Mill (Harrop), Narrows, Slater and Proctor Creeks Monitoring Program

Harrop – Procter Watershed

Report on Creek Parameters

2020 – 2021 reporting year

Submitted January 2022

Prepared for

The Harrop Procter Watershed Protection Society

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Introduction

This report documents findings on Mill (Harrop) Creek, Narrows Creek, Slater Creek and Proctor Creek for the Harrop-Proctor Community Cooperative from June 2020 to October 2021. The cooperative holds a community forest license which lies within Mill and Narrows Creek watersheds; members of the Harrop-Procter community are actively involved in the collection of samples and data.

The water monitoring program was initiated in 1999 for the purpose of baseline data collection and water quality characterization. It is instrumental in the identification of changes associated with climate and development activities in the watersheds managed by the cooperative.

Program background

The present water monitoring program is structured around recommendations from L.H. MacDonald's monitoring guidelines (1). Sample frequency was established based on recommendations of local scientists and forest hydrologists in Canada and Idaho State, USA. For the 2020 – 2021 reporting year, 52 water samples were collected from Mill (Harrop) Creek and 63 samples collected from Narrows Creek. 2 new creeks have been added to the monitoring program this year. 38 Slater Creek samples were collected from April to August 2021. 22 Proctor Creek samples were collected from April to September 2021. Reliability of data presented in the following report is directly related to the frequency and fidelity of samples collected. Much of the data below and conclusions drawn from it would not be possible if not for the highly dedicated community associates of the community cooperative.

The program relies on automated and manual readings of instream flow gauges. Onset brand, HOBO MX2001 water level loggers were installed on both creeks in November 2017. Measurements for water level and temperature were taken every 6 hours and averaged for a daily reading. Beginning on September 29, measurements were taken every 15 minutes. Beginning in 2017, reporting was done as water level in meters using the sensor; flow measurements were not recorded from 2017- 2019/2020. For this reporting year, survey benchmarks were established for both Mill (Harrop) and Narrows Creeks, rating curves were established and flow measurements were calculated in m^3/sec. The previous site for Narrows creek was removed and re-established on January 8, 2021. There is no flow data available prior to this date for this reporting year. Both new creeks (Slater and Proctor) will have rating curves established in Spring 2022. Data collected for these creeks began in April 2021 and is reported using water level.

Members of the Harrop-Proctor Community Cooperative obtained samples throughout and following storm events or heavy rain. Collection was emphasized during spring freshet and fall rain events, as well as during periods where creek waters appear turbid. Samples were kept cool and dark prior to lab delivery. Collected samples were tested for turbidity and conductivity. Coliform tests were collected (5 over 30 days) at a frequency according to Provincial Guidelines (1) during September 2021 for the 2020– 2021 testing period for Mill (Harrop) and Narrows creeks.

All physical tests were performed at Passmore Laboratory Ltd. and follow carefully outlined methods (2). Passmore Laboratory Ltd. is certified by the Provincial Enhanced Water Quality Assurance Program (EWQA) which regulates microbiological testing of drinking water.

An additional thank you goes to Marjorie Davison for gauge readings and samples collection from June 2020 – June 2021.

Mill (Harrop) Creek

Table 1: Summary Data on Mill Creek.

	Flow		Conductivity		Turbidity	Suspended Sediment	Number
Year	Maximum m^3/sec	Minimum m^3/sec	Maximum µS/cm	Minimum µS/cm	Maximum NTU	Maximum mg/l	Samples (n)
2002	-	-	95.8 (08/08)	51.4 (06/17)	1.9 (06/17)	12.6 (05/29)	15
2003	2.8 (06/10)	0.15 (03/08)	119 (09/20)	52.2 (06/10)	2.5 (05/05)	32.1 (10/31)	32
2004	2.6 (05/28)	0.28 (03/13)	111 (01/31)	59.0 (04/16)	0.55 (03/26)	2.7 (06/27)	17
2005	4.2 (05/17)	0.30 (12/10)	106 (04/05)	59.6 (05/17)	0.85 (06/17)	12.6 (06/17)	35
2006	11.8 (05/18)	0.30 (03/29)	115 (10/12)	45.7 (05/18)	13.0 (05/18)	149.0 (05/18)	39
2007	6.9 (06/06)	0.10 (01/10)	119 (09/28)	50.8 (06/06)	1.3 (06/06)	11.4 (06/16)	22
2008	5.6 (06/01)	0.20 (02/24)	115 (03/17)	55.3 (06/01)	0.65 (05/19	7.4 (05/19)	21
2009	3.2 (05/31)	0.30 (03/04)	154 (11/18)	58.2 (06/16)	0.55 (05/31)	5.5 (05/17)	11
2010	3.3 (06/14)	0.20 (02/09)	137 (08/08)	59.5 (06/14)	0.55 (04/22)	6.7 (06/24)	40
2011	4.03 (05/26)	0.27 (03/15)	122 (12/09)	55.9 (06/06)	3.0 (06/06)	8.0 (05/25)	47
2012	7.8 (06/02)	0.217 (09/27)	122 (12/19)	48.4 (06/22)	2.3 (06/07)	42.9 (06/16)	55
2013	10.6 (05/13)	0.366 (09/02)	158 (06/22)	50.0 (05/13)	2.3 (05/12)	37.7 (05/12)	54
2014	3.71 (05/25)	0.149 (01/18)	171 (02/15)	55.5 (05/25)	2.8 (04/05,12)	65.9 (04/05)	55
2015	3.7 (06/02)	0.08 (01/01)	131 (05/05)	59.0 (06/06)	0.7 (05/21)	4.8 (05/25)	43
2016	3.27 (05/16)	0.134 (01/01)	111 (09/19)	58.7 (05/27)	0.45 (03/14)	-	22
2017	9.98 (05/29)	-	114 (02/27)	55.4 (05/02)	4.5 (05/23)	75.5 (05/23)	15
2018	-	-	125.8 (09/04)	52.9 (05/26)	12.6 (05/18)	-	32
2019	-	-	132.7 (08/22)	56.3 (02/06)	2.7 (05/12)	-	52
2020	2.615 (06/13)	0.239 (09/22)	184.3 (02/17)	46.4 (05/31)	83.40 (05/31)	-	44

- Insufficient data

Mill Creek Flow and Conductivity

Conductivity is described as Specific Conductance expressed as micro siemens per cm at 25° C. It measures a fluid's ability to carry an electric charge and is directly related to the concentration of dissolved ions in solution. An inverse relation is expected to be observed between Conductivity and flow; as a result, Conductivity may be used as a proxy to deduce flow levels when sufficient data is not available.

Mill Creek typically experiences high flow between mid-May to early June and low flow occurs in Fall to early Spring (3,4). Conductivity values showed a high of 128.6 µS/cm on 09/21 agreeing with low flows. Lowest values of 58.89 uS/cm and 55.69 uS/cm also agreed with 2 spikes in water flow at its highest during freshet on May 18, 2021 and June 4, 2021 (Figure 1). With higher volumes of water, salts and ions become more diluted which is reflected in the lower conductivity values.

