Springbrook Creek Watershed Final Water Quality Monitoring Report For 2021/2022



A project of

In partnership with

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Introduction

The Lost Urban Creeks Project highlights streams in urban areas, streams that have a history of stormwater and industrial wastewater impacts. These creeks often flow through communities most impacted by pollution and social injustice, highlighting environmental inequities in our region. Many of these creeks used to support salmon but salmon and other species sensitive to pollution can no longer be found or are in decline in these urban waterways. They can even pose a human health threat to the communities around them.

In our project, we chose to examine the water quality of Springbrook Creek, which flows through South King County and historically supported healthy runs of Chinook salmon. Its headwaters are still so pure that the City of Renton uses its springs as a source for drinking water[1]. Many parts of the creek were straitened into ditches decades ago to conform to property lines and agricultural field, the latter which no longer exist. As Springbrook Creek flows through the now densely developed areas of Kent and Renton, it is quickly surrounded by homes, commercial businesses, parking lots and impervious surfaces that deliver pollution and sediment to the creek from stormwater runoff. The creek is also overrun in many places by invasive species and in many areas it lacks an adequate tree canopy to provide shade for the creek to improve water temperature conditions. Today no salmon are found in a watershed where they used to spawn. Some segments of the creek may pose a human health concern for the surrounding communities due to bacteria contamination.

Youth from Unleash the Brilliance (UTB), a unique youth mentoring program have been working with Puget Soundkeeper Alliance and other partners to restore the health of Springbrook Creek. UTB Youth have contributed over 3000 hours of paid work to protect clean water in Puget Sound. In the Lost Urban Creeks Project, they participate in the following activities along Springbrook Creek:

- **Monitoring Water Quality** – Regularly monitor water quality along the creek to document conditions and identify pollution.
- **Restoring Habitat** – Plan and conduct restoration work in the Black River Forest and new restoration efforts along Springbrook Creek. Doing regular clean-ups along the creek and surrounding region.
- **Building Community** – Many people live, work, and play near Springbrook Creek. UTB Youth engage community members in their work to improve the creek for everyone to enjoy.
- **Developing the Skills of the Youth** – Build environmental literacy to become future leaders, re-connecting to their education, and increasing their job skills.

This paper documents the results a year of the water quality monitoring efforts covering the wet (Oct to Apr) and dry seasons (May to Sep) for 2021 to 2022. During this period, Springbrook creek was

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[1] *The City of Renton has a groundwater water right for 1050 gallons per minute (gpm) from the infiltration (spring) area, but currently use only up to approximately 750 gpm. No water is returned to the creek. (Personal communication, Lauren Imhoff, Senior Program Specialist, City of Renton Public Works, Feb 19, 2021).*

sampled quarterly and was compared to quarterly sampling in other watersheds (Longfellow Creek, Des Moines Creek, Barnes/Massey Creeks, and McSorley Creek). Our hope is to better understand the challenges for salmon to return to Springbrook Creek and the opportunities and potential for this watershed to be restored to achieve fishable, swimmable, and drinkable waters.

Background

Springbrook Creek

Springbrook Creek is a part of the Green-Duwamish River Watershed and is the largest sub-basin of the lower Green River Basin. It is part of Water Resource Inventory Area (WRIA) 9 and drains an area of about 15,763 acres[2]. Others have studied Springbrook Creek and its water quality in the past[3] and have provided a list of reasons explaining the decline in salmonid use, including riparian conditions, hydrology modification, sediment conditions, water quality, and land use. Springbrook Creek is also on a Washington State list[4] of impaired streams due to water quality violations for high temperatures and low dissolved oxygen levels at multiple locations[5]. This appears to be a chronic seasonal occurrence and is believed to be the result of low summer water flows, lack of adequate riparian vegetation and shade, and pollution[6]. Two other organizations are conducting water quality monitoring in the Springbrook Watershed. King County (2022) monitors one location (Station 317) in the lower watershed monthly and Drainage District No. 1 (2022) monitors nine locations in the middle and lower basin, twice a year (as well as four additional stations starting in the spring of 2021). In 2021, King County determined that Springbrook is rated as a stream with poor water quality on its Water Quality Index[7] (King County, 2022a).

More information can be found about the larger Green River Basin of which Springbrook is a part at: https://kingcounty.gov/services/environment/watersheds/green-river.aspx.

Longfellow Creek

Longfellow Creek is also a WRIA 9 creek that flowing exclusively through the city of Seattle in the West Seattle neighbourhood. The creek's headwaters begin at Roxhill Bog, and it flows north for 4.2 miles until draining into the Duwamish River near its mouth. The Longfellow basin drains

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[2] *Kerwin, J. and Nelson (2020) WRIA 9 Habitat Limiting Factors and Reconnaissance Assessment for Salmon Habitat Report, Part3.3-2*

[3] *Ibid. Regular monitoring has taken place at one station on Springbrook near Longacres in Renton (KCM-0317) starting in 1996 and became monthly monitoring in 2004 under the King County Ambient and Wet Weather Streams Monitoring program. In addition, Drainage District #1 monitors several locations in the watershed twice a year 2008.*

[4] *State Department of Ecology's 303(d) list*

[5] *Kerwin, J. and Nelson (2020) P3.3-12.*

[6] *Harza (1995) in Kerwin, J. and Nelson (2020).*

[7] *The Water Quality Index (WQI) is based on several water quality parameters, which are used to create a single score between 1 (poor water quality) and 100 (good water quality) that can then be used to compare different waterbodies. Stations scoring 80 and above meet water quality standards and are of "low concern", scores 40 to 80 indicate "moderate concern", and water quality at stations with scores below 40 are of "high concern." For the most recent year of sampling (2021), Springbrook had a score of 26.*

approximately 2,685 acres (King County, 2016). Longfellow Creek has two small unnamed tributaries that drain from the left-bank and may provide refuge habitat for over-wintering juvenile salmon (WRIA 9, 2000). Ninety-three percent (93%) of the basin is developed, 6% of the basin is forest, and only 1% is wetland, with a majority of this natural habitat found along the Longfellow Creek Legacy Trail. There has been extensive hydromodification and channelization of the creek, with the upper 4,900 feet of creek flowing underground through pipes of varying sizes (King County, 2016). Longfellow Creek was placed on Washington State's List of impaired streams due to water quality violations for fecal coliform bacteria, dissolved oxygen, and water temperature (WA State). Beginning in 1992 King County has conducted monthly water quality monitoring at two locations (Station C370 and Station J370). Longfellow Creek is categorized as "Salmonid Spawning, Rearing, and Migration Habitat with Coho and Chum Salmon and Steelhead and Cutthroat trout using the creek (King County, 2016). The piping of the upper 4,900 feet of the creek blocks fish passage, limiting rearing and spawning habitat. Additionally, there is concern about growing rates of Coho salmon pre-spawn mortality in the lower reaches of the creek. Development driven habitat loss and increases in impervious surfaces have increased stormwater runoff into the creek (WRIA 9, 2000).

Des Moines Creek

Des Moines Creek is part of the Green-Duwamish watershed located in WRIA 9 (Ecology). The creek flows through the city of Des Moines and drains into the Puget Sound at Des Moines Beach. There is an east tributary flowing from Bow Lake that drains into Des Moines Creek and another small, unnamed tributary flowing from a residential neighbourhood that drains into the Des Moines Creek mainstem at river mile 0.8. The basin is heavily developed for residential and commercial use while the lower reaches of the creek contain forest and riparian habitat buffers along the Des Moines Creek trail. Des Moines creek was placed on Washington State's list of impaired streams due to water quality violations for water temperature, dissolved oxygen, and fecal coliform bacteria (Ecology). Des Moines creek provides habitat for Chinook, Chum, Coho, and Pink Salmon as well as Steelhead Trout (WA State).

Barnes Creek

Barnes creek is part of the Green-Duwamish watershed located in WRIA 9. The creek flows through the city of Des Moines and drains into Massey Creek. The basin is highly developed for residential and commercial use with the Barnes Creek Nature Trail providing some forest and riparian buffer habitat. Barnes creek was placed on Washington State's list of impaired streams due to water quality violations for dissolved oxygen and fecal coliform bacteria.

Massey Creek

Massey creek is part of the Green-Duwamish watershed located in WRIA 9 (Ecology). The creek flows through the city of Des Moines and drains to the Puget Sound at the Des Moines Marina. Barnes Creek is a tributary of Massey creek. Massey Creek is on the Washington State's list of impaired streams due to water quality violations of fecal coliform bacteria and dissolved oxygen (Ecology). Massey Creek provides habitat for Chinook, Chum, Coho, and odd-year Pink salmon as well as steelhead trout (WA State).

McSorley Creek

McSorley Creek is part of the Green-Duwamish Watershed located in WRIA 9 (Ecology). The creek flows through the city of Des Moines and drains into the Puget Sound at Saltwater State Park Beach. McSorley Creek has a north fork flowing from Parkside Elementary School and a south fork flowing from South 272nd Street. The two forks meet and drain into the mainstem of McSorley creek in Saltwater State Park. McSorley Creek was placed on Washington State's list of impaired streams due to water quality violations of fecal coliform bacteria and dissolved oxygen (Ecology). McSorley Creek is used by spawning Coho and Chum Salmon as well as Cutthroat Trout. Juvenile Chinook Salmon will benefit from rearing habitat provided by the pocket estuary. Forage fish, such as Sand Lance and Surf Smelt, will be able to use the newly formed beach as spawning habitat (WA State).

