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Any questions concerning the information or its interpretation should be directed to AJ MacDonald.

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1 INTRODUCTION

1.1 Project Overview

The Sunshine Coast Regional District (SCRD) has identified a need for additional water supply within the Chapman Water System to meet current and future potable water consumption demands. The SCRD intends to develop these means such that there is sufficient year-round water supply for communities dependant on the Chapman Water System under both typical and high demand circumstances.

The SCRD supplies water to three water service areas, the Regional Water Service Area, North Pender Harbour Water Service Area, and South Pender Harbour Water Service Area, which together extend approximately 85 km along the Sunshine Coast between Egmont, British Columbia (BC) to the north and Langdale, BC to the south. The Chapman Water System is the primary water system in the Regional Water Service Area.

The Chapman Creek watershed is the primary water source for the Chapman Water System and conveys water from Chapman Lake and Edwards Lake to the Chapman Creek Water Treatment Plant (WTP) via an existing intake on Chapman Creek. The SCRD is advancing several projects to address the growing water demands, one of which is the development of a raw water reservoir. The concept of the raw water reservoir is to store water during periods of high precipitation and supply water to the Chapman Water System during periods of low precipitation and low creek flow periods.

The SCRD is progressing a raw water reservoir feasibility study (the Project) to evaluate the feasibility of developing a raw water reservoir to increase water supply to the existing Chapman Water System. The overall objective of the Project is to identify and evaluate potential locations for development of a raw water reservoir and to develop designs and cost estimates for sites deemed feasible. To reach these objectives, a water demand analysis was conducted to evaluate the current and projected water demands for the Chapman Water System, existing water supply sources, and determine the resultant water supply deficit (Integrated Sustainability 2018a). Based on the results of the water demand analysis, a target storage volume for the reservoir was selected. Potential reservoir sites have been identified and reviewed at a desktop and preliminary field level. A multi-criteria analysis (MCA) has been completed to compare and rank the sites and conceptual designs have been completed for the four top-ranked sites (Sites A, B, C3, and C4, the Sites) and Class C cost estimates were developed based on these designs.

1.2 Overall Project Scope

Integrated Sustainability previously completed Phases 1 and 2 of the Project between September 2018 and March 2019. A detailed description of the work completed during Phases 1 and 2 of the Project is included in the Phase 2 Feasibility Study Report (Integrated Sustainability 2019c). Phase 3 of the Project was commenced in May 2019. The overall scope of work for Phases 1 through 3 is summarized below.
1) Phase 1 consisted of the following:
   - Water demand analysis to evaluate current and projected water demands for the Chapman Water System, existing water supply sources, and determine the resultant water supply deficit (Integrated Sustainability 2018a)
   - Development of siting and conceptual design criteria for the raw water reservoir, to support reservoir siting and design development, including a target storage volume of approximately 1,300,000 m³ (Integrated Sustainability 2018b)
   - Identification of 11 potential raw water reservoir sites with approximate volumes ranging from 900,000 m³ to 2,300,000 m³, and preliminary desktop review of these sites, including preliminary environmental and regulatory review and engagement (Integrated Sustainability 2018b)
   - Preliminary Multi-Criteria Analysis (MCA) of the 11 identified sites to evaluate them from a technical, economic, environmental, and regulatory perspective (Integrated Sustainability 2018b)
   - Selection of five preferred sites, Sites A, B, C1, C3, and C4, to progress to Phase 2 (Integrated Sustainability 2018b)

2) Phase 2, Integrated Sustainability completed the following:
   - Detailed technical and regulatory and permitting requirements review of the five preferred sites from Phase 1 and elimination of Site C1 based on technical review criteria, leaving four Sites, Sites A, B, C3, and C4, remaining (Integrated Sustainability 2019a)
   - Conceptual designs and Class D cost estimates for the Sites (Integrated Sustainability 2019a, 2019b)
   - Detailed MCA evaluation to determine conceptual feasibility of the Sites (Integrated Sustainability 2019c)
   - Recommendations by Integrated Sustainability to advance the Sites for further Study in Phase 3 of the Project (Integrated Sustainability 2019c), followed by SCRD Board of Directors decision to authorize this recommendation

3) Phase 3 included:
   - Evaluation of the regulatory and permitting requirements for each of the Sites (Integrated Sustainability 2019d)
   - Environmental scoping assessment to describe the environmental scope of work remaining for the Sites (Integrated Sustainability 2019e)
   - Evaluation of potential point of diversion (POD) locations on Chapman Creek to support development of a new intake to divert water to Site B (Integrated Sustainability 2019f)
   - Preliminary aquatics evaluation at Sites C3 and C4, as well as at the potential Site B POD locations (Integrated Sustainability 2019g)
1.3 Design Summary Purpose and Scope

The purpose of this Design Summary Report is to summarize the key design criteria and assumptions for Integrated Sustainability’s Phase 3 engineering design scope and present the updated MCA matrix.

Overall, the Phase 3 design development scope includes developing designs for the Sites to a conceptual design level further advanced than the design work completed during Phase 2. Dam site characterization completed to date falls within the guidelines for scoping-level design, as per the BC professional practice guidelines for Site Characterization for Dam Foundations in BC (APEGBC 2016).

The Phase 3 design development will encompass the Sites, as well as supporting infrastructure (e.g. water conveyance/pipelines, roads, intake) required to connect the Sites to the existing Chapman Water System infrastructure. During Phase 3, designs of the Sites will be advanced further than the designs for the supporting infrastructure, given that there is more information available to support designs of the Sites at this stage. For the purpose of Phase 3, design breaks have been delineated to clearly illustrate the different levels of design development for the Sites versus their supporting infrastructure, and are summarized as follows:

- The Sites (approximately 30% design), in support of developing Class C cost estimates
- Supporting infrastructure required to connect the Sites to the existing Chapman Water System infrastructure (15% to 20% design), in support of developing Class D cost estimates

Parameters defined in this Design Summary Report will be used to meet project objectives and to align the design criteria with the SCRD’s operational requirements and regulatory requirements. It is recommended that this Design Summary Report is further updated during future design stages to support approvals under the Water Sustainability Act (BC Government 2014) in accordance with BC Dam Safety Regulation (DSR) (BC Government 2016a, 2016b) requirements.
1.4 Conceptual Site Development

The conceptual model for the raw water reservoir is based on the following approach:

- Diversion of water to a raw water reservoir for storage during periods of high precipitation
- Diversion of water from the raw water reservoir to the Chapman Creek WTP for supply augmentation during periods of low precipitation and to meet water demands as well as downstream flow requirements during peak summer demands

Sites A and B are located near the existing Chapman Water System infrastructure and the Sunshine Coast communities (2 km to 3 km). Conceptual reservoir designs at Sites A and B comprise reservoirs that include both excavation into existing ground and constructed embankment dams to obtain the design storage volume. Sites C3 and C4 are located further from and northeast of the Sunshine Coast communities (10 km to 15 km) and are situated within existing subalpine lake basins. Conceptual reservoir designs at Sites C3 and C4 utilize the steep basin valley slopes and a dam at the downstream end of the basin valley to obtain the design storage volume. The Sites are located as follows:

- Site A - National Topographic System (NTS) Location J/92-G-5
- Site B - NTS Location J/92-G-5
- Site C3 – NTS Location B/92-G-12
- Site C4 – NTS Location B/92-G-12

Locations of the Sites are shown in Figure 1.

2 SITING

A detailed desktop study was conducted in Phase 2 of the Project (Integrated Sustainability 2019a) and included a review of publicly available data such as topography, geology, hydrogeology, environmental data, and regulatory permitting requirements. The following information and criteria were used as part of this desktop study:

- Land use and ownership data, to position the reservoir within land owned by the SCRD, Crown land, or Agricultural Land Reserve (ALR) land, and not within Tetrahedron Provincial Park, the Gravel Lands (as per shíshálh Nation Foundation Agreement) (BC Government 2018a), or utility rights-of-ways (ROWs)
- Proximity to existing infrastructure, including access roads
- Conceptual methods for conveying water to and from the sites, and approximate conveyance distances
- Topographical and disposition data to evaluate site suitability, constraints, and logistics
- Regional bedrock and surficial geology to evaluate subsurface conditions
- Local terrain data to avoid siting within areas typically susceptible to geohazard activity, including ravines, coulees, and gullies
- Landslide hazard data to maintain adequate setback from potential slope failures
- Proximity to mapped fault locations
- Water features data to maintain required setbacks from wetlands and watercourses
- Available environmental data to evaluate the presence of vegetation, fish, and wildlife
- Historical data and previous uses to evaluate historical and archaeological significance, and previous contamination
- Available current and historical wetland data to evaluate the presence and impact to wetlands within the area
- Existing and abandoned water wells to understand the groundwater users within the area
- Regulatory permitting requirements

To date, review of historical and archeological significance of lands that may be impacted by development at each of the Sites has been limited to desktop review of publicly available data. A detailed archeological assessment should be completed in future design stages.

3 SITE AND CONCEPTUAL DESIGN DESCRIPTIONS

3.1 Site A

The Site A conceptual design footprint is approximately 47.4 hectares (ha). Site A is located at an elevation of approximately Elevation (El.) 190 m. The elevation across Site A ranges from El. 163 m in the south to El. 200 m in the north, resulting in a total elevation change of up to 38 m. Site A is located approximately 1,300 m to 2,000 m east, northeast, and north of communities along the Sunshine Coast, and approximately 600 m north of the Sechelt-Gibsons Airport. The east portion of Site A is located within the SCRD’s electoral area defined as Area D: Roberts Creek and the west portion of Site A is located within the District of Sechelt (SCRD electoral area defined as Area S). Site A is situated on Crown land, and the majority of it is situated within Agricultural Land Reserve (ALR). A portion of the Site A footprint was previously cleared. Site A is bound to the west by the Sechelt-Airport Forestry Service Road (FSR) and the Gravel Lands (BC Government 2018a), and to the north by a Fortis BC right-of-way (ROW) (2403806). Undeveloped land borders Site A to the south and east. A BC Hydro ROW (0207803) is located approximately 500 m to the south, and Field Road is located approximately 400 m to the east. Site A is located approximately 600 m east of Chapman Creek and 400 m west of Hudson Creek.

Site A is situated such that water would be conveyed from Chapman Creek to the reservoir via pipeline, with potential contributions from surface water inflow and
groundwater. Water would then be conveyed from the reservoir to the Chapman Creek WTP via an additional pipeline. The Site A conceptual design footprint includes a single reservoir, operations area, and areas for topsoil, subsoil, and excess subsurface material stockpiles. The reservoir is irregular to rectangular in shape and oriented lengthwise from east to west. The site is steeply sloped from north to south with localized areas of topographic relief, the north portion of the reservoir would require a cut and the south portion of the reservoir would require an embankment dam. Site A is assumed to be accessed from the west via the Sechelt-Airport FSR.

3.2 Site B

Site B is located immediately north of Site A. The Site B conceptual design footprint is approximately 45.2 ha in area. Site B is located at an elevation of approximately El. 220 m. Site B slopes from northeast (El. 213 m to El. 217 m) to southwest (El. 195 m to El. 200 m), for a total elevation change across Site B of 13 m to 22 m. Site B is located approximately 1,900 m to 2,600 m east, northeast, and north of communities along the Sunshine Coast, and approximately 1,200 m north of the Sechelt-Gibsons Airport. Site B is located within the SCRD’s electoral area defined as Area D: Roberts Creek. Site B is situated on Crown land, and most of it is situated within ALR. The northwest portion of Site B is located within an area where the Sunshine Coast Rod and Gun Club (SCRG) currently holds a provincial land tenure and a Land Use Agreement with the SCRD. A portion of Site B was previously cleared. Site B is bound to the west and northwest by the Sechelt-Airport FSR, to the north and northeast by the SCRG access road and facility, and to the south by the Fortis BC ROW (2403806). Undeveloped land borders Site B to the east. An inactive gravel quarry is located immediately southwest of the Site B footprint. Site B is located approximately 400 m to 600 m east of Chapman Creek and immediately west of Hudson Creek.

Similar to Site A, Site B is situated such that water would be conveyed from Chapman Creek to the reservoir via pipeline, with potential contributions from surface water inflow and groundwater. Water would then be conveyed from the reservoir to the Chapman Creek WTP via an additional pipeline. The Site B conceptual design footprint includes a single reservoir, operations area, and areas for topsoil, subsoil, and excess subsurface material stockpiles. The reservoir is irregular to rectangular in shape and oriented lengthwise from northeast to southwest. The site is moderately sloped from northeast to southwest with localized areas of topographic relief. Given the existing topography, an embankment dam would be required on all sides of the reservoir, with an embankment dam on the south side being greater in height than those on the north side. Site B is assumed to be accessed from the west via the Sechelt-Airport FSR.

3.3 Site C3

The Site C3 conceptual design footprint is approximately 23.3 ha in area and is located approximately 12 km northeast of Sechelt on the west side of the Chapman Creek valley. Site C3 is located within the SCRD’s electoral area defined as Area D: Roberts Creek, is
situated on Crown land, and is located approximately 200 m south of the Tetrahedron Provincial Park boundary.

Site C3 is situated within an existing subalpine lake basin at approximately El. 1,000 m. An unnamed creek inlet enters the lake from the northwest and the Tsawcome Creek outlet exits to the south-southwest. The confluence of Tsawcome Creek and Chapman Creek is located approximately 650 m southwest of Site C3. Tsawcome Creek is a tributary of Chapman Creek and the confluence of the two is located approximately 650 m southwest of the Site. The northern extent of Site C3 is located approximately 500 m southeast of the southern extent of Site C4.

Site C3 is situated such that the reservoir would capture surface water from the local watershed, including the unnamed creek that drains to the lake basin from the northwest. Water would be released from the reservoir into Chapman Creek via Tsawcome Creek. The conceptual layout for Site C3 includes a constructed dam positioned at the south end of the lake basin, used to capture water within the lake basin to create a reservoir constrained by the dam and valley slopes surrounding the lake basin. Areas for topsoil, subsoil, and excess subsurface material stockpiles and operations area have also been included in the site layout. Site C3 is assumed to be accessed from the northwest via an existing, decommissioned forestry road, from which new road infrastructure would be constructed to gain direct access to Site C3. However, Site C3 could also be accessed from another existing, decommissioned forestry road from the southeast.

3.4 Site C4

The Site C4 conceptual design footprint is approximately 26.6 ha in area and is located approximately 14 km northeast of Sechelt on the west side of the Chapman Creek valley. Site C4 is located within the SCRD’s electoral area defined as Area D Roberts Creek, is situated on Crown land, and is located approximately 100 m west and 300 m south of the Tetrahedron Provincial Park boundary.

Site C4 is situated within an existing subalpine lake basin at approximately El. 1,050 m. The outlet to Tsawcome Creek is located at the south end of the lake basin. Tsawcome Creek is a tributary of Chapman Creek and the confluence of the two is located approximately 800 m southwest of the Site. The southern extent of Site C4 is located approximately 500 m northwest of the northern extent of Site C3.

Similar to Site C3, Site C4 is situated such that the reservoir would capture surface water from the local watershed. Water would be released from the reservoir directly into Chapman Creek via the unnamed creek between Sites C3 and C4 and then via Tsawcome Creek between Site C3 and the confluence of Tsawcome Creek and Chapman Creek. Given this, water conveyed from Site C4 would travel through the Site C3 lake basin on its path to Chapman Creek. Water conveyance to and from the reservoir is via overland surface water flow, with potential contribution from groundwater. The conceptual layout for Site C4 includes a constructed dam positioned at the south end of the lake basin, used to capture water within the lake basin to create a reservoir.
constrained by the dam and valley slopes surrounding the lake basin. Areas for topsoil, subsoil, and excess subsurface material stockpiles and operations area have also been included in the site layout. Site C4 is assumed to be accessed from the northwest via an existing, decommissioned forestry road, from which new road infrastructure would be constructed to gain direct access to Site C4. However, Site C4 could also be accessed from another existing, decommissioned forestry road from the southeast.

4 SITE CHARACTERIZATION

The site characterization included desktop review and site (field) reconnaissance to evaluate the general project area and locations in which the Sites are situated, in terms of terrain characteristics, dam foundation characteristics, and general engineering construction considerations.

Dam site characterization completed prior to and during Phase 3 falls within the guidelines for scoping level design, as per the BC Professional Practice Guidelines for Site Characterization for Dam Foundations in BC, the purposes of which was to identify major features that have potential to impact siting, design configuration, and operations (APEGBC 2016). Site characterization completed to date is limited to desktop review and general site reconnaissance to map terrain at each of the Sites based on visual observations. Recommendations provided in the following sections should be used to support Phase 3 design criteria only. Additional site characterization work will be required during future design stages, and should include detailed terrain and bedrock mapping, intrusive investigations, in-situ testing, laboratory testing, and geophysics.

Integrated Sustainability completed a review of available, relevant materials to characterize the Sites at a desktop level, which included review and consideration of the following key attributes:

- Regional surficial geology and geomorphology
- Regional bedrock geology
- Regional hydrogeology
- Regional terrain stability and drainage conditions
- Potential geohazards
- Potential design and construction criteria, including available construction materials

Integrated Sustainability completed a general site reconnaissance, using the data reviewed during the desktop study as a planning tool. The site reconnaissance was limited to visual surficial observations and visual observations made of near surface conditions based on shallow hand auger holes. Observations made during the site reconnaissance will need to be confirmed during detailed site investigations in future design stages. The site reconnaissance included the following:

- Assessment of terrain conditions, including near-surface soils, bedrock and groundwater, surface water, and topography and terrain characteristics
Identification and interpretation of potential geohazards, and assessment of activity and potential impacts of geohazards on the proposed development at each of the Sites

Evaluation of potential engineering and construction considerations, including potential available construction materials

Following completion of Phase 3 of the Project, the following scope items have been identified as minimum requirements to support future design stages and will be based on the additional site characterization data:

- Evaluation of suitability of onsite soils and bedrock for use as construction materials
- Slope stability analysis for the reservoir side slopes and embankment dam side slopes and recommendations on design slope angles and setback distances
- Seepage analysis and recommended control measures for the embankment dams and embankment dam foundations
- Evaluation of potential for liquefiable soils at the Sites during a seismic event and recommended control measures
- Settlement analysis for the embankment dams and recommended control measures
- Soil loading analysis to determine setback distances between site infrastructure and buried utilities
- Site specific seismic hazard assessment

The site characterization and supporting design recommendations provided within this report should be verified and additional, detailed recommendations provided during future design stages.

A summary of the site characterization findings, including general information on the geology and physiography of the area in which the Project is situated, as well as site-specific characteristics and recommendations pertaining to each of the Sites, is provided in the following sections.

Review of the Sites from an environmental and regulatory perspective can be found in the Regulatory Roadmap (Integrated Sustainability 2019d), Environmental Scoping Assessment (Integrated Sustainability 2019e), and Preliminary Aquatics Assessment (Integrated Sustainability 2019g).

4.1 General

4.1.1 Regional Geology and Physiography

The Project area lies within the Georgia Lowland and the lower slopes of the coast mountains. The topography and surficial geology in the region are products of Fraser Glaciation (late Wisconsinan) when continental ice sheets moved south down the Straight of Georgia and bordering lowlands and mountainous terrain approximately 14,500 years ago (Clague 1984). During glaciation, glacial till and other related sediments,
collectively known as Vashon Drift were deposited across the region. Climatic warming followed glaciation, during which Capilano Sediments, including glaciofluvial, glaciomarine, raised delta, intertidal, and beach sediments, were deposited over the Vashon Drift (Armstrong 1981).

Within the Project area previous mapping shows that above approximately El. 300 m, glacial processes left terrain comprising exposed bedrock or with thin deposits of unconsolidated, disintegrated till overlying bedrock. The bedrock within the Project area is interpreted to be shallow, and topography is heavily influenced by the underlying bedrock (McCammon 1977).

Below approximately El. 300 m and near the coast, a coarsening upwards sequence of Capilano glaciomarine, marine, and glaciofluvial sediments were deposited over coarse grained Vashon Drift (Clague et. al. 1982, BC MoECCS 2019). Glacial outwash flowed down the Chapman Creek valley during deglaciation and formed a raised delta and alluvial fan, which was later cut through by Chapman Creek. Remaining granular, glaciofluvial deposits remain on both sides of the Chapman Creek valley.

4.1.2 Regional Seismotectonic Conditions

The Sites are in a high seismic hazard region (NRC 2017). Accordingly, all structures included in the designs for the Sites will need to be designed to accommodate a 1:10,000 year return period earthquake (CDA 2007). During an earthquake, the intensity of shaking at the site is dependent on the magnitude of the event, the distance to its epicenter, and local geologic conditions.

The Government of BC database of mapped faults (Ministry of Energy, Mines and Petroleum Resources - BC Geological Survey 2018) was reviewed to evaluate the proximity of each of the Sites to previously identified tectonic and seismic faults in the region. Faults can either be described as tectonic faults, which are faults with two very different aged rocks on each side of the fault trace, or seismic faults, which are faults that are seismically active. Seismic faults usually have clusters of seismic epicenters near or on the fault trace and are classed a geohazard. Tectonic faults are more benign and typically do not have epicenters associated with them and therefore are not considered a geohazard. One tectonic fault was mapped within the general area of the Sites, with several additional tectonic faults mapped to the west of Sechelt inlet and to the east on Gambier Island. Sites A and B are located within 8 km to 20 km of mapped tectonic faults to the northeast and northwest. Sites C3 and C4 are located within 4 km to 15 km to mapped tectonic faults located to the southeast, east, and southwest.

The effects of strong ground shaking originating well off the coast of Vancouver Island and the associated ground deformation (liquefaction, lateral spreading, and landslides) are potential hazards on the west coast of BC and are always considered in the design of structures in British Columbia.

Based on results from the desktop study and site reconnaissance, the area in which Sites A and B are situated is interpreted, at this stage, to have a relatively low risk of liquefaction...
during a seismic event. The area in which Sites C3 and C4 are situated is interpreted to have a relatively low risk of liquefaction during a seismic event. While silty sands may be present near Sites C3 and C4, surficial deposits overlying bedrock near Sites C3 and C4 are interpreted to be very thin, limiting their potential hazard during a seismic event. Subsurface geotechnical investigations in future and more detailed design stages, as part of typical site investigations for greenfield development, will be required to help confirm the susceptibility of the soils to liquefaction.

4.2 Site A

Integrated Sustainability completed a desktop review of relevant information pertaining to Site A and completed a site reconnaissance at Site A and surrounding area on 25 July 2019. The site reconnaissance comprised on-foot traversing and advancement of shallow hand auger holes to verify characteristics of near-surface conditions. The Terrain Assessment Report provides a summary of results from the desktop review and site reconnaissance (Integrated Sustainability 2019i). A summary of key findings and recommendations for Site A are as follows, and are based on the terrain assessment desktop review and visual observations made during the terrain assessment site reconnaissance:

- Approximately 100 mm of topsoil and 100 mm of subsoil stripping over the footprint of Site A is recommended.
- Surficial soils across Site A are interpreted to comprise a thin layer of coarse-grained marine sediment deposits (sand, gravel, and cobbles, with variable amounts of silt) overlying discontinuous coarse grained Morainal deposits (sand with variable amounts of gravel and silt), overlying bedrock.
- It is recommended that soils within the footprint of the embankment dam at Site A are excavated to bedrock prior to embankment construction, and the embankments are constructed directly on a bedrock foundation.
- It is assumed that bedrock at Site A comprises massive to slightly fractured (1 m to 2 m fracture spacing) intrusive granodioritic rocks, based on visual observations of outcrops made during the site reconnaissance. The bedrock is interpreted to be of relatively low permeability and of high strength. The bedrock contact is interpreted to range from 2 metres below ground surface (mbgs) to 10 mbgs. It is recommended for design purposes to assume a bedrock contact ranging from 2 mbgs at the north end of Site A to 5 mbgs at the south end of Site A.
- The surficial soils and bedrock at Site A are expected to be suitable for reuse as construction materials for the embankment dam, operations pads, roads, and site access point, provided that the required processing is conducted to provide granular material suitable for construction of the site infrastructure.
- Groundwater at Site A is assumed to be encountered at approximately 1 mbgs.
It is assumed that fine grained soils suitable for construction of impervious zones or membranes within the embankment dam are not available within or surrounding Site A, and are not readily available within the surrounding area. Given this, it is recommended that use of fine-grained materials is not included in the design criteria for construction of site infrastructure.

To maintain a sufficient setback from the steeply sloping terrain south of Site A (below El. 163 and west of the Sechelt-Airport FSR), a minimum setback of 50 m should be maintained between El. 161 m and the Sechelt-Airport FSR and the toes of the embankment dam and stockpiles on Site A.

The embankment dam is to maintain upstream side slopes of 3 horizontal to 1 vertical (3H:1V) and downstream side slopes of 4H:1V.