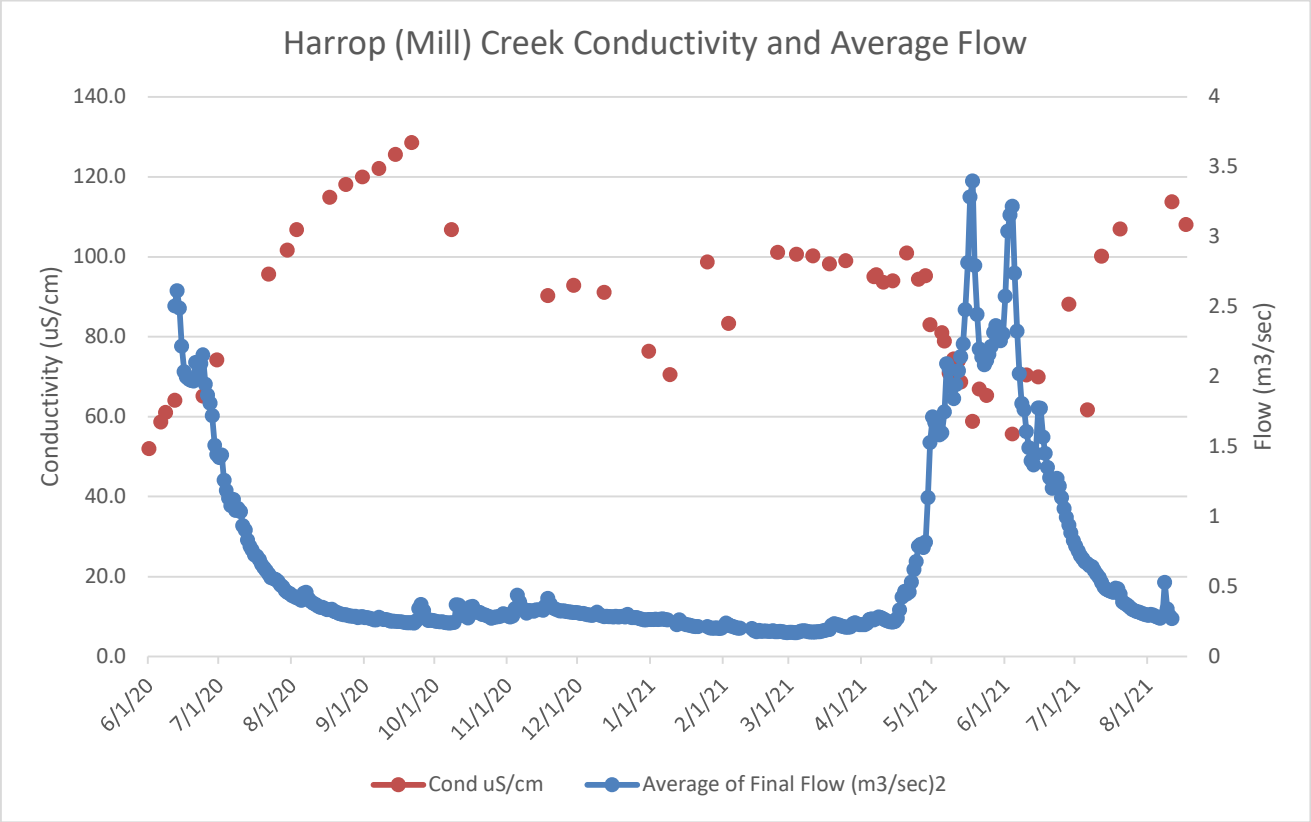

Figure 1: Conductivity values, Average Flow for the 2020 – 2021 reporting period on Mill (Harrop) Creek.

Mill Creek Flow and Turbidity

Turbidity is caused by colloidal matter such as clay, silt, or finely divided organic and inorganic matter. Rather than measuring the number of suspended particles in a liquid, Nephelometric Turbidity Units (NTU) measure the scattering effect that particles have on light.

All of the samples obtained tested below 1 NTU except for a high value of 5.60 NTU, due to a large-scale rain event. Raw drinking water without treatment for particulates should have NTU values less than 1. All other samples being below 1 NTU signify a clean stream (5);

Provincial Guidelines recommend that for raw waters of exceptional clarity, which normally do not require treatment to reduce natural turbidity, readings should not exceed 5 NTU at any time; natural background turbidity should be less than 5 NTU (5).

Steam flow and Turbidity are often directly related; as water flow increases, so will turbidity levels. This is reflected in Figure 2. Highest Flows during runoff from also shows second and third highest Turbidity levels at 0.969 NTU and on 05/13/2021 and 0.674 NTU on 05/18/2021.

Turbidity was graphed in a logarithmic scale in response to the skewness towards large values; few points were much larger than the bulk of the data.

