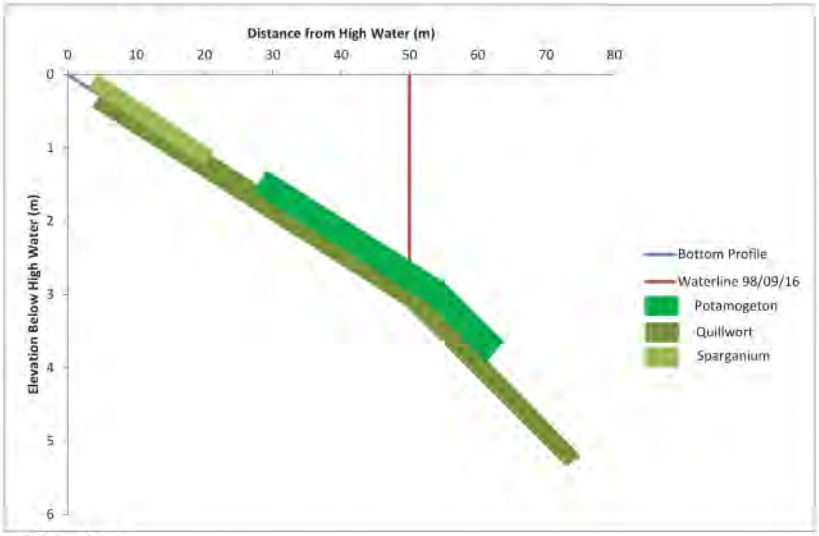
Aquatic Vegetation

Aquatic vegetation transects were conducted in Chapman Lake during late summer of 1998. Aquatic plants surveyed were limited to submergent species; however, water levels in the lake were below normal high water levels. The dominant species inventoried consisted of bristle-like quillwort (*Isoetes echinospora*) and was observed growing on suitable substrates throughout the lake. Dominant plant species typically occur between the 1 m and 4 m below the high water level. Narrow-leaved bur-reed (*Sparganium sp*.) and pondweed (*Potamogeton sp*.) were observed on the exposed or shallow lake areas, particularly at the east end of the lake. Figure 1 illustrates the zonation of aquatic vegetation in Chapman Lake from the survey transects for the study completed in 1998.

The main disturbance to aquatic vegetation during operations was identified as desiccation due to drying; however, it was noted that drying stress is already present seasonally in the littoral zone where most of the aquatic vegetation occurs and the dominant plant (quillwort) appeared to be very tolerant to desiccation under existing water level fluctuations in the reservoir. It is likely that the reduced growing season caused by existing drawdown leads to increased thermal drying stress on bur-reed and pondweed and abundance levels were low.

Figure 1. Zonation of Aquatic Vegetation in Chapman Lake



Source: Whitehead 1999

Sensitive Species

A list of plant species potentially within the study area was compiled using the BC Conservation Data Centre database. The same search categories as above were used to compile the information. Table 1 provides a summary of the resulting species, including the BC designation and Species at Risk statuses. A total of seven sensitive BC species were identified, with no SARA listed species results.

Table 1. Sensitive Plant Species in the Sunshine Coast Forest District

Common Name	Scientific Name	Species Type	BC Status	SARA Status
elegant Jacob's-ladder	*Polemonium elegans*	Dicot	Blue	
Kamchatka spike-rush	*Eleocharis kamtschatica*	Monocot	Blue	
poison oak	*Toxicodendron diversilobum*	Dicot	Blue	
Roell's brotherella	*Brotherella roellii*	Nonvascular plant	Red	
slimleaf onion	*Allium amplectens*	Monocot	Blue	
small spike-rush	*Eleocharis parvula*	Monocot	Blue	
snow bramble	*Rubus nivalis*	Dicot	Blue	

A search was also conducted in the BC Conservation Data Centre database for terrestrial ecological communities in the area surrounding Chapman Lake. Criteria used to focus the search results was applied using the regional and forest districts for the Sunshine Coase filters. In addition, the biogeoclimatic zone of Coastal Western Hemlock, subzone very wet maritime and montane (CHWvm2) variant filters were applied. Table 2 below provides the results of the ecological community database search of the area, which includes BC sensitive species status.

Table 2. Sensitive Ecological Community Plant Species in the Sunshine Coast, Coastal Western Hemlock Biogeoclimatic Zone (CHWvm2)

Common Name	Scientific Name	BC Status	Endemic
Amabilis fir - Sitka Spruce / devil's club	*Abies amabilis - Picea sitchensis / Oplopanax horridus*	Blue	
Amabilis fir - Western Red cedar / salmonberry Very Wet Maritime	*Abies amabilis - Thuja plicata / Rubus spectabilis* Very Wet Maritime	Yellow	
amabilis fir - western red cedar / three-leaved foamflower Very Wet Maritime	*Abies amabilis - Thuja plicata / Tiarella trifoliata* Very Wet Maritime	Yellow	
Sitka sedge / peat-mosses	*Carex sitchensis / Sphagnum* spp.	Red	Y
Sitka willow / Sitka sedge	*Salix sitchensis / Carex sitchensis*	Blue	Y
western redcedar - western hemlock / sword fern	*Thuja plicata - Tsuga heterophylla / Polystichum munitum*	Blue	
western redcedar - yellow-cedar / spleenwort-leaved goldthread	*Thuja plicata - Xanthocyparis nootkatensis / Coptis aspleniifolia*	Yellow	
western redcedar - yellow-cedar / skunk cabbage	*Thuja plicata - Xanthocyparis nootkatensis / Lysichiton americanus*	Yellow	
western hemlock - amabilis fir / deer fern	*Tsuga heterophylla - Abies amabilis / Blechnum spicant*	Blue	
western hemlock - amabilis fir / Alaskan blueberry	*Tsuga heterophylla - Abies amabilis / Vaccinium alaskaense*	Yellow	
western hemlock - lodgepole pine / grey reindeer	*Tsuga heterophylla - Pinus contorta / Cladina rangiferina*	Yellow	Y
western hemlock - western redcedar / salal Very Wet Maritime	*Tsuga heterophylla - Thuja plicata / Gaultheria shallon* Very Wet Maritime	Blue	Y
yellow-cedar / peat-mosses	*Xanthocyparis nootkatensis / Sphagnum* spp.	Yellow	

Wildlife Resources

Wildlife values within the Chapman Creek watershed are not well known and information is limited. The watershed appears to support populations of Columbian black-tailed deer (*Odocoileus hemionus columbianus*), black bear (*Ursus americanus*), cougar (*Puma concolor*) and other furbearing animals. Other wildlife known to use the watershed include: waterfowl, gulls, shorebirds, raptors, upland game birds, woodpeckers, a variety of songbirds, small mammals, amphibians and reptiles. Species recorded in Tetrahedron Provincial Park include: mountain goat (*Oreamnos americanus*), coyote (*Canis latrans*), mink (*Mustela vison*), marten (*Martes Americana*), river otter (*Lontra canadensis*) and bobcat (*Lynx rufus*), a variety of rodents, rock ptarmigan (*Lagopus muta*), woodpecker, grouse, ravens (*Corvus corax*), and marbled murrelets (*Brachyramphus marmoratus*; MELP 1997). It is thought that many of the larger animals tend to be transient users wildlife corridors to pass through the park. Hunting is prohibited within the park; however, the lower reaches of the watershed provide recreational hunting opportunities. There are no approved Wildlife Habitat Areas in the assessment area. There is a lack of emergent vegetation (e.g., cattail, bulrush) within the high water perimeter of Chapman Lake, however, some limited opportunities for nesting birds is available in this area.

Sensitive Wildlife Species

A list of sensitive wildlife species potentially found in the study area was compiled using the BC Conservation Data Centre database. The search categories used to compile the information included a search of the Sunshine Coast Forest District and refining the search results using the Coastal Western Hemlock and Mountain Hemlock biogeoclimatic zones. Habitat types used to further filter survey results included forest, grassland/shrub, lakes, riparian, stream/river and wetland. BC Red listed species include any plant, animal or plant community that is extirpated, endangered or threatened and Blue listed species are considered to be of special concern in BC, but are not extirpated, endangered or threatened. The Species at Risk Act, Schedule 1, is federal government legislation enacted to protect extirpated, endangered and threatened species and species of special concern across Canada. A total of 45 sensitive BC wildlife species were identified, with 16 SARA listed species results.

Water Resources

The Chapman Creek watershed (Watershed Code: 900-120400) is located approximately 5 km east of Sechelt, BC and provides approximately 85% of the drinking water and fire protection for more than 21,000 residents between Langdale and Earl's Cove, including the District of Sechelt. Water storage is provided by both Chapman and Edwards Lakes which are located on the Tetrahedron Plateau in Tetrahedron Provincial Park. A control structure on Edwards Lake allows water to be released when required to augment flows in Chapman Creek.

Comment [DB1]: I think the number mentioned earlier in the report was 10k

Chapman Creek flows south from the Tetrahedron Plateau for approximately 24 km and discharges into the Strait of Georgia. Chapman Creek watershed is approximately 73 km^2 in area and the drinking water intake is located approximately 175 m above sea level and 7.5 km upstream of the mouth of Chapman Creek. Approximately 65 km^2 of the Chapman Creek watershed is located above the SCRD water intake.

Chapman Lake

Chapman Lake lies at an elevation of 976 m above sea level in steeply sloping terrain; surrounding ridgetops and peaks typically reach more than 1,500 m elevation. The lake has a surface area of 31.2 ha and a maximum depth of approximately 30 m, making it the largest lake in the Chapman Creek watershed. The catchment area of the lake is 6.58 km², and the lake is fed by 2 main streams, both of which enter at the east end of the lake. The lake volume at the high water level is approximately 3.7 million m^3 with an average outflow rate of 0.476 m^3/s. Based on these data, the average retention time of water in the lake is approximately 90 days. The short retention time reflects the high level of precipitation in the watershed. Outflow from the lake is controlled by a concrete dam and valve located on the west side of the lake and operated by the SCRD. During a typical year, water stored behind the dam is allowed to overflow naturally until there is a need to supplement the flows to Chapman Creek, at which time the dam is opened to release stored water from the reservoir. The annual lake level variation is currently between 1.5 m to 3 m.

Chapman Lake Water Quality

Whitehead (1999) reported the results of limited water quality monitoring on Chapman Lake. Parameters measured included Secchi disc transparency, temperature and dissolved oxygen. The Secchi disk indicated clear water with a reading at 6.5 metres. Temperature and dissolved oxygen results ranged from 16°C at the surface to 7°C at depth and from 16 mg/l at the surface to 6.5 mg/l at depth, and indicated the lake was stratified with a thermocline between 2 m and 3 m. During the monitoring program gas bubbles were observed throughout the lake and particularly at the east end in the shallower areas. Based on the smell of hydrogen sulphide it was concluded the gas bubbles were originating from anaerobic decomposition originating in the lake sediments.

Comment [DB2]: Check number. This is a little high for the elevation and temperature

Chapman Lake Water Quantity

A water demand and supply analysis under changing climatic conditions was conducted on the Chapman water system on the Sunshine Coast. The study assessed the impacts of climate change on water consumption and water supply within the Chapman watershed. Historic temperature, precipitation and discharge data were collected to determine historic trends. The impacts from Pacific Decadal Oscillations and El Niño Southern Oscillations on climate and discharge were analyzed to determine the impacts of climate change.

The results from this study indicated that climate patterns on the Sunshine Coast have changed over the last 50 years, with annual average temperatures increasing by approximately 2°C and average total annual precipitation decreasing by 24 mm. Climate trends were determined to impact the available water supply as temperatures and snowpack elevation were increasing. This increased temperatures and diminishing snow pack is causing the snow to melt earlier and more rapidly during the spring season and existing streamflow regime in Chapman Creek is shifting towards a more rain dominated regime, which would change the entire water holding dynamic of the watershed. Discharge data further showed that peak discharge occurred earlier in the spring, which affects summer base flows when demand for domestic distribution and environmental services was highest. Climate conditions during the summer season were also determined to be impacting supply as the increasing temperatures were assumed to cause the snowpack to be depleted earlier in the summer season and the decreasing trends in precipitation were resulting in less recharge to storage reservoirs.

The increases in temperature and decreases in precipitation trends were shown to be correlated to water consumption during the summer season when water supplies are the most limited. The significant correlation between water consumption and temperature and precipitation identifies how climate change may impact water consumption behaviors on the Sunshine Coast.

Sunshine Coast climate is characterized by cool and wet winters and warm and dry summers (Figure 3). The summer season is the critical time of year for water supply, as this is when water demand is highest and available water supply is most limited. Trends over the last 50 years are suggesting that summer temperatures are increasing (Figure 4) and total summer precipitation is decreasing (Figure 5).

Figure 2. Annual average total monthly precipitation and average monthly temperature in Gibsons, BC (1962 to 2013)

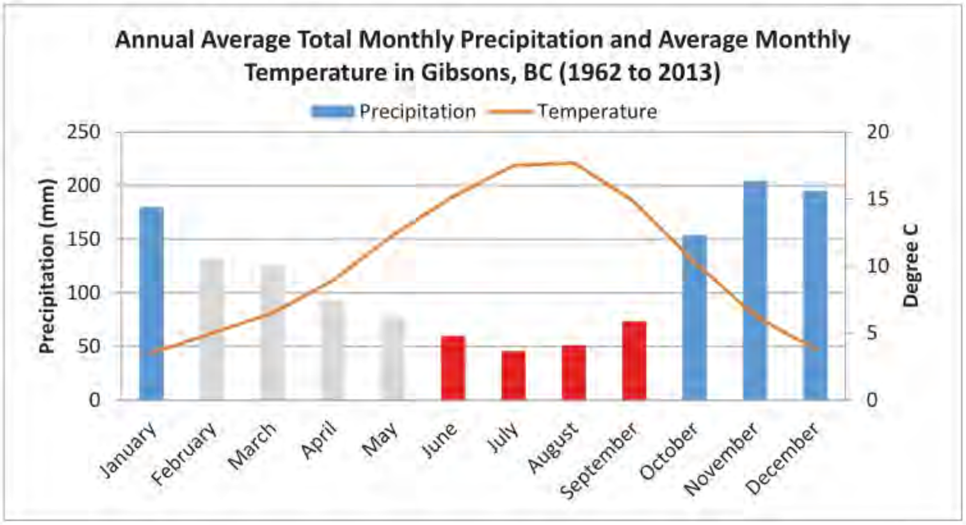


Figure 3. Historic monthly mean temperatures for July to September collected in Gibsons, BC from 1962 to 2013

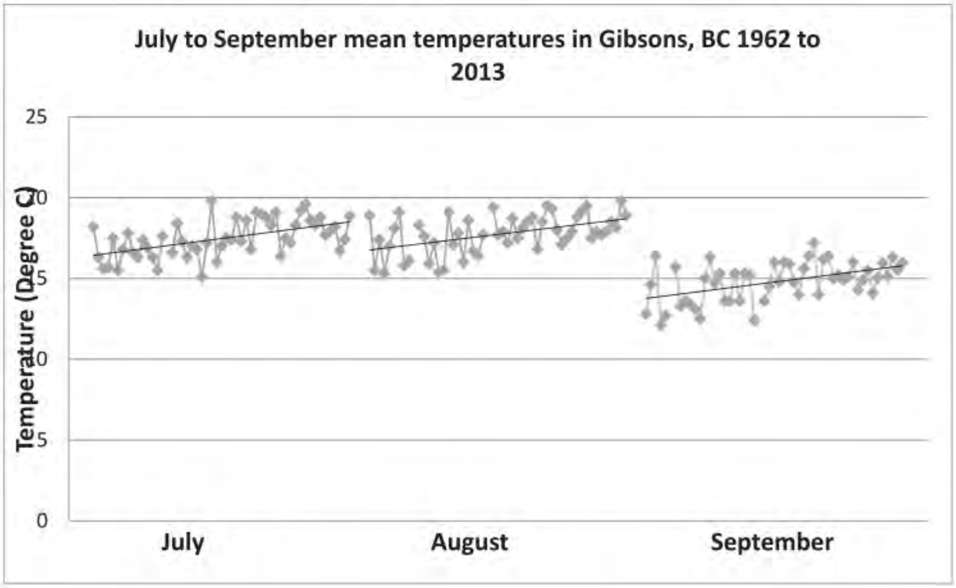


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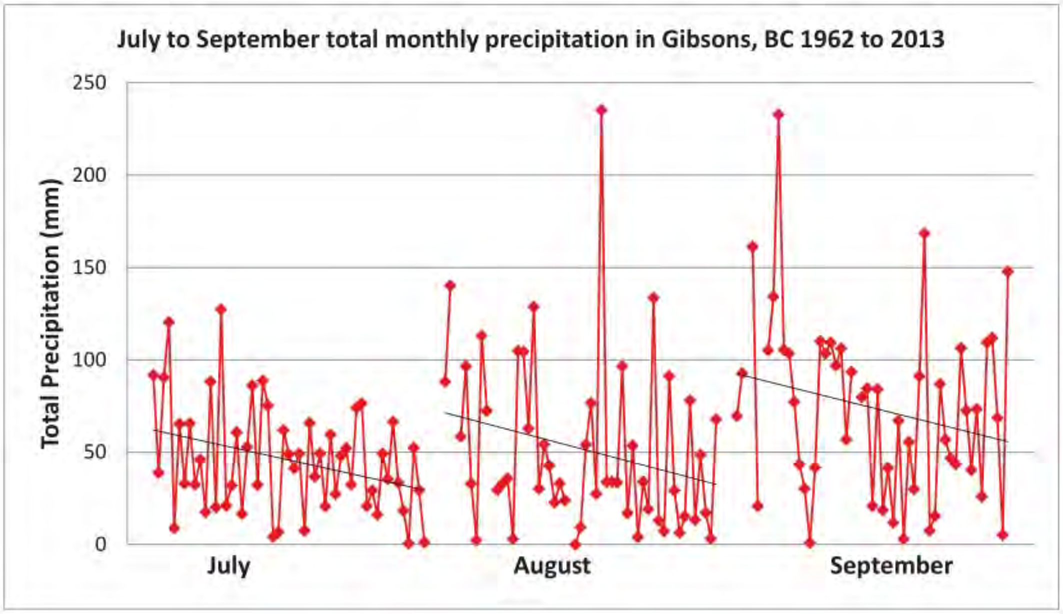
Figure 4: Historic monthly total monthly precipitation for July to October collected in Gibsons, BC from 1962 to 2013



As part of the study, a sensitivity analysis was completed and identified that the total water consumption during the summer could regularly exceed the equivalent to the available water supply in the next 10 years if water demand does not change, snow pack continues to decrease in the winter, summer temperatures increase by an average 1 or 2 °C, and prolonged droughts become more common.

Geology

Chapman Lake lies within an area of granite rock of the late Jurassic and early Cretaceous ages (156 to 114 million years old), characterised as quartz diorite. Coastal watersheds underlain by rock types such as quartz diorite tend to be slightly acidic due to the low buffering capacity of these rocks and the natural low pH of rainfall.

The dominant soil-types within the Chapman watershed contain large concentrations of organically combined iron and aluminium in their subsoils. In poorly-drained soils on the Tetrahedron Plateau organic matter is not broken down as quickly as in areas of well-drained soils, which means that organic and clay colloids, and aluminium and iron compounds are common elements in the water supply and characterize the natural water quality in this area.

Historical and Cultural Significance

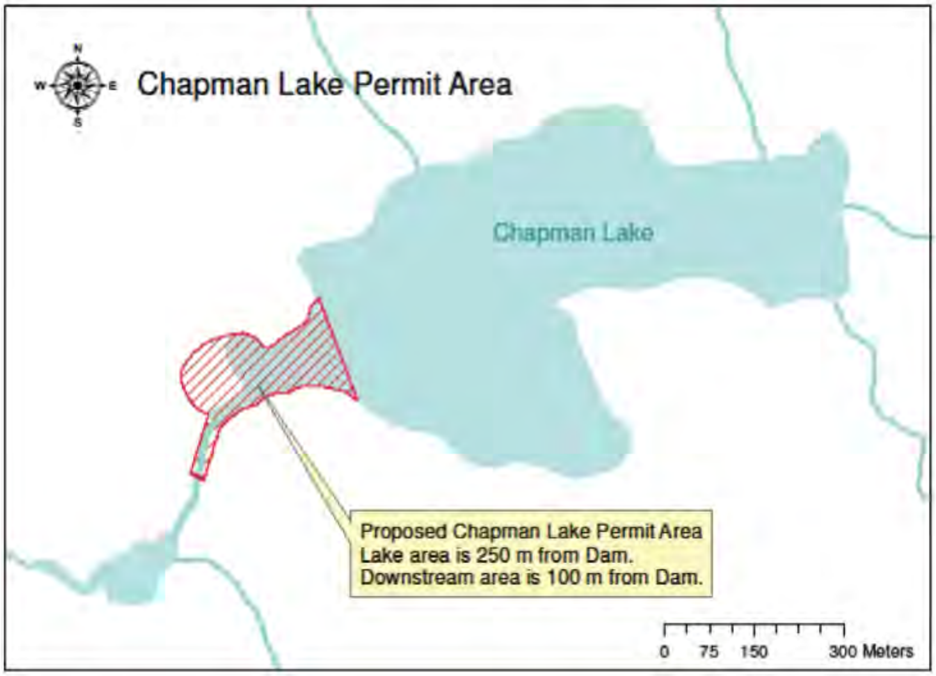
There were no available records of archaeological, historical and cultural heritage values at Chapman Lake. Chapman Lake lies within the traditional aboriginal territory of the shíshálh Nation. An assessment by Global Village Research Consultants (1998) confirmed the '*no sites recorded....within a 9 to 10 mile vicinity of Chapman Lake and the upper drainage of Chapman Creek*". AECOM recently reviewed the BC archaeological site database for any newly recorded sites in the project area and no new records have been added.

c. Location and size of all proposed and current improvements

Location

The location of the proposed permit area is outlined in the Figure below.

Figure 5. Proposed amended permit area at Chapman Lake



Siphon Design

The siphon consists of five parallel 200 mm HDPE pipes that are 255 m in length. The siphon will run over the existing dam structure from Chapman Lake into Chapman Creek. The inlet will be installed at an elevation of 963 m which is approximately 11 m below the top of the dam and will reach into the lake approximately 180 m from the existing dam. The inlets will be secured and anchored in place using concrete blocks and buoys. The outlet of the pipe will be located approximately 50 meters downstream of the existing dam at an approximate elevation of 965 m. Refer to attached engineering design drawings.

Siphon Construction

The installation of the siphon system will involve transportation of pre-fused sections of HDPE pipe to Chapman Lake via helicopter. The installation process will begin with laying the outlet pipe (with attached gate valve) then will proceed with laying the subsequent lengths of that pipe, ending with the inlet pipe (with attached check valve and buoy). The sections of pipe will be bolted together at Chapman Lake and the inlet pipe will be tied-off to lake bed anchor blocks. This process will be duplicated for a second complete siphon length. Once the first two pipe lengths are assembled and in place, the pump/vacuum and blow-off ports will be constructed at the high point of each pipe. The siphons will be primed and commissioned as soon as possible after completion of construction. The operation of the first two siphons will be monitored for 24 hours by the SCRD Siphon Technicians. If the operation of the first two siphon lengths is considered to be a success, the remaining lengths will be constructed through the same process as the previous two. For construction details, refer to the Detailed Construction Plan.

If the siphon is considered to be unsuccessful after 24 hours of operation, alternative options will be considered in consultation with First Nations, BC Parks, and MFLNRO.

d. If applicable, details of the physical changes to the site that would be required to meet the needs of the proposal and the proposed mitigation of such changes

The physical changes and the proposed mitigation strategies are outlined in the table below.

Table 3. Physical changes and proposed mitigation measures from the proposed works

Physical changes	Proposed mitigation
Lake bed disturbance from machine activity when assembling the pipes	Operating the machine in the upper areas of the exposed lake bed where the ground cover is compacted and disturbance is minimal. In sensitive areas where lake grasses are present or ground conditions are softer, ¾" plywood will be placed on the ground to form a track and reduce any significant disturbance from a machine.
Excavating benches where necessary within the lake bed for the level placement of the lock blocks	An excavator will be used to dig out a flat area for placement of the lock blocks. The area to be disturbed will be sized according the size the size of the lock blocks to minimize disturbance. This work will occur when the lake level is below the location where the lock block will be placed to minimize any sedimentation into the lake.
Soil disturbance from machine activity	Machine access routes will be flagged at predetermined locations and routes in advance to minimize vegetation disturbance and to concentrate all disturbance from the machine into a small of an area as possible.

e. Construction Schedule (if applicable) for proposed new permanent and/or temporary facilities

A project of this nature has numerous variables that impact timing (e.g. weather, water demand etc.). The dates for the construction schedule are unknown until it is realized that the siphon is needed, which is when the water supply has approximately 30 days remaining.

From when the decision is made to install the siphon, construction and commissioning are estimated at 35 days of which approximately eight days will be in channel/lake work.

f. Photographs of the site and area adjacent to the proposed land use/occupancy

Figure 6. The proposed site at Chapman Lake showing the proposed alignment of the siphon lines and the sensitive aquatic grassy area to be protected as detailed in Table 3.

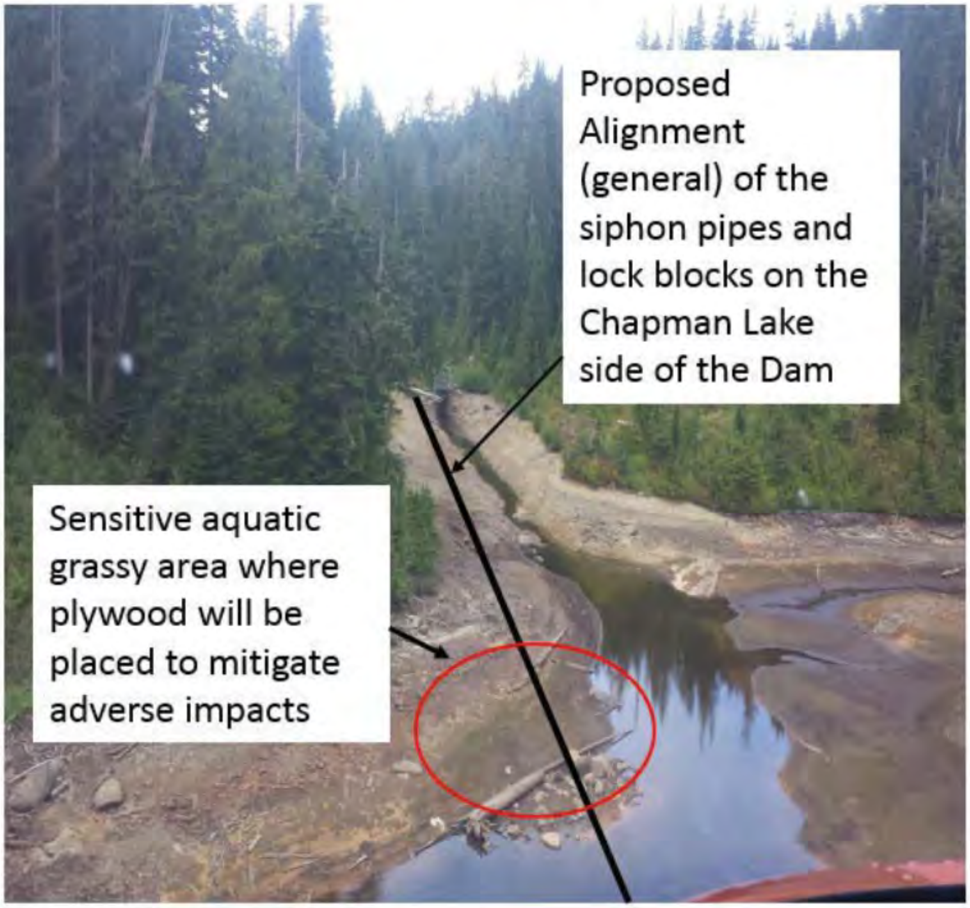


Figure 7. Site plan at Chapman Lake showing the camp area, access pad, proposed alignment of the siphon pipes, and general assembly area.

Copyright

g. Type of transportation and access route to the proposed site

Helicopter will be the primary mode of transport to and from the proposed site.

h. Initial five year operational plan

Because this is a short term plan, there is no intention of operating this siphon system for five years. Once the siphons are operational, the operational plan will consist of having at least one person on site at all times to ensure that the siphons are in operation and to also address any issues with operation in a timely manner.

Section B – Experiences of the Applicant

Park Use Permit - The SCRD has held a Park Use Permit (PUP) for the purposes of maintaining water impoundment infrastructure at Chapman and Edwards Lake and a helicopter pad at Chapman Lake in Tetrahedron Park since the park was established. The SCRD's PUP was renewed February 1, 2014 and the current PUP No. 102714 is valid until January 31, 2024

Constructing waterworks – The Sunshine Coast Regional District's waterworks crew consist of staff members who have been installing waterworks infrastructure for over 30 years.

Environmental management/monitoring – The SCRD has personal on staff who have extensive experience in environmental management, including experience in designing, implementing and monitoring Environmental Monitoring Plans.

Section C – Potential Impacts

a. Impacts and mitigation measures on vegetation, wildlife and watercourses

Table 4. Impacts and mitigation measures on vegetation, wildlife, and watercourses

Introduction of invasive plants	All machines and equipment to be used for this project will be cleaned and inspected prior to being used at the lake for the construction and operation of the siphon. This strategy is intended to prevent the spread or introduction of invasive plants through the transport of machines and equipment.
Soil and vegetation disturbance from temporary camp to be used during installation and operation of the siphon	The periphery of areas required for accommodation, staging and construction will be marked with flagging. All personnel who will be working on site will be directed during orientation to concentrate all of the activity and foot traffic to select areas only.
Disturbance to Wildlife	All wildlife observations and encounters will be recorded. This will include any instances where wildlife activity is disturbed from personnel working at the site. Minimizing attractants to wildlife will be achieved through sound waste management. Food waste or any other waste that may attract wildlife will be contained in a lockable bear-proof container. The waste generated from the site will be removed on an as needed basis. A portable toilet will be available and all human waste will be collected in the toilet and flown off site as needed.
Disturbance from a pertochemiacal spill	To mitigate the impacts from any potential petrochemical spill, all machinery with hydraulics will use vegetable oil wherever possible. A spill kit will be on stand-by to contain any spills should they occur and spill response training will be provided to operators and staff. While fueling equipment, containment will be maintained by using soaker cloth under the area of where the filling is occurring. The pumps used for priming the siphons will be housed in containment boxes lined with plastic. In the event of a spill, the spill will be reported to the Spills Reporting Line and the Lead Environmental Monitor (EM) will be contacted and will provide mitigation advice. Depending on the severity of the spill the EM will be brought to the site as soon as possible to oversee mitigation measures. An onsite staff or operator will be required to record the causes of the spill, the response undertaken and the apparent effects of the spill.
Disturbance from erosion and sediment laden run-off	The risk of erosion and sedimentation is highest when periods of intense rainfall coincide with active construction. These risks will be minimized by ensuring the construction takes place during dry conditions. The exposed lake bed on the south side of the outlet channel will be where the assembly and moving of the pipe will occur and the setting of lock blocks to anchor the pipe. Construction activity will occur on the most compacted ground accessible below the high

	water mark where the substrate consists of a shallow layer of sandy loam above glacial till and bedrock. This area is considered to be stable and the risk that planned activities will result in a rise in creek turbidity over the background level is considered to be low.

b. Impacts to watercourses or water bodies

Refer to Table 3.

c. Special features

N/A

d. Impacts on Park access

Access to the park will not be impacted from the proposed works.

e. Impacts to aesthetics and visual values

The location of the proposed works is not visible from any trails with the park and therefore is expected to have no impacts to landscape aesthetics or visual values (see also section g).

f. Impacts on cultural values including traditional use by First Nations

There were no available records of archaeological, historical and cultural heritage values at Chapman Lake. Chapman Lake lies within the traditional aboriginal territory of the shishálh Nation. An assessment by Global Village Research Consultants (1998) confirmed the ‘*no sites recorded....within a 9 to 10 mile vicinity of Chapman Lake and the upper drainage of Chapman Creek*”. AECOM recently reviewed the BC archaeological site database for any newly recorded sites in the project area and no new records have been added.

g. Impacts to park users

Although no park trails intersect with the proposed location for the works, park users who are on any nearby trails may be impacted when the siphon pipes, equipment, or personnel are being transported by helicopter. This potential disturbance to park users will be mitigated through notification of schedule of works to BC parks and appropriate signage within the park to notify users of the works.

Figure 5. General location of Chapman Lake

Date 21 Sept/17

Lynda Fayfe SCRD Environmental Monitor

- ~~[illegible]~~ requested to trim a ~~[illegible]~~ route downstream from weir ~50m on river L so staff can access for siphon layout - I approved
- she will flag & GPS mark trail & photos of the route & any vegetation that may be required to be removed so I can review

---

s.22 convo Garden Bay Marine Park

SCRD Chapman

Q's
- How much blasting below weir (depth)?
- slope of outflow pipe?
- replacing existing weir?
- How far downstream @ Edwards is pipe & cable in?
- What is downstream cable & pipe? Temp?

- Lynda's flagged trail seems reasonable (but rough)
  - brushing & clearing of fallen trees (
  - Is additional infrastructure?
-

Page

Date

3 days to install 2 pipes

S pipes?