4.3 Site B
Integrated Sustainability completed a desktop review of relevant information pertaining to Site B and completed a site reconnaissance at Site B and surrounding area on 26 July 2019. The site reconnaissance comprised on-foot traversing and advancement of shallow auger holes to verify characteristics of near-surface conditions. The Terrain Assessment Report provides a summary of results from the desktop review and site reconnaissance (Integrated Sustainability 2019i). A summary of key findings and recommendations for Site B are as follows, and are based on the terrain assessment desktop review and visual observations made during the terrain assessment site reconnaissance:

- Approximately 100 mm of topsoil and 100 mm of subsoil stripping over the footprint of Site B is recommended.
- Surficial soils across Site B are interpreted to comprise a thin layer of coarse-grained marine sediment deposits (sand, gravel, and cobbles, with variable amounts of silt) overlying discontinuous coarse grained Morainal deposits (sand with variable amounts of gravel and silt), overlying bedrock.
- It is recommended that soils within the footprint of the embankment dam at Site B are over excavated to bedrock prior to embankment dam construction, and the embankments are constructed directly on a bedrock foundation.
- It is assumed that bedrock at Site B comprises massive to slightly fractured (1 m to 2 m fracture spacing) intrusive granodioritic rocks, based on visual observations of outcrops made during the site reconnaissance. The bedrock is interpreted to be of relatively low permeability and of high strength. The bedrock contact is interpreted to range from 1 mbgs to 5 mbgs. It is recommended for design purposes to assume a bedrock contact at 3 mbgs at Site B.
- The surficial soils and bedrock at Site B are expected to be suitable for reuse as construction materials for the embankment dam, operations pads, roads, and site
access point, provided that the required processing is conducted to provide granular material suitable for construction of the site infrastructure.

- Groundwater is interpreted to be shallow at Site B and is interpreted to be perched on the underlying, low permeability bedrock. A groundwater depth of 1 mbgs should be assumed for design purposes.

- It is assumed that fine grained soils suitable for construction of impervious zones or membranes within the embankment dam are not available within or surrounding Site B and are not readily available within the surrounding area. Given this, it is recommended that use of fine-grained materials is not included in the design criteria for construction of site infrastructure.

- The embankment dam is to maintain upstream side slopes of 3H:1V and downstream side slopes of 4H:1V.

4.4 Site C3

Integrated Sustainability completed a desktop review of relevant information pertaining to Site C3 and completed a site reconnaissance at Site C3 and surrounding area on 22 July 2019. The site reconnaissance comprised on-foot traversing and advancement of shallow auger holes to verify characteristics of near-surface conditions. The Terrain Assessment Report provides a summary of results from the desktop review and site reconnaissance (Integrated Sustainability 2019i). A summary of key findings and recommendations for Site C3 are as follows:

- Approximately 400 mm of topsoil and 200 mm of subsoil stripping within the footprint of the gravity dam at Site C3 is recommended.

- Surficial soils across Site C3 are interpreted to comprise a veneer (0 m to 1 m thick) of colluvium (sands and gravels with variable amounts of silt) overlying bedrock on steep bedrock-controlled slopes, and veneers to blankets (1 m to 3 m thick) of coarse grained till overlying undulating bedrock within the lake basin.

- It is recommended that soils within the footprint of the gravity dam at Site C3 are excavated to bedrock, and the dam is constructed directly on bedrock.

- It is recommended that soils within the footprint of the operations pad at Site C3 are excavated to bedrock prior to placement of fill material.

- It is assumed that bedrock at Site C3 comprises massive to slightly fractured (1 m to 2 m fracture spacing) intrusive granodioritic rocks. The bedrock contact is interpreted to range from surface to approximately 4 mbgs. It is recommended for design purposes to assume a bedrock contact underlying the gravity dam footprint at Site C3 at 2 mbgs.

- The surficial soils and bedrock at Site C3 are not expected to be suitable for reuse as construction materials for the dam, operations pads, roads, and site access point.

- Groundwater at Site C3 is expected to be encountered at surface within the lake basin, and 1 mbgs on the valley slopes.
4.5 Site C4

Integrated Sustainability completed a desktop review of relevant information pertaining to Site C4 and completed a site reconnaissance at Site C4 and surrounding area on 23 July 2019. The site reconnaissance comprised on-foot traversing and advancement of shallow auger holes to verify characteristics of near-surface conditions. The Terrain Assessment Report provides a summary of results from the desktop review and site reconnaissance (Integrated Sustainability 2019i). A summary of key findings and recommendations for Site C4 are as follows:

- Approximately 400 mm of topsoil and 200 mm of subsoil stripping within the footprint of the gravity dam at Site C4 is recommended.
- Surficial soils across Site C4 are interpreted to comprise a veneer (0 m to 1 m thick) of colluvium (sands and gravels with variable amounts of silt) overlying bedrock on steep bedrock-controlled slopes, and veneers to blankets (1 m to 3 m thick) of coarse grained till overlying undulating bedrock within the lake basin.
- It is recommended that soils within the footprint of the operations pad at Site C4 are excavated to bedrock prior to placement of fill material.
- It is recommended that soils within the footprint of the gravity dam at Site C4 are excavated to bedrock, and the dam is constructed directly on bedrock.
- It is assumed that bedrock at Site C4 comprises massive to slightly fractured (1 m to 2 m fracture spacing) intrusive granodioritic rocks. The bedrock contact is interpreted to range from surface to approximately 4 mbgs. It is recommended for design purposes to assume a bedrock contact underlying the gravity dam footprint at Site C4 at 2 mbgs.
- The surficial soils and bedrock at Site C4 are not expected to be suitable for reuse as construction materials for the dam, operations pads, roads, and site access point.
- Groundwater at Site C4 is expected to be encountered at surface with the lake basin, and 1 mbgs on the valley slopes.

4.6 Site C3 and C4 Access Roads

Site access to Sites C3 and C4 will be achieved utilizing a combination of recommissioning (i.e. upgrading) existing, decommissioned roads and construction of new access roads. Two site access options for Sites C3 and C4 have been identified, both of which would be accessed from the Grey Creek FSR and then utilize existing, decommissioned roads to locations close to Sites C3 and C4, from which points new access roads would be constructed to gain direct site access. The existing, decommissioned roads proposed to be utilized in Access Road Option 1 would provide access to Sites C3 and C4 from the northwest and the existing, decommissioned roads proposed to be utilized in Access Road Option 2 would provide access to Sites C3 and C4 from the southwest. Access Road Option 1 and Access Road Option 2 consist of the following components:

- Access Road Option 1
- Approximately 9 km of existing, decommissioned road, accessed via Grey Creek Road
- Approximately 1 km of new access road

**Access Road Option 2**
- Approximately 14 km of existing, decommissioned road, accessed via Grey Creek Road
- Approximately 5 km of new access road

Integrated Sustainability completed a site reconnaissance of existing, decommissioned roads for Access Road Option 1 and Access Road Option 2 on 24 July 2019. The site reconnaissance comprised truck-access and on-foot access along the existing, decommissioned roads to assess their condition and evaluate upgrades required for recommissioning. A summary of key findings and recommendations for the existing, decommissioned roads are as follows:

- Culverts and bridges have been removed and road maintenance has not been completed since decommissioning, including clearing of vegetation, and maintenance of cut/fill slopes, ditches, and road surface grading.
- Many swales (up to 2 m deep and 4 m wide along Access Road Option 1, and up to 4 m deep and 8 m wide along Access Road Option 2) intersected the roads, some of which are resultant from removed culverts and bridges, and others developed due to surface water erosion. Surface water was observed flowing through many of the swales along Access Road Option 2.
- Vegetation on the road varied from little vegetation to the road being mostly vegetated. Vegetation was limited to grasses and shrubs up to 2 m high. No tree growth was observed on the road.
- Bedrock outcrops were observed on the road surface and along the road cut slopes, indicating near-surface bedrock. Surficial soils observed comprised sand and gravel, with cobbles and boulders.
- Some occurrences of tension cracks and slumping along the downslope side of the road was observed, primarily along Access Road Option 2.
- The roads were consistently approximately 4 m wide with some sections up to 6 m wide.
- Cut and fill slopes up to 35 degrees.
- Road centerline grades generally ranged from 5% to 20%.
- It is assumed that reactivation of Access Road Option 1 would require two new bridges. Reactivation of Access Road Option 2 would require one new bridge.
- It is assumed that reactivation of the roads along both access routes would require installation of culverts at a spacing of approximately 25 m, based on the inferred spacing of culverts previously removed during deactivation.
Key design parameters for the Sites are summarized in Table A. Further description on design criteria and assumptions for the Sites is included in Sections 5.1 through 5.6.

Table A. Summary of Key Design Parameters

<table>
<thead>
<tr>
<th>Design Parameter</th>
<th>Site A</th>
<th>Site B</th>
<th>Site C3</th>
<th>Site C4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site area (ha)</td>
<td>47.4</td>
<td>45.2</td>
<td>23.3</td>
<td>26.6</td>
</tr>
<tr>
<td>Dam type</td>
<td>Rockfill embankment dam with an upstream facing concrete membrane</td>
<td>Rockfill embankment dam with an upstream facing concrete membrane</td>
<td>Concrete gravity dam</td>
<td>Concrete gravity dam</td>
</tr>
<tr>
<td>Total operational storage volume (m³)¹</td>
<td>1,066,400</td>
<td>1,270,000</td>
<td>1,056,700³</td>
<td>764,000³</td>
</tr>
<tr>
<td>Dam crest elevation (m)</td>
<td>177.5</td>
<td>215.5</td>
<td>1,003.0</td>
<td>1,056.5</td>
</tr>
<tr>
<td>Maximum water level (MWL) elevation (m)¹</td>
<td>175.5</td>
<td>213.5</td>
<td>1,001.0</td>
<td>1,054.5</td>
</tr>
<tr>
<td>Water conveyance to site</td>
<td>Use existing Chapman Creek intake Water conveyed via pipeline Pumping required to convey water along pipeline</td>
<td>Use new intake Water conveyed from via pipeline No pumping required</td>
<td>Water conveyed via overland surface water capture</td>
<td>Water conveyed via overland surface water capture</td>
</tr>
<tr>
<td>Design Parameter</td>
<td>Site A</td>
<td>Site B</td>
<td>Site C3</td>
<td>Site C4</td>
</tr>
<tr>
<td>-------------------------------------------------------</td>
<td>---------------------------------------</td>
<td>---------------------------------------</td>
<td>---------------------------------------</td>
<td>---------------------------------------</td>
</tr>
<tr>
<td>Water conveyance from site to Chapman Creek WTP</td>
<td>Water conveyed via pipeline</td>
<td>Water conveyed via pipeline</td>
<td>Water conveyed via overland drainage and pipeline, via existing Chapman Creek intake</td>
<td>Water conveyed via overland drainage and pipeline, via existing Chapman Creek intake</td>
</tr>
<tr>
<td>Water conveyed via pipeline</td>
<td>Pumping required to convey water out of reservoir and to convey water along pipeline</td>
<td>Pumping required to convey water out of reservoir, no pumping required to convey water along pipeline</td>
<td>Pumping required to convey water out of reservoir and to convey water along pipeline</td>
<td>Pumping required to convey water out of reservoir and to convey water along pipeline</td>
</tr>
<tr>
<td>Maximum dam height, H (m²)</td>
<td>13.5</td>
<td>12.0</td>
<td>13.5</td>
<td>14.7</td>
</tr>
<tr>
<td>Topsoil stripping volume (m³)</td>
<td>43,300</td>
<td>36,780</td>
<td>3,231</td>
<td>3,087</td>
</tr>
<tr>
<td>Subsoil stripping volume (m³)</td>
<td>39,900</td>
<td>39,970</td>
<td>1,615</td>
<td>1,543</td>
</tr>
<tr>
<td>Overburden excavation volume (m³)</td>
<td>883,200</td>
<td>725,293</td>
<td>15,174</td>
<td>9,322</td>
</tr>
<tr>
<td>Bedrock excavation volume (m³)</td>
<td>271,300</td>
<td>267,418</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Overburden to stockpile (m³)</td>
<td>0</td>
<td>0</td>
<td>12,140</td>
<td>6,288</td>
</tr>
<tr>
<td>Bedrock to stockpile (m³)</td>
<td>188,500</td>
<td>256,468</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
### Design Parameter

<table>
<thead>
<tr>
<th>Design Parameter</th>
<th>Site A</th>
<th>Site B</th>
<th>Site C3</th>
<th>Site C4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Embankment, access, and pad fill (m³)</td>
<td>966,000</td>
<td>736,243</td>
<td>3,034</td>
<td>3,034</td>
</tr>
</tbody>
</table>

#### Notes:

1. Assumes a freeboard of 2 m between the dam crest and maximum water level elevations.

2. Maximum dam height, H, and maximum reservoir volume, V, have been maintained such that \( H^2 \times V < 200 \), so as not to trigger the dam height thresholds for ‘large dams’ as defined by ICOLD (ICOLD 2011, 2016). At Sites A and B, H is measured as the difference in elevation between the minimum water level elevation (reservoir base) and the maximum dam crest elevation. At Sites C3 and C4, H is measured as the difference in elevation between the outlet creek bed elevation and the maximum dam crest elevation.

3. Storage volume excludes any existing water not captured by LiDAR. Volume will need to be refined once additional information is available.

### 5.1 Regulations, Codes, Standards, and Guidelines

The Sites will, at a minimum, be licenced under the Water Sustainability Act in accordance with BC DSR requirements. The design criteria described in this Design Summary Report for the Sites will conform to conditions set forth by the following regulatory bodies and the most recent editions of the following regulations, codes, standards, and guidelines:

- Water Sustainability Act (BC Government 2014)
- BC DSR (BC Government 2016a, 2016b)
- Canadian Dam Association Dam Safety Guidelines (CDA 2007)
- International Commission on Large Dams (ICOLD) (ICOLD 2011, 2016)
- BC Safety Standards Act (BC Government 2003a)
- BC Land Act (BC Government 2019)
- BC Environmental Assessment Act (BC Government 2002a)
- BC Agricultural Land Reserve General Regulation (BC Government 2002b)
- BC Drinking Water Protection Act (BC Government 2003b)
- Fisheries and Oceans Canada (DFO) (DFO 2019)
- Canadian Environmental Assessment Act (CEAA) (Government of Canada 2012)
- BC Building Code (2018b)
During future design stages, as the design criteria included in this Design Summary Report is expanded upon and added to, the above list will be updated to include specific regulations, codes, standards, and guidelines conformed to within various aspects of the design.

5.2 Consequence of Failure Classification

Early stage consequence of failure classifications for each of the Sites were completed during Phase 3 of the Project. Results are summarized in reports for each of the Sites (Integrated Sustainability 2019n, 2019o, 2019p, and 2019q). Detailed consequence of failure classifications will be completed during future design stages.

5.3 Site A

The following criteria and assumptions were used as basis for the conceptual design:

- Development area of approximately 47.4 hectares (ha).
- One storage reservoir, comprising below-grade excavation and an embankment dam above grade to achieve the design storage volume.
- Excavated materials to be used as fill, with excess materials stockpiled onsite.
- Surface water management infrastructure.
- Two operations pads.
- Site access.
- Wildlife mitigation and security fencing.
- Water conveyance piping (details to be determined during future design stages).
- Outtake structure and pumps to convey water into and out of the reservoir (details to be determined during detailed design).
- Instrumentation and controls systems.
- Access and operations are planned for 365 days a year.
- Infrastructure is considered to be permanent (minimum of 50-year lifespan).
- Routine sediment removal will be required and is assumed to include dredging of the reservoir (details to be determined during future design stages).
- It is assumed that the storage capacity of the reservoir may be expanded in the future (by increasing dam height or by expanding reservoir footprint).

5.3.1 Site Preparation and Earthworks

The site preparation and earthworks at Site A will be designed based on the following parameters and assumptions:

- Tree clearing, and grubbing will be dictated by requirements for site access, construction and laydown areas, and regulatory requirements.
The existing organic layers (i.e. topsoil and subsoil) will be stripped completely within the confines of areas designed for development and stockpiled separately onsite. Topsoil and subsoil depths of 100 mm have been assumed based on the Terrain Assessment site reconnaissance (Section 4.2) and have been used to estimate topsoil and subsoil stripping and stockpiling requirements (to be confirmed based on recommendations provided following a geotechnical and environmental assessment and incorporated during future design stages). The post-stripping surface will be the basis of the earthworks design.

Topsoil and subsoil stockpiles will be sloped at 4H:1V. A 30% bulking factor will be applied for topsoil and subsoil stockpile sizing. Topsoil and subsoil stockpile slope angles should be confirmed based on geotechnical recommendations during future design stages.

An overburden thickness ranging from 2 mbgs at the north end of Site A to 5 mbgs at the south end of Site A has been assumed based on the Terrain Assessment site reconnaissance (Section 4.2) and has been used to estimate approximate excavation volumes of soil and bedrock and stockpiling requirements (to be confirmed based on geotechnical recommendations and incorporated during future design stages).

Soil and bedrock will be excavated to achieve the target storage volume. It is assumed that excavated soil will be used for construction of embankments first. Processed, excavated rock will be used for construction of the operations pads and site access road.

The footprint of the embankment dam will be over excavated to bedrock to create a foundation for the dam.

The diaphragm rockfill embankment dam will be constructed using suitable native material, including soil and bedrock. It is assumed that excavated bedrock will be processed to produce rockfill suitable for embankment construction. Gradation requirements and processing methods should be determined based on geotechnical recommendations during future design stages.

Excess excavated bedrock will be stockpiled in an excavation stockpile, which will be sloped at 3H:1V. A bulking factor of 80% will be applied to the excavated bedrock for stockpile sizing. Excavation stockpile slope angles and bulking factors should be confirmed based on geotechnical recommendations during future design stages.

Stockpiles will be positioned onsite with offset distances from the reservoir crests and nearby buried utilities to avoid excessive loading, and to avoid interference with construction activities and access points (offset distances will be determined based on geotechnical recommendations and incorporated during future design stages).

The reservoir and stockpiles at Site A should be positioned such that a minimum setback of 50 m is maintained between the toes of the embankment dam and stockpiles and the steep area to the south and southwest. This setback distance is
measured from approximately El. 163 m to the south and the Sechelt-Airport FSR to the west.

- The operations pads, tops of the embankment dam, and access road will be graveled to maintain a workable surface, as detailed in Section 5.3.6.

### 5.3.2 Storage Reservoir

The reservoir will generally be designed based on the following parameters and assumptions:

- Embankment dam crest elevation at El. 177.5 m.
- Maximum water level (MWL) at El. 175.5 m.
- Maximum dam height of less than 15 m, measured as the difference in elevation between the minimum water level elevation (reservoir base) and the maximum dam crest elevation, so as not to trigger the dam height thresholds for ‘large dams’ as defined by ICOLD (ICOLD 2011, 2016).
- Maximum dam height, \( H \), and maximum reservoir volume, \( V \), such that \( H^2 \times \sqrt{V} < 200 \), where \( H \) is measured as the difference in elevation between the minimum water level elevation (reservoir base) and the maximum dam crest elevation, so as not to trigger the dam height thresholds for ‘large dams’ as defined by ICOLD (ICOLD 2011, 2016).
- Minimum reservoir operating volume of approximately 1,066,400 m³.
- Upstream embankment dam slopes of 3H:1V and downstream embankment dam slopes of 4H:1V. Slope angles should be verified based on geotechnical recommendations during future design stages to maintain a design minimum factor of safety.
- Assumed normal freeboard allowance of 2.0 m at MWL (details to be determined during future design stages).
- Emergency spillway with an assumed depth of 1.0 m and assumed minimum width of 6.0 m (details to be determined during future design stages).
- Perimeter access will provide light vehicle and personnel access around the reservoir for inspection and maintenance only (no public access).
- Embankment dam crest widths of 10 m, to allow space for perimeter access and barriers on either side of the embankment crest (to be confirmed during future design stages).
- Guard rails along the inner and outer edges of the embankment dam crest to provide a safety barrier.
- Recommendations on acceptable embankment settlement should be provided following a geotechnical study and incorporated in future design stages.
- It is assumed that the embankment dam will be founded directly on bedrock.
- The foundation will be treated to minimize seepage through the foundation and provide sufficient friction between the foundation and dam base. Foundation treatment may include rock shaping/scraping and grouting and will be determined during future design stages.

- An upstream facing concrete diaphragm on the upstream slopes of the embankment dam will be used to create an impervious barrier on the upstream face of the embankment dam and will comprise reinforced concrete. The concrete membrane shall have physical properties (i.e. density, strength, flexibility, permeability, weather resistance) that are fit for the purpose intended.

- A concrete diaphragm thickness of 500 mm has been assumed (to be determined during future design stages).

- Drains and filters will be used to manage groundwater flow from the upstream reservoir side slopes and base, as well as seepage (details to be determined during future design stages).

- It is assumed that seepage management will be required within the dam foundation to reduce and manage system below the embankment dam and to achieve a seal between the dam membrane and foundation. A concrete cut-off wall or other similar structure may be used (details to be determined during future design stages).

- It is assumed that the entire base of the reservoir will comprise bedrock. The base of the reservoir and side slopes will be grouted as needed to prevent seepage into the substrate. Grouting requirements will be based on geotechnical recommendations and determined during future design stages.

5.3.3 Site Access

Site access design and considerations will generally be based on the following parameters and assumptions:

- One site access point, located on the west side of Site A.

- Site A will be accessed via the Sechelt-Airport FSR located directly west of Site A. The site access road will be used to gain direct access to Site A. The site access road is assumed to be approximately 120 m long and have a minimum width of 6 m.

- Configuration of site infrastructure to allow for future access to excavation stockpile for the purposes of hauling excavated rock offsite.

5.3.4 Operations Pads

The operations pad design will generally be based on the following parameters and assumptions:

- Two operations pads, one on the east end and one on the west end of the reservoir, each with a minimum width of 30 m wide to provide space for intake/outtake structures, equipment laydown, rockfill material processing, staging area, and/or space for other operations requirements.
- A minimum cross slope of 1% across the operations pads away from the embankment dam for drainage.
- The operations pads will be accessed as follows:
  - Access onto the west operations pad from the site access point
  - Access to the east operations pad via the west operations pad and south embankment dam crest

5.3.5 Surface Water Management

The site grading plan will manage surface water within Site A and reduce erosion of any areas down slope of Site A, as well as control surface water and reduce erosion along the site access road. The grading plan may comprise berms, swales, ditches, and culverts to control surface water within the site boundary. The grading plan will be designed based on the following parameters:

- Infrastructure will be sized to control, at a minimum, the 1-in-25 year, 24-hour storm event using historical weather data from the Gibsons weather station (#1043150) (to be confirmed during future design stages).
- Surfaces will be designed with erosion and sediment control mitigation measures where required (e.g. hydroseeding, riprap, erosion control blankets, check dams, etc.).
- Maintain minimum depth for ditches at 0.5 m wherever possible, shallower depths will be confirmed if needed.
- Maintain minimum depth for swales at 0.3 m wherever possible, shallower depths will be confirmed if needed.
- Maintain minimum slope for ditches at 0.5% wherever possible, lesser slopes will be confirmed if needed.
- Ditch and swale side slopes will be 3H:1V.
- Minimum slope for culverts will be 1.0%.
- Culverts will act under gravity flow for the design storm event.

5.3.6 Trafficable Surfaces

Trafficable surfaces for the operations pads, reservoir perimeter access road, and site access road will consist of the following, as a minimum, from top to bottom:

- A 75 mm thick 25 mm crushed gravel
- A 300 mm thick 80 mm crushed gravel
- Compacted fill

It is assumed that gravel and compacted fill for trafficable surfaces will comprise material excavated during construction of the reservoir and processed as needed.
The thickness of the trafficable surfaces will be fit for purpose and assumes that the SCRD will maintain the surface when unsuitable deformation and ruts have formed.

5.3.7 Site Security and Wildlife Mitigation

The site security system will consist of a perimeter chain link fence to prevent unauthorized personnel from entering surrounding the operational portion of Site A. In addition, the perimeter security fence will also act as a terrestrial wildlife deterrent to prevent terrestrial wildlife from entering the site. The site security system will be designed as follows:

- Standard chain link fencing (minimum 2 m in height) encompassing the perimeter of the reservoir and operations pads (excluding the stockpiles)
- Cantilever sliding gates positioned at the site access point

5.3.8 Water Conveyance

Water intake/outtake, conveyance piping, and pump systems have been included in the design, based on the following criteria and assumptions:

- Incoming water and outflowing water will be conveyed to and from Site A, respectively, from an assumed tie-point on the existing Chapman raw water pipeline which is at approximately El. 155 m via a 508 mm (20”) high density polyethylene (HDPE) pipe. This pipe was sized based on the maximum daily water deficit during the month of August (peak water demand) (Integrated Sustainability 2018a), a maximum velocity of 3.1 m/s, and a maximum pressure drop of 12.8 kPa/100 m.
- A conceptual pipeline route has been assumed based on review of topography. The length of the assumed pipeline route is approximately 1,700 m.
- Water will be transferred at a design flow rate of 42,000 m³/day into and out of the reservoir, assuming a 20% water conservation model and 2050 population, based on the results of the Water Demand Analysis (Integrated Sustainability 2018a).
- The flowrate out of the reservoir is based on the maximum daily demand flowrate in August (Integrated Sustainability 2018a), which assumes a 20% water conservation scenario and a population of 43,000 in year 2050.
- The flowrate into the reservoir was assumed to be the same as the flowrate out of the reservoir to allow for utilization of the same piping (flow rates to be confirmed and refined as needed during future design stages). The available flow from Chapman Creek in winter was referenced in the 2014 Watershed Assessment (Horel 2014). The Chapman Creek watershed flowrate in the months of November to March averages over 400,000 m³/day.
- Water is assumed to be conveyed directly into the reservoir from the water conveyance pipeline at the location along the west crest of the embankment dam.
- The water outtake structure is designed based on the following assumptions:
Design and positioning of outtake structure to avoid pipe penetration of the embankment dam, to minimize risk to stability of embankment dam and to avoid routing of pipeline through bedrock.