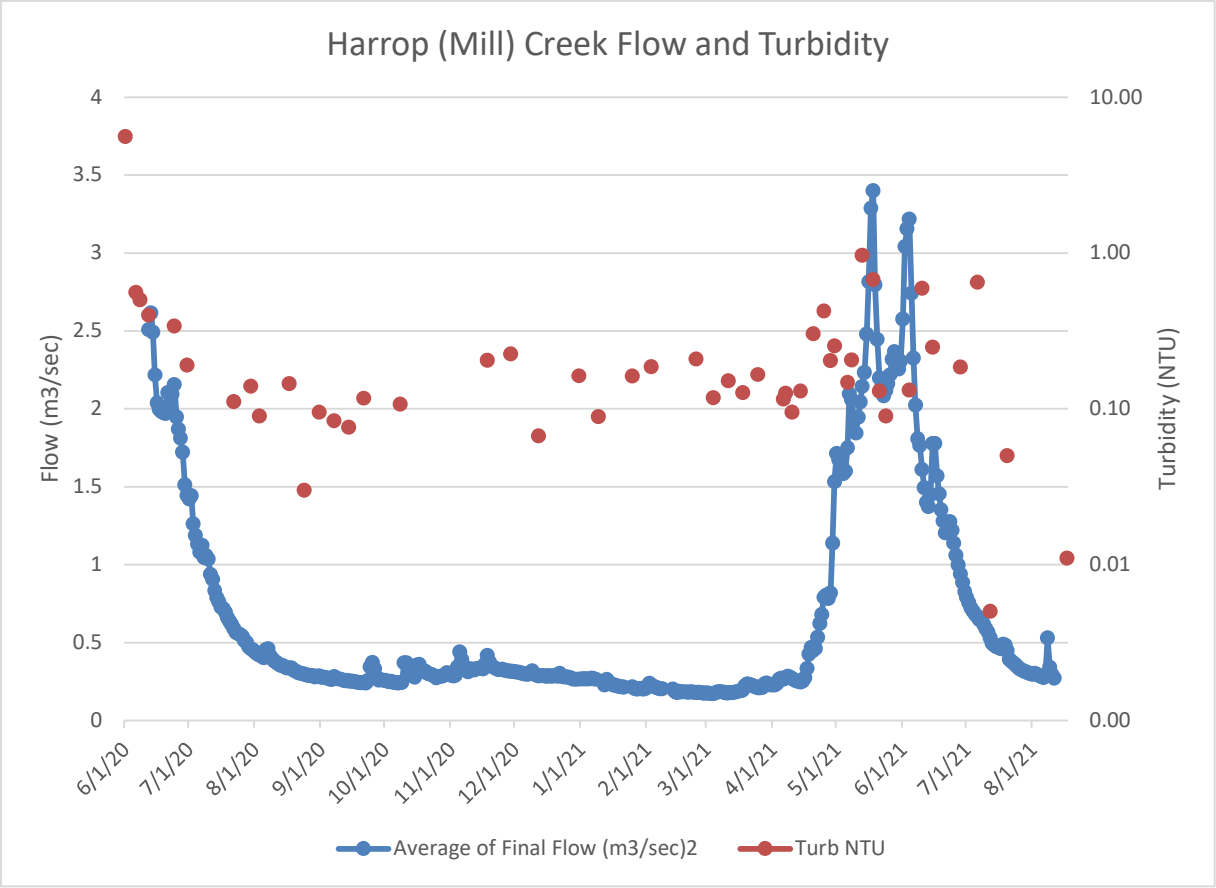

Figure 2: Maximum Preliminary Flow vs. Turbidity values for the 2020 – 2021 reporting period on Mill (Harrop) Creek

Mill Creek Conductivity and Turbidity

Figure 3 was constructed using 52 samples collected between June 2020 and October 2021, detailing the relative relationship of conductivity and turbidity for Mill Creek. The lowest Conductivity value at 52 uS/cm correlated with the highest Turbidity of 5.6 NTU on 06/01/2020. This also coincided with spikes in water levels (Figure 3). The highest conductivity value was at 128.6 on 09/21/2020.

Turbidity was graphed in a logarithmic scale in response to the skewness towards large values; few points were much larger than the bulk of the data.

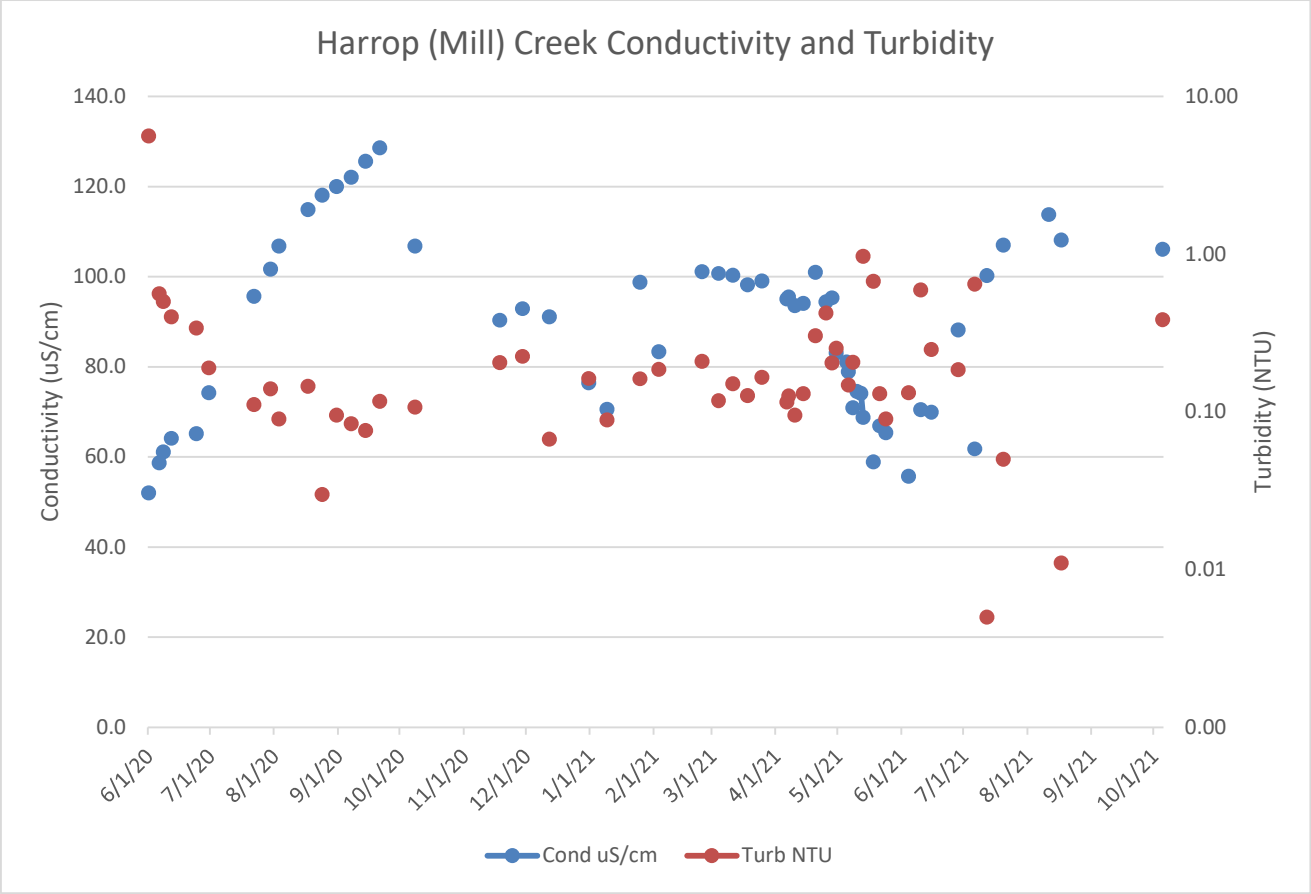

Figure 3: Turbidity and Conductivity values for the 2020 – 2021 reporting period on Mill (Harrop) Creek.

Mill (Harrop) Creek Temperature

For previous years, temperature readings for Mill Creek were taken every 6 hours and averaged for a daily reading. Beginning on September 29, readings were taken every 15 minutes. No unusually high or low temperatures were noted in the 2020 – 2021 reporting period. Readings followed trends from previous years, with lower maximum readings and higher minimum readings (3,4).