- mini excavator to flatten locations for blocks
  - 1-1.5 days of excavator

SCRD Siphon meeting 14:00 26 Sept 17

Why not stage 4 now if real concern, instead of waiting until siphon ready
public may then not conserve

12 flights
crew, porta potty, plywood, mini excavator
spill kit, lock blocks

6 concrete blocks ; possibly 2 more if required

- last block @ end of pipe ~ 10m depth

Date

Reed call for clarification
on issued PUP

☆ - can SCRD go ahead w/out in place

☆ - placing materials waiting on excavation
until signed permit

Raph will provide updated Work Plan & Timeline

email confirmation from SCRD that

~~5 business~~

Sept 17

ator

quired

Page

[redacted]

AECOM SCRD Meeting 11:00 26 MAY 16

☆ PUP requirement for research
- Rod to discuss w Chris & Jennie on what will be required
- AECOM will start preparing WORKPLAN proposal for additional research & study
- reviewing Jannas recommendations
- fish sampling touch base w Mike Willcox & Iain Lunan
- PEM OR TEM mapping available?
- SCRD can provide Drawdown regime data
  - good accurate data since 2010

siphon? ☆ - What will be required for PUP ammendment to ammendment? get back to AECOM/SCRD ASAP
- FN consultation update
  - nothing scheduled since meeting was cancelled in mid April due to blockade at Band offices

☆ Rod provide list & contacts of stakeholders for public ~~conservation~~ consultation meetings

☆ Rod provide summary of TAC meeting by next week get comment from Aquatic Ecosystems

— Tentative site visit reschedule to Tues 31st

☆ROD SCRD requesting formal letter from Jennie summarizing phone convo w Bryan Shoji

- new bathymetric data available & AECOM will provide in next update STRAITLINE land surveyors conducted in 2013 — SCRD could not confirm if BC Parks was made aware of works

Chapman Site visit 31 MAY 16

mentioned in Joanna's e

- machinery - 1 drilling machine ~ Bobcat size
  - diesel compressor
  - moderate size excavator - on tracks
  - mini dumptruck
- ☆ - does not have to be ~9.2m at inlet but that is ideal for function/engineering of pipe hydraulics
- new permit area to cover pipe
- temp area is for staging & space for construction
- what to do with organics/wood etc in channel SID Recommendation
  scrape off & place back on top of blasted rock?
- coffer dam ~50m across - water filled bladder
- AECOM leaning towards not a high level geotechnical survey
- new flow structure at trench/tunnel interface - manhole down to valve in valve in pipe -
  - may move valve near outflow
- ☆ - need to get layout of staging area & camp plan
- ☆ - BC PARKS will need confirm how much ground disturbance we will approve for staging area
  - fuel storage - pipes from containment?
  - long-term pipe maintenance required?
  - I would hope machinery will not need to be on upland at all during construction phase & remain in trench

mentioned in Joanna's letter

BC PARKS Needs

- ✓ camp layout plan facilities structures etc
- complete list of equipment
- fueling procedures
- ✓ Remediation plan - veg planting, invasive monitoring
- ✓ long term monitoring plan - water (temp, O_2, dynamics), veg, fish, amphibians
- determine sensitive breeding windows
- ✓ erosion & sediment control plan
- ✓ emergency plan - staff, spill
- final Permit Area map
- ✓ identify spawning habitat
- food & storage & removal
- ✓ additional research & study

13 June 16

SCRD / BC Parks Meeting

con call

Jim Standen, ~~Bob Austad~~, Jennie Aikman
Garry Nohr, Janette Loveys, ~~Susan Hunt~~, Bryan Shoji

Garry - thanks for siphon permit
- concerned that new application has not moved forward

* - provide any written stakeholder comment to SCRD
  - confirm which has been provided
- SCRD will provide public comment from 2013 CRWP process

- SCRD goal to have complete package & additional work completed by end of summer

- Jennie indicated that after above received BC Parks would work to have decision w/in 4 weeks

Chapman Internal Update Meeting 15 June 16
Rod, Chris, Joanna, Sandra, Grant
Bryan Robinson

- Rod provided update of recent meetings & letters
- Joanna letter to Sandra & Brian, Grant
- Sandra indicated no Section 11 application has been submitted as of yet
  - she will follow up
  - they will look into possible extension until Oct 31, 2017 - the process will be communicated to SCRD
- FLNRO Water & DFO will arrange separate meeting

---

17 June 16

TO DO FOR JOSH
- ID card
- Uni ORDER
- update & provide Attendance spreadsheet
- Cultural Site Map

16 Aug 16

Chapman discussion w/ Joanna
- motorized boat? spill kit & plan
- PUP decision
- additional field work
- AECOM appears to feel it is just step in process
- How can we make decisions w/out all info?
- fettering Jennie's decision
- Can we write provisions for changes to PUP if anything comes out in field work.

- Joanna feels we will be short on data & Jennie will have to make decision w/out.
- write mitigation measures into PUP

- the more they can reduce uncertainty will help in decision

---

19 Aug 16

call w/ Josh
- extension
- T&L
- shift plan
- Fire Ban

Chapman Update 5 Dec 16
con call

SCRD Janette Loveys, Dave Crosby
BC Parks Jennie Aikman, Wade Anderson, Rod Dalziel, Joanna
Remko Rosenbloom, Allan Johnsrude Hirner

EIA complete
→ provided to FN awaiting comment expecting by early January

- Jennie has requested EIA updated application ASAP

☆. Janette confirmed she is 1st point of contact going forward

- Pre-qualification of bidders process complete
  - just to keep process moving in hopes of approval at end of March

Jan 16th 10am next meeting

s.13,s.14,s.16

27 JAN 17

SCRD meeting
Chapman next steps
Jennie, Janette, Alan, Remko, Joanna

①- Background on how we got to now
②- Timelines
③- Chapman SCRD EA

①·Sec 30 Park Act schedule D reviewed based on
s.14
[redacted]

What to do in iterim (this summer)? Jennie - BC Parks would consider extending the siphon ammendment again
Aug 23RD 2017 Water License short term use expiry
☆ SCRD will need to apply for new ↑ application Remko states administrative process - can't extend current ∴ need new one - SCRD should apply soon
SCRD needs to re-apply for PUP ammendment extension

Boundary Adjustment Process
Category 3
Janette is stating that she feels SCRD board is unlikely to initiate this process and lead as proponent ; constituents may not be supportive

(2) Timelines - SCRD to determine if to iniate STAGE
ideally prior to Government election lockdown
BC Parks / Water to provide letter to Janette
stating boundary ammendment process must occ
* Feb 16th is next SCRD committee meeting - it wil
be open public meeting where letter will be
discussed - Janette needs letter by Feb 3RD

☆ When did BC Parks 1ST hear trench proposal? basic 03 N 3 app 29
develop timeline for entire process; when did
legal 1ST provide advice on possibility? 18 May

- Both shishálh & Squamish have received AECOM EA
  - both in elections mode into March
    - expect response from shishalh by end of month

AECOM EA [illegible] no longer Confidential - Janet
- it was labelled confidential in respect to shi
  so had opportunity to review

Janette will provide digital copies
- SCRD willl post on their website Feb 10th

- Groundwater investigation study now underway
  ~1 year process; prelim by fall
- SIB has unofficially shown interest in engineered
  on SIB lands

14 FEB 17

phone convo w̄ Jennie

· Rod on PROV SPR liaising process

· SCRD - exploring *Category 2 Boundary Ammendm
Brian Bartheleimer, Jim Standon involved
☆ Rod review
- SCRD meeting this week
  - not mentioning Boundary Ammendment
- ——— nature of rights to water is change
- ——— Vicky now involved
- response review new EA by Feb 24th (not hard date)
- FLNRO requires new Water Licence for additional water to adequately address downsteam fi requirements

RPAS - 5% of Mary's time for BC Parks 1.5 days/mon

- Judy Becker is Parks lead (or Laurel Niemi)

- Clapman update
- confirm that process is now continue w/ Amendment application review as is w/ decision subject to boundary amendment
- Boundary amendment process how/when
- was letter sent to SCRD by Feb 3RD outlining legal opinion 3; B A process

s.22 [redacted]

s.22 [redacted]

- 2 weeks to get suggestions to Barry

Water Quality & Quantity

s.14

* TAC demanding requesting BC Parks must lead conduct public consultation process

- point 2 of Action pg 16 – Review options available

EA pg 15

Jason Hay comment provided hard copy

- SCRD to proper analysis of alt. sources.

- TAC committee will develop list of Q's & concerns & requests BC Parks response

Barry pg ii, 3, 14-16, 38, 40, 42, 44 (Goal 1), 48, 12

Page 053 of 389

Withheld pursuant to/removed as

s.13; s.16

- What is not public knowledge
- I need to respond to Q's re: connection, boundary
- Boundary amendment proposals require comprehensive public consultation

- Minister is comfortable moving forward w Category 2 Boundary Ammendment Decision Note required -Vi

* · BC Parks is committed to review of AECOM AE to provide feedback if more field study may be requi
  - Joanna is ~1/2 ~~way~~ completed initial review

- FLNRO has not completed review yet
  - initial thought is downstream flow requirements needs more analysis
    - as downstream fish require more water ∴ greater lake drawdown would be required more frequently

SCRD Chapman Update next steps 02 MAR 17

Jennie, Joanna, Renato, Rod, Ken Morrison, Allan Johnsrude

- Joanna & Lisa will have discussion of serve
  by end of next week

- MAR 17th for target response to SCRD both
  BC Parks, FLNRO

- Hoping to get a Minister Approval of Cat 2 bef
  MARCH 31st

- can call TAC etc and address anything in Jennie's letter a
  public record
  - if want clarifications ~~can~~ need to request in writing
  - continuing to work through our process
- BC Parks working to determine next steps
  - SCRD Board is now reviewing options

- good convo w Barry & Dan - both appreciated the update & apologized for the mess
  - Dan indicated it was not him who went to SCRD & Coast Reporter
  - Barry felt indirectly it was Dan

13 AUG 15

Chapman - SCRD con call
Jennie, Chris, Dylan

- PUP
- Water licence

① Do we require PUP ammendment?
② Does FLNRO Water Authorizations have authority over BC Parks for water allocation?

October to near end of August

1 000 000 m^3 ~45 days of water ~5m draw down

changes
① Permit Area @ end of lake
② new infrastructure
③ 601 h) l) m)

- What is ammendment to Water Act licence?
- What are Remko's thoughts?
- Does proposal meet Water Act?

- Impact Assessment
- Ammendment should include Heli-pad Permit Area & provision

Actions
- Chris touch base w̅ Renko
- Touch base w̅ SCRD

- Rod speak w̅ Barry
  - consultation w̅ Water Management Branch
  - do not state a PUP ammendment is required

[illegible]

14 AUG 15

SCRD hired consultant who completed siphon option including ENV assessment as part of their Section 8 Water Act application

① Rod take lead
② FLNRO Renko & James - thoughts ENV, amount of H_2O, license
③ Touch base w̅ Monte - copy of FN approval
④ Chapman folder on SSC Area V drive
⑤ Megan Compt Front Counter how fast can process
⑥ Draft a plan of what we need from SCRD for PUP application
⑦ Responding to Public & TAC
⑧ End of day today - quick update for Chris & J

Monte call
- heli flights
- PUP application
- FN letter
- ENV assessment
- ~~[illegible]~~ change from Oct to Aug

- Temp Water Act ammendment
  - 24 months   1,000,000 m^3/year 5m if all
    45 days of Water

~ 30+ days remaining in allowable system

32m depth Chapman Lake
3 down already

- as part of FN letter
  - SIB requirement for Arch assessment

- Would like letter of support — To SCRD for Water License application

17 Aug 15

Remko convo

- possibly concerns of additional sediment
- feels they are not releasing enough for fisheries values
- needs to be done unfortunately

☆ Get any additional comments or concerns & requirements to Remko & James FRIDAY morning

- ~~[illegible]~~

SCRD requirements
- monitoring of ?

- Standards & Best Practices for Instream Works

22 AUG15

SCRD amendment application

Q's for Monte
- does you want to change Designated Rep from Bryan Shoji ~~to Monte Staats~~
  Phone# Fax# Email#
- Section 8 STU 24 Aug 15 → 23 Aug 16 ?
- is 2 weeks enough for removal of equipment · YE
- in Whitehead 1999 report - it disincluded the siphon options as it stated the discharge woul need to be 200-500m past weir b/c short plan not full 5m dropdown plan

☆ fish screen can affect siphon quality
Requesting not to use
- currently fish can move back & forth thru valve

?
· YES
pment
the
would
short term
thru

28 Aug 15

~~phone convo w Adam Vallance~~
~~Powell River Sea Kayak~~

SCRD - Chapman
discussion w Chris & Dennis

Rod To Discuss
- term
- review Chris' Q's in PUP document

s.13,s.16
[redacted]

- PFR
- Public consultation - TAC
- SCRD hoping to begin on Monday
- need Joanna comment

- Joanna site visit Sept 7-14
- TAC inform aft[illegible] decision

s.14
[redacted]

- Squamish FN land info - CAAD confirm boundary
  - ✓ w Remko ✓ NOT IN SQUAMISH Territory
- in PUP wording RE: Temp, Emerg situation
  + add cover letter stating this
- Send letter to shishalh - we are prepared to issue amendment
  - Rod prepare

~~Derelict boat~~
~~SPR backfill~~

13:30 SCRD - INFRA   03 Sept 15

UPDATE from Bryan Shoji GM Infrastructure Servi

- as of today 231mm since Aug 27th
  - Chapman 9" over weir
  - Edwards not quite replenished
- will drop to STAGE 3 on Friday
- Should have sufficient supply for this season
- Bryan reviewed SCRD Comprehensive Regional Water Plan
  - ★ page 4 - staff recommending deepening Chap outflow channel
  - long-term plan for engineered lake
  - not recommending siphon other than for emergency situation

what report is this?

Need more detail (emergency only?; permanent Stage 4 only?

- anticipate dam replacement 2038

★ · When do they plan to install temp siphon w high water now - would be chang in permit & require approval

Mark Lebbell · suggested looking into multiple source options other than Chapman watershed for diversity & reliability

[redacted]

Rod - Review TET MP re: water, infrastructure, source
designation, etc...

★ • Board put forward MOTION for approval of planning's
approvals of deepening channel of Chapman

★ • SCRD must explore alternates sources
- engineered reservoir outside Chapman
- [illegible] • from other than Dayton Knight

- will need comprehensive IA

[redacted]

BRETT de Wynter P.Eng
BRUCE FORD Senior Biologist
Peter Tarasi Sr. ENG 25 Jan 16

s proposal design
for 5m drawdown on Chapman Lake
- will work to get meeting planned ~1 month
AECOM w have Bryan away
- AECOM will provide basic proposal prior to meeting in Feb

---

27 JAN 16

PUP Risk Management & Liability - training
Leading session - Melissa McCABE Director in Risk Management Branch
Aaron Lubonic
facilitator - Megan Beveridge

Idemnity - means an agreement to protect the Province from losses, claims or damages arising from actions of the Permittee or activities undertaken on the permit area

Insurance -

reasons - insure 3RD party claims
- " province does not pay
- assurance the Permittee can survive a lo
- protect province from Permittees activities
- legislation (Auto, Worksafe)
- insure BC Parks property facilities

107257 Auth
3274458 Tracking

★ Review Parks Insurance Table - Share Point

SCRD timeline 23 FEB 16

- drought conditions over past few years
- implementing stricter water restrictions earlier in year
- ~~approached~~ submitted BC Parks w̄ emergency siphon proposal on 19 Aug 15
- a short term (12 month) PUP ammendment was issued to allow for a siphon system to be installed on Chapman Lake for an additional draw down of 5m
- on 28 Aug 15 (SCRD did not provide agreement to authorize until 06 Apr 16)
- letter from RD Jennie Aikman accompanied PUP ammendment
- AS Dalziel attended SCRD Infrastructure meeting ~~with~~ on 03 Sept 15 (see notebook)
  - proposals / motions
- 08 Dec 15 phone convo Marta indicating in process of securing consultant "to look into options for expanding water supply in SCRD"
  - I mentioned BC Parks would like to arrange meeting
- Rod emailed Bryan Shioji 14 Jan 16
  - requesting meeting
- SCRD Bryan replied 05 Jan 15
- I met w̄ AECOM 25 Jan 16 basic intros

✱ Search SCRD emails

25 FEB 16

SCRD Water Discussion w̄ Jennie & Chris

Q's · BC Parks initial position
- Designation change?
- SCRD may say why hasn't BC Parks reviewed & provided options
- review PARK ACT as it relates

- SCRD water system grandfathered in

① Send letter reference previous letter; BC Parks is now aware, meet to discuss
PARK SCRD plans
② Arrange meeting FLNRO water staff
- PARK ACT limitations

- letter to Bryan, Dave Director?
- letter ask for proposal
- updates on other options
- Press release
- follow up to schedule meeting

- Rod truck base w̄ Vicky

SCRD - AECOM meeting 15 MAR 16

Quick Agenda

- SCRD update
- PWP ammendment ~~[illegible]~~ validation
-

- AECOM March 3RD letter

- Intros Bryan Shoji, Chris, Jennie, Rod
  Bruce Ford, Brett deWynter, Andrew
  Biologist Engineer Manager FN Public

  Dave Crosby will be lead for SCRD

SCRD update
- 200-300 l/s during season
- 2013 Comprehensive Water Plan - 25 year plan
  - short term additional Chapman drawdown
  - long term artificial reservoir
    ~40 years lease on gravel pit
    ~ 2021 have design etc... in place
  - Conservation plans - restrictions, metering (complete 2019)
    12K meters

MAR 16

Rod

D

wdown

place
complete 2019)
metres

Q from Chris - is there another greater drawdown in 20 years?

- [illegible]

AECOM letter March 3RD options

- timeline July 4th construction start - developed timeline backwards from there - as needed construction window

- always concern of [illegible] hazardous component to rock

3 options proposed
*1 not possible as new amendment proposal required
*2

Dave Crosby - original licenses & Tenures

Potential Roadblocks -
- ambitious timeline
- IA
- FN consultation
- original tenure scope
- comprehensive public consultation

Public & Consultation so far
- plan to meet shíshálh FN on Friday MAR 18th
- plans to engage ↗ & Squamish, conservation groups

Sunshine Coast Conservation Assn.

TOC, TAC, hatchery, Ruby lake Lagoon, D of Sechelt, Town of Gibsons, DFO, FLNRO, Coastal Health
- plans for Open House ~ early June

- plan is augment + some additional studies since undertaken w the Whitehead Report - add evaluation proposals

* AECOM will need to know by end of April if allowable as far BC Parks Approval (ie no designation change required)

Level 2 screening IA?

BC Parks will have decision on possibility by April 4th - Chris will propose meeting
- AECOM will have
  - more construction details
  - early consultation
  - Level 2 screening IA

- Edwards natural flows into Gray Creek but when SCRD opens dam flows into Chapman system

DEBRIEF

- timeline unrealistic
- provide letter before April 4th meeting
- comprehensive IA for this proposal – not Whitehead IA
- ✱ - Rod follow-up w/ Dave Crosby re: original tenures & licences - any other rights prior to Park establishments
- touch base w/ Renzo, ~~DFO~~, F&W
- Jennise will work w/ legal - Lisa McBain & Ken Morrison

provide all info now to

April 16

29 APRIL 16

Chapman Lake discussion
Jennie, Chris, Joanna, Rod

- AECOM heavily relying on 1999 EIA
  - is this adequate
- Jennie feels these timelines are still unrealistic
  - will discuss w Jim
- concerns from TAC George Smith, Ian Lemm, DFO

- get referal from DFO in writing
  - we want to receive written response
- ☆ Rod: schedule need to have internal meeting Water, Fisheries, Ecosystems
- Joanna will complete comprehensive review of 1999 IA
- ☆ Develop Timeline list of actions completed who was contacted
- Sett internal meeting in NJ Van 12, 13, 14, 17, 18

- ☆ suggest TAC goes to SCRD with concerns to arrange meeting
- ☆ Call to discuss Joannas review late next week Rod arrange ✓ in PUP is approved

- in breifing note s.13

*What to include in briefing note?
options
gaps

* Keep folder organized & clean
- add emails SAVE AS PDF

- We will need consultation records & response from FN
- We can provide application documents upon request to stakeholders but should refer to SCRD

09 MAY 16

TAC meeting
- 16 MAR 16 initial meeting w AECOM & SCRD
- SCRD Permit Ammendment Application received on 29 April 16
- BC Parks is meeting tomorrow to discuss a review of the 1999 Whitehead IA
- BC Parks will be arranging a meeting w Fisheries, Water Authorization, Ecosystems

s.14

6pm Charter House 09 MAY 16
Attendance: Rod Dalziel

- what has changed from 1999 IA
  - climate considerably higher snowpack
  - much drier
  - timing of precipitation - heavy in winter, very dry in summer
  - ecosystem classification has advanced signif
    - age class maps, Species at risk
  - how much MH do we have in this district
    - how much represented in TET
    - sensitivities of this zone
- difficult to maintain & rehab this zone

Dan

Dan
- stability of lakeshore (steep sided) w̄ 8m drop
  - turbidity & siltation
- Tzoonie Tyson ~~Lake~~ ~~microhydro~~ IPP project as example of lake sedimentation
- feels 1999 IA inadequate & feels Whitehead is not qualified for some of these concerns

Cindy
- needs soils specialist
- feels 17 yo is out of date

Barry
- does not agree w̄ process - feels SCRD should have referendum

Dan - have BC Parks commission IA not SCRD

agreed all around

Michelle
- test siphon system this year & give more time to review proposal

☆ Barry - review Terms of Reference from 1999 IA

☆☆ TAC Consensus that 1999 IA inadequate as things ☆ (above) have changed over time & science has improved & that BC Parks should commission IA ~~including alternative sou~~

☆

Dan - greater study into existing (known) aquifers

s.13

[redacted]

Barry, Victor
- BC Parks needs to balance protection of park values & water needs

Victor. needs BC Parks to determine what end game, maximum further ammendments

Dan. conflicting Acts Park

What is confidence that Park Act ~~is~~ will be last desicion? Can be trumped by other ~~gove~~ gov (ie emergency situation)

Dan. options Conservation, rain harvesting, alternative sources, rain barrel subsidies, water metering

Michelle - testing bedrock depth composition soils on shoreline

The intent of CONSULTATION has changed. from MP thorough public

Cindy. fisheries studies Dolly Varden requirements, water temp

Herz. propose to have larger forum conservation groups

s.13,s.22

Barry - Terms of Reference must be produced to determine if IA is adequate
- for current application AECOM
- 1999 IA
- Bryan Shoji proposal from SCRD options

① · need improved IA
② · we have temp solution for siphon
③ then properly investigate other sources

Duane - additional IA info

- current & detailed analysis of fisheries, soils, aquatic inverts (fish food) & hydrology

Barry's email 10:35am 10May16

10 MAY 16

Chapman Lake 1999 Review discussion
Jennie Joanna Chris Rod

Joanna - AECOM assessment has flawed
- why chose trenching option?
  - no rationale

* How much extra time would the 5m drawdown provide

- what has the annual drawdown been since 1999

Jennie's letters to Bryan

Whitehead recommended additional research baseline
- water quality
- fish sampling inc. salamanders
- vegetation transects - Joanna recommends longer transects

admitted

* Rod summarizing TAC notes & provide to Jennie et al & SCRD

1. Public Consultation, IA additions, legal, other agencies

Public Consultation
- what do we want to see?

To Do

1. Jennie call Bryan to express our concerns (inadequate IA, inadequate Public Consultation)
2. Site visit 3, possible further discussion around ①
3. Lisa McBain legal response
4. Internal gov meeting (Fisheries, Water Stewardship, Ecosystems)
   - Rod arrange meeting in N Van May 16th
     - Jaiman, Kenji, Remko, Ian Blackburn
       Josh Matt
   - Iain forwarded to Mike Wilcox Christina Robinson

☆Grant McBAIN

☆ Sandra Jensen Water Officer

[redacted]

18 MAY 16

1877 353 9184

MOD PART 2708252#

Chapman Internal Meeting

- Grant has not recieved any referral or contact from SCRD to date
- SCRD ~~received~~ applied for amendment to Water License
    - for additional drawdown
    - and expansion of works / infrastructure
  - they will need new Water Licence as it is new major works Section 11 application
  - new license for additional drawdown
- Sandra is agreement w extension to siphon ammendment & Water would issue another Short Term Use permit or extension of 1 year

Grant - min flow concerns asking min 0.3cms
SCRD is suggesting .22cms
- no agreed approved min flow
- Hatchery requires 0.6 winter 0.2 summer

- Joanna - water table - amphibians
  - fire hazard

Jennie - We all need good communication & coordination going forward. Not wanting to duplicate work between agencies.

Water application Section 11 general process
- 140 days
- referrals to BC Parks, DFO, lands, Regional Fisheries, FN
- some public consultation
  - ↳ Hatchery
  - ↳ any other potential Water Licence holders

- Joanna will have summarized comments to Sandra

☆ - Rod schedule update with all internal June 15th afternoon

Rod send updated PUP to Sandra

- Construction Aggregates Leheigh - how much water selling to them & details
- methal mercury concern

s.14 [redacted]

Province of
British Columbia

Ministry of
Environment
and Parks

Lower Mainland Region
10334 — 152A Street
Surrey
British Columbia
V3R 7P8
Telephone: (604) 584-8822

ORDER

WATER ACT

Section 15

File No. 0309244

In the matter of Conditional Water Licence 50724, which authorizes the storage of water from Chapman Creek.

Having determined that Order in Council 2277 has been amended by Order-in-Countil 1576 to permit the issue of water licences for purposes other than waterworks without reference to cabinet, and being satisfied that no persons rights will be injuriously affected, I hereby amend clause (c) of the said licence to read as follows:-

(c) The date from which this licence shall have precedence is 13th July, 1967.

and delete clause (j).

Dated at Surrey, B. C., this 30th day of June, 1987.

Jw McCracken

J.W. McCracken, P. Eng.
Regional Water Manager

WATER MANAGEMENT BRANCH

MINISTRY OF ENVIRONMENT

THE PROVINCE OF BRITISH COLUMBIA—WATER ACT

CONDITIONAL WATER LICENCE

Sunshine Coast Regional District of P.O. Box 800, Sechelt, British Columbia V0N 3A0

is hereby authorized to store water as follows:

(a) The source of the water supply is **Edwards Creek** and the reservoir is **Edwards Lake.**

(b) The point of diversion is located as shown on the attached plan.

(c) The date from which this licence shall have precedence is **13th July 1967.**

(d) The purpose for which this licence is issued is **storage,** with the water which is stored to be used as set out in Conditional Water Licences 11728, 16599, 22345, 65258 and 65259.

(e) The maximum quantity of water which may be stored is **700 acre feet per annum.**

(f) The period of the year during which the water may be used is the **whole year.**

(g) The land upon which the water is to be used and to which this licence is appurtenant is **within the boundaries of the Sunshine Coast Regional District.**

(h) The works authorized to be constructed are a **dam,** which shall be located approximately as shown on the attached plan.

(i) The construction of the said works shall be completed and the water beneficially used prior to **31st day of December, 1993.** Thereafter, the licensee shall continue to make a regular beneficial use of water in the manner authorized herein.

Neil Peters

Neil J. Peters, M.A.Sc., P. Eng.
Acting Regional Water Manager

File No. 2000974 Date issued: 15th August, 1990 **Conditional Licence: 69966**

LAND AND WATER MANAGEMENT
WATER RIGHTS BRANCH

MINISTRY OF THE
ENVIRONMENT

THE PROVINCE OF BRITISH COLUMBIA—WATER ACT

CONDITIONAL WATER LICENCE

Sunshine Coast Regional District of Box 800, Sechelt, B.C. V0N 3A0

is/are hereby authorized to store water as follows:—

(*a*) The source(s) of the water-supply is/are Chapman Creek and the reservoir is Chapman Lake.

(*b*) The point(s) of storage is/are located as shown on the attached plan.

(*c*) The date from which this licence shall have precedence is 18th July, 1974.

(*d*) The purpose for which the water is to be used is as set out in Conditional Licences 11728, 16599, 22345 and 50723.

(*e*) The maximum quantity of water which may be stored is 735 acre feet per annum, and such additional quantity as the Engineer may from time to time determine should be allowed for losses.

(*f*) The period of the year during which the water may be stored is the whole year.

(*g*) The land upon which the water is to be used and to which this licence is appurtenant is as set out in Conditional Licences 11728, 16599, 22345 and 50723.

(*h*) The works authorized to be constructed are dam, which shall be located approximately as shown on the attached plan.

(*i*) The construction of the said works shall be commenced on or before the 28th day of February, 1979, and shall be completed and the water beneficially used on or before the 31st day of December, 1990.

(j) The rights granted under this licence are subject to a reserve established by Order in Council No. 2277/1967.

(k) The Engineer for the Vancouver Water District may at any time, by an Order in writing, order the release of water from Chapman Lake in order to maintain a minimum flow in Chapman Creek for the preservation of fish life.

AMENDED 30/6/87

H. D. DeBeck,
Comptroller of Water Rights.

File No. 0309244 Date issued: 1st August, 1978

Conditional Licence No. 50724

ENTERED ON
Map No. 92/NW
By JPB

Province of
British Columbia
MINISTRY OF
ENVIRONMENT,
LANDS AND PARKS

BC Environment
LOWER MAINLAND REGION

10334 — 152 A Street
Surrey
British Columbia
V3R 7P8
Telephone: (604) 582-5200
Facsimile: (604) 660-8926

ORDER

WATER ACT

Section 15

File No. 0309244

In the matter of Conditional Water Licence 50724, which authorizes the storage of water from Chapman Creek and the reservoir is Chapman Lake.

Having determined that Conditional Licences 11728 and 50723 have been amended, and being satisfied that no persons rights will be injuriously affected, I hereby amend Clauses (d) and (g) of the said licence to read as follows:

(d) The purpose for which the water is to be used is set out in Conditional Licences 69217, 16599, 22345 and 107474, or any licences issued in substitution thereof.

(g) The land upon which the water is to be used and to which this licence is appurtenant is as set out in Conditional Licences 69217, 16599, 22345 and 107474, or any licences issued in substitution thereof.

Dated at Surrey, British Columbia, this 16th day of May, 1994.

Robert Edwards

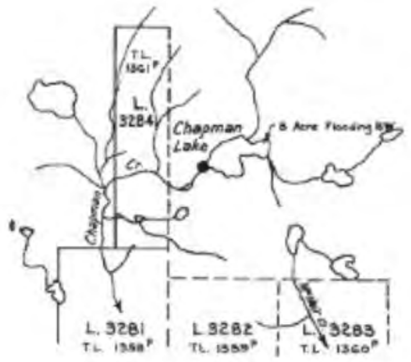
Robert A. Edwards, P. Eng.
Assistant Regional Water Manager

British Columbia

VANCOUVER WATER DISTRICT

G.1, NEW WESTMINSTER DISTRICT

Scale: 80 Chains to 1 Inch



LEGEND

Dam ○
Ref. Map 92^{G}/NW (8-8)
Right of Way ●

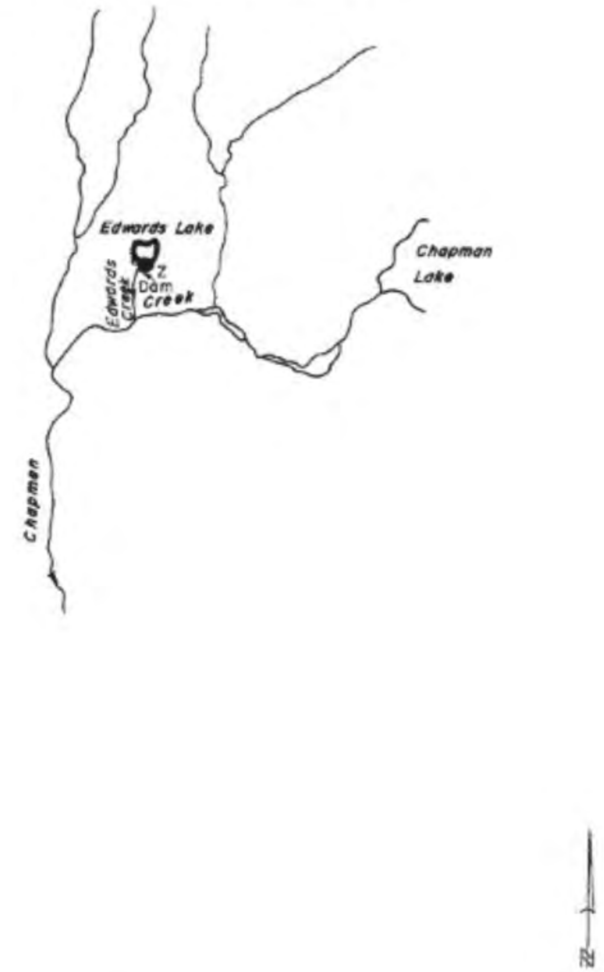
Signature

Date 1st Aug. 1978
CL 50724
File 0309244
R/W Permit No. 11586

Howe Sound Precinct

For Diversion see CL.'s 11728, 16599, 22345 & 50723

Province of British Columbia



WATER DISTRICT : VANCOUVER
PRECINCT : HOWE SOUND
LAND DISTRICT : NEW WESTMINSTER

LEGEND

Scale : 1:20,000
Dam : ●
Map Number : WR 926-052

Permit over Crown Land: ▬

Signature Neil Peters

Date 15th August, 1990.

C.L. 69966
File 2 000974
P.C.L. 17965
For Diversion see C.L. 11728
C.L.50723
C.L.65258
C.L.65259
C.L.69217

LAND AND WATER MANAGEMENT
WATER RIGHTS BRANCH

MINISTRY OF THE
ENVIRONMENT

THE PROVINCE OF BRITISH COLUMBIA—WATER ACT

CONDITIONAL WATER LICENCE

Sunshine Coast Regional District of Box 800, Sechelt, B.C. V0N 3A0

is/are hereby authorized to store water as follows:—

(*a*) The source(s) of the water-supply is/are Chapman Creek and the reservoir is Chapman Lake.

(*b*) The point(s) of storage is/are located as shown on the attached plan.

(*c*) The date from which this licence shall have precedence is 18th July, 1974.

(*d*) The purpose for which the water is to be used is as set out in Conditional Licences 11728, 16599, 22345 and 50723.

(*e*) The maximum quantity of water which may be stored is 735 acre feet per annum, and such additional quantity as the Engineer may from time to time determine should be allowed for losses.

(*f*) The period of the year during which the water may be stored is the whole year.

(*g*) The land upon which the water is to be used and to which this licence is appurtenant is as set out in Conditional Licences 11728, 16599, 22345 and 50723.

(*h*) The works authorized to be constructed are dam, which shall be located approximately as shown on the attached plan.

