Harrop-Procter Watershed Protection Society

Harrop, Slater, Procter and Narrows Creeks 2021-2022 Streamflow & Water Quality Monitoring Results

Prepared by:

Kootenay Environmental Innovations

Know Your Drainage

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Acronyms

- CFU……..Colony Forming Units
- FEC……Filtration Exemption Criteria
- GCDWQ……Guidelines for Canadian Drinking Water Quality
- HPCC…… ….Harrop-Procter Community Cooperative
- HPWPS……Harrop-Procter Watershed Protection Society
- KEI……Kootenay Environmental Innovations
- MX2001……A model of sensor which measures water level
- NTU……..Nephelometric Turbidity Unit
- QHR……Qualified Hydrometric Reviewer
- RISC……..Resources Information Standards Committee
- SG……Staff Gauge
- SWTO…… Surface Water Treatment Objectives

Background

Kootenay Environmental Innovations (KEI) was retained by the Harrop-Procter Watershed Protection Society (HPWPS) to conduct streamflow (i.e., discharge) monitoring at Harrop Creek, Slater Creek, Narrows Creek and Procter Creek starting in the spring of 2020, and report on water quality metrics sampled by HPWPS's board members. Water quality samples were analyzed using desktop water quality instruments owned by the society or by Passmore Laboratories.

The HPWPS is a subsidiary of Harrop-Procter Community Cooperative (HPCC), which manages forests within the monitored watersheds and runs a sawmill utilizing the harvested timber. HPCC's mandate is to "practice socially and environmentally progressive forestry that protects local watersheds while creating sustainable jobs in our community." The HPWPS's mandate is to ensure "that the Community Forest's day-to-day operations are undertaken with water protection and other ecological values in mind."

Harrop and Narrows Creeks have been monitored for their water quality and discharge since 2002, while Procter and Slater Creeks began being monitored in the spring of 2021. The monitoring aligns with the HPWPS and HPCC's mandates and is intended to ensure that both organizations have the information they need to fulfill their mandates.

Study Objectives/Scope

Based on KEI's roles and responsibilities, its objectives were to collect, analyze, and report on discharge data per the BC Hydrometric RISC standards. The discharge data is presented in this report, and a comprehensive spreadsheet containing each calculation used to calculate the discharge data.

KEI also presents the water quality data for those creeks, including:

- specific conductivity,
- pH,
- turbidity,

- verified E. coli,
- fecal (thermotolerant) coliforms, and
- total coliforms.

Results/Discussion

The following sections will display the streamflow and water quality results of the 2021 and 2022 monitoring seasons. The importance and purpose of each monitoring metric are outlined, and all trends observed in the data are discussed.

Since the residents of Harrop and Procter villages rely on surface water for their consumption, all aspects of the water quality will be discussed compared to the Drinking Water Treatment Objectives for Surface Water in BC, hereafter referred to as Surface Water Treatment Objectives or SWTO. The SWTO includes standards for untreated source water and treated water. Since the Villages of Harrop and Procter do not provide filtered or treated water to their residents, a section of the SWTO titled the Filtration Exemption Criteria (FEC) will be referred to as these are the requirements that would have to be met at a minimum if the villages chose to provide potable drinking water with approval of Interior Health.

The SWTO is limited to monitoring microbiological parameters such as bacteria (coliforms), protozoa and viruses in addition to turbidity. When comparison is needed outside of the scope of the SWTO, the Guidelines for Canadian Drinking Water Quality (GCDWQ) will be referenced.

Referencing the water quality samples collected by the HPWPS board members and analyzed either by themselves or by an accredited lab is in no way meant to be used to make decisions on the potability of drinking water. To determine the potability of drinking water, the first step is to consult with Interior Health and follow their source-specific requirements for determining water potability. This analysis aims to observe general water quality and quantity trends over the long term only.

Streamflow

The streamflow has been collected following the BC Hydrometric RISC standards by KEI since 2021. The following is a summary of the monitoring results for 2021 and 2022.

MX2001 Failures

All four creeks were measured using MX2001 (Figure 1) water level sensors, which in 2023 were proved to contain faulty hardware. The hardware failure led to batteries being rapidly consumed without warning or reason, resulting in total data loss between site visits. The issue was difficult to diagnose as the manufacturer, ONSET, suggested the issues were with the batteries or how the loggers were programmed. Only after multiple failures throughout the East and West Kootenays were brought to ONSET's attention did ONSET investigate the hardware.



Figure 1: ONSET MX2001 Water Level Sensor

The results of their investigation proved that MX2001s manufactured during the COVID-19 pandemic suffer from hardware defects, which are now known to have caused the multiple data losses experienced at each of HPWPS's sites. Credits to Hoskin Scientific are expected to be available for all MX2001s purchased after 2020.

Ice and Leaf Litter Blockages at Slater Creek

As shown in Figure 2 and Figure 3, leaf and ice buildup at the grizzly grate immediately downstream of the water level sensorFigure 3 led to inaccurate streamflow data while the blockages occurred. Consequently, the streamflow data collected at Slater is less accurate as the blockages occur incrementally, and no visual or written record is available to confirm when the blockages were present.



Figure 2: Leaf Litter Blockage at Slater Creek



Figure 3: Ice Blockage at Slater Creek

Narrows Creek Control Change

Narrows Creek suffered from a significant change in its control during the 2022 freshet. In hydrology, the term "control" refers to a physical characteristic of a stream which determines the water level at a location throughout various streamflows. The control at the Narrows Creek streamflow monitoring location consists of large boulders and cobbles which create a pool. Calculating accurate streamflow from water levels, referred to as "stage," requires that the control remains stable from year to year.

As seen in Figure 4, the stage during periods of low flow in the summer and winter months changed drastically at the Narrows Creek station. The result is that the station will require 5-6 flow measurements at unique stage levels each year that the control changes to calculate even reasonably accurate flow data. Two other options are to relocate or abandon the station.

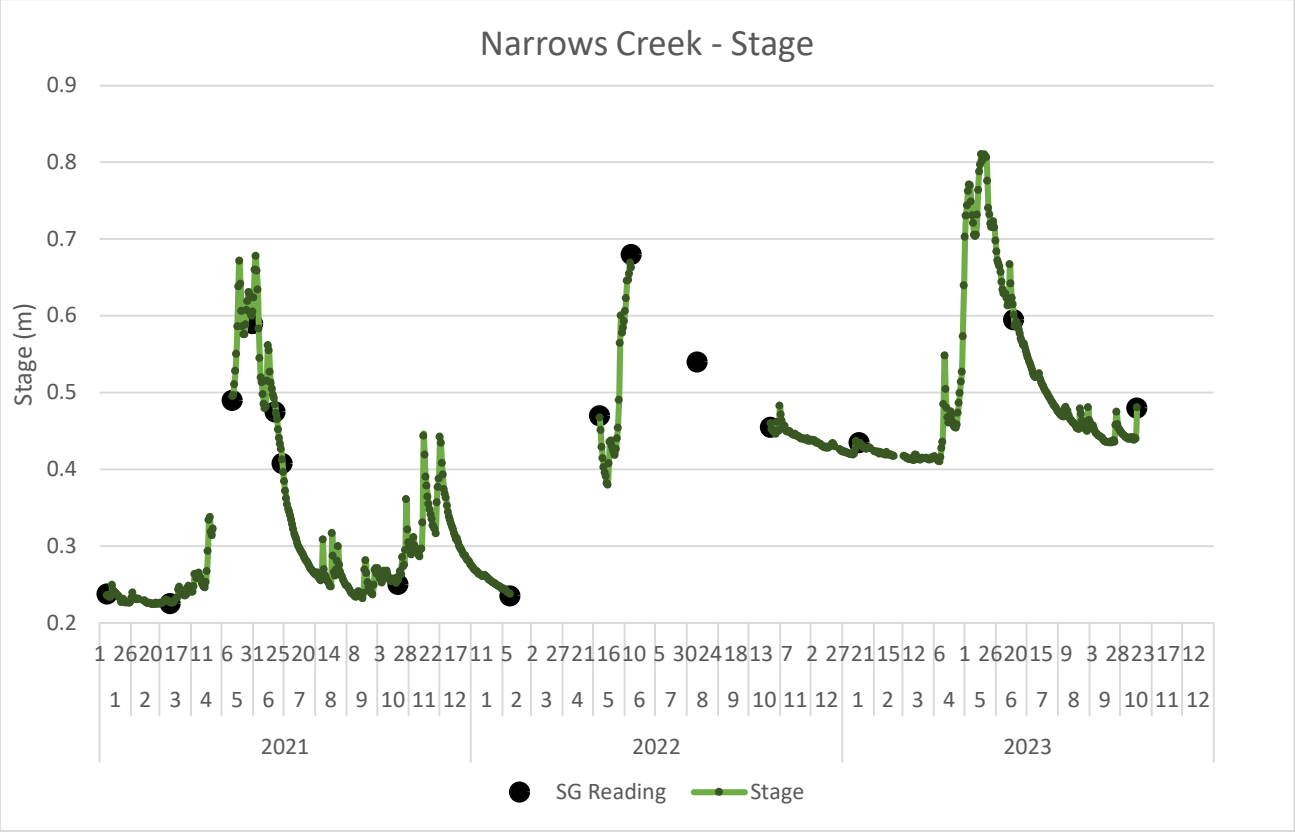
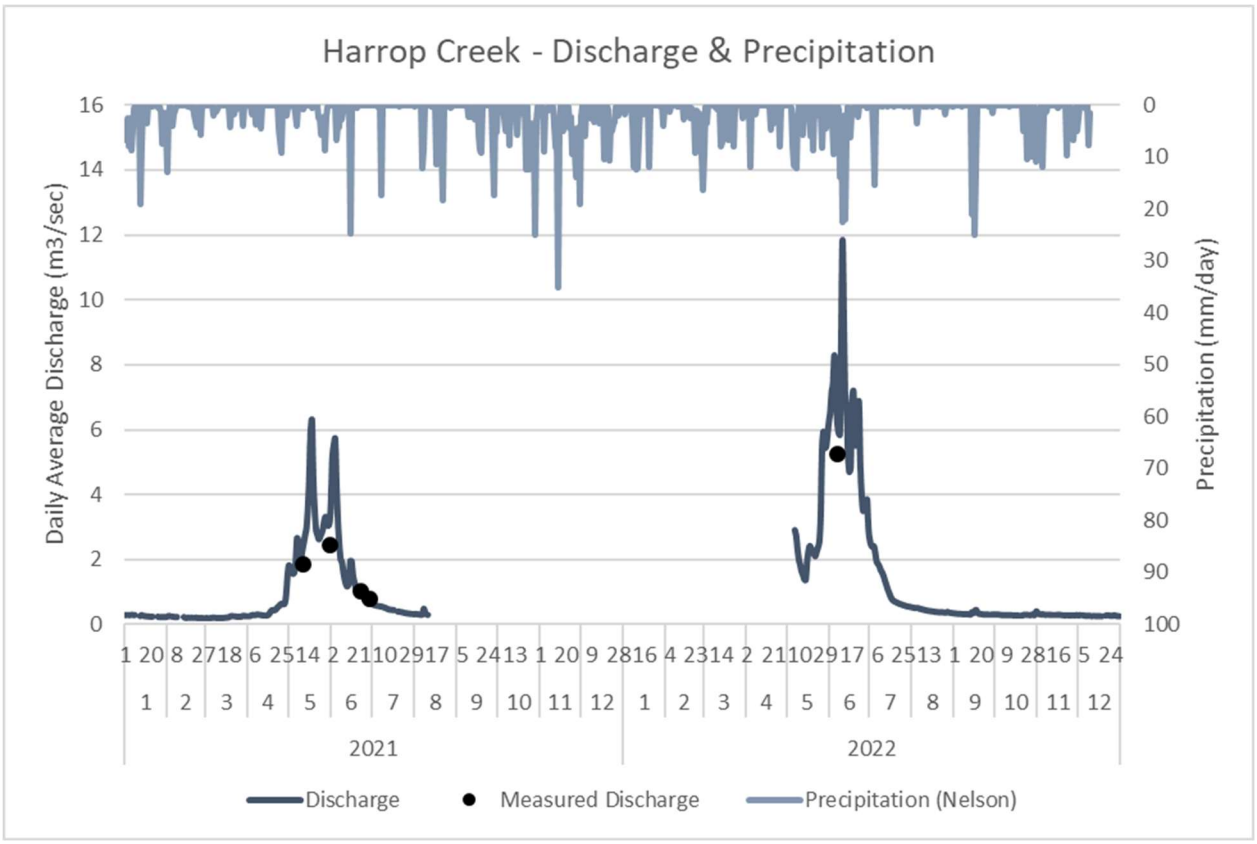
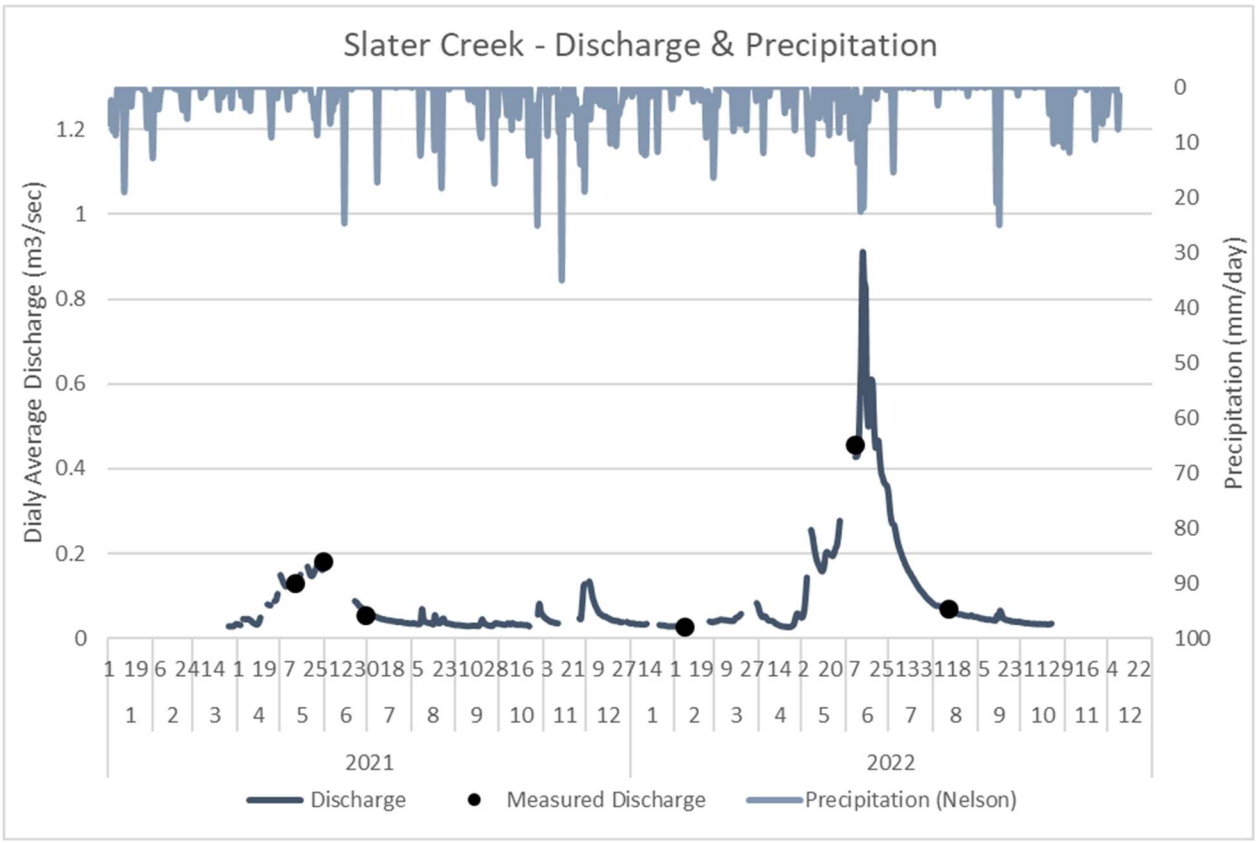


