2337005 Appendix 1 – Sunshine Coast Regional District's (SCRD) – Church Road Well Field – Adaptive Management Plan and Monitoring Program Requirements

The annual monitoring program for the Church Road Wellfield includes measuring parameters at several areas to confirm quantity and quality of groundwater and surface water. It also involves the measurement and quantification of fish habitat in Soames Creek as water levels are changing seasonally. This program is part of the provincial requirements for the operation of the wellfield, which is hydraulically connected to the Creek, and has a self mitigating augmentation line to maintain flow levels in the Creek supporting fish habitat. This list is prepared for bidding purposes, typical of what is expected in scope and scale, and may change to some degree upon contract award.

Throughout this RFP there are references to SCRD-supplied data. It is assumed that the Contractor will communicate and coordinate with SCRD staff to obtain the right data at the appropriate time and communications must be in a timely manner. It is the expectation that the Contraction will initiate this request.

All data collected and assessed as described in the "narrative" below, as well as any collection required for the purpose of the monitoring but not mentioned specifically in the narrative, must be collected and interpreted by the Contractor.

Monitoring annually for the following components:

- Surface water flows
- Surface water quality
- Fish and fish habitat
- Groundwater levels
- Groundwater quality

For each component, information on the following parameters is provided:

- Monitoring locations
- Data retrieval and monitoring methods
- Monitoring frequency and timing
- Reporting

1 SURFACE WATER FLOWS

Monitoring of flow at the locations outlined in Figure 1 will be collected in various ways and frequencies as outlined in Table 1.

Please note that week 1 is from commencement of wellfield operation this summer. Then the frequency reduces as time passes.

Locations (Figure 1)

Table 1

Monitoring Location	Monitoring Method	Monitoring Frequency
Soames Creek Hydrometric Station	Pressure transducer data logger connected to the supervisory control and data acquisition (SCADA) system	SCRD to provide
	Field measurement using flow measurement instrument	Monthly
Augmentation Discharge	SCADA-connected flow meter	SCRD to provide
U/S Granthams Springs	Field measurement using flow measurement instrument	Week 1: Daily Weeks 2–4: Weekly After week 4: Monthly
Granthams Landing Well Discharge 1	Bucket and stopwatch	Week 1: Daily Weeks 2–4: Weekly After week 4: Monthly
Granthams Landing Well Discharge 2	Bucket and stopwatch	Week 1: Daily Weeks 2–4: Weekly After week 4: Monthly

Shaded fields are not to be costed, but the data will be provided as part of the reporting/deliverable scope.

Note:
Instruments used to measure creek flow should be serviced and calibrated annually to ensure they maintain their accuracy. Gradations on buckets will be clear and checked for accuracy. At least three measurements

will be taken, and the results averaged to obtain the flow rate when using the bucket and stopwatch method. All field measurements will be conducted following guidance in the Manual of British Columbia Hydrometric Standards (RISC 2018).

A ramping rate threshold of 2.5 cm/hr will be used; this is the standard set by Fisheries and Oceans Canada for fry-bearing streams, as cutthroat trout will be at the fry life stage during the predominant time of well diversion (Knight Piesold Consulting 2005). Note that based on creek stage changes observed from 2019 and 2020 summer streamflow data, this threshold is conservative, as it is significantly lower than naturally occurring stage changes recorded over the period of an hour after a storm.

Stage-discharge relationships developed for the hydrometric station used in 2019 and 2020 show that a creek stage change of 2.5 cm/hr was equivalent to a change in flow of at least 6 L/s. Therefore, the proposed 1 L/s incremental flow changes every 15 minutes should remain within the 2.5 cm/hr threshold. However, if ramping rates exceed the threshold of 2.5 cm/hr, the period between incremental changes in augmentation rate will be increased appropriately (depending on streamflow). The Contractor is expected to contact the SCRD to discuss and/or implement these changes and they should be reported monthly and annually.

2 SURFACE WATER QUALITY

Water quality will be monitored at four locations, as outlined in Table 2 and shown in Figure 2. Monitoring will be ongoing to confirm that the quality of water is suitable to avoid negative effects on the ecology of Soames Creek.