Methods

Youth interns of the Lost Urban Creek Project were trained in July of 2019 and again in the summers of 2020 and 2021 by the Sno-King Watershed Council to conduct water quality monitoring of Springbrook Creek Watershed using methods established by the Alabama Water Watch and Global Water Watch (AWW/GWW) as well as those outlined in our LUC Quality Assurance Program Plan (QAPP) [8]. Each year, eight locations (see Appendix A & B) were monitored quarterly throughout the Springbrook watershed for water and air temperature, pH, dissolved oxygen, specific conductance, turbidity, total dissolved solids, nitrates, and salinity. Quarterly monitoring was also initiated at other creeks to provide youth with experience monitoring and comparing Springbrook to other urban creeks (See Appendix C). Weather, water flows and site conditions were noted at all sites.

Site locations were identified using a three-letter code for the name of the creek (e.g., SPR for Springbrook Creek, MIL for Mill Creek, and PAN for Panther Creek, LON for Longfellow Creek, DES for Des Moines Creek, BAR for Barnes Creek, MAS for Massey Creek, and MCS for McSorley Creek) and a number for the number of river miles the site was located from the mouth of the creek (e.g., SPR1.4 is at Springbrook Creek, 1.4 river miles from the mouth of the creek). The higher this number, the higher up in the watershed the site is located.

A YSI ProPlus multimeter was the main equipment used along with a turbidity tube and telescoping measuring rod. Equipment calibration, training, data collection and management are all detailed in the Lost Urban Creek Sampling plan.

For basic water quality parameters, we visited sites creeks quarterly from September 2021 to September 2022 (both wet & dry Seasons)[9]. Appendix A and C have the list of sample locations and Appendix B and D have map showing monitoring sites included in this analysis. Sites were selected to see water quality variability between upper and lower watershed stations.

Monitoring results were compared to Water Quality Standards for Surface Waters of the State of

[8] *Forterra NW & Puget Soundkeeper Alliance. (2020). Approved by EPA Region 10.*

[9] *The number of sites visited in September 2019 and November 2019 were limited (4 sites and 1 site, respectively).*

Washington's Administrative Code. See Chapter 173-201A WAC (WADOE, 2022)

Results

Table 1 below provides an overview of all data collected by the Lost Urban Creeks Project during both the wet and dry seasons in the Springbrook, Longfellow, Des Moines, Barnes/Massey and McSorley Creeks.

Table 1: Water Quality Data Table

Parameter	Wet Season Mean (Geomean)*	Wet Season (Min-Max)	Dry Season Mean (Geomean)*	Dry Season (Min-Max)	State Standard	Violation?
	Springbrook Creek					
Dissolved Oxygen (mg/L)	7.507	1.8-12.7	4.866	1.19-10.15	10 mg/L	Yes: 13 samples at 5 sites (MIL 0.9, PAN0.0, SPR1.4, MIL5.3, & PAN2.0) out of 24 samples did not meet state standard
pH	7.263	6.4-8.1	7.311	6.7-8.03	6.5-8.5	Yes: 1 sample at 1 site (GAR0.0) out of a total of 24 samples taken in the wet season was slightly below state standard. None of the 8 samples in dry season violated state standards
Turbidity (NTU)	2.739	2-15	3.471	2-30	5 NTU over normal background turbidity (which for Springbrook Creek may be approximately 10 NTUs)	Wet season: While no sites violated our determined standard based on Springbrook Creek, 4 samples at 5 sites (MIL 0.8, SPR 1.4, GAR 0.0) out of 24 samples had turbidity of 12-15, which is likely above state standard in relation to normal background level of turbidity; Dry Season: Yes, 2 samples at 2 sites (MIL0.8 & PAN0.0) out of 8 samples did not meet state standard
Water Temp. (deg. C)	8.988	5.2-12.6	12.64	13.6-20.3	≤17.5 ° C.	Wet season: None. Dry season: Yes, 4 samples at 4 sites (MIL0.8, PAN0.0, SPR1.4, GAR0.0) out of 8 samples did not meet state standard
SPC (µs/cm)	179.1	93.1-302	269.863	192-360.4	N/A	N/A
TDS (mg/L)	116.438	60.5-196	171.065	125-219	N/A	N/A
Precipitation (inches)	0.032	0.01-0.11	0	0	N/A	N/A
	Longfellow Creek					
Dissolved Oxygen (mg/L)	7.455	10.9-5.1	7.3	5.89-9.72	10 mg/L	Wet Season: Yes, 1 sample at one site (LON4.5) out of 2 samples did not meet state standard. Dry Season: Yes, 4 samples at 2 sites (LON0.7 & LON3.4) out of 4 samples did not meet state standard
pH	6.033	5.6-6.5	7.235	6.8-7.8	6.5-8.5	Wet Season: Yes, 1 sample at one site (LON4.5) out of 2 samples did not meet state standard. Dry season: None
Turbidity (NTU)	9.486	2-45	6.791	2-28	5 NTU over the normal background level of turbidity	Wet Season: Yes, 1 sample at one site (LON0.7) out of 2 samples did not meet state standard. Dry Season: Yes, 2 sample at 2 sites (LON0.7 & LON3.4) out of 4 samples did not meet state standard
Water Temp. (deg. C)	12.049	12-12.1	14.657	12.7-17.9	≤17.5 ° C.	Wet season: None. Dry Season: Yes, 1 sample at 1 site (LON0.7) out of 4 samples did not meet state

Parameter	Wet Season Mean (Geomean)*	Wet Season (Min-Max)	Dry Season Mean (Geomean)*	Dry Season (Min-Max)	State Standard	Violation?
						standard.
SPC (µs/cm)	76.497	44.4-131.8	287.472	277.2-308.1	N/A	N/A
TDS (mg/L)	49.536	28.6-85.8	188.102	28.6-85.8	N/A	N/A
Precipitation (inches)	0.27	0.27	0.028	0.02-0.04	N/A	N/A
	Des Moines Creek					
Dissolved Oxygen (mg/L)	11.656	10.3-13.4	9.502	8.5-10.01	10 mg/L	Wet Season: None. Dry Season: Yes, 3 samples at 2 sites (DES0.2 & DES2.0) out of 5 samples did not meet state standard
pH	7.385	6.7-7.8	7.553	7-7.8	6.5-8.5	None
Turbidity (NTU)	3.482	2-8	2	2-2	5 NTU over the normal background level of turbidity	None
Water Temp. (deg. C)	7.44	6.5-8	13.316	12.9-13.9	≤17.5 ° C.	None
SPC (µs/cm)	196.973	149.1-254.9	209.431	131.4-261	N/A	N/A
TDS (mg/L)	127.95	97-165.8	136.035	85-170	N/A	N/A
Precipitation (inches)	0.197	0.08-0.36	0.05	0-0.05	N/A	N/A
	Barnes-Massey Creeks					
Dissolved Oxygen (mg/L)	11.4	11.4-11.4	9.586	8.6-10.66	10 mg/L	Wet Season: None. Dry Season: Yes, 5 samples at 3 sites (BAR0.6, BAR0.8 & MAS0.2) out of 6 samples did not meet state standard
pH	7.6	7.6-7.6	7.447	6.85-7.8	6.5-8.5	None
Turbidity (NTU)	2	2-2	2	2-2	5 NTU over the normal background level of turbidity	None
Water Temp. (deg. C)	7.2	7.2 (only one sample)	13.059	10.5-15.5	≤17.5 ° C.	None
SPC (µs/cm)	272.4	272.4 (only one sample)	184.555	108.4-271.1	N/A	N/A
TDS (mg/L)	177	177 (only one sample)	119.69	70-175	N/A	N/A
Precipitation (inches)	0.36	0.36	0.153	0-0.47	N/A	N/A
	McSorley Creek					
Dissolved Oxygen (mg/L)	12.361	11.8-12.95	9.962	9.85-10.15	10 mg/L	Wet Season: None Dry Season: Yes, 2 samples at 1 site (MSC0.0) out of 3 samples did not meet state standard
pH	8.094	7.8-8.4	7.926	7.9-7.98	6.5-8.5	None
Turbidity (NTU)	2	2-2	2	2-2	5 NTU over the normal background level of turbidity	None

Parameter	Wet Season Mean (Geomean)*	Wet Season (Min-Max)	Dry Season Mean (Geomean)*	Dry Season (Min-Max)	State Standard	Violation?
Water Temp. (deg. C)	7.341	7-7.7	13.925	13.3-14.4	≤17.5 ° C.	None
SPC (µs/cm)	197.849	197.6-198.1	203.634	175.6-270	N/A	N/A
TDS (mg/L)	128.499	70-175	132.523	114-176	N/A	N/A
Precipitation (inches)	0.36	0.36	0.016	0-0.05	N/A	N/A

**Geometric means taken from monthly precipitation data for Kent, WA (NOAA,2021) and monthly flow data from USGS Station 12113346 Springbrook Creek at Orillia, WA (USGS, 2021).*

For discussion of previous sampling results, please refer to our 2021 report (Puget Soundkeeper Alliance, 2021).

During the wet season, most water quality parameters, were well within the range that would allow salmon to survive but the final column of Table 1 above provides information on violations of State Water Quality Standards and where and when these exceedances occurred. Graphs of the quarterly data for each creek are included in the discussion of the key parameters below. In addition to three graphs of the 2021-2022 data for Springbrook, Longfellow, and Des Moines-Barnes/Massey-McSorley, a four graph shows all data collected for each parameter in Springbrook Creek's mainstem stations (SPR5.0 and SPR1.4) since the beginning of the Lost Urban Creeks Water Monitoring Program in 2019 (the first two years, data was collected monthly).