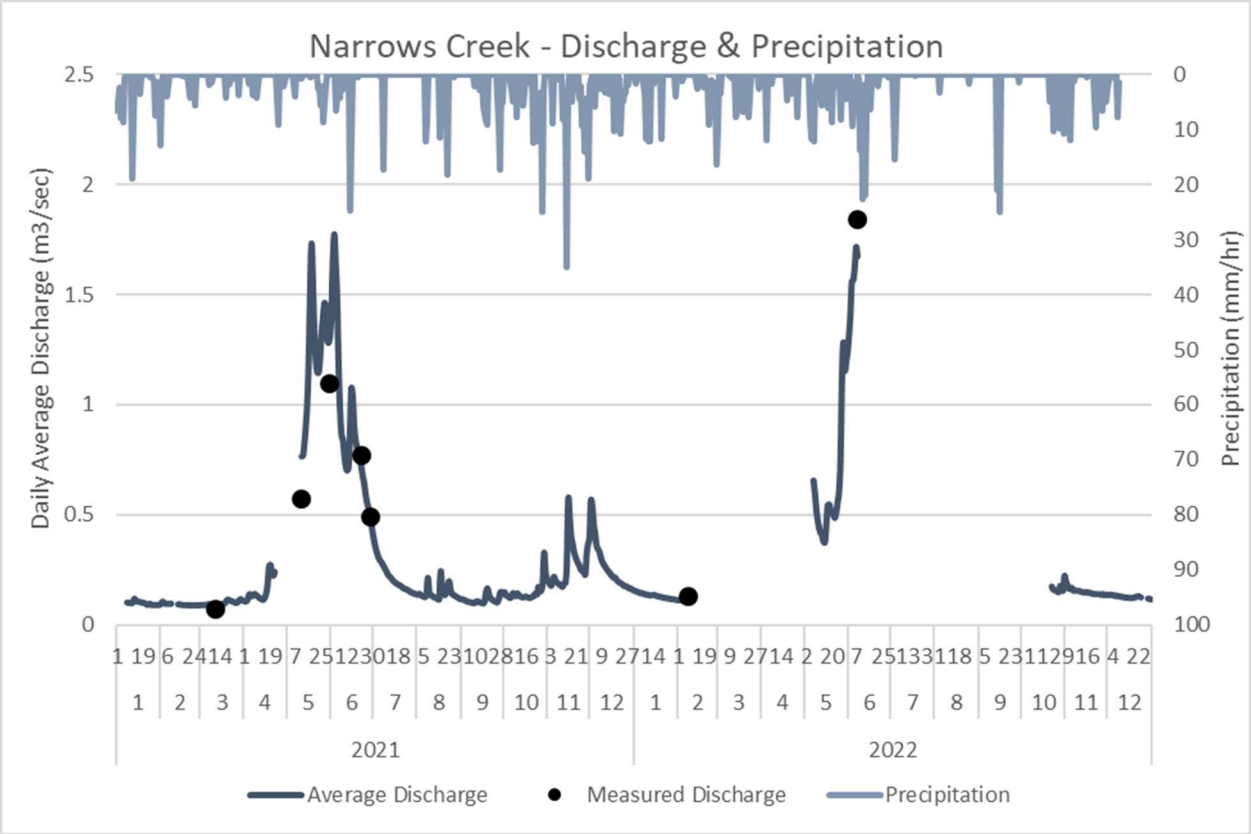
Figure 4: Stage at Low Flow Conditions, Shift due to Control Change

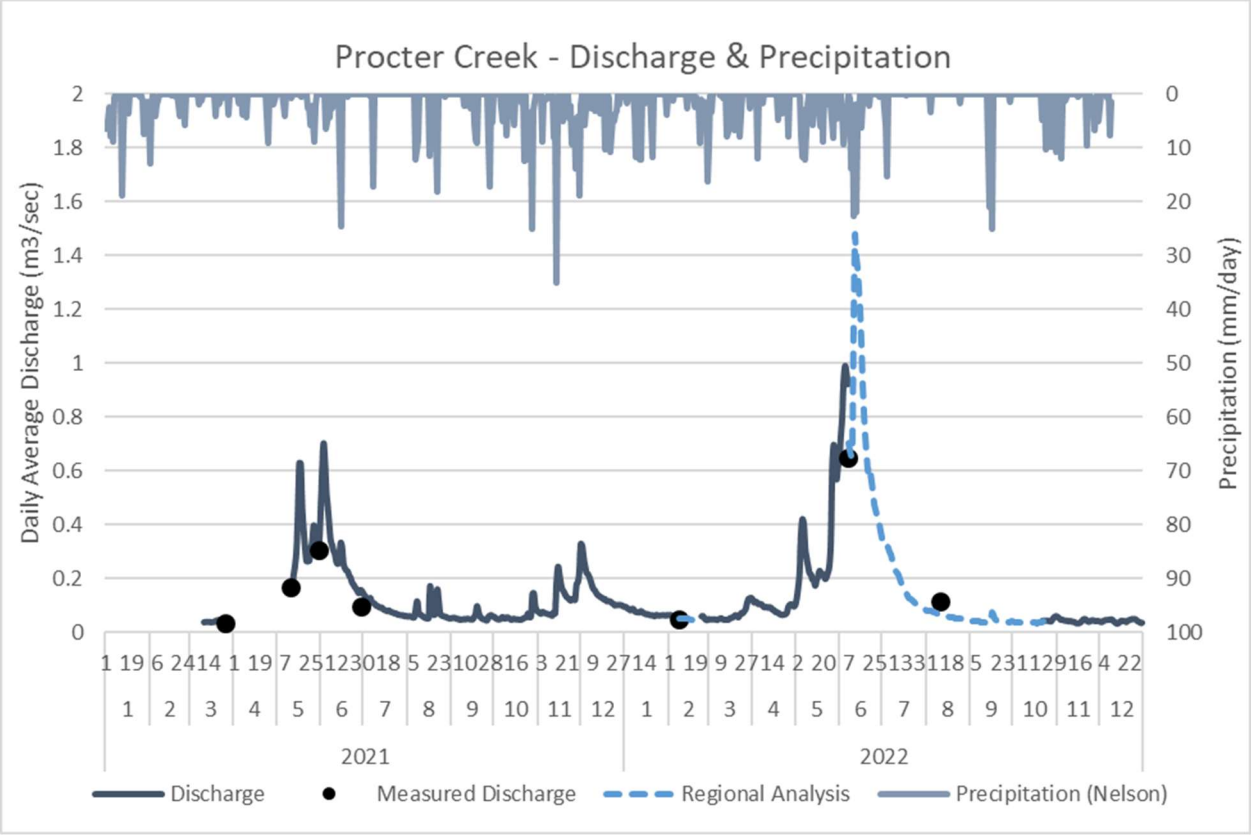
Streamflow Magnitude

As seen in the hydrograph for each creek on the following pages, 2021 had significantly lower flows than 2022. In addition, the 2022 freshet was notable for being delayed and concentrated due to unseasonably cold temperatures throughout the spring. An indicator of the delayed freshet can be seen in the Redfish snow pillow data available online. The snow pillow measures the weight of snow, referred to as snow-water equivalent, in the alpine across the West Arm from the Harrop and Procter villages. The snow-water equivalent data for 2022 was at record highs going into the summer since data collection began in 2003.