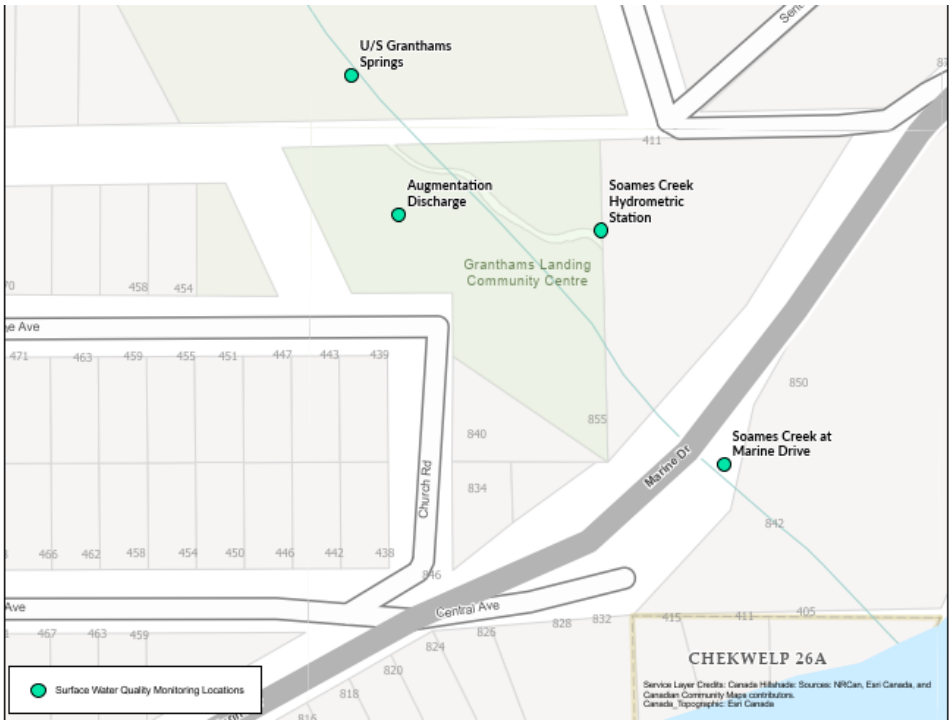
Table 2

Monitoring Location	Easting	Northing	Rationale
U/S Granthams Springs	464141	5473674	To measure creek water quality and temperature upstream of any diversion- or augmentation-induced impact
Augmentation Discharge	464156	5473630	To measure the quality of water directly released into Soames Creek, as part of the creek augmentation scheme, to ensure it meets water quality guidelines
Soames Creek Hydrometric Station	464215	5473624	To measure water quality and temperature downstream of the augmentation discharge after it has joined the flow from the main creek
Soames Creek at Marine Drive	464259	5473551	To measure changes in water quality further downstream, prior to discharge into the ocean

Water quality will be monitored by collecting monthly grab samples from each monitoring location outlined in Table 2. Field parameters (pH, conductivity, temperature, turbidity, dissolved oxygen) will be measured each time a water sample is collected. During the first month of wellfield operation, field measurements will be taken more frequently, with daily monitoring during the first week, reduced to weekly monitoring for weeks 2 to 4, and monthly monitoring thereafter (see Table 3). This will help identify unforeseen changes in

water quality that could have a negative effect on creek ecology. Field measurements will be measured using calibrated handheld water quality meters.

Figure 2



Water samples will be sent to a laboratory accredited by the Canadian Association for Laboratory Accreditation for analysis of the following parameters employing best practices:

- Physical parameters: pH, turbidity, total dissolved solids (TDS), total suspended solids, conductivity, colour, and total hardness;
- Anions and nutrients: nitrate, nitrite, ammonia, total phosphorous, orthophosphate, total alkalinity, chloride, fluoride, and sulphate; and
- Total and dissolved metals: aluminum, arsenic, barium, boron, calcium, chromium, copper, iron, lead, manganese, mercury, potassium, selenium, sodium, uranium, and zinc.
- Sampling will be conducted in accordance with the requirements set out in the British Columbia Field Sampling Manual (Ministry of Environment 2013).
- All sampling events will have a quality assurance/quality control (QA/QC) program: at least one duplicate sample per 10 samples taken, plus a field blank and trip blank during each sampling event. A QA/QC sample is required for a minimum of 10% of all samples.
- Prior to collecting water samples, field parameters (pH, conductivity, temperature, turbidity, dissolved oxygen) will be measured and recorded using calibrated water quality monitors.
- The sampler will wear a new pair of nitrile gloves at each sampling location.
- Samples will be collected in laboratory-supplied bottles with preservatives (where required). Samples requiring filtration will be filtered by the sampler on site using laboratory-supplied filters and syringes. All samples will be collected and filtered following specific laboratory requirements.
- On completion of filling sample bottles, the bottles will be labelled (if not pre-labelled) and put into cool boxes packed with ice. The samples will then be transported to the laboratory in the ice-packed

cool boxes. Ideally, a temperature between freezing and 6°C will be maintained. The samples will be submitted to the laboratory and processed for analysis within 3 days, which is the shortest hold time of any of the parameters being tested (colour, turbidity, orthophosphate). A completed and signed chain-of-custody form will be submitted to the laboratory with the samples.

Water quality thresholds are as per the British Columbia Water Quality Guidelines for Aquatic Life (BCWQG AL). A threshold has not been set for the U/S Granthams Springs, as water quality at this location is not impacted by operation of the wellfield, but rather represents background water quality values.

Table 3

Monitoring Location	Monitoring Type	Monitoring Frequency	Threshold
U/S Granthams Springs	Water sample	Monthly	-
	Field measurements	Week 1: Daily Weeks 2–4: Weekly After week 4: Monthly	-
Augmentation Discharge	Water sample	Monthly	BCWQG AL
	Field Measurements	Week 1: Daily Weeks 2–4: Weekly After week 4: Monthly	
Soames Creek Hydrometric Station	Water sample	Monthly	BCWQG AL
	Field Measurements	Week 1: Daily Weeks 2–4: Weekly After week 4: Monthly	BCWQG AL
	Temperature data logger	Hourly	SCRD to provide. A 1.0°C change in monthly mean temperature statistics
Soames Creek at Marine Drive	Water sample	Monthly	BCWQG AL
	Field Measurements	Week 1: Daily Weeks 2–4: Weekly After week 4: Monthly	

Shaded fields are not to be costed, but the data will be provided as part of the reporting/deliverable scope.