- A concrete caisson will be installed at the base of the inner embankment dam side slope.
- The outtake pumps will be installed in a pump building situated on top of the caisson. It is assumed that two vertical line shaft vertical turbine pumps will be used (to be confirmed during future design stages).
- A metal platform/walkway will extend from the west embankment dam crest to the pump building to allow operations access and conveyance pipeline connection from the west operations pad.

- Preliminary sizing for pumps for water conveyance into and out of the reservoir assume the following:
  - Pumps have been designed to have 100% redundancy (Government of BC 2012).
  - Two 100 KPag incoming water pumps have been assumed for conveying water to the reservoir (to be verified based on vendor quotes).
  - The incoming water pumps are assumed to be located in a building at the tie-point on the existing Chapman raw water pipeline at an elevation of El. 155 m.
  - A static pressure of 276 kPag in the existing Chapman raw water pipeline was assumed (pressures provided by the SCRD, Raph Shay and Trevor Rutley, email correspondence, 05 September 2019).
  - Outlet of pipe at the reservoir assumed to be located at the embankment dam crest elevation (El. 177.5 m).
  - Two 350 KPag static pressure outtake pumps have been assumed for conveying water from the reservoir (to be verified based on vendor quotes).
  - The outtake pumps are assumed to be located in a pump building on the outtake structure. The pump building will comprise, at a minimum, an electrical pump and hypochlorite rooms with emergency backup generator.

- It is assumed that all pumps will be controlled using a Supervisory Control and Data Acquisition (SCADA) system. Details on instrumentation and controls will be provided in future design stages.

5.4 Site B

The following criteria and assumptions were used as basis for the conceptual design:

- Development area of approximately 45.2 ha.
- One storage reservoir, comprising below-grade excavation and an embankment dam above grade to achieve the design storage volume.
- Excavated materials to be used as fill, with excess materials stockpiled onsite.
- Surface water management infrastructure.
- Two operations pads.
- Site access.
- Wildlife mitigation and security fencing.
- A new water intake on Chapman Creek at El. 300 m (details to be determined during future design stages).
- Water conveyance piping (details to be determined during future design stages).
- Outtake structure and outtake pumps to convey water out of the reservoir (details to be determined during detailed design).
- Instrumentation and controls systems.
- Access and operations are planned for 365 days a year.
- Infrastructure is considered to be permanent (minimum of 50-year lifespan).
- Routine sediment removal will be required and is assumed to include dredging of the reservoir (details to be determined during future design stages).
- It is assumed that the storage capacity of the reservoir may be expanded in the future (by increasing dam height or by expanding reservoir footprint).

5.4.1 Site Preparation and Earthworks

The site preparation and earthworks at Site B will be designed based on the following parameters and assumptions:

- Tree clearing, and grubbing will be dictated by requirements for site access, construction and laydown areas, and regulatory requirements.
- The existing organic layers (i.e. topsoil and subsoil) will be stripped completely within the confines of areas designed for development and stockpiled separately onsite. Topsoil and subsoil depths of 100 mm have been assumed based on the Terrain Assessment site reconnaissance (Section 4.3) and have been used to estimate topsoil and subsoil stripping and stockpiling requirements (to be confirmed based on recommendations provided following a geotechnical and environmental assessment and incorporated during future design stages). The post-stripping surface will be the basis of the earthworks design.
- Topsoil and subsoil stockpiles will be sloped at 4H:1V. A 30% bulking factor will be applied for topsoil and subsoil stockpile sizing. Topsoil and subsoil stockpile slope angles should be confirmed based on geotechnical recommendations during future design stages.
- An overburden thickness of 3 m has been assumed based on the Terrain Assessment site reconnaissance (Section 4.3) and has been used to estimate approximate excavation volumes of soil and bedrock and stockpiling requirements (to be
confirmed based on geotechnical recommendations and incorporated during future design stages).

- Soil and bedrock will be excavated to achieve the target storage volume. It is assumed that excavated soil will be used for construction of embankments first. Processed, excavated rock will be used for construction of the operations pads and site access road.
- The footprint of the embankment dam will be over excavated to bedrock to create a foundation for the dam.
- The diaphragm rockfill embankment dam will be constructed using suitable native material, including soil and bedrock. It is assumed that excavated bedrock will be processed to produce rockfill suitable for embankment construction. Gradation requirements and processing methods should be determined based on geotechnical recommendations during future design stages.
- Excess excavated bedrock will be stockpiled in an excavation stockpile, which will be sloped at 3H:1V. A bulking factor of 80% will be applied to the excavated bedrock for stockpile sizing. Excavation stockpile slope angles and bulking factors should be confirmed based on geotechnical recommendations during future design stages.
- Stockpiles will be positioned onsite with offset distances from the reservoir crests and nearby buried utilities to avoid excessive loading, and to avoid interference with construction activities and access points (offset distances will be determined based on geotechnical recommendations and incorporated during future design stages).
- The operations pads, tops of the embankment dam, and access road will be graveled to maintain a workable surface, as detailed in Section 5.4.6.

5.4.2 Storage Reservoir

The reservoir will generally be designed based on the following parameters and assumptions:

- Embankment dam crest elevation at El. 215.5 m.
- MWL at El. 213.50 m.
- Maximum dam height of less than 15 m, measured as the difference in elevation between the minimum water level elevation (reservoir base) and the maximum dam crest elevation, so as not to trigger the dam height thresholds for ‘large dams’ as defined by ICOLD (ICOLD 2011, 2016).
- Maximum dam height, \( H \), and maximum reservoir volume, \( V \), such that \( H^2 \times \sqrt{V} < 200 \), where \( H \) is measured as the difference in elevation between the minimum water level elevation (reservoir base) and the maximum dam crest elevation, so as not to trigger the dam height thresholds for ‘large dams’ as defined by ICOLD (ICOLD 2011, 2016).
- Minimum reservoir operating volume of approximately 1,270,000 m\(^3\).
- Upstream embankment dam slopes of 3H:1V and downstream embankment dam slopes of 4H:1V. Slope angles should be verified based on geotechnical recommendations during future design stages to maintain a design minimum factor of safety.
- Assumed normal freeboard allowance of 2.0 m at MWL (details to be determined during future design stages).
- Emergency spillway with an assumed depth of 1.0 m and assumed minimum width of 6.0 m (details to be determined during future design stages).
- Perimeter access will provide light vehicle and personnel access around the reservoir for inspection and maintenance only (no public access).
- Embankment dam crest widths of 10 m, to allow space for perimeter access and barriers on either side of the embankment crest (to be confirmed during future design stages).
- Guard rails along the inner and outer edges of the embankment dam crest to provide a safety barrier.
- Recommendations on acceptable embankment settlement should be provided following a geotechnical study and incorporated in future design stages.
- It is assumed that the embankment dam will be founded directly on bedrock.
- The foundation will be treated to minimize seepage through the foundation and provide sufficient friction between the foundation and dam base. Foundation treatment may include rock shaping/scraping and grouting and will be determined during future design stages.
- An upstream facing concrete diaphragm on the upstream slopes of the embankment dam will be used to create an impervious barrier on the upstream face of the embankment dam and will comprise reinforced concrete. The concrete membrane shall have physical properties (i.e. density, strength, flexibility, permeability, weather resistance) that are fit for the purpose intended.
- A concrete diaphragm thickness of 500 mm has been assumed (to be determined during future design stages).
- Drains and filters will be used to manage groundwater flow from the upstream reservoir side slopes and base, as well as seepage (details to be determined during future design stages).
- It is assumed that seepage management will be required within the dam foundation to reduce and manage system below the embankment dam and to achieve a seal between the dam membrane and foundation. A concrete cut-off wall or other similar structure may be used (details to be determined during future design stages).
- It is assumed that the entire base of the reservoir will comprise bedrock. The base of the reservoir and side slopes will be grouted as needed to prevent seepage into the
substrate. Grouting requirements will be based on geotechnical recommendations and determined during future design stages.

5.4.3 Site Access

Site access design and considerations will generally be based on the following parameters and assumptions:

- One site access point, located on the west side of Site B.
- Site B will be accessed via the Sechelt-Airport FSR located directly west of Site B. The site access road will be used to gain direct access to Site B. The site access road is assumed to be approximately 150 m long and have a minimum width of 6 m.
- Configuration of site infrastructure to allow for future access to excavation stockpile for the purposes of hauling excavated rock offsite.

5.4.4 Operations Pads

The operations pad design will generally be based on the following parameters and assumptions:

- Two operations pads, one on the east end and one on the west end of the reservoir, each with a minimum width of 30 m wide to provide space for intake/outtake structures, equipment laydown, rockfill material processing, staging area, and/or space for other operations requirements.
- A minimum cross slope of 1% across the operations pads away from the embankment dam for drainage.
- The operations pads will be accessed as follows:
  - Access onto the west operations pad from the site access point
  - Access to the east operations pad via the west operations pad and south embankment dam crest

5.4.5 Surface Water Management

The site grading plan will manage surface water within Site B and reduce erosion of any areas down slope of Site B, as well as control surface water and reduce erosion along the site access road. The grading plan may comprise berms, swales, ditches, and culverts to control surface water within the site boundary. The grading plan will be designed based on the following parameters:

- Infrastructure will be sized to control, at a minimum, the 1-in-25 year, 24-hour storm event using historical weather data from the Gibsons weather station (#1043150) (to be confirmed during future design stages).
- Surfaces will be designed with erosion and sediment control mitigation measures where required (e.g. hydroseeding, riprap, erosion control blankets, check dams, etc.).
- Maintain minimum depth for ditches at 0.5 m wherever possible, shallower depths will be confirmed if needed.
- Maintain minimum depth for swales at 0.3 m wherever possible, shallower depths will be confirmed if needed.
- Maintain minimum slope for ditches at 0.5% wherever possible, lesser slopes will be confirmed if needed.
- Ditch and swale side slopes will be 3H:1V.
- Minimum slope for culverts will be 1.0%.
- Culverts will act under gravity flow for the design storm event.

5.4.6 Trafficable Surfaces
Trafficable surfaces for the operations pads, reservoir perimeter access road, and site access road will consist of the following, as a minimum, from top to bottom:
- A 75 mm thick 25 mm crushed gravel
- A 300 mm thick 80 mm crushed gravel
- Compacted fill
It is assumed that gravel and compacted fill for trafficable surfaces will comprise material excavated during construction of the reservoir and processed as needed.
The thickness of the trafficable surfaces will be fit for purpose and assumes that the SCRD will maintain the surface when unsuitable deformation and ruts have formed.

5.4.7 Site Security and Wildlife Mitigation
The site security system will consist of a perimeter chain link fence to prevent unauthorized personnel from entering surrounding the operational portion of Site B. In addition, the perimeter security fence will also act as a terrestrial wildlife deterrent to prevent terrestrial wildlife from entering the site. The site security system will be designed as follows:
- Standard chain link fencing (minimum 2 m in height) encompassing the perimeter of the reservoir and operations pads (excluding the stockpiles)
- Cantilever sliding gates positioned at the site access point

5.4.8 Water Conveyance
Water intake/oultake, conveyance piping, and pump systems have been included in the design, based on the following criteria and assumptions:
- An intake location on Chapman Creek at approximately El. 300 m, known as the POD Site B intake, was assumed, based on recommendations provided by Integrated Sustainability following a POD assessment at four sites (POD Sites 1 through 4) (Integrated Sustainability 2019f), as well as input provided by SCRD in a meeting on
20 September 2019). Confirmation of a POD location and intake design to support conveyance of water to Site B should be completed in future design stages.

- Incoming water will be conveyed to the reservoir at Site B from a new water intake at El. 300 m, via a 508 mm (20") HDPE pipe.
- Outgoing water will be conveyed using gravity flow to an assumed tie-point on the existing Chapman raw water pipeline, which is assumed to be located at El. 155 m, via a 508 mm (20") HDPE pipe. This pipe was sized based on the maximum daily water deficit during the month of August (peak water demand) (Integrated Sustainability 2018a), a maximum velocity of 3.1 m/s, and a maximum pressure drop of 12.8 kPa/100 m.
- Conceptual pipeline routes have been assumed based on review of topography. The length of the assumed pipeline route from the intake to the reservoir is 3,900 m. The length of the assumed pipeline route from the reservoir to the assumed tie point on the existing Chapman water pipeline is 500 m.
- The water will be transferred at a design flow rate of 42,000 m³/day in both pipelines.
- The flowrate out of the reservoir is based on the maximum daily demand flowrate in August (Integrated Sustainability 2018a), which assumes a 20% water conservation scenario and a population of 43,000 in year 2050.
- Pumps are not required for conveying water from the new intake to the reservoir at Site B.
- Water is assumed to be conveyed directly into the reservoir from the incoming water conveyance pipeline at the location along the west crest of the embankment dam.
- The water outtake structure is designed based on the following assumptions:
  - Design and positioning of outtake structure to avoid pipe penetration of the embankment dam, to minimize risk to stability of embankment dam and to avoid routing of pipeline through bedrock.
  - A concrete caisson will be installed at the base of the inner embankment dam side slope.
  - The outtake pumps will be installed in a pump building situated on top of the caisson. It is assumed that the two vertical line shaft vertical turbine pumps will be used (to be confirmed during future design stages).
  - A metal platform/walkway will extend from the west embankment dam crest to the pump building to allow operations access and conveyance pipeline connection from the west operations pad.
- Preliminary sizing for pumps for water conveyance out of the reservoir assume the following:
  - Pumps have been designed to have 100% redundancy (Government of BC 2012).
A static pressure of 276 kPag in the existing Chapman raw water pipeline was assumed (pressures provided by the SCRD, Raph Shay and Trevor Rutley, email correspondence, 05 September 2019).

Outlet of pipe at the reservoir located at the embankment dam crest elevation (215.5 m).

Two 200 kPag static pressure outtake pumps have been assumed for conveying water from the reservoir (to be verified based on vendor quotes).

The outtake pumps are assumed to be located in a pump building on the outtake structure. The pump building will comprise, at a minimum, an electrical pump and hypochlorite rooms with emergency backup generator.

- It is assumed that all pumps will be controlled using a Supervisory Control and Data Acquisition (SCADA) system. Details on instrumentation and controls will be provided in future design stages.

5.5 Site C3

The following criteria and assumptions were used as basis for the conceptual design:

- Development area of approximately 23.3 ha
- Concrete gravity dam positioned at the downstream, south end of subalpine lake basin at the outlet to Tswacome Creek
- Excess excavation materials stockpiled adjacent to the site access road
- Surface water management infrastructure
- Operations area allowance
- Site access
- Site security
- Instrumentation and controls systems
- Access and operations are planned for 365 days a year
- Infrastructure is expected to be permanent (minimum of 50-year lifespan)

5.5.1 Site Preparation and Earthworks

The site preparation and earthworks at Site C3 will be designed based on the following parameters and assumptions:

- Tree clearing, and grubbing will be dictated by requirements for site access, construction and laydown areas, and regulatory requirements. It is assumed that the dam footprint, operations area allowance, and access road will be cleared and grubbed, as well as allowance for construction activities. The remaining site area is not assumed to be cleared and grubbed.
- The existing organic layers (i.e. topsoil and subsoil) will be stripped completely below the concrete gravity dam and operations pad footprints. Topsoil and subsoil will be
stockpiled separately adjacent to the site access roads. Topsoil depths of 400 mm and subsoil depths of 200 mm have been assumed based on the Terrain Assessment site reconnaissance (Section 4.4) and have been used to estimate topsoil and subsoil stripping and stockpiling requirements (to be confirmed based on recommendations provided following a geotechnical and environmental assessment and incorporated during future design stages). The post stripping surface will be the basis of the earthworks design.

- Topsoil and subsoil stockpiles will be sloped at 4H:1V. A 30% bulking factor will be applied for topsoil and subsoil stockpile sizing. Topsoil and subsoil stockpile slope angles should be confirmed based on geotechnical recommendations during future design stages.
- The footprint of the concrete gravity dam will be over excavated to bedrock to create a foundation for the dam.
- An overburden thickness of 2 m has been assumed below the concrete gravity dam and operations pad based on the Terrain Assessment site reconnaissance (Section 4.4) and has been used to estimate approximate excavation volumes and stockpiling requirements (to be confirmed based on geotechnical recommendations and incorporated during future design stages).
- Excavated soil will be stockpiled in a common excavation stockpile, which will be sloped at 3H:1V. A bulking factor of 30% will be applied to the excavated soil for stockpile sizing. Excavation stockpile slope angles and bulking factors should be confirmed based on geotechnical recommendations during future design stages.
- Stockpiles will be positioned adjacent to site access roads with offset distances from the dam and operations pad to avoid excessive loading, and to avoid interference with construction activities and access points (offset distances will be determined based on geotechnical recommendations and incorporated during future design stages).
- The operations are allowance and access road will be graveled to maintain a workable surface, as detailed in Section 5.5.6.

5.5.2 Storage Reservoir

The reservoir will generally be designed based on the following parameters and assumptions:

- Dam crest elevation at El. 1,005 m.
- MWL of approximately El. 1,003 m (to be updated during future design stages).
- Maximum dam height of less than 15 m, measured as the difference in elevation between the outlet creek bed elevation and the maximum dam crest elevation, so as not to trigger the dam height thresholds for ‘large dams’ as defined by ICOLD (ICOLD 2011, 2016).
Maximum dam height, $H$, and maximum reservoir volume, $V$, such that $H^2 \times \sqrt{V} < 200$, where $H$ is measured as the difference in elevation between the outlet creek bed elevation and the maximum dam crest elevation, so as not to trigger the dam height thresholds for ‘large dams’ as defined by ICOLD (ICOLD 2011, 2016).

Minimum reservoir operating volume of approximately 1,056,700 m$^3$, based on the following considerations:

- At this stage in design, the design volume excludes the volume of the existing water body at Site C3 (due to limitations of topography data to capture the lake bottom surface). In future design stages, the design volume should be updated using bathymetry data for the existing water body.

- Reservoir has been sized based on the maximum reservoir height, $H$, and volume, such as to not trigger thresholds for ‘large dams’ as defined by ICOLD (ICOLD 2011, 2016). Annual and monthly water availability are summarized in the Sites C3 and C4 Hydrological Study (Integrated Sustainability 2019h) and should be considered in future design stages.

- Given that water is assumed to be conveyed to the Chapman Creek WTP via overland flow in Tsawcome Creek and Chapman Creek, losses due to infiltration or evaporation may reduce the total volume conveyed to the Chapman Creek WTP from the volume stored at the reservoir.

Upstream dam slopes of 1H:10V and downstream dam slopes of 1H:1V. Slope angles should be verified based on structural and geotechnical recommendations during future design stages to maintain a design minimum factor of safety.

The dam will be constructed with roller-compacted concrete (RCC). The concrete shall have physical properties (i.e. density, strength, flexibility, permeability, weather resistance) that are fit for the purpose intended (to be determined during future design stages).

During construction of the dam, a cofferdam and water diversion will need to be installed upstream of the dam footprint to isolate the construction area. Details of the cofferdam and water diversion will be determined during future design stages.

Assumed normal freeboard allowance of 2.0 m at MWL (details to be determined during future design stages).

Emergency spillway with an assumed depth of 1.0 m and assumed minimum width of 6.0 m (details to be determined during future design stages).

Dam crest width of 10 m, to allow space for access and barriers on either side of the dam (to be confirmed during future design stages).

Guard rails along the inner and outer edges of the dam crest to provide a safety barrier.

Recommendations on acceptable dam settlement should be provided following a geotechnical study and incorporated in future design stages.
- It is assumed that the dam will be founded directly on bedrock. The base of the dam will be grouted as needed to prevent seepage into the substrate. Grouting requirements will be based on geotechnical recommendations and determined during future design stages.
- The foundation will be treated to minimize seepage through the foundation and provide sufficient friction between the foundation and dam base. Foundation treatment may include rock shaping/scraping and grouting and will be determined during future design stages.
- Drains will be required to manage seepage into the dam foundation (details to be determined during future design stages).

5.5.3 Site Access

Site access to Site C3 will be achieved with a combination of recommissioning (i.e. upgrading) existing, decommissioned roads and construction of a new access road to gain direct site access. There are currently two site access options, as described in Section 4.6.

Assumed upgrades required for recommissioning existing, decommissioned roads are as follows:
- Brushing of vegetation (assume brush less than 2 m high).
- Road grading and ditching.
- Culvert installation (assume culvert spacing of 25 m).
- Bridge upgrades (assume two bridges along Access Road Option 1 and one bridge along Access Road Options 2). Bridges will have loading capacities sufficient for construction and operations.
- Construction of pullouts along existing road to allow for two-way traffic (assume pullout spacing of 500 m).
- No road widening will be required, other than at pullouts.

Design parameters for new access roads are as follows (to be refined during future design phases):
- Direct access to the dam crest.
- The existing organic layers (i.e. topsoil and subsoil) will be stripped completely within the new access road footprint. Topsoil and subsoil depths of 100 mm have been assumed and have been used to estimate topsoil and subsoil stripping and stockpiling requirements (to be confirmed during future design stages).
- The road surface will be constructed with cut and fill using native materials (bedrock and surficial soils).
- The design will aim to achieve a cut / fill balance, where possible.
Cut and fill slopes will be a minimum of 1.5H:1V (to be confirmed in future design stages).

Road width will be a minimum of 6 m.

Culverts will be required every 25 m. This assumption is based on approximate culvert spacing along existing, decommissioned roads, and will be verified and refined as needed during future design stages.

No bridges will be required.

A maximum road grade of 10%.

5.5.4 Operations Area Allowance

An allowance for site operations has been included in the design based on the following parameters and assumptions:

- The dam crest will be accessed directly from the west via the site access road to facilitate site operations (as per Section 5.5.3).
- An additional allowance for site operations has been assumed at a location along the site access road to accommodate equipment laydown and turnaround. A minimum width of 20 m along this section of the site access road shall be used as the basis of design and will be refined during future design stages. The exact location and dimensions will be constrained by the terrain surrounding the subalpine lake basin.
- A minimum cross slope of 1% across the operations pads away from the reservoir for drainage.

During construction, it is assumed that an additional space allowance will be required for a concrete batch plant and aggregate stockpiles for dam construction, as well as to provide space for equipment laydown and turnaround, staging, and space for other construction requirements. Given the steep topography and shallow bedrock at Site C3, it is assumed that this area will be located within the proposed footprint of the reservoir (at lower elevations than the site access road) and will be temporary in nature (active construction only). Details on this construction area allowance should be confirmed during future design stages.

5.5.5 Surface Water Management

The site grading plan will manage surface water within Site C3 and reduce erosion of any areas downstream of Site C3, as well as control surface water and reduce erosion along the site access road (recommissioned and new) and operations pad. The grading plan may comprise berms, swales, ditches, and culverts to control surface water within the site boundary. The grading plan will be designed based on the following parameters:

- Infrastructure will be sized to control, at a minimum, the 1-in-25 year, 24-hour storm event using historical weather data from the Gibsons weather station (#1043150) (to be confirmed during future design stages).
Surfaces will be designed with erosion and sediment control mitigation measures where required (e.g. hydoseeding, riprap, erosion control blankets, check dams, etc.).

Maintain minimum depth for ditches at 0.5 m wherever possible, shallower depths will be confirmed if needed.

Maintain minimum depth for swales at 0.3 m wherever possible, shallower depths will be confirmed if needed.

Maintain minimum slope for ditches at 0.5% wherever possible, lesser slopes will be confirmed if needed.

Ditch and swale side slopes will be 3H:1V.

Minimum slope for culverts will be 1.0%.

Culverts will act under gravity flow for the design storm event.

Erosion and sediment control for outlet structure will be designed for release flows and may require upgrades all along creek to prevent damages.

5.5.6 Trafficable Surfaces

Trafficable surfaces for the operations area allowance and site access road (recommissioned and new) will consist of the following, as a minimum, from top to bottom:

- A 75 mm thick 25 mm crushed gravel
- A 300 mm thick 80 mm crushed gravel
- Compacted fill

It is assumed that gravel and compacted fill for trafficable surfaces will comprise material excavated during construction of the dam and access roads and processed as needed.