Harrop Creek - Discharge & Precipitation
Daily Average Discharge (m3/sec)
Precipitation (mm/day)
2021
2022
Discharge
Measured Discharge
Precipitation (Nelson)


Slater Creek - Discharge & Precipitation
Dialy Average Discharge (m3/sec)
Precipitation (mm/day)
2021
2022
Discharge
Measured Discharge
Precipitation (Nelson)


Narrows Creek - Discharge & Precipitation
Daily Average Discharge (m3/sec)
Precipitation (mm/hr)
2021
2022
Average Discharge
Measured Discharge
Precipitation


Procter Creek - Discharge & Precipitation
Daily Average Discharge (m3/sec)
Precipitation (mm/day)
2021
2022
Discharge
Measured Discharge
Regional Analysis
Precipitation (Nelson)

Turbidity

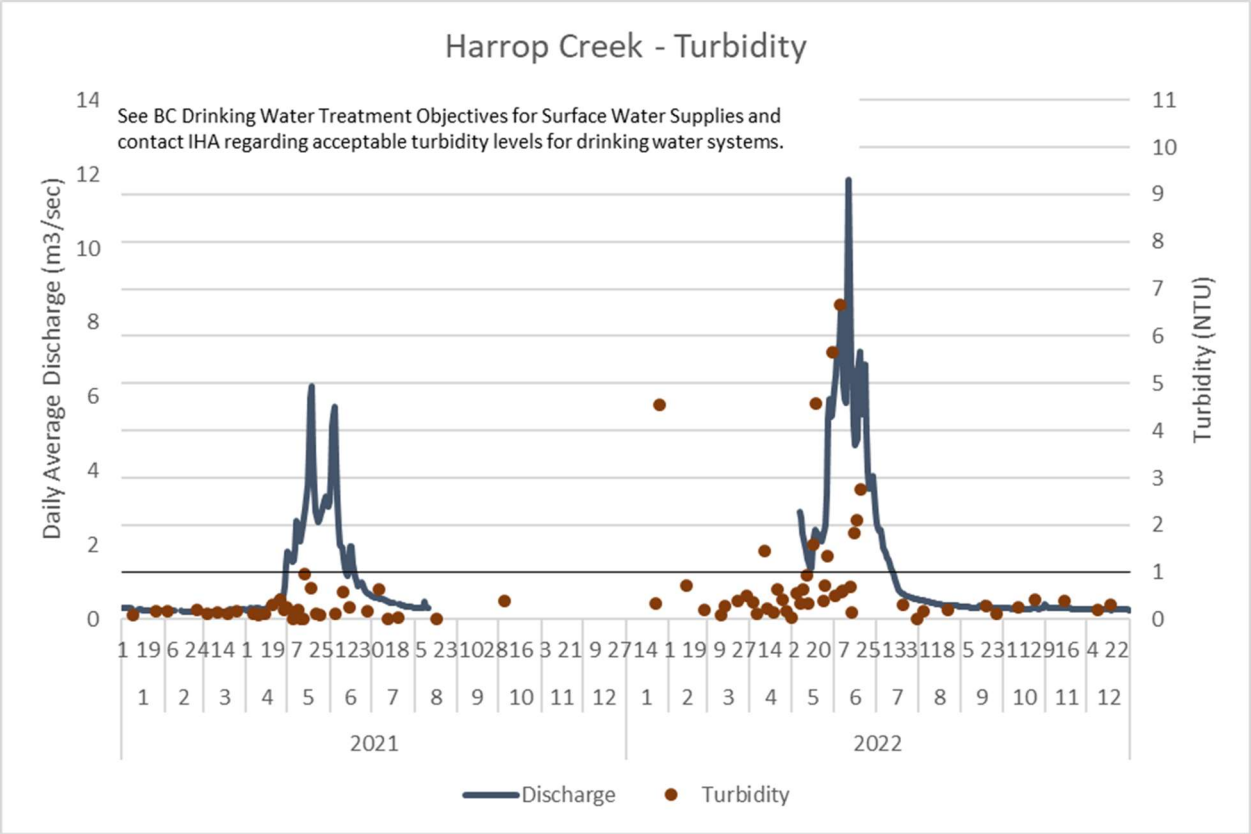
Turbidity is a commonly monitored water quality parameter as it indicates potential pathogens in the water, provides surface area upon which bacteria can grow, and negatively impacts water treatment by decreasing the effectiveness of UV and chlorine disinfection and prematurely clogging filters (B.C. Ministry of Forests and Range, 2010) (BC Ministry of Health, 2012). Additionally, turbidity is cost-effective to monitor. Because of the value of turbidity data and ease of monitoring, the dataset collected by HPWPS's board members for the 2021 and 2022 monitoring periods is of excellent value for analyzing water quality in all four creeks.

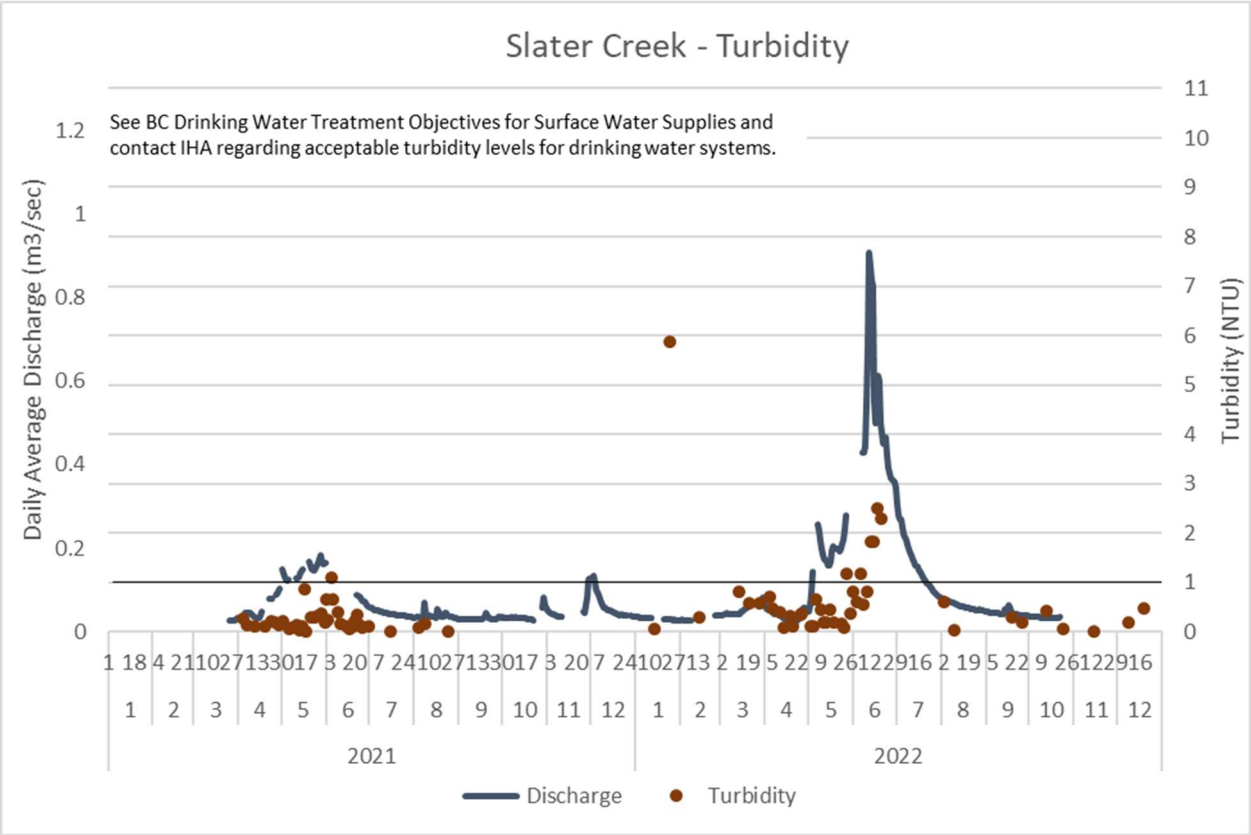
The most applicable legislation to compare the HPWPS results to is the province's Filtration Exemption Criteria (FEC) since the villages of Harrop and Procter do not filter their drinking water. The FEC requires daily average turbidity measurements to be collected using continuous monitoring instrumentation, which was not implemented in this monitoring program. However, the FEC gives good guidance in this situation, noting that turbidity should not exceed "around 1 [Nephelometric Turbidity Units] NTU, but do not exceed 5 NTU for more than two days in a 12-month period" (BC Ministry of Health, 2012).