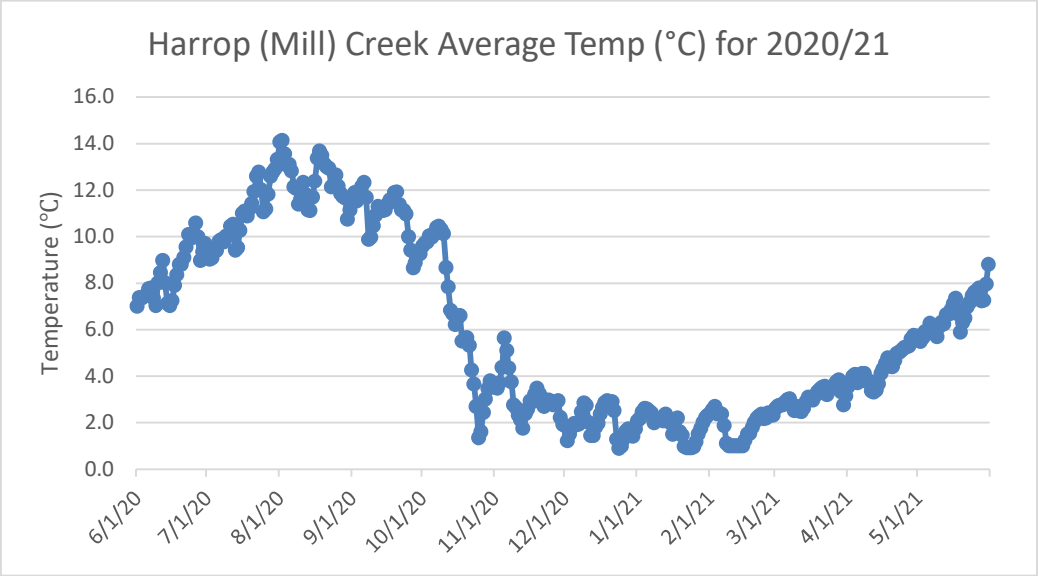

Figure 4: Temperature values for the 2020 – 2021 reporting period on Mill Creek.

Mill (Harrop) Creek Coliforms

Provincial Guidelines recommend collection of five samples over 30 days. Samples are normally collected in late summer when water temperatures are high. There are no official provincial standards for untreated drinking water, however, our experience monitoring creeks in the Kootenays has shown there is a relation between development activities and fecal coli/E.coli counts. Total coliforms are not associated with human infection but thermotolerant or fecal coliforms and E.coli should not be present. See Health Canada "Bacterial Waterborne Pathogens": www.hc-sc.gc.ca

In 2021, 5 samples were collected between 09/02 and 10/05. Total coliforms were present and increased from mid to late September. On 09/14, 1 Fecal Coliform was present in the water sample. On 09/28, 4 Fecal and 4 E. coli bacteria were present in the sample with the highest number of Total Coliforms at 52 CFU/100mL.

Table 2: Coliform Data for Mill (Harrop) Creek for 2020 -2021 reporting period

	Coliform Bacteria		
Date	Total coliforms CFU/100mL	Fecal coliforms CFU/100mL	E. coli CFU/100mL
2021-09-02	4	0	0
2021-09-07	28	0	0
2021-09-14	51	1	0
2021-09-28	52	4	4
2021-10-05	7	0	0

Narrows Creek

Table 3: Summary Data on Narrows Creek.

	Flow		Conductivity		Turbidity	Suspended Sediment	Number
Year	Maximum m^3/sec	Minimum m^3/sec	Maximum uS/cm	Minimum uS/cm	Maximum NTU	Maximum mg/l	Samples (n)
1999	-	1.86 (12/31)	157 (11/24)	86.2 (06/24)	0.9 (06/24)	9.0 (06/24)	25
2000	2.3 (06/17)	0.09 (11/18)	210 (12/15)	74 (06/09)	1.7 (05/03)	3.3 (06/07)	26
2001	2.47 (05/25)	0.07 (02/23)	176 (04/13)	83.2 (05/25)	1.3 (05/25)	4.2 (05/25)	11
2003	3.6 (06/09)	0.158 (03/28)	164 (02/15)	75.4 (06/05)	3.2 (05/30)	30.6 (05/30)	41
2004	1.32 (06/20)	0.08 (12/01)	176 (03/19)	96.6 (06/14)	0.35 (05/05)	3.6 (05/05)	42
2005	1.95 (05/17)	0.099 (04/08)	167 (02/10)	90.5 (05/17)	0.45 (05/17)	1.5 (06/17)	40
2006	5.33 (05/20)	0.122 (02/25)	175 (02/11)	77.9 (05/20)	7.0 (05/20)	64.5 (05/17)	41
2007	3.87 (06/17)	0.087 (03/18)	168 (01/02)	76.7 (06/05)	4.0 (06/05)	58.5 (06/05)	13
2009	3.58 (05/31)	0.04 (03/20)	166 (03/10)	55.5 (05/31)	0.7 (05/31)	8.8 (05/31)	56
2010	2.4 (06/03)	0.134 (02/10)	170 (02/26)	87.9 (06/14)	0.55 (06/14)	5.3 (06/14)	36
2011	4.66 (06/21)	0.094 (12/10)	181 (04/20)	90.6 (06/21)	3.3 (06/06)	24.5 (05/12)	52
2012	4.0 (06/23)	0.09 (12/10)	180 (04/14)	82.1 (06/23)	8 (06/23)	126 (06/23)	39
2013	3.2 (06/23)	0.02 (10/05)	168 (04/23)	78.1 (05/12)	1.8 (05/08)	23.1 (05/06)	46
2014	2.13 (05/25)	0.08 (01/04)	148 (12/06)	55.6 (05/23)	0.95 (03/29)	5.1 (03/29)	57
2015	1.33 (06/02)	0.04 (01/01)	182 (01/01)	86.3 (05/11)	4.5 (10/06)	10.3 (05/21)	46
2016	1.4 (05/09)	0.14 (01/26)	179 (02/27)	99.9 (05/09)	0.45 (12/06)	-	21
2017	3.9 (5/29) *	0.119 (01/23)	174 (02/27)	76 (12/08)	6.5 (05/23)	58.6 (05/23)	16
2018	-	-	185 (04/01)	81.1 (10/20)	16.5 (05/18)	-	30
2019	-	-	171.1 (08/27)	89.1 (05/30)	6.00 (01/05)	-	43
2020	-	-	188.2 (09/22)	92.9 (06/01)	21.8 (06/01)	-	50

* As of August, 2017

\- Insufficient data

Narrows Creek Flow and Conductivity

Peak flows for Narrows Creek normally occurs between mid-May and mid-June. Low flows ensue in winter to early spring and occasionally fall. Flow measurements were only obtained beginning January 2021 as the previous site was compromised and data was insufficient. Figure 5 outlines Flow, beginning January 8, graphed against conductivity in µS/cm measured from June 2020. High flow was recorded from 06/02/21 to 06/04 /21 along with the lowest Conductivity readings of the reporting year. The lowest Conductivity reading of 92.69 uS/cm was noted on 06/05/21.