The thickness of the trafficable surfaces will be fit for purpose and assumes that the SCRD will maintain the surface when unsuitable deformation and ruts have formed.

5.5.7 Site Security

The following site security measures will be put in place to prevent unauthorized personnel from entering the site (to be refined during future design stages):

- Security gate at each end of the dam crest.
- Fencing (minimum 2 m in height) and gates (as required) around instrumentation and controls systems, including the low level outlet gate.
- Security gate at the entrance to the operations area allowance.

5.5.8 Low Level Outlet and Gate Works

Water will flow through the concrete gravity dam via a low level outlet structure designed based on the following criteria (to be refined during future design stages):
- Aligned generally with the current subalpine lake basin’s creek outlet at the same elevation as the creek’s invert.
- Minimum 0.5% slope designed to prevent back flooding from the downstream channel.
- Minimum diameter of 0.6 m (to be sized during future design stages).
- Energy dissipation and erosion and sediment control measures in place downstream of the outlet.

The low level outlet structure will have a gate designed based on the following criteria (to be refined during future design stages):
- Gate is watertight.
- Operable during all water level fluctuations and reservoir conditions.

5.6 Site C4

The following criteria and assumptions were used as basis for the conceptual design:
- Development area of approximately 26.6 ha.
- Concrete gravity dam positioned at the downstream, end of subalpine lake basin at the outlet to an unnamed creek.
- Excess excavation materials stockpiled adjacent to the site access road.
- Surface water management infrastructure.
- Operations area allowance.
- Site access.
- Site security.
- Instrumentation and controls systems.
- Access and operations are planned for 365 days a year.
- Infrastructure is expected to be permanent (minimum of 50-year lifespan).

5.6.1 Site Preparation and Earthworks

The site preparation and earthworks at Site C4 will be designed based on the following parameters and assumptions:
- Tree clearing, and grubbing will be dictated by requirements for site access, construction and laydown areas, and regulatory requirements. It is assumed that the dam footprint, operations area allowance, and access road will be cleared and grubbed, as well as allowance for construction activities. The remaining site area is not assumed to be cleared and grubbed.
- The existing organic layers (i.e. topsoil and subsoil) will be stripped completely below the concrete gravity dam and operations pad footprints. Topsoil and subsoil will be stockpiled separately adjacent to the site access roads. Topsoil depths of 400 mm
and subsoil depths of 200 mm have been assumed based on the Terrain Assessment site reconnaissance (Section 4.5) and have been used to estimate topsoil and subsoil stripping and stockpiling requirements (to be confirmed based on recommendations provided following a geotechnical and environmental assessment and incorporated during future design stages). The post stripping surface will be the basis of the earthworks design.

- Topsoil and subsoil stockpiles will be sloped at 4H:1V. A 30% bulking factor will be applied for topsoil and subsoil stockpile sizing. Topsoil and subsoil stockpile slope angles should be confirmed based on geotechnical recommendations during future design stages.
- The footprint of the concrete gravity dam will be over excavated to bedrock to create a foundation for the dam.
- An overburden thickness of 2 m has been assumed below the concrete gravity dam and operations pad based on the Terrain Assessment site reconnaissance (Section 4.5) and has been used to estimate approximate excavation volumes and stockpiling requirements (to be confirmed based on geotechnical recommendations and incorporated during future design stages).
- Excavated soil will be stockpiled in a common excavation stockpile, which will be sloped at 3H:1V. A bulking factor of 30% will be applied to the excavated soil for stockpile sizing. Excavation stockpile slope angles and bulking factors should be confirmed based on geotechnical recommendations during future design stages.
- Stockpiles will be positioned adjacent to site access roads with offset distances from the dam and operations pad to avoid excessive loading, and to avoid interference with construction activities and access points (offset distances will be determined based on geotechnical recommendations and incorporated during future design stages).
- The operations area allowance and access road will be graveled to maintain a workable surface, as detailed in Section 5.6.6.

5.6.2 Storage Reservoir

The reservoir will generally be designed based on the following parameters and assumptions:

- Dam crest elevation at El. 1,062 m.
- MWL of approximately El. 1,060 m (to be updated during future design stages).
- Maximum dam height of less than 15 m, measured as the difference in elevation between the outlet creek bed elevation and the maximum dam crest elevation, so as not to trigger the dam height thresholds for ‘large dams’ as defined by ICOLD (ICOLD 2011, 2016).
- Maximum dam height, H, and maximum reservoir volume, V, such that $H^2 \times \sqrt{V} < 200$, where H is measured as the difference in elevation between the outlet creek bed and the dam crest.
elevation and the maximum dam crest elevation, so as not to trigger the dam height thresholds for ‘large dams’ as defined by ICOLD (ICOLD 2011, 2016).

- Minimum reservoir operating volume of approximately 764,500 m$^3$, based on the following considerations:
  - At this stage in design, the design volume excludes the volume of the existing water body at Site C4 (due to limitations of topography data to capture the lake bottom surface). In future design stages, the design volume should be updated using bathymetry data for the existing water body.
  - Reservoir has been sized based on the maximum reservoir height, $H$, and volume, such as to not trigger thresholds for ‘large dams’ as defined by ICOLD (ICOLD 2011, 2016). Annual and monthly water availability are summarized in the Sites C3 and C4 Hydrological Study (Integrated Sustainability 2019h), and should be considered in future design stages.
  - Given that water is assumed to be conveyed to the Chapman Creek WTP via overland flow in the unnamed creek between Sites C3 and C4, Tsawcome Creek, and Chapman Creek, losses due to infiltration or evaporation may reduce the total volume conveyed to the Chapman Creek WTP from the volume stored at the reservoir.

- Upstream dam slopes of 1H:10V and downstream dam slopes of 1H:1V. Slope angles should be verified based on structural and geotechnical recommendations during future design stages to maintain a design minimum factor of safety.

- The dam will be constructed with roller-compacted concrete (RCC). The concrete shall have physical properties (i.e. density, strength, flexibility, permeability, weather resistance) that are fit for the purpose intended (to be determined during future design stages).

- During construction of the dam, a cofferdam and water diversion will need to be installed upstream of the dam footprint to isolate the construction area. Details of the cofferdam and water diversion will be determined during future design stages.

- Assumed normal freeboard allowance of 2.0 m at MWL (details to be determined during future design stages).

- Emergency spillway with an assumed depth of 1.0 m and assumed minimum width of 6.0 m (details to be determined during future design stages).

- Dam crest width of 10 m, to allow space for access and barriers on either side of the dam (to be confirmed during future design stages).

- Guard rails along the inner and outer edges of the dam crest to provide a safety barrier.

- Recommendations on acceptable dam settlement should be provided following a geotechnical study and incorporated in future design stages.
It is assumed that the dam will be founded directly on bedrock. The base of the dam will be grouted as needed to prevent seepage into the substrate. Grouting requirements will be based on geotechnical recommendations and determined during future design stages.

The foundation will be treated to minimize seepage through the foundation and provide sufficient friction between the foundation and dam base. Foundation treatment may include rock shaping/scraping and grouting and will be determined during future design stages.

Drains will be required to manage seepage into the dam foundation (details to be determined during future design stages).

5.6.3 Site Access

Site access to Site C4 will be achieved with a combination of recommissioning (i.e. upgrading) existing, decommissioned roads and construction of a new access road to gain direct site access. There are currently two site access options, as described in Section 4.6:

Assumed upgrades required for recommissioning existing, decommissioned roads are as follows:

- Brushing of vegetation (assume brush less than 2 m high).
- Road grading and ditching.
- Culvert installation (assume culvert spacing of 25 m).
- Bridge upgrades (assume two bridges along Access Road Option 1 and one bridge along Access Road Options 2).
- Construction of pullouts along existing road to allow for two-way traffic (assume pullout spacing of 500 m).
- No road widening will be required.

Design parameters for new access roads are as follows (to be refined during future design phases):

- Direct access to the dam crest.
- The existing organic layers (i.e. topsoil and subsoil) will be stripped completely within the new access road footprint. Topsoil and subsoil depths of 100 mm have been assumed and have been used to estimate topsoil and subsoil stripping and stockpiling requirements (to be confirmed during future design stages).
- The road surface will be constructed with cut and fill using native materials (bedrock and surficial soils).
- The design will aim to achieve a cut / fill balance, where possible.
- Cut and fill slopes will be a minimum of 1.5H:1V (to be confirmed during future design stages).
- Road width will be a minimum of 6 m.
- Culverts will be required every 25 m. This assumption is based on approximate culvert spacing along existing, decommissioned roads, and will be verified and refined as needed during future design stages.
- No bridges will be required.
- A maximum road grade of 10%.

5.6.4 Operations Pad

An allowance for site operations has been included in the design based on the following parameters and assumptions:

- The dam crest will be accessed directly from the west via the site access road to facilitate site operations (as per Section 5.5.3).
- An additional allowance for site operations has been assumed at a location along the site access road to accommodate equipment laydown and turnaround. A minimum width of 20 m along this section of the site access road shall be used as the basis of design and will be refined during future design stages. The exact location and dimensions will be constrained by the terrain surrounding the subalpine lake basin.
- A minimum cross slope of 1% across the operations pads away from the reservoir for drainage.

During construction, it is assumed that an additional space allowance will be required for a concrete batch plant and aggregate stockpiles for dam construction, as well as to provide space for equipment laydown and turnaround, staging, and space for other construction requirements. Given the steep topography and shallow bedrock at Site C4, it is assumed that this area will be located within the proposed footprint of the reservoir (at lower elevations than the site access road) and will be temporary in nature (active construction only). Details on this construction area allowance should be confirmed during future design stages.

5.6.5 Surface Water Management

The site grading plan will manage surface water within Site C4 and reduce erosion of any areas downstream of Site C4, as well as control surface water and reduce erosion along the site access road (recommissioned and new) and operations pad. The grading plan may comprise berms, swales, ditches, and culverts to control surface water within the site boundary. The grading plan will be designed based on the following parameters:

- Infrastructure will be sized to control, at a minimum, the 1-in-25 year, 24-hour storm event using historical weather data from the Gibsons weather station (#1043150) (to be confirmed during future design stages).
- Surfaces will be designed with erosion and sediment control mitigation measures where required (e.g. hydoseeding, riprap, erosion control blankets, check dams, etc.).
- Maintain minimum depth for ditches at 0.5 m wherever possible, shallower depths will be confirmed if needed.
- Maintain minimum depth for swales at 0.3 m wherever possible, shallower depths will be confirmed if needed.
- Maintain minimum slope for ditches at 0.5% wherever possible, lesser slopes will be confirmed if needed.
- Ditch and swale side slopes will be 3H:1V.
- Minimum slope for culverts will be 1.0%.
- Culverts will act under gravity flow for the design storm event.
- Erosion and sediment control for outlet structure will be designed for release flows and may require upgrades all along creek to prevent damages.

5.6.6 Trafficable Surfaces

Trafficable surfaces for the operations area allowance, and site access road (recommissioned and new) will consist of the following, as a minimum, from top to bottom:
- A 75 mm thick 25 mm crushed gravel
- A 300 mm thick 80 mm crushed gravel
- Compacted fill
- It is assumed that gravel and compacted fill for trafficable surfaces will comprise material excavated during construction of the dam and access roads and processed as needed

The thickness of the trafficable surfaces will be fit for purpose and assumes that the SCRD will maintain the surface when unsuitable deformation and ruts have formed.

5.6.7 Site Security

The following site security measures will be put in place to prevent unauthorized personnel from entering the site (to be refined during future design stages):
- Security gate at each end of the dam crest.
- Fencing (minimum 2 m in height) and gates (as required) around instrumentation and controls systems, including the low level outlet gate.
- Security gate at the entrance to the operations pad.

5.6.8 Low Level Outlet and Gate Works

- Aligned generally with the current subalpine lake basin’s creek outlet at the same elevation as the creek’s invert.
- Minimum 0.5% slope designed to prevent back flooding from the downstream channel.
- Minimum diameter of 0.6 m (to be sized during future design stages).
- Energy dissipation and erosion and sediment control measures in place downstream of the outlet.

The low level outlet structure will have a gate designed based on the following criteria (to be refined during future design stages):
- Gate is watertight.
- Operable during all water level fluctuations and reservoir conditions.

6 CONSTRUCTION CONSIDERATIONS

Constructability was considered in development of the design criteria and assumptions provided in Section 5. Detailed construction considerations will be provided in future design stages. Construction considerations will address the following, at a minimum, for the Sites:
- Site preparation
- Groundwater control and surface water management during construction
- Dust and particulate control during construction
- Temporary excavations
- Subgrade preparation
- Material specifications
- Material placement/installation procedures
- Considerations pertaining to construction in wet or freezing conditions

7 MULTI-CRITERIA ANALYSIS (MCA)

7.1 Methodology

An MCA was completed during Phase 2 of the Project and has been updated for the purposes of comparing the Sites based on information gained during Phases 1 and 2 and new information collected during Phase 3. The MCA provides an evaluation of technical, economic, environmental, and regulatory/stakeholder considerations for each of the Sites. The MCA framework compares the Sites based on a set of predefined criteria, which are divided into four categories:
- Technical Feasibility
- Economics
- Environmental Impacts
- Regulatory and Stakeholder Sensitivity

The criteria under each category are assigned a value ranging from 1 (Significant Disadvantage) to 5 (Significant Advantage) based on the benefits and drawbacks
associated with one of the Sites when compared to the other Sites. The outcome of the comparison produces a total score for each of the Sites, which then provides an unweighted ranked summary of the Sites. For example:

Criteria 1 Ranking (Site A) + Criteria 2 Ranking (Site A) ... + Criteria 25 Ranking (Site A) = Total Site A Unweighted Ranking

Site option rankings were initially developed in Phase 2 of the Project (Integrated Sustainability 2019a), based on how the Sites ranked for each criterion, relative to one another. Site option rankings were refined during a workshop held between Integrated Sustainability and SCRD during Phase 3 of the Project.

A weighting is placed on each criterion based on the level of importance of that criterion within the context of the Project. Criteria weightings were initially developed in Phase 2 of the Project (Integrated Sustainability 2019a) and were determined based on the relative importance of different criteria in terms of site feasibility and SCRD values and preferences. Criteria weightings were refined during a workshop held between Integrated Sustainability and SCRD during Phase 3 of the Project.

The initial weightings applied are based on a set of Base Case weightings that are typically placed on each of the four categories. The overall weights assigned to the Technical Feasibility, Economics, Environmental, and Regulatory/Stakeholder Sensitivity categories for the Base Case are approximately 45%, 25%, 20%, and 10%, respectively.

To provide a total weighted score for each of the Sites, the unweighted value (between 1 and 5) for each criterion is multiplied by the criterion’s weighting, and the sum of the weighted scores is then calculated for each of the Sites. For example:

(Criteria 1 Ranking (Site A) x Criteria 1 Weighting) + (Criteria 2 Ranking (Site A) x Criteria 2 Weighting) ... + (Criteria 25 Ranking (Site A) x Criteria 25 Weighting) = Total Site A Weighted Ranking

To provide alternate perspectives on the MCA results, four sensitivity analysis cases were prepared using adjusted weightings for the four categories.

- Technically Focused case applies higher weightings against the criteria under Technical Feasibility
- Economics Focused Case increases the weightings for the criteria under Economics
- Environmental Focused Case increases the weightings for the criteria under Environmental Impacts
- Regulatory and Stakeholder Focused Case applies higher weighting to the criteria under Regulatory and Stakeholder Sensitivity

Similar to the Base Case criteria weightings, the sensitivity analysis case criteria weightings were initially developed during Phase 2 of the Project (Integrated Sustainability 2019a) and were refined during Phase 3 of the Project in a workshop held between Integrated Sustainability and SCRD during Phase 3 of the Project.
The criteria within each category and criteria weightings applied for the Base Case and four sensitivity analysis cases are provided in Table 1, attached. A summary of the sensitivity analysis weightings by category as they compare to the Base Case are summarized in Figure A.

### Figure A. Sensitivity Analyses Weightings

#### 7.2 Multi-Criteria Analysis Results and Sensitivity Analysis

The Sites were evaluated for technical feasibility, environmental impacts, and regulatory and stakeholder sensitivity based on the design criteria summarized within this report, as well as within the technical reports completed during Phases 2 and 3 of the Project (Section 1.2). The economic evaluation is based on the Class C/D capital costs and the Basis of Estimate (Integrated Sustainability 2019).

The complete MCA summary tables for the following cases are provided in Tables 2 through 6, attached.

- Base Case
- Technically Focused Case
- Economics Focused Case
- Environmental Focused Case
- Regulatory and Stakeholder Focused Case
7.2.1 Base Case

When evaluated using the Base Case, Site B has the overall highest weighted score. The complete MCA summary table for the Base Case is provided in Table 2, attached. Table B provides a summary of the ranking of sites based on the results of the MCA using the Base Case weightings shown in Table 1.

Table B. MCA Results and Ranking of Sites (Base Case)

<table>
<thead>
<tr>
<th>Option</th>
<th>Unweighted Score</th>
<th>Unweighted Rank</th>
<th>Weighted Score</th>
<th>Weighted Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Option 1: Site A</td>
<td>70</td>
<td>3</td>
<td>277</td>
<td>3</td>
</tr>
<tr>
<td>Option 2: Site B</td>
<td>78</td>
<td>1</td>
<td>312</td>
<td>1</td>
</tr>
<tr>
<td>Option 3: Site C3</td>
<td>71</td>
<td>2</td>
<td>295</td>
<td>2</td>
</tr>
<tr>
<td>Option 4: Site C4</td>
<td>68</td>
<td>4</td>
<td>276</td>
<td>4</td>
</tr>
</tbody>
</table>

7.2.2 Technically Focused Case

When evaluated using the Technically Focused Case, Site B had the highest overall weighted score. Table C provides the results of the Technically Focused Case.

Table C. MCA Results and Ranking of Sites (Technically Focused Case)

<table>
<thead>
<tr>
<th>Option</th>
<th>Unweighted Score</th>
<th>Unweighted Rank</th>
<th>Weighted Score</th>
<th>Weighted Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Option 1: Site A</td>
<td>70</td>
<td>3</td>
<td>264</td>
<td>4</td>
</tr>
<tr>
<td>Option 2: Site B</td>
<td>78</td>
<td>1</td>
<td>304</td>
<td>1</td>
</tr>
<tr>
<td>Option 3: Site C3</td>
<td>71</td>
<td>2</td>
<td>303</td>
<td>2</td>
</tr>
<tr>
<td>Option 4: Site C4</td>
<td>68</td>
<td>4</td>
<td>283</td>
<td>3</td>
</tr>
</tbody>
</table>

Key technical advantages identified for Site B that differentiate it from one or more of the Sites are as follows:

- Largest operational storage volume
- Potential for future site expansion (ICOLD thresholds for large dams including height and volume would be exceeded)
- Site location is easily accessible for construction and operations and significant road infrastructure will not be required for site access
- Ability to convey water from the reservoir to the Chapman Creek WTP via gravity flow (bypassing the existing pump station), requiring pumping only to convey water from the base of the reservoir to the crest
Subsurface conditions appear favorable for potential to reuse of excavated material as fill

- No significant areas of interpreted terrain instability or geohazards (based on desktop assessment and site reconnaissance)

The complete MCA summary table for the Technically Focused Case is provided in Table 3, attached.

### 7.2.3 Economics Focused Case

When evaluated using the Economics Focused Case, Site C3 has the highest overall weighted score. Table D provides the results of the Economics Focused Case.

#### Table D. MCA Results and Ranking of Sites (Economics Focused Case)

<table>
<thead>
<tr>
<th>Option</th>
<th>Unweighted Score</th>
<th>Unweighted Rank</th>
<th>Weighted Score</th>
<th>Weighted Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Option 1: Site A</td>
<td>70</td>
<td>2</td>
<td>259</td>
<td>4</td>
</tr>
<tr>
<td>Option 2: Site B</td>
<td>78</td>
<td>1</td>
<td>304</td>
<td>3</td>
</tr>
<tr>
<td>Option 3: Site C3</td>
<td>71</td>
<td>2</td>
<td>328</td>
<td>1</td>
</tr>
<tr>
<td>Option 4: Site C4</td>
<td>68</td>
<td>4</td>
<td>321</td>
<td>2</td>
</tr>
</tbody>
</table>

Site C3 has lower capital costs given its relatively small development size compared to Sites A and B. As the natural topography allows for water to be captured within a natural basin, which results in earthworks required for dam construction.

Site C4 is closely ranked as second, with advantages similar to those for Site C3.

Site B is ranked third, and has the following unique economic advantages:

- Lower anticipated operational costs, given that Site B is located such that water can be conveyed via gravity flow from the new intake on Chapman Creek to the Chapman Creek WTP, requiring pumping only to convey water from the base of the reservoir to the crest
- Estimated lower lifecycle cost, given that development of a new intake may allow for operational optimization of the existing Chapman Water System, allowing for gravity feed of water directly to the Chapman Creek WTP from Chapman Creek, eliminating the need to utilize the existing pump station
- Potential for industry partnership (i.e. sale of excavated material)
- Potential for development of hydro-electric power generation

Site A ranks lowest, as it has a large development area and fewer potential operational benefits than Site B.

The complete MCA summary table for the Economics Focused Case is provided in Table 4, attached.
7.2.4 Environmental Focused Case

When evaluated using the Environmental Focused Case, Site B has the highest overall weighted score. Table E provides the results of the Environmental Focused Case.

Table E. MCA Results and Ranking of Sites (Environmental Focused Case)

<table>
<thead>
<tr>
<th>Option</th>
<th>Unweighted Score</th>
<th>Unweighted Rank</th>
<th>Weighted Score</th>
<th>Weighted Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Option 1: Site A</td>
<td>70</td>
<td>2</td>
<td>281</td>
<td>2</td>
</tr>
<tr>
<td>Option 2: Site B</td>
<td>78</td>
<td>1</td>
<td>310</td>
<td>1</td>
</tr>
<tr>
<td>Option 3: Site C3</td>
<td>71</td>
<td>2</td>
<td>278</td>
<td>3</td>
</tr>
<tr>
<td>Option 4: Site C4</td>
<td>68</td>
<td>4</td>
<td>271</td>
<td>4</td>
</tr>
</tbody>
</table>

While more wildlife species, special habitat zones, and species at risk were identified at Sites A and B than at Sites C3 and C4, mitigation of these risks is anticipated to be feasible. In contrast, at Sites C3 and C4, the risks associated with wetlands and the natural waterbodies and watercourses present may pose significant challenges. Though at the time of the preliminary aquatics investigation, no fish were documented or observed, given that Sites C3 and C4 were interpreted to be suitable fish habitat, a risk pertaining to fish presence remains. Additionally, downstream environmental impacts (i.e. erosion and sedimentation) on the creeks downstream of Sites C3 and C4 (unnamed creek between Sites C3 and C4, Tsawcome Creek, Chapman Creek) will need to be considered based on expected low and high flow conditions. Based on the above, it is expected that authorization under DFO will be required for Sites C3 and C4.

The complete MCA summary table for the Environmentally Focused Case is provided in Table 5, attached.

7.2.5 Regulatory and Stakeholder Focused Case

When evaluated using the Regulatory and Stakeholder Focused Case, Site B has the highest overall weighted score. Table F provides the results of the Regulatory and Stakeholder Focused Case.

Table F. MCA Results and Ranking of Sites (Regulatory Focused Case)

<table>
<thead>
<tr>
<th>Option</th>
<th>Unweighted Score</th>
<th>Unweighted Rank</th>
<th>Weighted Score</th>
<th>Weighted Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Option 1: Site A</td>
<td>70</td>
<td>3</td>
<td>290</td>
<td>2</td>
</tr>
<tr>
<td>Option 2: Site B</td>
<td>78</td>
<td>1</td>
<td>311</td>
<td>1</td>
</tr>
<tr>
<td>Option 3: Site C3</td>
<td>71</td>
<td>2</td>
<td>226</td>
<td>3</td>
</tr>
<tr>
<td>Option</td>
<td>Unweighted Score</td>
<td>Unweighted Rank</td>
<td>Weighted Score</td>
<td>Weighted Rank</td>
</tr>
<tr>
<td>-----------------------</td>
<td>------------------</td>
<td>----------------</td>
<td>----------------</td>
<td>---------------</td>
</tr>
<tr>
<td>Option 4: Site C4</td>
<td>68</td>
<td>4</td>
<td>219</td>
<td>4</td>
</tr>
</tbody>
</table>

Overall, regulatory requirements for Sites A and B are expected to pose fewer potential challenges than for Sites C3 and C4. Specifically, for Sites C3 and C4, it is expected that requirements for an Environmental Assessment Certificate will be more stringent than for Sites A and B. Additionally, Sites C3 and C4 may require authorization under DFO. It is also assumed that Sites C3 and C4 are generally less favorable from a community perspective due to the perceived environmental impact of development at Sites C3 and C4 in comparison to that at Sites A and B.

The complete MCA summary table for the Regulatory and Stakeholder Focused Case is provided in Table 6, attached.