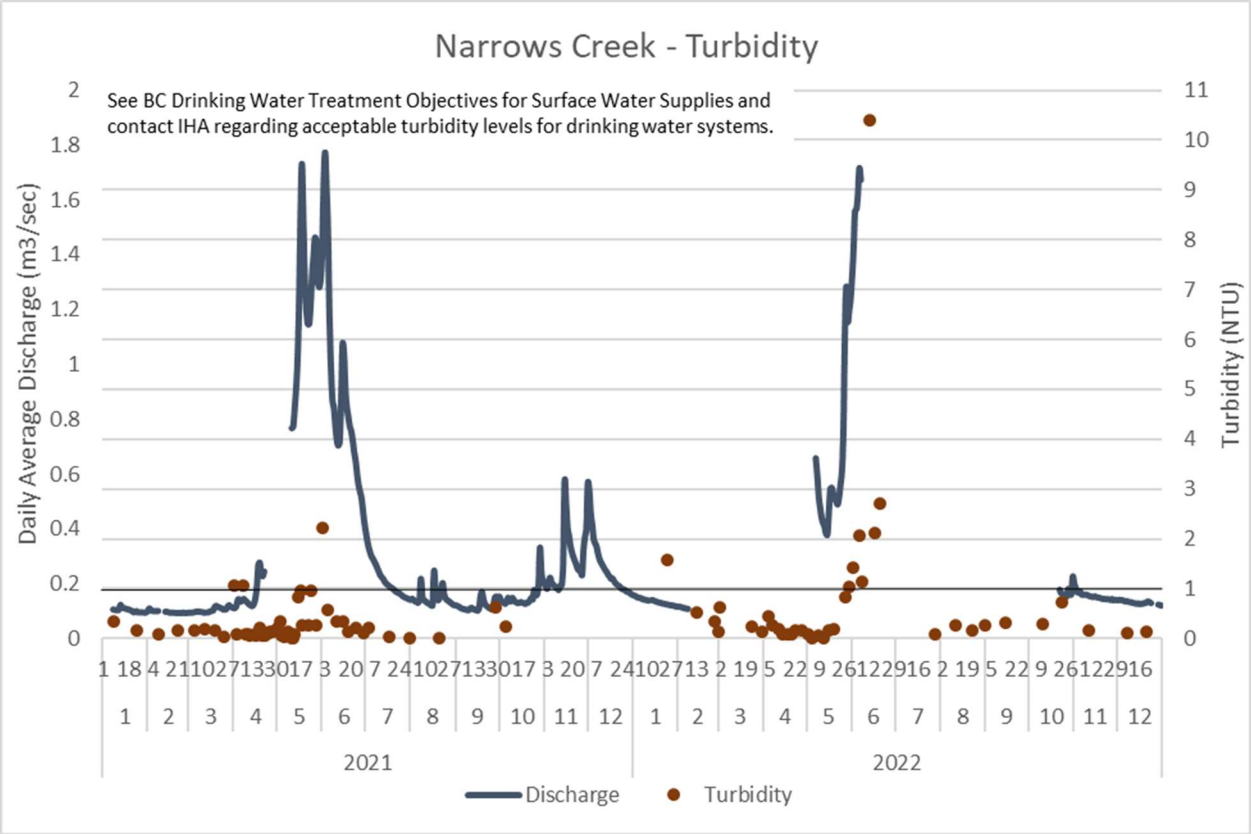
Turbidity Results

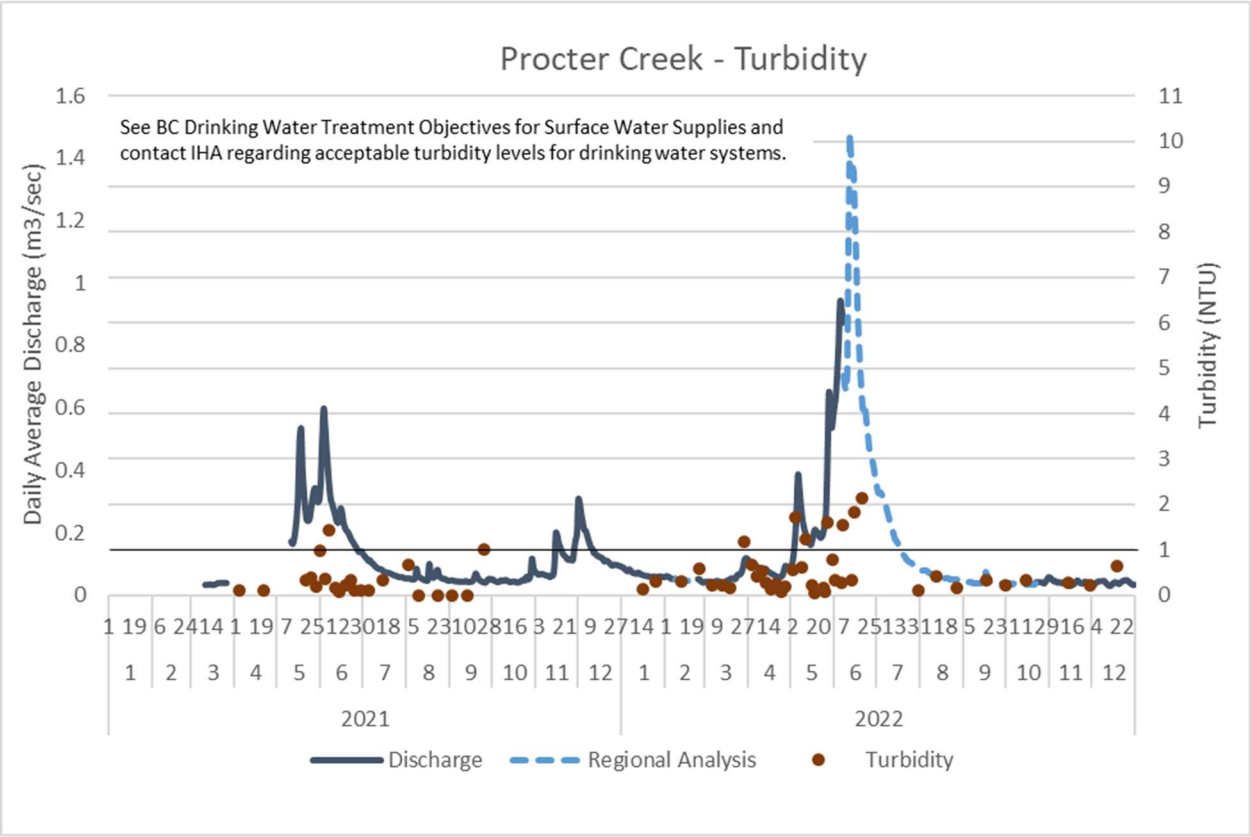
Since the sampling program does not allow daily average turbidity levels to be calculated and sampling is not conducted daily, the best metric to observe is the number of turbidity samples above 1 NTU and above 5 NTU. Reviewing the data in the graphs below shows that all four creeks have reported turbidity values above 1 NTU, with 2022 having more results exceeding 1 NTU than 2021.

However, when observing the number of data points above 5 NTU, the difference between the turbidity in each creek becomes clear. In 2021 and 2022, the results show that Harrop had the worst water quality concerning turbidity, with four higher than 4 NTU and two of those being greater than 5 NTU. While Narrows had only one result higher than 5 NTU, it was the most turbid of all four creeks at greater than 10 NTU. Slater also only had one result over 5 NTU, but it was below 6 NTU, while Procter Creek had no results over 5 NTU.


Harrop Creek - Turbidity
See BC Drinking Water Treatment Objectives for Surface Water Supplies and contact IHA regarding acceptable turbidity levels for drinking water systems.
Daily Average Discharge (m3/sec)
Turbidity (NTU)
2021
2022
Discharge
Turbidity


Slater Creek - Turbidity
See BC Drinking Water Treatment Objectives for Surface Water Supplies and contact IHA regarding acceptable turbidity levels for drinking water systems.
Daily Average Discharge (m3/sec)
Turbidity (NTU)
2021
2022
Discharge
Turbidity


Narrows Creek - Turbidity
See BC Drinking Water Treatment Objectives for Surface Water Supplies and contact IHA regarding acceptable turbidity levels for drinking water systems.
Daily Average Discharge (m3/sec)
Turbidity (NTU)
2021
2022
Discharge
Turbidity


Procter Creek - Turbidity
See BC Drinking Water Treatment Objectives for Surface Water Supplies and contact IHA regarding acceptable turbidity levels for drinking water systems.
Daily Average Discharge (m3/sec)
Turbidity (NTU)
2021
2022
Discharge
Regional Analysis
Turbidity

