessons learned discussed in this report under the six areas identified by the Commission should mitigate or reduce the potential for similar budget challenges from occurring on future major capital projects. In particular, BC Hydro should have ramped up its internal Project resources more proactively and sooner and going forward, BC Hydro should consider how to better communicate the breadth of low-probability, high-consequence risks on a project that have the potential to result in significant budget and schedule impacts, if they materialize.

The decision to adopt an observational approach meant that any actual geotechnical differences from the pre-construction geotechnical investigations would be addressed through design changes during Project construction. While this is an accepted approach for similar projects and was supported by a Technical Advisory Board of international dam engineering and construction experts, it carried an

inherent risk that initial budget amounts may not be sufficient for major geotechnical challenges and consequential design changes, if they materialized. These risks did materialize and were compounded by the impacts of the COVID-19 pandemic, which occurred at the peak of planned construction, maximizing cost and schedule impacts.

Going forward, it will be critical for BC Hydro to continue to build its commercial capacity and to plan to ramp up dedicated contract and commercial management resources, with representation on the project leadership team, earlier in the project lifecycle to effectively manage the commercial impact of contractor claims. Where applicable, future major capital projects should ramp up these resources from the outset.

During the course of the Project, various improvements were made to address Risk Management including combining various risk registers into a single central risk register and increasing the visibility and reporting of identified risks; improved mapping of identified risks to the Cost and Schedule Risk Analysis; increasing the frequency of Cost and Schedule Risk Analysis; better applications and systems; adding more experienced resources to the central risk management team; and a greater role for the Project Assurance Board and the Independent Oversight Advisor. Future major capital projects should consider implementing these improvements early, where appropriate.

Site C benefited greatly from a large and varied group of external independent experts from around the world, who provided advice, knowledge and guidance on complex technical investigations, designs, and construction solutions. Future major capital projects should consider retaining third-party experts early in the project development cycle and should consider establishing a Technical Advisory Board. In addition, thorough investigations should be conducted early to inform design

considerations and to develop strong geotechnical models to evaluate performance and inform required design enhancements.

While the Project implemented these activities, significant geotechnical challenges still occurred, with substantial cost and schedule impacts. This emphasizes the importance of future project teams taking steps to ensure that project governing bodies are aware of low-probability, high-consequence risks that are not fully reflected in the project budget. The budget and schedule impacts of these high-consequence, low-probability risks materializing must be clearly communicated.

The mandate, expertise and independence of the Project's governing bodies were improved over time and future major capital projects should take steps to implement these improvements from the beginning, where appropriate. These improvements included: developing and updating a skills matrix for the project's governing bodies so that the expertise matches the project's needs as the project advances through construction; providing sufficient time for the governing bodies to consider the matters on which their advice is sought; establishing subcommittees where additional advice and oversight is required; and ensuring the independence of the Project Board from other governance bodies (such as the BC Hydro Board of Directors and the Executive Team) and making independent external advice available to them.

Regular Environment and Permitting Forums with First Nations provided an effective platform to discuss construction activities, permitting requirements, and environmental and Indigenous concerns. Input from these forums was actively integrated into permit applications and environmental mitigation and management programs and facilitated the timely issuance of permits. This approach is now being adapted for other BC Hydro initiatives, including the North Coast Transmission Line projects.

A key reason for the successes achieved on the Project was its integrated leadership approach. The Project was structured as a separate business unit with its own dedicated functional groups with a direct reporting relationship to the President and CEO. This structure helped to drive the necessary tone and approach across a broad range of organizational challenges. Future major projects should adopt similar approaches, where appropriate, especially as projects increase in complexity. Every day on a major project involves substantial expenditures and the need for strong collaboration to quickly remove obstacles, which is supported by an effective integrated leadership team.

In addition to Site C, BC Hydro has completed several other major capital projects over the past 20 years, including:

- Vancouver Island Transmission Reinforcement Project;
- Interior to Lower Mainland Transmission Project;
- Northwest Transmission Line Project;
- Dawson Creek/Chetwynd Area Transmission Project;
- John Hart Generating Station Replacement Project;
- Ruskin Dam and Powerhouse Upgrade Project;
- GMS Units 1 to 5 Turbine Replacement Project;
- Fort Nelson Generating Station Upgrade Project; and
- Hugh Keenleyside Spillway Gates Project.

Lessons from these projects have been captured within our Lessons Learned Practice, and like the lessons from Site C discussed in this Report will continue to guide the planning and implementation of future major projects. Since 2018, these lessons have been included in Final Reports filed with the Commission, a practice BC Hydro will continue for active and future major projects.

BC Hydro has entered a phase of increased capital investment. Table 51 below sets out major projects in BC Hydro's current $36 billion Capital Plan announced in January 2024.