3 FISH AND FISH HABITAT

Fish and fish habitat will be monitored at three locations, as outlined in Table 4 and Figure 3. These locations represent indicative flow measurements required for pool connectivity within the Creek. As flow levels change with season so too will these habitat required flows. Fish and fish habitat monitoring will be ongoing to assess whether operation of the wellfield has an effect on the ecology of Soames Creek and whether mitigation is required.

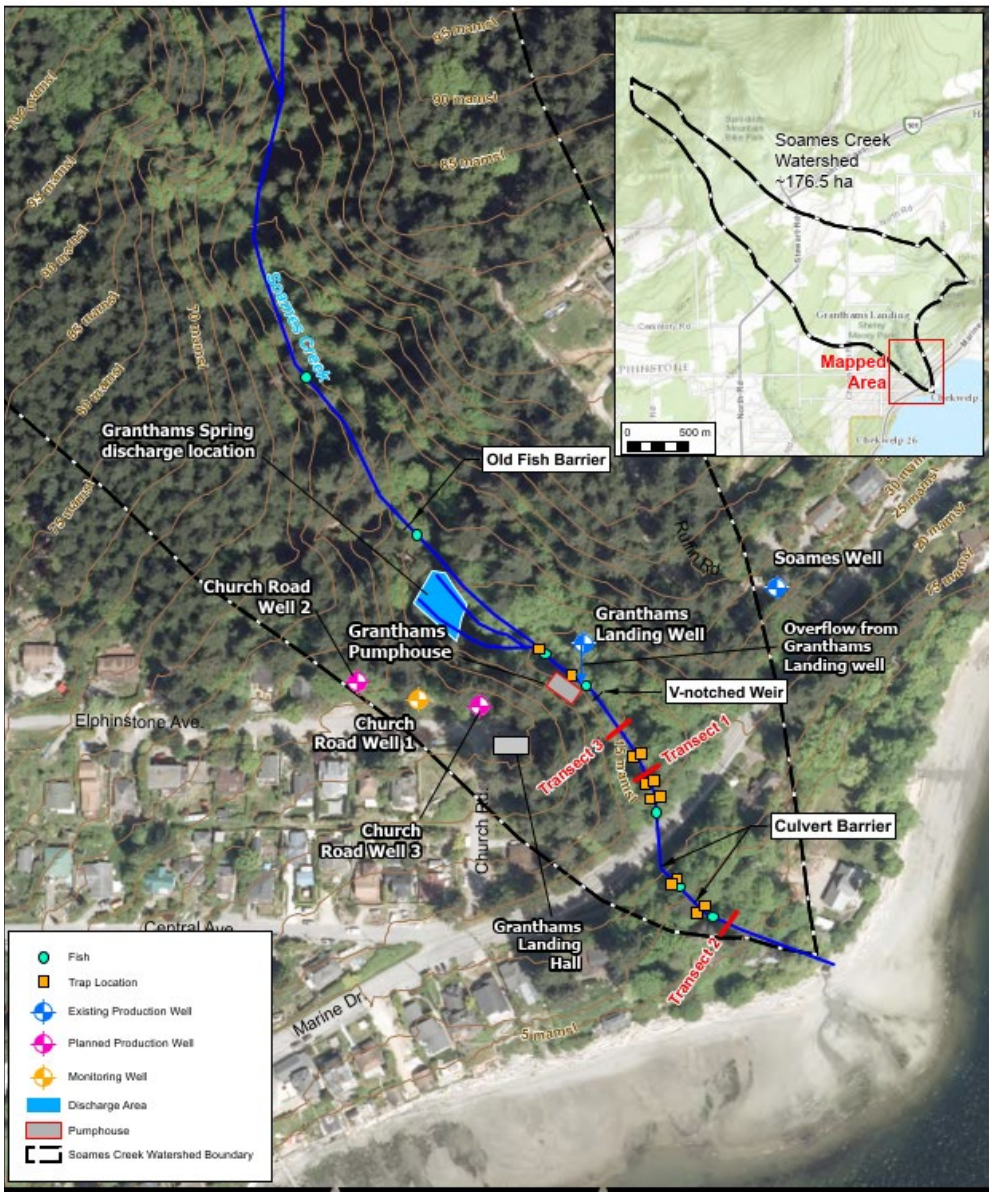
Fish and fish habitat will be assessed in the following manner:

- Document fish habitat within Soames Creek,
- Collect streamflow (at transects) and channel hydraulic information to support wetted usable width (WUW) and habitat suitability indices (HSI) investigations to determine value and reduction of critical fish habitat as flows decrease.