(*i*) The construction of the said works shall be commenced on or before the 28th day of February, 1979, and shall be completed and the water beneficially used on or before the 31st day of December, 1990..

(j) The rights granted under this licence are subject to a reserve established by Order in Council No. 2277/1967.

(k) The Engineer for the Vancouver Water District may at any time, by an Order in writing, order the release of water from Chapman Lake in order to maintain a minimum flow in Chapman Creek for the preservation of fish life.

H. D. DeBeck,
Comptroller of Water Rights.

File No. 0309244 Date issued: 1st August, 1978 Conditional Licence No. 50724

PROVINCE OF
BRITISH COLUMBIA

MINISTRY OF THE ENVIRONMENT

PERMIT UNDER THE WATER ACT AUTHORIZING THE OCCUPATION OF CROWN LAND

Sunshine Coast Regional District of Box 800, Sechelt, B.C. V0N 3A0

the holder(s) of Conditional/~~Final~~ Water Licence(s) 30724 authorizing ~~the diversion of water from~~ storage of water in Chapman Lake is/are hereby

flooding and

authorized to occupy Crown land by constructing, maintaining, and operating thereon the works authorized under the said water licence and any licences which may be issued in substitution thereof.

(*a*) The Crown land which is authorized to be occupied under this permit is a portion of unsurveyed land, Group 1 New Westminster District,

the location of which is shown approximately on the plan attached to the said water licence.

(*b*) The approximate dimensions of the Crown land authorized to be occupied under this permit are

(1) damsite		1 acre
(2) flooded		8 acres
	total area	9 acres

(*c*) Subject to the payment of royalty, stumpage, and other compensation, and the obtaining of a licence to cut timber as provided under Condition 5, the permittee may cut and remove from the said land any timber, the removal of which is necessary to permit construction and maintenance of the said works, **and clearing of the said land which may be flooded.**

(*d*) The annual rental for this permit is $12,00 , which is subject to review and revision at any time at the discretion of the Crown.

(*e*) This permit is appurtenant to the land, mine, or undertaking to which the aforesaid water licence is appurtenant.

(*f*) The conditions relative to the rights granted under this permit are printed on the back of this form.

W.R. Redel
Assistant Deputy Minister of the Environment
Land and Water Management

File No. 0309244

Ref. Map 92G/NW(B-3)

W. R. Map ----

Date issued: 1st August,1978 Permit No. 11586

I HEREBY CERTIFY THIS TO BE A TRUE COPY OF A
DOCUMENT ON RECORD IN THE WATER RIGHTS BRANCH

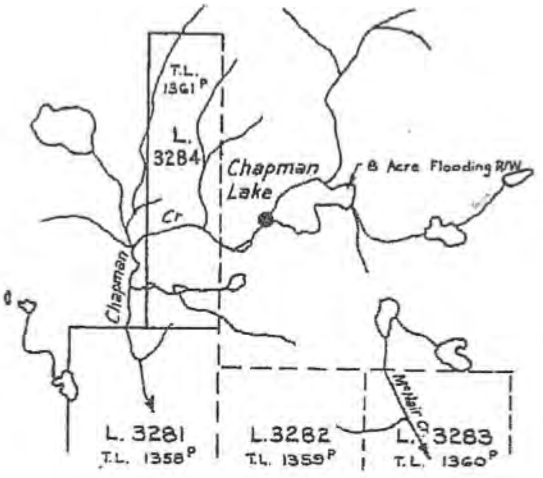
COMPTROLLER OF WATER RIGHTS

W.R.B. 12—5M-477-8133

British Columbia

VANCOUVER WATER DISTRICT
G.1, NEW WESTMINSTER DISTRICT

Scale: 80 Chains to 1 Inch



TRUE NORTH

N

LEGEND

Dam ○
Ref. Map 92G/NW (B-3)
Right of Way ●

Signature

Date 1st Aug. 1978
C.L. 50724
File 0309244
R/W Permit No. 11586

[illegible]

Howe Sound Precinct

For Diversion see C.L.'s 11728, 16599, 22345 & 50723

Province of British Columbia   Ministry of Environment

PERMIT UNDER THE WATER ACT AUTHORIZING THE OCCUPATION OF CROWN LAND

The holder of Conditional Water Licence 69966 whose licence authorizes the diversion of water from Edwards Creek, is hereby authorized to occupy Crown Land by constructing, maintaining and operating thereon the works authorized under the said licences and any licences which may be issued in substitution thereof.

(a) The Crown Land which is authorized to be occupied under this permit is a portion within the boundaries of the Sunshine Coast Regional District, the location of which is shown approximately on the plan attached to the said water licence.

(b) The approximate dimensions of the Crown Land authorized to be occupied under this permit is 70 acres.

(c) The permittee may cut and remove from the said Crown Land any timber necessary to permit construction and maintenance of the said works. Prior to the cutting, destruction or flooding of any timber, the permittee shall apply for and obtain a licence to cut timber from the District Manager and the amount of stumpage, royalty and (or) compensation payable to the Crown in respect of trees, including merchantable or young growth, cut, removed, damaged, or destroyed by the permittee, shall be the sum or sums fixed by the Forest Service of the Province of British Columbia.

(d) This permit is appurtenant to the land, mine or undertaking to which the aforesaid water licence is appurtenant.

(e) This permit shall become void if the water licence with respect to which the permit is issued should terminate, be abandoned or cancelled, or amended so as to render this permit unnecessary.

(f) This permit is issued and accepted on the understanding that the permittee shall indemnify and save harmless the Government of the Province of British Columbia for all loss, damage to works, cost or expense suffered by the permittee by reason of the Crown Land or any portion thereof being submerged or damaged by erosion or otherwise affected by flooding.

(g) The holder of this permit shall not be entitled to compensation if the Crown grants permits to other persons to occupy the land affected by this permit.

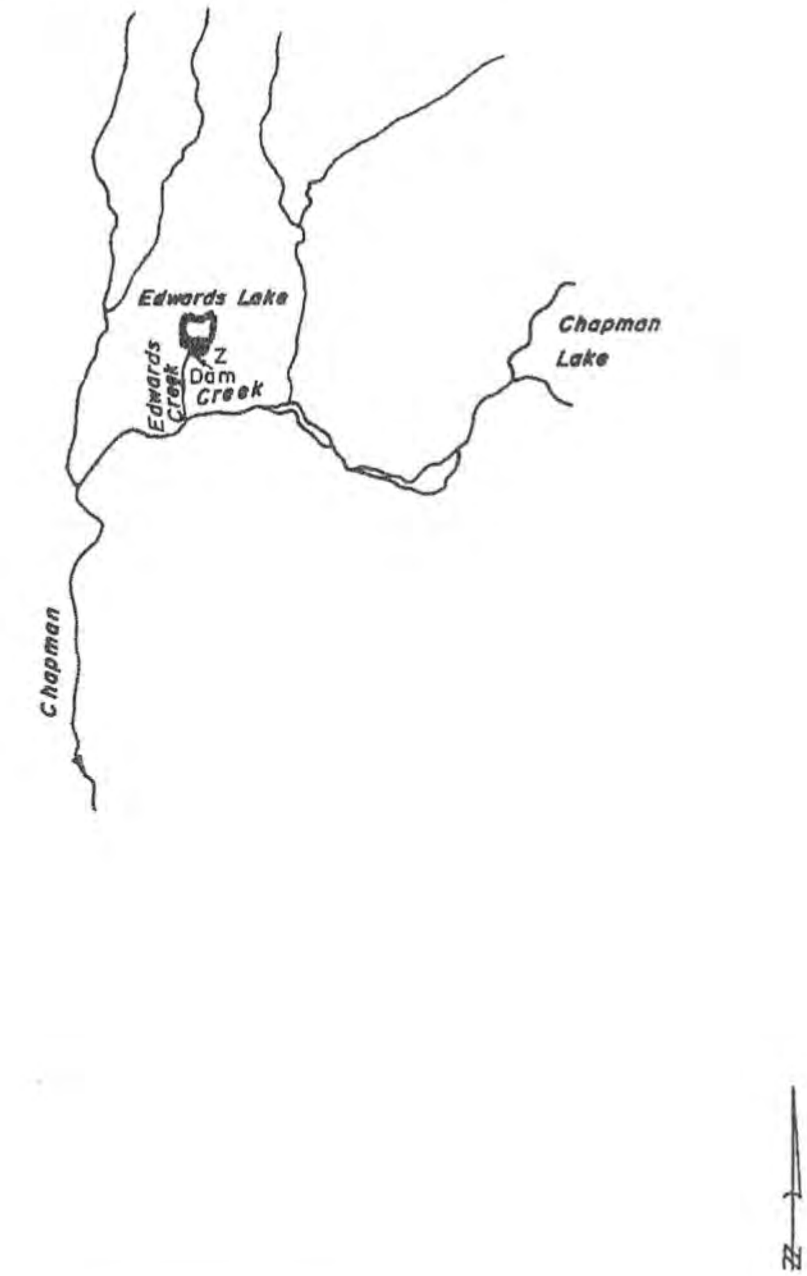
(h) In the event of a dispute at any time with respect to the area or boundaries of the land affected by this permit, the holder shall, at his own expense, have the said land surveyed by a duly qualified surveyor.

Neil Peters

Neil J. Peters, M.A.Sc., P. Eng.
Acting Regional Water Manager
duly authorized designate of
the Minister of Environment

File No. 2000974   Date Issued: 15th August, 1990   Permit No: 17965

Province of British Columbia



WATER DISTRICT : VANCOUVER
PRECINCT : HOWE SOUND
LAND DISTRICT : NEW WESTMINSTER

LEGEND

Scale : 1:20,000
Dam : ●
Map Number : WR 926-052

Permit over Crown Land: ▬

Signature

Date 15th August, 1990.

C.L. 69966
File 2 000974
P.C.L. 17965

For Diversion see C.L.11728
C.L.50723
C.L.65258
C.L.65259
C.L.69217

WATER MANAGEMENT
BRANCH

MINISTRY OF
ENVIRONMENT

THE PROVINCE OF BRITISH COLUMBIA—WATER ACT

CONDITIONAL WATER LICENCE

Sunshine Coast Regional District of P.O. Box 800, Sechelt, British Columbia V0N 3A0

is hereby authorized to store water as follows:

(a) The source of the water supply is **Edwards Creek** and the reservoir is **Edwards Lake.**

(b) The point of diversion is located as shown on the attached plan.

(c) The date from which this licence shall have precedence is **13th July 1967.**

(d) The purpose for which this licence is issued is **storage,** with the water which is stored to be used as set out in Conditional Water Licences 11728, 16599, 22345, 65258 and 65259.

(e) The maximum quantity of water which may be stored is **700 acre feet per annum.**

(f) The period of the year during which the water may be used is the **whole year.**

(g) The land upon which the water is to be used and to which this licence is appurtenant is **within the boundaries of the Sunshine Coast Regional District.**

(h) The works authorized to be constructed are a **dam,** which shall be located approximately as shown on the attached plan.

(i) The construction of the said works shall be completed and the water beneficially used prior to **31st day of December, 1993.** Thereafter, the licensee shall continue to make a regular beneficial use of water in the manner authorized herein.

Neil Peters

Neil J. Peters, M.A.Sc., P. Eng.
Acting Regional Water Manager

File No. 2000974 Date issued: 15th August, 1990 **Conditional Licence: 69966**

Section 8 Development Plan – Short Term Water Use

Sunshine Coast Regional District

August 14, 2015

Introduction

Chapman Creek is the main water supply for the Sunshine Coast as it supplies water to approximately 90% of the area residents (23,000 people). During the summer months, instream flows in Chapman Creek are regulated through impoundment structures on Chapman and Edwards Lakes, which are the main water storage reservoirs for the water system and both are situated within the Tetrahedron Provincial Park. The total available water storage capacity for withdrawal is 1.7 million m^3.

Currently, the available water supply is at risk of becoming fully depleted as a result of the prolonged period of drought that has been experienced this summer (2015). In order to ensure the ongoing delivery of potable water to area residents and fresh water for environmental values, the Sunshine Coast Regional District is requesting a **Short Term Use Approval** under Section 8 of the *Water* Act to access an additional 1,000,000 m^3 of water (5 m of additional storage – 8 m in total) in Chapman Lake through a proposed siphon system.

Current Water Licensing

- Conditional water licence (storage in Chapman Lake) – #C050724
    - 906,607 m^3 per year (approximately 3 m of storage)

Design Aspects

The following design criteria was used to design the emergency siphon system:

- Dam elevation: 974m
- Bottom of dam channel elevation: 970m
- Channel dimensions: 90 m long x 2.2 m wide
- Low water level: 968.8 m
- Low-low water level: 967 m
- Target flow rate: 400 – 550 L/S

The proposed siphon would consists of four (4) 300 mm diameter HDPE Dr_{11} siphon lines. The estimated length of each siphon is 250 m. The thicker Dr_{11} rating is intended to prevent the siphon line from collapsing in a vacuum as it will be largely unsupported while in operation. The HDPE Dr_{11} pipe is available in 15.2 m lengths, each length weighing about 920 lbs.

The staging area for accommodation (likely a small trailer or tent), porto potties, and eating areas would be on the north side of the outlet channel about 100 m up from the existing helicopter pads.

The staging area for equipment would be above the high water mark at the end of the North side of the channel at the outlet of the lake. There are no access roads to the site. All access will be by helicopter or by foot under bad weather conditions. The intake to the siphon would be anchored with a lock block near the siphon prime valve, and a fish screen. The estimated lake depth that the screen would be set at is 963 m, or 4 m below the low-low water level elevation of 967 m.

The discharge lines would be positioned approximately 50 m downstream of the dam. The difference in elevation between the lake water surface and the outlet discharge elevation is critical in establishing a minimum discharge flow rate. The proposed outlet discharge elevation is a minimum of 9 m below the lowest lake surface level (elevation of 960 m). Refer to Attachment A for the stamped engineered design drawings.

As of now, the current construction plan includes fusing the HDPE into 30.4 m lengths (2 pipes) and then each pipe length will be flown by helicopter and positioned in place for install. Each section of fused pipe (2 pipe lengths) will be fitted with a flange and the entire length of the siphon will be connected by these flanges. More details on the construction plan will be available during the week of August 17, 2015.

Reservoir information

Under the SCRD's conditional water licence for storing water on Chapman Lake (#C050724), the SCRD is permitted to store 907,000 m^3 of water, which equates to approximately 3m of total draw down. This request is proposing an additional 5m of drawdown (8m in total). Refer to Figure 1 for the map showing the bathymetry and key water levels.

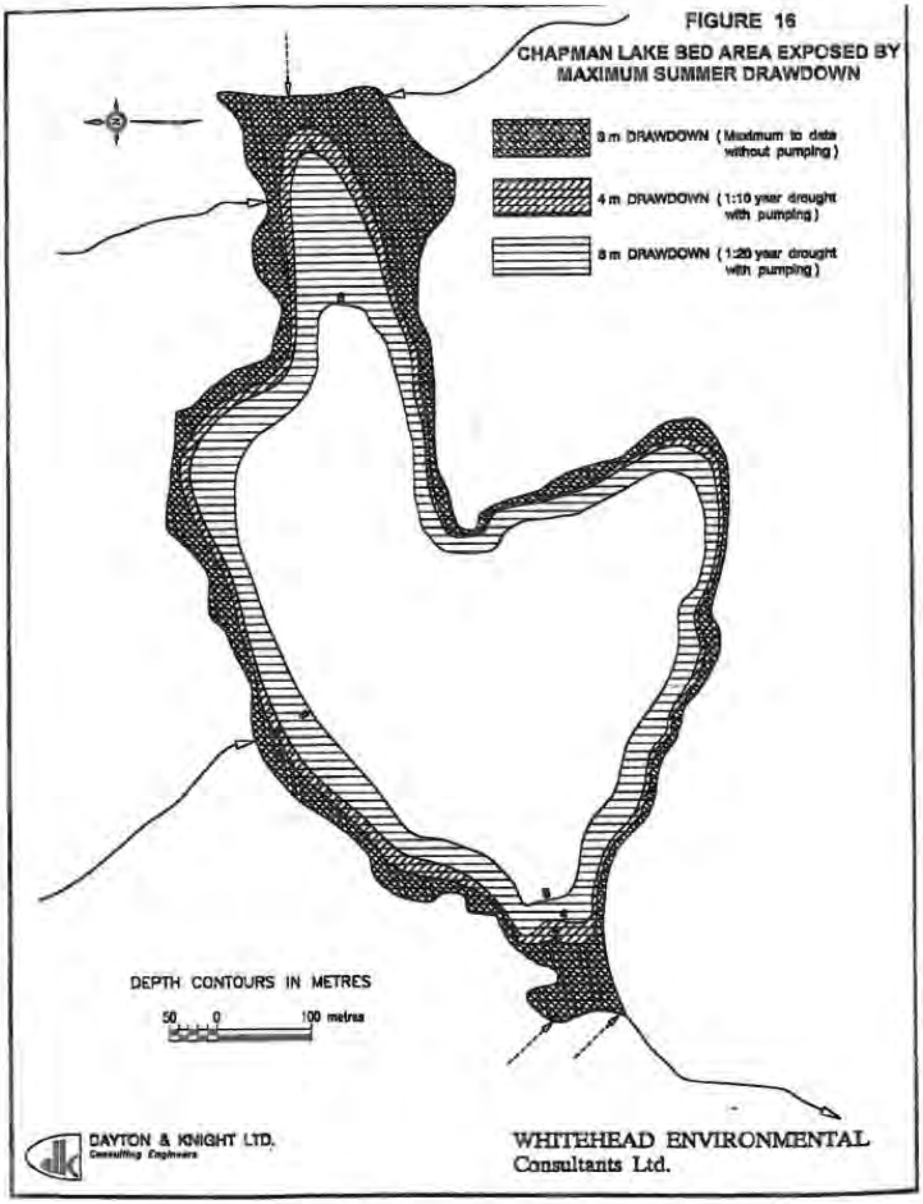


Figure 1. Chapman Lake bed area exposed by maximum drawdown (Referenced from "Impact Assessment – Sunshine Coast Proposed Water Storage Project (Floating Pump Station) on Chapman Lake in Tetrahedron Provincial Park" (1999))

Geotechnical Considerations

The watershed geology at higher elevation areas where the lakes are situated exhibits bedrock outcrops and mainly consist of glacial till, outwash and ice contact deposits, and post-glacial colluvium. Chapman Lake lies within an area of granitic rock of the late Jurassic and early crustaceous ages and is characterized by quartz diorite.

Seismic Considerations

There are no concerns with seismic activity from this proposal.

Project Related Considerations

Flooding – This proposal poses no risk to any flooding in the lake as the sole purpose of the siphon is to increase lake drawdown. There is also no risk to any flooding in the creek. The maximum flow rate from the proposed siphon system is 500 L/S and the creek is capable of withstanding flows higher than 10,000 L/S.

Erosion – There is no risk of erosion in the creek from the increased flows as the maximum flow from the proposed siphon is significantly less than typical peak flows. There is some risk of erosion from drawing down the lake and exposing the lake bed.

The exposed lake bed may be subject to erosion due to runoff and wave action. Runoff during heavy rainfall may result in some degree of erosion and transport of sediment into the water and this impact will be greatest immediately following the intense rains. However, the lake itself will act as a settling pond and is expected to naturally mitigate the potential for high levels of turbidity. Wave action can create turbulence that may re-suspend sediments, however, the impact of erosion from wave action is not considered significant (Whitehead, 1999).

Lands Related Issues

Chapman Lake is situated within the Tetrahedron Provincial Park, which is a Class A Provincial Park. The SCRD has a Land Use and Occupancy Park Use Permit (PUP) (102714) from the Ministry of Environment. Under the PUP, the permit area description includes the areas adjacent to the outlets of Chapman Lake and Edwards Lake in Tetrahedron Park (refer to Figure 2.).

Section 5 of the Special Provisions in the PUP reads:

- All activities relating to maintaining water impoundment structures and regulating water levels must be in accordance with the *Water Act*.

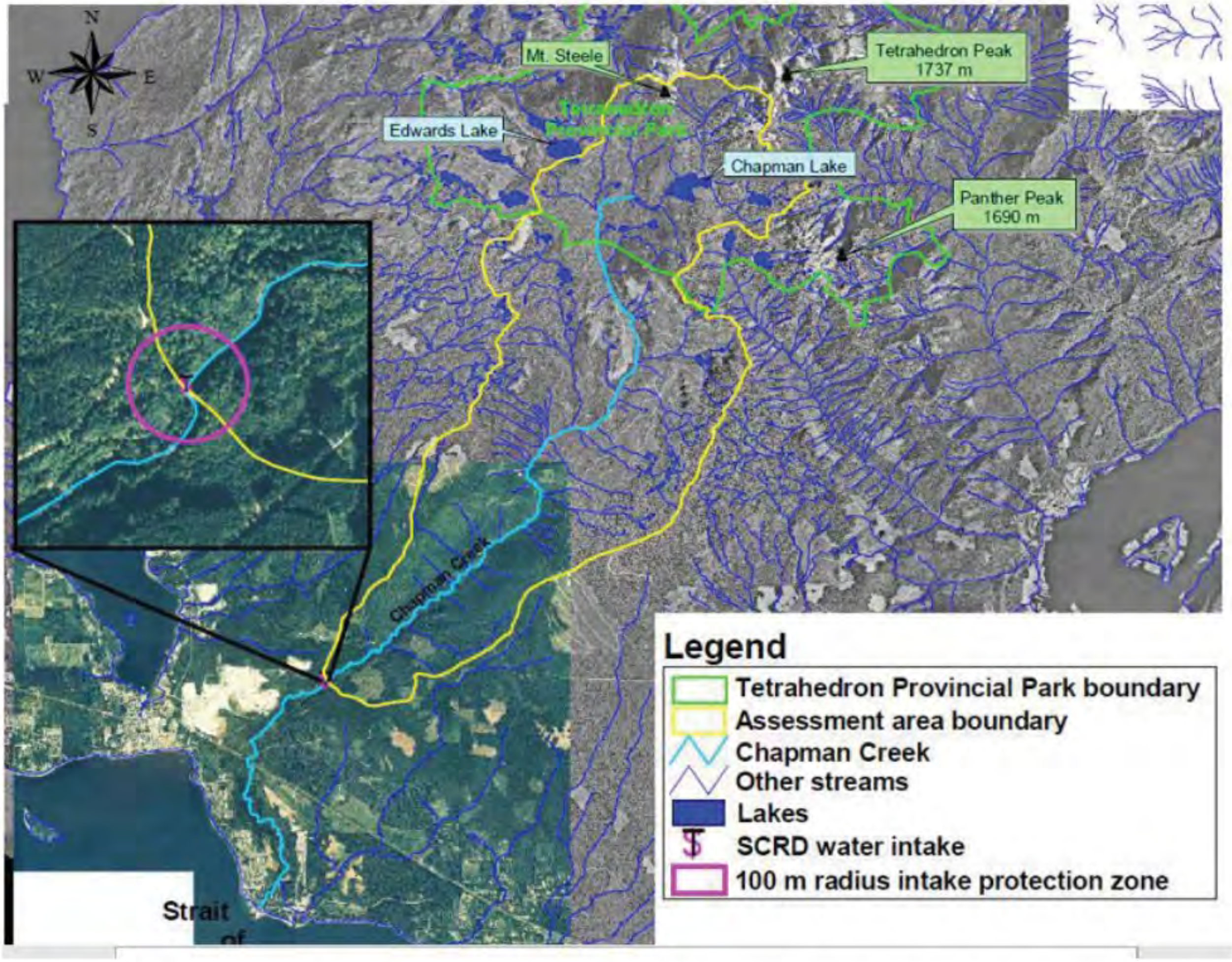


Figure 2. Delineation of the Chapman Creek drinking water watershed, including Chapman Lake and Edwards Lake, and the intake to the water treatment plant that supplies water to the Chapman Creek water system for area residents on the Sunshine Coast near Sechelt, BC

<u>Water Related Issues</u>

Water Quantity

Period of time:	The proposal is for 45 Days based on 1,000,000 m^3
Amount of water:	1,000,000 m^3

Climatic Information:

Sunshine Coast climate is characterized by cool and wet winters and warm and dry summers (Figure 3). The summer season is the critical time of year for water supply, as this is when water demand is highest and available water supply is most limited. Trends over the last 50 years are suggesting that summer temperatures are increasing (Figure 4) and total summer precipitation is decreasing (Figure 5).

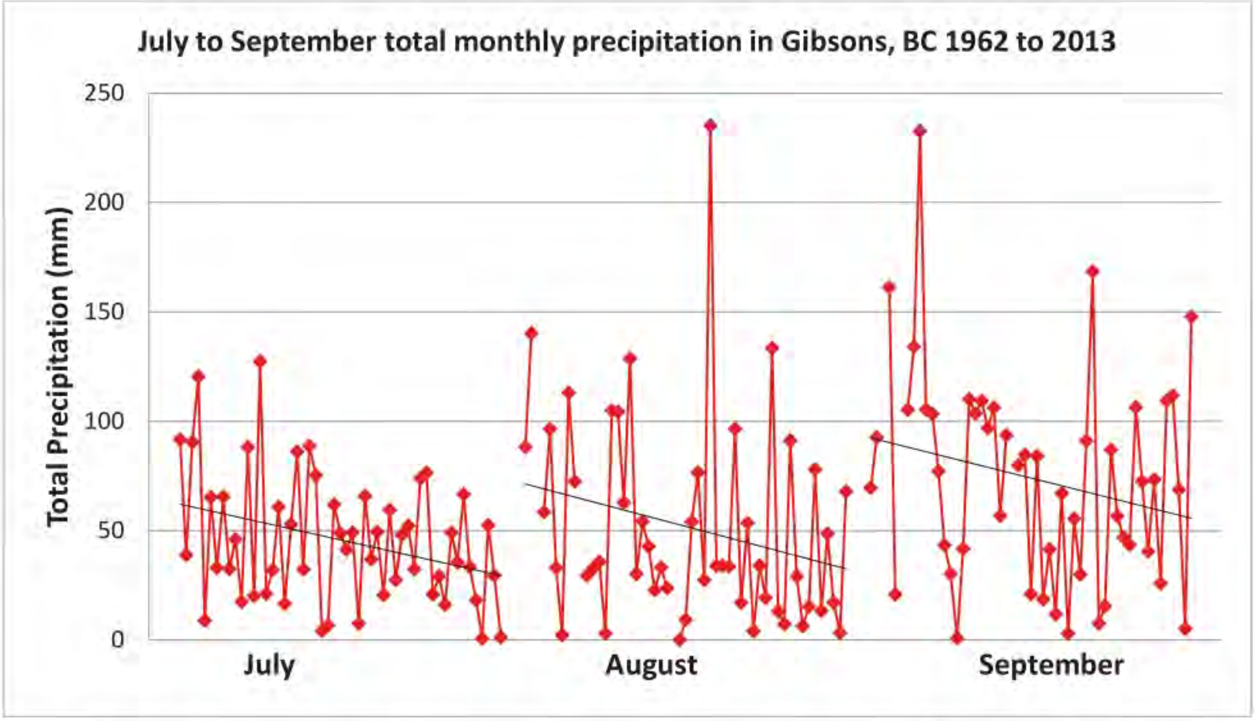


Figure 5: Historic monthly total monthly precipitation for July to October collected in Gibsons, BC from 1962 to 2013

Watershed Characteristics:

The Chapman Creek watershed area is approximately 65 km^2

Chapman Lake is 31.2 ha in size and Lake catchment area is 6.58 km^2

Sources into the reservoir:

The lake is fed by 2 main streams, both which enter at the east end of the basin.

Flow estimation methods:

Under natural conditions, the average outflow rate is approximately 500 L/S and the average retention time in the lake is 90 days (2006 Chapman Creek Source Assessment).

Outflow from the lake during the summer months are controlled when lake levels are below the top of the existing weir. Typically, controlled flows from the lake range from 100 L/S to 350 L/S. Measuring flows through the weir are performed by measuring pressure and flow in the outflow pipe.

The estimated flows under the proposed siphon system will range between 440 L/S and 500 L/S, which is based on the elevation at the intake and the outflow.

Hydrographs (mean annual discharge, maximum and minimum values)

The streamflow regime in Chapman Creek is defined as a hybrid regime, which is characterized by a winter freshet influenced by winter rain and a spring freshet influenced by spring snowmelt (Figure 6). Annual discharge patterns in Chapman Creek can act as an indicator for water supply for the Chapman

Instream flow requirements

For most of the year (typically October to June) instream flows in Chapman Creek occur under natural conditions. During the summer months (typically July to September), instream flows in Chapman Creek are regulated through impoundment structures on Chapman and Edwards Lakes. During this period when flows are regulated, the SCRD has targeted instream flows of 200 to 220 L/S.

Fish values

Chapman Creek is a salmon bearing creek with populations of Coho, Chum, and Pink salmon. Populations of rainbow and cutthroat trout and steelhead are also present in Chapman Creek. A salmon hatchery also exists on the creek where populations of Coho salmon are raised.

For most years, the timing of instream flow requirements to support Coho and Chum salmon coincide with the fall rains as salmon runs for both of these salmon species peak in October and November. Pink salmon tend to start their run in August and September. In years where water supplies are limited and at risk of becoming fully depleted, such as this year, the minimum instream flows are targeted in order to prolong the available water supply for as long as possible.

Recreation Use

Recreational fishing and hiking occurs on Chapman Creek during all periods of the year.

Cultural Use

The Sechelt Indian Band (SIB) has designated the Chapman Creek watershed as a *Conservation Area* in their Strategic Land Use Plan (SLUP), 2007. The management direction for conservation areas outlined in the SIB's SLUP includes:

- Maintaining and where necessary restoring the area to largely natural or wilderness condition for the enjoyment of present and future generations.
- Providing for the continuation of *shishálh* culture, subsistence and renewable resource harvesting activities
- Enabling non-industrial, sustainable economic development activity compatible with the *shishálh* Nation social, cultural, and ceremonial uses and where appropriate to the zoning and management directions for each of the *shishálh lil xemit tems swiya* areas.

Affected Water Users

Other water users that may be affected by this proposal include the Chapman Creek Fish Hatchery (Sunshine Coast Salmonid Enhancement Society). This hatchery relies on flows in Chapman Creek in order to operate their hatchery and raise their salmon stocks. With the installation of the proposed siphon, current target flows instream Chapman will remain if the period of drought continues.

Construction Activities

The SCRD is working on completing the installation of the proposed siphon system within the first week of September under the following schedule.

- Week of August 17 – Starting to Procuring the materials and arranging for equipment

- Week of August 24 – Receiving materials and equipment and preparing the material for transport at a staging area near the helicopter hanger (e.g. at a chosen area when the pipes can be fused together and then easily transported to an area where the helicopter can pick them up and deliver them to Chapman Lake).
- Week of August 31 – Transport the materials and equipment to Chapman Lake by helicopter and begin installing the infrastructure
- Week of September 7 – Commission the Siphon system as a trial to ensure it's fully operational when it's needed.

Safety Aspects

This proposal poses no risk to any flooding in the lake as the sole purpose is to increase drawdown. There is also no risk to any flooding in the creek. The maximum flow rate from the proposed siphon system is 500 L/S and the creek is capable of withstanding flows higher than 10,000 L/S.

Future Monitoring

The SCRD will continue to record and monitor streamflows and all water quality parameters at the SCRD's water treatment plant (e.g. turbidity, temperature, pH, conductivity, and colour).

s.16

Environmental Monitoring

An environmental monitoring program will be designed to ensure that environmental impacts are mitigated. This program will be designed and implemented under the direction of a fisheries biologist (Dave Bates) and with support from qualified SCRD staff. Under this EM program, water quality will be recorded on a daily basis at either the SCRD's water treatment plant and/or at specific locations in Chapman Creek and Chapman Lake. A qualified EM will visit the lake at least once week and will proceed to the lake immediately if there are any unforeseen concerns with environmental values.

An emergency response plan will be designed to prevent and mitigate impacts from hydrocarbons (e.g. fuel from the jet pump for priming siphons). This will include designating a zone for use of the pump with containment requirements for equipment and spill kits on site.

Remaining Environmental Concerns

The impacts to wildlife will be mitigated whenever possible. This will include implementing a strict waste management plan, whereby no food waste or any other waste that may attract wildlife will be minimized and contained wherever possible.

Summary and Conclusions

The lake storage reservoirs for the Chapman Creek water system, which supplies approximately 90% of the population within the Regional Water System on the Sunshine Coast (23,000 people), are at risk of becoming fully depleted as a result of the prolonged hot and dry weather experienced so far this year (2015). Maintaining water to area residents will require accessing more water than is currently available under the existing infrastructure at Chapman Lake. The SCRD is proposing to install a siphon into Chapman Lake to access 1,000,000 m^3 (5 m of additional drawdown) to increase water supply for at least another 45 days.

s.16

The SCRD is also in consultation with BC Parks because the proposed siphon will be installed within the Tetrahedron Provincial Park boundary.

Ideally, the siphon system will be installed and commissioned by the first week of September, 2015. Once in operation, ongoing environmental monitoring and archeological assessments will be underway.

The infrastructure will remain in place for a period of 24 months, as per Section 8 of the *Water Act.*

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Canada V0N 3A1

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F 604.885.7909
Toll free 1.800.687.5753

info@scrd.ca
www.scrd.ca

February 15, 2016

Ministry of Environment
PASB – Park Use Permits
PO Box 9371 Stn Prov Govt
Victoria, BC V8W 9M3
Fax: 250-387-1695

Re: Annual Reporting for Park Use Permit # 102714 (2015)

As a requirement of the Sunshine Coast Regional Districts Park Use Permit (#102714), please see the enclosed Park Use Activity Report for a summary of activities in 2015.

The number of trips to Chapman and Edwards Lakes was higher than in previous years due to small capital projects and the severe drought conditions experienced on the Sunshine Coast this past summer. An amendment to the existing permit was approved (August, 2015) to temporarily increase the Chapman Lake Permit area to install an emergency siphon. Other works included an upgrade of an existing helipad to improve structural stability and the Edwards Lake control upgrade.

If you have any questions in regards to the information provided the attached report, please contact the undersigned.