1. Dissolved Oxygen (DO)

Based on new research, the Washington State standard for aquatic life (specifically the spawning, rearing and migration of salmon) was revised as of April 2022. Dissolved Oxygen in the water column should be at least 10 mg/L (represented by the dashed red line in the charts below). This standard was previously required at least 8 mg/L or higher. The figures below the monitoring data shows that the lower stations on Springbrook, Panther, Garrison and Mill Creek are consistently failing to meet State Water Quality standards for Dissolved Oxygen throughout the year. This is also true for the mainstem stations (SPR5.0 and SPR1.4) since the start of the monitoring effort in 2019. Longfellow samples were limited but both the middle and upper stream locations did not meet State standards, nor did two of the lower stream locations sites in spring and summer. For Des Moines, Barnes/Massey & McSorley Creeks results were more mixed. There was a general decline in oxygen levels in Spring and Summer, compared to fall and winter, with several stations dropping below State standards.

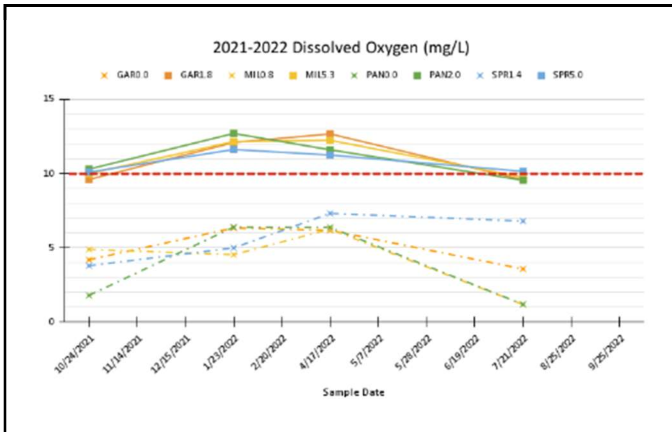


Figure 1: Springbrook Creek Dissolved Oxygen (2021-2022)

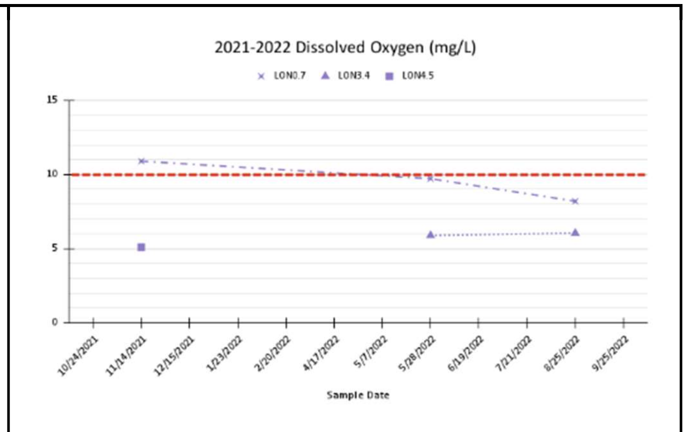


Figure 2: Longfellow Creek Dissolved Oxygen (2021-2022)

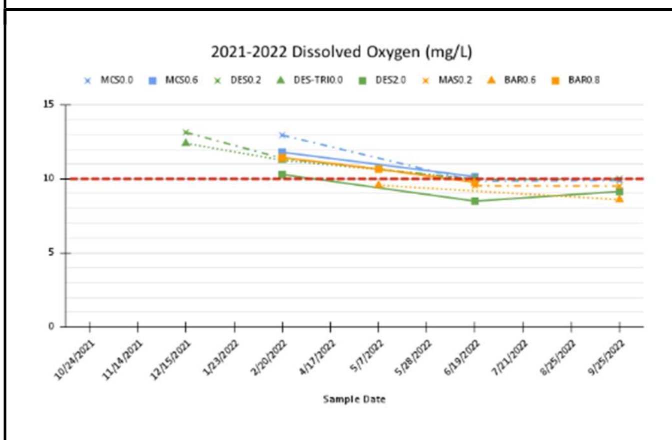


Figure 3: Des Moines, Barnes/Massey & McSorley Creeks Dissolved Oxygen (2021-2022)

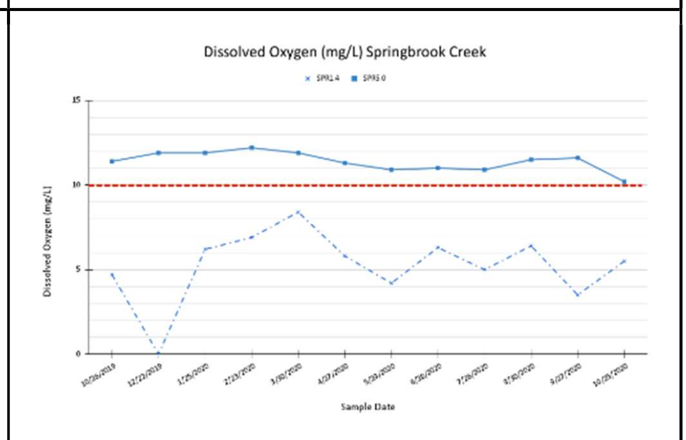


Figure 4; Springbrook Creek Mainstem Dissolved Oxygen (2019-2022)

2. Temperature

The Washington State Temperature Limit for salmonid streams waters should always be ≤17.5 °C. During the dry season, which experienced lower rainfalls and lower stream flows in all creeks, water temperatures increased significantly at each of the four lower Springbrook Creek sites (MIL0.8, PAN0.0, SPR1.4, GAR0.0) and this was a pattern seen since the start of the survey effort in Springbrook since 2019. Longfellow samples are more limited for the year and one downstream station had a single temperature exceedance (LON0.7). Des Moines, Barnes, Massey and McSorley had no temperature exceedances.

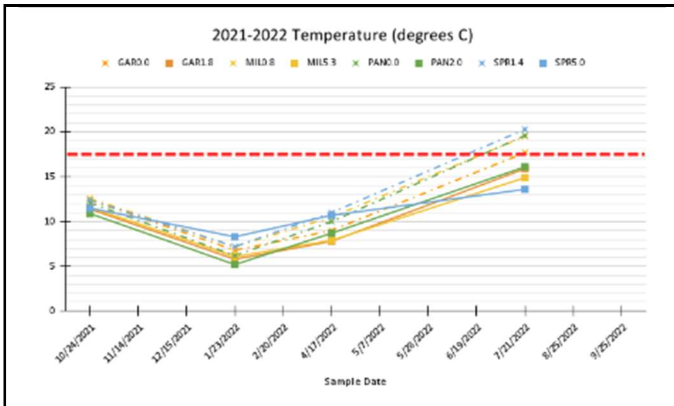


Figure 6: Springbrook Creek Temperature (2021-2022)

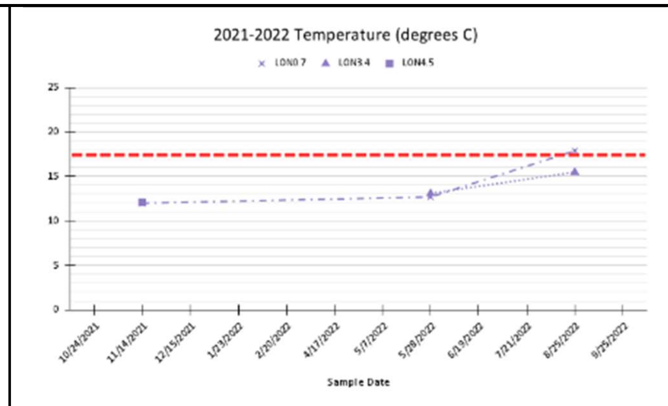


Figure 7: Longfellow Creek Temperature (2021-2022)

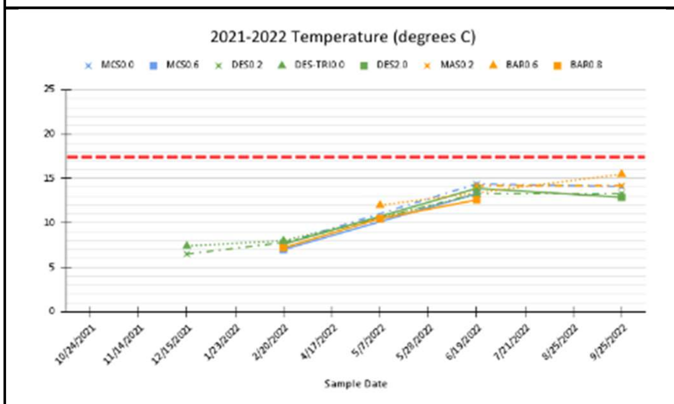


Figure 8: Des Moines, Barnes/Massey & McSorley Creeks Temperature (2021-2022)

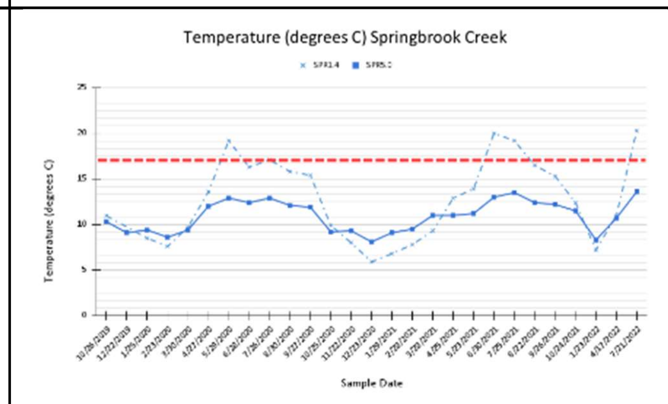


Figure 9: Springbrook Creek Mainstem Temperature (2019-2022)

3. pH

The Washington State pH standard for salmonid streams waters should be between 6.5 and 8.5. Our findings showed that most stations are within Washington State Standards. Only one station on Garrison Creek in Springbrook Watershed (GAR0.0) dipped slightly below the State Standard in April of 2023. Longfellow Creek's most upstream station (LON4.5) in Roxhill Bog could only be sampled once and had the lowest pH level.