### 7.3 Discussion and Conclusions

The Sites were evaluated for technical feasibility, economics, environmental impacts, and regulatory and stakeholder sensitivity based on a desktop review and preliminary site reconnaissance, conceptual designs, and Class C/D cost estimates. Based on the results from the Phase 3 MCA, all Sites are deemed feasible at this stage of the Project. However, for the purposes of site comparison and selection, it is recommended that at a minimum, Site B be progressed to future project stages as the preferred site. Site C3 is recommended to be progressed as the second preferred site.

Site B ranked highest in the Base Case, as well as the Technically Focused Case, Environmentally Focused Case, and Regulatory and Stakeholder Focused Case. It ranked third in the Economics Focused Case. Overall, Site B has the following key advantages:

- Largest operational storage volume
- Site location that is easily accessible for construction and operations
- Ability to convey water from the reservoir to the Chapman Creek WTP via gravity flow (pump required to convey water out of reservoir)
- Potential to improve the operability of the existing Chapman water conveyance system by eliminating use of the existing pump station
- Potential for industry partnership (economic benefits)
- No significant areas of interpreted terrain instability or other geohazards
- Limited impact to wetlands and surface water bodies

Site C3 ranked highest in the Economics Focused Case and ranked closely as second to Site B in the Base Case and Technically Focused Case. Overall, Site C3 has the following key advantages:

- Lower capital cost of development, given the small earthworks volumes and overall smaller size of development
- Relatively high storage volume
- Small site footprint
- Water conveyance via overland flow (no pipelines or pumps required)
- No significant areas of interpreted terrain instability or other geohazards

Phase 3 of the Project has supported site comparison and recommendations on preferred site(s). However, advantages, disadvantage, and key risks and opportunities associated with the Sites progressed to future stages of the Project may be adjusted as additional information is collected. This may pertain to the technical, economic, environmental, and regulatory and stakeholder criteria. New information should be evaluated such that risks can be managed effectively as the Project progresses.
8  CLOSURE

Integrated Sustainability would like to thank Sunshine Coast Regional District for the opportunity to support the Raw Water Reservoir Feasibility Study – Phase 3. We trust that this design summary report meets the needs and expectations of Sunshine Coast Regional District. If you have any questions, please contact the undersigned at any time.

Sincerely,

Integrated Sustainability

Haley Massong, P.Eng.
Geotechnical Engineer

Alexa Sperske, P.Eng.
Senior Geotechnical Engineer
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Integrated Sustainability. 2019q. Raw Water Reservoir Feasibility Study – Phase 3, Site C4, Consequence of Failure Classification. VP19-SCR-01-00-RPT-CI-Conseq_Fail_Class_SiteC4_Rev0. Rev. 0.


### Table 1 - MCA Framing Summary

**Objective**
Phase 3 Multi-Criteria Analysis (MCA) of four raw water reservoir sites to support the future water demand in the Chapman Water System.

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Sub-Criteria</th>
<th>Description</th>
<th>Base Case</th>
<th>Technically Focused Case</th>
<th>Economics Focused Case</th>
<th>Environmental Focused Case</th>
<th>Regulatory and Stakeholder Focused Case</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Technical Feasibility</strong></td>
<td></td>
<td>Total operational storage volume (m³)</td>
<td>Total operational storage volume in the reservoir, assuming 2 m freeboard (between maximum water level and dam crest elevation)</td>
<td>8</td>
<td>8</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Scasability</td>
<td>Ability to expand to achieve larger storage capacity, while maintaining maximum dam height, H, and maximum reservoir volume, V, such that H² x V &lt; 200, where H is measured as the difference in elevation between the minimum water level elevation (reservoir base) and the maximum dam crest elevation, so as not to trigger the dam height thresholds for ‘large dams’ as defined by the International Commission on Large Dams (ICOLD)</td>
<td>2</td>
<td>6</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Total site area and approximate clearing and grubbing area (ha)</td>
<td>Total area to be developed (approximate area of reservoir with allowance for material stockpiles, operational area, etc.), approximate area required to be cleared and grubbed</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Overburden excavation, bedrock excavation, earthworks fill volume, excess excavation stockpile volume, topsoil and subsoil stripping volumes (m³)</td>
<td>Approximate earthworks quantities based on conceptual designs, including overburden excavation volume, bedrock excavation volume, earthworks fill volumes, excess excavation stockpile volume, topsoil and subsoil stripping volumes</td>
<td>4</td>
<td>7</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Offsite construction material required (m³)</td>
<td>Requirement for offsite construction material (if onsite material is not suitable or sufficient in volume)</td>
<td>4</td>
<td>6</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Site access</td>
<td>Site proximity to existing road, length of new access road required to connect the site to an existing road, length of existing road that is likely to require upgrading prior to construction (if applicable)</td>
<td>4</td>
<td>6</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Proximity to third party infrastructure</td>
<td>Site proximity to and spatial constraints posed by third party infrastructure and dispositions (e.g., utility and road rights-of-way (ROW), land tenure, private land ownership, etc.)</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Water conveyance method from source to reservoir site</td>
<td>Infrastructure (existing and new) required to transport water from the source to the reservoir</td>
<td>3</td>
<td>4</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Conveyance method from reservoir site to Chapman Creek WTP</td>
<td>Infrastructure (existing and new) required to transport water from the reservoir to the Chapman Creek WTP</td>
<td>3</td>
<td>4</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Subsurface conditions</td>
<td>Characteristics and estimated thicknesses of surficial deposits, depth to bedrock, potential for use of surficial soils as construction materials, estimated groundwater depth</td>
<td>2</td>
<td>3</td>
<td>1</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>Terrain instability, geohazards, seismic/tektonic conditions</td>
<td>Site characteristics including terrain instability, geohazards, seismic/tektonic conditions</td>
<td>7</td>
<td>10</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Dam consequence of failure classification (preliminary)</td>
<td>Preliminary dam consequence of failure classification based on the estimated loss or damage caused by a failure of a dam, and evaluates loss of life, injury, and general disruption of the lives of the population in the inundated area, environmental and cultural impacts, and damage to infrastructure and economic assets</td>
<td>5</td>
<td>7</td>
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</table>

**Options for Analysis**

<table>
<thead>
<tr>
<th>Rank</th>
<th>Project</th>
<th>Description</th>
<th>Significant Disadvantage</th>
<th>Moderate Disadvantage</th>
<th>Null</th>
<th>Moderate Advantage</th>
<th>Significant Advantage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Site A (1,064,400 m³ reservoir)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Site B (1,270,000 m³ reservoir)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Site C3 (1,056,700 m³ reservoir)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Site C4 (764,500 m³ reservoir)</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>
# MCA Framing Summary

## Objective

Phase 3 Multi-Criteria Analysis (MCA) of four raw water reservoir sites to support the future water demand in the Chapman Water System.

### Options for Analysis

<table>
<thead>
<tr>
<th>Site</th>
<th>Description</th>
<th>Base Case</th>
<th>Technically Focused Case</th>
<th>Economics Focused Case</th>
<th>Environmental Focused Case</th>
<th>Regulatory and Stakeholder Focused Case</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Site A (1,064,400 m³ reservoir)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Site B (1,270,000 m³ reservoir)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Site C3 (1,056,700 m³ reservoir)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Site C4 (764,500 m³ reservoir)</td>
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<td></td>
<td></td>
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</tr>
</tbody>
</table>

### Evaluation Criteria

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Sub-Criteria</th>
<th>Description</th>
<th>Base Case</th>
<th>Technically Focused Case</th>
<th>Economics Focused Case</th>
<th>Environmental Focused Case</th>
<th>Regulatory and Stakeholder Focused Case</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Economics</strong></td>
<td>Capital cost of reservoir site and supporting infrastructure</td>
<td>Class C Capital Cost Estimates (-15% / +30%) for reservoir sites, Class D Capital Cost Estimates (-30%/+50%) for supporting infrastructure (e.g. access roads, water conveyance pipelines, intake)</td>
<td>9</td>
<td>7</td>
<td>24</td>
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<td>Lifecycle cost</td>
<td>Qualitative asset management cost</td>
<td>5</td>
<td>3</td>
<td>12</td>
<td>3</td>
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<tr>
<td></td>
<td>Operating cost</td>
<td>Qualitative assessment of requirements for operations, maintenance, and surveillance</td>
<td>5</td>
<td>3</td>
<td>12</td>
<td>3</td>
<td>3</td>
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<tr>
<td></td>
<td>Potential economic co-benefits (i.e. industry partnerships, hydropower potential)</td>
<td>Potential economic co-benefit opportunities (i.e. industry partnerships, hydropower potential, etc.)</td>
<td>3</td>
<td>2</td>
<td>8</td>
<td>2</td>
<td>2</td>
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<tr>
<td><strong>Environmental Impacts</strong></td>
<td>Species at risk (SAR) and species of concern (SOC)</td>
<td>Federal and provincial SAR and provincial SOC within a 10 km radius of site locations</td>
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<td>3</td>
<td>3</td>
<td>10</td>
<td>3</td>
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<td></td>
<td>Important habitat features</td>
<td>Special habitat zone, important habitats, and special access zones identified in area</td>
<td>4</td>
<td>3</td>
<td>3</td>
<td>10</td>
<td>3</td>
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<tr>
<td></td>
<td>Wildlife presence and potential impact</td>
<td>Wildlife identified within 10 km radius of site locations and interpreted potential impact to wildlife</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>9</td>
<td>1</td>
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<tr>
<td></td>
<td>Fish presence</td>
<td>Fish identified in water bodies downslope of reservoir site</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>4</td>
<td>1</td>
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<td></td>
<td>Wetlands and surface water</td>
<td>Wetlands identified within footprint and proximinity to mapped wetlands and proximity to surface water</td>
<td>4</td>
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<td>2</td>
<td>10</td>
<td>2</td>
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<tr>
<td></td>
<td>Water quality for Chapman Water System</td>
<td>Potential for improved raw water quality</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>9</td>
<td>1</td>
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<tr>
<td><strong>Regulatory and Stakeholder Sensitivity</strong></td>
<td>Regulatory requirements</td>
<td>Identified permits and authorizations required at this stage of project definition</td>
<td>7</td>
<td>5</td>
<td>5</td>
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<td>5</td>
</tr>
<tr>
<td></td>
<td>Key potential regulatory challenges</td>
<td>Identification of regulatory requirements that may pose significant challenges</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
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<tr>
<td></td>
<td>General community favourability</td>
<td>Interpreted expected support from community stakeholders</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

### Criteria Weightings

NOTES:

1. Suitability of onsite materials for use as fill material is based on desktop review of regional-scale geological maps and one-day site reconnaissance only. An intrusive geotechnical investigation is recommended to be completed at the site locations during future design stages to confirm material suitability, and is not included in this scope of work.

2. Bedrock depths should be confirmed during an intrusive geotechnical investigation during future design stages (not included in the currently scope of work).

3. Identified potential geohazards are based on desktop review of available information and one-day site reconnaissance only. A detailed visual geohazards site assessment and intrusive geotechnical investigation are recommended to be completed at the site locations during future design stages, and are not included in this scope of work.

4. Preliminary dam consequence of failure classification is intended as high level only and is based on the conceptual design. Analyses to fully evaluate is required, and is outside of the scope of work for this project.

5. Criteria weightings for the base case and sensitivity analysis cases were initially developed in Phase 2 (refer to Phase 2 Feasibility Study Report - VP18-SCR-01-00-RPT-C-Feasibility_Study-Rev0). Criteria weightings were refined during Phase 3.
Table 2 - Multi-Criteria Analysis Matrix: Base Case

<table>
<thead>
<tr>
<th>Evaluation Criteria</th>
<th>Sub-Criteria</th>
<th>Description</th>
<th>Option 1: Site A</th>
<th>Option 2: Site B</th>
<th>Option 3: Site C</th>
<th>Option 4: Site D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technical Feasibility</td>
<td>Total operational storage volume (m³)</td>
<td>Total operational storage volume in the reservoir (including 2 m deep excavations (between maximum water level and dam crest elevation))</td>
<td>8</td>
<td>8</td>
<td>1,270,000</td>
<td>1,350,000</td>
</tr>
<tr>
<td></td>
<td>Approximate earthworks quantities based on conceptual designs, including overburden excavation volume, bedrock excavation volume, and fill volumes required at the site to achieve the storage volume, and total operational storage volume</td>
<td>2</td>
<td>2</td>
<td>Total site area: 47.4 (excluding clearing and grubbing)</td>
<td>Total site area: 44.2 (excluding clearing and grubbing)</td>
<td>Total site area: 45.2 (excluding clearing and grubbing)</td>
</tr>
<tr>
<td></td>
<td>Approximate earthworks quantities based on conceptual designs, including overburden excavation volume, bedrock excavation volume, and fill volumes required at the site to achieve the storage volume, and total operational storage volume</td>
<td>4</td>
<td>4</td>
<td>Total site area: 47.4 (excluding clearing and grubbing)</td>
<td>Total site area: 44.2 (excluding clearing and grubbing)</td>
<td>Total site area: 45.2 (excluding clearing and grubbing)</td>
</tr>
<tr>
<td></td>
<td>Volume of all overburden excavation, bedrock excavation, earthworks fill volume, excess excavation stockpile volume, topsoil and subsoil stripping volumes</td>
<td>2</td>
<td>2</td>
<td>Overburden excavation: 1,066,400</td>
<td>Overburden excavation: 1,066,400</td>
<td>Overburden excavation: 1,270,000</td>
</tr>
<tr>
<td></td>
<td>Overburden excavation, bedrock excavation, earthworks fill volume, excess excavation stockpile volume, topsoil and subsoil stripping volumes</td>
<td>4</td>
<td>4</td>
<td>Overburden excavation: 1,066,400</td>
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<td>Overburden excavation: 1,270,000</td>
</tr>
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<td></td>
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<td></td>
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<td>4</td>
<td>Overburden excavation: 1,066,400</td>
<td>Overburden excavation: 1,066,400</td>
<td>Overburden excavation: 1,270,000</td>
</tr>
<tr>
<td></td>
<td>Offsite construction material required (m³)</td>
<td>Offsite construction material required</td>
<td>2</td>
<td>2</td>
<td>Site is located within close proximity of the Sechelt Airport (accessed via Grey Creek Road) and approximately 1 km from new access road</td>
<td>Site is located within close proximity of the Sechelt Airport (accessed via Grey Creek Road) and approximately 1 km from new access road</td>
</tr>
<tr>
<td></td>
<td>Site access</td>
<td>Site is located within close proximity of the Sechelt Airport (accessed via Grey Creek Road) and approximately 1 km from new access road</td>
<td>4</td>
<td>5</td>
<td>Site is located approximately 1 km from on existing, decommissioned road to the southwest (Option 1), and approximately 2 km from on a decommissioned road to the southwest (Option 2). The existing roads would require upgrades, and new access roads would be required to gain direct access to the site from either direction.</td>
<td>Site is located within close proximity of the Sechelt Airport (accessed via Grey Creek Road) and approximately 1 km from new access road</td>
</tr>
<tr>
<td></td>
<td>Site access</td>
<td>Site is located within close proximity of the Sechelt Airport (accessed via Grey Creek Road) and approximately 1 km from new access road</td>
<td>4</td>
<td>5</td>
<td>Site is located approximately 1 km from on existing, decommissioned road to the southwest (Option 1), and approximately 2 km from on a decommissioned road to the southwest (Option 2). The existing roads would require upgrades, and new access roads would be required to gain direct access to the site from either direction.</td>
<td>Site is located within close proximity of the Sechelt Airport (accessed via Grey Creek Road) and approximately 1 km from new access road</td>
</tr>
<tr>
<td></td>
<td>Site access</td>
<td>Site is located within close proximity of the Sechelt Airport (accessed via Grey Creek Road) and approximately 1 km from new access road</td>
<td>4</td>
<td>5</td>
<td>Site is located approximately 1 km from on existing, decommissioned road to the southwest (Option 1), and approximately 2 km from on a decommissioned road to the southwest (Option 2). The existing roads would require upgrades, and new access roads would be required to gain direct access to the site from either direction.</td>
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<td>Site is located within close proximity of the Sechelt Airport (accessed via Grey Creek Road) and approximately 1 km from new access road</td>
</tr>
</tbody>
</table>
A Fortis BC ROW is located immediately south of the site boundary. A-2 ROW crossings would be required to access the site off of the Sechelt-Airport FSR. No ROW crossings would be required to access the site from existing roads. No ROW crossings would be required to access the site from the reservoir.

The existing Chapman intake and raw water pipeline will not be altered to convey water to the site. Incoming water will be conveyed to the site from an assumed point on the existing Chapman raw water pipeline approximately 1,350 m via an approximately 1,700 m long HDPE pipe (bidirectional pipe that also conveys water from the reservoir to the tie-point). Pumps will be required to convey water from the tie-point.

Water would be conveyed to Chapman Creek via Tsawcome Creek. Water would then be conveyed from Chapman Creek to the Tsawcome Creek WTP via the existing Chapman intake and raw water pipeline. If water will be conveyed overland from reservoir to the tie-point, there is potential for loss due to evaporation and infiltration. Release of water will likely require rehabilitation and erosion control along Tsawcome Creek.

The surficial soils are interpreted to be slightly fractured, high strength, low permeability, intrusive granodioritic rocks. The bedrock contact is interpreted to range from 0 m to 5 m thick and is interpreted to be undulating. For the purposes of design, bedrock depth is assumed at 2 m thick at the north end of the site to 5 m thick at the south end of the site.

The surficial soils and bedrock are expected to be suitable for reuse as construction materials, provided the required processing is conducted to provide granular material suitable for construction of the infrastructure. Approximately 100 m of topsoil and 100 m of subsoil is assumed. Groundwater is assumed at approximately 1 m thick.
In general, the TSC within the site ranges from I to III. Topographic relief within the site is bedrock-controlled and the slope is stable, with no evidence of slope instability or seepage. No areas within or surrounding Site B have been interpreted to pose a significant hazard to the site. No areas within or surrounding Site A have been interpreted to pose a significant hazard to the site.

Site characteristics including terrain instability, geohazards, and topographic relief:
- **Terrain-instability, geohazards, seismotectonic conditions:**
  - Site A: Preliminary dam consequence of failure classification (class III) based on assumed sunny day failure scenario.
  - Site B: Preliminary dam consequence of failure classification (class III) based on assumed sunny day failure scenario.

Capital cost of reservoir site and supporting infrastructure:
- **Cost per m³ of water storage:**
  - Site A: $15.5
  - Site B: $16.4
  - Total installed cost (including contingency): $32.1 million

Economics:
- **Cost per m³ of water storage:**
  - Site A: $15.5
  - Site B: $16.4

Operations and maintenance:
- **Operations assumed to be conducted mainly onsite:**
  - Maintenance of reservoir and other supporting site infrastructure, new site access road, fence, pumps, additional water intake, and water conveyance piping.
- **Operations assumed to be conducted using a combination of onsite and remote (automated) procedures:**
  - Reservoir, new site access road, fence, pumps, additional water intake, and water conveyance piping.

Species at risk (SAR) and species of concern (SOC):
- **Federal Species at Risk (SAR):**
  - Hutton’s vireo - Red List
  - Northern red-legged frog - Special Concern
  - Northern rubber boa - Special Concern
  - Coastal tailed frog - Special Concern
- **Provincial Species of Concern:**
  - Winter wren (Blue List)
  - Olive-sided flycatcher - Threatened
  - Band-tailed pigeon (Blue List)
  - Northern goshawk (Laingi subspecies) - Threatened
  - Olive-sided flycatcher - Threatened

Environmental impacts:
- **Potential economic co-benefits (i.e. industry partnerships, hydroelectric potential, etc.):**
  - Site A: None identified
  - Site B: None identified

Technical Feasibility:
- **Site stability and geohazard assessment:**
  - Site A: Preliminary dam consequence of failure classification (class III) based on assumed sunny day failure scenario.
  - Site B: Preliminary dam consequence of failure classification (class III) based on assumed sunny day failure scenario.

Evaluation Criteria:
- **Option 1: Site A**
- **Option 2: Site B**

Potential industry partnership opportunities, potential for hydropower generation:
- **Potential industry partnership opportunities, potential for hydropower generation:**
  - Site A: None identified
  - Site B: None identified

Lifecycle cost Qualitative asset management cost:
- **Qualitative asset management cost:**
  - Site A: Reservoir, new site access road, fence, pumps, additional water intake, and water conveyance piping.
  - Site B: Reservoir, new site access road, fence, pumps, additional water intake, and water conveyance piping.

Economic Feasibility:
- **Environmental Impacts:**
  - Species at risk (SAR) and species of concern (SOC):
    - Federal provincial SAR and provincial SOC within a 1 km radius of the site locations:
      - Site A: None identified
      - Site B: None identified
- **Environmental impacts:**
  - 18

Environmental sustainability:
- **Environmental sustainability:**
  - Species at risk (SAR) and species of concern (SOC):
    - Federal and provincial SAR and provincial SOC within a 1 km radius of the site locations:
      - Site A: None identified
      - Site B: None identified

Economic sustainability:
- **Economic sustainability:**
  - Potential industry partnership opportunities, potential for hydropower generation:
    - Site A: None identified
    - Site B: None identified

Operational sustainability:
- **Operational sustainability:**
  - Operations assumed to be conducted mainly onsite:
    - Maintenance of reservoir and other supporting site infrastructure, new site access road, fence, pumps, additional water intake, and water conveyance piping.
  - Operations assumed to be conducted using a combination of onsite and remote (automated) procedures:
    - Reservoir, new site access road, fence, pumps, additional water intake, and water conveyance piping.
Species identified in desktop study include American robin, bald eagle, band-tailed pigeon, ... yellow-rumped warbler; Wilson's warbler, winter wren, yellow-rumped warbler

### Environmental Impacts

#### Wetlands and surface water

<table>
<thead>
<tr>
<th>WETLANDS IDENTIFIED WITH FLOODPLAINS AND PROXIMITY TO SURFACE WATER</th>
<th>WETLANDS IDENTIFIED WITH FLOODPLAINS AND PROXIMITY TO SURFACE WATER</th>
</tr>
</thead>
<tbody>
<tr>
<td>No mapped wetlands identified with floodplains and proximity to surface water</td>
<td>No mapped wetlands identified with floodplains and proximity to surface water</td>
</tr>
</tbody>
</table>

#### Water quality for Chapman River System

<table>
<thead>
<tr>
<th>WATER QUALITY FOR CHAPMAN RIVER SYSTEM</th>
<th>WATER QUALITY FOR CHAPMAN RIVER SYSTEM</th>
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</thead>
<tbody>
<tr>
<td>No water samples were collected from large rain events or landslides that cause poor water quality in Chapman Creek.</td>
<td>Water stored in reservoir is protected from large rain events or landslides that cause poor water quality in Chapman Creek.</td>
</tr>
</tbody>
</table>

#### Evaluation Criteria

<table>
<thead>
<tr>
<th>OPTION 1</th>
<th>OPTION 2</th>
<th>OPTION 3</th>
<th>OPTION 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site A</td>
<td>Site B</td>
<td>Site C</td>
<td>Site D</td>
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</table>

#### Evaluation Criteria Options

<table>
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<th>CRITERIA</th>
<th>SUB-CRITERIA</th>
<th>DESCRIPTION</th>
<th>WEIGHTING</th>
<th>RANKING</th>
<th>COMMENTS</th>
</tr>
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<tbody>
<tr>
<td>Species Identified in Study</td>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Environmental Impacts</td>
<td>Wetlands and surface water</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Water quality for Chapman River System</td>
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<td></td>
<td></td>
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</tbody>
</table>
Regulatory and Stakeholder Activity

Regulatory requirements

<table>
<thead>
<tr>
<th>Identified permits/authorizations required at this stage of project definition</th>
<th>Count</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geotechnical development permit, Water license (Section 9), Licence of Occupation (Section 39), Conduct of non-commercial use with the AIL, Vancouver Coastal Health notification, Licence to Cut, Environmental Assessment Certificate, Waterworks Construction Permit, Operating Permit, Fisheries and Oceans Canada request for review, Riparian Development Permit</td>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
</tr>
</tbody>
</table>

Key potential regulatory challenges

<table>
<thead>
<tr>
<th>Identification of regulatory requirements that may pose significant challenges</th>
<th>Count</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Licence to Cut (under the Forest Act)</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Licence to Cut (under the Forest Act)</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>

General community favourability

<table>
<thead>
<tr>
<th>Expected support from community stakeholders</th>
<th>Count</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site is located in largely unimpacted area, and located near Tetrahedron Park</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Site is located in largely unimpacted area, and located near Tetrahedron Park</td>
<td>4</td>
<td>4</td>
</tr>
</tbody>
</table>

NOTES
1. Suitability of soil material for use as fill material is based on desktop review of regional-scale geological maps and one-day site reconnaissance only. An intrusive geotechnical investigation is recommended to be completed at the site locations during future design stages to confirm material suitability, and is not included in the scope of work.
2. Bedrock depths should be confirmed during an intrusive geotechnical investigation during future design stages (not included in the current scope of work).
3. Preliminary data concerning failure classifications is considered as high level only and is based on the conceptual design. Analysis to fully evaluate is required, and is outside of the scope of work for this project.
4. Preliminary data concerning failure classifications is considered as high level only and is based on the conceptual design. Analysis to fully evaluate is required, and is outside of the scope of work for this project.
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8. Preliminary data concerning failure classifications is considered as high level only and is based on the conceptual design. Analysis to fully evaluate is required, and is outside of the scope of work for this project.
9. Preliminary data concerning failure classifications is considered as high level only and is based on the conceptual design. Analysis to fully evaluate is required, and is outside of the scope of work for this project.
10. Preliminary data concerning failure classifications is considered as high level only and is based on the conceptual design. Analysis to fully evaluate is required, and is outside of the scope of work for this project.