Yours Truly,

SUNSHINE COAST REGIONAL DISTRICT

Beth Brooks
Environmental Technician, Infrastructure Services
604-885-6800

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Sechelt, British Columbia
Canada V0N 3A1

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Sunshine Coast Regional District - Tetrahedron Park Use Activity Report

Prepared by: Beth Brooks

Year: 2015

Permit no.: 102714

Transportation: Airspan Helicopters

Date	Flight Hours	Location	Activities
12/3/2015	1.0	Chapman Lake, Edwards Lake	Repeater sites check
4/30/2015	1.0	Chapman Lake, McNair Lake/cabin	Snow survey locates, potential weather station sites
5/21/2015	1.0	Chapman Lake, Edwards Lake	Lake control upgrade
6/1/2015	1.2	Chapman Lake, Edwards Lake	Snow course prep
6/1/2015	1.2	Chapman Lake	Helipad upgrade (WO 23904)
6/8/2015	1.0	Chapman Lake	Helipad upgrade
6/8/2015	0.6	Chapman Lake	Helipad upgrade - sling load
6/8/2015	1.0	Chapman Lake, Mount Steele, McNair cabin	Finalize weather station location (w/ Rod Dalziel, Bill Floyd)
6/9/2015	0.4	Chapman Lake	Helipad upgrade
6/9/2015	1.0	Chapman Lake	Helipad upgrade - sling load
6/10/2015	0.4	Chapman Lake	Helipad upgrade
6/15/2015	1.4	Edwards Lake	Lake control upgrade
6/22/2015	1.0	Chapman Lake, Edwards Lake	Lake control upgrade
7/13/2015	1.0	Edwards Lake	Lake control upgrade
7/20/2015	0.8	Edwards Lake	Lake control upgrade
7/21/2015	0.9	Edwards Lake, Chapman Lake	Lake control upgrade
8/7/2015	0.7	Edwards Lake, Chapman Lake	Lake control upgrade
8/12/2015	0.6	Chapman Lake, Edwards Lake	Siphon install planning
8/17/2015	0.7	Chapman Lake, Edwards Lake	Siphon install planning
8/20/2015	0.7	Chapman Lake, Edwards Lake	Siphon install, lake controls check
8/25/2016	1.1	Edwards Lake	Lake control upgrade
8/26/2015	0.8	Edwards Lake	Lake control upgrade
8/27/2015	0.5	Edwards Lake, Chapman Lake	Lake control upgrade
10/23/2015	0.5	Chapman Lake	Weather station location archeology assessment
10/27/2015	0.6	Edwards Lake, Chapman Lake	Survey work review
11/5/2015	0.8	Chapman Lake	Works planning

Sunshine Coast Regional District

Chapman Lake Water Supply Expansion Project Environmental Assessment

Prepared by:
-AECOM
3292 Production Way, Floor 4
Burnaby, BC, Canada V5A 4R4
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604 444 6400 tel
604 294 8597 fax

November, 2016

Project Number: 60485918

Distribution List

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Revision History

Revision #	Date	Revised By:	Revision Description

AECOM: 2015-04-13

Statement of Qualifications and Limitations

The attached Report (the "Report") has been prepared by AECOM Canada Ltd. ("AECOM") for the benefit of the Client ("Client") in accordance with the agreement between AECOM and Client, including the scope of work detailed therein (the "Agreement").

The information, data, recommendations and conclusions contained in the Report (collectively, the "Information"):

- is subject to the scope, schedule, and other constraints and limitations in the Agreement and the qualifications contained in the Report (the "Limitations");
- represents AECOM's professional judgement in light of the Limitations and industry standards for the preparation of similar reports;
- may be based on information provided to AECOM which has not been independently verified;
- has not been updated since the date of issuance of the Report and its accuracy is limited to the time period and circumstances in which it was collected, processed, made or issued;
- must be read as a whole and sections thereof should not be read out of such context;
- was prepared for the specific purposes described in the Report and the Agreement; and
- in the case of subsurface, environmental or geotechnical conditions, may be based on limited testing and on the assumption that such conditions are uniform and not variable either geographically or over time.

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This Statement of Qualifications and Limitations is attached to and forms part of the Report and any use of the Report is subject to the terms hereof.

AECOM: 2015-04-13

Quality Information

Report Prepared By:

Melissa Mukai

Melissa Mukai, RP. Bio, P. Bio, EP. Bio
Aquatic Biologist

Report Prepared By:

Keith Bell

Keith Bell, RPF
Senior Ecologist

Bruce A Ford.

Bruce Ford, MRM, RP. Bio
Senior Environmental Biologist

Report Reviewed By:

Brett deWynter, P. Eng.
Project Manager

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Figures

Tables

Executive Summary

The SCRD's Chapman Water System supplies potable water to approximately 10,000 Sunshine Coast service connections between Gibsons and Secret Cove with the main source being Chapman Creek and includes two headwater alpine lake reservoirs. The primary reservoir is Chapman Lake with a concrete dam and valve located on the outlet which is operated remotely by the SCRD to control releases into Chapman Creek. The existing dam on Chapman Lake is three metres high fitted with a sluice gate at the bottom of the structure. The amount of water that can be released annually from Chapman Lake is currently limited by the water licence to 906,600 m^3, however, the current estimates indicate that the amount of water actually available is slightly less at 905,000 m^3. The current maximum drawdown of Chapman Lake is 3.0 m and during a typical year, water stored behind the dam is allowed to overflow naturally until the water level drops below the dam crest and which point the SCRD begins to manage the release from the sluice gate. A portion of the total flow released from Chapman is conveyed down Chapman Creek to the point of diversion for the SCRD water treatment plant. In addition to the flow diverted for the drinking water needs of the community, a minimum additional flow of 0.2 m^3/s is released to accommodate the hatchery and the in-stream requirements for fish. The SCRD also manages the water demand through restrictions that are brought into effect in summer months. The current water control structures are permitted under an existing BC Park Use Permit and various Water Licences.

The Chapman Lake Supply Expansion Project is designed to access additional water from Chapman Lake for release into Chapman Creek during times of drought. The infrastructure required includes a gravity fed system with a 190-m long, 900-mm diameter pipe buried beneath the existing outlet channel. The intake for the pipe would have an invert elevation of 965.1 m which would allow access to an additional 1 million m^3 of water. In September 2015 the SCRD Board adopted a resolution that in part stated that this new infrastructure would "only be utilized during periods of drought and until the long term source development projects specified in the SCRD's Comprehensive Regional Water Plan are constructed".

In August 2016 a field campaign was conducted to augment the environmental assessment study done in 1998 (Whitehead 1999) to complete an environmental assessment for the project. Findings from 2016 included:

- Rock samples from the area of the existing dam were collected and submitted for geochemical analysis. The results from the samples indicate that the rock is not acid generating.
- Additional fish sampling support the findings in the Whitehead (1999) report, only Dolly Varden Char (DV) were caught and all but one large fish were similar in size to the fish caught by Whitehead. Also the gill netting catch per unit effort was very similar between the 2 studies. Note, we have confirmed that fish samples from the 1998 study were sent to BC MOE for analysis and they were confirmed to be DV (Dave Bates, pers. Comm.). EVS (1999) reported that Chapman Lake may have historically supported cutthroat trout but suggests that rainbow trout were stocked into the lake before the province maintained stocking records and they may have out-competed the cutthroat trout. The report also suggests that the DV may be a result of fish stocking. We could find no information to substantiate these suggestions. Overall conclusion is that Chapman Lake supports a mono culture of Dolly Varden Char.
- Fish sampling indicates that juvenile rearing takes place in tributary streams and young of the year do not enter the lake. The tributary that flows into the lake from the north into the east end of the lake appears to be the most productive stream for spawning DV. The other large stream at the east end of the lake (flowing in from the south, yielded no juvenile DV during sampling. The small stream channels such as the one near the helipad at the west end of the lake also appear to be spawning and nursery areas for DV.

- Water samples were submitted to a lab for analysis of standard parameters. The only parameter that exceeded Canadian Council of Ministers of the Environment (CCME) was total aluminum reported at 0.111 mg/L just above the criteria of 0.1 mg/L. Water chemistry and other parameters (i.e. secchi reading) indicates the lake is oligotrophic (low productivity), which is expected for this high elevation lake.
- Whitehead (1999) commented on a rotten egg smell emanating from the mud substrate suggesting the presence of hydrogen sulfide. We analyzed water samples for hydrogen sulfide and the results indicate that H_2S levels in the lake are below detection.
- All water samples analyzed for total mercury were below the detection limit of 0.005 micrograms/L (parts per billion).
- 2016 temperature and dissolved oxygen profiles of the Chapman Lake water column were very similar to the 1998 data.
- Muscle tissue from 5 fish were analyzed for total mercury and results ranged from 0.029 to 0.184 mg/Kg wet weight. This compares to the BC Tissue Residue Guidelines to Protect Wildlife from Mercury Toxicity, which is 0.033 mg/kg wet weight for methyl-mercury. The majority of the mercury in fish tissue would be in the form of methyl-mercury. This is provided as a measure of current conditions for comparison with future samples.
- The field program collected data on vegetation and ecological communities to complete Terrestrial Ecosystem Mapping for the area within 500 m of the lakeshore.
- Plant surveys in August did not identify any rare plants within the proposed construction area.
- Opportunistic observations of wetland areas and creeks did not reveal any SARA listed amphibians that could be present including the western toad or the coastal tailed frog.

A summary of the project effects, mitigation measures and determination of residual impacts of the project were completed in order to assess the construction and operational impacts for the project. The assessment focused on seven environmental and social aspects associated with the construction and operation of the new system. The following table provides a summary of the findings. The construction phase will employ standard construction techniques for which there are mitigation measures that are effective for containing and managing the effects of earth moving, blasting and other general requirements (fuel handling, waste management, etc.). Because this work is being carried out in a provincial park environment the residual effects of some construction activities have been rated moderate but the effects are only present during construction and will revert to pre-construction conditions once construction is finished. A site remediation plan will be developed to return all disturbed areas to pre-construction conditions and the remediation work will be monitored to track the effectiveness of the work and, if necessary, identify additional work that might be required to achieve proper restoration.

The operational phase will result in increased drawdown of the lake during summer drought conditions with the main issue being the frequency that the lake will be drawn down below the current maximum of 3 m. Studies in 2013 indicated that the SCRD would require storage of 2,090,000 m^3 to meet water demand for the projected population in 2036 during a 1 in 25 year drought. This exceeds the existing combined storage capacity of Edwards and Chapman Lake by 394,000 m^3 and would require drawing Chapman Lake down to approximately -4.5 m. Recent climate change modelling conducted by Metro Vancouver for the lower mainland suggests that annual precipitation will increase by the 2050s but the summer months through September will experience an average reduction in precipitation of 19% and May snow packs could diminish by 50%. This combination will change the summer hydrology of the Chapman Lake watershed and likely cause the current 1:25 year drought conditions to occur more frequently by the 2050s, however the SCRD is planning on developing alternative water sources to augment the Chapman system well before 2050.

In a more immediate time frame, the existing storage capacity of the Edwards and Chapman Lakes system is still not sufficient to meet current water demand under drought conditions. The 2013 analysis suggests that current storage could satisfy a 1 in 21 year drought event. This is due to the required water release to maintain the environmental base flow and the per capita demand for water in the Chapman System. The SCRD is taking steps to reduce the per capita demand through the installation of water meters and a more rigorous application of the drought management plan (i.e. water use restrictions). There is also anecdotal information that suggests that the 2015 drought could be in the order of a 1 in 100 year drought, however this result was based on an analysis of the 2015 conditions on St Mary's Lake on Salt Spring Island which typically experiences dry summer conditions. In the near term, the combination of water demand management and potential severity of the 2015 drought suggest that drawing Chapman Lake down below -3 m will be an infrequent event and a full draw down of 8 m would only occur under the most extreme drought conditions. The expected drawdown of Chapman Lake to meet severe drought conditions is between 4 and 5 m.

The residual impacts of the operation of the proposed system and drawing the lake down by a full 8 m has been rated as negligible or low, primarily because it is expected to occur infrequently and the lake would refill within a short time once the fall rains begin. Also, there should be several years between drought conditions that will allow recovery from any detrimental effects caused by significant drawdown below -3 m. However, monitoring of biophysical parameters in and around Chapman Lake during periods of draw down below -3 m is recommended to confirm the assessment of the effects presented here.

Project Effects, Proposed Mitigation Residual Effect and Assessment of the Proposed SCRD Water Project

Component	Mitigation Measures	Residual Effect	Magnitude	Geographic Extent	Temporal Bound	Overall Impact
Geophysical: Blasting	Blasting plan to be developed by a certified blaster Limit blasting overpressures to a maximum of 133 dB (follow DFO guidelines http://www.dfo-mpo.gc.ca/pnw-ppe/measures-mesures/index-eng.html)	Construction: Vibration and Noise	L	L	L	Low
		Operation: No residual effect	-	-	-	-
Air Quality	Use well maintained equipment Apply dust suppression when required On site fuel containers to be have proper caps and to be covered Minimize helicopter flights to the area	Construction: Degraded air quality from heavy equipment, helicopter use and dust	L	M	Low	Low
	Monitor effects during drawdown	Operation: Increase of dust from lake drying	L	L	L	Negligible
Noise	Typical mitigation measures may not be practical due to the need to complete the work within a defined period. Use proper and well maintained equipment Minimize flights required to the area Work outside of sensitive breeding windows Avoid areas with species sensitive to noise Early and late day work to be avoided Some mitigation measures may not be practical	Construction: noise from blasting, helicopter and construction equipment	M	M	L	Medium
		Operation: No residual effect	-	-	-	-
Terrestrial Resources	Develop a vegetation remediation plan Proper camp design and set up Erosion and sediment control plan Fence off the work and laydown areas Ensure appropriate construction timing to avoid wildlife breeding season or conduct appropriate surveys prior to clearing (i.e. birds and amphibians) Proper management of potential wildlife attractants	Construction: Temporary loss of vegetation/wildlife habitat and change in biodiversity, camp wildlife attractant, disruption of wildlife, Draw down effects on wildlife such as amphibians	L	M	L	Medium

Component	Mitigation Measures	Residual Effect	Magnitude	Geographic Extent	Temporal Bound	Overall Impact
		Operation: Potential effect on amphibians from lowered water levels in wetlands	L	M	L	Low
Aquatic Resources	Emergency spill response plan/spill cleanup equipment and properly trained staff Installation of sediment and erosion control measures Installation of intake pipe in the dry Salvage fish from any areas where water is cut-off from the lake and will be dewatered	Construction: Release of sediment or other deleterious substances, resuspension of sediment, contamination with wastes. Potential restriction of access to spawning areas	M	M	L	Medium
	Water demand reduction programs (e.g. metering) Infrequent drawdown below -3 m Maintain current water release requirements to maintain fish habitat downstream during low water Provide sufficient plunge pool at base of dam to avoid harm to fish going over the dam and dropping 8 m	Operation: Instability of shoreline or creek mouths causing sedimentation and erosion, Changes in lake dynamics including temperature profiles Drying of exposed shoreline below -3 m and associated changes to lake side and aquatic vegetation. Downstream effects unchanged Temporary restriction of access to spawning areas for Dolly Varden	M	M	L	Low
Socio-Community: Recreation	See air quality and noise for mitigation Installation of information signage Screening of construction areas Minimize duration of construction	Construction: Reduced quality of recreational experience due to equipment noise and other activities related to construction	L	L	L	L
	Infrequent drawdown of lake below -3 m	Operation: Altered viewscapes leading to diminished quality of recreational experience	L	L	L	Low
Heritage Resources	Confine work areas to sites disturbed during the original dam and channel construction in 1978 Monitor for artifacts of archaeological significance during excavation Conduct archaeological survey of shoreline when draw down for construction is at its lowest level	Preliminary field reconnaissance did not identify a significant potential for archaeological resources to be present in the construction area	-	-	-	-

1. Introduction

The Sunshine Coast Regional District (SCRD) operates a number of water distribution facilities within its jurisdiction between Egmont and Langdale. One of the systems, the Regional Water Service Area, supplies 90% of the Sunshine Coast residents with Chapman Creek being the main source of water. The Chapman Creek system includes two headwater lakes which are managed to provide water during low flow summer conditions. The SCRD has installed outlet structures on both lakes to control the release of water.

Chapman Lake and the upper Chapman Creek watershed are located in Tetrahedron Provincial Park a Class A park which is protected under the Park Act and subject to conditions of the park's management plan (MELP 1997). The lake is also in the shíshálh Nation territory (formerly Sechelt Indian Band).The SCRD license for water storage in Chapman Lake pre-dates the creation of Tetrahedron Provincial Park, and once the park was established, the park management plan (BC Parks 1997) included the continued use of the lake as a community water supply for the SCRD. The current water control structures are permitted under an existing Park Use Permit and Water Licences. There is also a temporary Park Use Permit and temporary short-term Water Use Permit in place for a temporary syphon system (both of which expire in August 2017).

In 2013 the SCRD Board approved a Comprehensive Regional Water Plan (CRWP) that was developed by Opus Dayton Knight (2013). The CRWP identified that under current conditions the Chapman Creek system did not have the capacity to provide water during drought conditions. The CRWP made recommendations for both short term water supply requirements and options for longer term needs to meet projected population growth and water demand in 2036. The short term plan recommended accessing additional water from Chapman Lake to mitigate the risk of water shortages during drought conditions. The plan recommended establishing a floating pump or alternative design on Chapman Lake to draw water into Chapman Creek. The CRWP was made available to the public and was the subject of public consultation before it was approved by the SCRD Board in 2013.

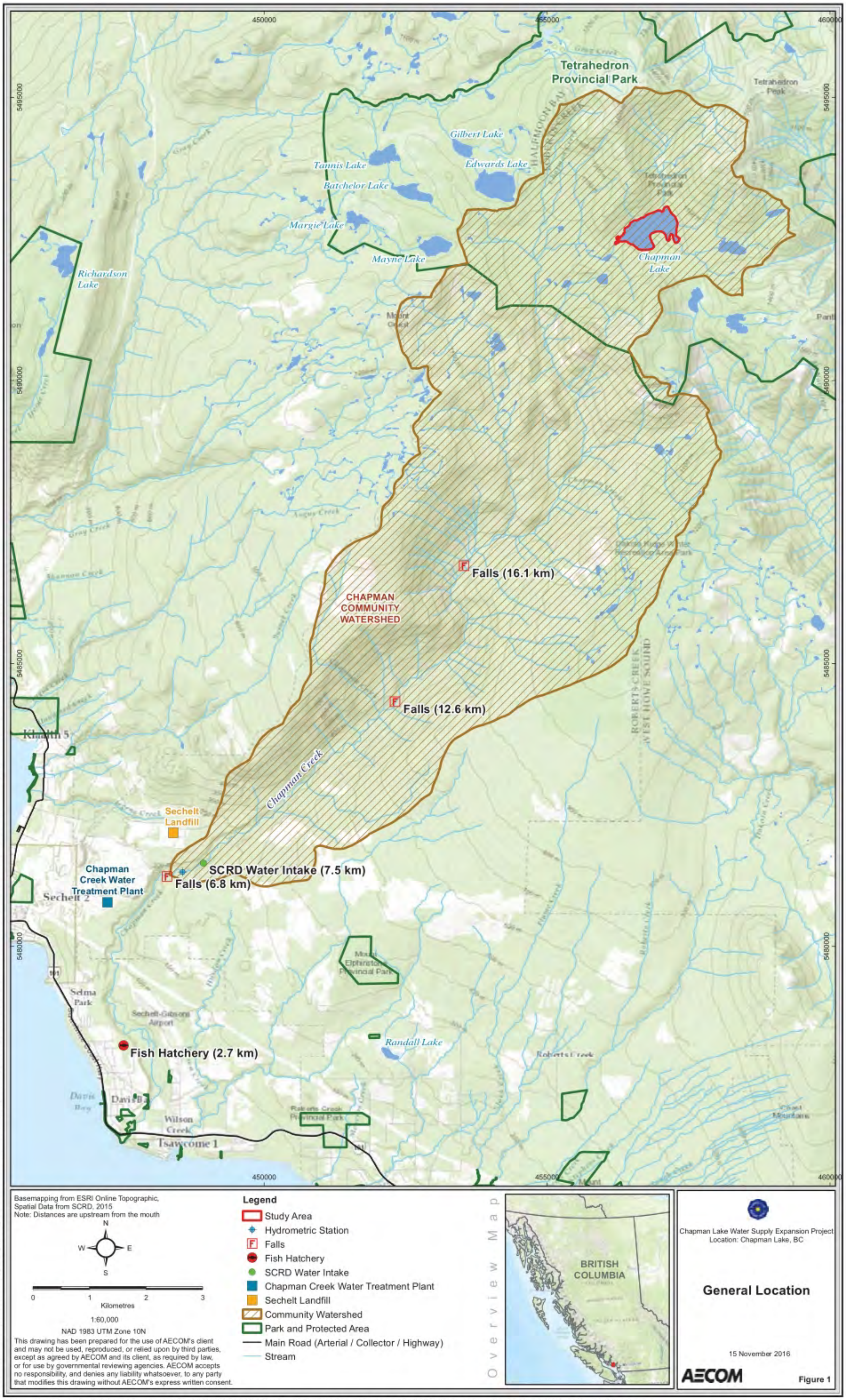
In 2015 much of BC including the Sunshine Coast experienced a series of record conditions (low snow pack, low rainfall and high temperatures) resulting in a severe shortage of water in Chapman Creek with Chapman Lake coming within a few days of running out of accessible water. The exceptional circumstances of the summer of 2015 resulted in the SCRD imposing Stage 4 water restrictions in the area serviced by the Chapman water system. To alleviate the acute water shortage, the SCRD was granted approval for Short Term Use of Water by the Province, permitting a maximum diversion of an additional 1.0 million m^3 of water from the Chapman Lake by installing a series of pipes that would syphon water out of the lake. However, water restrictions were lifted in early September after 4.5 days of rain refilled Chapman Lake. Given this experience the SCRD Board decided to implement the plan approved in its 2013 CRWP and install a permanent gravity fed system that would be capable of accessing an additional 1 million m^3 of water from Chapman Lake. The following resolution adopted by the SCRD Board at its September 10, 2015 meeting implementing a revised Drought Mitigation Option:

> THAT the General Manager Infrastructure Services' report dated August 25, 2015 titled Drought Mitigation Options be received;
>
> AND THAT the SCRD move forward with the design and approval process for the Deepen Channel option, recognizing that the system will only be utilized during periods of drought and until the long term source development projects specified in the Comprehensive Regional Water Plan are constructed;

> AND FURTHER THAT the design, engineering and environmental impact assessment of the Deepen Channel option be presented to the Board for consideration.

The Board committed to use the additional water from Chapman Lake only during periods of drought and not to meet long term demand. Other solutions would be investigated to meet the water demand for the growing population on the Sunshine Coast.

AECOM Canada Ltd. was hired by the SCRD to complete the engineering, public consultation, and environmental assessment work associated with the implementation of the Project. This report is provided to support the permitting process that is required to obtain approval from the provincial government, specifically for an amendment to the SCRD's Park Use Permit, and a water licence under the Water Sustainability Act.



Basemapping from ESRI Online Topographic,
Spatial Data from SCRD, 2015
Note: Distances are upstream from the mouth

1:60,000

NAD 1983 UTM Zone 10N

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Chapman Lake Water Supply Expansion Project
Location: Chapman Lake, BC

General Location

15 November 2016

Figure 1

File Location: P:\60485918\900-Work\920-929 (GIS)\02_Maps\2016-04-11-GeneralLocation\Figx-2016-04-12-GeneralLocation-60485918-003.mxd Date Revised: November 15, 2016 Reviewed By: Paper Size: 11"x17" Scale is referenced to the specified paper size.

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1.1 Regulatory Requirements

The Sunshine Coast Regional District has had a Park Use Permit in place since the park was created in 1995 that allows the SCRD to occupy and use areas at the outlet of Chapman and Edwards Lakes for the purpose of managing the drinking water supply for the Sunshine Coast. The current Park Use Permit for Chapman Lake (No. 102714) was issued on February 1, 2014 for a period of 10 years. However, in order to construct the new infrastructure and manage additional drawdown of Chapman Lake an amendment to the existing Park Use Permit will be required. In April 2016 the SCRD filed an application to amend the permit. In June 2016 BC Parks provided the SCRD with a review of the materials submitted and requested additional data be collected and summarized to facilitate the assessment of the application. Additional information requested required the SCRD to confirm and update the data collected in 1998 and presented in the report "*Impact Assessment. Sunshine Coast's Proposed Water Storage Project (Floating Pump Station) on Chapman Lake, in Tetrahedron Provincial Park*" (Whitehead 1999). The proposal to withdraw additional water from Chapman Lake was originally approved in 1999 but was not proceeded with by the SCRD Board at the time but has been resurrected and approved by the current Board to address the shortfall in the Chapman System to supply adequate water during drought conditions as predicted by studies (Opus DaytonKnight 2013) and experience during the summer of 2015. The Park Use Permit application requires that an environmental assessment (EA) report be prepared and consultation be carried out.

The SCRD will also require licences and approvals under the Water Sustainability Act (WSA). The approval to make changes in and about a stream will be required for the works required to install the gravity system and any other associated works in Chapman Lake or immediately downstream in Chapman Creek. A new water licence will be required to withdraw the additional 1 million m^3 of water out of Chapman Lake. This EA will also be used as part of the application for the WSA approval and in partial fulfillment of the water licence application which requires an assessment of environmental flow needs to ensure aquatic resources are not put at risk. This report includes discussion of the effects of additional water withdrawal from Chapman Lake and any alterations to flows in Chapman Creek immediately downstream of the lake. The SCRD has undertaken studies of the lower or anadromous section of Chapman Creek to determine the minimum flow requirements for fish that utilize that section of the creek which will be summarized in Section 5.3.

1.2 Watershed Administration

The Chapman Creek watershed intersects with the Coast Forest Region and the Sunshine Coast Forest District, the Sunshine Coast Timber Supply Area, and Tree Farm Licence Area 39 (MOF 2005 in Triton 2006). The majority of Chapman Creek watershed is designated as a Community Watershed under the Forest and Range Practices Act. As the primary source for drinking water on the Sunshine Coast, the Vancouver Coastal Health Authority is responsible for ensuring that the relevant portions of the provincial Health Act and the Drinking Water Protection Act are applied to the watershed.

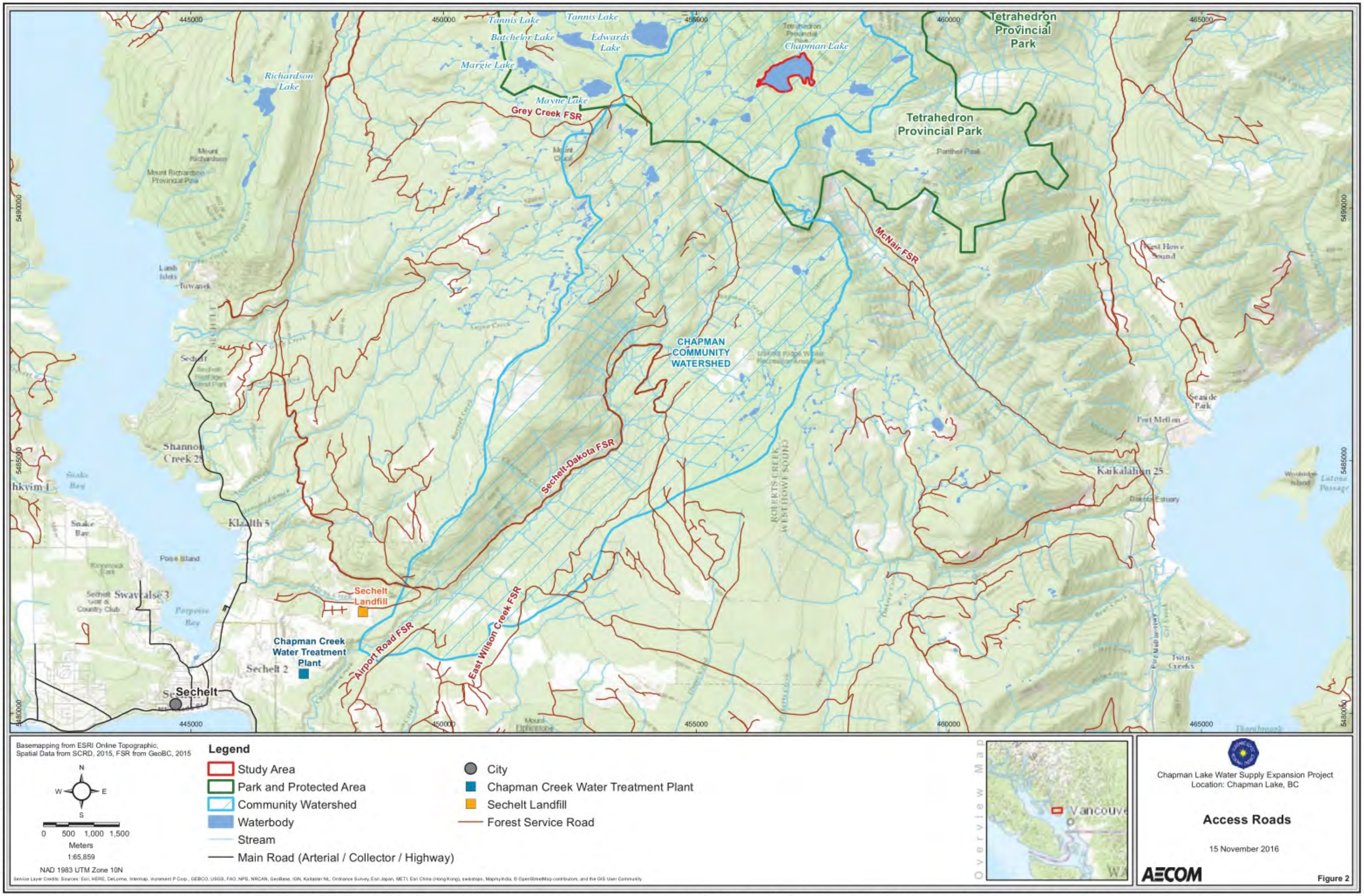
The portions of the watershed above 800 m elevation are located within Tetrahedron Provincial Park (Figure 1). The middle portions of the watershed are mostly provincial Crown land. The lower portions of the watershed above the SCRD water intake are also mainly Crown land, with five private legal parcels (District Lot 2461, 2463, 2462, 7613 and 3374).

The watershed is also located within the Chapman Landscape Unit, which is managed under the Chapman Landscape Unit Plan (MSRM 2002 in Triton 2006). This plan specifies Old Growth Management Areas (OGMA) in which timber harvesting and road construction cannot occur unless no other practicable options exist, in which case there is a provision for replacement of these areas. There are at least seven OGMAs within the assessment area.

1.3 Access Description

The main access points into the lower watershed include the Sechelt-Dakota FSR, the Airport Road FSR and the East Wilson Creek FSR (Figure 2). Access roads within the watershed are gravel and vary in width (1 or 2 lanes) and accessibility. Since 2001 a number of access roads in the lower and mid-portions of the watershed have been deactivated and rehabilitated.

Access to the lakes and cabins in the upper watershed in Tetrahedron Provincial Park is by foot from trail heads accessed via West Main Road to Gray Creek Mainline, which is located within the Gray Creek watershed and from the east along the McNair FSR.



Basemapping from ESRI Online Topographic,
Spatial Data from SCRD, 2015, FSR from GeoBC, 2015

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Chapman Lake Water Supply Expansion Project
Location: Chapman Lake, BC

Access Roads

15 November 2016

AECOM

Figure 2

File Location: P:\60485918\900-Work\920-929 (GIS)\02_Maps\Study Area\2016-03-04-AccessRoads\Figx-2016-03-04-AccessRoads-60485918-001.mxd Date Revised: November 15, 2016 Reviewed By: AM
Paper Size: 11"x17" Scale is referenced to the specified paper size.

2. SCRD Water Supply

2.1 Overview of SCRD Water Supply

The SCRD operates multiple water systems to supply the residents and businesses of the Sunshine Coast with potable water. The largest system is the Chapman Water System which supplies potable water to approximately 10,000 Sunshine Coast service connections servicing 23,000 customers between Gibsons and Secret Cove. The water source is Chapman Creek and surrounding watershed, which includes two headwater alpine lakes that have been modified to serve as reservoirs. The primary reservoir is Chapman Lake and Edwards Lake is a secondary source and both lakes are within Tetrahedron Provincial Park. Dams have been built on the outlet of each lake which allows the SCRD to control the flow of water into Chapman Creek for withdrawal 17 km downstream at the intake for the Chapman Creek Water Treatment Plant.

The existing dam on Chapman Lake is three metres high and from fall to spring water flows freely over the top of the dam. When water levels drop below the dam crest a sluice gate at the bottom of the structure is used to control the release of water from the lake. The sluice gate can be remotely operated from Regional District offices through Supervisor Control and Data Acquisition (SCADA). The amount of water that can be stored in Chapman Lake is prescribed in water license No. C050724 at 906,600 m^3. However, more recent estimates have calculate the volume to be slightly less at 905,000 m^3. The amount of water that can be released is governed by the configuration of the outlet channel and control structure. The release of the maximum volume from Chapman Lake results in a vertical drawdown of approximately 3.0 m below the outlet crest height. Photographs provided in the Photograph Section of the report show the area of the existing dam, the outlet channel and immediately downstream in Chapman Creek. The SCRD has a similar water release structure on Edwards Lake that has the capacity to release 791,000 m^3. The combined capacity of Edwards and Chapman Lakes is 1,696,000 m^3.

During a typical year, snow melt and rainfall ensure that the lake is at the full pool elevation of 974 m and the water stored behind the dam is allowed to overflow naturally until the water level drops below the crest. At this point the SCRD opens the existing low flow outlet and the flow from the outlet pipe is regulated to maintain sufficient flow for fish and water supply. The current operating procedure is to maintain at least 0.3 m^3/s in the creek below the water intake for the water treatment plant (Figure 3) under normal conditions and 0.2 m^3/s under low flow conditions. The amount released from Chapman Lake is determined by the amount of flow measured at the stream flow gauge located downstream of the SCRD water intake. The Water Treatment Plant has a design capacity to treat 0.3 m^3/s or 24,500,000 liters per day.