Table 4

Monitoring Location	Easting	Northing	Rationale
Transect 1	10.464212	5473559	To measure pool connectivity just above the Marine Drive culvert.
Transect 2	10.464278	5473500	To measure pool connectivity south of the Marine Drive culvert. A fish barrier to upstream passage.
Transect 3	10.464199	5473611	To measure pool connectivity just below the hydrometric station (V-notch weir).

Figure 3



Transects are “a directional line, along which sampling stations are established or visual observations are made”. They are located in habitats important to the fish species of interest (Figure 3). The locations for this assessment were chosen based on their importance to cutthroat, riffle crests, as they provide spawning, rearing and refuge habitat and are subject to changes in variability throughout the flow year. Across each transect, every 15 cm, vertical water depth and velocity is measured to capture the changes over varying streambed topography (these are “cells’).

Habitat collection includes the measurement of residual pool depths, large woody debris, spawning gravel, and identification of barriers to fish passage along the alignment and GPS coordinates of their locations after major storms. Collect from the ocean to the most northern fish collection location on Figure 3.

In situ measurements of temperature, conductivity, dissolved oxygen, turbidity and pH should be collected random locations along the alignment (noted above).

Table 5

Monitoring Location	Monitoring Type	Monitoring Frequency	Threshold
Transect 1	Water sample	Quarterly	Jan - Mar: when flows > 30 L/s Apr – Jun: when flow 15-29 L/s Jul – Sep: when flows <15 L/s Oct – Dec: when flows 15-29 L/s
	Fish collection	Annually (fall)	Confirm fish presence, age class and activity.
Transect 2	Water sample	Quarterly	Jan - Mar: when flows > 30 L/s Apr – Jun: when flow 15-29 L/s Jul – Sep: when flows <15 L/s Oct – Dec: when flows 15-29 L/s
	Fish collection	Annually (fall)	Confirm fish presence, age class and activity.
Transect 3	Water sample	Quarterly	Jan - Mar: when flows > 30 L/s Apr – Jun: when flow 15-29 L/s Jul – Sep: when flows <15 L/s Oct – Dec: when flows 15-29 L/s
	Fish collection	Annually (fall)	Confirm fish presence, age class and activity.

Measurements to be taken only when flows are less than 50 L/s for safety reasons.

Equipment needed:
Level logger and stadia to confirm flow measurement locations and water elevations at the time of sampling.
Flow tracker or flow stick to measure flows in shallow depths. Manual flow measurements may be required at times when there is not enough depth for automated measurements.
Multimeter to measure in-situ parameters of temperature, pH, dissolved oxygen, conductivity and turbidity.
Electrofisher
Minnow traps and bait
Fish collection permits (DFO and MoF) – 90 days in advance

4 GROUNDWATER LEVELS

Groundwater level data will be collected to assess the impact that groundwater diversion from the wellfield has on water levels within the production wells, observation wells, and a private water supply well, as well as the wider aquifer setting.

Ongoing monitoring of the wells will allow the impact of short- and long-term groundwater diversion on aquifer water levels (i.e., aquifer sustainability) to be observed. The data will be used to show whether the water level in the wells respond as anticipated during operation of the wellfield, and whether aquifer water levels can recover each year following recharge. This information will inform whether the individual diversions from each well and the licensed total annual diversion quantity is sustainable from an aquifer capacity perspective.

Groundwater levels will be monitored and recorded in eight wells: three SCRD Church Road Wellfield production wells, four SCRD observation wells, and one private water supply well, as outlined in Table 6 and shown in Figure 4.

Table 6

Well Name		Well Type	Easting	Northing	Rationale
Church Road Wellfield	**Church Road Well 2**	Production	464107	5473614	To maintain water level above pump and above a set threshold level (2 m above sea level) to minimize saline intrusion.
	Church Road Well 3	Production	464146	5473607	To assess aquifer recovery to determine sustainability of groundwater diversion.
	Soames Well	Production	464290	5473657	To confirm or reassess sustainable well yield.
Church Road Monitoring Well 1		Observation	464137	5473607	To assess the impact of groundwater diversion on aquifer water level in close proximity to the Church Road production wells; during wellfield operation, the water level better reflects aquifer water level with no well losses recorded from pumping the well. To assess aquifer recovery to determine sustainability of groundwater diversion.
Church Road Monitoring Well 2		Observation	464153	5473551	To assess the impact of groundwater diversion on aquifer water level between the Church Road production wells and the coast; during wellfield operation, the water level better reflects aquifer water level with no well losses recorded from pumping the well. To assess aquifer recovery to determine sustainability of groundwater diversion.
Esperanza Road Monitoring Well		Observation	463937	5474201	To assess the impact of wellfield operation on upgradient aquifer water levels during operation and recovery.
901 Sentinel Road		Private Water Supply	464395	5473802	To ensure sufficient water remains within this well to provide the owner with their water supply needs.
Granthams Landing Well		Observation	464236	5473615	To observe the impact of artesian pressure head in this well to help in the design of future well decommissioning.

Figure 4

The three production wells will contain water level (pressure) transducer data loggers. These will be connected to the SCRD's SCADA system and provide instantaneous water level readings. In addition, water level data in the production wells will be logged and recorded at 1-minute intervals to provide a continuous record of groundwater level in the wells. Manual dip readings will be taken for each well using a well sounder lowered into a dedicated well sounding tube installed in each production well, and measurements will be taken on a monthly basis to verify the transducer data.