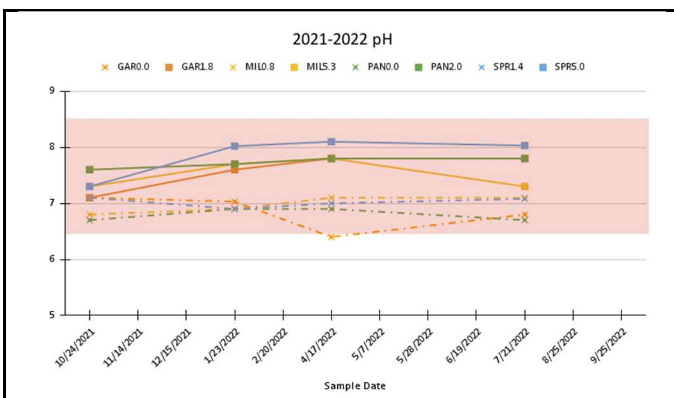


Figure 6: Springbrook Creek pH (2021-2022)

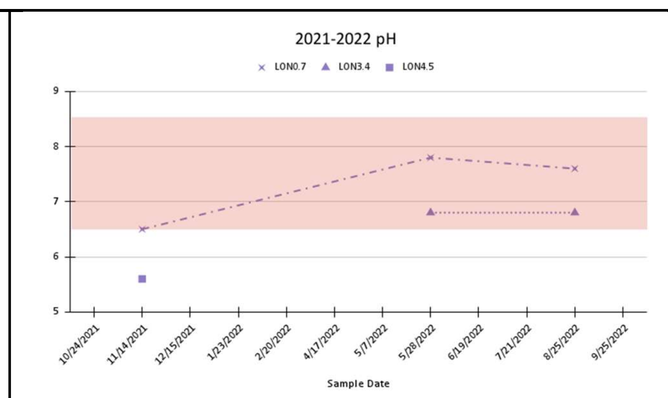
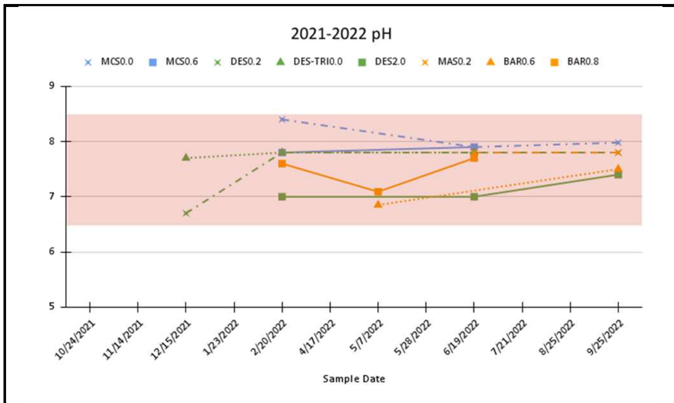


Figure 7: Longfellow Creek pH (2021-2022)



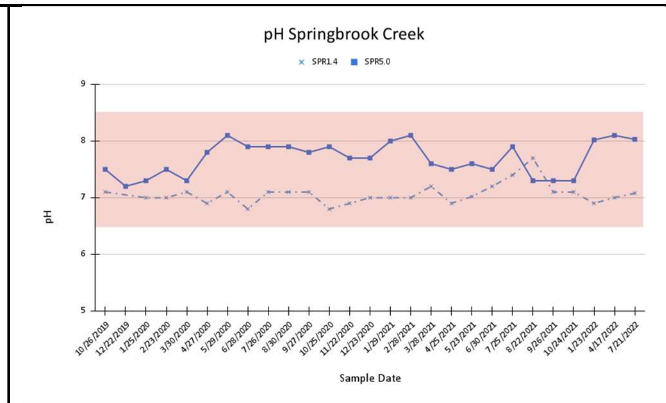


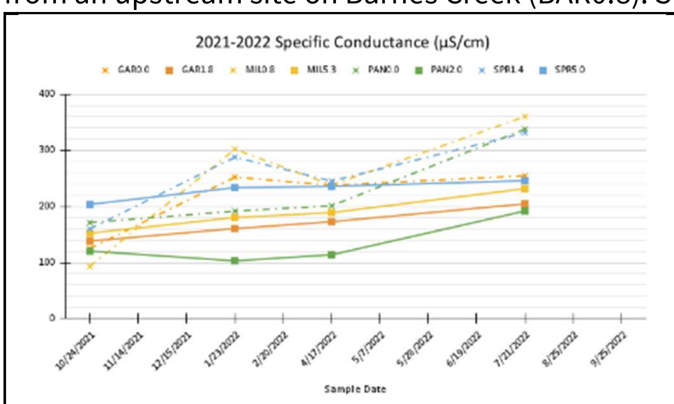
Figure 8: Des Moines, Barnes/Massey & McSorley Creeks pH (2021-2022)

Figure 9: Springbrook Creek Mainstem pH (2019-2022)

4. Specific Conductance & Total Dissolved Solids

There is no state standard related to these two water quality parameters. Specific conductance is simply a measure of water's ability to conduct electricity. Total Dissolved Solids (TDS) are related to Specific conductance (SPC) and were calculated by the ProDSS field meter from the SPC reading and a TDS multiplier set to the default of 0.65. TDS is a measure of the total combined content of all inorganic and organic substances that are present in a water in molecular, ionized, or micro-granular suspended form.

Except for SPR5.0, which is close to the headwaters springs of Springbrook Creek and is likely carrying a higher mineral load, most of the lower stations in the creek tended to have higher conductivity and total dissolved solids readings than the upper stations, indicating that material is entering the creek and its tributaries as they flow downstream. This pattern may be happening in Longfellow Creek and other creeks but there is limited data to determine this. In Des Moines Creek, a small tributary that is carrying stormwater from neighbourhood streets above the creek had some of the highest conductivity and total dissolved solids for this watershed except for one February sample from an upstream site on Barnes Creek (BAR0.8). See graphs below.



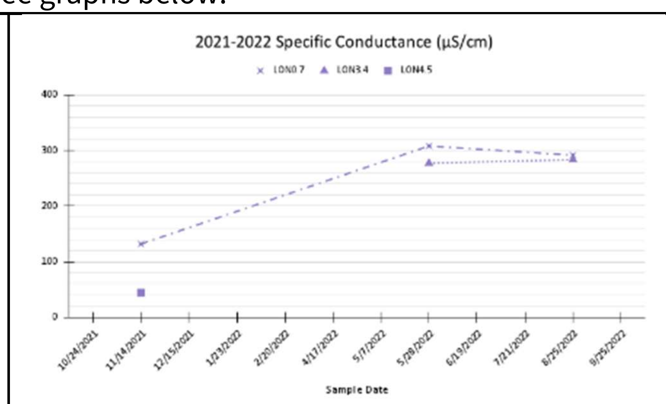


Figure 10: Springbrook Creek Sp. Conductance (2021-2022)

Figure 10: Longfellow Creek Sp. Conductance (2021-2022)

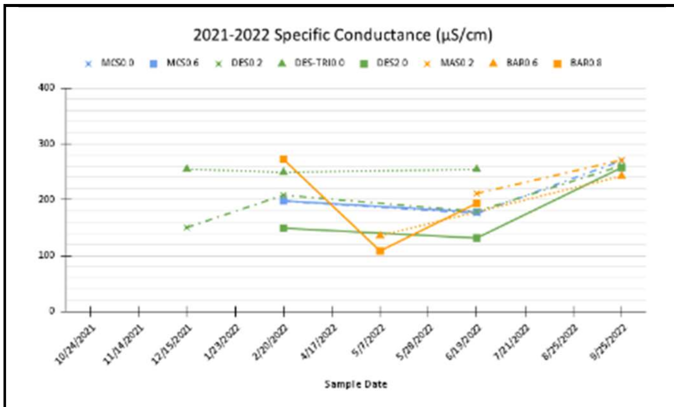


Figure 10: Des Moines, Barnes/Massey & McSorley Creeks Sp. Conductance (2021-2022)

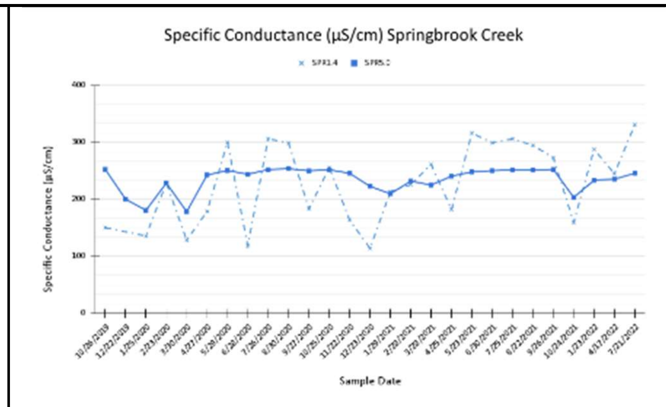


Figure 10: Springbrook Creek Mainstem Sp. Conductance (2019-2022)

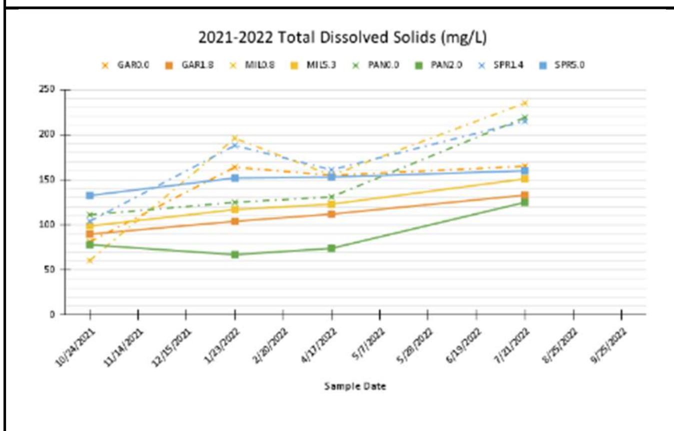


Figure 10: Springbrook Creek Total Dissolved Solids (2021-2022)