Since 2014 SCRD has been able to monitor the water levels and flow releases from Chapman Lake in real time and adjust the water flow from the lake remotely. This monitoring now allows the SCRD to accurately manage the flow from Chapman Lake to meet the drinking water demands and to supply the flows required for fish. Prior to 2014 flow from the lake was adjusted manually and required SCRD staff to fly up to the lake and make the necessary adjustments which was done on an as needed basis. Figure 3 shows the drawdown and refill of Chapman Lake for 2014 – 2016.

The fish hatchery located downstream of the SCRD intake also has a water licence on Chapman Creek and it typically uses up to 0.1 m^3/s of the instream flow but their water licence allows them to take a maximum of 0.28 m^3/s. The hatchery use of the water is a flow through situation with water extracted from the creek, it passes through the hatchery and is released back into the creek less than 100 meters downstream of the intake.

2.2 Hydrology of Chapman Creek

A detailed analysis of the hydrology of Chapman Creek can be found in Chapman and Reksten (1991). This report summarized the stream flow data from two Water Survey of Canada gauges that were operated on Chapman Creek; 08GA046 was located at the lower end of the creek near Wilson Creek Community and operated from 1959 to 1970. Station 08GA060 was established on the creek upstream of the original SCRD water intake and ran from 1970 to 1988. A third station not included in this study, 08GA078, was established downstream of the current SCRD water intake and operated from 1993 to 2003. Chapman and Reksten (1991) analyzed the data from 1959 to 1988 which includes 9 years of data after the flow control was established on Chapman Lake in 1979. The fact that flows out of Chapman Lake were managed is not anticipated to have a significant effect on the overall hydrologic analysis as the Chapman Lake watershed is just 8.6 km^2 (13%) of the entire watershed captured by Station 08GA060 of 64.5 km^2. The biggest influence would have been during the summer low flow periods when the SCRD releases the water held in Chapman Lake to augment flows.

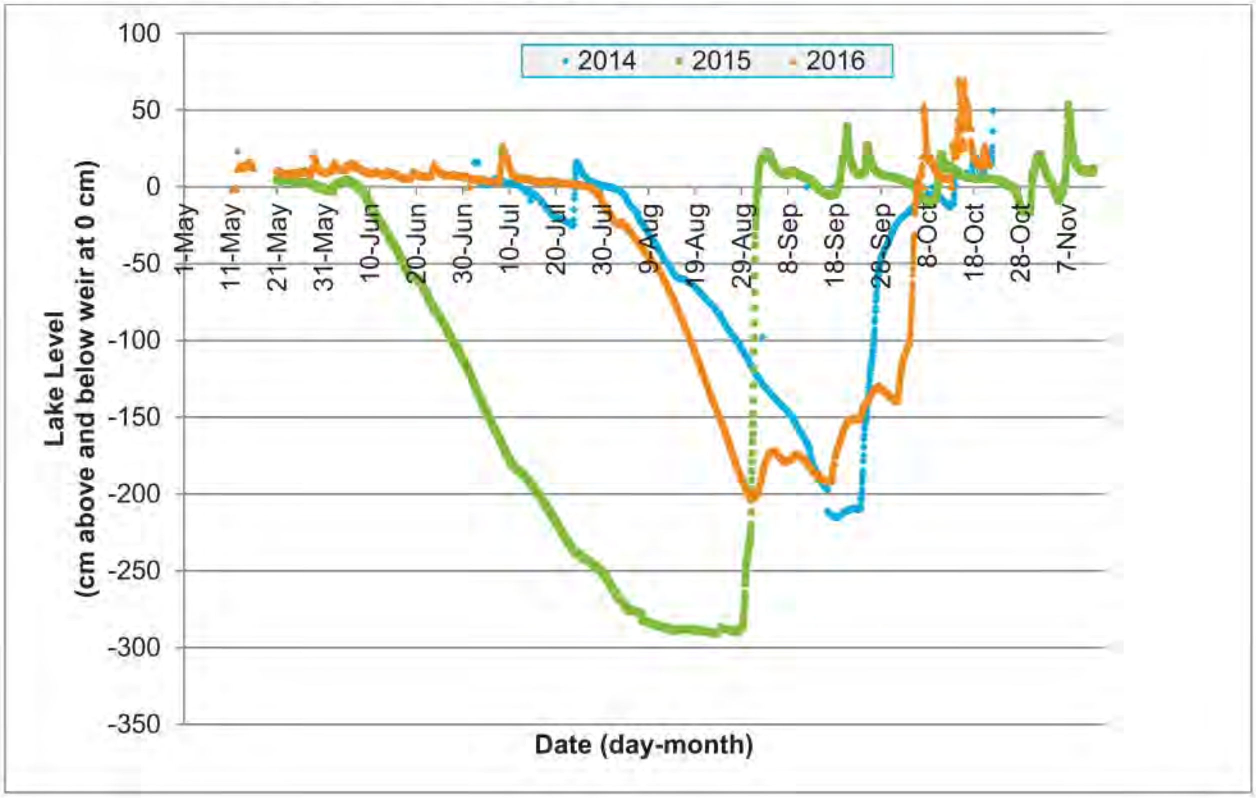

Figure 3: Chapman Lake water levels May to October, 2014 to 2016

The following summarizes the results from Chapman and Reksten (1991) based on the gauging station located above the SCRD intake (Sta 08GA060). Mean annual discharge was 4.53 m^3/s with the months of peak flow being May and June with an average flow of approximately 7 m^3/s and the month of lowest average flow was August at 1.18 m^3/s (Figure 4).

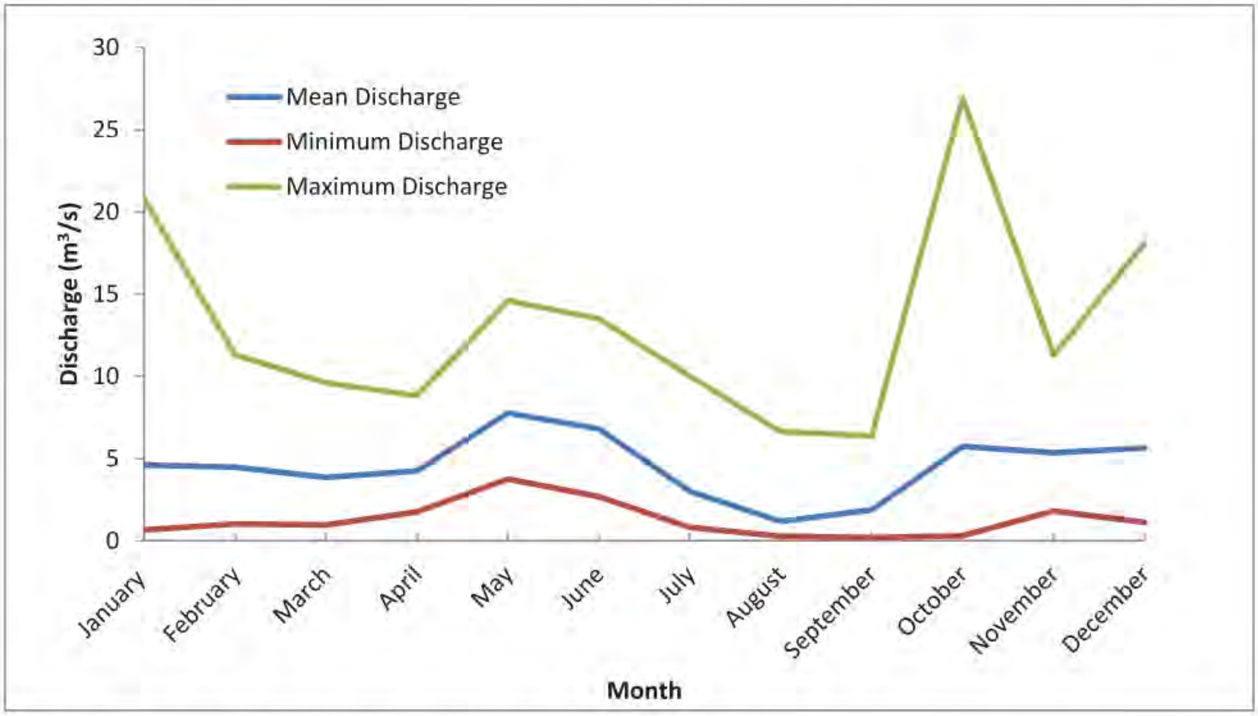

Figure 4: **Chapman Creek Hydrograph (Station 08GA060)**

Chapman and Reksten (1991) calculated flows for various low flow return periods for Chapman Creek at the station above the SCRD intake (08GA060) using data from 1970-1988. The results estimated the frequency of low flows in Chapman Creek for June 1 to September 30. The normal 7 day low flow was 0.21 m^3/s (i.e. with a 2 year return period) and the 7 day low with a 10 year return period was 0.06 m^3/s.

Table 1 provides the flow values for the summer months for the Chapman Lake watershed area estimated by prorating the Chapman Creek data by the proportion of the Chapman Lake watershed.

Table 1: **Estimated monthly mean, maximum and minimum flow into Chapman Lake based on 1959 – 1988 data for Chapman Creek (calculated from Chapman and Reksten 1991 data)**

Month	Discharge m^3/s		
	Mean Flow	Maximum	Minimum
May	1.03	1.95	0.50
June	0.91	1.80	0.36
July	0.40	1.33	0.11
August	0.16	0.88	0.04
September	0.25	0.85	0.03
Annual	0.604	0.91	0.39

The existing capacity for Chapman and Edwards Lakes has been demonstrated to be limited based on the conditions during the summer of 2015. Continuous, controlled water release from Chapman Lake began on May 30th and the lake was down to -2.9 m by August 5th. Had the proposed gravity release system been in place in 2015 and SCRD had not gone to stage 4 water restrictions and the ongoing release from Chapman Lake followed the same rate as the 10 days prior to the start of stage 4 (average 3.5 cm per day), Chapman Lake would have been lowered to -3.8 m.

Using the minimum estimated inflows into Chapman Lake (Table 1), Table 2 provides an estimate of the amount of water that is available during low water conditions based on lowest recorded flows over 29 years of flow measurements on Chapman Creek. The estimated total amount of water available between June 1 and September 30 assumes that the lake is full on May 31.

Table 2: Estimate of total monthly flow into Chapman Lake under low flow conditions

Month	Low Flow m^3/s	Month Total m^3
June	0.36	933,100
July	0.11	296,600
August	0.04	107,100
September	0.03	77,800
Total		1,414,600 m^3
Current Available Storage (Chapman + Edwards)		1,696,000 m^3
Total Available water June 1 – Sept 30		3,110,600 m^3

The CRWP estimates that the current annual average daily water demand over the year for the Chapman Water System to be 14,300 m^3/day with summer demand ranging from 18,000 to 25,000 m^3/day. The fish flow 0.2 m^3/s amounts to 17,280 m^3 per day. Using an average summer demand of 21,000 m^3/day, the Chapman system would be able to supply 38,280 m^3 per day for approximately 81 days. This is considered a conservative estimate as it only accounts for the contribution from the Chapman and Edwards Lake areas of the Chapman Creek watershed and not the other 83% of the watershed that also contributes flow to lower Chapman Creek. However, to provide certainty of fish flows and drinking water supply in more severe drought conditions, i.e. 1 in 25 year drought access to additional water from Chapman Lake is required.

2.3 Meeting Future Demand

In 2013 the SCRD issued a Comprehensive Regional Water Plan to provide guidance for water conservation and system expansion to accommodate the growth identified in various Official Community plans through to the year 2036 (Opus Dayton Knight 2013). The CRWP evaluated the capacity of Chapman and Edwards Lakes to provide water through a 1 in 25 year return period drought, a level of service recommended by provincial guidelines for managing drought (MOE 2016). Analysis provided in the CRWP considered the projected population growth and associated water requirements under a scenario of intensive management of water demand through to 2036 (i.e. use of water metering). The scenario included a population growth of 2% per year and an average water usage of 480 litres per capita per day based on implementation of intensive demand management measures. Under this scenario the projected storage volume required to meet the water demand during a 1 in 25 year drought was 2,090,000 m^3 of water (Opus DaytonKnight 2013). This indicated that the Chapman system was 350,000 m^3 short of being able to meet the water demand in 2036 under drought conditions. Withdrawing another 350,000 m^3 of water from Chapman Lake would draw the lake down to approximately -4.5 m.

The CRWP also concluded that the existing storage in Chapman and Edwards Lakes was only capable of suppling water through a 1:21 yr. drought. This analysis was based on the existing per capita demand for water from the Chapman System. The SCRD is taking steps to reduce the water demand through the installation of water meters (to be operational in 2018), more rigorous application of a drought management plan and education. The water metering program is expected to reduce the existing demand by 25% (Opus DaytonKnight 2013). The current project to access additional water from Chapman Lake was developed to address this short fall over the short term while additional sources of drinking water were developed.

2.4 Climate Change

Climate change is an important consideration in the assessment of Chapman Lake being able to provide sufficient water in the future. A study by Staats (2014) indicated that the data suggests that the Chapman Creek watershed is shifting from a snowmelt dominated system to one more reliant on rain fall. The hydrologic analysis of the Chapman Creek watershed by Chapman and Reksten (1991) shows that the months with the highest mean flows are May and June, likely due to snow melt, however, higher maximum flows are reported for January and October, driven by rain and rain on snow events. In September 2016, Metro Vancouver released "Climate Projections for Metro Vancouver" which used various climate models to develop predicted changes in climate parameters such as temperature, precipitation, and snow pack by the years 2050 and 2080. AECOM has reviewed this report and provided a summary in the context of Chapman Lake which is provided in Appendix A. This report confirms the findings by Staats including the prediction for smaller snow packs by up to 50% by the year 2050, and longer and drier summers extending into September with increased rainfall in the fall, winter and spring months.

Chapman Lake responds relatively quickly to rainfall events, for example over 829,000 m^3 of water flowed into Chapman Lake over 4.5 days of rainfall to fill the lake quickly in the fall of 2015. This suggests that even under climate change rainfall will continue to fill the lake quickly in the fall and would keep it full through the spring months. The local rainfall weather station at Gower Point in Gibsons, the closest station with a long record of weather data collected by Environment Canada[1] shows evidence of decreasing summer rainfall. Figure 5 shows the rainfall from June through September for various time periods. The average July rainfall in the 2011 – 2016 period is 6% less than in the period from 1981 – 2010. August rainfall has decreased 11% over the same period. This supports observations from SCRD staff that summer conditions have been drier in recent years and flows in Chapman Creek have been lower.

The effect of the reduced base flow from a smaller snow pack resulting from climate change is difficult to quantify without stream and precipitation gauges in the upper reaches of Chapman Creek. This along with an average decrease in rain of 19% by 2050 and another 10% by 2080 during the summer period will result in what is currently considered to be a 1:25 year drought to occur more frequently. The analysis in Section 2-2 indicates that the current water supply will last for 81 days under low flow conditions. If the 19% reduction in rainfall estimated to occur with climate change is applied, the available water will drop to 66 days. The additional 1,000,000 m^3 of water available in the lake if it is drawn down to -8 m would extend the water supply for another 26 days for a total of 92 days of water available under extreme drought conditions.

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[1] *http://climate.weather.gc.ca/historical_data/search_historic_data_e.html*

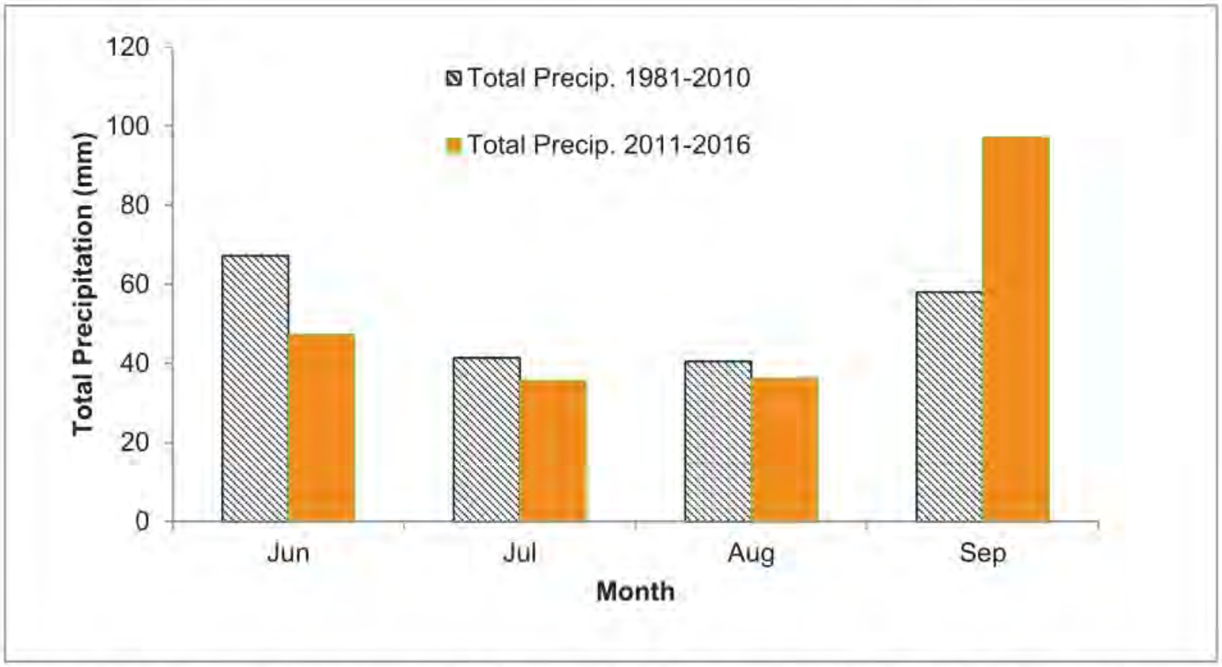


Figure 5 **Precipitation recorded at Gower Point Gibsons from 1981 - 2016 (from Environment Canada)**

While climate change is predicted to further reduce the available water supply that can be provided by Chapman Lake during summer conditions, the predicted values used here are not expected to be reached until 2050. Also, the analysis provided has been done conservatively using current low flow levels, assuming no contribution of water from the rest of the Chapman Creek watershed and without any efforts to reduce the water demand on the Chapman Water System.

2.5 Summary

The CRWP has predicted that the current Chapman Creek system does not have sufficient capacity to meet demands under drought conditions. This was evident in 2015 when the SCRD was required to implement Stage 4 water restrictions. There is some evidence that the drought in 2015 was much more severe than the 1 in 25 year condition assessed in the CRWP. A study of drought conditions on St Mary Lake on Salt Spring Island estimated that the return period of the 2015 drought was in excess of a 1 in 100 year event (Hodgins 2015). Had the SCRD been able to draw water out of Chapman Lake below the -3 m level, analysis suggests that the lake would have been drawn down to -3.8 m in 2015. Climate change analysis indicates that conditions could get more severe with drier, warmer summers but there will be plenty of water over the rest of the year to refill the lake should significant summer drawdown be required to satisfy water demand during droughts. The analysis presented here used predicted conditions in 2036 and 2050 but the SCRD continues to carry out the recommendation in the CRWP which includes the development of additional water supply and storage in order to meet the projected population growth through to 2036. While future conditions will increase the possibility of drawing Chapman Lake drawn to -8 m, the 2015 experience and the CRWP analysis of 2036 drought conditions suggest that the drawdown of -4 m to -5 m will be sufficient to meet 1:25 year drought conditions. However, for purposes of this assessment it will be assumed that a full 8 m draw down could occur on a frequency of 1 in 25 years.

3. Project Description

3.1 Plan

In order to access additional water during times of drought the SCRD has chosen to augment the existing outlet infrastructure at Chapman Lake by adding a gravity fed system. This includes a 900 mm diameter, 210 m long pipe buried beneath the existing outlet channel. The pipe intake would be located at an elevation of 966 m or 8 m below the current "full" water elevation of the lake (974 m). The pipe will be installed using an open cut excavation in the existing soil and bedrock complete with cutting through the existing concrete outlet weir. With the proposed new intake pipe installed at a deeper location SCRD will have access to another 1 million m^3 of water. Drawings of the proposed layout are provided in the Drawings section of the report.

The new 900 mm dia. pipe will be fitted with a T–shaped intake providing two openings to keep intake velocities to a minimum (Drawing C-103). The two 1.9 m diameter intakes will be fitted with a 25 mm open area trash rack. Calculations indicate that the velocity around the intake will be 0.14 m/s for this configuration. The objective of this design is to reduce velocities that would pull debris toward the intake and entrain the fish that could be present. The cover is intended to prevent sticks and debris from entering the diversion pipe, while minimizing the opportunity for plugging.

The existing 3 m deep outlet structure will be maintained and the deeper outlet will be located just to the left (looking downstream as shown on drawing C-100) with a separate valve and operating mechanism. As shown on the drawings, the channel downstream of the outlet will be deepened to receive the water from the low level pipe. The discharge channel will be extended approximately 25 m downstream and will provide a 2 m deep pool at the base of the 8 m high dam. The pool will provide protection to fish that pass over the weir

The control of the flow from Chapman Lake will be achieved with 2 valves located on the cast-in-place concrete weir wall constructed at the existing outlet of the lake. The existing -3 m control valve and water supply channel will be maintained and used as the primary mechanism for the controlled release of water from Chapman Lake. Once the water levels drop below - 3 m a new valve located at the outlet of the 900 mm diameter diversion pipe will be opened. This valve will control the flow of water through the new 900 mm diameter diversion pipe that will allow water access to the available water down to -8 m.

Downstream of the existing weir the plan is to enhance the existing channels to provide defined flow paths during the overflow events and the operation of both the -3 m and -8 m diversion valves. During the overflow events the water will be diverted into a plunge pool. The overflow plunge pool will also be the outlet for the -8 m diversion. The -3 m diversion and downstream channel will be maintained as a path for fish during the operation of this valve. The -3 m diversion channel will discharge into the -8 m pool prior to entering the existing Chapman Creek channel to ensure there is always flow within the plunge pool. This plan is intended to improve the current situation that results in fish being trapped in the pools downstream of the existing weir after overflow events.

Figure 6 identifies the existing Park Use Permit area and the additional area that will be required to construct the new intake. The yellow area is the extra space needed for construction, laydown and worker camp that represents a land area of approximately 1,500 m^2 and an in-lake area of approximately 11,700 m^2 for a total of 13,700 m^2 that would be required for the pipe installation

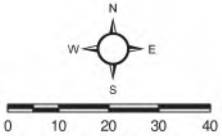
Legend

🟥 Chapman Lake Current Park Use Permit Area (0.344 ha)

🟨 Temporary Use Area (Approximate)

Overview Map

Basemapping from BING Online Imagery, Spatial Data from SCRD, 2015



Metres

1:1,500

NAD 1983 UTM Zone 10N

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Chapman Lake Water Supply
Expansion Project
Location: Chapman Lake, BC

Temporary Chapman Lake Permit Area

10 November 2016

AECOM

Figure 6

Service Layer Credits: Sources: Esri, HERE, DeLorme, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

File Location: P:\60485918\900-Work\920-929 (GIS)\02_Maps\2016-04-04-TemporaryLandUse\Figx-2016-04-04-ChapmanLakePUPandTUA-60485918-001.mxd
Paper Size: 8.5"x11" Scale is referenced to the specified paper size.

Date Revised: November 10, 2016

Reviewed By:

3.2 Construction

Construction of the project is restricted due to weather and snowpack conditions. Typically there is considerable inflow to the lake through June. In order to carry out the construction the lake level must be lowered to install a coffer dam to dewater the outlet channel and allow the excavation necessary to install the pipe. Work must be completed prior to the start of significant fall rain which could have the potential to overtop the coffer dam. Considering these constraints the preferred construction schedule is from July 4 to September 30, 2016. The following is the general order of work within that 3 month period. This schedule is likely to change as the design work is advanced and more details on the preferred construction methods are developed:

- The SCRD would open the existing -3 m outlet in April/May, 2017.
- Site clearing and set up of a construction camp for approximately six people in mid-June.
- Establish a laydown area to store and maintain equipment, fuel, waste management facilities, etc.
- Install the syphon system to bypass water around the existing outlet channel to maintain flow in Chapman Creek by June 15th.
- Once the lake is down to -3 m an initial coffer dam will be established at Sta 0+100 (Drawing C-101). Specific details of the coffer dam will be left up to the successful contractor but it is anticipated that something like a Portadam will be used (see Appendix B) that does not require the use of large volumes of material.
- Once the area is isolated from the lake, work will begin on the dam, and the low level outlet channel, expected to start on July 1, 2017.
- It is expected that the coffer dam will be moved a few times during the course of the project as the water level is lowered in Chapman Lake in order to move it out beyond the intake location to complete the installation of the pipe. The pipe excavation will start at the existing weir and move toward the middle of the lake. In order to install the intake end of the pipe the lake may have to be drawn down below the -8 m level depending on the type of coffer dam used.
- During this past summer a seismic survey was completed to determine the approximate location of the bedrock without completing test drilling or digging test pits. The seismic survey determined that the bed rock is expected to be roughly 0.5 m below the existing soil surface. During construction the soil overburden will be stripped and stockpiled. The stockpiled overburden will be used for pipe bedding and surround. The trench rock will be blasted to a depth upwards of 7 m to install the low level outlet pipe. Blast rock will be used to infill the trench and to armour the -3 m channel leading to the outlet. Drawing C-103 provides details of the trench.
- The majority of the trench excavation for the diversion pipe will consist of bedrock blasting. The rock blasting will be completed in small controlled blasts that comply with the DFO guidelines. The blasted rock will be used for the trench backfill. Screened, clean blast rock will be used to amour the surface of the channel.
- Material removed from the trench will be used to backfill the trench and re-establish the existing channel at a -3 m elevation (relative to full pool level). Excess material from the trench will be spread along the side and top of the existing channel and graded to match the existing land. This will be completed to allow the channel at the -3 m elevation to be used in the future as the primary point of diversion during the summer months. The channel will be connected to the existing weir wall that contains the existing -3 m diversion valve on the north side of the Chapman Lake outlet. This will allow the existing -3 m diversion and channel at the outlet of Chapman Lake to be retained.
- Downstream of the existing weir the plan is to enhance the existing channels to provide defined flow paths during the overflow events and the operation of both the -3 m and -8 m diversion valves. During the overflow events the water will be diverted into a plunge pool. The overflow plunge pool will also be the outlet for the -8 m diversion. The -3 m diversion channel will discharge into the -8 m pool prior to

entering the existing Chapman Creek channel to ensure there is always flow within the plunge pool. This plan is intended to improve the current situation that results in fish being trapped in the pools downstream of the existing weir after overflow events. The plunge pool is the point of discharge for the -8 m diversion pipe that will be used during situations when the water level in Chapman Lake is less than 3 m below the weir elevation.

- The existing weir wall will be strengthened to meet the current dam standards once the rock blasting for the installation of the 900 mm diameter -8 m diversion pipe is completed. The new weir will be constructed with cast-in-place concrete.
- Substantial completion is expected by September 15th, 2017.
- A site restoration plan will be prepared to restore the camp, laydown and excavation areas and the banks of the outlet channel. The restoration plan will include the use of native grass seed and the planting of trees and shrubs as appropriate. A comprehensive restoration plan will be developed as described in Section 7.0.

3.3 Operation

As indicated the SCRD Board has passed a resolution that committed to only drawing water from below the existing operating level (-3.0 m) to avoid stage 4 water restrictions during times of drought. The SCRD's Drought Management Plan has identified four stages of increasing restriction of water use. The first stage automatically goes into effect on May 1. Subsequent restrictions are imposed based on the evaluation of a set of criteria and guidelines used to assess risk of drought or water shortage. In determining increases to restriction to Stages 2, 3 and 4 the SCRD considers the following:

- Time of year and typical seasonal trends;
- Snow pack assessments and snowmelt forecasts;
- Storage volume of water sources and draw down rates;
- Stream flows and monitoring data;
- Weather, recent conditions and short and long term forecasts;
- Water usage, recent consumption and trends; and,
- Water supply system performance.

Withdrawing water below -3.0 m will not occur unless drought conditions have required Stage 3 restrictions and weather forecasts indicate that conditions will persist and the lake will not be recharged by rainfall. Sufficient water will be released through the low level outlet to meet the current requirements to protect fish and to service the community. The current operation requires sufficient flow to be released from Chapman Lake to maintain an instream flow for fish of 0.3 m^3/s below the SCRD intake which can be reduced to 0.2 m^3/s during the summer dry season with an additional amount added to meet the SCRD water demands which typically requires a total flow release from Chapman Lake of approximately 0.44 m^3/s to 0.55 m^3/s.

4. Aboriginal Consultation and Public Participation

4.1 Introduction

The BC Parks Impact Assessment User Guide describes Ministry expectations in terms of Aboriginal consultation and public participation at various levels of review:

Level 2, Detailed Screen

At this level, potential public issues should already have been identified.

Further consultation may be required in certain circumstances. For example:

- if new issues are identified in the Detailed Screen or if previously identified issues require elaboration
- the public may be contacted as a source of more detailed information on protected area values or human uses in the area of the proposed action
- the public may be contacted if any specific issues are found to have significant impacts that may potentially affect interest groups or the general public.

If a proposed action is approved at this stage, or if the action requires further evaluation (through a full impact assessment), the responsible officer should identify any recommendations for public consultation as part of the decision statement for the Detailed Screen.

Level 3, Full Impact Assessment Report

This level of assessment requires considerably more public consultation. At a minimum there will be public notification regarding the proposed action. The public involvement program should be appropriate to the scale and complexity of the assessment. The parameters and objectives of the public involvement program should be defined in the terms of reference for the study (BC Parks Impact Assessment Part 2, User Guide, Appendix 6, 1999)

The BC Parks Tetrahedron Park Management Plan further states:

> …with respect to the SCRD's need to enhance its water system infrastructure/water use of the Chapman/Gray Creek watersheds within the park for future community water supply. A public consultation process to review any options proposed by government that may affect the existing park designation will be implemented… (BC Parks Tetrahedron Park Management Plan 1997)

Clarification of Aboriginal consultation and public participation requirements for the Project was provided in BC Parks Regional Director's correspondence of June 6, 2016 with SCRD Infrastructure Department General Manager. The correspondence considers whether letters of support can be obtained from the shíshálh (Sechelt) Nation and Skwxwú7mesh Úxwumixw (Squamish) Nation to confirm their interests have been addressed, while expressing interest in having the SCRD hold additional meetings with stakeholder groups to address concerns regarding the Project.

Aboriginal consultation and public participation related to the current Project continues the SCRD's extensive Aboriginal and public engagement activities initiated prior to adoption of a Comprehensive Regional Water Plan in 2013.The following SCRD Chapman Lake Water Supply Expansion Project Activity and Issues Tracking Table is based on implementation of the Project's Aboriginal Consultation and Public Participation Plan (March 2016. See Appendix C). Implementation of the Plan included production and distribution of a plain-language Information Package and accompanying map (updated June 2016. Appendix C). Drafts of the Park Use Permit amendment application and supporting environmental assessment report for the Project were also distributed to the shíshálh (Sechelt) Nation and Skwxwú7mesh Úxwumixw (Squamish) Nation for review.

4.2 Activity and Issues Tracking Table

The following provides a summary of Aboriginal Consultation and Public Participation for the SCRD Chapman Lake Water Supply Expansion Project.