The SCRD owns Church Road Monitoring Wells 1 and 2, Esperanza Road Monitoring Well, and Granthams Landing Well. The well at 901 Sentinel Road is a private well used by the owner. Each well has or will have a water level pressure transducer data logger installed within it, recording data at 15-minute intervals. These data loggers will not be connected to the SCRD's SCADA system, so the data needs to be downloaded at the same frequency as the manual well sounding.

Table 7

Well Name	Monitoring Type	Monitoring Frequency
Church Road Well 2	Pressure transducer data logger connected to the supervisory control and data acquisition (SCADA) system	SCRD to provide. Instantaneous readout, logging data at 1-minute intervals
	Manual, using well sounder	Monthly
Church Road Well 3	SCADA-connected pressure transducer data logger	SCRD to provide. Instantaneous readout, logging data at 1-minute intervals
	Manual, using well sounder	Monthly
Soames Well	SCADA-connected pressure transducer data logger	SCRD to provide. Instantaneous readout, logging data at 1-minute intervals
	Manual, using well sounder	Monthly
Church Road Monitoring Well 1	Pressure transducer data logger at 15-minute intervals.	Download: Week 1: Daily Weeks 2–4: Weekly After week 4: Monthly
	Manual using well sounder	Week 1: Daily Weeks 2–4: Weekly After week 4: Monthly
Church Road Monitoring Well 2	Pressure transducer data logger at 15-minute intervals.	Download: Week 1: Daily Weeks 2–4: Weekly After week 4: Monthly
	Manual using well sounder	Week 1: Daily Weeks 2–4: Weekly After week 4: Monthly
Esperanza Road Monitoring well	Pressure transducer data logger at 15-minute intervals.	Download: Week 1: Daily Weeks 2–4: Weekly After week 4: Monthly
	Manual using well sounder	Week 1: Daily Weeks 2–4: Weekly After week 4: Monthly
901 Sentinel Road	Pressure transducer data logger at 15-minute intervals.	Download: Week 1: Daily Weeks 2–4: Weekly After week 4: Monthly
	Manual using well sounder	Week 1: Daily Weeks 2–4: Weekly After week 4: Monthly
Granthams Landing Well	Pressure transducer data logger at 15-minute intervals.	Download: Week 1: Daily Weeks 2–4: Weekly After week 4: Monthly
	Pressure gauge	Week 1: Daily Weeks 2–4: Weekly After week 4: Monthly

All equipment used to monitor groundwater levels, should be certified-calibrated before use and have an accuracy within 0.01 m (1 cm). Dip tapes should be checked and calibrated annually to ensure they have not become stretched and are working effectively. All equipment lowered into the wells will be disinfected with a 200-ppm chlorine-based solution prior to installation/use to minimize the risk of introducing or causing cross-contamination of pathogens to and between the wells.

During the monthly measurements, all transducer data loggers that are powered by an internal battery will be checked to confirm that there is sufficient battery capacity remaining. If the battery is low, a replacement data logger will be installed (supplied by the SCRD). In addition, during data download, the logger will be checked to confirm that there is sufficient memory on the device to record all measurements until the next visit to download the data.

The following procedure will be followed at each well when conducting monthly groundwater level monitoring:

- Disinfect the well sounder prior to use.
- Lower the well sounder into the sounding tube until it sounds on hitting water, pull back the sounder, and re-test the depth to water to confirm the reading.
- Measure the reading against a known datum point (e.g., top of sounding tube), and make a note of the depth to water and the date and time the reading was taken. Ideally the measurement time will coincide with a logger recording interval.
- Remove the well sounder from the well.
- For wells installed with a non–SCADA-connected data logger (SCADA-connected data loggers will automatically record water level data to a data management system), download water level data from the data logger using either a connection to a direct read cable (if used with the logger) or pull the logger to the surface and connect it to a reader interface.
- Download and save the data and check that the data recorded has been saved and appears valid. Check the data logger battery and memory status. Replace the logger if the battery is low or if data appears to be corrupt. Reset the logger if memory is low.
- If the data logger was removed from the well, disinfect the logger and cable, and return it to the well in its dedicated sounding tube.

5 GROUNDWATER QUALITY

Groundwater quality data will be collected from four wells within the aquifer: the three production wells and Church Road Monitoring Well 2, as outlined in Table 8 and shown in Figure 4. The water samples will be sent for analysis to an accredited laboratory. The data will be used to:

- Monitor groundwater quality over time to ensure it continues to meet the:
- GCDWQ (Health Canada 2022) and British Columbia Water Quality Guidelines (BCWQG) for potable water supply (Ministry of Environment 2020); and BCWQG AL (Ministry of Environment 2022), for creek augmentation in Soames Creek, if required.
- Provide an early warning if groundwater diversion causes saline intrusion into the aquifer.