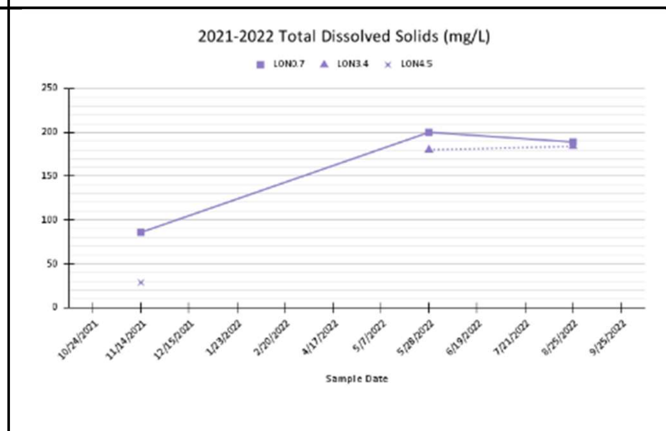


Figure 10: Longfellow Creek Total Dissolved Solids (2021-2022)

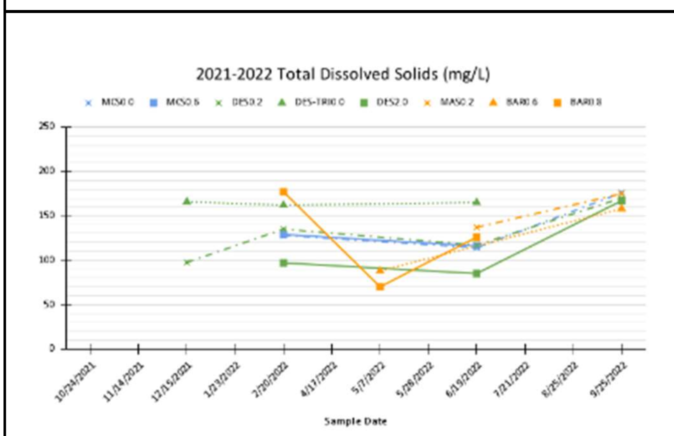


Figure 10: Des Moines, Barnes/Massey & McSorley Creeks Total Dissolved Solids (2021-2022)

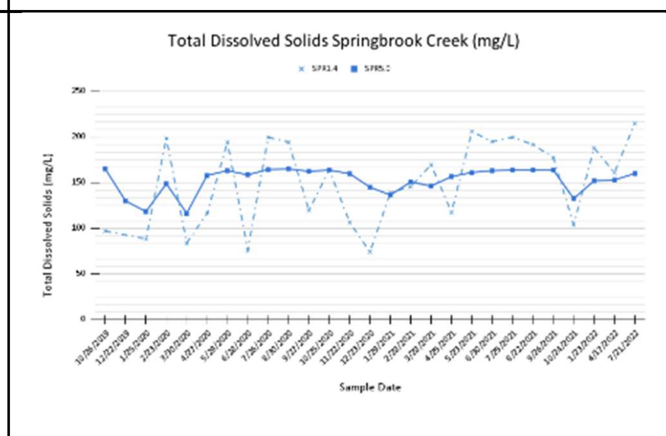


Figure 10: Springbrook Creek Mainstem Total Dissolved Solids (2019-2022)

5. Turbidity

Turbidity is the cloudiness or haziness of a fluid caused by suspended solids floating in the water and is measured in units called nephelometric turbidity units or "NTUs." Due to winter rains bringing more sediment into the creek, we might expect to see higher turbidity levels in the wet season. For

Salmon and according to Washington State standards, turbidity should not be more than 5 NTU over the normal background level of turbidity. In the case of Springbrook Creek and for comparison to other creeks, we consider baseline to be 10 NTUs overall (thus an exceedance would be 15 NTUs) but the evaluation can also consider that downstream stations should not increase over 5 NTUs from the turbidity level of its upstream station.

In Springbrook Creek, all upstream locations throughout the year had turbidity <2 NTUs. This has always been true of Springbrook Creeks upstream station (SPR5.0) since the start of the monitoring work in 2019. Yet downstream stations on the mainstem and tributaries (except in April 2022), was often 5 NTUs or higher (with the highest reading at MIL0.8 and PAN0.0 in July 2022). Since the start of the survey work in 2019, the lower Springbrook Creek station (SPR1.4) has exceeded the upper stations turbidity by 5 or more NTUs on at least seven occasions.

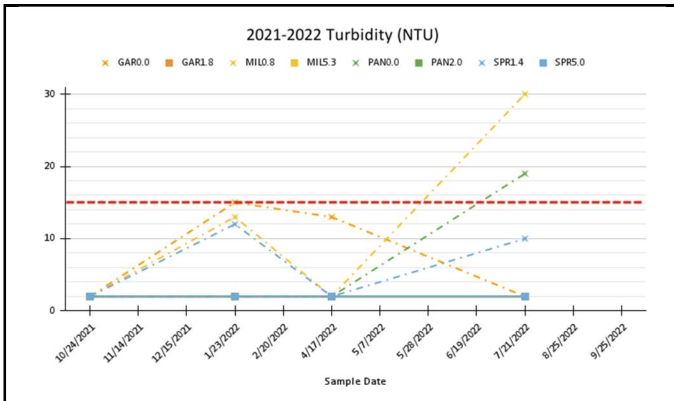


Figure 11: Springbrook Creek Turbidity (2021-2022)

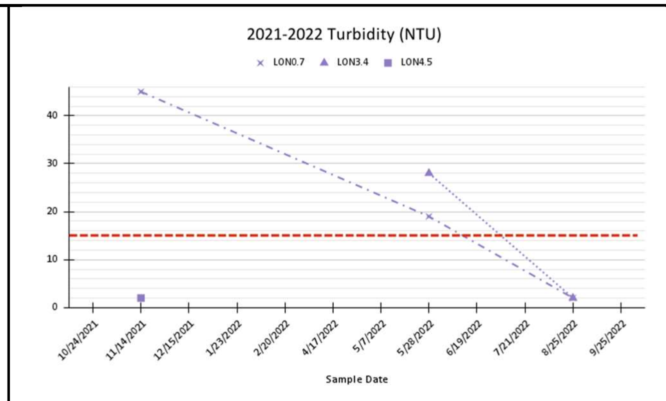


Figure 12: Longfellow Creek Turbidity (2021-2022)

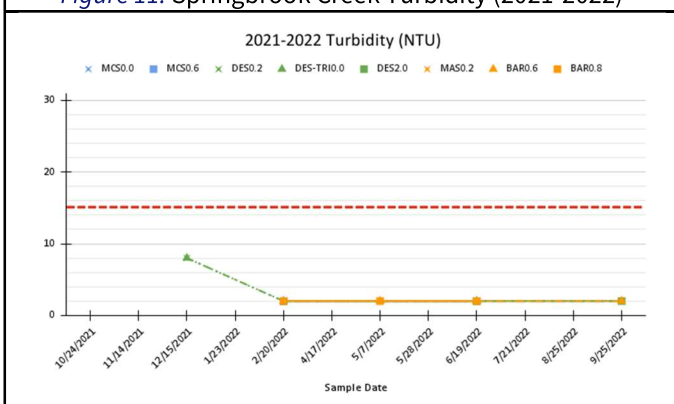


Figure 13: Des Moines, Barnes/Massey & McSorley Turbidity (2021-2022)

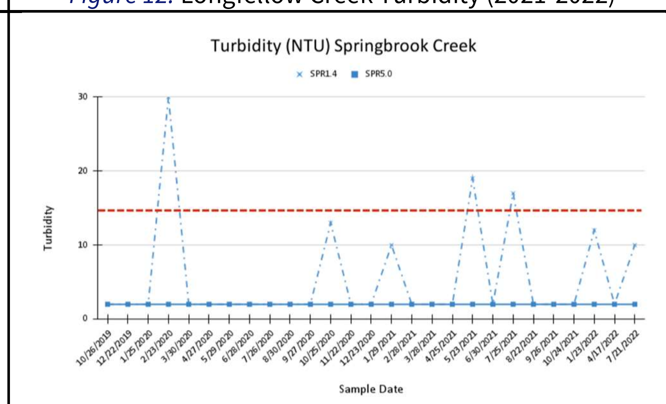


Figure 14: Springbrook Creek Mainstem Turbidity (2019-2022)

Discussion

Based on the 2021-2022 sampling year, water quality monitoring conducted in the Lost Urban Creeks Project, which were evaluated against current State Standards (Ecology, 2022) that are based on requirements for salmon and the protection of human health, indicate that there were three water quality parameters of concerns in the Springbrook Creek Watershed. At certain stations, typically lower in the Springbrook Watershed, dissolved oxygen, turbidity, and temperature indicate poor water quality.

1. Dissolved Oxygen

Springbrook has a very clear pattern in both the wet and the dry season, where the lower stations in the basin regularly do not meeting State standards (i.e., dissolved oxygen levels are lower than the 10 mg/L standard), while the upper stations do. This pattern has been seen in Drainage District No. 1 bi-yearly monitoring data (2022) as well as King County's monthly monitoring data (2022b). And this pattern is clear when we look at all Springbrook Creek mainstem data since the LUC project first started its monitoring efforts in 2019.

In comparison, Longfellow upstream stations tended to have lower oxygen than the downstream station, but more monitoring would be needed to see if this is a consistent pattern (the most upstream station had limited flow and the middle station was at the end of a beaver pond, whereas the lowest station had a more energetic flow). Des Moines area creeks had mainly showed a slight decline in oxygen levels (sometimes slipping below State standards) during warmer conditions in spring and summer.