Table 3: Summary of Aboriginal Consultation and Public Participation

Date	Activity	Summary / Issues Raised
Aboriginal Consultation - shíshálh Nation (Sechelt Nation)		
February 2016 (multiple dates)	Email correspondence and phone conversations – planning / logistics	Request for meeting with shíshálh Nation to initiate Aboriginal consultation process
15 March, 2016	Email correspondence with shíshálh Nation Rights and Title staff	Detailed background information on the Project including: • Sechelt Indian Band Rights and Title Application Form • Chapman Lake Project – Draft Information Package • Chapman Lake Project – First Nations Territories Map • Draft Aboriginal Consultation and Public Participation Plan • Correspondence with BC Parks re: Park Use Permit application process 3 March 2016 • Chapman Lake Storage Project Impact Assessment Report (Whitehead 1999) • Excerpt from Whitehead Report on Cultural Values (1999) • Bates Report on Low Summer Flows in Chapman Creek (2015) • SCRD Infrastructure Reports to Board re: Preferred Option (September 2016)
18 March, 2016	Meeting with shíshálh Nation Rights and Title staff and consulting aquatic biologist	Introduction to Project and discuss draft public participation and technical information packages and project description • Request that archaeological Preliminary Field Reconnaissance be undertaken to supplement Archaeological Overview Assessment • Appropriate protections and mitigation measures to protect Chapman Creek aquatic resources • Deepening of channel considered short-term solution; interest in longer-term development of engineered lake water storage as part of SCRD Comprehensive Regional Water Plan (CRWP) • Interest in protection of rare plants during construction activities • Discussion of including shíshálh Nation consulting biologist in Park Use Permit amendment and environmental assessment report review • Request for information to refresh Chief and Council's knowledge of CRWP

Date	Activity	Summary / Issues Raised
22 April, 2016	Email correspondence with shíshálh Nation Rights and Title staff	Revised electronic copy of the draft Park Use Permit amendment application incorporating comments and recommendations made by Dave Bates (shíshálh Nation's consulting aquatic biologist)
26 April, 2016	Email correspondence with shíshálh Nation Rights and Title staff	SCRD General Manager provided information on the CRWP as requested
31 May, 2016	Chapman Lake project site visit with shíshálh Nation Rights and Title staff, Director of Lands and Resources and consulting archaeologist, together with SCRD and BC Parks representatives	
3 June 2016	Email correspondence from shíshálh Nation Rights and Title staff to SCRD Infrastructure Department	Request by shíshálh Nation Rights and Title staff for original photos of original water supply project footprint at Chapman Lake
4 July, 2016	Phone call by SCRD Infrastructure Department General Manager with shíshálh Nation Rights and Title staff	Enquiry to confirm the shíshálh Nation Rights and Title staff have sufficient information to complete their report to Chief and Council re: Project recommending support / non-objection
31 August 2016	Email correspondence with shíshálh Nation Rights and Title staff	Request for information on additional environmental field studies; schedule of studies; proposed timing of additional draw-down of Chapman Lake if required during a drought period. Information was provided by the SCRD Infrastructure Department
November 3, 2016	Meeting with shíshálh Nation Rights and Title staff and SCRD Infrastructure Department staff	Follow-up meeting to review the results of additional environmental field programs and letter of support / non-objection for the Project
Aboriginal Consultation – Skwxwú7mesh Úxwumixw Nation (Squamish Nation)		
February 2016 (multiple dates)	Email correspondence and phone conversations – planning / logistics	Request for meeting with Skwxwú7mesh Úxwumixw Nation to initiate Aboriginal consultation process
1 March, 2016	Conference call with Skwxwú7mesh Úxwumixw Nation Chief, Executive Assistant and land use / archaeological consultant	Brief introduction to project. (water supply storage at Chapman Lake lies outside of Skwxwú7mesh Úxwumixw Nation territory; Chapman Lake water system provides water to Sunshine Coast residents east of Roberts Creek within Skwxwú7mesh Úxwumixw Nation territory) Request for more detailed information for review Potential interest in flow rates in relation to Chapman Creek Hatchery
22 March, 2016	Email to Úxwumixw Nation Executive Assistant and consultant	Public participation and technical Information Packages provided to Skwxwú7mesh Úxwumixw Nation for review
29 March, 2016	Follow-up email to Úxwumixw Nation Executive Assistant and consultant requesting meeting to discuss project	Response pending
6 April, 2016	Follow-up email to Úxwumixw Nation Executive Assistant and consultant requesting meeting to discuss project	Response pending

Date	Activity	Summary / Issues Raised
19 April, 2016	Email correspondence from Skwxwú7mesh Úxwumixw Nation consultant	Request for clarification on: • whether there would be reduced flows that would have any negative impact on the Chapman Hatchery downstream of the lake later in the summer • due to climate change concerns, are any plans being made to have water conservation or capture to supplement residential requirements to reduce the need to draw from the lake
22 April, 2016	Email to Skwxwú7mesh Úxwumixw Nation consultant	Response to email correspondence 19 April, providing electronic copies of SCRD park use permit for Chapman Lake (installation of syphon) from BC Parks and Park Use Permit amendment application (deepening of channel; pipe installation and valve system) to BC Parks for review, as well as clarification regarding issues raised. • Indication of Skwxwú7mesh Úxwumixw Nation support or non-objection for the Project requested Response pending
Public Participation		
16 February, 2016	SCRD General Manager interview with CFUN Mountain FM re: Chapman Lake Project	Water management strategy, activities and details of the proposed Chapman Lake water supply expansion project. The interview included water demand strategies and implementation of universal metering; discussion of water restrictions in 2015.
18 March, 2016	Informal meeting in Gibsons with representatives from the Sunshine Coast Conservation Association, Tetrahedron Park Outdoors Club, Tetrahedron Alliance, Tuwanek Ratepayers Association	Introduction to the Project and wide-ranging discussion. Project plain-language Information Package and map distributed, as well as providing requested electronic copy of the environmental assessment produced for the Chapman Lake floating pump option (Whitehead, 1999). Issues raised included: • An interest in diversifying the Sunshine Coast's sources of water supply • The detrimental effects of drawing down Chapman Lake during periods of drought • Imposition of water restrictions earlier to encourage reduced water usage • Whether adequate flow rates were maintained for the Chapman Creek Hatchery • Whether SCRD financial resources should be spent on universal metering program • Tetrahedron Park's three pillars: regional water supply, biodiversity and recreation
30 March 2016	Teleconference discussion with Chapman Creek Hatchery General Manager	Discussion of flow rates in Chapman Creek and ongoing efforts made by the SCRD to maintain flow rates adequate for the hatchery and fish stocks in Chapman Creek
5 April 2016	Teleconference discussion with Ruby Lake Lagoon Nature Reserve Society Executive Director	Based on the Executive Director's training as a limnologist with 45 years of experience, discussion of the "literal fringe" of lakes, suggesting the this area is "dynamic and resilient" with few resident species.
8 April 2016	Teleconference discussion with Vancouver Coastal Health's Drinking Water Officer	Discussion of the importance of the adequate water supply and permitting requirements for expansion of the Sunshine Coast's water supply
13 April 2016	West Howe Sound Community Association Meeting	SCRD Infrastructure presentation; Question and Answer session

Date	Activity	Summary / Issues Raised
24 April 2016	Earth Day event – Roberts Creek	SCRD Booth and discussion with public re: water strategy, activities and Chapman Lake Water Supply Expansion Project
26 April 2016	Sunnycrest Mall	SCRD Booth and discussion
28 April 2016	Trail Bay Mall	SCRD Booth and discussion
29 April 2106	Email correspondence from Tetrahedron Park Outdoors Club member with Chair of Tetrahedron Advisory Council (TAC) re: Project prior to TAC Meeting 9 May 2016	Issues raised included: • Protection of ecological mix • Importance of Tetrahedron Park in protecting biodiversity • Creation of park, recognizing the role of Chapman Lake in providing the Sunshine Coast's water supply, with provision for draw-down during periods of drought • Provision for further modification to manage further water supply requirements if there were no better options • Climate change • SCRD inaction on development of long-term water supply management system / dependency on one creek • SCRD has done no population growth analysis • SCRD has done no aquifer analysis • SCRD has not considered reservoir creation outside of Chapman water system • SCRD has provided no backyard water collection subsidies • SCRD does not implement mandatory prohibition of lawn and driveway watering • SCRD have implemented a universal metering system but there is no redundancy in the system • Increased dependency on Chapman system is short-sighted – an engineering cheap fix
30 April 2016	*Spring in Sechelt* Community Event	SCRD Booth and discussion
3,4,5, May 2016	Chapman Water Treatment Plant	School tours
6 May 2016	Chapman Water Treatment Plant	Public tours
9 May, 2016	Tetrahedron Advisory Council (TAC) Meeting	(See April 29 email correspondence above) SCRD Staff not invited
10 May 2016	Sunnycrest Mall	SCRD Booth and discussion
10 May 2016	Egmont Community Meeting	SCRD Infrastructure presentation; Question and Answer session
11 May 2016	Elphinstone Community Association Meeting	SCRD Infrastructure presentation; Question and Answer session
12 May 2016	Sandy Hook Community Association Meeting	SCRD Infrastructure presentation; Question and Answer session

Date	Activity	Summary / Issues Raised
16, 17, 18, 19, 24, 25 and 26, May 2016	SCRD Community Dialogue Sessions (various locations in the Regional District)	The public's main area of interest was water supply management and the Chapman Lake Water Supply Expansion Project. Key concerns raised: • Inadequate water supply and too much reliance on water demand management (i.e. metering) – balanced by discussion of the SCRD's water supply expansions efforts • Cost of water metering and impact on rates • Water rate structure design, particularly concerns regarding not penalizing young families and food production
9 June, 2016	SCRD Infrastructure Committee	Presentation and public meeting with AECOM Project staff providing SCRD directors and the public an opportunity to ask questions regarding the Project
June 10 2016	Notice of Alternative Approval Process for financing of Chapman Lake Water Supper Expansion Project	Deadline for submission of elector response form July 26, 2016
18 June 2016	Home and Garden Show	SCRD Booth and discussion
21 June 2016	Sechelt Community Association Board	SCRD Infrastructure presentation; Question and Answer session
22 June 2016	Roberts Creek Community Association	SCRD Infrastructure presentation; Question and Answer session
25 June 2016	Children's Festival - Gibsons	SCRD Booth and discussion
June 2016	Notice of Alternative Approval Process	Deadline for submission of elector response form July 26, 2016
1 July 2016	Canada Day - Sechelt	SCRD Booth and discussion
13 July 2016	Additional Chapman Lake Water Supply Expansion Project information uploaded to the SCRD website	SCRD Water Supply Expansion Project Fact Sheet and Frequently Asked Questions document during Alternative Approval Process
10 July 2016	Halfmoon Bay Country Fair	SCRD Booth and discussion
23 July 2016	Sea Cavalcade	SCRD Booth and discussion
28 July 2016	SCRD News Release	"Chapman Lake Supply Expansion Project to Proceed With Elector Approval"
13,14 August 2016	Sunshine Coast Arts Council Fair	SCRD Booth and discussion
26,27 August 2016	Rogue Festival	SCRD Booth and discussion

4.3 Aboriginal Consultation and Public Participation Summary Outcomes

As indicated by the Activity and Issues Tracking Table above, the SCRD has actively engaged with and encouraged public participation by Sunshine Coast residents through a variety of events and forums throughout spring and summer 2016. Supplementing water supply and demand discussions provided during Community Dialogue Sessions in various locations in the region, the SCRD posted information on the Project on its website, including an Information Package and Frequently Asked Questions document. An Alternative Approval Process for financing of the Project was successful in late July.

Further discussions with affected Aboriginal communities (the shíshálh Nation and Squamish Nation) are anticipated pending results of additional environmental studies requested by BC Parks and undertaken in August. Following review of the draft Park Use Permit and amended environmental assessment report the SCRD anticipates receiving First Nations' response in short order.

5. Current Conditions

5.1 Geology

5.1.1 Bedrock Geology

5.1.1.1 Regional Overview

The oldest rocks of the Chapman Lake area belong to the upper Triassic Vancouver group-Karmutsen Formation. This formation is dominated by mafic volcanic flows; associated basaltic breccias and high level mafic dikes and small mafic intrusive pods. The Karmutsen Formation is intruded and partially enveloped by late Jurassic to Cretaceous dioritic intrusive rock, which is mainly composed of quartz diorite and granodiorite.

According to the MINFILE database, the Thornhill Creek limestone occurrence is located within five kilometers of Chapman Lake, on the southeast side of Salmon Inlet. Locally, a mass of white, crystalline limestone is reported to occur. The deposit is situated near the north end of a 6-kilometre long pendant of andesitic to rhyodacitic flows and pyroclastics, greenstone, argillite and schist of the Lower Cretaceous Gambier Group lying in quartz diorite of the Tertiary-Cretaceous Coast Plutonic Complex.

5.1.1.2 Chapman Lake Watershed

Chapman Lake lies within an area of granite rock of the late Jurassic and early Cretaceous ages (156 to 114 million years old). Coastal watersheds underlain by rock types such as quartz diorite tend to be slightly acidic due to the low buffering capacity of these rocks and the natural low pH of rainfall (McKeown et. al., 2002; Triton, 2006).

The dominant soil-types within the Chapman Lake watershed contain large concentrations of organically combined iron and aluminum in their subsoils (Carson, 1999; Whitehead, 1999). In poorly-drained soils on the Tetrahedron Plateau organic matter is not broken down as quickly as in areas of well-drained soils, which means that organic and clay colloids and aluminum and iron compounds are common elements in the water supply and characterize the natural water quality in this area (Triton, 2006).

5.1.2 Generation of Acid Rock Drainage and Metal Leaching

In the natural environment, rocks are broken down into soil through exposure to air and water in a process called weathering. During weathering, minerals react with air and water to release some of their constituents (ions) into the surrounding aqueous environment. In many cases, the primary minerals are transformed into secondary residual minerals during this process. The ions that go into solution may be transported away by runoff, streams, and groundwater and therefore have a large influence on water quality. If a rock is buried beneath other rocks and soil, it naturally weathers very slowly. However, when it is excavated during construction or mining, the weathering process can increase substantially because previously unexposed rocks are broken up and exposed to rain, snow and air at the surface.

5.1.2.1 Acid Rock Drainage

Some rocks contain minerals that can produce acid during weathering. The resulting acidic water is known as "acid rock drainage" or ARD. The most typical and strongest acid-generating mineral is pyrite (FeS_2), which forms sulfuric acid (H_2SO_4) when it reacts with oxygen and water during weathering:

$$FeS_2(s) + 15/4\ O_2 + 7/2\ H_2O = 2\ H_2SO_4 + Fe(OH)_3(s)$$

The oxidation of pyrite is a complex process involving a series of redox reactions, hydrolysis, and complex ion formations. The process also tends to release associated heavy metals into solution. Other sulfides and a few other types of minerals can also form acid, but to a lesser extent. The acid-generation potential (AP) of a rock is the total capacity of that rock to generate acid if all of its acid-generating minerals react to completion during weathering.

Typically, rocks are predicted to be potentially acid generating (PAG) or not potentially acid generating (non-PAG) based on the relative amounts of constituent minerals that can form acid and those that can neutralize acid. The best and most common acid neutralizing mineral is calcite, which is calcium carbonate ($CaCO_3$) (Price 2009):

$$CaCO_3(s) + H_2SO_4 = Ca^{2+} + SO_4^{2-} + H_2O + CO_2\ (g)$$

Other carbonates, including dolomite [$CaMg(CO_3)2$] and ankerite [$Ca(Fe,Mg,Mn)(CO_3)2$] can also neutralize acid to varying extents. In contrast, siderite ($FeCO_3$) is not considered to have neutralization potential, due to its iron content, unless it has magnesium or calcium substituting for some of the iron. Similar to the definition of AP, the acid-neutralization potential (NP) of a rock is its total capacity to neutralize acid if all its carbonate minerals react to completion.

5.1.2.2 Metal Leaching

Elevated ML is most commonly associated with ARD due to the high solubility of many metals under acidic conditions. However, some other constituents, including metalloids that form oxyanions such as arsenic, selenium, and molybdenum, and salts such as sulfate, can be released into the environment even if the water draining the rock has a neutral or basic pH (e.g., Smith 2007).

The task of geochemical characterization at a proposed excavation site is to identify the potential of rocks to produce ARD and/or ML that could affect water quality in surface water and/or groundwater.

5.1.2.3 Sample Collection and Rock Description

One rock sample was collected and submitted to Maxxam Analytics in Burnaby, British Columbia for geochemical analysis. The rock sample was collected from exposed rock at the base of the existing dam on May 31, 2016.

The rock was highly weathered and covered with algae and/or aquatic organisms. It is classified as mudstone, which is evident from its black color and very fine grain size. It appears that the limestone has been partially altered due to contact metamorphism, as indicated by the associated greenish colored rock that is inferred to be of intrusive volcanic origin.

5.1.3 Methodology

The rock sample was submitted to Maxxam Analytics Inc. for the following tests:

5.1.3.1 Whole Rock Analysis

Whole rock analysis is the determination of major element oxides of a rock sample. This will total approximately 100% in non-mineralized samples. The prepared rock sample is mixed with $LiBO_2/Li_2B_4O_7$ flux. Crucibles are fused in a furnace. The cooled bed is dissolved in ACS grade nitric acid and analyzed by ICP and/or ICP-MS. Loss on ignition (LOI) is determined by igniting samples then measuring the weight loss.

5.1.3.2 Total Recoverable Elemental Analysis

To determine "whole rock" concentrations of metals, samples were subjected to bulk geochemical analysis after digestion with aqua regia ($HCl + HNO_3$). This digestion is routinely used for analysis of trace heavy metals to allow quantification of the maximum potential reservoir of leachable metals. It also allows comparison of concentrations of selected constituents with average crustal abundance data for similar rock types. The digestion does not completely dissolve resistant minerals such as quartz, spinels, zircon, rutile, ilmenite, chromite, or some silicates. Thus, the concentrations of certain major rock-forming constituents including aluminum, calcium, magnesium, potassium, sodium, and iron may be under-reported by this method. The same is true for more weathering-resistant forms of zirconium, chromium, uranium, thorium, and vanadium.

5.1.3.3 Acid Base Accounting

Acid-Base Accounting (ABA) is the series of laboratory tests designed to estimate a rock's acid potential (AP) and neutralizing potential (NP). The AP of a rock is the total capacity of that rock to generate acid if all of its acid-generating minerals react to completion during weathering. Similar to the definition of AP, the NP of a rock is its total capacity to neutralize acid if all its carbonate minerals react to completion. Both AP and NP are expressed in units of tons of calcium carbonate equivalent per 1,000 tons of material (t $CaCO_3$/kt) to allow direct comparisons. Corrections must be made when the respective minerals are not all pyrite or calcite.

The following tests were included in the ABA analysis:

- Paste pH
- To assess the acid generating status of sample at the time of sampling
- Neutralization Potential

A fizz test is employed to provide a guide to the amount of acid to be initially added to the test. NP is determined by treating a sample of known weight with excess hydrochloric acid at ambient temperatures for approximately 24 hours. Acid is added as required during the acid treatment stage to maintain sufficient acidity for reaction. After treatment, the unconsumed acid is titrated with base to pH 8.3 to allow calculation of the calcium carbonate equivalent of the acid consumed.

<u>Sulphate Sulphur (HCl Extractable)</u>

Sulphate sulphur is extracted from the sample with dilute hydrochloric acid and analyzed using the Konelab. Most sulphate containing minerals are soluble in HCl, but pyritic and organic sulfur species are not. Also, most sulphate minerals including gypsum and anhydrite are non-PAG. However, other minerals such as melanterite ($FeSO_4.7H_2O$) are considered PAG because they will release acid upon dissolution. Mineralogical analysis is used to distinguish between PAG and non-PAG sulphates.

Sulphide Sulphur (HNO_3 extractable)

The residue from the HCl extraction used to determine sulphate sulphur is subsequently extracted using nitric acid. This HNO_3 extract is boiled to dryness and dissolved into HCl to arrive at an extract with the same matrix as the HCl extract (approximately 5% HCl).

Acid Potential

To assess the samples acid-generation capacity. AP is determined from the calculated sulphide sulphur analysis, assuming (1) total conversion of sulphide to sulphate, and (2) production of 4 moles of H+ per mole of pyrite oxidized, in which a conversion factor of 31.25 is used to convert percent contained sulphur to kg $CaCO_3$ equivalent per tonne of material (kg $CaCO_3$/T).

Carbonate Carbon Content

To allow estimate of reactive NP due to presence of carbonate minerals.

Neutralization Potential Ratio (NPR = NP/AP)

Most jurisdictions have a NPR criterion for classifying a sample as non-PAG or PAG. Price (2009) recommends the following classification:

NPR > 2: Sample is considered non-PAG

2 > NPR > 1: Test is inconclusive

1 > NPR: Sample is considered PAG

Net Neutralization Potential (NNP = NP – AP)

A sample is classified as PAG if its acid generation potential exceeds the acid neutralization capacity such that the NNP is a negative number. If a positive NNP value is less than +20 kg $CaCO_3$/T, the test is typically considered inconclusive. Price (2009) does not recommend using NNP in characterizing the future acid producing potential. However, it is potentially useful in mitigation design.

5.1.3.4 Shake Flask Extraction

The shake flask extraction (SFE) is applied to identify parameters potentially prone to leaching in the field.

Samples were shaken for 24 hours at 3:1 water to solids ratio by weight with reverse osmosis deionized (RODI) water. Gentle agitation is provided to ensure continuous exposure of all surfaces and mixing of the rinse solution. Twenty-four hours is a nominal residence time.

5.1.4 Results and Discussion

5.1.4.1 Types and Occurrence of Minerals

Table 4 presents the results of the Whole Rock Analysis of the Chapman Lake rock sample. These amounts represent the relative amounts of major element oxides of a rock sample and normalized to 100%.

The Chapman Lake rock sample is mainly composed of quartz (SiO_2), hematite (Fe_2O_3) and Ca/Mg minerals. The CaO and MgO may be derived from fragments of plagioclase and feldspar. Limestone and/

calcite are also a potential source of CaO and MgO, as these minerals are a common cementing agent in shale and sandstone.

Table 4: Results of Whole Rock Analysis – ICP

Sample ID		Chapman Lake
Depth (m.b.g.s)		0.00
Lithology Description		Mudstone
Weathering		Moderate (II)
Major Element Oxides Composition	**Unit**	**Value**
SiO_2	%	42.8
Al_2O_3	%	13.2
Fe_2O_3	%	11.4
MgO	%	8.91
CaO	%	16.2
Na_2O	%	1.4
K2O	%	1.4
TiO_2	%	1.1
P_2O_5	%	0.1
MnO	%	0.2
Cr_2O_3	%	0.157
Ba	ppm	237.0
Ni	ppm	279.0
Sr	ppm	243
Zr	ppm	75
Y	ppm	15
Nb	ppm	11
Sc	ppm	35
LOI	%	3
Total	%	99.88

The high quartz content (42.8%) is consistent with the mudstone classification. Sedimentary rock usually exhibits a high quartz content because quartz is one of the most abundant minerals in the exposed continental crust. It is an extremely hard, resistant and chemically stable mineral. The low content of potassium (K_2O) indicates that potassium (K)-feldspar has been weathered from the parent rock.

5.1.4.2 Total Recoverable Elemental Analysis

The Total Recoverable Elemental Analysis was conducted to quantify of the maximum potential reservoir of leachable metals. Laboratory concentrations of selected constituents were compared to five times the average crustal abundance data (Price, 1997) for similar rock types (i.e., Shale and Deep-Sea Clay Sediment) to identify metals that are locally elevated.

Table 5 presents the concentrations of a number of constituents from the aqua-regia digestion of the Chapman Lake sample, as well as the average crustal abundances of those constituents in Shale and Deep-Sea Clay. In most cases, the values for both reference data sets were similar, with the exception of silicon. Deep-Sea Clay contains concentrations of silicon (25%) that are approximately 3.5 times higher than those found in Shale (7.3%).

In order to estimate element enrichment in the Chapman Lake sample, a screening criterion was developed by multiplying the crustal abundance values by a factor of five, which is commonly applied in ML/ARD assessments. No elements were found to be present at concentrations above the five times crustal abundance screening criterion for Shale and/or Deep-Sea Clay.

Table 5: Comparison of Total Recoverable Constituents to Crustal Abundance – Chapman Lake

Parameters	Units	Crustal Abundance in Rocks from Price (1997)				Chapman Lake
		Shale[a]	Shale x5[b]	Deep-sea Clay[a]	Deep-sea Clay x5[b]	
Aluminum (Al)	%	8	40	8.4	42	1.97
Antimony (Sb)	ppm	1.5	7.5	1	5	<0.1
Arsenic (As)	ppm	13	65	1	5	0.6
Barium (Ba)	ppm	580	2900	2300	11500	19
Bismuth (Bi)	ppm	-	-	-	-	<0.1
Boron (B)	ppm	100	500	230	1150	<20
Cadmium (Cd)	ppm	0.3	1.5	0.42	2.1	0.3
Calcium (Ca)	%	2.21	11.05	2.9	14.5	2.24
Chromium (Cr)	ppm	90	450	90	450	276
Cobalt (Co)	ppm	19	95	74	370	25.2
Copper (Cu)	ppm	45	225	250	1250	8
Gallium (Ga)	ppm	19	95	20	100	4
Gold (Au)	ppb	-	-	-	-	1.1
Iron (Fe)	%	4.72	23.6	6.5	32.5	2.27
Lanthenum (La)	ppm	92	460	115	575	<1
Lead (Pb)	ppm	20	100	80	400	3.7
Magnesium (Mg)	%	1.5	7.5	2.1	10.5	1.4
Manganese (Mn)	ppm	850	4250	6700	33500	400
Mercury (Hg)	ppm	0.4	2	-	-	<0.01
Molybdenum (Mo)	ppm	2.6	13	27	135	<0.1
Nickel (Ni)	ppm	68	340	225	1125	120
Phosphorus (P)	%	0.07	0.35	0.15	0.75	0.053
Potassium (K)	%	2.66	13.3	2.5	12.5	0.1
Scandium (Sc)	ppm	13	65	19	95	6.1
Selenium (Se)	ppm	0.6	3	0.17	0.85	<0.5
Silicon (Si)	%	7.3	36.5	25	125	-
Silver (Ag)	ppm	0.07	0.35	0.11	0.55	<0.1
Sodium (Na)	%	0.96	4.8	4	20	0.162
Strontium (Sr)	ppm	300	1500	180	900	60
Sulfur (S)	%	0.24	1.2	0.13	0.65	<0.05
Tellurium (Te)	ppm	-	-	-	-	<0.2
Thallium (Tl)	ppm	1.4	7	0.8	4	<0.1
Thorium (Th)	ppm	12	60	7	35	<0.1
Titanium (Ti)	%	0.46	2.3	0.46	2.3	0.109
Tungsten (W)	ppm	1.8	9	-	-	<0.1

Parameters	Units	Crustal Abundance in Rocks from Price (1997)				Chapman Lake
		Shale[a]	Shale x5[b]	Deep-sea Clay[a]	Deep-sea Clay x5[b]	
Uranium (U)	ppm	3.7	18.5	1.3	6.5	<0.1
Vanadium (V)	ppm	130	650	120	600	43
Zinc (Zn)	ppm	95	475	165	825	84

Notes:

[a] *From Price (1997), Appendix 3*

[b] *Enrichment criteria based upon crustal abundance data multiplied by a factor of 5.*

Exceeds One Enrichment Criteria

Exceeds Two Enrichment Criteria

Lower limit of detection exceeds criteria from both compilations.

Comparison of the results for the major silicate forming constituents including aluminum, potassium, sodium, and iron show that they are less than their average crustal abundance criteria, suggesting these nutrients may have been leached over time due to natural weathering processes. However, calcium and magnesium are comparable with the Shale and Clay crustal abundance, indicating that the rock sample may contain another calcium and magnesium-bearing mineral (i.e., calcite or dolomite cement).

Although silicon was not analyzed, the high SiO_2 content (42.8%) obtained from Whole Rock Analysis suggests that the composition of Chapman rock sample is more similar with Deep-Sea Clay derived sediments.

5.1.4.3 Acid Base Accounting

The risk of acid generation was determined based upon the NPR and total sulfide-sulphur content following the method described by Price (2009).

The results of ABA testing are presented in Table 6, and indicate that the Chapman Lake sample has an alkaline paste pH value, with no measurable sulfur (<0.02%), and high concentrations of neutralizing material. This resulted in an NPR value that is significantly greater than 2, and the Chapman Lake sample is classified as non-PAG.

Table 6: Acid Base Accounting (ABA) Results - Chapman Lake

Depth (m.bgs)	Lithology Description	Weathering	Paste pH	CO_2	$CaCO_3$ Equiv.	Total S	HCl Extractable Sulphur	HNO_3 Extractable Sulphur	Non Extractable Sulphur (by diff.)	Acid Generation Potential (AP)	Mod. ABA Neutralization Potential (NP)	Net Neutralization Potential NNP=NP-AP	Neutralization Potential Ratio NPR = NP/AP	Acid Generation Status
				wt%	Kg $CaCO_3$/T	wt%	wt%	wt%	wt%	Kg $CaCO_3$/T	Kg $CaCO_3$/T	Kg $CaCO_3$/T		
0.00	Mudstone	Moderate (II)	8.85	0.58	13.20	<0.02	<0.01	<0.01	<0.02	<0.3	25.00	> 24.70	> 83.33	Non-PAG

Notes:

*AP = HNO_3 Extractable Sulphide Sulphur*31.25*

$CaCO_3$ Equivalency = Carbonate Carbon (CO_2)(100/44)*10*

Mod. ABA Neutralization Potential - MEND Acid Rock Drainage Prediction Manual,
MEND Project 1.16.1b (pages 6.2-11 to 17), March 1991.

5.1.4.4 Shake Flask Extraction

The shake flask extraction (SFE) results are presented in Table 7. The results are compared to the Contaminated Sites Regulation (CSR), Schedule 6 water quality criteria for the protection of freshwater aquatic life, and the BC Approved and Working Water Quality Guidelines (BCWQG) for protection of freshwater aquatic life.

The CSR Schedule 6 numerical standards were developed for groundwater and generally assume a tenfold dilution factor to account for groundwater discharge to surface watercourses. BCWQG are the applicable surface water quality guidelines for ambient freshwater.

In general, the Chapman Lake sample produced low concentrations of easily leached constituents when subjected to the SFE analysis, which is consistent with the results of the total elemental analysis. None of the leached constituent concentrations exceeded CSR Schedule 6 Criteria. Cadmium, chromium and copper concentrations slightly exceeded the BCWQGs.

The results of the SFE analysis confirm the results of the ABA testwork in that the SFE leachate pH value is alkaline, and leachate exhibited moderate alkalinity (>20 mg/L). As such, the rock sample indicates there is sufficient acid buffering capacity and the rock is not highly sensitive to acid inputs.

5.1.5 Conclusions

Based on the results of the preliminary geochemical investigation, the following conclusions are drawn:

Based on a review of geologic mapping for the Chapman Lake site, bedrock lithology at all locations is anticipated to consist of late Jurassic to Cretaceous quartz diorite and granodiorite. However, the collected Chapman Lake sample appears to be highly weathered mudstone. The lithology is difficult to identify from the surface sample due to the highly weathered surface. The rock sample analyzed as part of this work was collected from exposed surface rock which may be not representative of subsurface bedrock lithologies present in the area. However, based on the results of the analysis completed on the surface sample collected and the other observations made well completing the field investigations it is expected that acid producing rock being present within the proposed construction area is low for the following reasons:

1. Sulphide minerals were not detected by the whole rock analysis, suggesting a low potential for acid generation.
2. The total metal analysis indicates that no elements are present at concentrations above their respective average crustal abundance screening criteria.
3. The risk of acid generation was determined to be low based on the neutralizing potential ratio (NPR) and total sulfide-sulphur content. The Chapman Lake sample is classified as non-PAG.
4. Shake flask extraction results were consistent with the ABA testwork and whole rock chemistry data as follows:
    1. Leachate pH is alkaline and moderately alkaline, so there is sufficient acid buffering capacity and a low sensitivity to acid inputs.
    2. No leachate constituent concentrations exceeded CSR Schedule 6 Criteria.
    3. Cadmium, chromium and copper marginally exceeded BCWQGs.

Table 7: MEND Shake Flash Extraction Results – Chapman Lake

Sample ID	Units	Contaminated Sites Regulation (CSR) Schedule 6 Criteria	British Columbia Water Quality Guidelines (BCWQG)- - Aquatic Life (Aquatic Water)	Chapman Lake	Duplicate	QA/QC
Hardness (as $CaCO_3$)	mg/L	-	-	21.5	22.8	*
pH (Lab)	-	-	-	9.29	9.4	*
Electrical Conductivity (Lab)	µS/cm	-	-	52.7	55.4	*
Total Alkalinity (as CaCO3)	mg/L	-	10 (minimum) [b]	25	26	*
Bicarbonate	mg/L	-	-	30	32	*
Carbonate	mg/L	-	-	<0.5	<0.5	-
Hydroxide (OH)	mg/L	-	-	<0.5	<0.5	-
Sulfate (SO_4)	mg/L	1000	128[a]	<0.5	<0.5	-
Dissolved Metals						
Aluminum (Al)	mg/L	-	-	0.657	0.671	*
Antimony (Sb)	mg/L	0.2	0.02 [c]	0.000051	0.000052	*
Arsenic (As)	mg/L	0.05	0.005	0.000729	0.000792	*
Barium (Ba)	mg/L	10	5 [c]	0.00138	0.00133	*
Beryllium (Be)	mg/L	0.053	0.0053 [c]	<0.000010	<0.000010	-
Bismuth (Bi)	mg/L	-	-	<0.0000050	<0.0000050	-
Boron (B)	mg/L	50	1.2	<0.050	<0.050	-
Cesium (Cs)	mg/L	-	-	<0.000050	<0.000050	-
Cadmium (Cd)	mg/L	0.0001 - 0.0006 [a]	0.00001 - 0.00004 [a,c]	0.000013	0.000016	*
Calcium (Ca)	mg/L	-	-	7.5	7.96	*
Chromium (Cr)	mg/L	0.09	0.001 [c]	0.00179	0.00228	24
Cobalt (Co)	mg/L	0.04	0.11	0.000111	0.000161	*
Copper (Cu)	mg/L	0.02 - 0.09 [a]	0.002 - 0.017 [c]	0.00245	0.00258	*

Sample ID	Units	Contaminated Sites Regulation (CSR) Schedule 6 Criteria	British Columbia Water Quality Guidelines (BCWQG)- - Aquatic Life (Aquatic Water)	Chapman Lake	Duplicate	QA/QC
Iron (Fe)	mg/L	-	1	0.0904	0.119	27
Lanthenum (La)	mg/L	-	-	<0.000050	<0.000050	-
Lead (Pb)	mg/L	0.04 - 0.16 ^{a}	0.003 - 0.096 ^{c}	0.000041	0.000049	*
Lithium (Li)	mg/L	-	0.87 ^{c}	<0.00050	<0.00050	-
Magnesium (Mg)	mg/L	-	-	0.661	0.708	*
Manganese (Mn)	mg/L	-	0.6 - 2.5 ^{a}	0.00218	0.00289	28
Mercury (Hg)	mg/L	0.001	-	<0.000050	<0.000050	-
Molybdenum (Mo)	mg/L	10	2	0.000103	0.00012	*
Nickel (Ni)	mg/L	0.25 - 1.5 ^{a}	0.065 ^{a,c}	0.00172	0.00212	21
Phosphorus (P)	mg/L	-	-	0.0328	0.0337	*
Potassium (K)	mg/L	-	-	0.627	0.66	*
Rubidium (Rb)	mg/L	-	-	0.000548	0.000545	*
Selenium (Se)	mg/L	0.01	0.002	<0.000040	0.000044	-
Silicon (Si)	mg/L	-	-	3.81	3.81	*
Silver (Ag)	mg/L	0.0005 - 0.015 ^{a}	0.0001 - 0.003 ^{a}	<0.0000050	<0.0000050	-
Sodium (Na)	mg/L	-	-	1.83	1.94	*
Strontium (Sr)	mg/L	-	-	0.0169	0.0171	*
Sulphur (S)	mg/L	-	-	<10	<10	-
Tellurium (Te)	mg/L	-		<0.000020	<0.000020	-
Thallium (Tl)	mg/L	0.003	0.0003 ^{c}	0.000002	0.000002	-
Thorium (Th)	mg/L	-	-	<0.0000050	<0.0000050	-
Tin (Sn)	mg/L	-	0.00008 ^{c}	<0.00020	<0.00020	-
Titanium (Ti)	mg/L	1	-	0.00508	0.00462	*
Tungsten (W)	mg/L	-	-	0.000145	0.000158	*
Uranium (U)	mg/L	3	-	0.000012	0.000013	*

Sample ID	Units	Contaminated Sites Regulation (CSR) Schedule 6 Criteria	British Columbia Water Quality Guidelines (BCWQG)- - Aquatic Life (Aquatic Water)	Chapman Lake	Duplicate	QA/QC
Vanadium (V)	mg/L	-	-	0.00501	0.00501	*
Zinc (Zn)	mg/L	0.075 - 2.4 [a]	0.0075 - 0.056 [a]	0.00033	0.00077	80
Zirconium (Zr)	mg/L	-	-	<0.00010	<0.00010	-

Notes:

[a] *Guideline/standard varies with hardness*

b *If alkalinity < 10 mg CaCO3/L (<4 mg dissolved Ca/L), then waterbody is highly sensitive to acid inputs.*

c *Presented in the working water quality guidelines (BCWQG)*

Exceeds BCWQG AW

Exceeds CSR AW

5.2 Aquatic

The Chapman Creek watershed (Watershed Code: 900-120400) is located approximately 5 km east of Sechelt, BC. Chapman Creek flows south from the Tetrahedron Plateau for approximately 24 km and discharges into the Strait of Georgia. Chapman Creek watershed is approximately 73 km² in area.