Table 8

Well Name	Well Type	Easting	Northing	Rationale

Church Road Wellfield	**Church Road Well 2**	Production	464107	5473614	To ensure groundwater quality does not deteriorate over time and continues to meet the GCDWQ and BCWQG for drinking water. To ensure groundwater quality does not deteriorate over time and continues to meet the BCWQG AL (for use as augmentation water). To ensure that the water treatment plant remains effective in treating the raw water to provide potable water that goes into supply. To monitor for evidence of saline intrusion.
	Church Road Well 3	Production	464146	5473607	
	Soames Well	Production	464290	5473657	
Church Road Monitoring Well 2		Observation	464153	5473551	To monitor for evidence of saline intrusion.

Note: BCWQG – British Columbia Water Quality Guidelines; BCWQG AL – British Columbia Water Quality Guidelines for Aquatic Life; GCDWQ – Guidelines for Canadian Drinking Water Quality

Raw groundwater will be sampled from the three production wells (Table 9). Samples will be collected monthly and sent to an accredited laboratory for analysis of the following parameters:

- Physical parameters: pH, turbidity, TDS, total suspended solids, conductivity, colour, and total hardness;
- Anions and nutrients: nitrate, nitrite, ammonia, total phosphorous, orthophosphate, total alkalinity, chloride, fluoride, and sulphate; and
- Total metals: aluminum, arsenic, barium, boron, calcium, chromium, copper, iron, lead, manganese, mercury, potassium, selenium, sodium uranium, and zinc.

A groundwater sample will also be collected from Church Road Monitoring Well 2 (Table 9). This well was specifically constructed between the Church Road Wellfield and the coast to be used to provide an early warning of potential saline intrusion into the aquifer, as required under clause (j), part (3) of CWL #502568. Church Road Monitoring Well 2 extends to the base of the aquifer, with 3 m of slotted screen at the bottom. The groundwater sample taken from this well will be analyzed for conductivity, TDS, and chloride monthly.

During each sampling event at all four wells, field measurements will be taken of pH, electrical conductivity, temperature, and dissolved oxygen using a flow-through cell and calibrated handheld multi-parameter water quality meter.

In addition to collecting the water samples, the data logger in Church Road Monitoring Well 2 also measures conductivity. Conductivity will be recorded at 15-minute intervals and the data logger downloaded on a monthly basis. At the start of wellfield operation, the data logger will be downloaded on a daily basis for the first week, weekly during weeks 2 to 4, and on a monthly basis thereafter. The monthly downloads will be completed on the same day that the groundwater level data and water sample are collected from this well. The data logger is set to Pacific Standard Time and programmed for conductivity measurements to be recorded every 15-minutes. The conductivity logger data will be compared to the field conductivity measurements and laboratory conductivity results to verify the data logger is working correctly.

Monthly review of the raw water quality data against the guidelines will identify changes and trends in the parameter concentrations prior to thresholds being met. If a decline in water quality is noted, the treatment plant operators will be notified so that they are aware of any potential future operational changes that may be required to meet the GCDWQ or BCWQG AL.

In accordance with the British Columbia's Best Practices for Prevention of Saltwater Intrusion (BC Ministry of Environment 2016), wells containing groundwater with a chloride concentration greater than 150 mg/L, specific conductivity greater than 1,000 µS/cm, or TDS greater than 700 mg/L are considered to be affected by saltwater intrusion. Consequently, the following thresholds have been designated for the wells which will trigger a response:

- Chloride: 75 mg/L
- Specific conductivity: 500 µS/cm
- TDS: 350 mg/L

If these thresholds are triggered, it indicates that saline intrusion may be occurring, and operation of the wellfield will need to be reviewed and potentially adjusted, contact the SCRD immediately.

Table 9

Well Name	Monitoring Method	Monitoring Frequency	Threshold
Church Road Well 2	Water sample	Monthly	GCDWQ and BCWQG AL: • Chloride: 75 mg/L • Specific conductivity: 500 µS/cm • TDS: 350 mg/L
Church Road Well 3	Water sample	Monthly	GCDWQ and BCWQG AL: • Chloride: 75 mg/L • Specific conductivity: 500 µS/cm • TDS: 350 mg/L
Soames Well	Water sample	Monthly	GCDWQ and BCWQG AL: • Chloride: 75 mg/L • Specific conductivity: 500 µS/cm • TDS: 350 mg/L
	Conductivity data logger	Monthly	Download
Church Road Monitoring Well 2	Water sample	Monthly	GCDWQ and BCWQG AL: • Chloride: 75 mg/L • Specific conductivity: 500 µS/cm • TDS: 350 mg/L

Note:
BCWQG AL – British Columbia Water Quality Guidelines for Aquatic Life
GCDWQ – Guidelines for Canadian Drinking Water Quality
TDS – total dissolved solids

- All water quality sampling will be conducted in accordance with the requirements set out in the British Columbia Field Sampling Manual.
- All sampling events will have a QA/QC program, at least one duplicate sample per 10 samples taken, plus a field blank and trip blank during each monthly sampling event. A QA/QC sample is required for a minimum of 10% of all samples.