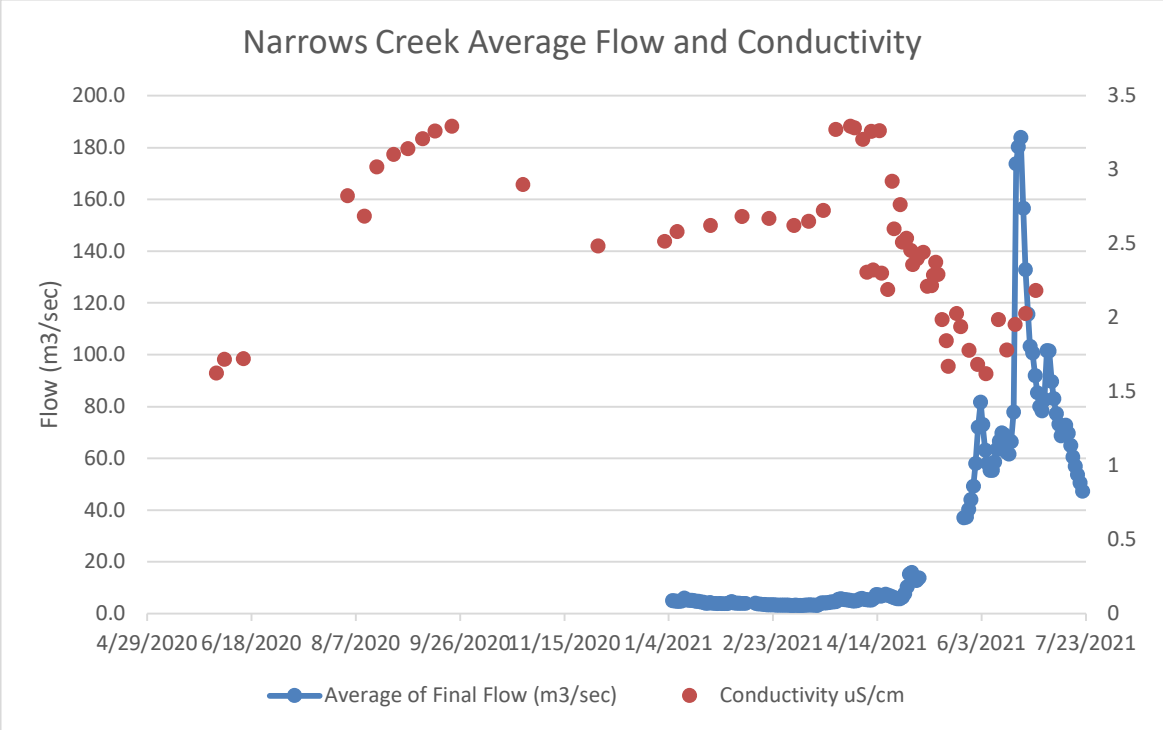

Figure 5: Average Flow and Conductivity values for the 2020 – 2021 reporting period on Narrows Creek.

Narrows Creek Flow and Turbidity

Characterized by low turbidity in the past, Narrows Creek showed largely low NTU values for the 2020 – 2021 sampling period (Figure 6). Turbidity values remained primarily below 1 NTU apart from 5 samples obtained on 06/01, 06/05, 06/14 and on 04/01 and 04/07. Samples collected on 06/05, 06/14, 04/01, and 04/07 ranged between 1.00 – 1.41 NTU. During the previous reporting year, a historical high for Narrows Creek was noted on 31/05 at 416.0 NTU, followed by 21.8 NTU on 06/01; this marks the highest reading observed for over 18 years of recorded monitoring data, noted shortly after a large-scale rain event which occurred at the end of May. (4)

Turbidity was graphed in a logarithmic scale in response to the skewness towards large values; few points were much larger than the bulk of the data.

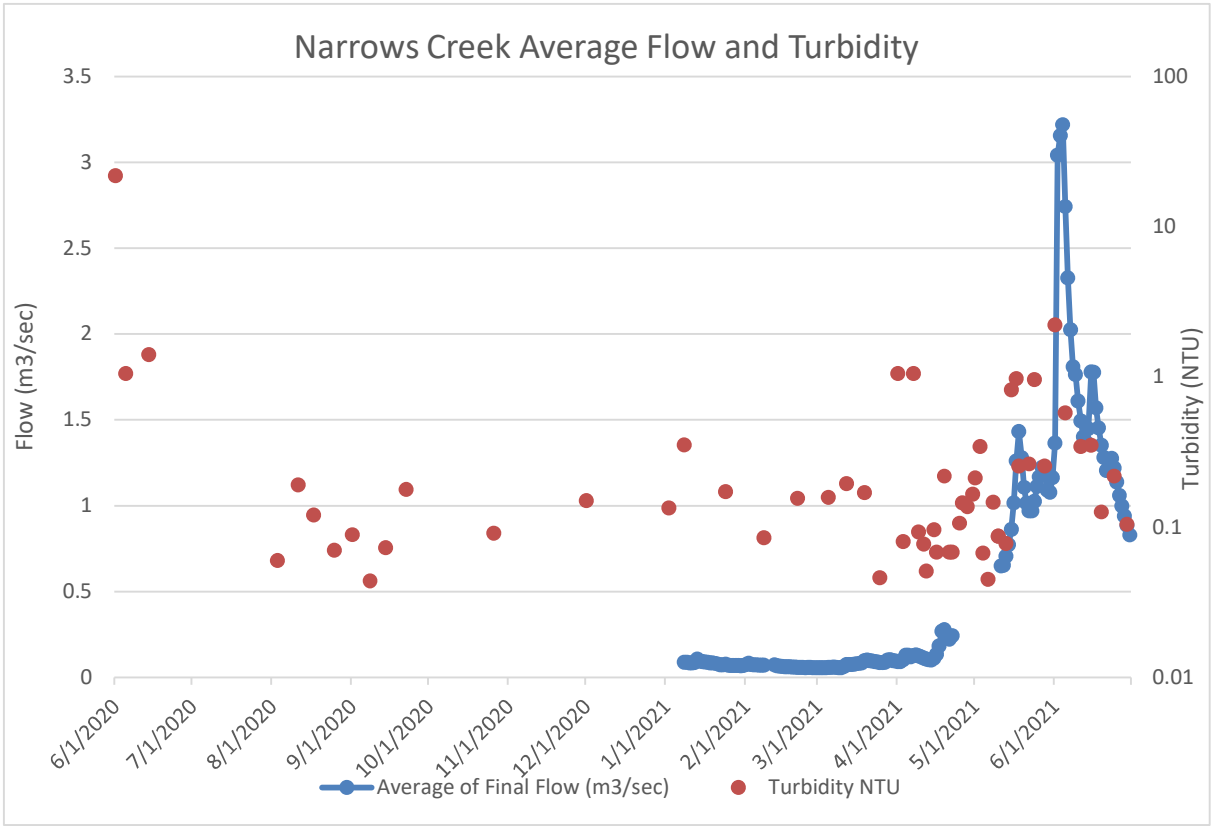

Figure 6: Average Flow and Turbidity values for the 2020 – 2021 reporting period on Narrows Creek.