Tetrahedron Provincial Park was established to maintain and enhance the area's water quality and community watersheds for Sunshine Coast residents and preserve its wilderness characteristics by offering limited backcountry recreation opportunities. Tetrahedron Provincial Park is characterized by steep, short mountainous peaks, spongy, water laden meadows and numerous small lakes, including Chapman Lake. Abundant rainfall and snow pack recharges the freshwater supply.

5.2.1 Chapman Lake

Chapman Lake lies at an elevation of 974 m above sea level in steeply sloping terrain; surrounding ridgetops and peaks typically reach over 1,500 m elevation. A bathymetric survey of the lake was completed by Strait Land Surveying Inc. in 2013 and the following data was derived from that survey data. The lake has a surface area of 33.5 ha and a maximum depth of approximately 31 m. It is the largest lake in the Chapman Creek watershed. The catchment area of the lake is 6.58 km², and the lake is fed by 2 main streams, both of which enter at the east end of the lake. The lake volume at the high water level is approximately 4.1 million m^3 with an average outflow rate of 0.604 m^3/s. Based on these data, the average retention time of water in the lake is approximately 79 days. The short retention time reflects the high level of precipitation in the watershed. Outflow from the lake is controlled by a concrete dam and valve located on the west side of the lake and operated by the SCRD. During a typical year, water stored behind the dam is allowed to overflow naturally until there is a need to supplement the flows to Chapman Creek, at which time the dam is opened to release stored water from the reservoir. The annual lake level variation is currently between 1.5 m to 3 m.

5.2.2 Chapman Lake Water Quality

Whitehead (1999) conducted a limited assessment of water quality of Chapman Lake. Parameters measured included Secchi disc transparency, temperature and dissolved oxygen. The Secchi disk indicated clear water with a reading at 6.25 metres. Temperature ranged from 16°C at the surface to 7°C at depth with a thermocline evident at a depth of approximately 4 m. During the monitoring program gas bubbles were observed throughout the lake and particularly at the east end in the shallower areas. Based on the smell of hydrogen sulphide it was concluded the gas bubbles were originating from anaerobic decomposition originating in the lake sediments (Whitehead 1999).

Water quality parameters measured during the August 2016 field survey included Secchi disk, temperature and dissolved oxygen depth profiles and laboratory analysis of samples collected at the surface, thermocline and bottom at the deepest points in the lake (Figure 9). Laboratory analysis included physical properties, anions, nutrients, organic carbon, chlorophyll a and total metals. Details of the results of analysis for each of the sample analysis locations are provided in Appendix D. Results of analysis were compared to both the Approved BC Water Quality Guidelines and Canadian Council of Ministers of the Environment (CCME).

Secchi disk readings taken from the deepest part of the lake were measured to be 7.35 m, which was 1.1 m deeper than readings obtained by Whitehead (1999). Dissolved oxygen and temperature depth profiles were taken from 2 locations in the lake as shown on Figure 9. Results of the temperature and dissolved oxygen profiles are depicted in Figure 7 and Figure 10 respectively. Temperatures ranged from 17.9°C at the surface to 3.9°C at depth with the thermocline occurring between the 4 m to 9 m depth. Similar results were obtained in 1999 (Whitehead) although a profile to the bottom was not performed in the original study. Temperature was consistent between the two locations measured in 2016. Dissolved oxygen levels peaked at approximately the 4 m to 6 m depth.

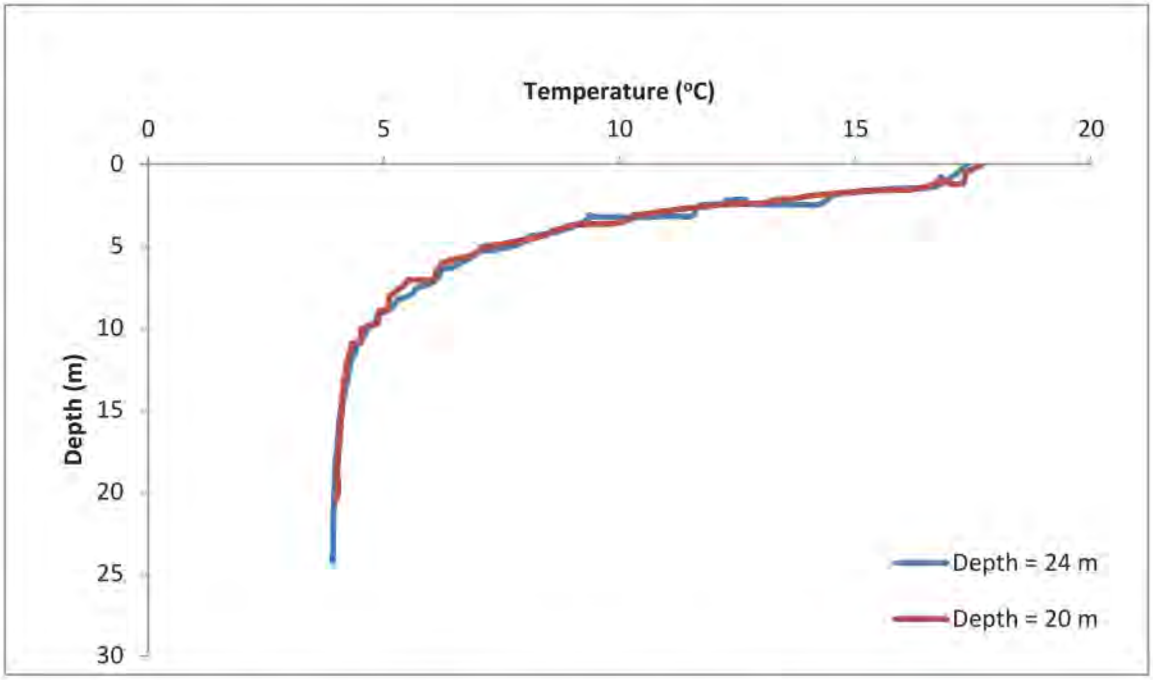


Figure 7: Temperature Depth Profiles in Chapman Lake, 2016

The SCRD collects temperature data of the surface water at the outlet of the lake. Figure 8 provides a plot of the data collected in 2014, 2015 and 2016. Water temperature occasionally exceeds 20° C during the summer months with the exception of the hot summer of 2015 when surface water temperatures were at or above 20° C for almost three weeks.

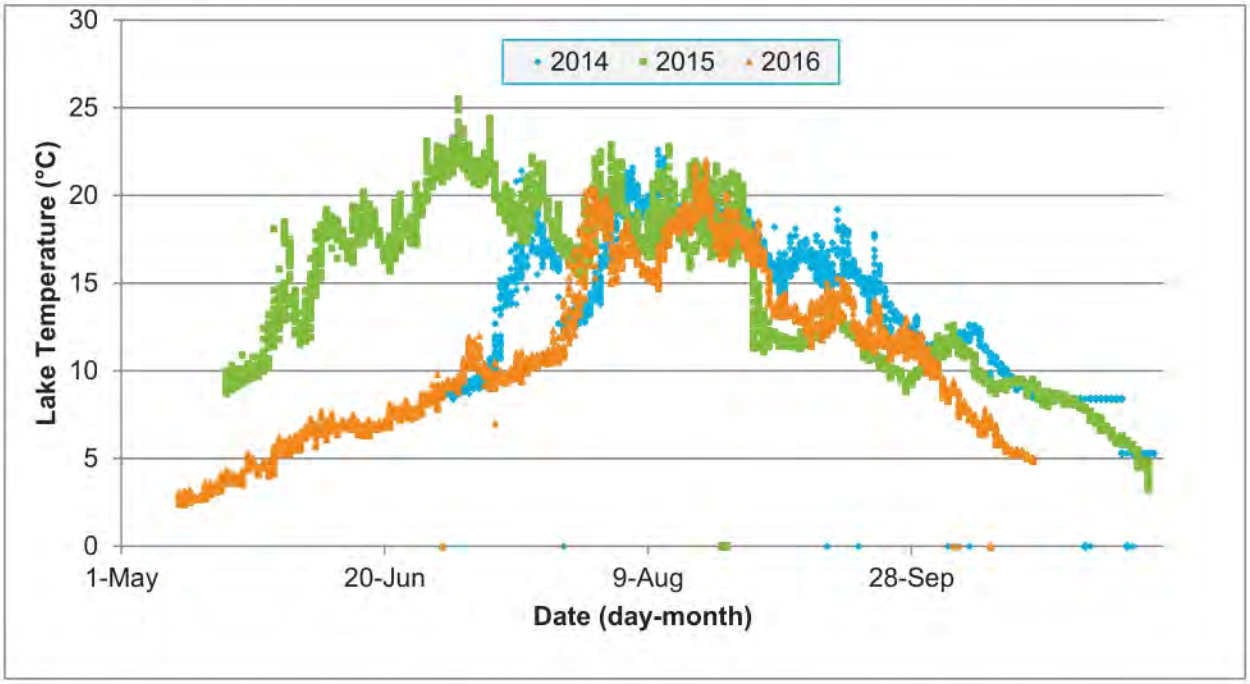
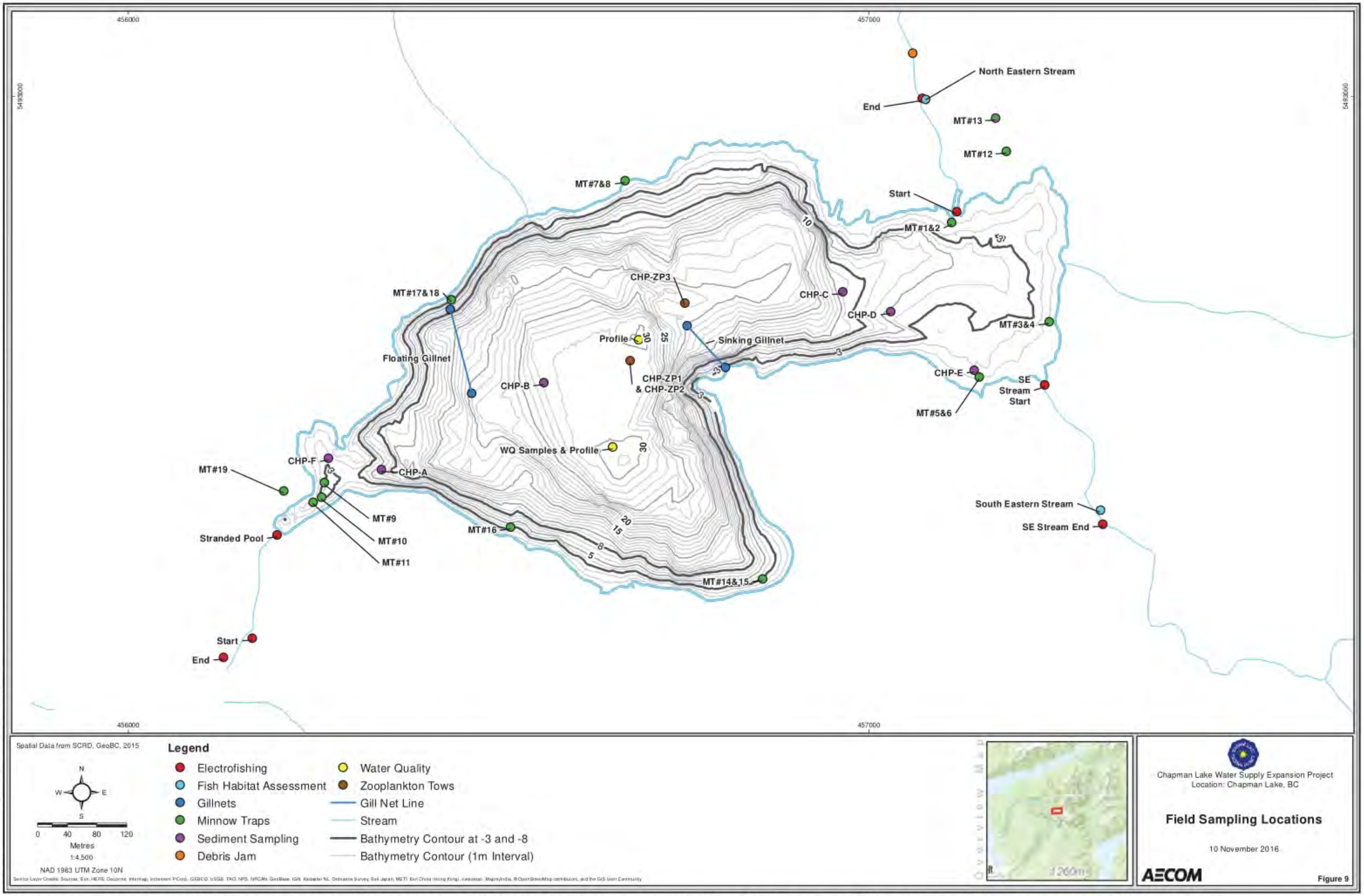


Figure 8: Surface Water Temperature at the Outlet of Chapman Lake, 2014 to 2016



Service Layer Credits: Sources: Esri, HERE, DeLorme, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

Chapman Lake Water Supply Expansion Project
Location: Chapman Lake, BC

Field Sampling Locations

10 November 2016

AECOM

Figure 9

File Location: P:\60485918\900-Work\920-929 (GIS)\02_Maps\2016-09-21-FieldData\Figx-2016-09-21-ChapmanLakeFieldData-60485918-003.mxd Date Revised: November 10, 2016 Reviewed By: AM
Paper Size: 11"x17" Scale is referenced to the specified paper size

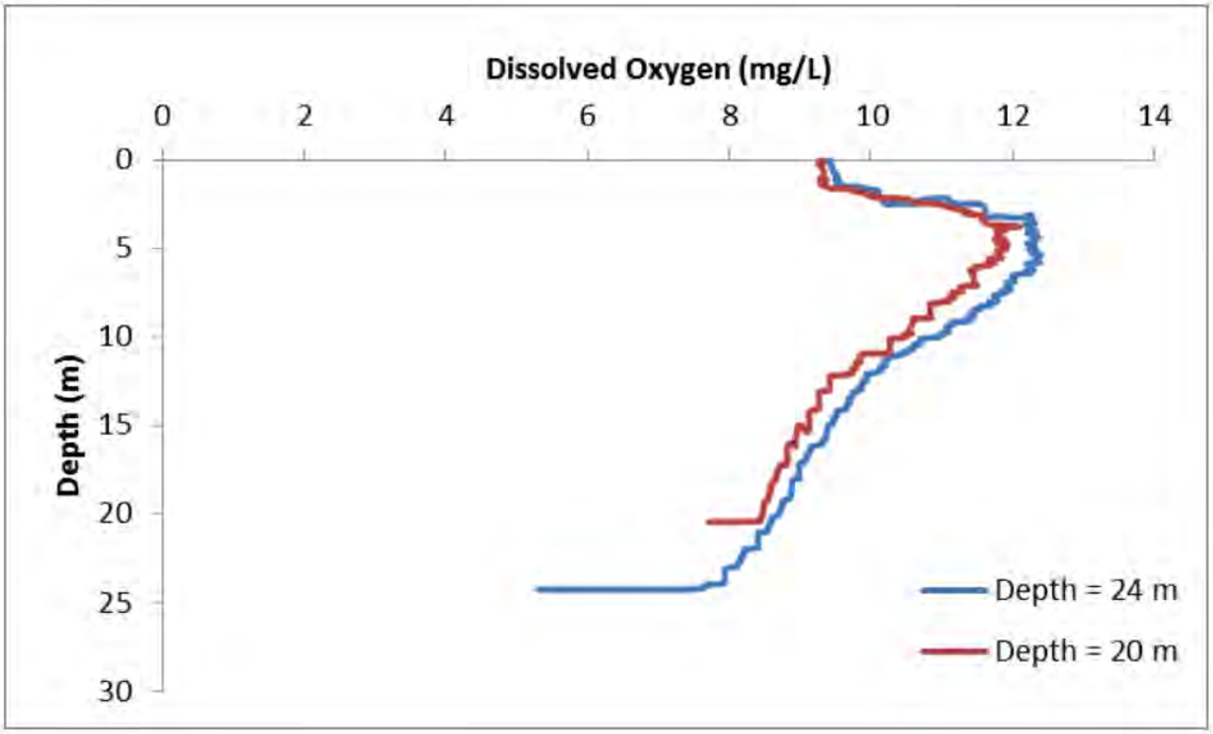


Figure 10: Dissolved Oxygen Depth Profile in Chapman Lake, 2016

Sample analysis indicated that water was generally slightly acidic (mean 6.83), with low buffering capacity and nutrients. Phosphorus levels in the lake were in the ultra-oligotrophic range (CCME 2004). Comparisons of available water quality parameters to guideline values measured one exceedance of total aluminum measured at the bottom depth. Hydrogen sulphide readings at all depths were below detection limits. The study conducted in 1999 (Whitehead) noted the smell of hydrogen sulphide and the visible presence of gas bubbles in the lake. No presence of gas bubbles or releasing of gas bubbles were noted during the 2016 field investigation. Table 8 provides a summary of key water quality parameters taken at the sample site shown on Figure 9. The complete set of parameters and sampling results is provided in Appendix D.

Table 8: Summary of Key Water Quality Parameters in Chapman Lake, 2016

Key Parameter	Units	Surface	Thermocline (6 m)	Bottom
pH	-	6.90	6.78	6.81
Sulphide (as H2S)	mg/L	<0.021	<0.021	<0.021
Orthophosphate-Dissolved (as P)	mg/L	<0.0010	<0.0010	0.0011
Phosphorus (P)-Total	mg/L	0.0020	<0.0020	0.0023
Total Hardness (CaCO3)	mg/L	7.79	6.28	7.73
Total Aluminum (Al)	mg/L	0.0551	0.0875	**0.111**

Bolded values exceeded Water Quality Guidelines, see Appendix D

5.2.3 Sediment Quality

Sediment characterization occurred during the 1998 study by conducting course sediment approximations along transects throughout the lake. Slopes were noted as well as surficial materials classification into mud/silt, sand, gravel and bedrock. A map was produced of the approximate distribution of surficial materials. Materials around the lake range from deep organic forest soils to alluvial sands and gravels and bedrock. Below the high water level, silt was predominant due to the deposition of mineral and organic material from the overlying water column.

During the 2016 study, observational confirmation of the approximate distribution of surficial materials based on the map produced during the previous assessment was completed. Additionally, sediment samples were collected using an Eckman grab sampler at 4 locations, which consisted of 2 shallow depths, mid-depth and deep depth (Figure 9) in 2016. Samples were collected and placed into glass jars and sent for grain size analysis to ALS Laboratories in Burnaby, BC. Samples were kept cold at all times between sample collection and delivery to the lab.

The results of the 2016 laboratory analysis confirms the previous findings in the 1998 study, that silt was the predominant lake material observed at depth. Figure 11 provides the percent composition grain size for each of the sample locations. The dominant grain size at each of the locations was silt.

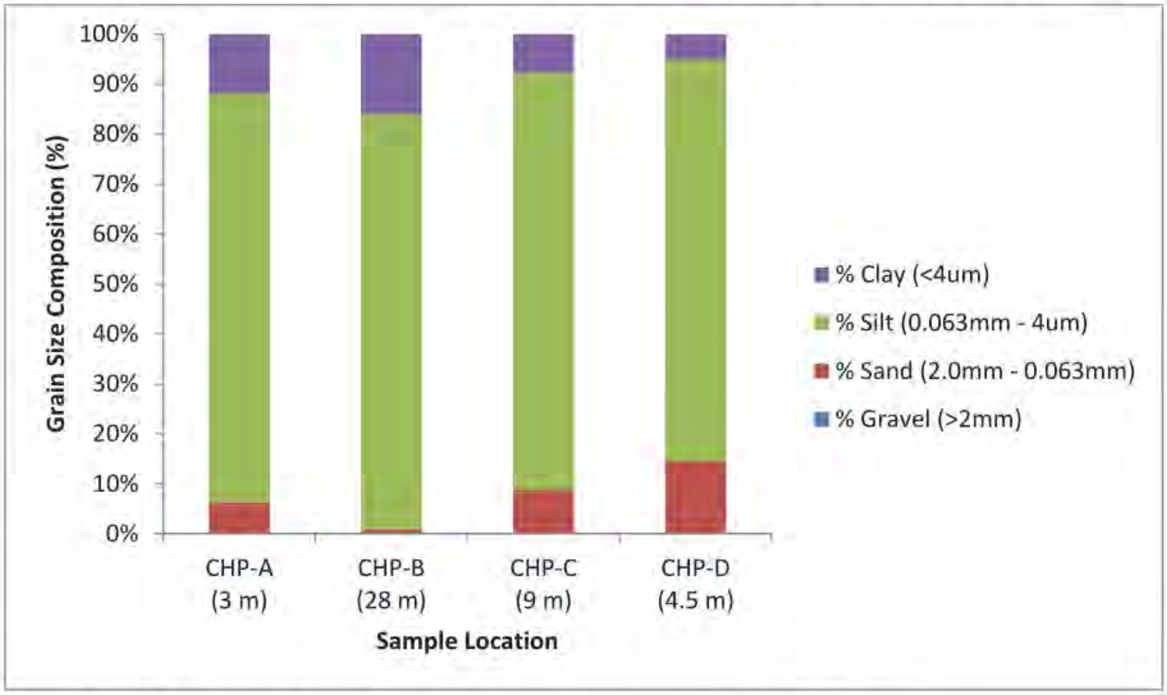


Figure 11: Sediment Grain Size Analysis in Chapman Lake, 2016

5.3 Fisheries Resources

5.3.1 Chapman Lake Fish

The provincial Fish Inventory Summary System[2] database reports that the headwaters section of Chapman Creek supports resident populations of Dolly Varden char (*Salvelinus malma*) and rainbow trout (*O. mykiss*). Coastal cutthroat trout (*O. clarki clarki*) have also been reported in the headwaters of

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[2] http://a100.gov.bc.ca/pub/fidq/welcome.do

Chapman Creek. A fish sampling program was undertaken to supplement existing information to support the impact assessment in 1998.

During the 1998 study, gillnetting and minnow trapping methods were used to sample the lake during a 24 hour period. The gill net was set at the surface at a single location near the centre of the lake with minnow traps set along the eastern portion of the lake. Only Dolly Varden char averaging 14 cm long were captured in the lake during this sampling period. The majority of fish were caught between 0.5 m to 1.5 m from the surface. The average length and weight of the 68 gillnet captured fish were 139 mm and 29.3 g respectively (Whitehead 1999).

The 2016 fish sampling program in the study area consisted of minnow trapping gillnetting and electrofishing. Two gillnets were used for sampling, a sinking and floating net. The sinking gill net was set in the same location as the 1998 assessment. Minnow traps were set throughout the lake along the shallows, in areas with appropriate fish habitat (e.g. trees, boulders). Electrofishing was conducted in the lake outlet stream below the dam and at the two larger inlet streams along the eastern portion of the lake. The sampling effort for each method is provided in Table 9, Table 10 and Table 11 with the sampling locations shown on Figure 9. Five fish were selected to represent the range of sizes caught and were submitted to the laboratory for analysis of mercury concentrations.

Table 9: Minnow Trapping Effort in Chapman Lake, 2016

MT Ref	Deployment	Retrieval	Total Soak Time (hh:mm)
1	8/23/2016 16:30	8/24/2016 9:35	17:05
2	8/23/2016 16:30	8/24/2016 9:35	17:05
3	8/23/2016 16:45	8/24/2016 9:20	16:35
4	8/23/2016 16:45	8/24/2016 9:20	16:35
5	8/23/2016 16:50	8/24/2016 9:15	16:25
6	8/23/2016 16:50	8/24/2016 9:15	16:25
7	8/23/2016 17:00	8/24/2016 9:10	16:10
8	8/23/2016 17:00	8/24/2016 9:10	16:10
9	8/23/2016 17:20	8/25/2016 12:30	43:10
10	8/23/2016 17:20	8/25/2016 12:30	43:10
11	8/23/2016 17:20	8/25/2016 12:30	43:10
12	8/24/2016 15:50	8/25/2016 11:25	19:35
13	8/24/2016 15:50	8/25/2016 11:25	19:35
14	8/24/2016 16:05	8/25/2016 11:45	19:40
15	8/24/2016 16:05	8/25/2016 11:45	19:40
16	8/24/2016 16:10	8/25/2016 11:50	19:40
17	8/24/2016 16:15	8/25/2016 12:00	19:45
18	8/24/2016 16:15	8/25/2016 12:00	19:45
19	8/24/2016 10:00	8/25/2016 12:30	26:30

Table 10: Electrofishing Total Effort in Streams along Chapman Lake, 2016

Location	Total Electrofishing Effort (seconds)
Downstream of dam	448
Stranded pools downstream of dam	60
South east stream	426
North east stream	408

Table 11: Gillnetting Total Effort

Net Type	Deployment	Retrieval	Total Soak Time (hh:mm)
Sinking Net	8/24/2016 15:10	8/25/2016 10:00	18:50
Floating Net	8/24/2016 15:40	8/25/2016 8:50	17:10

A total of 16 fish were captured by minnow traps; 14 captured by electrofishing; and, 87 were captured in the gill nets. Appendix E provides details of the fish captured for each of the sampling methods, including length, weight, species and condition factor. Weight, length and stomach contents were recorded for 50 fish captured in the gill nets that were representative of the size and location of the fish caught, the rest were counted only. All fish captured were identified as Dolly Varden. Photos of fish captured are provided in Photographs 12 through 14.

5.3.1.1 Fish Size

The average fish length captured in and around Chapman Lake was 118 mm (fork length), which was 20 mm smaller than the average length reported in the 1998 study. The average length of fish captured in the lake in gill nets was 144 mm; average capture length in the north eastern stream during electrofishing was 67 mm; and, fish captured in minnow traps in channels off the lake was 59 mm. Length-frequency histograms were produced for fish in streams and in the lake and results are provided in Figure 12. Length frequency trends and capture locations indicate that younger fish remain in the streams and don't move to the lake until they reach a larger size.

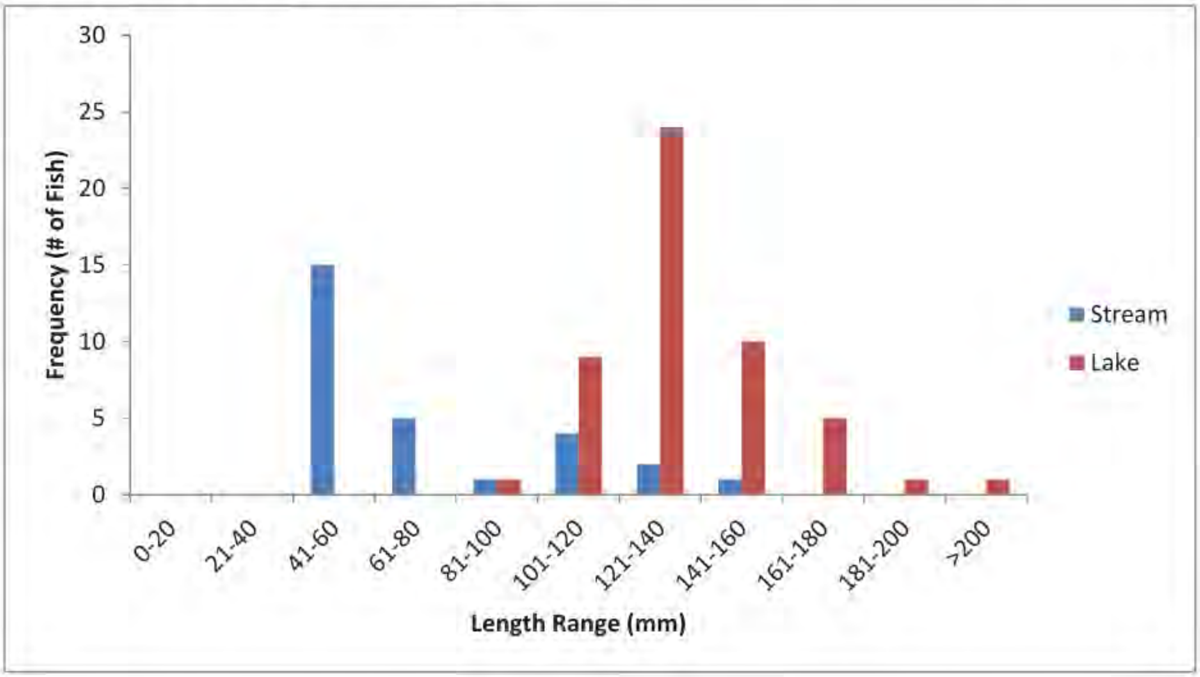

Figure 12: Length Frequency Histogram of Fish Captured in Chapman Lake and Inlet Streams, 2016

Weight-length regressions for fish were calculated as:

$$\ln(W) = a + b\,x\,(\ln(L))$$

where W = weight (g) and L = fork length (mm), a = the intercept of the regression, and b = the slope of the regression.

Both weight and length were transformed using natural logarithms to normalize the distributions and produce homogenous variances. The slope of the regression (b) provides information on fish growth. If b = 3 the growth is isometric, which means the shape of the fish does not change with growth. The results of the length-weight regression analysis are provided in Figure 13. The slope for fish in Chapman Lake was 3.07 indicating the fish growth is isometric, a typical growth pattern for healthy salmonids.

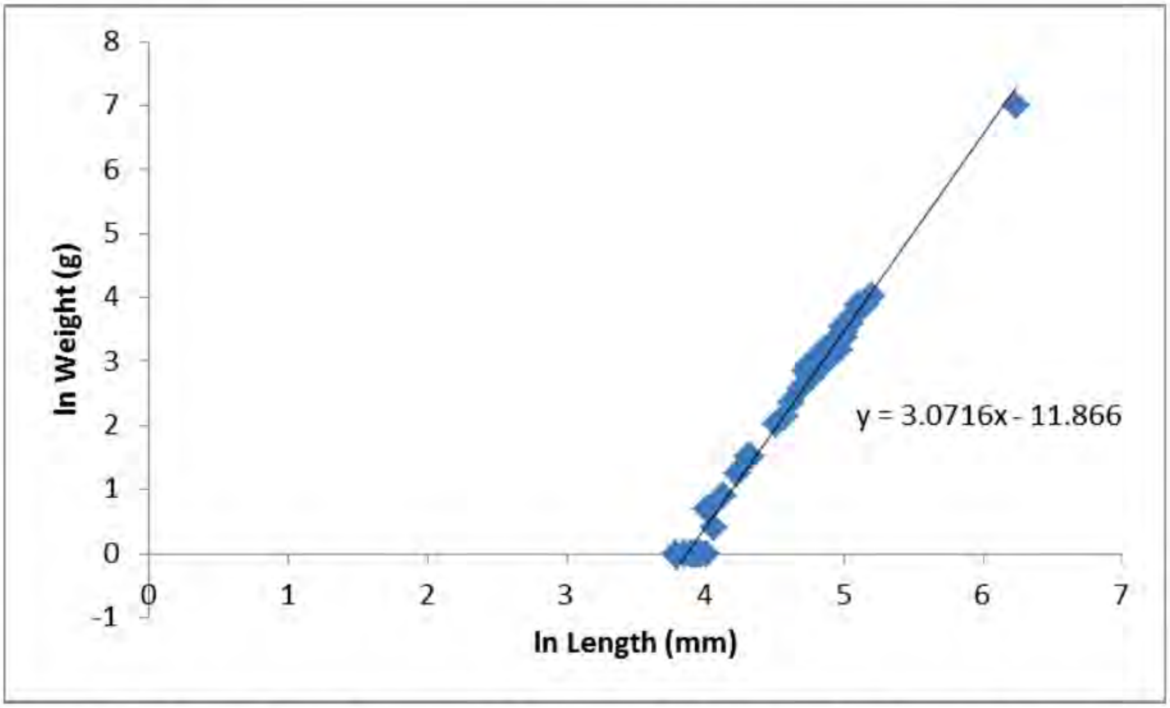

Figure 13: Length Weight Regression Analysis of Fish Captured in Chapman Lake, 2016

5.3.1.2 Fish Condition

A Fulton condition factor (K) was calculated for each fish as:

$$K = \left(\frac{W}{L^3}\right) \times 100{,}000$$

where W = weight (g) and L = fork length (mm).

A summary of condition factors (K) statistics for each of the fish captured is presented in Appendix E. The condition factor represents an index of the "fatness" of the fish as measured by the weight of the fish relative to its length. Thus, the heavier a fish is for a given length the higher the condition factor. The average condition factor (0.99) for all captured fish was close to 1, which is an indication that the fish are in relatively good condition. Values below 1 suggest poor nutrition or other factors are limiting the health of fish.