- Prior to collecting water samples, the well water level will be measured and then the well will be purged a minimum of three times the volume of water in the well casing; it will be sampled only after field parameters (pH, conductivity, oxidation reduction potential) have stabilized. Field monitoring equipment will have been calibrated prior to use.
- The sampler will wear a new pair of nitrile gloves at each sampling location.
- Samples will be collected in laboratory-supplied bottles with preservatives (where required). Samples requiring filtration will be filtered by the sampler on site using laboratory-supplied filters and syringes. All samples will be collected and filtered following specific laboratory requirements.
- On completion of filling sample bottles, the bottles will be labelled (if not pre-labelled) and put into cool boxes packed with ice. The samples will then be transported to the laboratory in the ice-packed cool boxes. Ideally, a temperature between freezing and 6°C will be maintained.
- The samples will be submitted to the laboratory and processed for analysis within 3 days, which is the shortest hold time of the parameters being tested (colour, turbidity, orthophosphate).
- A completed and signed chain-of-custody form will be submitted to the laboratory with the samples.

6 REPORTING

Providing an orderly approach to data management and monitoring documentation will maximize the intended benefits of the monitoring program and expedite identification of possible issues of concern so that mitigation measures can be implemented if needed.

All data collected, will be added to existing datasets to continually develop the dataset time series. We are asking for a simple Excel spreadsheet to track all of the data collected, in a format that allows for comparison over time for each parameter.

6.1 FIRST MONTH – WEEKLY SUMMARY

When wellfield operation begins, data will be collected on a more frequent basis for the first month (becoming less frequent as the month progresses) to monitor the impacts that the wellfield is having on the environment and other users, and to confirm that the impacts are as anticipated. This will allow any deviations from the anticipated impacts to be identified quickly and any required mitigation or changes in wellfield operation to be made by decision makers. Weekly spreadsheet data will be made available for review during the first month.

6.2 MONTHLY

A short monthly summary memorandum will be prepared within two weeks of collecting the data and receiving the water quality results from the laboratory. The memorandum will present the monthly monitoring results. This evaluation will include the following sections:

<u>Surface Water Flows</u>

- a summary of ramping rate data collected during the month, threshold exceptions and any changes required.
- SCRD will provide hydrometric data for Contractor review monthly. Ongoing monthly monitoring and monthly review of data will provide frequent chances to evaluate the streamflow and creek

stage data to check that they don't hit the thresholds. Monthly reporting shall outlining the monitoring results and will include a comparison of the data against the thresholds. If a threshold is met, recommendations for operational changes will be made.

Surface Water Quality

- A comparison of water quality parameters to the threshold values noted in the respective tables, highlight concerns with the data or impacts to the environment, and provide recommendations in response to those concerns.
- A comparison of water quality parameters between sampling locations, to note which may be at the most risk. This should also be correlated to requisites for fish health and the transect data.
- SCRD provided temperature data (hourly collected) to be analyzed for monthly maximum, minimum, and mean statistics.
- Comparisons of water temperature between sites (i.e., upstream and downstream of the supplemental flow discharge), and between time periods (i.e., before and after start of operation) will be completed.
- If Project-related changes in monthly temperature metrics exceed the threshold of 1.0°C, an assessment of the biological significance of the temperature changes will be initiated. This assessment will be completed through the calculation of biological indicator metrics from the temperature data and may include:
    - Number of degree days outside daily minimum and maximum guideline values;
    - Growing season degree sums; and
    - Days outside optimal temperature ranges for incubation, rearing, and spawning.
- The minimum and maximum degree-day thresholds are calculated to assess the frequency of occurrence of water temperature events that may be harmful to fish or those that occur outside the optimal temperatures for fish growth or reproduction. Cutthroat trout is the most abundant and widely distributed fish species documented in Soames Creek. Temperatures recorded for the Project could be compared to cutthroat trout temperature tolerances or optimum temperature ranges documented in provincial guidelines[1].
- Growing season degree sums are calculated (as per Coleman and Fausch 2007[2]) as an indicator of fish-rearing potential, which has been positively correlated with cutthroat trout recruitment and growth of a number of other fish species[3][4].
- If the temperature changes are determined through this assessment to be biologically significant and potentially negatively affecting fish, options for either warming or cooling of the supplemental flow will be investigated to mitigate for potential negative effects of the temperature change.

Fish and Fish Habitat

- Changes in the water depths across the fish habitat transects over time, correlated to flow measurements from the hydrometric station.

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[1] British Columbia Ministry of Environment and Climate Change Strategy (ENV). 2018. British Columbia Approved Water Quality Guidelines: Aquatic Life, Wildlife & Agriculture, Summary Report. British Columbia Ministry of Environment and Climate Change Strategy, Water Protection & Sustainability Branch. March 2018. Available at: https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/wqgs-wqos/approved-wqgs/wqg_summary_aquaticlife_wildlife_agri.pdf

[2] Coleman, M.A., and K.D. Fausch. 2007. Cold Summer Temperature Limits Recruitment of Age-0 Cutthroat Trout in High-Elevation Colorado Streams. *Transactions of the American Fisheries Society*. 136: 1231-1244.

[3] Neuheimer, A.B., and C.T. Taggart. 2007. The growing degree-day and fish size-at-age: the overlooked metric. *Canadian Journal of Fish and Aquatic Sciences*. 64: 375-385.