Water temperature can impact dissolved oxygen levels (see discussion below) and high nutrient content in the water can also lead to low dissolved oxygen because nutrients encourage plant growth but as plants start to die off and are consumed by other organisms, this can cause oxygen to be removed from the water.

Low and/or stagnant water flows and a lack of turbulence can also lower the dissolved oxygen in the creek, and this may be the case in much of the lower part of the Springbrook watershed and some parts of the upper Longfellow Creek. In Springbrook, the Black River Dam/Pump Station and culverts (i.e., at Panther Creek and Highway 167) contributes to lower flows and potential stagnation in the lower basin as well. High levels of Iron bacteria found throughout the watershed but particularly in Panther Creek can also consume oxygen and may contribute to low levels. Other pollutants in stormwater that wash into the stream during the winter are likely also impacting dissolved oxygen levels as indicated by conductivity levels (see Figure 10), but this was beyond the scope of the current project to evaluate.

2. Temperature

Water temperatures increased only during summer with exceedances of the State temperature standard taking place in lower basin sites only in Springbrook and Longfellow Creeks. This would be a concern to any resident fish or young salmonids using these creeks' lower reaches as a refuge during the summer. Higher conductivity measurements also indicate potential problems in the lower basin particularly in the dry season.

The amount of oxygen dissolved in water is affected by water temperature, as warmer water has less oxygen. While water temperature was within acceptable ranges at many sites during the wet season, when salmon could be spawning in the creek, some of these creeks have limited riparian vegetation to provide shade to the water.

3. pH

Nearly all sample locations in all creeks met State pH standards except those discussed below. In general, for Springbrook Creek, the creek became more acidic as it flowed downstream, the opposite was true for Longfellow and to some extent Des Moines area creeks (Des Moines, Barnes/Massey & McSorley), though this is less clear.

The pH of Garrison Creek at River Mile 0.0 was typical of most other downstream stations in Springbrook's Watershed but it did dip the lowest in April of 2022. Longfellow Creek's most upstream station (LON4.5) is in Roxhill Bog. This station dried out after the November monitoring, but its pH reflects typical acidic conditions of a fen.

4. Specific Conductance & Total Dissolved Solids

Conductivity is not a pollutant itself but serves as an indicator of the presence of pollutants. Conductivity of water is affected by the presence of dissolved substances in the water, including salts and heavy metals. Some of these substances are harmful to aquatic life and to humans, especially at high concentrations.

Conductivity ranged from a low of 44.4 µs/cm in Longfellow's upstream station (LON4.5) to a high of 360.4 µs/cm in MIL0.8 (Total Dissolved Solids ranged from a low of 28.6 mg/L to a high of 219 mg/L in the same stations). In general, the measurements for conductivity and total dissolved solids appear to be typical of urban watersheds.

5. Turbidity

Water with high turbidity levels can clog fish gills of salmonids and suffocate them. High levels of conductivity and total dissolved solids also often correlate with high turbidity. The particles in highly turbid water also attach to other pollutants, such as metals and bacteria. Most northwest creeks, urban or not, usually have near zero turbidity outside of rain events. High stormwater flows can bring in more pollution from the surrounding land to the creek or re-suspend the sediments in the creek.

Every upstream station in all the creeks surveyed in 2021-2022 had low turbidity. But downstream sites in Springbrook Creek showed frequent exceedances of over 5 NTUs above upstream sites (since the start of the monitoring work in 2019, there have been seven exceedances in the lower mainstem station of Springbrook – SPR1.4). Longfellow had limited monitoring data but showed one clear exceedance in November of 2021. Des Moines Area Creeks had only one exceedance in December 2022 at a tributary that is bringing stormwater flows down from neighbourhood streets above the creek.

Recommendations

In the summer of 2023, the State Department of Ecology accepted Lost Urban Creeks Water Temperature Data into their Environmental Information Management (EIM) Database, which will allow this data to be utilized in Ecology's water quality assessments. We encourage the Department of Ecology to find ways to ensure that robust and reliable volunteer-based and community-generated environmental data can be used in the EIM Database.

In the past, we've made several recommendations targeted to improving overall water quality to create better conditions for salmonids and sensitive species. These include:

- Evaluate how the operations of the Black River Pump Station can be changed to improve flows in the lower part of the watershed (particularly in regard to the Station Retrofit).
- Plant trees in areas of the creek lacking riparian vegetation to improve shading and help decrease water temperatures in the creek.
- Address water stagnation issues in lower Panther Creek by improving the culvert under State Route 167.
- Increased efforts to control stormwater flows through riparian and stream restoration and implement green stormwater infrastructure projects, which will help to filter out and/or biologically treat pollutants and sediment entering the creek.

Some recommendations we have provided relate to addressing trash that gets into the creek:

- Give more attention to accessible but less visible areas of the creek, where trash is accumulating. Programs like the Kent Adopt-A-Spot Program can be very effective (especially if the program can target commercial landowners and managers to address trash accumulating on or near commercial sites).
- Extending the Springbrook trail system into the City of Kent (along Springbrook and Mill Creek) and provide amenities such as trash cans more frequently along the length of the trail.

In addition, based on past data and information from King County and the Drainage District, recommendations have been suggested to address human health concerns caused by bacteria contamination and the need for a more comprehensive approach to the restoration of the entire watershed to achieve more fishable, swimmable, and drinkable waters in Springbrook. These include:

- Investigate further to identify the source of bacteria inputs, such as adding monitoring station(s) at outfall upstream or other upstream sites and consider other source-tracking methods to identify where the bacteria is coming from. This would include bacteria DNA analysis.
- Develop a Springbrook Watershed Restoration Plan that involves all stakeholders and prioritizes restoration activities that are comprehensive for the entire watershed. This will have a more lasting impact over opportunistic and episodic restoration activities by different groups working separately. Individual projects (or at least their impacts on and implications for the restoration of the entire watershed) should be included together as part of a larger vision for Springbrook Creek that works to solve its chronic water quality health problems. These include, but may not be limited to, plans and projects such as:

    - Lost Urban Creek Project Restoration plans,
    - Kent's Mill Creek Re-establishment Project,
    - Renton's proposed stream improvement projects (such as one to improve flow on Panther Creek),
    - King County's Black River Pump Station Retrofit Project, and
    - the Drainage District No 1's Planting Plan.

Next Steps

The 2021-2022 monitoring year included two additional sites in Garrison Creek (another tributary to Springbrook in Kent) and monitoring sites on Longfellow Creek in West Seattle, and Des Moines, Barnes, Massey, and McSorley Creeks in Des Moines, Washington. Starting in October 2022, youth interns continued quarterly monitoring in Springbrook Creek and started regular quarterly monitoring visits to six sites in May Creek, a small watershed in Renton, WA. In addition, the project introduced bacteria monitoring at these sites. A short report on the findings of the 2022-2023 monitoring year is planned to be released in early 2024.

For the 2023-2024 monitoring year, youth will continue quarterly monitoring in Springbrook Creek and return to quarterly monitoring along Longfellow Creek.

For more information about the Lost Urban Creeks Project, contact LUC@pugetsoundkeeper.org or find us on Instagram at @lost_urban_creeks.

Acknowledgements

The following Unleash the Brilliance youth interns participating in monitoring, data entry, data analysis and presentations of the water quality monitoring effort in the Springbrook Watershed between 2021 and 2022: Alley Gardner, Anthony Pioquinto, Ashley Chavez, Carolyn "Carrie" Brown, Chloe Trujillo, Cole Dozier, Dylan Dozier, Emanuel Chavez, Hannah Park, Hayden Power, Heavenly "Angel" Graham, Hyein Park, Ikeoluwa Alao, Jaelyn Patton, Jalina Martin, K'Vaughn Patton, Noah Bagby, Sacorra Silva Acosta, Serena Elizabeth Auble, Sharlene Pioquinto, Tyreek Robertson, Vylet Brooks, Yafet Amine, and Zajiante "Zay" Tayvion.

Also, thanks to Terrell Dorsey, founder, and CEO of Unleash the Brilliance as well as Mark Dorsey who has helped chaperone the youth. The project could not have been successful without these two individuals. We also want to send our thanks to Eric Adman with the Sno-King Watershed Council (for providing training and equipment); our former project partner Forterra, Drainage District No. 1, Stephanie Hess of King County for her advice and feedback on the work, and members of the Puget Soundkeeper Alliance Poly-Tech Committee for their comments and suggestions on this report.

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Water Resource Inventory Area (WRIA) 9 - Green/Duwamish and Central Puget Sound Watershed (December 2020).