Narrows Creek Conductivity and Turbidity

The highest turbidity value of 21.8 NTU coincided with the second lowest conductivity value of 92.9 uS/cm as seen on 06/01 and (Figure 7). This coincided with spikes in water levels as recorded in the 2019-2020 report (4).

Turbidity was graphed in a logarithmic scale in response to the skewness towards large values; few points were much larger than the bulk of the data.

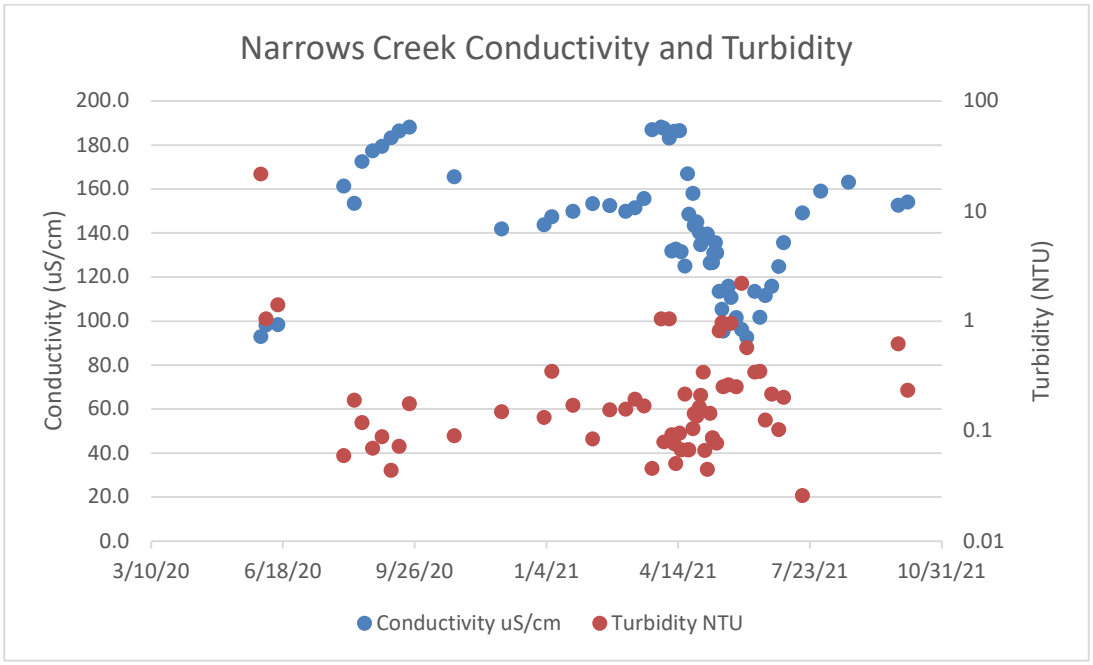

Figure 7: Turbidity and Conductivity values for the 2020 – 2021 reporting period on Narrows Creek.

Narrows Creek Temperature

Temperature readings for Narrows Creek were taken every 15 minutes hours and averaged for a daily reading, as seen in Figure 8. No unusually high or low temperatures were noted in the 2020 – 2021 reporting period; readings followed trends from previous years (3, 4).

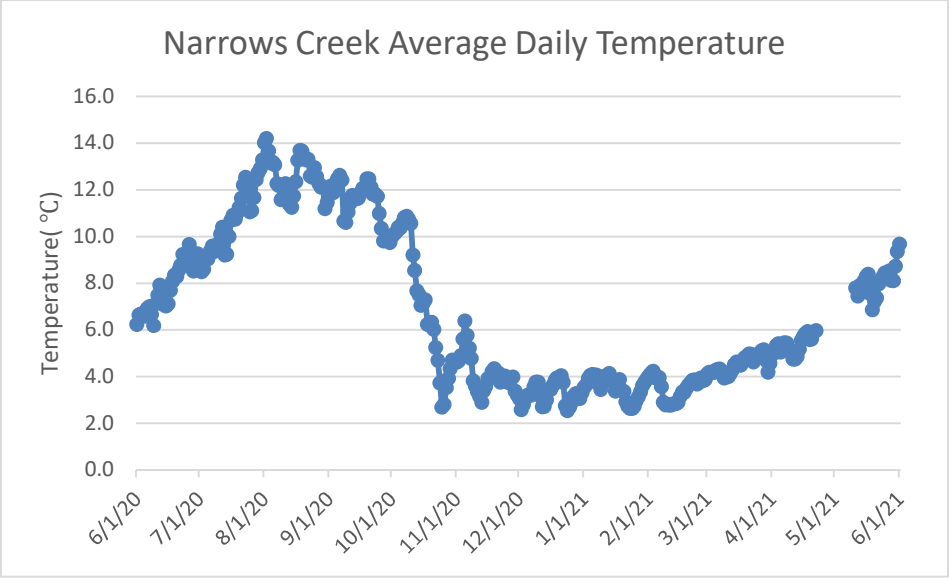

Figure 8: Temperature values for the 2020 – 2021 reporting period on Narrows Creek

Narrows Creek Coliforms

In 2021, 5 samples were collected between 09/07 and 10/05. Total coliforms were present and increased from mid to late September. 09/08 was the highest value of 109 Total Coliforms with one Fecal and 1 E.coli bacteria. On 10/05 the value decreased to 7 Total Coliforms and 1 Fecal Coliform.

Table 4: Coliform Data for Narrows Creek for the 2020 -2021 reporting period

	Coliform Bacteria		
Date	Total coliforms CFU/100mL	Fecal coliforms CFU/100mL	E. coli CFU/100mL
2021-09-07	22	0	0
2021-09-14	38	0	0
2021-09-21	65	0	0
2021-09-28	109	1	1
2021-10-05	7	1	0

Slater Creek and Proctor Creeks

Slater and Proctor Creek sample collection for Conductivity and Turbidity measurements commenced on 04/04/21. Flow measurements will be done and rating curves will be established in Spring 2022 for both creeks. For the purposes of this reporting period, Water Level is used as a proxy for Flow for both creeks.

Slater Creek Water Level and Conductivity

The lowest conductivity values of 103.4 uS/cm and 97.76 uS/cm coincides directly with the highest water levels of 6.8 m on 05/17 and 05/18. Figure 9 also reflects the inverse relationship between Conductivity and flow. Higher flows generally have lower conductivity as the ions are diluted.