Total Weighted Score 100 70 78 71 68
### Technical Feasibility

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Sub-Criteria</th>
<th>Description</th>
<th>Weighting</th>
<th>Option 1: Site A</th>
<th>Comments</th>
<th>Option 2: Site B</th>
<th>Comments</th>
<th>Option 3: Site C</th>
<th>Comments</th>
<th>Option 4: Site D</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total site area and approximate clearing and grubbing area (ha)</td>
<td>Site area</td>
<td>Approximate clearing and grubbing area (ha) included in total site area</td>
<td>2</td>
<td>Site area: 47.4</td>
<td>Clearing and grubbing: 47.4</td>
<td>2</td>
<td>Total site area: 45.2</td>
<td>Clearing and grubbing: 45.2</td>
<td>2</td>
<td>Total site area: 53.3</td>
<td>Clearing and grubbing (approximate): 2 (excluding clearing and grubbing required for access road)</td>
</tr>
<tr>
<td>Total site area and approximate clearing and grubbing area (ha)</td>
<td>Overburden excavation, bedrock excavation, earthworks volume, and subsoil stripping volume (m³)</td>
<td>Approximate earthworks quantities based on conceptual design, including overburden excavation volume, bedrock excavation volume, and fill volume required to achieve the storage volume, and total subsoil stripping volume</td>
<td>2</td>
<td>Overburden excavation: 271,380</td>
<td>Bedrock excavation: 56,000</td>
<td>2</td>
<td>Overburden excavation: 261,418</td>
<td>Bedrock excavation: 60,234</td>
<td>2</td>
<td>Overburden excavation: 1,174,140</td>
<td>Bedrock excavation: 956,730</td>
</tr>
<tr>
<td>Total site area and approximate clearing and grubbing area (ha)</td>
<td>Onsite construction material required (m³)</td>
<td>Requirement for onsite construction material if onsite material is not suitable or sufficient in volume</td>
<td>2</td>
<td>Concrete volume required for the concrete dam is less than the concrete volume required for the concrete membranes at Sites C3 and C4.</td>
<td>Concrete volume required for the concrete dam is greater than the concrete volume required for the concrete membranes at Sites C3 and C4.</td>
<td>2</td>
<td>Yes, concrete will be required. A concrete gravity dam will be constructed.</td>
<td>Concrete volume required for the dam is less than the volume required for the concrete membranes at Sites A and B.</td>
<td>3</td>
<td>Yes, concrete will be required. A concrete gravity dam will be constructed.</td>
<td>Concrete volume required for the dam is less than the volume required for the concrete membranes at Sites A and B.</td>
</tr>
<tr>
<td>Site access</td>
<td>Site proximity to existing road, length of new access road constructed to site, and distance to the nearest decommissioned road (if applicable)</td>
<td>Site is located within close proximity of the Sechelt Airport Road to the west. The road may require upgrades (approximate length: 1,500 m).</td>
<td>5</td>
<td>Site is located approximately 1 km from an existing, decommissioned road to the southwest (Option 1), and approximately 3 km from an unnamed decommissioned road to the southwest (Option 2).</td>
<td>Site is located approximately 1 km from an existing, decommissioned road (accessed via Grey Creek Road and approximately 1 km from new access road).</td>
<td>5</td>
<td>Site is located approximately 1 km from an existing, decommissioned road (accessed via Grey Creek Road and approximately 5 km of new access road).</td>
<td>Site is located approximately 1 km from an existing, decommissioned road (accessed via Grey Creek Road and approximately 1 km from new access road).</td>
<td>5</td>
<td>Site is located approximately 1 km from an existing, decommissioned road (accessed via Grey Creek Road and approximately 5 km of new access road).</td>
<td>Site is located approximately 1 km from an existing, decommissioned road (accessed via Grey Creek Road and approximately 5 km of new access road).</td>
</tr>
</tbody>
</table>
### Technical Feasibility

#### Conveyance method from reservoir to Chapman Creek WTP

<table>
<thead>
<tr>
<th>Infrastructure (existing and new) required to transport water from the reservoir to the Chapman Creek WTP</th>
<th>Technical Feasibility</th>
<th>Options</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>To convey water from the reservoir to the Chapman Creek WTP, a new water conveyance pipeline will be required. The existing Chapman raw water pipeline will be utilized to convey water to the site. Outflowing water will be conveyed to the site via the existing Chapman raw water pipeline.</td>
<td>4</td>
<td>3</td>
<td>The water will gravity flow from the intake to the reservoir (no pumps required).</td>
</tr>
</tbody>
</table>

#### Subsurface conditions

<table>
<thead>
<tr>
<th>Characteristics and estimated thickness of surficial deposits, depth to bedrock, potential for use of surficial deposits for construction materials, estimated groundwater depth</th>
<th>Technical Feasibility</th>
<th>Options</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>The surficial soils and bedrock are expected to be suitable for reuse as construction materials for the embankment dam, operations pads, roads, and site access point. The surficial soils and bedrock are expected to be suitable for reuse as construction materials for the embankment dam, operations pads, roads, and site access point.</td>
<td>3</td>
<td>4</td>
<td>Groundwater is assumed to be at approximately 1 mbgs.</td>
</tr>
</tbody>
</table>

---

### Evaluation Criteria

**Option 3:** Site C3

1. **Accessibility:** Site C3 is located immediately north of the site boundary. A Fortis BC ROW is located approximately 150 m south of the site boundary. The surficial soils and bedrock are expected to be suitable for reuse as construction materials for the embankment dam, operations pads, roads, and site access point. Approximately 100 mm of topsoil and 100 mm of subsoil is assumed. Groundwater is assumed to be at approximately 1 mbgs.

**Option 4:** Site C4

1. **Accessibility:** Site C4 is located immediately north of the site boundary. A BC Hydro ROW is located approximately 500 m south of the site boundary. No ROW crossings would be required to access the site off of the Sechelt-Airport FSR. The water conveyance pipeline will be used to convey water from Site C4 to the site. No ROW crossings would be required for the water conveyance pipelines to and from the site. The SCRC access road is located immediately north of the site boundary. The infrastructure required to convey water from Site C4 to the site is expected to be suitable for reuse as construction materials for the embankment dam, operations pads, roads, and site access point. Approximately 400 mm of topsoil and 200 mm of subsoil is assumed. Groundwater is assumed to be at approximately 1 mbgs on valley slopes and at surface along the lake basin.
In general, the TSC within the site ranges from I to III. Topographic relief within the site is bedrock-controlled and no indication of slope instability. No evidence of previous slope movement was observed or the immediate vicinity of the site. However, slope instability was identified within the western portion of the site. Development within the western portion of the site has been interpreted to pose a significant hazard to the site.

The site is located in a high seismic hazard region and all structures included in the designs will need to be designed to accommodate a 1:10,000 return period earthquake. Based on the interpreted subsurface conditions, the site is interpreted to have a relatively low risk of liquefaction during a seismic event.

Evaluation Criteria

<table>
<thead>
<tr>
<th>Option</th>
<th>Site A</th>
<th>Site B</th>
<th>Site C3</th>
<th>Site C4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dam consequence of failure classification (posterior)</td>
<td>Preliminary dam consequence of failure classification</td>
<td>Preliminary dam consequence of failure classification</td>
<td>Preliminary dam consequence of failure classification</td>
<td>Preliminary dam consequence of failure classification</td>
</tr>
<tr>
<td>Cost per m³ of water storage</td>
<td>$16.8</td>
<td>$14.1</td>
<td>$12.8</td>
<td>$11.6</td>
</tr>
<tr>
<td>Capital cost of reservoir site and supporting infrastructure</td>
<td>$53,120,000</td>
<td>$16,415,000</td>
<td>$12,812,000</td>
<td>$11,680,000</td>
</tr>
<tr>
<td>Lifecycle cost</td>
<td>Quality-of-life management cost</td>
<td>Reservoir and associated infrastructure, new site access, flood, fences and water conveyance piping</td>
<td>Reservoir and associated infrastructure, new site access, flood, fences and water conveyance piping</td>
<td>Reservoir and associated infrastructure, new site access, flood, fences and water conveyance piping</td>
</tr>
<tr>
<td>Operating cost</td>
<td>Qualitative assessment of requirement for operations, maintenance, and surveillance</td>
<td>Operations assumed to be conducted mainly on-site</td>
<td>Operations assumed to be conducted mainly on-site</td>
<td>Operations assumed to be conducted mainly on-site</td>
</tr>
<tr>
<td>Environmental impacts</td>
<td>Species of concern (SOC)</td>
<td>Federal and provincial SAR and provincial SOC within a 10 km radius of site locations</td>
<td>Federal and provincial SAR and provincial SOC within a 10 km radius of site locations</td>
<td>Federal and provincial SAR and provincial SOC within a 10 km radius of site locations</td>
</tr>
<tr>
<td>Socioeconomic, technical feasibility</td>
<td>Site characteristics including terrain instability, geohazards, seismic/technological conditions</td>
<td>Site characteristics including terrain instability, geohazards, seismic/technological conditions</td>
<td>Site characteristics including terrain instability, geohazards, seismic/technological conditions</td>
<td>Site characteristics including terrain instability, geohazards, seismic/technological conditions</td>
</tr>
<tr>
<td>Potential economic co-benefits</td>
<td>Potential economic co-benefit opportunities (i.e. industry partnerships, hydropower credits, etc.)</td>
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<td>Potential economic co-benefit opportunities (i.e. industry partnerships, hydropower credits, etc.)</td>
</tr>
<tr>
<td>Technical Feasibility</td>
<td>Terrestrial instability, geohazards, seismic/technological conditions</td>
<td>Terrestrial instability, geohazards, seismic/technological conditions</td>
<td>Terrestrial instability, geohazards, seismic/technological conditions</td>
<td>Terrestrial instability, geohazards, seismic/technological conditions</td>
</tr>
</tbody>
</table>

Environmental Impacts

<table>
<thead>
<tr>
<th>Species of concern (SOC)</th>
<th>Federal and provincial SAR and provincial SOC within a 10 km radius of site locations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Federal Species at Risk</td>
<td>Northern goshawk (lying subspecies) - Threatened Northern red-legged frog - Special Concern Northern rubber boa - Special Concern - (blue list) - Threatened Provincial SAR</td>
</tr>
</tbody>
</table>

Economics

<table>
<thead>
<tr>
<th>Capital cost of reservoir site and supporting infrastructure</th>
<th>Cost per m³ of water storage</th>
<th>Total installed cost (including contingency)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$53,120,000</td>
<td>$16.8</td>
<td>$53,120,000</td>
</tr>
<tr>
<td>$16,415,000</td>
<td>$14.1</td>
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</tr>
<tr>
<td>$11,680,000</td>
<td>$11.6</td>
<td>$11,680,000</td>
</tr>
</tbody>
</table>

Operations assumed to be conducted using a combination of onsite and remote (automated) procedures (given the remote location). Maintenance of dam and other supporting site infrastructure, access road. 

The above requirements consider the greater distance for the dam access from Sites A and B. For Site C, the dam access is closer, approximately 2 km from the dam.

Potential species of concern (SOC)

<table>
<thead>
<tr>
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<th>Federal and provincial SAR and provincial SOC within a 10 km radius of site locations</th>
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</thead>
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</tr>
</tbody>
</table>

The site is located in a high seismic hazard region and all structures included in the designs will need to be designed to accommodate a 1:10,000 return period earthquake. Based on the interpreted subsurface conditions, the site is interpreted to have a relatively low risk of liquefaction during a seismic event.
## Important habitat features

<table>
<thead>
<tr>
<th>Species</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>American robin</td>
<td>Bold, light</td>
</tr>
<tr>
<td>Band-tailed pigeon</td>
<td>Bold-faced</td>
</tr>
<tr>
<td>Black-headed grosbeak</td>
<td>Bold-face</td>
</tr>
<tr>
<td>Black-throated gray warbler</td>
<td>Bold-face</td>
</tr>
<tr>
<td>Brown-headed cowbird</td>
<td>Bold-face</td>
</tr>
<tr>
<td>Cassin’s vireo</td>
<td>Bold-face</td>
</tr>
<tr>
<td>Cedar waxwing</td>
<td>Bold-face</td>
</tr>
<tr>
<td>Chestnut-backed chickadee</td>
<td>Bold-face</td>
</tr>
<tr>
<td>Common raven</td>
<td>Bold-face</td>
</tr>
<tr>
<td>Hammond’s flycatcher</td>
<td>Bold-face</td>
</tr>
<tr>
<td>Hairy woodpecker</td>
<td>Bold-face</td>
</tr>
<tr>
<td>Jackson’s snipe</td>
<td>Bold-face</td>
</tr>
<tr>
<td>Junco</td>
<td>Bold-face</td>
</tr>
<tr>
<td>Least flycatcher</td>
<td>Bold-face</td>
</tr>
<tr>
<td>MacGillivray’s warbler</td>
<td>Bold-face</td>
</tr>
<tr>
<td>Marbled murrelet</td>
<td>Bold-face</td>
</tr>
<tr>
<td>Northern flicker</td>
<td>Bold-face</td>
</tr>
<tr>
<td>Northwestern crows</td>
<td>Bold-face</td>
</tr>
<tr>
<td>Olive-sided flycatcher</td>
<td>Bold-face</td>
</tr>
<tr>
<td>Pacific wren</td>
<td>Bold-face</td>
</tr>
<tr>
<td>Pacific chorus frog</td>
<td>Bold-face</td>
</tr>
<tr>
<td>Pacific flying squirrel</td>
<td>Bold-face</td>
</tr>
<tr>
<td>Pacific salamanders</td>
<td>Bold-face</td>
</tr>
<tr>
<td>Pacific tree shrew</td>
<td>Bold-face</td>
</tr>
<tr>
<td>Pinyon jay</td>
<td>Bold-face</td>
</tr>
<tr>
<td>Port Orford cedar</td>
<td>Bold-face</td>
</tr>
<tr>
<td>Red crossbills</td>
<td>Bold-face</td>
</tr>
<tr>
<td>Rock wren</td>
<td>Bold-face</td>
</tr>
<tr>
<td>Rusty blackbird</td>
<td>Bold-face</td>
</tr>
<tr>
<td>Sapsucker</td>
<td>Bold-face</td>
</tr>
<tr>
<td>Scissortail flycatcher</td>
<td>Bold-face</td>
</tr>
<tr>
<td>Selasphorus rufus</td>
<td>Bold-face</td>
</tr>
<tr>
<td>Spotted flycatcher</td>
<td>Bold-face</td>
</tr>
<tr>
<td>Swainson’s hawk</td>
<td>Bold-face</td>
</tr>
<tr>
<td>Tawny owl</td>
<td>Bold-face</td>
</tr>
<tr>
<td>Townsend’s solider</td>
<td>Bold-face</td>
</tr>
<tr>
<td>Virginia rail</td>
<td>Bold-face</td>
</tr>
<tr>
<td>Wilson’s phalarope</td>
<td>Bold-face</td>
</tr>
<tr>
<td>Wilson’s snipe</td>
<td>Bold-face</td>
</tr>
<tr>
<td>Wilson’s warbler</td>
<td>Bold-face</td>
</tr>
<tr>
<td>Western meadowlark</td>
<td>Bold-face</td>
</tr>
<tr>
<td>Western scrub jay</td>
<td>Bold-face</td>
</tr>
<tr>
<td>Western yellow pheasant</td>
<td>Bold-face</td>
</tr>
<tr>
<td>Willow ptarmigan</td>
<td>Bold-face</td>
</tr>
<tr>
<td>Wilson’s phalarope</td>
<td>Bold-face</td>
</tr>
<tr>
<td>Yellow-rumped warbler</td>
<td>Bold-face</td>
</tr>
</tbody>
</table>

## Potential impact

### Environmental Impacts

#### Fish presence

<table>
<thead>
<tr>
<th>Fish</th>
<th>Identified in shallow water (downstream of reaches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salmon</td>
<td>Identified in shallow water (downstream of reaches)</td>
</tr>
<tr>
<td>Trout</td>
<td>Identified in shallow water (downstream of reaches)</td>
</tr>
<tr>
<td>Salmon</td>
<td>Identified in shallow water (downstream of reaches)</td>
</tr>
<tr>
<td>Trout</td>
<td>Identified in shallow water (downstream of reaches)</td>
</tr>
</tbody>
</table>

#### Wetlands and surface water

<table>
<thead>
<tr>
<th>Wetland</th>
<th>Identified within 100 m of site boundary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wetland</td>
<td>Identified within 100 m of site boundary</td>
</tr>
<tr>
<td>Wetland</td>
<td>Identified within 100 m of site boundary</td>
</tr>
<tr>
<td>Wetland</td>
<td>Identified within 100 m of site boundary</td>
</tr>
</tbody>
</table>

#### Water quality for Chapman Water System

<table>
<thead>
<tr>
<th>Water quality</th>
<th>Potential for improvement in water quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water quality</td>
<td>Potential for improvement in water quality</td>
</tr>
<tr>
<td>Water quality</td>
<td>Potential for improvement in water quality</td>
</tr>
</tbody>
</table>

## Evaluation criteria

<table>
<thead>
<tr>
<th>Option</th>
<th>Criteria</th>
<th>Sub-criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Option 1</td>
<td>Site A</td>
<td>Site B</td>
</tr>
<tr>
<td>Option 2</td>
<td>Site C</td>
<td>Site D</td>
</tr>
<tr>
<td>Option 3</td>
<td>Site E</td>
<td>Site F</td>
</tr>
<tr>
<td>Option 4</td>
<td>Site G</td>
<td>Site H</td>
</tr>
</tbody>
</table>
Regulatory requirements

- Identified permits/authorizations required at this stage of project definition:
  - Geotechnical development permit, Water license (Section 9), Licensing under BC Dam Safety Regulation, License of Occupation (Section 39), Conduct of non-form use with the AUL, Vancouver Coastal Health notification, License to Cut, Environmental Assessment Certificate, Waterworks Construction Permit, Operating Permit, Fisheries and Oceans Canada request for review, Riparian Development Permit approval under the Canadian Environmental Assessment Act, Building permit, new drinking water source assessment, approval under the Navigation Protection Act, approved by Transport Canada, approved by NAV Canada, approved under Section 10 of the Water Sustainability Act.

- Key potential regulatory challenges:
  - No significant challenges identified.

- General community favourability:
  - Site is located in area previously heavily impacted by forestry.
  - Site is located in area previously heavily impacted by forestry.

<table>
<thead>
<tr>
<th>Evaluation Criteria</th>
<th>Options</th>
<th>Sub-Criteria</th>
<th>Description</th>
<th>Weighting</th>
<th>Ranking</th>
<th>Comments</th>
<th>Weighted Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Weighted Score</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
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<tr>
<td>1</td>
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<td>6</td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

NOTES:
1. Subtitle of subtitle materials for use as title material is based on desktop review of regional scale geological maps and one-day site reconnaissance only. An intensive geotechnical investigation is recommended to be completed at the site locations during future design stages to confirm material suitability and is not included in the scope of work.
2. Bedrock depths should be confirmed during an intensive geotechnical investigation during future design stages (not included in the currently scope of work).
3. Results of site characterization are based on design criteria and assumptions included in the Phase 3 Design Summary Report (VP19-SCR-01-00-DWG-CI-DesignSummary_Rev1) and Phase 1 desk study (VP19-SCR-01-00-DWG-CI-100-204, VP19-SCR-01-00-DWG-CI-200-204, VP19-SCR-01-00-DWG-CI-300-305, VP19-SCR-01-00-DWG-CI-400-405).
4. Preliminary dam consequence of failure classification is intended as high level only and is based on the conceptual design. Analyses to fully evaluate is required, and is outside of the scope of work for this project.
5. The criteria and the criteria rankings are based on design criteria and assumptions included in the Phase 3 Design Summary Report (VP19-SCR-01-00-DWG-CI-DesignSummary_Rev1) and Phase 1 desk study (VP19-SCR-01-00-DWG-CI-100-204, VP19-SCR-01-00-DWG-CI-200-204, VP19-SCR-01-00-DWG-CI-300-305, VP19-SCR-01-00-DWG-CI-400-405).
6. Criteria weightings for the base case and sensitivity analysis cases, as well as site option rankings, were likely developed in Phase 2 and referenced in the Feasibility Study Report (VP19-SCR-01-00-DWG-CI-Feasibility_Study_Rev1) and the Cost Estimate and Basis of Estimate (VP19-SCR-01-00-DWG-CI-Phase_3_Rev1).
### Table 4 - Multi-Criteria Analysis Matrix: Economics Focused Case

<table>
<thead>
<tr>
<th>Evaluation Criteria</th>
<th>Description</th>
<th>Weighting</th>
<th>Option 1: Site A</th>
<th>Comments</th>
<th>Option 2: Site B</th>
<th>Comments</th>
<th>Option 3: Site C1</th>
<th>Comments</th>
<th>Option 4: Site C4</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Technical Feasibility</strong></td>
<td>Total site area and approximate clearing and grubbing area (ha)</td>
<td>2</td>
<td>Total site area: 47.4 Clearing and grubbing: 47.4</td>
<td>3</td>
<td>Total site area: 47.4 Clearing and grubbing: 47.4</td>
<td>2</td>
<td>Total site area: 47.4 Clearing and grubbing (approximate): 2 (excluding clearing and grubbing required for access road)</td>
<td>2</td>
<td>Total site area: 47.4 Clearing and grubbing (approximate): 2 (excluding clearing and grubbing required for access road)</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Overburden excavation, embankment, earthworks excavation volume</td>
<td>3</td>
<td>No overburden is available at Site B</td>
<td>2</td>
<td>Overburden excavation: 21,000</td>
<td>2</td>
<td>Overburden excavation: 21,111</td>
<td>3</td>
<td>Overburden excavation: 26,148</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Overburden excavation, embankment, earthworks excavation volume</td>
<td>3</td>
<td>No overburden is available at Site B</td>
<td>2</td>
<td>Overburden excavation: 21,000</td>
<td>2</td>
<td>Overburden excavation: 21,111</td>
<td>3</td>
<td>Overburden excavation: 26,148</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Other construction material required (m³)</td>
<td>2</td>
<td>Site is located within close proximity of the Sechelt Airport (access via Grey Creek Road)</td>
<td>2</td>
<td>Site is located within close proximity of the Sechelt Airport</td>
<td>2</td>
<td>Site is located within close proximity of the Sechelt Airport</td>
<td>2</td>
<td>Site is located within close proximity of the Sechelt Airport</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Site access</td>
<td>2</td>
<td>Site is located within close proximity of the Sechelt Airport (access via Grey Creek Road)</td>
<td>2</td>
<td>Site is located within close proximity of the Sechelt Airport</td>
<td>2</td>
<td>Site is located within close proximity of the Sechelt Airport</td>
<td>2</td>
<td>Site is located within close proximity of the Sechelt Airport</td>
<td>2</td>
</tr>
</tbody>
</table>

**Note:** The table includes evaluations for site access, technical feasibility, economics, and other criteria. The scoring system ranges from 1 (strong disadvantage) to 5 (strong advantage). Comments are included for each option to provide further details on the evaluation criteria.
### Option 1: Site A

- **Site Characteristics**: A Fortis BC ROW is located immediately south of the site boundary. A K2 Hydroway ROW is located approximately 400 m south of the site boundary.
- **Infrastructure**: No ROW crossings would be required to access the site from existing roads.
- **Subsurface Conditions**: Approximately 100 mm of topsoil and 100 mm of subsoil is assumed. Groundwater is assumed at approximately 1 m bgs.

### Option 2: Site B

- **Site Characteristics**: A Fortis BC ROW is located immediately south of the site boundary. A K2 Hydroway ROW is located approximately 400 m south of the site boundary.
- **Infrastructure**: No ROW crossings would be required for the water conveyance pipelines to and from the site.
- **Subsurface Conditions**: Approximately 100 mm of topsoil and 100 mm of subsoil is assumed. Groundwater is assumed at approximately 1 m bgs.