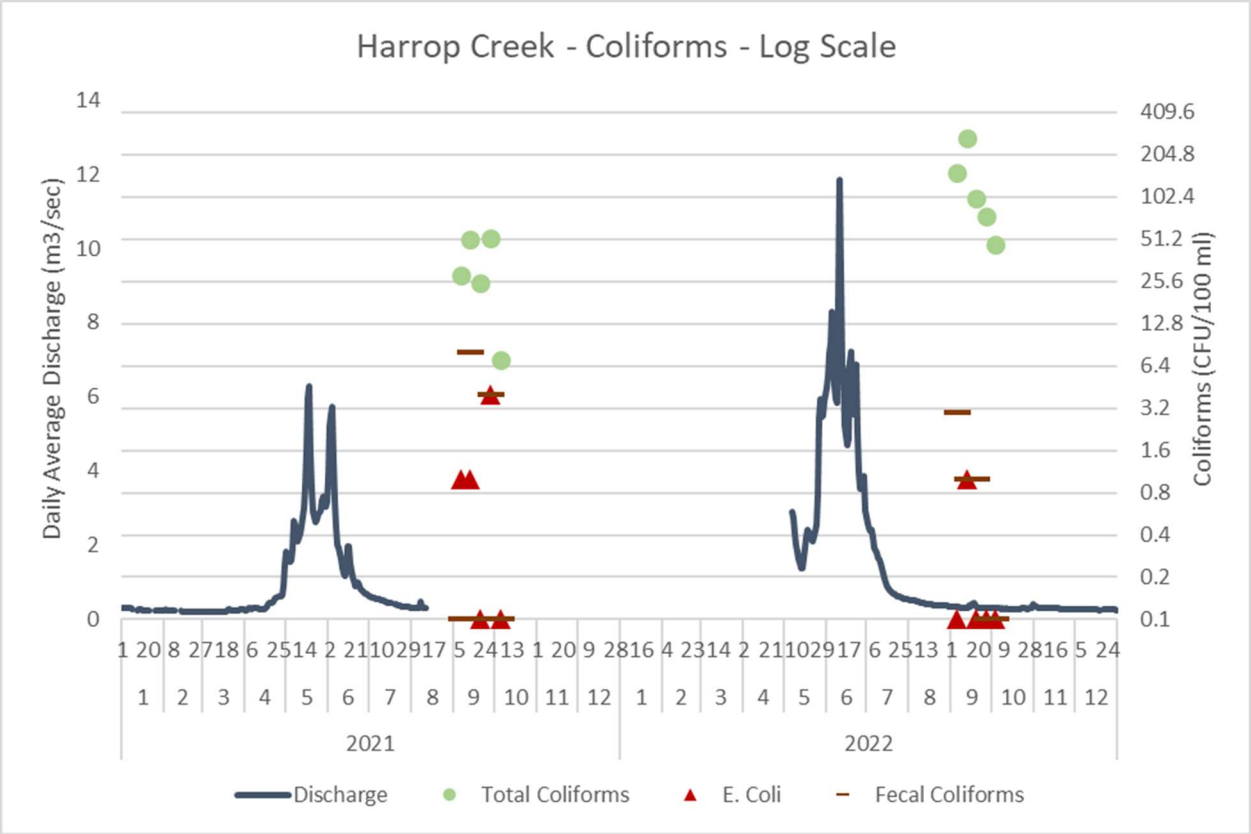
Coliforms

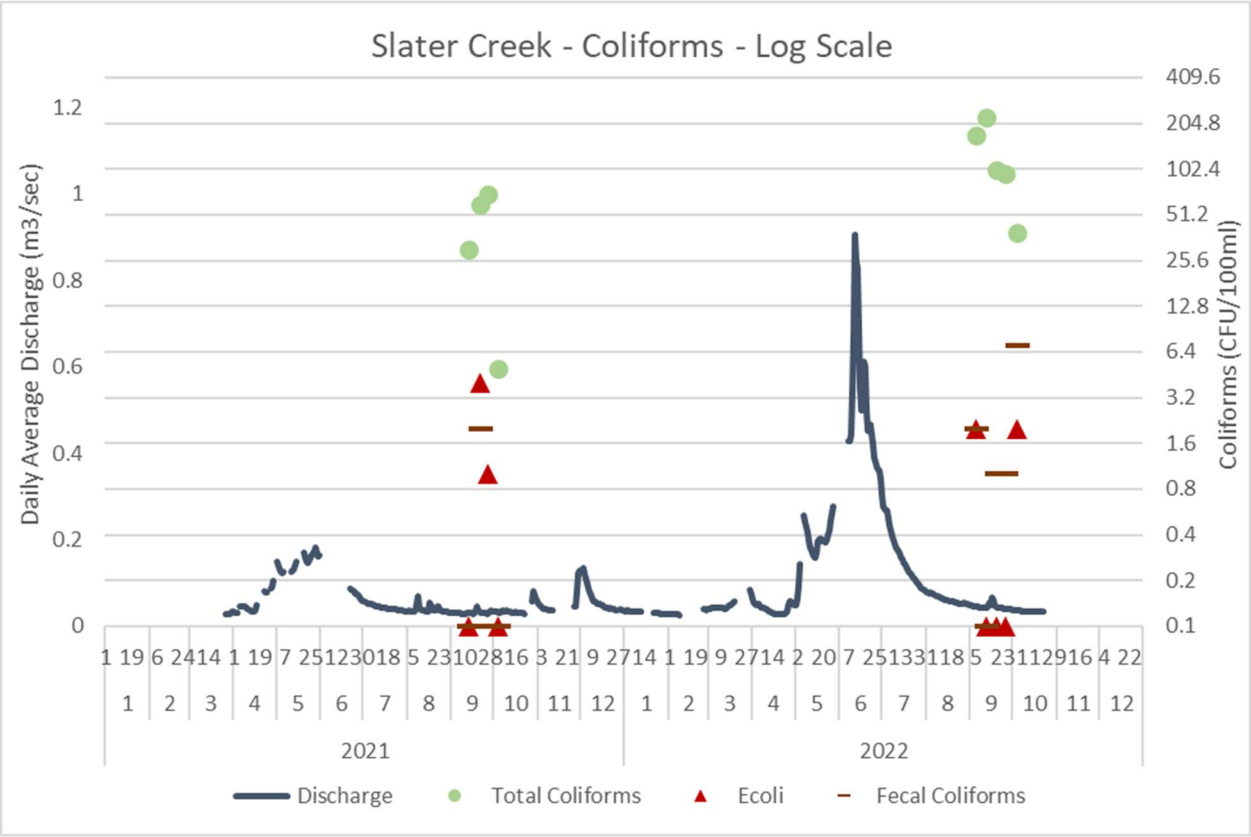
Coliforms may be the most critical water quality parameter commonly monitored as certain coliforms, such as E. coli, are known to be detrimental to human health. Unfortunately, compared to physical and chemical water quality parameters such as pH or turbidity, coliforms must be analyzed in an accredited laboratory, have moderately high analysis costs, and must be analyzed within a short period after sampling.

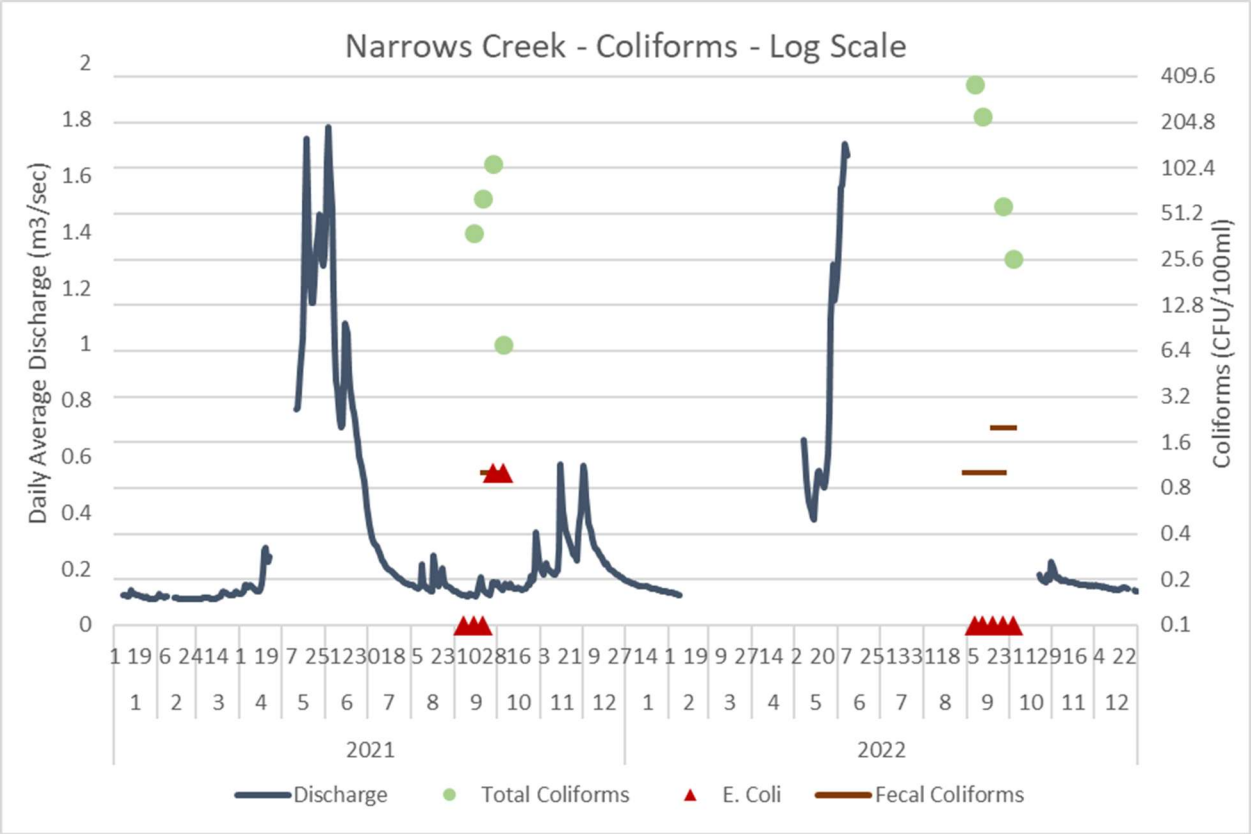
For treated water, the SWTO limits E. coli, fecal coliforms and total coliforms to zero detectable colony-forming units per 100mL (CFU/100mL). In untreated source water, the FEC allows some E. coli to be present, granted that several other best practices are in place and Interior Health has approved operating without a filter. The requirements are based on a weekly sampling regime; however, due to budget constraints, the 2021-2022 HPWPS monitoring program only collected five coliform samples over 30 days each fall. Thus, the results from the 2021-2022 HPWPS monitoring program are only peripherally applicable to the FEC limits, which state that "[t]he number of E. coli in raw water does not exceed 20 CFU/100 mL (or if E. coli data are not available less than 100 CFU/100 mL of total coliform) in at least 90% of the weekly samples from the previous six months."

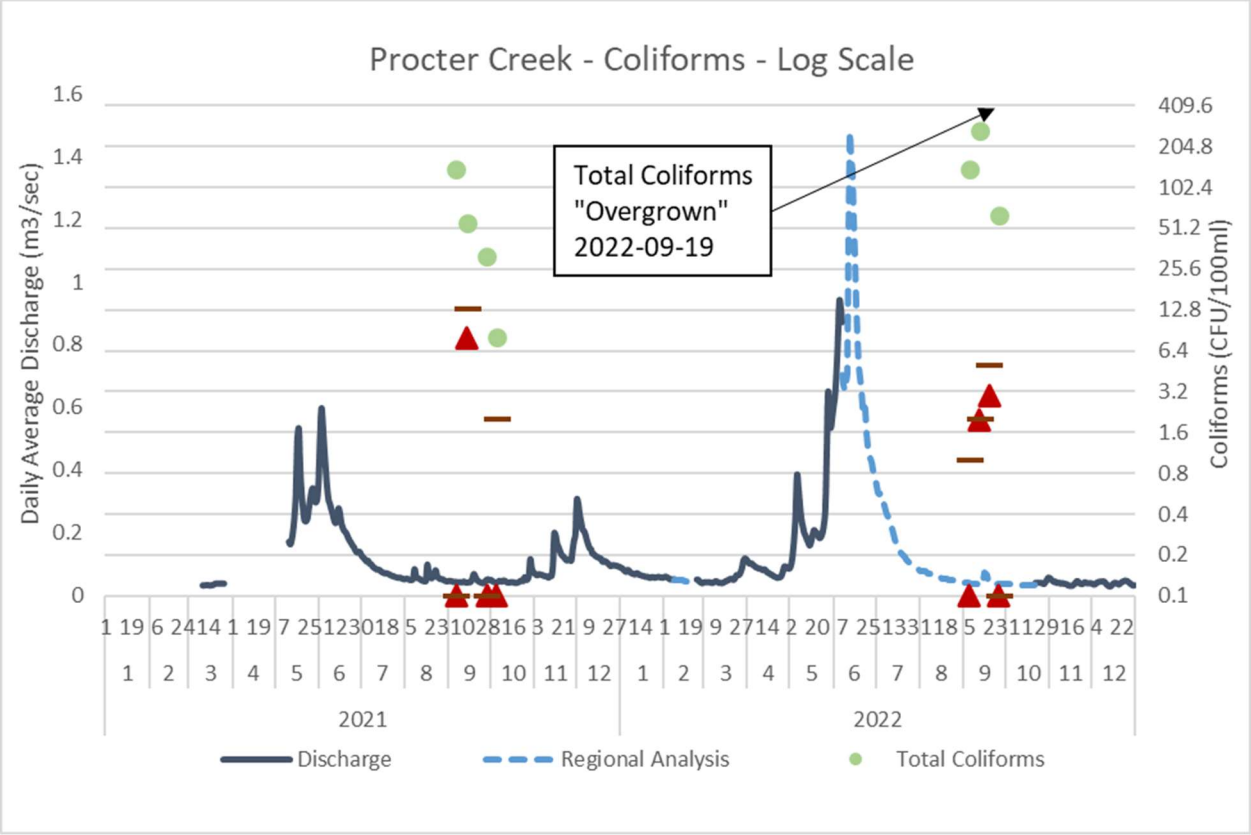
Coliform Results

Since weekly samples are not taken, the HPWPs monitoring can only be compared to the FEC requirements that E. coli results do not exceed 20 CFU/100 mL. No results from the E. coli samples returned values greater than 20 CFU/100 mL. However, coliforms, including E. coli, were present in raw water in lower limits. Thus, if water is not adequately treated within individual households, E. coli will be present in consumed water.