Appendix A: Springbrook Sample Locations for 2021-2022

#	Site Code*	Site Name	Description	Lat	Long	Additional Notes
1	SPR1.4	Springbrook below Panther Creek - River Mile 1.4	Below confluence with Panther Creek	47.459	-122.22748	Lowest station sampled, located below confluence with Panther Creek
2	SPR5.0	Springbrook at Trout Farm - River Mile 5.0	Upper Springbrook Creek	47.42852	-122.21501	Upper station below Renton Springs
3	MIL0.8	Lower Mill Creek - River Mile 0.8	Mill Creek	47.43017	-122.24216	Lower station above confluence with Springbrook
4	MIL5.3	Upper Mill Creek - River Mile 5.3	Upper Mill Creek	47.38285	-122.22414	Upper station below Kent Canyon
5	GAR0.0	Garrison Creek - River Mile 0.0	Lower Garrison Creek	47.429699	-122.225605	Lower Station near confluence with Springbrook Main Stem, near S 192nd St.
6	GAR1.8	Garrison Creek - River Mile 1.8	Upper Garrison Creek	47.406643	-122.21619	Upper station at S 218th Street Bridge
7	PAN0.0	Lower Panther Creek - River Mile 0.0	Lower Panther Creek	47.45894	-122.22709	Lower station above confluence with Springbrook
8	PAN2.0	Panther Creek - River Mile 2.0	Upper Panther Creek	47.44212	-122.20759	Upper station at Carr Rd S Culvert

**Site Codes consist of a 3-letter abbreviation for the name of the creek and a number representing the river miles to the mouth of the creek. For example, SPR5.0 is on Springbrook Creek 5 river miles up from the mouth of the creek.*

Appendix B: Maps of Springbrook Monitoring locations

21-22 Springbrook Creek Sampling Sites

KC Monitoring Location

- KCM-0317

Tributary Water Quality Locations

- 8 PAN0.0 - Panther River Mile 0.0
- 6 PAN2.0
- 3 GAR0.0
- 2 GAR1.8
- 1 MIL5.3 - Mill River Mile 5.3
- 4 MIL0.8

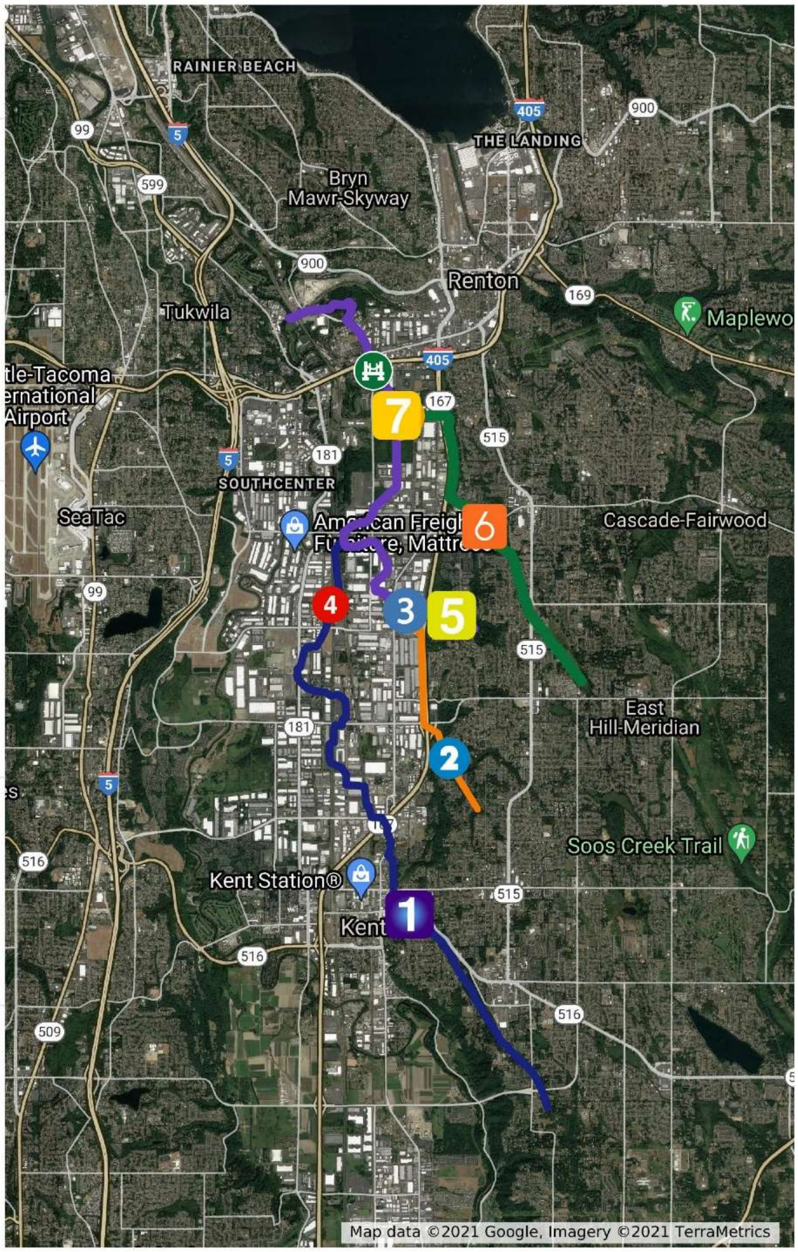
Main Stem Water Quality Locations

- 7 SPR1.4 - Springbrook River Mile 1.4
- 5 SPR5.0 - Springbrook River Mile 5.0

Creeks

- Springbrook Creek
- Mill Creek
- Panther Creek
- Garrison Creek

Lost Urban Creek Water Quality sampling locations



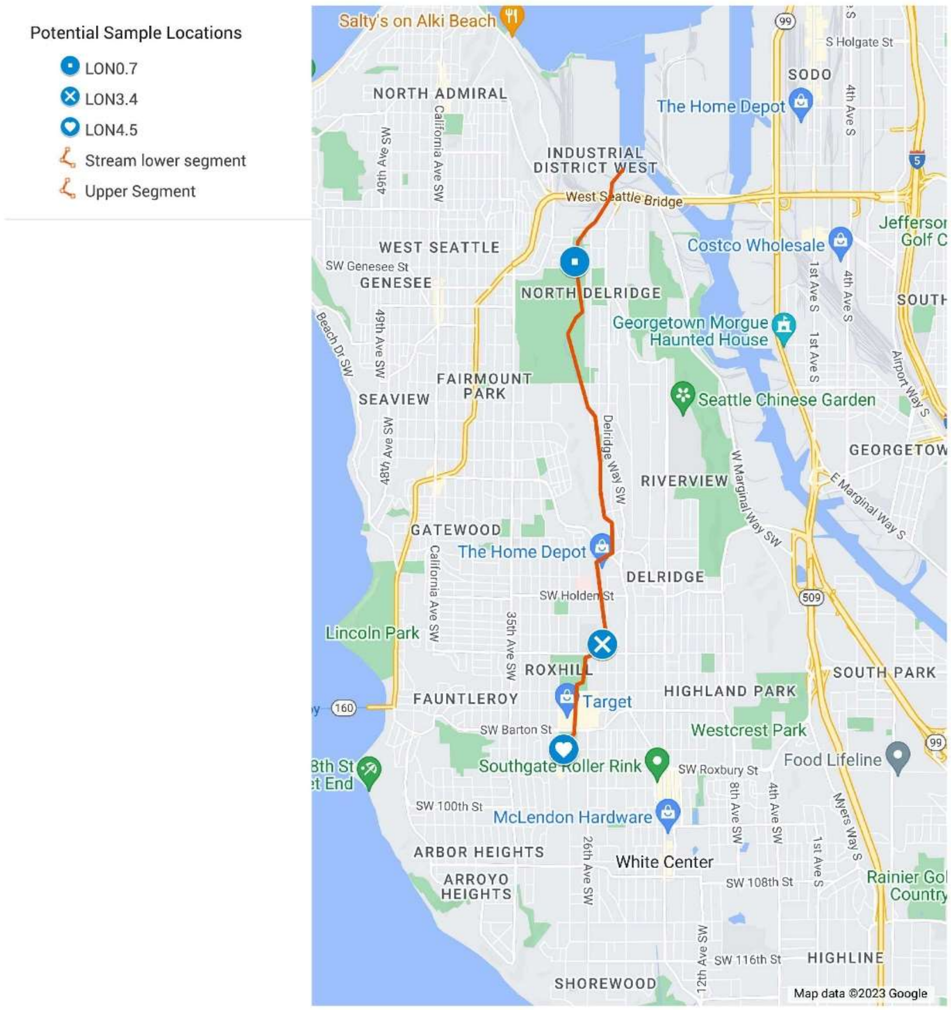
Appendix C: Additional Monitoring Locations

#	Site Code*	Site Name	Description	Lat	Long
9	LON0.7	Longfellow Creek - River Mile 0.7	Lower Longfellow in Dragonfly Pavilion	47.56527	-122.36754
10	LON 3.4	Longfellow Creek - River Mile 3.4	Middle Longfellow at Thistle Street Green Space	47.52915	-122.36383
11	LON4.5	Longfellow Creek - River Mile 4.5	Upper Longfellow at Roxhill Park	47.5192	-122.36922
12	DES0.2	Des Moines Creek - River Mile 0.2	Lower Des Moines Creek in DM Beach Park	47.40585	-122.32777
13	DES2.0	Des Moines Creek - River Mile 2.0	Upper Des Moines Creek	47.42262	-122.30535
14	DES-TRI0.0	Des Moines Creek Un-named Tributary - River Mile 0.0	Unnamed Tributary entering Des Moines Creek below WWTP	47.41204	-122.32051
15	BAR0.8	Barnes Creek - River Mile 0.8	Upper Barnes Creek	47.40282	-122.31244
16	BAR0.6	Barnes Creek - River Mile 0.6	Barnes Creek at S 223rd Street	47.40203	-122.31542
17	MAS0.2	Massey Creek - River Mile 0.2	Lower Massey Creek	47.39636	-122.32372
18	MCS0.0	McSorley Creek - River Mile 0.0	Lower McSorley Creek near beach	47.37291	-122.32354
19	MCS0.6	McSorley Creek - River Mile 0.6	Upper McSorley Creek	47.37526	-122.3152