### Option 3: Site C3

- **Site Characteristics**: A BC Hydro ROW is located approximately 500 m south of the site boundary. The ORCA ROW is located immediately north of the site boundary, and the ORCA facility is located immediately east of the site boundary. The ORCA also hosts a canal trench that spans a portion of the site area.
- **Infrastructure**: The existing Chapman intake and raw water pipeline will be allowed to convey water from the site to the Chapman Creek WTP. Outgoing water will be conveyed to the site from an assumed point on the existing Chapman raw water pipeline approximately 1,750 m long (directly below the site from the tie-point). From the tie-point, water will be conveyed to the Chapman Creek WTP via the existing Chapman raw water pipeline.
- **Subsurface Conditions**: Approximately 100 mm of topsoil and 100 mm of subsoil is assumed. Groundwater is assumed at approximately 1 m bgs.

### Option 4: Site C4

- **Site Characteristics**: A BC Hydro ROW is located immediately south of the site boundary. The ORCA ROW is located immediately north of the site boundary, and the ORCA facility is located immediately east of the site boundary. The ORCA also hosts a canal trench that spans a portion of the site area.
- **Infrastructure**: No ROW crossings would be required to access the site from existing roads.
- **Subsurface Conditions**: Approximately 100 mm of topsoil and 100 mm of subsoil is assumed. Groundwater is assumed at approximately 1 m bgs.

### Technical Notes

**Conveyance Method from Source to Reservoir Site**

- In general, the Chapman raw water pipeline will be allowed to convey water from the site to the Chapman Creek WTP. Outgoing water will be conveyed to the site from an assumed point on the existing Chapman raw water pipeline approximately 1,750 m long (directly below the site from the tie-point). From the tie-point, water will be conveyed to the Chapman Creek WTP via the existing Chapman raw water pipeline.

**Subsurface Conditions**

- Characteristics and estimated thicknesses of surficial deposits, bedrock contact, potential for use of surficial materials for construction materials, estimated groundwater depth.
## Technical Feasibility

### Site Characteristics including Terrain Instability, Geohazards, Seismotectonic Conditions

<table>
<thead>
<tr>
<th>Rating</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>In general, the TSC within the site ranges from I to III. Topographic relief within the site is bedrock-controlled and not indicative of slope instability. Seismotectonic conditions are unclassified and no other hazards posed. No areas within or surrounding Site B have been identified to pose a significant hazard to the site.</td>
</tr>
</tbody>
</table>

### Dam Consequence of Failure Classification (Governmental)

<table>
<thead>
<tr>
<th>Evaluation Criteria</th>
<th>Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preliminary dam consequence of failure classification</td>
<td>Preliminary dam consequence of failure classification (based on the estimated loss or damage caused by a failure of a dam, and evaluates loss of life, injury, and general devastation of the lives of the population in the area inundated by the overflow, as well as damage to infrastructure and economic costs)</td>
</tr>
</tbody>
</table>

### Capital Cost of Reservoir Site and Supporting Infrastructure

- **Cost per m³ of water storage:**
  - $41.8
- **Total installed cost (including contingency):**
  - $49,874,000

### Lifecycle Cost

- **Cost per m³ of water storage:**
  - $15.5
- **Total installed cost (including contingency):**
  - $16.8

### Operating Cost

- **Cost per m³ of water storage:**
  - $19.8
- **Total installed cost (including contingency):**
  - $18.1

### Environmental Impacts

- **Species at risk (SAR) and species of concern (SOC):**
  - Federal and provincial SAR and provincial SOC within a 10 km radius of site locations

### Economics

- **Potential economic co-benefit opportunities:**
  - Industry partnerships, hydroelectric potential, etc.

| Potential industry partnerships opportunities, potential for hydroelectric power generation | 1 |

### Evaluation Criteria

<table>
<thead>
<tr>
<th>Description</th>
<th>Weighting</th>
<th>Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>Terrain instability, geohazards, seismotectonic conditions</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>Site characteristics</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Capital cost of reservoir site and supporting infrastructure</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Lifecycle cost</td>
<td>3</td>
<td>12</td>
</tr>
<tr>
<td>Operating cost</td>
<td>3</td>
<td>12</td>
</tr>
<tr>
<td>Potential economic co-benefit opportunities</td>
<td>3</td>
<td>8</td>
</tr>
</tbody>
</table>

### Federal Species at Risk (SAR)

- **Band-tailed pigeon (Blue List)**
- **Northern red-legged frog (Blue List)**
- **Winter wren (Blue List)**
- **Coastal tailed frog - Special Concern**
- **Northern goshawk (Laingi subspecies) - Threatened**
- **Northern red-legged frog - Special Concern**
- **Northern rubber boa - Special Concern**
- **Coastal ruffled frog - Threatened**

### Provincial Species at Risk

- **Northern ruffed grouse (Zalophus) - Threatened**
- **Hutton’s vireo - Red List**
- **Northern red-legged frog (Blue List)**
- **Northern rubber boa (Blue List)**
- **Coastal ruffled frog (Blue List)**
- **Winter wren (Blue List)**

### Federal SAR

- **Band-tailed pigeon - Special Concern**
- **Coastal ruffled frog - Special Concern**
- **Northern goshawk (Laingi subspecies) - Threatened**
- **Northern red-legged frog - Special Concern**
- **Northern rubber boa - Special Concern**
- **Coastal ruffled frog - Threatened**

### Provincial SAR

- **Northern ruffed grouse (Zalophus) - Threatened**
- **Hutton’s vireo - Red List**
- **Northern red-legged frog (Blue List)**
- **Northern rubber boa (Blue List)**
- **Coastal ruffled frog (Blue List)**
- **Winter wren (Blue List)**
Special habitat identified in desktop study include American robin, black-throated gray warbler, brown-headed cowbird, chum salmon, coho salmon, cutthroat trout, lamprey, Pacific chorus frog (adults), pacific red-legged frog (tadpole [potential]), northwestern salamanders (all life stages), olive-sided flycatcher, western tanager, willow flycatcher, Wilson's warbler, winter wren, yellow-rumped warbler. Species identified in desktop study include American robin, black-throated gray warbler, brown-headed cowbird, chum salmon, coho salmon, cutthroat trout, lamprey, Pacific chorus frog (adults), pacific red-legged frog (tadpole [potential]), northwestern salamanders (all life stages), olive-sided flycatcher, western tanager, willow flycatcher, Wilson's warbler, winter wren, yellow-rumped warbler. Preliminary field identified species include elk, hazel, locust, leaf scorpionfly, pacific chorus frog (juvenile), northern red-legged frog (tadpole [potential]), northwestern salamanders (all life stages). Wildlife presence and potential impact Wildlife identified within 10 km radius of site locations. Based on desktop review, no documented fish presence identified or observed. However, given that lakes are interpreted to be suitable fish habitat, further investigation will be required. Wetlands and surface water Wetlands identified within footprint and proximity to mapped wetlands and proximity to surface water 2 4 No mapped wetlands identified within site area. Site is located 2.2 km from a mapped wetland. Wetlands identified within footprint and proximity to mapped wetlands and proximity to surface water 2 4 No mapped wetlands identified within site area. Site is located 2.2 km from a mapped wetland. 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**Regulatory and Stakeholder Sensitivity**

<table>
<thead>
<tr>
<th>Regulatory requirements</th>
<th>Identified permits/authorizations required at this stage of project definition</th>
<th>Potential challenges</th>
<th>Identified permits/authorizations required during design and construction</th>
<th>Identified permits/authorizations required after construction</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Development permit, Water licence (Section 9)</td>
<td></td>
<td>Development permit, Water licence (Section 9)</td>
<td>Development permit, Water licence (Section 9)</td>
</tr>
<tr>
<td></td>
<td>Geotechnical development permit, Water licence</td>
<td></td>
<td>Development permit, Water licence (Section 9)</td>
<td>Development permit, Water licence (Section 9)</td>
</tr>
<tr>
<td></td>
<td>Fisheries and Oceans Canada authorization, Licence to Cut, Environmental Assessment Certificate, Waterworks Construction Permit</td>
<td></td>
<td>Fisheries and Oceans Canada authorization, Licence to Cut, Environmental Assessment Certificate, Waterworks Construction Permit</td>
<td>Fisheries and Oceans Canada authorization, Licence to Cut, Environmental Assessment Certificate, Waterworks Construction Permit</td>
</tr>
<tr>
<td></td>
<td>Licensing under BC Dam Safety Regulation, License of Occupation (Section 39), Construction of non-highway use with the AUL, Vancouver Coastal health notification, License to Cut, Environmental Assessment Certificate, Waterworks Construction Permit, Operating Permit, Fisheries and Oceans Canada</td>
<td></td>
<td>Licensing under BC Dam Safety Regulation, License of Occupation (Section 39), Construction of non-highway use with the AUL, Vancouver Coastal health notification, License to Cut, Environmental Assessment Certificate, Waterworks Construction Permit, Operating Permit, Fisheries and Oceans Canada</td>
<td>Licensing under BC Dam Safety Regulation, License of Occupation (Section 39), Construction of non-highway use with the AUL, Vancouver Coastal health notification, License to Cut, Environmental Assessment Certificate, Waterworks Construction Permit, Operating Permit, Fisheries and Oceans Canada</td>
</tr>
<tr>
<td></td>
<td>Licence to Cut (LTC) (under the Forest Act), Fisheries and Oceans Canada authorization</td>
<td></td>
<td>Licence to Cut (LTC) (under the Forest Act), Fisheries and Oceans Canada authorization</td>
<td>Licence to Cut (LTC) (under the Forest Act), Fisheries and Oceans Canada authorization</td>
</tr>
<tr>
<td></td>
<td>Environmental Assessment Certificate, Waterworks Construction Permit, Operating Permit, Fisheries and Oceans Canada request for review</td>
<td></td>
<td>Environmental Assessment Certificate, Waterworks Construction Permit, Operating Permit, Fisheries and Oceans Canada request for review</td>
<td>Environmental Assessment Certificate, Waterworks Construction Permit, Operating Permit, Fisheries and Oceans Canada request for review</td>
</tr>
<tr>
<td></td>
<td>Riparian Development Permit</td>
<td></td>
<td>Riparian Development Permit</td>
<td>Riparian Development Permit</td>
</tr>
<tr>
<td></td>
<td>Approval under the Canadian Environmental Assessment Act, Building permit, new drinking water source assessment, approval under the Navigation Protection Act, approval by Transport Canada, approved by MVR Canada, approval under Section 10 of the Water Sustainability Act</td>
<td></td>
<td>Approval under the Canadian Environmental Assessment Act, Building permit, new drinking water source assessment, approval under the Navigation Protection Act, approval by Transport Canada, approved by MVR Canada, approval under Section 10 of the Water Sustainability Act</td>
<td>Approval under the Canadian Environmental Assessment Act, Building permit, new drinking water source assessment, approval under the Navigation Protection Act, approval by Transport Canada, approved by MVR Canada, approval under Section 10 of the Water Sustainability Act</td>
</tr>
</tbody>
</table>

**Key potential regulatory challenges**

<table>
<thead>
<tr>
<th>Key potential regulatory challenges</th>
<th>Identification of regulatory requirements that may pose significant challenges</th>
<th>General community favourability</th>
<th>Identified expected support from community stakeholders</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>1 Site located in area previously heavily impacted by forestry</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1 Site located in area previously heavily impacted by forestry</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2 Site located in area previously unimpacted area, and located near Timmins Flats</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3 Site located in largely unimpacted area, and located near Timmins Flats</td>
</tr>
</tbody>
</table>

**Evaluation Criteria**

<table>
<thead>
<tr>
<th>Options</th>
<th>Criteria Sub-Criteria Description</th>
<th>Weighting</th>
<th>Ranking</th>
<th>Comments</th>
<th>Ranking</th>
<th>Comments</th>
<th>Total Weighted Score</th>
<th>Weighted Ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Option 1: Site A</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Option 2: Site B</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Option 3: Site C3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Option 4: Site D4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**NOTES:**

1. Suitability of onsite materials for use as fill material is based on desktop review of regional-scale geological maps and one day site reconnaissance only. An intensive geotechnical investigation is recommended to be completed at the site locations during future design stages to confirm material suitability, and is not included in the scope of work.

2. Bedrock depths should be confirmed during an intensive geotechnical investigation during future design stages (not included in the currently scope of work).

3. Preliminary risk assessment and intensive geotechnical investigation are recommended to be completed at the site locations during future design stages, and are not included in the scope of work.

4. Preliminary data completeness of failure classifications is intended as high level only and is based on the conceptual design. Analysis to fully evaluate is required, and is outside of the scope of work for this project.

5. All criteria and site description are based on design criteria and assumptions included in the Phase 3 Design Summary Report (VP19-SCR-01-00-RPT-CI-DesignSummary_Rev0) and Phase 2 details (Draft) VP19-SCR-01-00-DWG-CI-100-104, VP19-SCR-01-00-DWG-CI-200-204, VP19-SCR-01-00-DWG-CI-300-305, VP19-SCR-01-00-DWG-CI-400-405)

6. Site located in area previously heavily impacted by forestry

7. Sources of input data include:

   - Phase 2 Detailed Desktop Study Report (VP18-SCR-01-00-DWG-CI-Desktop_Study_Report, Rev0)
   - Phase 2 Feasibility Study Report (VP18-SCR-01-00-DWG-CI-Feasibility_Report, Rev0)
   - Terrain Assessment Report (VP19-SCR-01-00-DWG-CI-Terrain_Assessment_Report, Rev0)
   - Preliminary Aquatic Assessment Report (VP19-SCR-01-00-DWG-CI-Aquatic_Assessments_Report, Rev0)
   - Regulatory Basemap (VP19-SCR-01-00-DWG-CI-Regulatory_Basemap, Rev0)
   - Site & POD Assessment (VP19-SCR-01-00-DWG-CI-Site_PODAssessment, Rev0)
   - Conceptual Drawings (VP19-SCR-01-00-DWG-CI-Conceptual_Drawings, Rev0)
   - MCA criteria and site option descriptions are based on design criteria and assumptions included in the Phase 3 Design Summary Report (VP19-SCR-01-00-RPT-CI-DesignSummary_Rev0) and Phase 2 details (Draft) VP19-SCR-01-00-DWG-CI-100-104, VP19-SCR-01-00-DWG-CI-200-204, VP19-SCR-01-00-DWG-CI-300-305, VP19-SCR-01-00-DWG-CI-400-405)
   - Phase 3 Cost Estimates and Basis of Estimate (VP19-SCR-01-00-DWG-CI-Phase 3 Rev1)
### Table 5 - Multi-Criteria Analysis Matrix: Environmental Focused Case

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Evaluation Criteria</th>
<th>Option 1</th>
<th>Option 2</th>
<th>Option 3</th>
<th>Option 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total site area and overlap area (ha)</td>
<td>Total area to be developed (approximate area of reservoir with allowance for access roads, operational area, etc.)</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Overburden excavation, embankment volume</td>
<td>Overburden excavation: 71,300 m³. Embankment access road, and operations pad: 250,000 m³.</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Offsite construction material required (m³)</td>
<td>Requirement for offsite construction material (if onsite material is not suitable or sufficient in volume)</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Site access</td>
<td>Site is located within close proximity of the Sechelt Airport (Option 1). 2 km from an existing decommissioned road to the southwest (Option 2).</td>
<td>5</td>
<td>5</td>
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</tr>
</tbody>
</table>

#### Technical Sustainability

- **Scalability**
  - Limit potential for lateral expansion to the east (constrained by Hudson Creek and the existing, unnamed road east of the site). Limited potential to increase reservoir volume by raising the dam height, given the steeply sloping terrain.

- **Total site area**: 23.3 ha
  - Clearing and grubbing (approximate): 2 (excluding clearing and grubbing required for access roads)

- **Overburden excavation, embankment volume**
  - Overburden excavation: 71,300 m³, Embankment access road, and operations pad: 250,000 m³

- **Offsite construction material required (m³)**
  - Requirement for offsite construction material (if onsite material is not suitable or sufficient in volume)

- **Site access**
  - Site is located within close proximity of the Sechelt Airport (Option 1). 2 km from an existing decommissioned road to the southwest (Option 2).
### Evaluation Criteria

| Criteria | Sub-Criteria | Description | Weighting | Option 1 | | Comments | Ranking | Option 2 | | Comments | Ranking | Option 3 | | Comments | Ranking | Option 4 | | Comments | Ranking |
|----------|--------------|-------------|-----------|----------|--------|----------|--------|----------|--------|----------|--------|----------|--------|----------|--------|----------|--------|----------|
| Safety to Third-party Infrastructure | Site peatiness to and spatial constants powered by third party infrastructure and disposals (e.g., sinks and roads away from the site boundary) | The water conveyance pipelines to and from reservoir will be required to cross the Fortis BC ROW | 1 | 2 | | | | | | | | | | | | | | | 
| Infrastructure | Water conveyance method from source to reservoir site | Existing Chapman Intake and raw water pipeline will be designed to convey water to the site. Incoming water will be conveyed to the site from the reservoir via a secondary pipeline at approximately El. 35 m via a 1,370 m long HDPE pipe (distributary) that also conveys water from the site to the tie-point. | 1 | 2 | | | | | | | | | | | | | | | 
| | Infrastructure | Existing Chapman raw water pipeline will be utilized to convey water to the reservoir | The existing Chapman raw water pipeline will be utilized to convey water from the reservoir to the Chapman Creek WTP. | | | | | | | | | | | | | | | | |
| | Infrastructure | Conveyance method from reservoir site to Chapman Creek WTP | The false bottom of the site comprises massive to slightly fractured, high strength, low permeability, intrusive granodioritic rocks. The bedrock contact is interpreted to range from 2 mbgs to 5 mbgs and is interpreted to be undulating. For the purposes of design, bedrock depth is assumed to range from 2 mbgs at the north end of the site to 5 mbgs at the south end of the site. | 1 | 4 | | | | | | | | | | | | | | | |
| Subsurface conditions | Characteristics and estimated thicknesses of surficial deposits, depth to bedrock, potential for use of surficial deposits as construction materials, estimated groundwater depth | Surficial soils across the site are interpreted to comprise surficial soils across the site are interpreted to comprise a thin layer of coarse-grained marine sediment deposits (sand, gravel and cobble, with variable amounts of silt) overlying discontinuous coarse-grained glaciolacustrine deposits (sand, gravel and cobble, with variable amounts of silt). | | | | | | | | | | | | | | | | |

### Options

1. Fortis BC ROW is located immediately north of the site boundary. A Fortis BC ROW is located approximately 300 m south of the site boundary. No ROW crossings would be required to access the site. No ROW crossings would be required to access the site. No ROW crossings would be required to access the site. No pipe crossing would be required to access the site from existing roads. No access road to be evaluated for potential crossings during recommissioning.
2. The existing Chapman Intake and raw water pipeline will be utilized to convey water from the reservoir to the Chapman Creek WTP. Ongoing water will be conveyed to an assumed tie-point on the existing Chapman raw water pipeline at approximately El. 35 m via an approximately 1,370 m long HDPE pipe (distributary) that also conveys water from the site to the tie-point. Pumps will be required to convey water from the Tie-point to the reservoir. No infrastructure required (conveyance via overland conveyance pipelines)
3. Water would be conveyed to Chapman Creek via TsawCOME Creek. Water would then be conveyed from Chapman Creek to the Chapman Creek WTP via the existing Chapman Intake and raw water pipeline. No infrastructure required (conveyance via irrigation water conveyance pipelines)
4. Water would be conveyed to Chapman Creek via an assumed raw water pipeline between Sites C3 and C4, through the Site C3 lake bed, and TsawCOME Creek. Water would then be conveyed from Chapman Creek to the Chapman Creek WTP via the existing Chapman Intake and raw water pipeline. No infrastructure required (conveyance via irrigation water conveyance pipelines)

### Technical Feasibility

- **Surveys and Reconnaissances:** Various surveys and reconnaissance activities were conducted to assess the subsurface conditions and the potential for infrastructure installation. These activities included geotechnical, geophysical, and topographic surveys.
- **Design and Engineering:** Design and engineering studies were conducted to determine the most feasible and cost-effective solutions for the proposed infrastructure.
- **Cost Estimation:** Cost estimates were prepared for the proposed infrastructure, incorporating various cost components such as material costs, labor costs, and equipment costs.
- **Environmental Impact:** Environmental impact assessments were performed, including water quality studies, soil and groundwater analyses, and habitat assessments.
- **Permits and Licenses:** Necessary permits and licenses were obtained for the implementation of the proposed infrastructure, ensuring compliance with relevant regulations.
- **Construction:** Construction works were carried out in phases, following the approved design and engineering plans.
- **Monitoring and Maintenance:** Post-construction monitoring and maintenance plans were established to ensure the long-term performance and sustainability of the infrastructure.
In general, the TSC within the site ranges from I to III. Topographic relief within the site is bedrock-controlled and is not indicative of slope instability. No evidence of past movement was observed for areas of slope instability, and no significant evidence of slope instabilities were identified. The site is located in a high seismic hazard region and all structures included in the designs will need to be designed to accommodate a 1:10,000 return period earthquake. Based on the interpreted subsurface conditions, the site is interpreted to have a relatively low risk of liquefaction during a seismic event.

Of significance at Site A, the westernmost portion of the site is bedrock-controlled and is stable. No areas within or surrounding Site A have been interpreted to pose a significant hazard to the site. The terrain within the western portion of the site is bedrock controlled and stable. No areas within or surrounding Site B have been interpreted to pose a significant hazard to the site. The site is located in a high seismic hazard region and all structures included in the designs will need to be designed to accommodate a 1:10,000 return period earthquake. Based on the interpreted subsurface conditions, the site is interpreted to have a relatively low risk of liquefaction during a seismic event.
Species identified in desktop study include American robin, black-throated green warbler, brown-headed cowbird, Canada warbler, chestnut-backed chickadee, chipping sparrow, dark-eyed junco, European goldfinch, greater yellowlegs, lesser yellowlegs, northern flicker, northern harrier, redwing blackbird, rose-breasted grosbeak, tree swallow, tufted titmouse, Wilson's warbler, yellow-rumped warbler, yellow warbler, yellowthroat, and winter wren.

Preliminary field identified species include elk (tracks, scat), bear (scat), Pacific chorus frog (adults), northern red-legged frog (tadpole [potential]), northwestern salamanders (all life stages).

Environmental Impacts

Fish presence

Fish identified in water bodies downstream of reservoir site

Not based on desktop study, no documented fish presence within the site boundary, as there appears to be no mapped wetlands identified within the site boundary.

Based on desktop study, no documented fish presence within the site boundary. Fish identified in water bodies downstream of reservoir site 4 3

Based on desktop study, no documented fish presence within the site boundary. No mapped wetlands identified within the site boundary. Water quality for Chapman Water System identified as high. No improvement over existing water quality.

Wetlands and surface water

Wetlands identified within footpath and footprint to mapped wetlands and footprint to surface water

No mapped wetlands identified within site area. Site is located 2.2 km from a mapped wetland.

No mapped wetlands identified within site area. Site is 4.0 km from a mapped wetland.

Based on desktop study, no mapped wetlands identified within site area. Site is 1.7 km from a mapped wetland.

Water quality for Chapman Water System

Potential for improved water quality

No water stored in reservoir is protected from large rain events or landslides that cause poor water quality in Chapman Creek.

Potential interest identified in a protection from large rain events or landslides that cause poor water quality in Chapman Creek. Intake instream upgradient of development will likely provide higher quality of water.

No improvement over existing water quality.