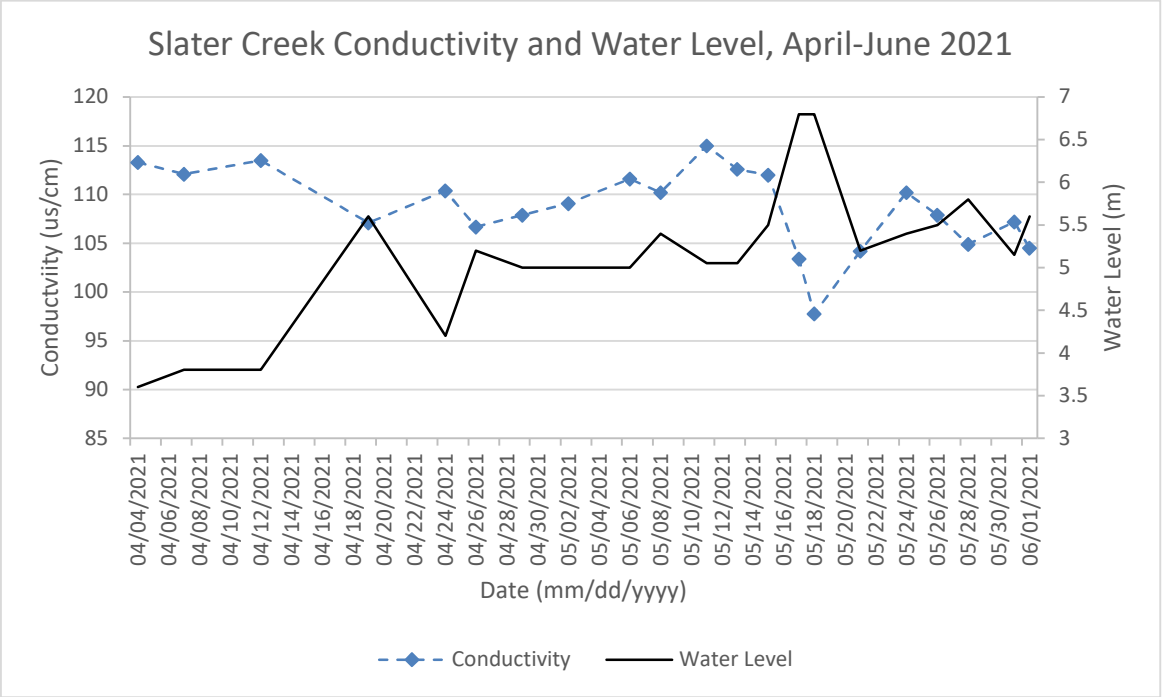

Figure 9: Conductivity values and Water Level for the 2020 – 2021 reporting period on Slater Creek.

Slater Creek Water Level and Turbidity

All Turbidity values measured were below 1 NTU for Slater Creek. The highest Turbidity value of 0.862 NTU coincides with the highest water level of 6.8 m. An anomalous value of 0.05 NTU directly follows this high value.

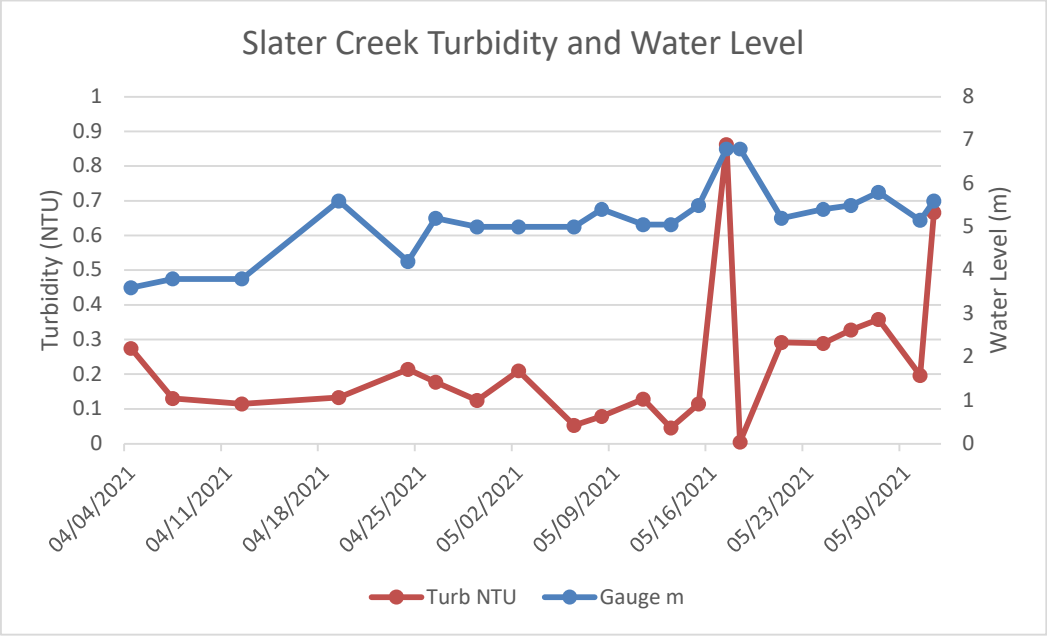

Figure 10: Turbidity values and Water Level for the 2020 – 2021 reporting period on Slater Creek.

Slater Creek Conductivity and Turbidity

In Figure 11, Conductivity and Turbidity values from Slater Creek reflect the typical inverse relationship between the two parameters. High values of Turbidity coincide with low values of Conductivity.

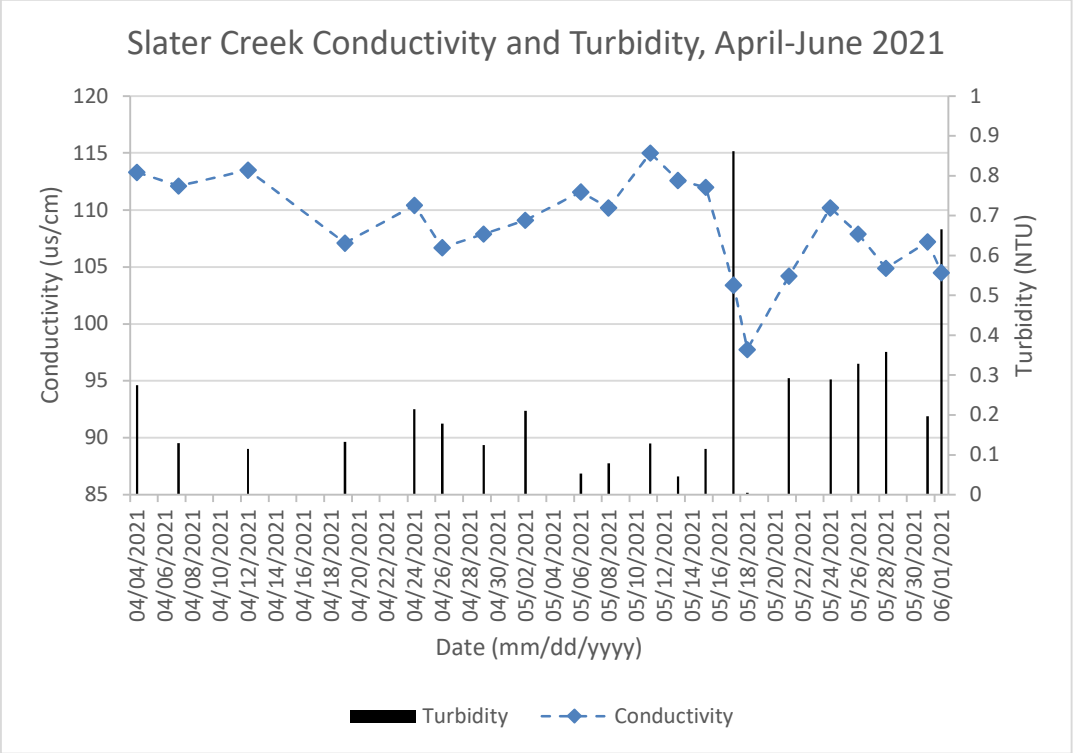

Figure 11: Turbidity and Conductivity values for the 2020 – 2021 reporting period on Slater Creek