Harrop Creek - Coliforms - Log Scale
Daily Average Discharge (m3/sec)
Coliforms (CFU/100 ml)
2021
2022
Discharge
Total Coliforms
E. Coli
Fecal Coliforms


Slater Creek - Coliforms - Log Scale
Daily Average Discharge (m3/sec)
Coliforms (CFU/100ml)
2021
2022
Discharge
Total Coliforms
Ecoli
Fecal Coliforms


Narrows Creek - Coliforms - Log Scale
Daily Average Discharge (m3/sec)
Coliforms (CFU/100ml)
2021
2022
Discharge
Total Coliforms
E. Coli
Fecal Coliforms


Procter Creek - Coliforms - Log Scale
Total Coliforms "Overgrown" 2022-09-19
Daily Average Discharge (m3/sec)
Coliforms (CFU/100ml)
2021
2022
Discharge
Regional Analysis
Total Coliforms

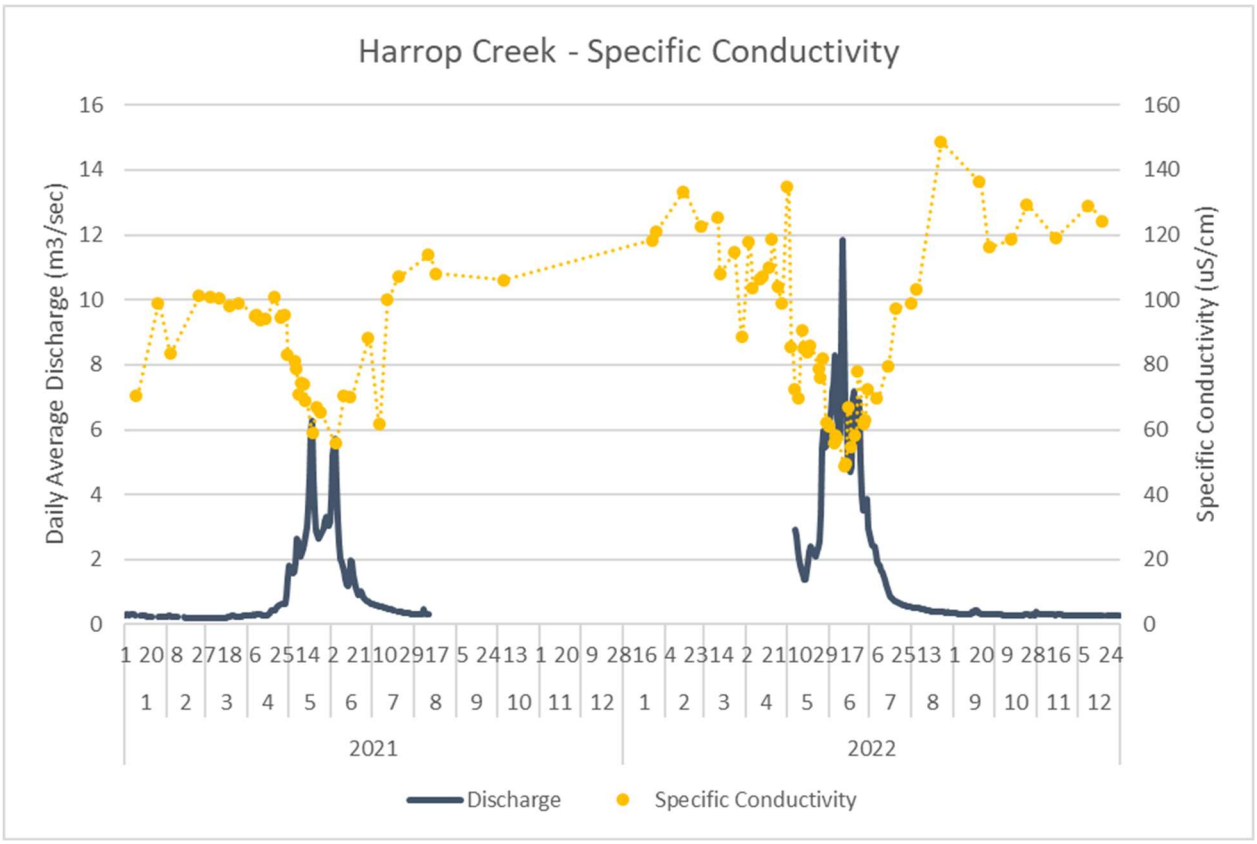
Specific Conductivity

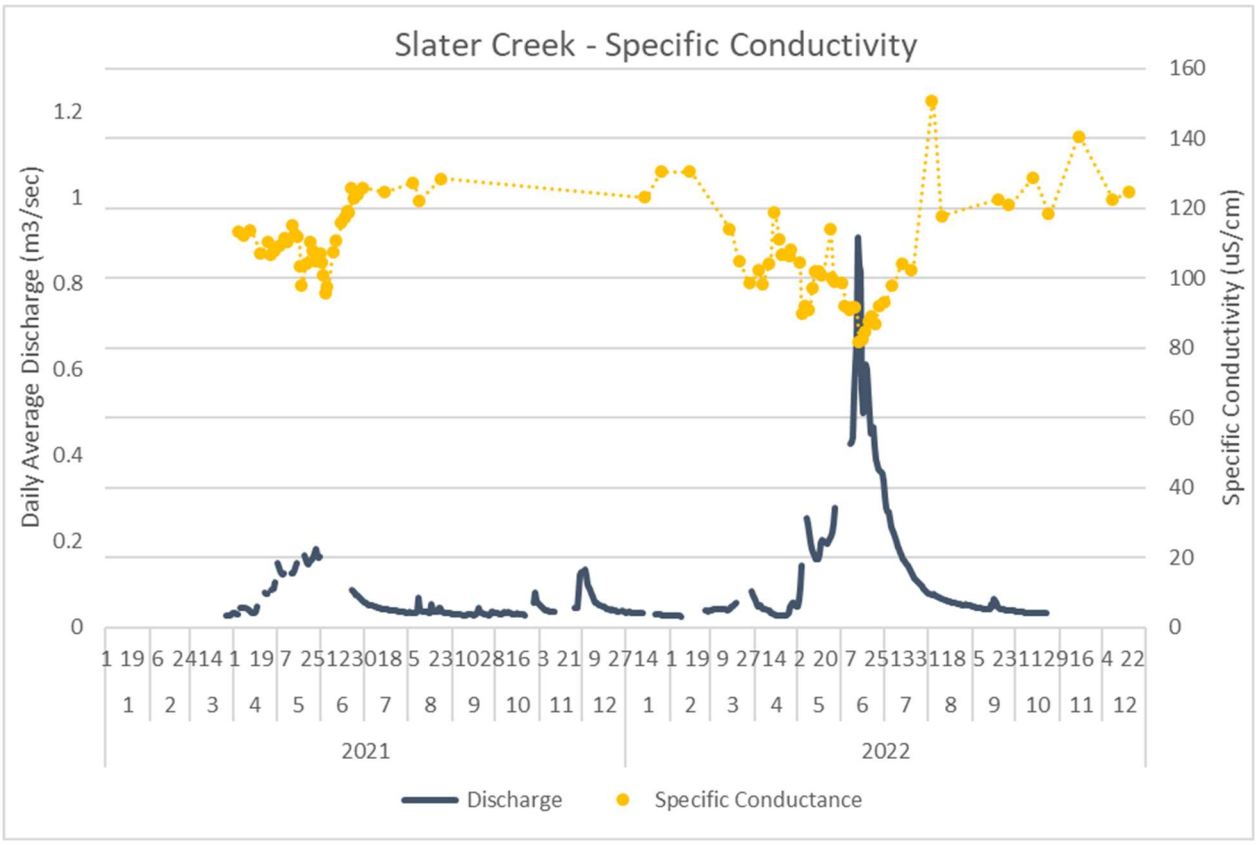
Specific conductivity, sometimes referred to as specific conductance, is a measure of the ability of electricity to pass through water when corrected for temperature. Conductivity increases with increased dissolved ions (B.C. Ministry of Forests and Range, 2010) , which can be broken up into two sources: naturally occurring and artificially introduced. Naturally occurring ions are present in groundwater since the water in contact with rocks and minerals dissolves ions naturally over time, creating more conductive water. Surface water runoff is generally associated with low conductivity, so conductivity levels will drop when surface runoff comprises the majority of streamflow. And the opposite is true as well: when water is sourced primarily from groundwater, conductivity levels will rise.

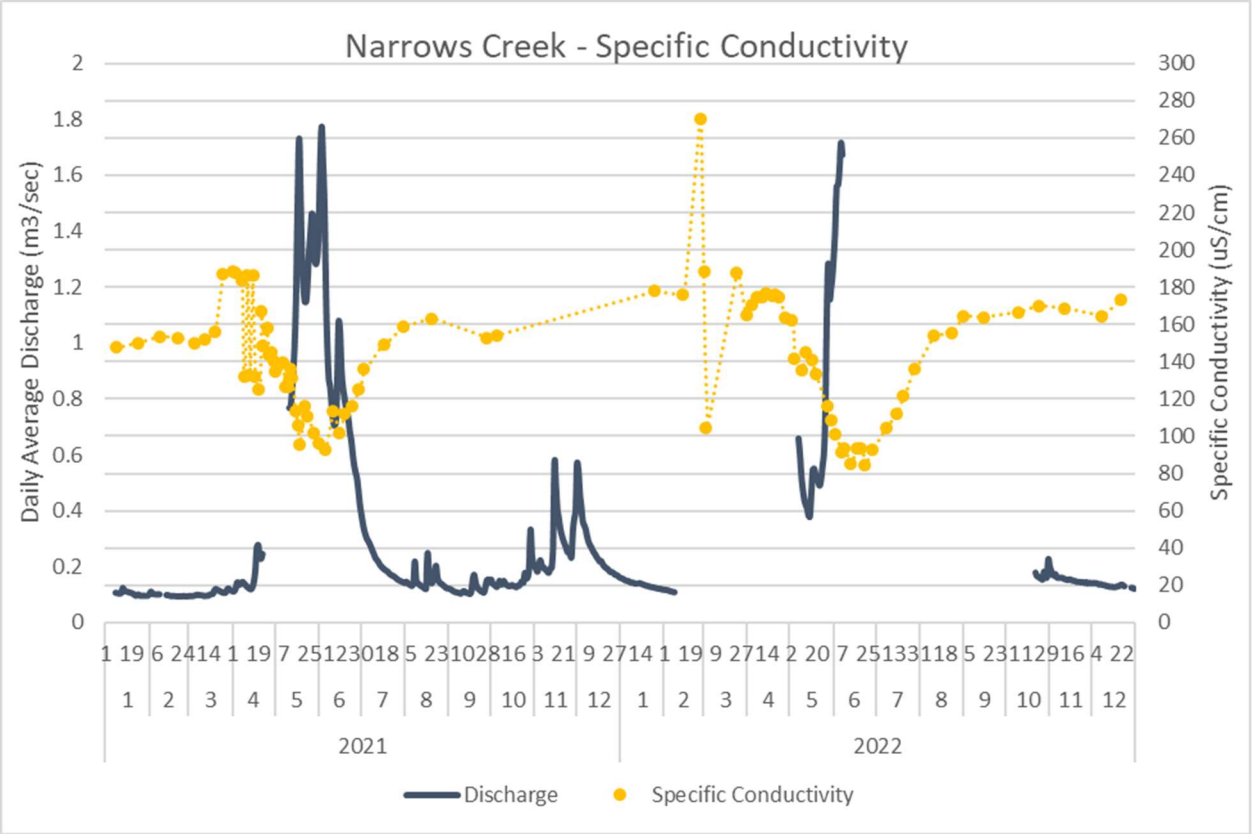
Conductivity monitoring can also identify non-natural sources of dissolved ions, such as pollutants, in a water body. Pollutants like salt applied to roads or landfill leachate often have high conductivity levels. If abnormal conductivity readings are recorded, this could indicate pollutants entering a stream.