5.3.1.3 Fish Age

Fish aging structures were obtained from a varied size class from the gill net captured Dolly Varden fish in Chapman Lake. Fish otoliths were removed from 20 fish and sent for fish aging analysis to a fish aging professional. A size analysis was completed prior to otolith removal to ensure a representative size class of fish was being analyzed. Details of the lengths, weights, sex and age of the selected gill net fish are provided below in Table 12 and the age frequency plot is provided in Figure 14. Results indicated that the average age of fish analyzed were 4+ years. Based on the age class of the analyzed otoliths in comparison with the overall captured fish length range, Table 13 below provides an approximate age-length classification.

Table 12: Gill Net Captured Dolly Varden Age Analysis Details

Fish Reference	Length (mm)	Weight (g)	Sex	Age
1	164	48.5	Male;	3+
2	166	48.5	Male	3+
5	126	20.5	Female	3+
16	123	19	Male	3+
17	132	24	Male	3+
20	126	20	Male	3+
21	128	24	Female	3+
25	126	22	Female	3+
28	128	21.5	Male	3+
3	140	28	Female	4+
11	127	19.5	Male	4+
13	120	17.5	Female	4+
14	130	24	Female	4+
15	141	23.5	Female	4+
19	127	21	Female	4+
23	125	20.5	Male	4+
27	182	56	Male	5+
29	170	47.5	Female	5+
30	156	36	Male	5+
10	510	1095.5	Male	8+

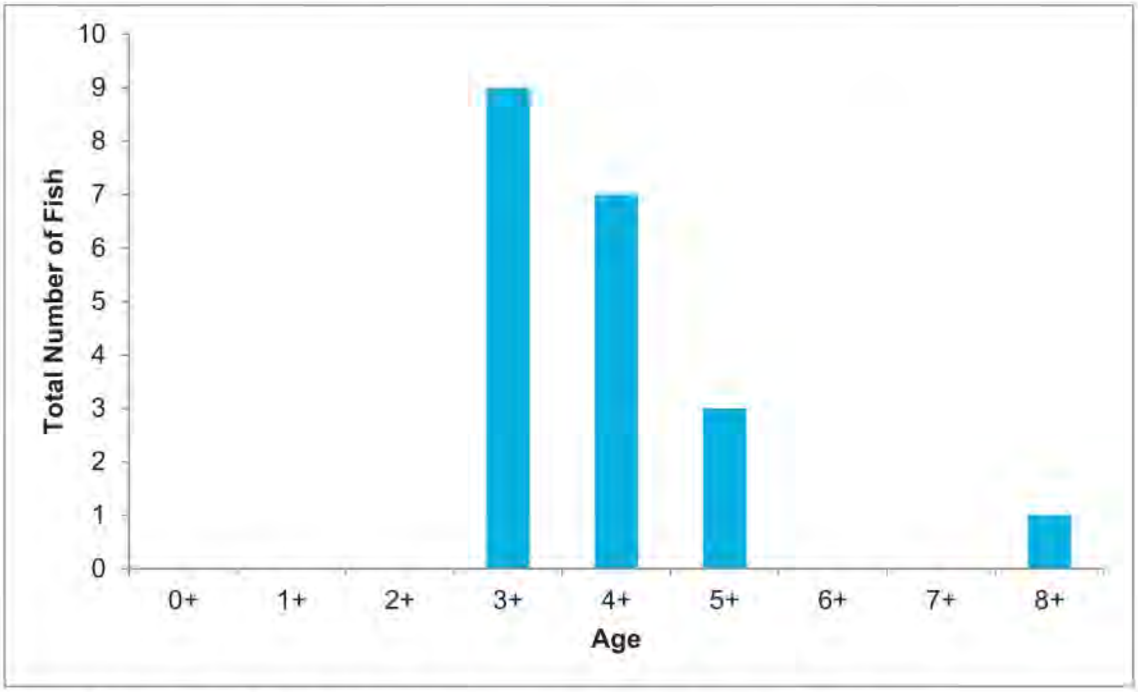

Figure 14: Plot of the Total Number of Fish Analyzed in each Age Class

Table 13: Estimated Age-Length Classification of Chapman Lake Dolly Varden

Age	Length Range (mm)
1	40-80
2	90-120
3-4	120-160
5	160-180
8	500

The estimated age and length suggest that there is a positive correlation between the size of a fish and age. To further support observations, an age to weight analysis was completed. Figure 15 below provides the log normalized weights plotted against age showing a positive trend. Further analysis was completed by comparing the condition factor of fish with age. The condition factor is a measure of the degree of well-being of a fish and primarily reflects the state of sexual maturity and degree of nourishment. Based on the population of fish analyzed, there is a decreasing trend in the condition of fish in Chapman Lake as they age.

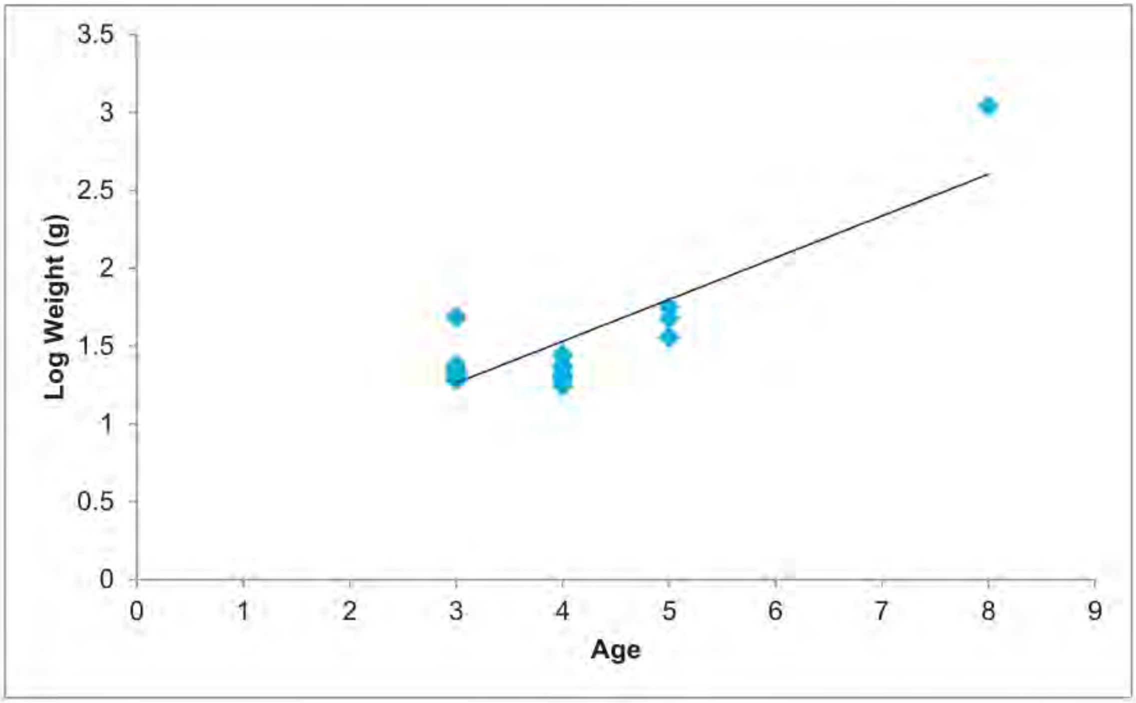

Figure 15: Weigh to Age Relationship of Dolly Varden Captured in Chapman Lake

5.3.1.4 Mercury in Fish Tissue

Mercury occurs naturally at low concentrations in air, water, soil, sediments, plants and animal tissues. The majority of mercury occurs in the environment in the inorganic form, with approximately 1% available in the organic form, methyl mercury. Methyl mercury enters the aquatic food chain when benthic organisms living in the sediment absorb methyl mercury into their tissues and then are consumed by organisms of higher trophic levels (Langston 1986), or when low levels of methyl mercury in the water column are absorbed across gill membranes or skin (Francesconi and Lenanton 1992). This organic form of mercury is considered to be the most toxic and can become concentrated in fish tissue as a result of bioaccumulation through diet. The formation and operation of reservoirs have been known to cause elevated levels of mercury into the food web through the release of methl mercury from the breakdown of submerged vegetation.

The 2016 fish sampling included analysis of the mercury concentration in fish tissue to establish a baseline for comparison to fish sampled at a future date. A range of size classes were selected for analysis and the whole fish was used. Results of total mercury samples with the associated physical fish parameters are provided in Table 14.

Table 14: Fish Tissue Total Mercury Results, 2016

Fish Reference	Length (mm)	Weight (g)	Age	Total Mercury (mg/kg wwt)
1	164	48.5	3+	0.068
2	166	48.5	3+	0.056
3	140	28	4+	0.089
10	510	1095.5	8+	0.184
19	127	21	4+	0.029

The results are provided as the concentration in wet weight of the tissue (wwt). Typically, mercury in fish tissue is primarily in the form of methyl mercury. The reported values of total mercury were compared against CCME and BC Tissue Residue Guidelines to Protect Wildlife from Mercury Toxicity, which is 0.033 mg/kg (MeHg, wwt). All but one of the fish had total mercury values that were higher than the stated criteria.

Figure 16 shows the relationship between mercury concentration and fish age. While the graph does indicate a trend of increasing concentration with age, had the oldest fish been removed from the analysis there would be no significant relationship. There was no evidence during the 2016 field study to indicate that the elevated levels of mercury in the Dolly Varden of Chapman Lake was anything but natural.

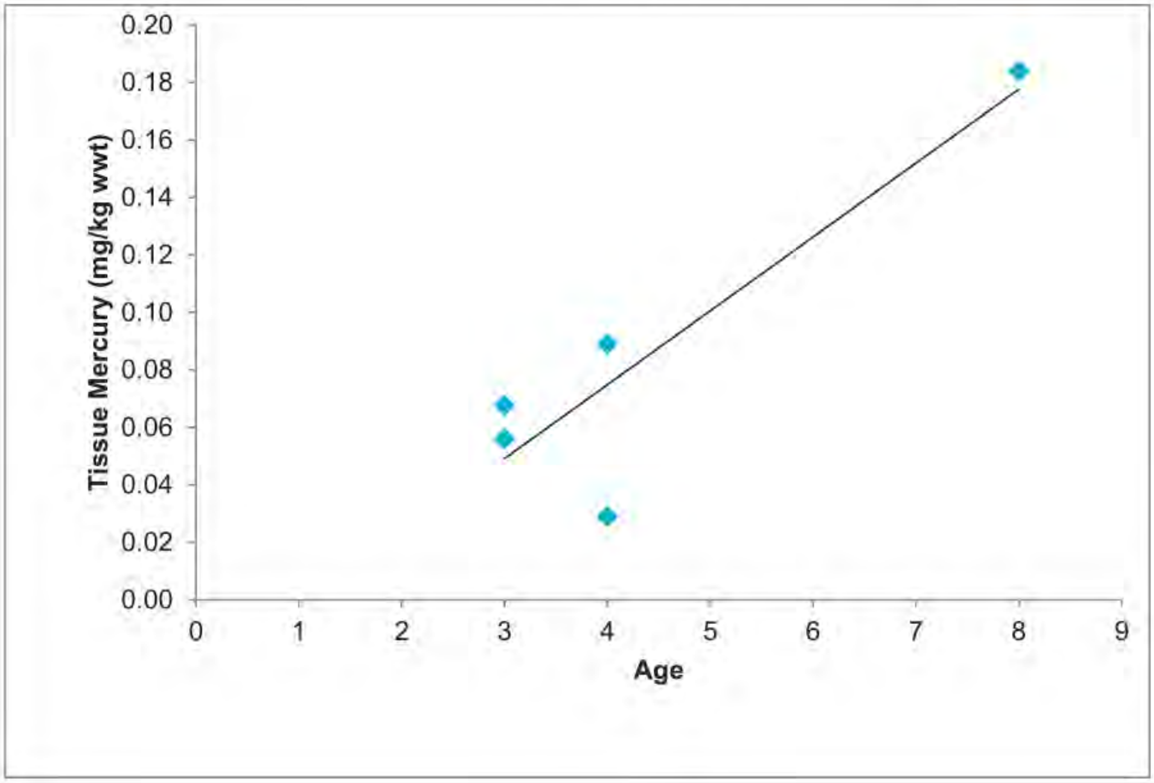

Figure 16: **Dolly Varden Tissue Mercury Concentration in Relation to Age in Chapman Lake**

5.3.2 Chapman Lake Benthic Invertebrates

Benthic macroinvertebrate sampling during 1998 field study was limited to identification of species from sediment samples collected along transects and incidental observations of other species. Benthic macroinvertebrates were identified from sediment samples collected at 3 m and 5 m depth using an Eckman dredge, along 9 transects. The main types of invertebrates collected were caddis fly larvae cases, bloodworms and other unidentified worms. The benthic macroinvertebrate abundance levels in Chapman Lake were considered low and similarly the density of benthic macroinvertebrate levels were low. During the 2016 field program, a total of 6 macroinvertebrate samples were collected at various locations at shallow, mid and deep locations in the lake (Figure 9). An Eckman grab sampler was used to collect a 500 ml of bottom substrate. Sample results suggest that the total abundance of organisms were correlated with depth with higher abundance in samples from shallower sites. Figure 17 and Figure 18 provide the abundance and biomass of the macroinvertebrates in each sample. The most dominant order present at each of the sample locations were Diptera (Figure 19). Diptera were also found in the stomach contents of the fish captured in the gillnets. Consistent with abundance and biomass, species richness was higher in the shallow samples (Figure 20).

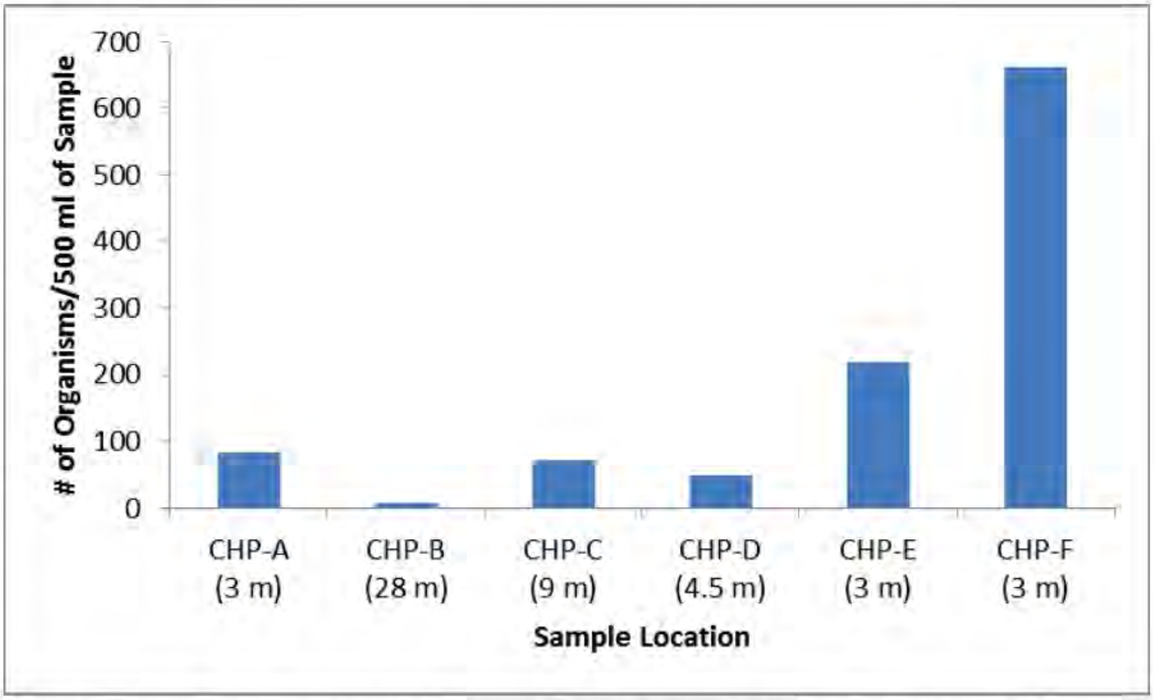

Figure 17: **Total Abundance of Benthic Macro Invertebrates in Chapman Lake Samples, 2016**

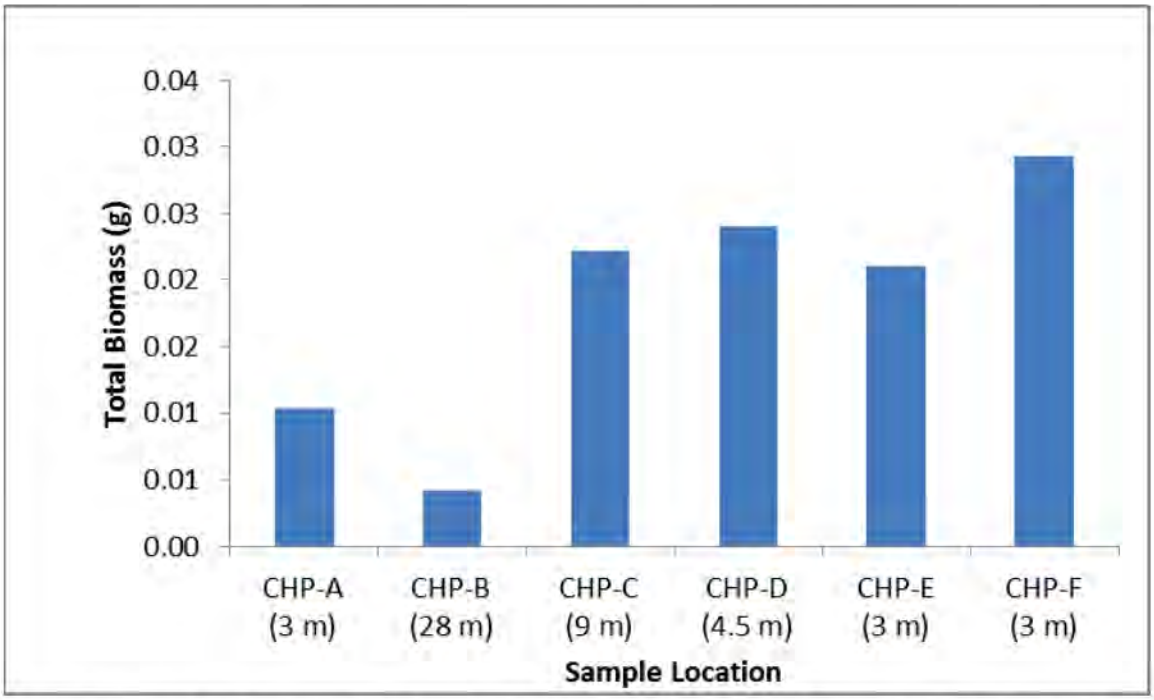

Figure 18: **Total Biomass of Benthic Macro invertebrates in Chapman Lake Samples, 2016**

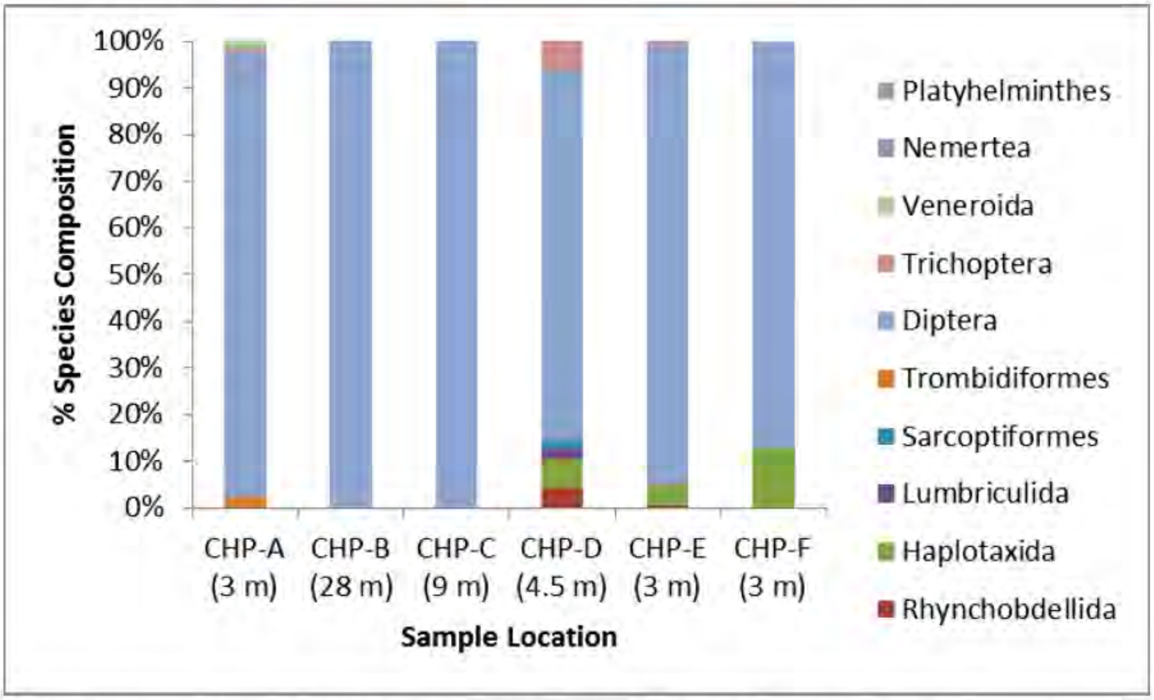

Figure 19: **Benthic Macro Invertebrate Sample Species Composition in Chapman Lake, 2016**

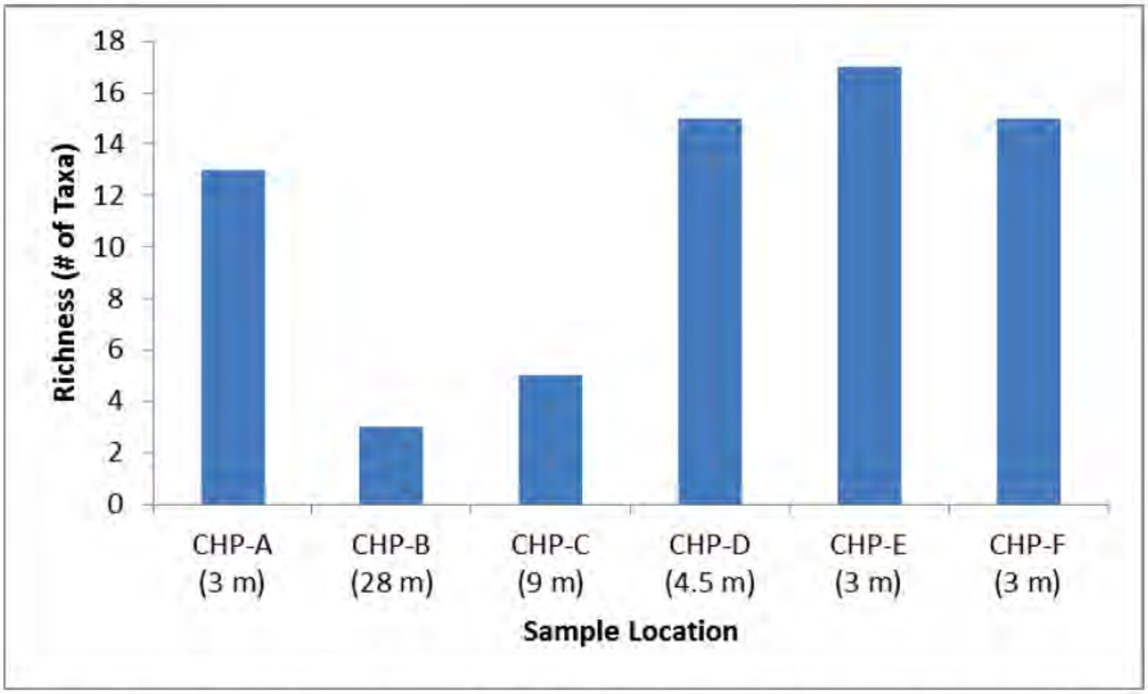

Figure 20: **Benthic Macro Invertebrate Samples Species Richness in Chapman Lake, 2016**

5.3.3 Chapman Lake Zooplankton

Sampling of zooplankton in Chapman Lake was carried out in 2016 to provide a baseline measure of food resources for comparison to future sampling results. Zooplankton was sampled using a vertical zooplankton tow at the deeper areas of the lake. Density of zooplankton (number of individuals/L) was calculated for each sample by dividing the total number of individuals of each species in a sample by the total volume sampled. Sample volume consisted of a calculation of the area of the sample net opening by the distance the net was towed. The volume of water filtered was calculated using the equation:

$$V = \pi r^2 d$$

Where r was the radius of the net mouth (0.1475 m) and d was the depth of net sampler. Volumes were converted from cubic metres to litres for abundance calculations.

The total abundance of zooplankton per litre of water for each site is provided in Figure 21. The samples CHP-ZP1 and CHP-ZP2 were taken from the same deep lake location (20 m) and CHP-ZP3 was taken at the mid-range depth (14 m). The largest number of zooplankton was captured from the 14 m depth location. Taxonomic richness at all sample locations was 10 taxa. The total taxa is the count of all unique taxa that was not represented by a lower taxonomic level in the sample.

Each sample consistently contained a relatively similar composition of 3 major groups of taxa which included cladocera, copepod and rotifera. Figure 22 shows the percent composition of the three major taxa groups at each sample location.

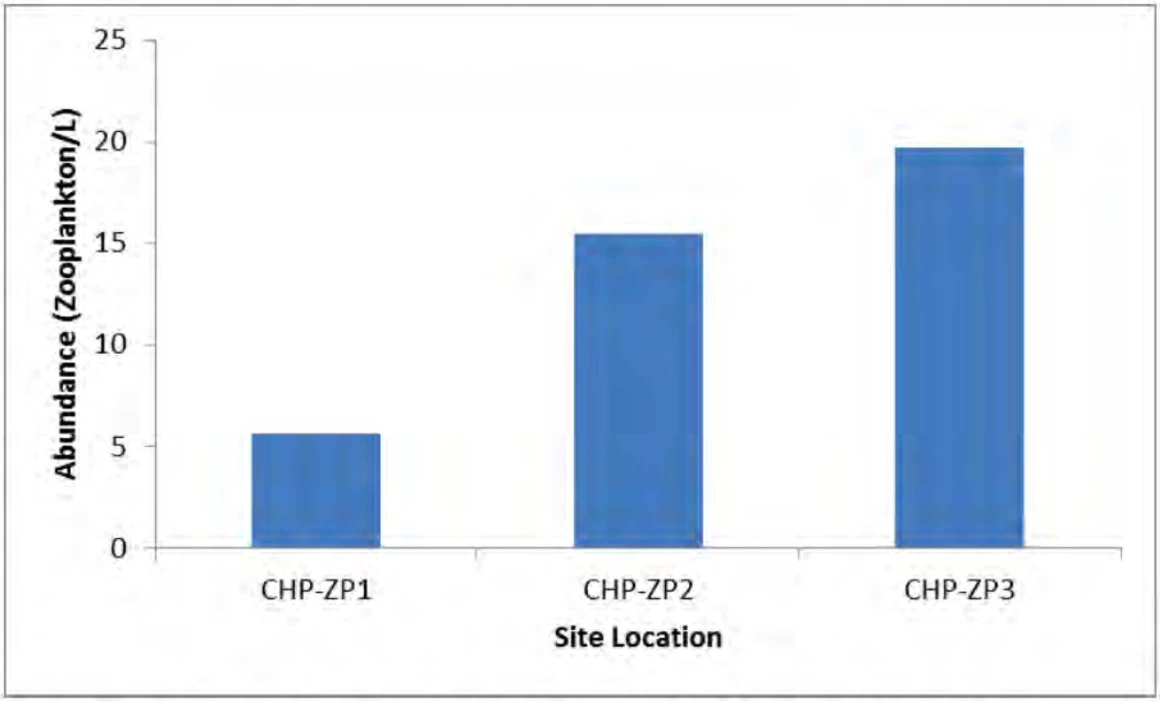

Figure 21: **Zooplankton Sample Total Abundance in Chapman Lake, 2016**

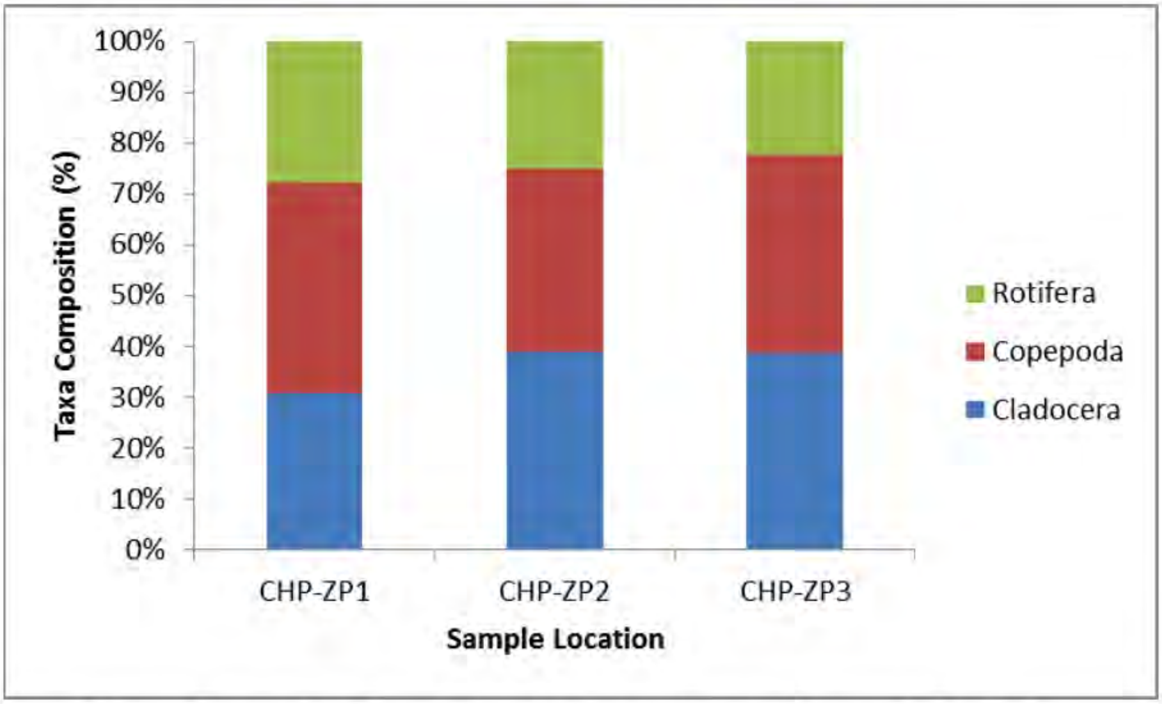

Figure 22: **Zooplankton Sample Species Composition in Chapman Lake, 2016**

5.3.4 Tributary Stream Fish Habitat Characteristics

Fish habitat assessments were completed for each of the streams that outlet into Chapman Lake at the eastern portion of the lake, as part of the 2016 study. Figure 9 provides the location where the habitat assessments were completed. Appendix F provides a summary of the RISC stream habitat cards that were completed including the physical characteristics of the stream and assessment of the quality of habitat for fish. Table 15 below provides habitat quality definitions and indicators.

Table 15: Definition and Indicators of Fish Habitat Types

Criteria	Habitat Ranking		
	High	**Moderate**	**Low**
Definition	Habitat that is critical in sustaining a subsistence, commercial, or recreational fishery, or any species at risk (i.e., aquatic red- and blue-listed species, those designated by COSEWIC, or those listed under SARA), or because of its relative rareness, productivity, and/or sensitivity[1]	Habitat that is used by fish for feeding, growth, and migration but not deemed critical. This category of habitat usually contains a large amount of similar habitat that is readily available to the stock.	Habitat that has low productive capacity and contributes marginally to fish production.
Indicators[2]	The presence of high-value spawning or rearing habitat (e.g., locations with an abundance of suitably sized spawning gravels, deep pools, undercut banks, or stable debris, which are critical to the population present), or the presence of any SARA-listed species, its residence, or critical habitat.[3]	Important migration corridors. The presence of suitable spawning habitat. Habitat with moderate rearing potential for the fish species present.	The absence of suitable spawning habitat, and habitat with low rearing potential (e.g., locations with an absence of deep pools, undercut banks, or stable debris, and with little to no substrate of spawning gravels suitably sized for fish species present).

[1] *See http://www.cosewic.gc.ca/.*

[2] *The indicators provided here are highly generalized and may require regional interpretation. For further information on conducting a habitat assessment, see: Fisheries and Oceans Canada's Working Near Water in BC and Yukon website (http://www.pac.dfo-mpo.gc.ca/habitat/index-eng.htm) and the BC Ministry of Environment's Fish and Fish Habitats website (http://www.env.gov.bc.ca/wld/fishhabitats/index.html).*

[3] *The* Species at Risk Act *prohibits the harming, harassing, capturing, taking, or killing of a species at risk or the destruction of its residence, or critical habitat as defined by act. For more information about SARA-listed species and their habitat, see: http://www.sararegistry.gc.ca*

One site (north eastern stream) was classified as having high quality fish habitat with suitable habitat for all stages of fish life cycles (spawning, rearing, overwintering, migration, and spawning/holding). The south eastern stream was rated as moderate, with no spawning or staging and holding areas. In general, the south eastern stream had a higher gradient (SE stream 4%, NE Stream 2%), greater channel width (SE stream 7.2 m bankfull, NE stream 6.9 m bankfull) and residual pool depth (SE stream= 16 cm, NE stream=5 cm) in comparison to the north eastern stream. The north eastern stream had a higher proportion of small cobbles and gravels with the south eastern stream having a higher proportion of larger cobbles and boulders. Figure 23 provides the quantitative estimate of the stream sediment composition and Photos 7 through 11 provide additional documentation of the two streams.

Following the ratings provided in Table 15 the north east stream habitat rating is high as it appears to be the stream that supports most of the spawning and rearing for Chapman Lake DV. There is approximately 240 m of good spawning and rearing habitat that is currently accessible in this tributary. Currently a log jam limits upstream migration but within 100 m upstream of the logjam the stream gradient appears to increase significantly and the stream substrate is dominated by boulders and bedrock. Approximately 225 m of the south east tributary is accessible would be rated as low to moderate based on observations that included the dominance of cobble/boulder substrate with limited spawning substrate, no DV were captured