***There were no Temperature values recorded for Slater Creek or Proctor Creek.*

Slater Creek Coliforms

In 2021, 4 samples were collected between 09/14 and 10/05. Total coliforms were present and increased from mid to late September. Sept 21st had 60 Total Coliforms with 4 Fecal and 2 E.coli bacteria. On 10/05 the value decreased to 5 Total Coliforms and 1 Fecal Coliforms.

Table 5: Coliform Data for Slater Creek for the 2020 -2021 reporting period

	Coliforms		
Date	Total coliforms CFU/100 mL	Fecal coliforms CFU/100mL	E. coli CFU/100mL
2021-09-14	30	0	0
2021-09-21	60	4	2
2021-09-28	70	1	0
2021-10-05	5	1	0

Proctor Creek Water Level and Conductivity

Conductivity levels were high when Water Levels were low following the typical relationship between Conductivity and Flow. A higher water level of 5 m directly coincided with a low Conductivity value of 104 uS.cm.

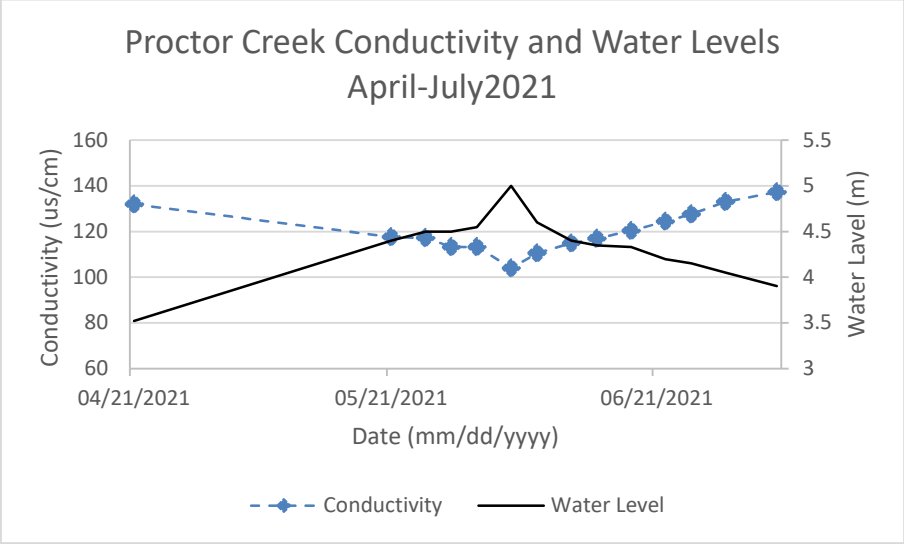

Figure 12: Conductivity values and Water Level for the 2020 – 2021 reporting period on Proctor Creek.

Proctor Creek Conductivity and Turbidity

In Figure 13, Conductivity and Turbidity values from Proctor Creek reflect the typical inverse relationship between the two parameters. High values of Turbidity coincide with low values of Conductivity.

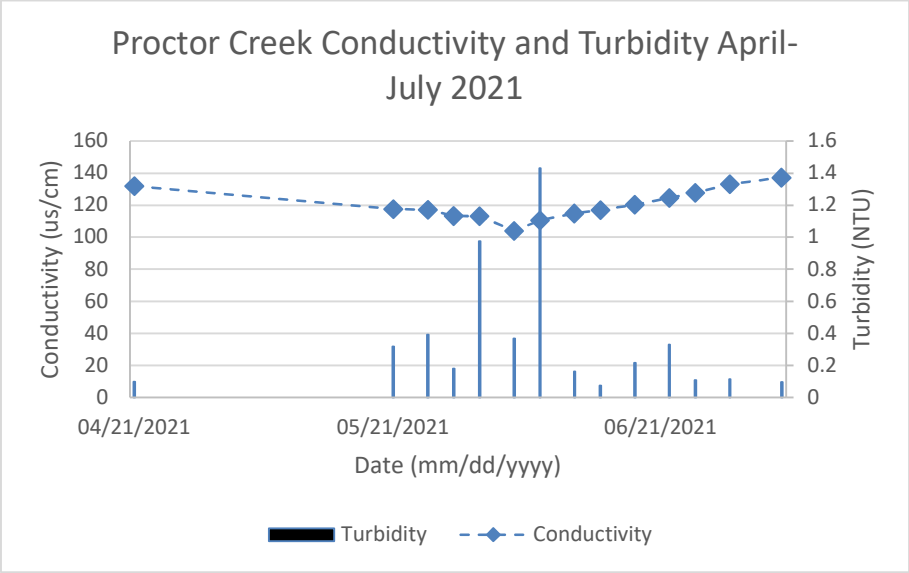

Figure 13: Conductivity and Turbidity values for the 2020 – 2021 reporting period on Proctor Creek.

Proctor Creek Coliforms

In 2021, only 2 samples were collected, one on 09/14 and one on 10/05. 09/14 had 56 Total Coliforms with 13 Fecal and 8 E.coli bacteria. On 10/05 the value decreased to 8 Total Coliforms and 2 Fecal Coliforms.

Table 6: Coliform Data for Proctor Creek for the 2020 -2021 reporting period

	Coliforms		
Date	Total coliforms CFU/100mL	Fecal coliforms CFU/100mL	E. coli CFU/100mL
2021-09-14	56	13	8
2021-10-05	8	2	0

References

(1) Monitoring Guidelines to Evaluate the Effects of Forestry Activities on Streams in the Pacific Northwest & Alaska, L.H McDonald EPA 910/9-91-001

(2) Standard Methods for Examination of Water and Wastewater, American Public Health Association 23t edition, 2017.

(3) Mill and Narrows Creeks Report for 2017 – 2018, J. Yeow 2019.

(4) Mill and Narrows Creek Report for 2019-2020, J. Yeow, 2020

(5) Province of British Columbia. 2019. Source Drinking Water Quality Guidelines. Ministry of Environment & Climate Change Strategy. https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/water-quality-guidelines/approved-wqgs/drinking-water-and-recreation/source_drinking_water_quality_guidelines_bcenv.pdf

Respectfully Submitted

Mechelle Babic
Passmore Laboratory Ltd