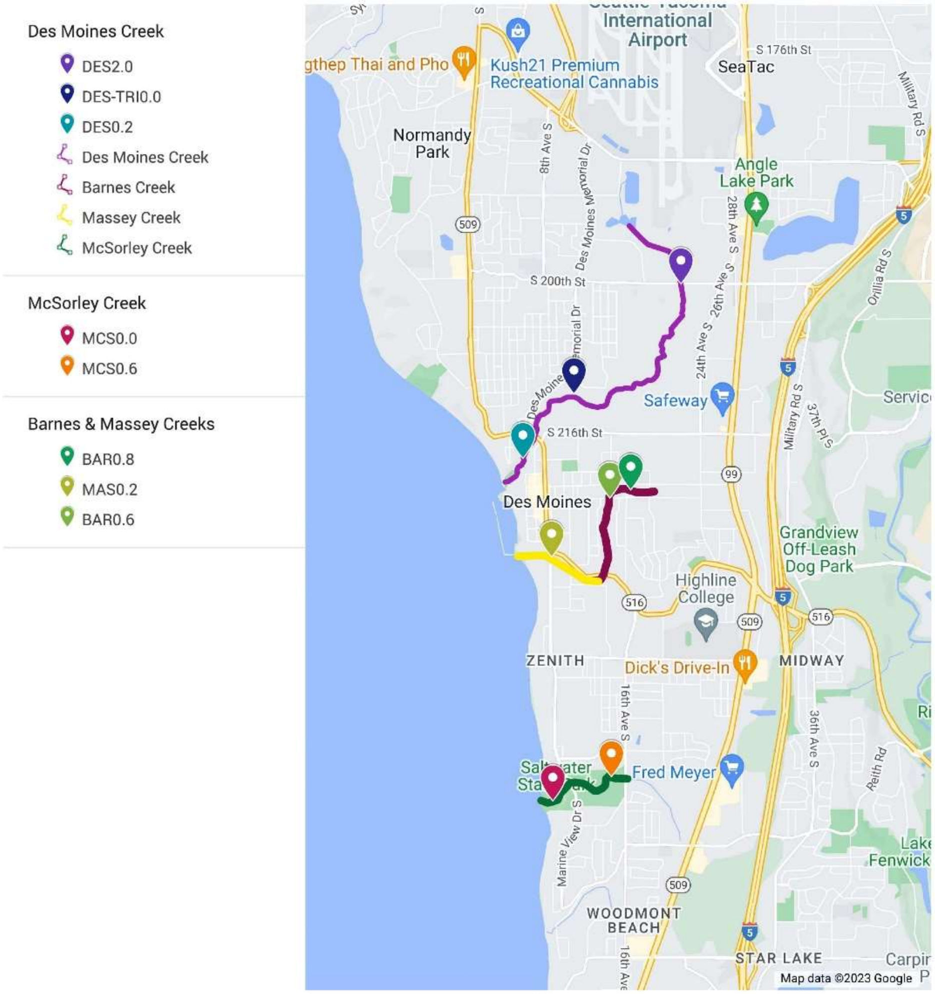
**Site Codes consist of a 3-letter abbreviation for the name of the creek and a number representing the river miles to the mouth of the creek. For example, MCS0.6 is on McSorley Creek at 0.6 river miles up from the mouth of the creek.*

Appendix D: Maps of Additional sampling locations

2021-22 Longfellow Creek Sample Locations



2021-22 Des Moines Area Sample Locations



Appendix E: LUC Water Quality Data

Date	Time	Site Code	Precipitation (inches)	Air Temp. (deg. C)	Temp. water (deg. C)	pH	DO (mg/L)	SPC (us/cm)	Turbidity (NTU)	TDS (mg/L)
10/24/2021	10:50	MIL5.3	0.11	13	11.6	7.3	10	152.4	2	98.8
10/24/2021	11:25	GAR1.8	0.11	13	11.4	7.1	9.6	138.3	2	89.7
10/24/2021	11:42	GAR0.0	0.11	13	12.4	7.1	4.2	125.1	2	81.3
10/24/2021	11:59	MIL0.8	0.11	13	12.6	6.8	4.9	93.1	2	60.5
10/24/2021	12:24	SPR5.0	0.11	13	11.5	7.3	10.1	203.7	2	132.6
10/24/2021	12:48	PAN2.0	0.11	13	10.9	7.6	10.3	120.4	2	78
10/24/2021	13:06	SPR1.4	0.11	14	12.4	7.1	3.8	160	2	104
10/24/2021	13:10	PAN0.0	0.11	14	12.1	6.7	1.8	171.2	2	111.2
11/14/2021	10:21	LON0.7	0.27	15	12	6.5	10.9	131.8	45	85.8
11/14/2021	12:45	LON4.5	0.27	15	12.1	5.6	5.1	44.4	2	28.6
12/15/2021	11:05	DES-TRI0.0	0.08	11	7.4	7.7	12.4	254.9	8	165.8
12/15/2021	10:25	DES0.2	0.08	4	6.5	6.7	13.14	150.3	8	97.5
1/23/2022	10:18	MIL5.3	0.01	4	6.1	7.7	12.15	180.4	2	117
1/23/2022	10:50	GAR1.8	0.01	5	5.8	7.6	12.09	160.7	2	104
1/23/2022	11:19	GAR0.0	0.01	6	6.8	7.03	6.34	252.4	15	164
1/23/2022	11:40	MIL0.8	0.01	8	7.2	6.9	4.54	302	13	196
1/23/2022	14:32	SPR5.0	0.01	5	8.3	8.02	11.62	233.7	2	152
1/23/2022	14:59	PAN2.0	0.01	5.5	5.2	7.7	12.7	103.1	2	67
1/23/2022	13:09	SPR1.4	0.01	5	7.2	6.9	5	288	12	188
1/23/2022	13:12	PAN0.0	0.01	5	6.2	6.9	6.4	191.8	2	125
2/20/2022	10:30	DES2.0	0.36	16	7.6	7	10.3	149.1	2	97
2/20/2022	11:09	DES0.2	0.36	16	7.8	7.8	11.39	208.3	2	135
2/20/2022	11:44	DES-TRI0.0	0.36	17	8	7.8	11.26	249.2	2	162
2/20/2022	13:26	BAR0.8	0.36	19	7.2	7.6	11.44	272.4	2	177
2/20/2022	14:03	MCS0.0	0.36	14	7.7	8.4	12.95	197.6	2	128
2/20/2022	14:36	MCS0.6	0.36	14	7	7.8	11.8	198.1	2	129
4/17/2022	10:40	MIL5.3	0.03	8	7.9	7.8	12.24	189	2	123
4/17/2022	11:20	GAR1.8	0.03	11	7.8	7.8	12.67	172.8	2	112
4/17/2022	11:50	GAR0.0	0.03	11	9	6.4	6.18	237.7	13	155
4/17/2022	12:34	MIL0.8	0.03	12	10.5	7.1	6.26	238.2	2	155
4/17/2022	14:02	SPR5.0	0.03	11	10.7	8.1	11.25	235.8	2	153
4/17/2022	14:27	PAN2.0	0.03	14	8.7	7.8	11.6	113.9	2	74
4/17/2022	15:04	SPR1.4	0.03	14	11	7	7.32	245.3	2	161
4/17/2022	15:14	PAN0.0	0.03	14	10	6.9	6.38	201.2	2	131
5/7/2022	11:50	BAR0.8	0.47	7	10.5	7.09	10.66	108.4	2	70
5/7/2022	13:38	BAR0.6	0.47	15	12	6.85	9.57	135.6	2	88
5/28/2022	10:58	LON0.7	0.04	14	12.7	7.8	9.72	308.1	19	200

Appendix E: LUC Water Quality Data

Date	Time	Site Code	Precipitation (inches)	Air Temp. (deg. C)	Temp. water (deg. C)	pH	DO (mg/L)	SPC (us/cm)	Turbidity (NTU)	TDS (mg/L)
5/28/2022	12:04	LON2.0	0.04	18	13.1	7.4	7.55	310.8	2	202
5/28/2022	12:38	LON2.3	0.04	15	12	7.8	10.18	307.9	2	200
5/28/2022	14:27	LON4.5	0.04	ND	ND	ND	ND	ND	ND	ND
5/28/2022	14:50	LON3.4	0.04	15	13.1	6.8	5.89	277.2	28	180
6/19/2022	10:43	DES2.0	Trace	15	13.9	7	8.5	131.4	2	85
6/19/2022	11:24	DES0.2	Trace	15	13.3	7.8	9.95	179.2	2	117
6/19/2022	11:47	DES-TRI0.0	Trace	17	13.2	7.8	10	254.5	2	165
6/19/2022	12:43	BAR0.8	Trace	20	12.6	7.7	9.76	193.6	2	126
6/19/2022	14:13	MAS0.2	Trace	20	14.2	7.8	9.53	211.3	2	137
6/19/2022	14:29	MCS0.0	Trace	22	14.4	7.9	9.85	175.6	2	114
6/19/2022	14:52	MCS0.6	Trace	20	13.3	7.9	10.15	178.1	2	116
7/21/2022	10:40	MIL5.3	0.00	29	14.9	7.3	9.75	231.8	2	151
7/21/2022	11:26	GAR1.8	0.00	20	15.9	7.8	9.58	204.8	2	133
7/21/2022	12:03	GAR0.0	0.00	33	17.7	6.8	3.58	254.7	2	165
7/21/2022	12:45	MIL0.8	0.00	33	19.5	7.1	1.19	360.4	30	235
7/21/2022	14:18	SPR5.0	0.00	33	13.6	8.03	10.15	246	2	160
7/21/2022	14:37	PAN2.0	0.00	26	16.1	7.8	9.55	192	2	125
7/21/2022	15:05	SPR1.4	0.00	30	20.3	7.08	6.8	331.4	10	215
7/21/2022	15:21	PAN0.0	0.00	30	19.6	6.7	1.2	337.8	19	219
8/25/2022	10:25	LON0.7	0.02	22	17.9	7.6	8.2	291.5	2	189
8/25/2022	11:17	LON1.5	0.02	23	17.7	7.7	8.7	303.6	2	197
8/25/2022	11:40	LON2.0	0.02	32	16.6	7.3	6.34	310.8	2	202
8/25/2022	12:07	LON2.3	0.02	33	16.1	7.8	9.21	315.3	2	205
8/25/2022	13:30	LON3.4	0.02	27	15.5	6.8	6.05	283.5	2	184