[4] Uphoff, C.F., C.W. Schoenebeck, W.W. Hoback, K.D. Koupal, and K.L. Pope. 2013. Degree-day accumulation influences annual variability in growth of age-0 walleye. *Fisheries Research*. 147: 394-398. Vancouver, BC.

- Identify periods of when creek flows may result in reduced connectivity and what those flow values are (correlated to the hydrometric station).
- Confirm that ramping rates in Soames Creek during wellfield pumping and creek augmentation are within appropriate levels to avoid environmental effects.

Groundwater Levels

Groundwater levels in the aquifer can be reviewed in real-time for the production wells linked to SCADA, and after monthly download of logger data and manual measurements for all other wells. Evaluation will include comparing groundwater level to the numerical trigger threshold values (Table 10).

Table 10

	Objective 1			**Objective 2**
	Church Road Well 2	**Church Road Well 3**	**Soames Well**	**901 Sentinel Road**
Well Datum (m asl)	40.98	40.14	31.82	45.5
Static Water Level (m asl)	24.5	24.5	21.5	21.2
Review Threshold (m asl)	8.4	8.1	13.9	18.8
Trigger Threshold (m asl)	2.0	2.0	4.0	10.5

Monthly will include a comparison of the groundwater level data against the thresholds and actions taken where a threshold was met.

Groundwater Quality

- This evaluation will include a comparison of water quality parameters to the threshold values in the Guidelines for Canadian Drinking Water Quality and BC Approved Water Quality Guidelines for the protection of freshwater aquatic life, and identification of trends in groundwater quality. Trend analysis will be used to estimate when the threshold might be met.
- Once a threshold has been reached, verification of the monitoring data will be carried out, including a comprehensive review of the laboratory results and field notes. Re-sampling and analysis may be required to confirm the result, especially if there may have been sampling issues or laboratory errors. The test results will be compared between different sampling locations to identify which environments are at risk so appropriate actions can be taken (e.g., health advisory for users of Soames Creek or shared users of the well) and the SCRD notified.
- Conductivity data from Church Road Wells 2 and 3, and Church Road Monitoring Well 2 will be reviewed and assessed to identify any trends in groundwater conductivity that could be an indicator of saline intrusion. The data will be verified against the water sample laboratory analysis results.

6.3 ANNUAL

An annual monitoring report will be prepared, December 1, presenting the results of the monitoring completed. Specific topics to be included are:

- Compilation of all data collected by component.

- Comparison of all parameters to threshold values over time.
- The Contractor will assess aquifer recharge through review of aquifer drawdown and recovery in all of the wells being monitored. If aquifer water levels do not recover to within 1 m of the previous years' typical high-water level observed in Church Road Wells 2 and 3, and Soames Well (typical non-pumping well water levels are shown in the Static Water Level row in Table 10), or a year-on-year decline in well water level is observed, the pumping rates from each well and the total quantity of groundwater diverted will be assessed. The groundwater diversion data (pumping rate, total quantity diverted, timing of diversion), groundwater level data, and precipitation data will be analyzed by the Contractor to re-evaluate the quantity of groundwater that can be diverted from the wells without causing a year-on-year decline in aquifer water level. Upon request, the SCRD will provide and share this information with the Contractor.
- The Contractor will comment on the following in the annual report:
    - Confirm that ramping rates in Soames Creek during wellfield pumping and creek augmentation are within appropriate levels to avoid environmental effects throughout the year. Ramping rate, expressed as changes in stage (i.e., creek water depth), will be used to assess flow ramping (Knight Piesold Consulting 2005) as a result of creek augmentation. Creek stage will be monitored at Soames Creek Hydrometric Station. The hydrometric station will record creek water levels in real time, with data continuously recorded via the SCRD's SCADA system. Ramping rates will be calculated by dividing the difference between two stage measurements by the time interval.
    - Confirm that operation of the wellfield does not have negative effects on surface water quality in Soames Creek.
    - Determine whether any changes in Soames Creek water temperature between the baseline and operational phases of the Project are biologically significant.
    - Confirm that the maximum available drawdown in each well is sufficient to meet the licensed diversion quantities. The maximum available drawdown has been set to minimize the risk of saline intrusion.
    - Confirm that other local groundwater users are not detrimentally affected by a reduction in aquifer water level.
    - Confirm that there is enough aquifer recharge available to sustainably meet the licensed diversion quantity.
    - Confirm that water quality in the aquifer meets an acceptable standard to maintain safe use by other users of the aquifer.
    - Confirm that water quality is suitable to avoid negative effects on the ecology of Soames Creek.
    - Confirm that operation of the wellfield does not cause saline intrusion, via acceptable water quality.

6.4 YEAR 2 REPORT

After two years of monitoring, the Contractor will prepare a report that identifies the nature of any impacts to Soames Creek, the aquifer, or users thereof. The report will be used to detail any changes that were made to the operation of the wellfield during the period and will inform further operational changes to the wellfield that may be required based on the monitoring data results. The report will also make recommendations for changes to the monitoring program, such as an increase or decrease in monitoring frequency, or the addition or removal of monitoring components and/or locations.