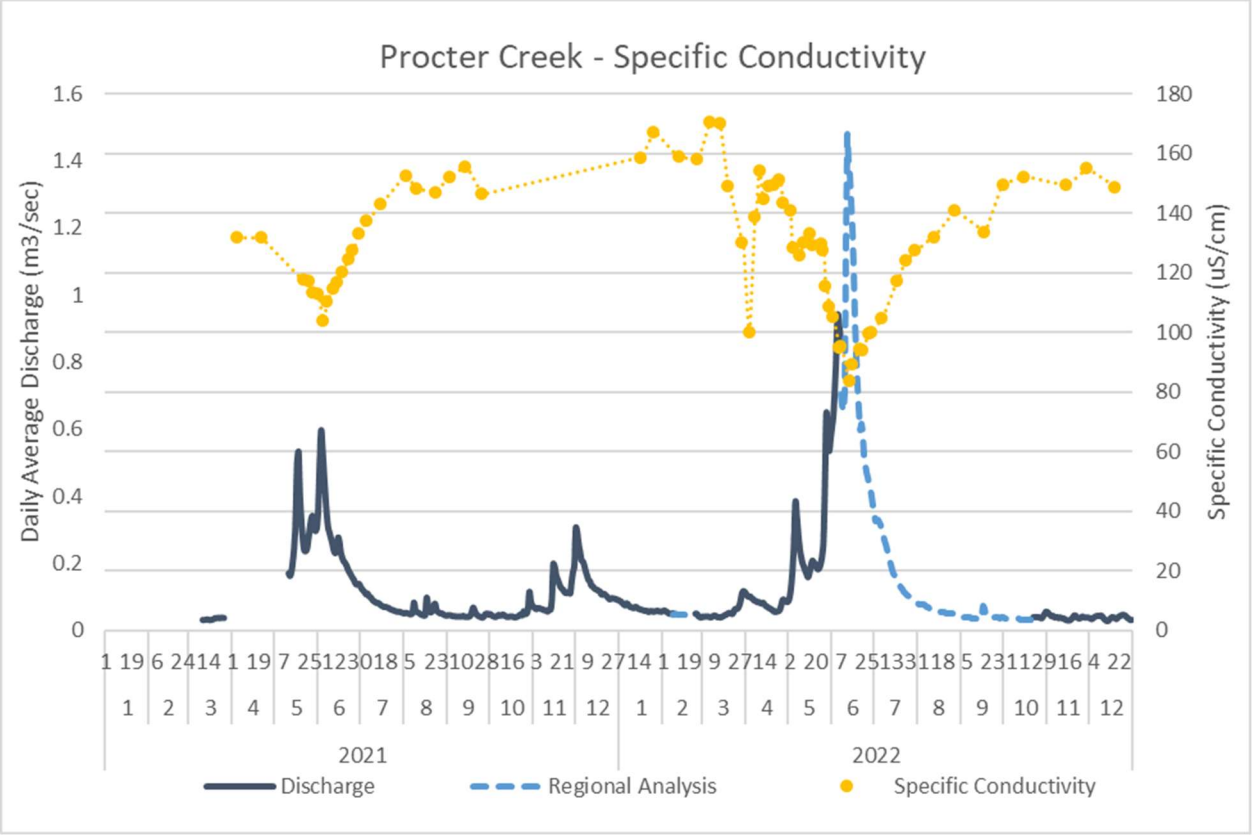
Specific Conductivity Results

Trends for specific conductivity during low and high flow periods were established throughout the 2021-2022 monitoring years, with no significant shifts in background conductivity being observed. Individual spikes and dips did occur at each creek, though they are not tied to any identified non-natural sources of dissolved ions. It is recommended that calibration, cleaning and record-keeping best practices be reviewed to validate the reading if data spikes are observed.


Harrop Creek - Specific Conductivity
Daily Average Discharge (m3/sec)
Specific Conductivity (uS/cm)
2021
2022
Discharge
Specific Conductivity


Slater Creek - Specific Conductivity
Daily Average Discharge (m3/sec)
Specific Conductivity (uS/cm)
2021
2022
Discharge
Specific Conductance


Narrows Creek - Specific Conductivity
Daily Average Discharge (m3/sec)
Specific Conductivity (uS/cm)
2021
2022
Discharge
Specific Conductivity


Procter Creek - Specific Conductivity
Daily Average Discharge (m3/sec)
Specific Conductivity (uS/cm)
2021
2022
Discharge
Regional Analysis
Specific Conductivity

pH

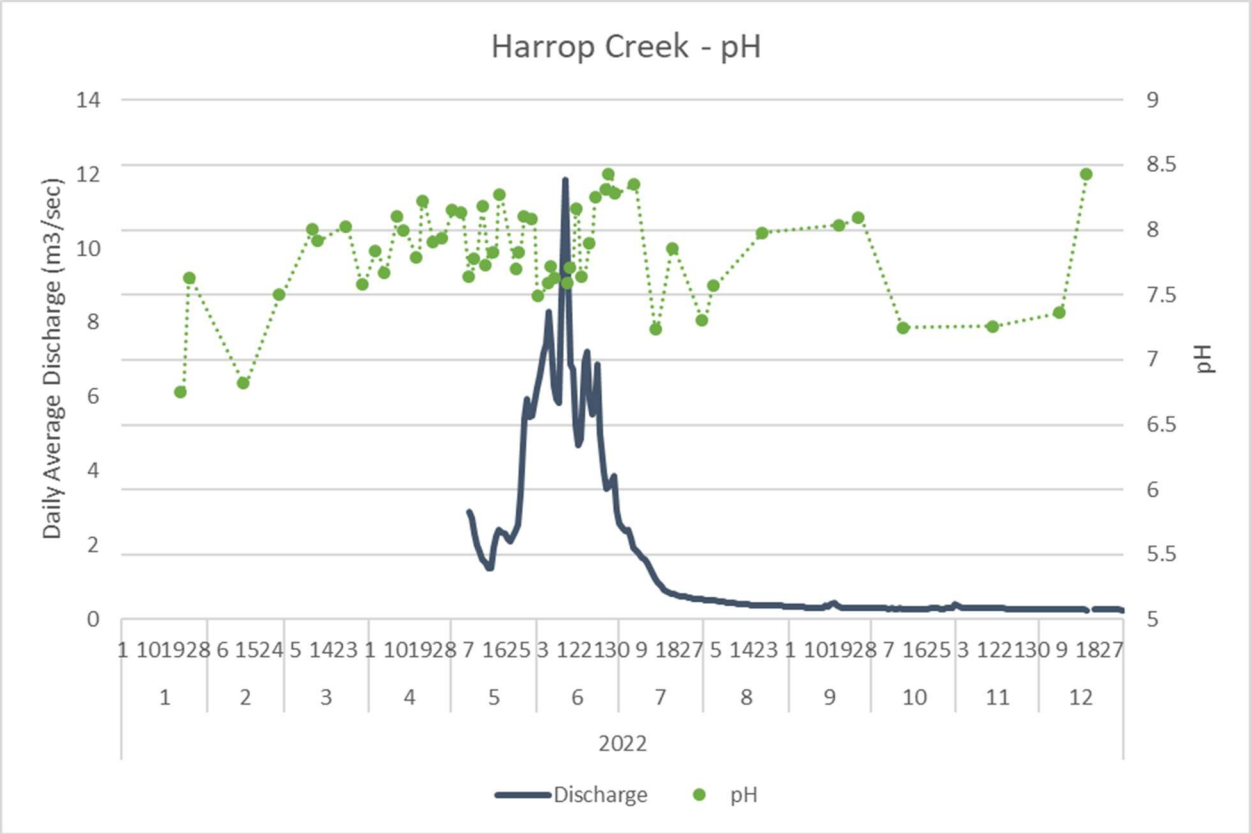
pH measures the activity of hydrogen ions within a liquid, which indicates whether the liquid is acidic, basic or neutral. The pH scale ranges from 0 to 14, with pH<7 being acidic, pH=7 being neutral, and pH>7 being basic. The scale is represented in log form, meaning a pH of 5 is ten times more acidic than a pH of 6.

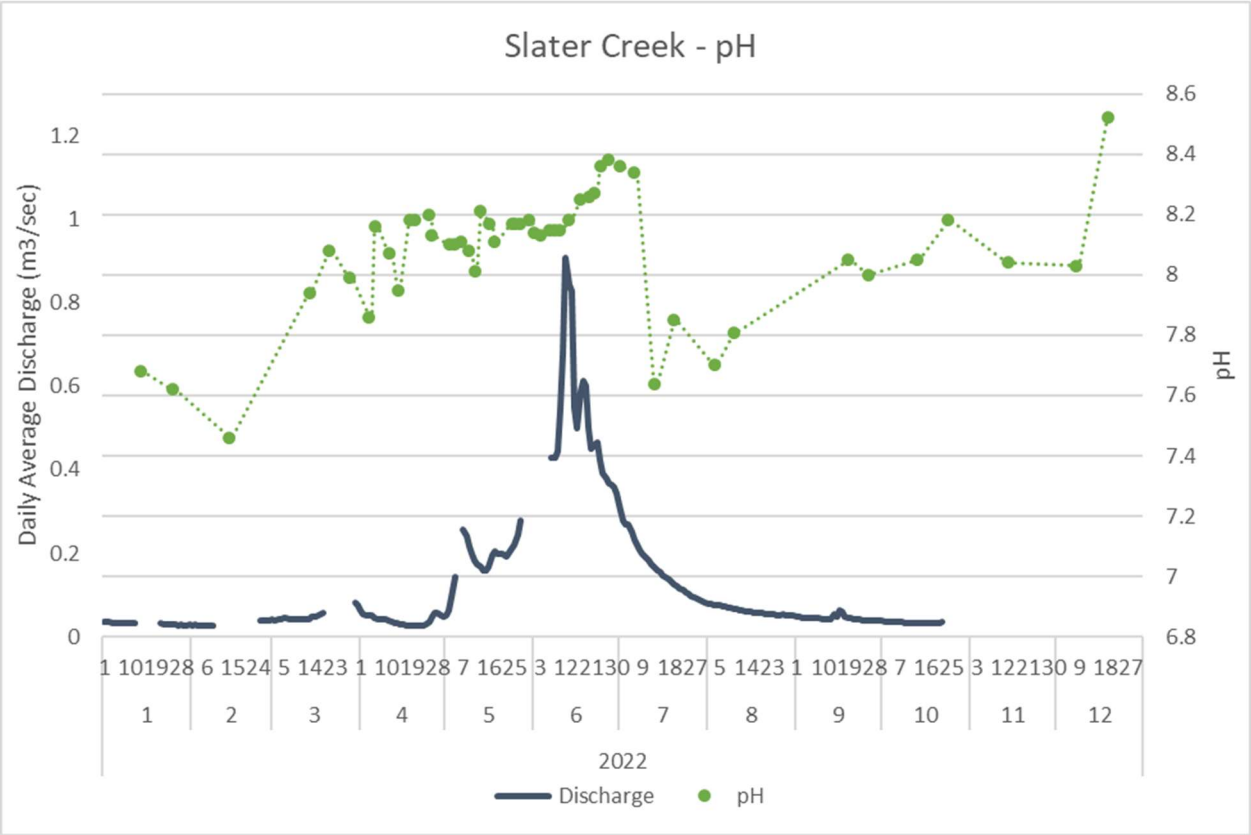
The importance of pH in drinking water is threefold. One is that water that is either too basic or too acidic would be harmful to human health. Another important aspect is to optimize drinking water treatment effectiveness. The most important in most scenarios is that acidic water is prone to leaching metals from plumbing components (Health Canada, 2023), the most concerning being lead.