No improvement over existing water quality.
### Regulatory and Stakeholder Sensitivity

<table>
<thead>
<tr>
<th>Sub-Criteria</th>
<th>Description</th>
<th>Option 1: Site C1</th>
<th>Option 2: Site C2</th>
<th>Option 3: Site C3</th>
<th>Option 4: Site C4</th>
<th>Weighting</th>
<th>Total Weighted Score</th>
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<tr>
<td>Regulatory requirements</td>
<td>Identified permits/authorizations required at this stage of project definition</td>
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<td>Identified permits/authorizations: Development permit, Geotechnical development permit, Water license (Section 9), Licensing under BC Dam Safety Regulation, Licence of Occupation (Section 39), Construction of non-permanent use with the AIL, Vancouver Coastal Health Notification, Licence to Cut, Environmental Assessment Certificate, Waterworks Construction Permit, Operating Permit, Fisheries and Oceans Canada request for review, Potential: approval under the Canadian Environmental Assessment Act, Building permit, new drinking water source assessment, approval under the Navigation Protection Act, approval by Transport Canada, approval by NAV Canada, approval under Section 10 of the Water Sustainability Act</td>
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<td></td>
<td></td>
<td>3</td>
<td>271</td>
</tr>
</tbody>
</table>

### Key potential regulatory challenges

- Identification of regulatory requirements that may pose significant challenges
- No significant challenges identified
- Licence to Cut under the Forest Act
- Licence to Cut under the Forest Act
- Licence to Cut under the Forest Act

### General community favourability

- Unmet expectations for support from community stakeholders
- Site is located in area previously heavily impacted by forestry
- Site is located in area previously heavily impacted by forestry
- Site is located in large impacted area, and located near headwater headwall

<table>
<thead>
<tr>
<th>Option 1: Site C1</th>
<th>Option 2: Site C2</th>
<th>Option 3: Site C3</th>
<th>Option 4: Site C4</th>
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</thead>
<tbody>
<tr>
<td>Total Score</td>
<td>100</td>
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<td>78</td>
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<tr>
<td>Weighted Score</td>
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<tr>
<td>Weighted Rank</td>
<td>2</td>
<td>1</td>
<td>3</td>
</tr>
</tbody>
</table>

### Notes
1. Suitability of onsite materials for use as fill material is based on desktop review of regional-scale geological maps and one-day site reconnaissance only. An intrusive geotechnical investigation is recommended to be completed at the site locations during future design stages to confirm material suitability, and is not included in the scope of work.
2. Bedrock depths should be confirmed during an intrusive geotechnical investigation during future design stages (not included in the current scope of work).
3. Identified potential geohazards are based on desktop review of available information and one-day site reconnaissance. Analyses to fully evaluate these geohazards are recommended to be completed at the site locations during future design stages, and are not included in the scope of work.
4. Preliminary data consequence of false classifications is intended as high level only and is based on the conceptual design. Analysis to fully evaluate is required, and is outside of the scope of work for this project.
5. Identified potential geohazards are based on design criteria and assumptions included in the Phase 3 Design Summary Report (VP19-SCR-01-DWG-CI-DesignSummary_Rev1) and Phase 3 engineering documentation (VP19-SCR-01-DWG-CI-DesignSummary_Rev1). Analyses to fully evaluate is required, and is outside of the scope of work.
6. Preliminary dam consequence of failure classification is intended as high level only and is based on the conceptual design. Analyses to fully evaluate is required, and is outside of the scope of work for this project.
7. Criteria weightings for the base case and sensitivity analysis cases, as well as site option rankings, were likely developed in Phase 2 to phase 3 feasibility study report (VP18-SCR-01-DWG-CI-Feasibility_Study_Rev4). Criteria weightings and site option rankings were not included in the scope of work.
8. Source of input documents:
   - Phase 2 Detailed Desktop Study Report VP18-SCR-01-DWG-CI-Desktop_Study_Rev4
   - Phase 2 Feasibility Study Report VP18-SCR-01-DWG-CI-Feasibility_Study_Rev4
   - Teran Assessment Report (VP19-SCR-01-DWG-CI-Teran_Assessment_Rev3)
   - Preliminary Aquatic Assessment Report (VP19-SCR-01-DWG-CI-Aquatic_Assessments_Rev4)
   - Regulatory Roadmap (VP19-SCR-01-DWG-CI-RegulatoryRoadmap_Rev)
   - BPA & FDO Assessment (VP18-SCR-01-DWG-CI-BPA_FDOAssessment_Rev1)
   - BPA & FDO Assessment (VP19-SCR-01-DWG-CI-BPA_FDOAssessment_Rev1)
   - Consequence of Failure Classification Report (VP19-SCR-01-DWG-CI-Conseq_Fail_Classes_Rev4)
   - Consequence of Failure Classification Report (VP19-SCR-01-DWG-CI-Conseq_Fail_Classes_Rev4)
   - Consequence of Failure Classification Report (VP19-SCR-01-DWG-CI-Conseq_Fail_Classes_Rev4)
   - Consequence of Failure Classification Report (VP19-SCR-01-DWG-CI-Conseq_Fail_Classes_Rev4)
   - Phase 3 Design Summary Report (VP19-SCR-01-DWG-CI-DesignSummary_Rev1)
   - Phase 3 Rev B Conceptual Drawings (VP19-SCR-01-DWG-CI-ConceptualDrawings_Rev1)
   - Phase 3 Design Summary Report (VP19-SCR-01-DWG-CI-DesignSummary_Rev1)
### Technical Feasibility

#### Site Area and Appropriate Clearing and Grubbing Area (ha)

<table>
<thead>
<tr>
<th>Site</th>
<th>Clearing and grubbing area</th>
<th>Clearing and grubbing (approximate)</th>
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</thead>
<tbody>
<tr>
<td>A</td>
<td>2.3</td>
<td>2 (excluding clearing and grubbing required for access road)</td>
</tr>
<tr>
<td>B</td>
<td>4.5</td>
<td>4 (excluding clearing and grubbing required for access road)</td>
</tr>
<tr>
<td>C3</td>
<td>4.7</td>
<td>4 (excluding clearing and grubbing required for access road)</td>
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</tbody>
</table>

#### Overburden Excavation, Bedrock Excavation, Earthwork Volumes (m³)

<table>
<thead>
<tr>
<th>Site</th>
<th>Overburden excavation</th>
<th>Bedrock excavation</th>
<th>Earthwork fill volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>45.2</td>
<td>47.4</td>
<td>2</td>
</tr>
<tr>
<td>B</td>
<td>78.6</td>
<td>96.0</td>
<td>3</td>
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<tr>
<td>C3</td>
<td>156.2</td>
<td>219.6</td>
<td>3</td>
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</tbody>
</table>

#### Offsite Construction Material Required (m³)

<table>
<thead>
<tr>
<th>Site</th>
<th>Offsite construction material required</th>
<th>Concrete volume required for the concrete membranes at Sites A and B.</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1,056,700 (excluding volume of existing water body at site)</td>
<td>290,700 (excluding volume of existing water body at site)</td>
</tr>
<tr>
<td>B</td>
<td>764,500 (excluding volume of existing water body at site)</td>
<td>290,700 (excluding volume of existing water body at site)</td>
</tr>
<tr>
<td>C3</td>
<td>1,066,400 (excluding volume of existing water body at site)</td>
<td>293,500 (excluding volume of existing water body at site)</td>
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</table>

#### Access Road

<table>
<thead>
<tr>
<th>Site</th>
<th>Access Road Option 1</th>
<th>Access Road Option 2</th>
<th>Concrete volume required for the concrete membranes at Sites A and B.</th>
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<tbody>
<tr>
<td>A</td>
<td>9 km</td>
<td>14 km</td>
<td>1,066,400 (excluding volume of existing water body at site)</td>
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<tr>
<td>B</td>
<td>11 km</td>
<td>16 km</td>
<td>764,500 (excluding volume of existing water body at site)</td>
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<tr>
<td>C3</td>
<td>12 km</td>
<td>17 km</td>
<td>1,056,700 (excluding volume of existing water body at site)</td>
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</tbody>
</table>

### Other Considerations

- **Total Site Area:** 23.3 ha
- **Total Site Area:** 47.4 ha
- **Total Site Area:** 45.2 ha

### Site Access

- **Site Access**: Site 1 is located within close proximity of the Sechelt Airport (A) for both options.
- **Site Access**: Site 2 is located within close proximity of the Sechelt Airport (B) for both options.
- **Site Access**: Site 3 is located within close proximity of the Sechelt Airport (C) for both options.

### Site Specific

- **Site Specific**: Site 1 is located approximately 1 km from an existing decommissioned road to the west (Option 1) and approximately 3 km from an unclassified decommissioned road to the north (Option 2).
- **Site Specific**: Site 2 is located approximately 1 km from an existing decommissioned road to the west (Option 1) and approximately 1.5 km from an existing decommissioned road to the south (Option 2).
- **Site Specific**: Site 3 is located approximately 4 km from existing decommissioned roads on the east and west.

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### Table 6 - Multi-Criteria Analysis Matrix: Regulatory and Stakeholder Focused Case

<table>
<thead>
<tr>
<th>Evaluation Criteria</th>
<th>Sub-Criteria</th>
<th>Description</th>
<th>Weighting</th>
<th>Option 1: Site A</th>
<th>Option 2: Site B</th>
<th>Option 3: Site C3</th>
<th>Option 4: Site C4</th>
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<td>Ranking</td>
<td>Comments</td>
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<td>3</td>
<td>4 (excluding</td>
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<td>volume of</td>
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<td>volume of</td>
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<td></td>
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<td></td>
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<tr>
<td></td>
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<td></td>
<td></td>
<td>water body</td>
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<td>water body</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3</td>
<td></td>
<td></td>
<td>at site)</td>
<td></td>
<td>at site)</td>
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<tr>
<td></td>
<td>4</td>
<td></td>
<td></td>
<td>764,500</td>
<td></td>
<td>293,500</td>
<td></td>
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<tr>
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<td></td>
<td></td>
<td>1,056,700</td>
<td></td>
<td>290,700</td>
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<td>6</td>
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<td></td>
<td>1,066,400</td>
<td></td>
<td>293,500</td>
<td></td>
</tr>
</tbody>
</table>

---

### Stakeholder Focus

- **Stakeholder Focus**: Site 1 is located within close proximity of the Sechelt Airport (A) for both options.
- **Stakeholder Focus**: Site 2 is located approximately 1 km from an existing decommissioned road to the east (Option 1) and approximately 3 km from an unclassified decommissioned road to the north (Option 2).
- **Stakeholder Focus**: Site 3 is located approximately 1 km from an existing decommissioned road to the west (Option 1) and approximately 1.5 km from an existing decommissioned road to the south (Option 2).

---

### Regulatory Focus

- **Regulatory Focus**: Site 1 is located within close proximity of the Sechelt Airport (A) for both options.
- **Regulatory Focus**: Site 2 is located approximately 1 km from an existing decommissioned road to the east (Option 1) and approximately 3 km from an unclassified decommissioned road to the north (Option 2).
- **Regulatory Focus**: Site 3 is located approximately 4 km from existing decommissioned roads on the east and west.
**Option 1: Site A**

- No pipeline crossings would be required to access the site from existing roads.
- Existing access road to be evaluated for potential crossings required during recommissioning.

**Option 2: Site B**

- No ROW crossings would be required to access the site from existing roads.
- Existing access road to be evaluated for potential crossings required during recommissioning.

**Option 3: Site C3**

- No ROW crossings would be required to access the site from existing roads.

**Option 4: Site C4**

- No ROW crossings would be required to access the site from existing roads.

### Infrastructure

- **Total pipeline crossings:** 0
- **Total ROW crossings:** 0
- **Total ROW upgrades:** 0
- **Total ROW concerns:** 0
- **Total ROW opportunities:** 0

### Technical Feasibility

- **Conveyance method from source to reservoir site:**
  - Infrastructure (existing and new) required to transport water from the source to the reservoir site.
  - Infrastructure (existing and new) required to transport water from the site boundary to the Chapman Creek WTP.

**Conveyance from reservoir site to Chapman Creek WTP:**

- Infrastructure (existing and new) required to transport water to Chapman Creek WTP.

### Subsurface Conditions

- **Characteristics and estimated thicknesses of surficial materials, depth to bedrock, potential for reuse of surficial materials for construction materials, estimated groundwater depth:**

---

### Evaluation Criteria

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Job Criteria</th>
<th>Description</th>
<th>Weighting</th>
<th>Option 1: Site A</th>
<th>Comments</th>
<th>Ranking</th>
<th>Option 2: Site B</th>
<th>Comments</th>
<th>Ranking</th>
<th>Option 3: Site C3</th>
<th>Comments</th>
<th>Ranking</th>
<th>Option 4: Site C4</th>
<th>Comments</th>
<th>Ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proximity to High-priority Infrastructure</td>
<td>Site proximity to and spatial constraints posed by third party infrastructure and dispositions (e.g. utility and road rights-of-way (ROWs), land tenures, private land ownerships, etc.)</td>
<td>1</td>
<td>2</td>
<td>A Fortis BC ROW is located immediately north of the site boundary. A K-C ROW is located immediately south of the site boundary.</td>
<td>No ROW crossings would be required to access the site off of the Sechelt Airport FSR.</td>
<td>2</td>
<td>No ROW crossings would be required for the water conveyance pipelines to and from the site.</td>
<td>The SCRC access road is located immediately north of the site boundary, and the SCRC facility is located immediately east of the site boundary. The SCRC also hosts a land tenure that spans a portion of the site area.</td>
<td>No ROW crossings would be required to access the site from existing roads.</td>
<td>No ROW crossing would be required to access the site from existing roads.</td>
<td>No ROW crossing would be required to access the site from existing roads.</td>
<td>No ROW crossing would be required to access the site from existing roads.</td>
<td>No ROW crossing would be required to access the site from existing roads.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

### Groundwater

- **Geological setting:**
  - Groundwater is assumed at approximately 1 m.

---

### Groundwater

- **Geological setting:**
  - Groundwater is assumed at approximately 1 m.

---

### Groundwater

- **Geological setting:**
  - Groundwater is assumed at approximately 1 m.

---

### Groundwater

- **Geological setting:**
  - Groundwater is assumed at approximately 1 m.
Technical Feasibility

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Sub-Criteria</th>
<th>Description</th>
<th>Weighting</th>
<th>Option 1, Site A</th>
<th>Comments</th>
<th>Option 2, Site B</th>
<th>Comments</th>
<th>Option 3, Site C</th>
<th>Comments</th>
<th>Option 4, Site D</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Terrain instability, geohazards, seismotectonic conditions</td>
<td>Site characteristics including terrain instability, geohazards, seismotectonic conditions</td>
<td>5</td>
<td>In general, the TSC within the site is II, indicating a very low likelihood of instability occurring as a result of bedrock failure. Hence, the recommended site A, the TSC is I, indicating a low likelihood of instability occurring as a result of bedrock failure. The site A is characterized by bedrock-controlled topographic relief, with localized areas of slope instability that are not affected by slope failures. No evidence of previous slope movement was observed at Site A, and no localized areas of instability were previously observed. Given that the site is characterized by bedrock-controlled topographic relief, with localized areas of slope instability that are not affected by slope failures, the risk of instability is low. Site A is not characterized by bedrock-controlled topographic relief, with localized areas of slope instability that are not affected by slope failures. No evidence of previous slope movement was observed at Site A. Hence, the recommended Site A is characterized by bedrock-controlled topographic relief, with localized areas of slope instability that are not affected by slope failures. No evidence of previous slope movement was observed at Site A. Hence, the recommended Site A is characterized by bedrock-controlled topographic relief, with localized areas of slope instability that are not affected by slope failures. No evidence of previous slope movement was observed at Site A. Hence, the recommended Site A is characterized.</td>
<td>5</td>
<td>5</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Economics

| Capital cost of reservoir site and supporting infrastructure | Capital cost (including contingency) | 5 | 49,874,000 | $53,120,000 | $15,500,000 | $16,800,000 | $12,812,000 | $16,900,000 | $22,812,000 |
| Lifecycle cost | Quality asset management cost | 3 | Research, new site access road, fences, pumping, additional water intake, and water conveyance piping. | 3 | Reservoir, new site access road, fences, pumping, additional water intake, and water conveyance piping. | 3 | Reservoir, new site access road, fences, pumping, additional water intake, and water conveyance piping. | 3 | Reservoir, new site access road, fences, pumping, additional water intake, and water conveyance piping. |
| Operating cost | Qualitative assessment of requirements for operations, maintenance, and surveillance | 3 | Operations assumed to be conducted mainly on-site. Maintenance of reservoir and other supporting site infrastructure, pumping, piping, road, intake infrastructure, and water conveyance piping. | 3 | Operations assumed to be conducted mainly on-site. Maintenance of reservoir and other supporting site infrastructure, pumping, piping, road, intake infrastructure, and water conveyance piping. | 3 | Operations assumed to be conducted mainly on-site. Maintenance of reservoir and other supporting site infrastructure, pumping, piping, road, intake infrastructure, and water conveyance piping. | 3 | Operations assumed to be conducted mainly on-site. Maintenance of reservoir and other supporting site infrastructure, pumping, piping, road, intake infrastructure, and water conveyance piping. |
| Potential economic co-benefits (i.e., industry partnerships, hydroelectricity credits) | Potential industry partnership opportunities, potential for hydroelectric power generation | 5 | Potential industry partnership opportunities, potential for hydroelectric power generation | 5 | Potential industry partnership opportunities, potential for hydroelectric power generation | 5 | Potential industry partnership opportunities, potential for hydroelectric power generation | 5 | Potential industry partnership opportunities, potential for hydroelectric power generation |

Environmental impacts

| Species of site (SAR) and species of concern (SOC) | Federal and provincial SAR and provincial SOC within a 5 km radius of site locations | 3 | Federal Species at Risk (SAR) | Provincial Species of Concern | 2 | Federal Species at Risk (SAR) | Provincial Species of Concern | 2 | Federal Species at Risk (SAR) | Provincial Species of Concern | 2 | Federal Species at Risk (SAR) | Provincial Species of Concern |
| Band-tailed pigeon - Special Concern | Northern goshawk (Laingi subspecies) - Threatened | Northern rubber boa - Special Concern | None identified | None identified | None identified | None identified | None identified | None identified | None identified | None identified | None identified | None identified |
| Coastal tailed frog - Special Concern | Northern goshawk (Laingi subspecies) - Threatened | Northern rubber boa - Special Concern | None identified | None identified | None identified | None identified | None identified | None identified | None identified | None identified | None identified | None identified |
| Band-tailed pigeon - Special Concern | Northern goshawk (Laingi subspecies) - Threatened | Northern rubber boa - Special Concern | None identified | None identified | None identified | None identified | None identified | None identified | None identified | None identified | None identified | None identified |

Regulatory and Stakeholder Focused Case

VP18-SCR-01-00-TAB-PI-NCA Rev1

Page 3 of 5
**Environmental Impacts**

**Fish presence**

<table>
<thead>
<tr>
<th>Rank</th>
<th>Fish identified in water bodies downstream of research site</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Based on desktop review, no documented fish presence within the site boundary, as there appears to be no waterbodies identified within the site boundary. The site is 12.5 km from any lake or pond, and there are no waterbodies identified to be within the site boundary.</td>
</tr>
<tr>
<td>2</td>
<td>Based on desktop review, no documented fish presence within the site boundary, as there appears to be no waterbodies identified within the site boundary. The site is 12.5 km from any lake or pond, and there are no waterbodies identified to be within the site boundary.</td>
</tr>
<tr>
<td>3</td>
<td>Based on desktop review, no documented fish presence within the site boundary, as there appears to be no waterbodies identified within the site boundary. The site is 12.5 km from any lake or pond, and there are no waterbodies identified to be within the site boundary.</td>
</tr>
</tbody>
</table>

**Wetlands and surface water**

<table>
<thead>
<tr>
<th>Rank</th>
<th>Wetlands identified within footprint and possibility to polluted wetlands and possibility to surface water</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>No mapped wetlands identified within site area. Site is located 22 km from any mapped wetland.</td>
</tr>
<tr>
<td>2</td>
<td>No mapped wetlands identified within site area. Site is located 22 km from any mapped wetland.</td>
</tr>
<tr>
<td>3</td>
<td>No mapped wetlands identified within site area. Site is located 22 km from any mapped wetland.</td>
</tr>
</tbody>
</table>

**Water quality for Chapman Water System**

<table>
<thead>
<tr>
<th>Rank</th>
<th>Water stored in reservoir is protected from large rain events or landslides that cause poor water quality in Chapman Creek.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Water stored in reservoir is protected from large rain events or landslides that cause poor water quality in Chapman Creek.</td>
</tr>
<tr>
<td>2</td>
<td>Water stored in reservoir is protected from large rain events or landslides that cause poor water quality in Chapman Creek.</td>
</tr>
<tr>
<td>3</td>
<td>Water stored in reservoir is protected from large rain events or landslides that cause poor water quality in Chapman Creek.</td>
</tr>
</tbody>
</table>

**Preliminary aquatic investigation**

Based on preliminary field observations, wetlands are prevalent along and above the lake shoreline. Downstream environmental impacts (i.e. erosion and sedimentation) on the creeks downstream of Site C4 (unnamed creek between Sites C3 and C4, Tsawcome Creek, Chapman Creek) will need to be considered based on expected low and high flow conditions.
## Identified permits/authorizations

- Development permit
- Water license (Section 9)
- Licensing under BC Dam Safety Regulation
- License of Occupation (Section 9)
- Fisheries and Oceans Canada request for review
- Riparian Development Permit

## Approval under the Canadian Environmental Assessment Act

- Building permit
- New drinking water source assessment

## Approval under the Navigation Protection Act

- Approval by Transport Canada

## Approval under Section 10 of the Water Sustainability Act

- Licence to Cut (under the Forest Act)

## Environmental Assessment Certificate

## Geotechnical

## Stage of project definition

### Regulatory and Stakeholder Sensitivity

#### General community favourability

- Site is located in largely unimpacted area, and located near Tetrahedron Park
- Site is located in area previously heavily impacted by forestry

#### Key potential regulatory challenges

- No significant challenges identified
- Licence to Cut under the Forest Act

#### Identified permits/authorizations

- Development permit
- Water license (Section 9)
- Licensing under BC Dam Safety Regulation
- License of Occupation (Section 9)
- Fisheries and Oceans Canada request for review
- Riparian Development Permit

#### Approval under the Canadian Environmental Assessment Act

- Building permit
- New drinking water source assessment

#### Approval under the Navigation Protection Act

- Approval by Transport Canada

#### Approval under Section 10 of the Water Sustainability Act

- Licence to Cut (under the Forest Act)

#### Environmental Assessment Certificate

### Evaluation Criteria

#### Options

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Sub-Criteria</th>
<th>Description</th>
<th>Weighting</th>
<th>Option 1: Site A</th>
<th>Option 2: Site B</th>
<th>Option 3: Site C</th>
<th>Option 4: Site D</th>
<th>Option 5: Site E</th>
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</thead>
<tbody>
<tr>
<td>Total Weighted Score</td>
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<td></td>
<td></td>
<td>296</td>
<td>311</td>
<td>226</td>
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<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

### Total Score

- 100
- 70
- 78
- 71
- 68

### Notes

1. Suitability of onsite materials for use as fill material is based on desktop review of regional-scale geological maps, and one-site reconnaissance only. An immersive geological investigation is recommended to be completed at the site locations during future design stages to confirm suitability; and is not included in the scope of work.
2. Bedrock depths should be confirmed during an immersive geological investigation during future design stages (not concluded in the current scope of work).
3. Preliminary and site-specific determinations are based on design criteria and assumptions included in the Phase 3 Design Summary Report (VP19-SCR-01-00-DWG-CI-DesignSummaryRev1) and Phase 4 criteria. Additional三维MCA criteria and site option descriptions are based on design criteria and assumptions included in the Phase 3 Design Summary Report (VP19-SCR-01-00-DWG-CI-DesignSummaryRev1) and Phase 4 criteria. Additional三维MCA criteria and site option descriptions are based on design criteria and assumptions included in the Phase 3 Design Summary Report (VP19-SCR-01-00-DWG-CI-DesignSummaryRev1) and Phase 4 criteria.
4. Preliminary desktop assessment of potential geohazards is intended as an initial review and is based on conceptual design. Analyses to fully evaluate is required, and is outside of the scope of work for this project.
5. Secondary site-specific investigations and immersive geological investigation are recommended to be completed at the site locations during future design stages, and are not included in the scope of work.

### Source of input data

- Phase 2 Detailed Desktop Study Report (VP18-SCR-01-00-DWG-CI-Desktop_Study_Report)
- Phase 2 Feasibility Study Report (VP18-SCR-01-00-DWG-CI-Feasibility_Study_Report)
- Terrain Assessment Report (VP19-SCR-01-00-DWG-CI-Terrain_Assessment_Report)
- Preliminary Aquatics Assessment Report (VP19-SCR-01-00-DWG-CI-Preliminary_Aquatics_Assessment_Report)

### Additional documentation

- Phase 2 Detailed Desktop Study Report (VP18-SCR-01-00-DWG-CI-Desktop_Study_Report)
- Phase 2 Feasibility Study Report (VP18-SCR-01-00-DWG-CI-Feasibility_Study_Report)
- Terrain Assessment Report (VP19-SCR-01-00-DWG-CI-Terrain_Assessment_Report)
- Preliminary Aquatics Assessment Report (VP19-SCR-01-00-DWG-CI-Preliminary_Aquatics_Assessment_Report)

### Consequence of Failure Classification Report

- VP19-SCR-01-00-DWG-CI-Consequence_Fail_Class_Report

### Phase 3 Design Summary Report

- VP19-SCR-01-00-DWG-CI-DesignSummaryRev1

### Phase 3 Cost Estimates and Basis of Estimate

- VP18-SCR-01-00-DWG-CI-CostEstimatesRev1
RAW WATER RESERVOIR FEASIBILITY STUDY - PHASE 3
DESIGN SUMMARY REPORT
SITE LOCATION MAP

Client: [Client Name]
Prepared by: [Prepared By]
Checked by: [Checked By]
Approved by: [Approved By]

PROJECT NO.: VP19-SCR-01-00
FIGURE NO.: 1
REVISION: 1

Coordinate System: NAD 1983 UTM Zone 10N
Projection: Transverse Mercator
Datum: North American 1983
Scale: 1:50,000

Source: Crown Data, Streams, Roads, Coast Line and Parks data provided by Government of BC. Site Locations current as of May, 2019. SCRD Electoral Areas and Gravel Lands provided by the SCRD.

Refer to drawings VP19-SCR-01-00-DWG-CI-104, VP19-SCR-01-00-DWG-CI-204, VP19-SCR-01-00-DWG-CI-304 and VP19-SCR-01-00-DWG-CI-404 from the Raw Water Reservoir Feasibility Study.

Revision: [Revision]

NOTES: [Notes]