Table 51 Major Projects in BC Hydro's 10-Year Capital Plan

Project	Description
Prince George to Terrace Capacitors Project	The purpose of this project is to increase the non-firm transfer capability of the North Coast 500 kV transmission system by approximately 500 MW. The increase in transfer capability will meet the needs of BC Hydro customers currently in the interconnection queue and support the reduction of GHG emissions.
North Coast Transmission Line (**NCTL**), Phase 1 (Prince George to Glenannan Transmission)	The purpose of this project is to construct a new 500 kV transmission line between the Williston and Glenannan substations to serve new customer loads located in the North Coast region of British Columbia.
NCTL, Phase 2 (Glenannan to Terrace Transmission)	The purpose of this project is to construct a new 500 kV transmission line between the Glenannan and Telkwa substations and the Telkwa and Skeena substations to serve new customers located in the North Coast region of British Columbia.
South Coast Transmission Reinforcement	The purpose of this project is to increase the transfer capability of the bulk transmission system serving the south coast from the interior to meet load demand in the Lower Mainland and Vancouver Island areas, and commitments for firm transmission service reservations on the B.C. to U.S. transfer path, including B.C.'s obligations under the Canada-U.S. Skagit River Treaty.
West Kelowna Transmission	The purpose of this project is to improve the reliability of service provided to the City of West Kelowna, the District of Peachland, and Westbank First Nation.
Revelstoke Unit 6 Installation	The purpose of this project is to install a sixth generating unit and related works and equipment in the Revelstoke Generating Station, which will add approximately 500 MW of capacity to BC Hydro's integrated system. Installing this generating unit and related works and equipment will help BC Hydro reliably meet the long-term system capacity needs resulting from the growing demand for electricity.

Project	Description
G.M. Shrum - U9 - U10 Generator and Turbine Refurbishment	The purpose of this project is to address reliability concerns with the Unit 9 and Unit 10 generators and turbines to ensure the safe and reliable operation of the units.
West End Substation Construction and System Reinforcement	The purpose of this project is to build a new underground substation in the West End neighborhood of Downtown Vancouver as part of the Downtown Vancouver Electricity Supply Plan. The new substation will replace the existing Dal Grauer substation.
Mica Unit 1 to 2 Turbine Overhaul Project	The purpose of the project is to improve the reliability of the turbines, reduce the risk of turbine failure, and mitigate safety risks to operating personnel at the Mica Generating Station.
La Joie - Dam Improvements	The purpose of this project is to address the safety, environmental, and reliability risks associated with identified deficiencies of the La Joie Dam's upstream face, intake tower and other water conveyance structures, their deteriorating condition, and their potential failure under seismic loads.
Mica - Discharge Facilities Seismic and Reliability Upgrades	The purpose of this project is to upgrade the three gated spillway, and a two gated outlet works at the Mica Dam. Upgrading these discharge facilities will ensure the continued safe containment of the reservoir during an earthquake, safe discharge of water from the reservoir after an earthquake, and reliable operation for all other service conditions, including periods of high inflows up to extreme floods.

The lessons outlined in this Report, along with insights from past projects, are broadly applicable to the projects listed in Table 51 above; however, the exact application will depend upon project specific circumstances.

For example, the North Coast Transmission Line, Phase 1 and Phase 2 Projects that involve constructing approximately 450 km of new 500 kV transmission lines and are expected to have a larger scope, schedule, and cost than other major projects in the capital plan, can benefit from several of the lessons presented in this Report, including:

- For very large complex projects, implement cost risk analysis and schedule risk analysis processes that are complete and transparent and include effective methods to quantify risks (**RM2**);
- Organize and size the project risk team for the complexity of the project and ensure it includes qualified resources with the appropriate knowledge, experience, and expertise (**RM3**);
- Conduct thorough investigations to inform design considerations early and to frame baseline information (**GR2**);
- Implement processes and have senior leadership involved early to set tone and expectation to assess and address contractor claims in a timely manner to avoid significant cost claims remaining open at contract completion (**CM3**); and
- Plan and build support for Indigenous procurement opportunities (**IC3**).

Other major projects will also benefit from applying lessons learned from the Site C Project and previous large-scale initiatives. As BC Hydro enters a period of increased capital investment, these insights will continue to inform planning and execution. In alignment with our Project and Portfolio Management framework, we will also continue to capture new learnings from each project, evolving our practices to meet emerging challenges.

10.1 Next Steps to Project Completion

With the successful filling of the reservoir, achievement of first power in 2024, and the sixth and final generating unit placed in service in August 2025, the Project has completed its most significant milestones. BC Hydro is now focused on safely completing the remaining scopes of work required to bring the Project to full completion, which is expected by March 2027. Remaining key activities, which are expected to be completed within the current approved Project budget and schedule, include:

- Finalizing Project documentation and transitioning assets from the Project to BC Hydro Operations;
- Addressing deficiencies and closing out contracts;
- Advancing site reclamation and completing remaining construction activities (e.g., backfilling the diversion tunnels, final site roads, and removal of the temporary construction bridge); and
- Development of a Project Completion and Evaluation report to be filed with the Commission in 2027.

As these remaining activities are advanced, BC Hydro will also continue to uphold its commitments, including those related to environmental monitoring and continued engagement with local communities and Indigenous Nations.