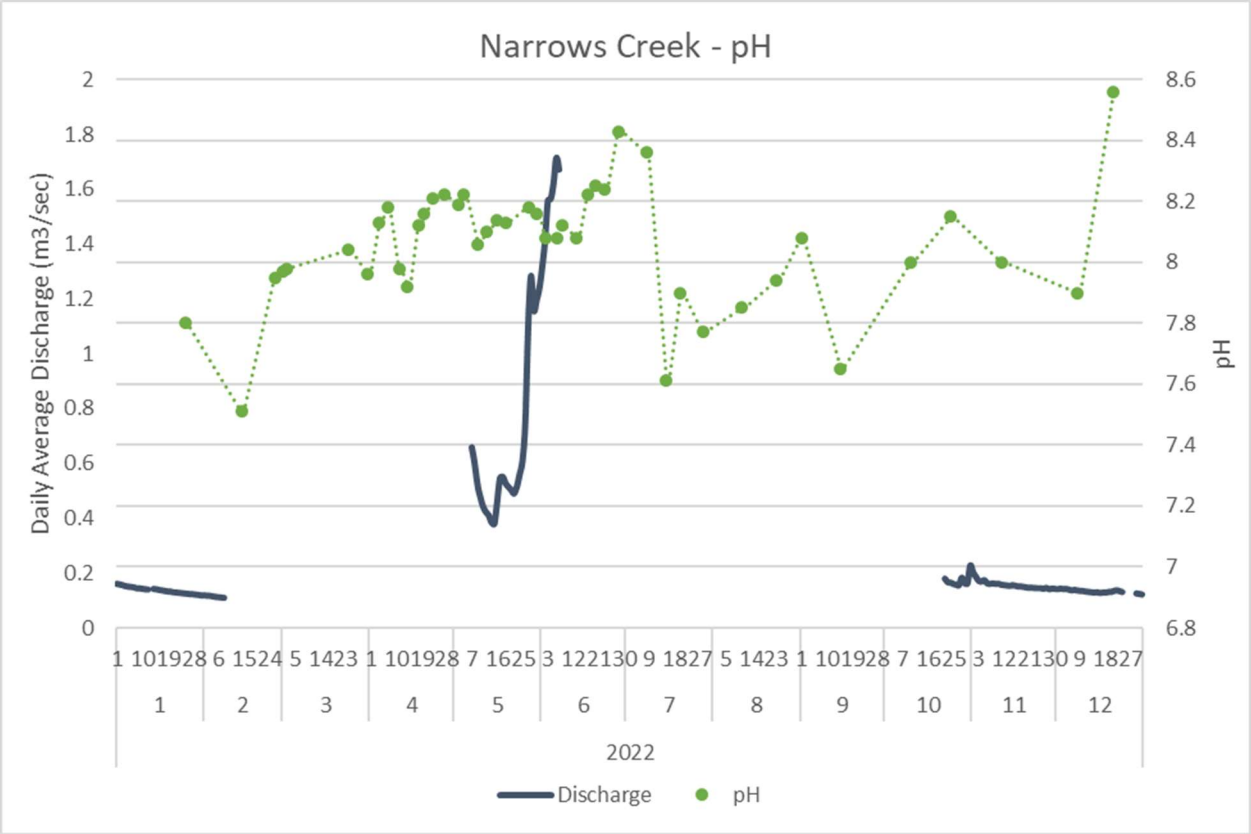
The SWTO does not set limits for pH, so the Guidelines for Canadian Drinking Water Quality (GCDWQ) is the best resource for referencing suitable pH levels in drinking water. Since the Harrop and Procter villages don't treat drinking water, raw source water from each of the four creeks can be assumed to be untreated within the distribution system, where metals can leach into the water. The limits outlined in the GCDWQ for pH in drinking water are between 7.0 and 10.5.

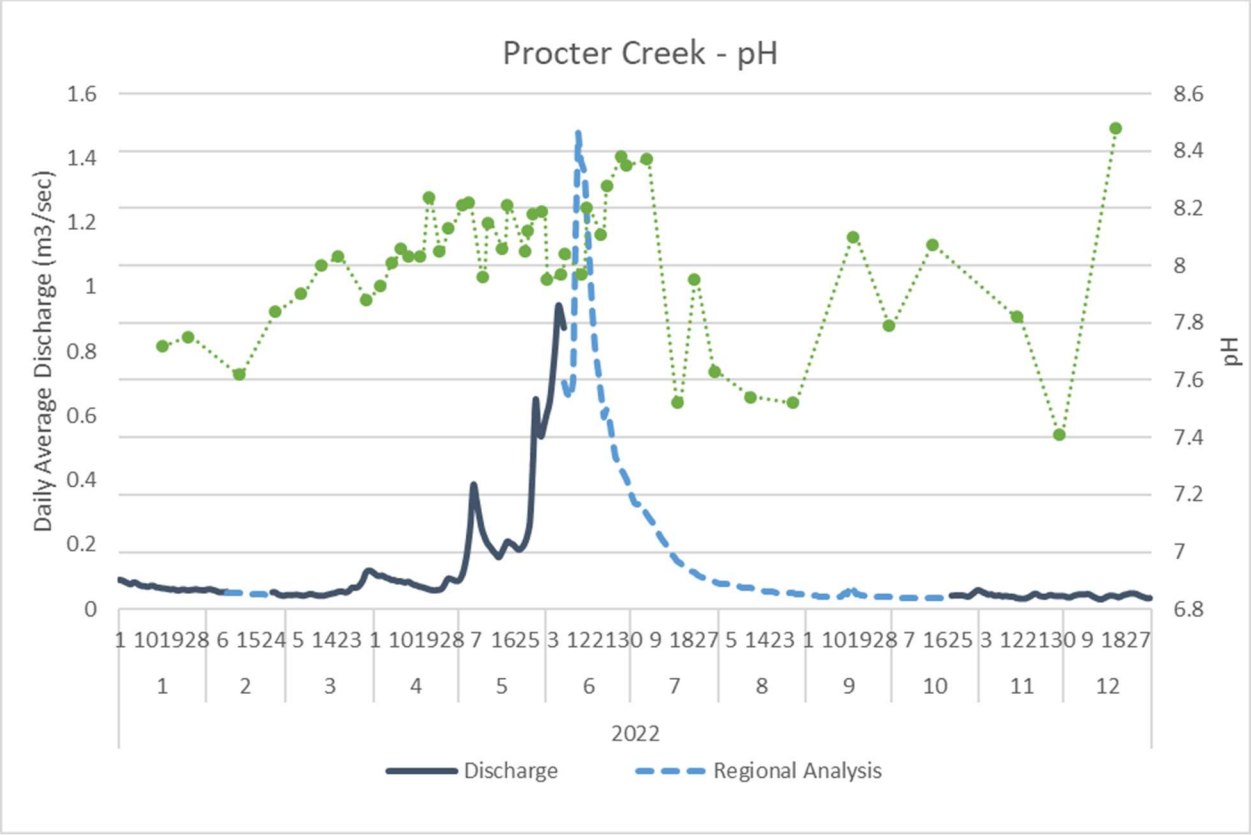
pH Results

The HPWPS board members began analyzing pH in 2022 using a handheld pH meter. During that period, all results from all four creeks, except for two at Harrop Creek, were within the guidelines. The two results outside the limits at Harrop Creek were between pH 6.5 and 7.0 and were the first and third readings taken during the first winter of monitoring. The remainder of the results were between pH 7.5 and 8.5.


Harrop Creek - pH
Daily Average Discharge (m3/sec)
pH
14
12
10
8
6
4
2
0
9
8.5
8
7.5
7
6.5
6
5.5
5
1 101928 6 1524 5 1423 1 101928 7 1625 3 122130 9 1827 5 1423 1 101928 7 1625 3 122130 9 1827
1 2 3 4 5 6 7 8 9 10 11 12
2022
Discharge
pH


Slater Creek - pH
Daily Average Discharge (m3/sec)
pH
1.2
1
0.8
0.6
0.4
0.2
0
8.6
8.4
8.2
8
7.8
7.6
7.4
7.2
7
6.8
1 101928 6 1524 5 1423 1 101928 7 1625 3 122130 9 1827 5 1423 1 101928 7 1625 3 122130 9 1827
1 2 3 4 5 6 7 8 9 10 11 12
2022
Discharge
pH


Narrows Creek - pH
Daily Average Discharge (m3/sec)
pH
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
8.6
8.4
8.2
8
7.8
7.6
7.4
7.2
7
6.8
1 101928 6 1524 5 1423 1 101928 7 1625 3 122130 9 1827 5 1423 1 101928 7 1625 3 122130 9 1827
1 2 3 4 5 6 7 8 9 10 11 12
2022
Discharge
pH


Procter Creek - pH
Daily Average Discharge (m3/sec)
pH
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
8.6
8.4
8.2
8
7.8
7.6
7.4
7.2
7
6.8
1 101928 6 1524 5 1423 1 101928 7 1625 3 122130 9 1827 5 1423 1 101928 7 1625 3 122130 9 1827
1 2 3 4 5 6 7 8 9 10 11 12
2022
Discharge
Regional Analysis

Disclaimer

The discharge data collected for Harrop-Procter Watershed Protection Society has been collected per the BC Hydrometric RISC Standards v.2 (RISC Standards) released in 2019. All data grades assigned to the discharge data have been assigned by Rory Gallaugher, AScT, Principal of Kootenay Environmental Innovations Ltd. (KEI). The data grades applied are intended to assist users of the discharge data in understanding KEI's considerations on how the data was collected and analyzed and how the site conditions met the requirements presented in standards requirement criteria Table 1-1 of the RISC Standards.

Per the RISC Standards, grading hydrometric data is a subjective practice based on the Qualified Hydrometric Reviewer's (QHR's) interpretation of the RISC Standards and the data collected. In practice, each QHR may grade data differently based on their interpretation of the instrumentation, field procedures used, and data calculation and assessment. The RISC standards are intended to support data collection using calibrated equipment to provide standardization for review and audits and support the archiving of hydrometric data of known quality.

Further, data grades only apply for the period reported in the report. Changes to the creek morphology, watershed, or climate may change the water level and creek discharge in ways not reported by this data. Therefore, it is recommended that, should the data presented in this report be used for engineering purposes, or where there is any chance of damage or harm to personal property or health, KEI expects that the engineer using the data to apply their own data grade, based on their own interpretation of the data. KEI will not be held liable for any damages that occur due to the use of this data.

Water quality data is collected by third-party individuals most of the time and, depending on the metric, is analyzed at accredited third-party labs or by the third party collecting the data. Though water quality data are presented in the report with an emphasis on the Province of British Columbia's Drinking Water Treatment Objectives (Microbiological) for Surface Water Supplies in British Columbia, KEI makes no representation as to the potability of the water. For questions regarding the potability of drinking water, KEI recommends contacting the water supplier and Interior Health.

References

B.C. Ministry of Forests and Range. (2010). *Compendium of Forest Hydrology and Geomorphology in British Columbia.* Victoria: Province of British Columbia.

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