Lower Columbia Urban Streams (LCUS) Monitoring
Annual Status Report (2020-2021)
Clark County Public Works, Clean Water Division

SAM funds Clark County to conduct annual stream health monitoring and track changes over time in the Lower Columbia region. This status and trends monitoring is a way to track regional progress reducing stormwater impacts on environmental health.

Stream health conditions in this study are measured by multiple indicators and LCUS findings are summarized below:

- Land Cover: All subwatersheds fell into the "Not Properly Functioning" category.
- Flow Metrics: TQmean values for most sites fell into "Supporting Salmonid Use".
- Total Impervious Area (TIA) and Daily Traffic Intensity (ADT): Subwatershed Benthic Index of Biotic Integrity (BIBI) scores generally declines with increasing TIA and ADT traffic values > 10,000 daily trip miles per square mile.
- BIBI: Taxa analysis showed moderate changes in composition due to replacement of some sensitive taxa by more tolerant taxa. Nearly all sites appeared to show stress from drought.
- Stream Temperature: No sites met state stream temperature criteria beneficial for salmonid use.
- Sediment: Metals (arsenic, cadmium, chromium, copper, lead and zinc) met freshwater sediment cleanup standards.
- Habitat: Substrate embeddedness for all sites fell into the "Marginal" and "Poor" stream condition category. All but one site had "Poor" BIBI scores with human disturbance index percentages > than 25. Sites with greater than 85% riparian cover had "Fair" BIBI scores. Sites with less than 85% riparian cover had "Poor" BIBI scores.

Why stream monitoring for stormwater management?

Stormwater management actions, implemented in Lower Columbia region under municipal stormwater permits, are intended to help reduce stormwater impacts to receiving waters. SAM's Lower Columbia Urban Streams (LCUS) monitoring provides a regional status assessment of selected streams in the permit coverage areas. Continued monitoring will eventually allow assessment of stream health trends. These assessments assist in evaluating whether collective stormwater and environmental management efforts are meeting state and regional goals to protect water quality and biota in streams. Current status of stream health in Clark County can be found in the 2020 Stream Health Report.

Stormwater runoff from urban and urbanizing areas is a major contributor to habitat and water quality degradation in small streams. Local jurisdictions throughout the Lower Columbia River region are increasing their stormwater management efforts to reduce flow volumes and pollutants. 2021 is the first year of a long-term regional evaluation of stream health that focuses on areas covered by municipal stormwater permits in the southwest Washington region, which include Clark and Cowlitz Counties; the Cities of Camas, Longview, Vancouver, Battle Ground, Kelso, and Washougal, and the Washington State Department of Transportation (WSDOT). The study is funded by the regional permittees, and Clark County is performing the study under an Interagency Agreement (IAA) with Ecology. This study will provide a better understanding of influential stressors contributing to impaired waters and overall stream health. Identifying stressors that impact hydrology and biological health may identify the most promising solutions to decrease the impacts of stormwater runoff to streams. Over time, results may detect changes in stream quality that indicate the effectiveness of stormwater management strategies. LCUS monitoring sites and associated drainage areas can be found in Appendix A.

Monitoring receiving water health indicators in urban/urbanizing areas

The LCUS study follows protocols developed for the on-going statewide stream health monitoring program Status and Trends Monitoring for Watershed Health and Salmon Recovery (WHSR) for physical habitat and biological measurements. In an attempt to better capture the stormwater related hydrologic and water chemistry changes, this study also monitors water level, temperature and conductivity continuously for one full water year at each targeted sampling site (Appendix B).

LCUS streams health status in 2021-2022

Total Impervious Area, or TIA, is a measure of the amount of hard surface and serves as an indicator of the potential impacts of urbanization and development on stream health. Impervious cover results in multiple stressors to a subwatershed, such as increased pollutant loads from stormwater runoff, altered stream flow, decreased bank stability, and increased water temperatures. The significance of this metric in reducing salmon recovery potential is based on the multiple impacts to the subwatershed as well as the nearly irreversible nature of imperviousness due to urbanization.

In terms of the subwatershed condition for TIA, all LCUS sites fell into the “Not Properly Functioning” (TIA > 10 - 20%) categories (EPA, 2018). This means that the subwatersheds of the LCUS study have too much impervious area for supporting watershed conditions that are healthy for macroinvertebrates and salmon. Another commonly used standard of < 10% TIA that is necessary to support healthy biota in streams is exceeded by all LCUS sites (Figure 1). TIA for LCUS subwatersheds ranged from 33 to 97 percent when all developed land cover categories were added together for each monitoring site’s drainage area.

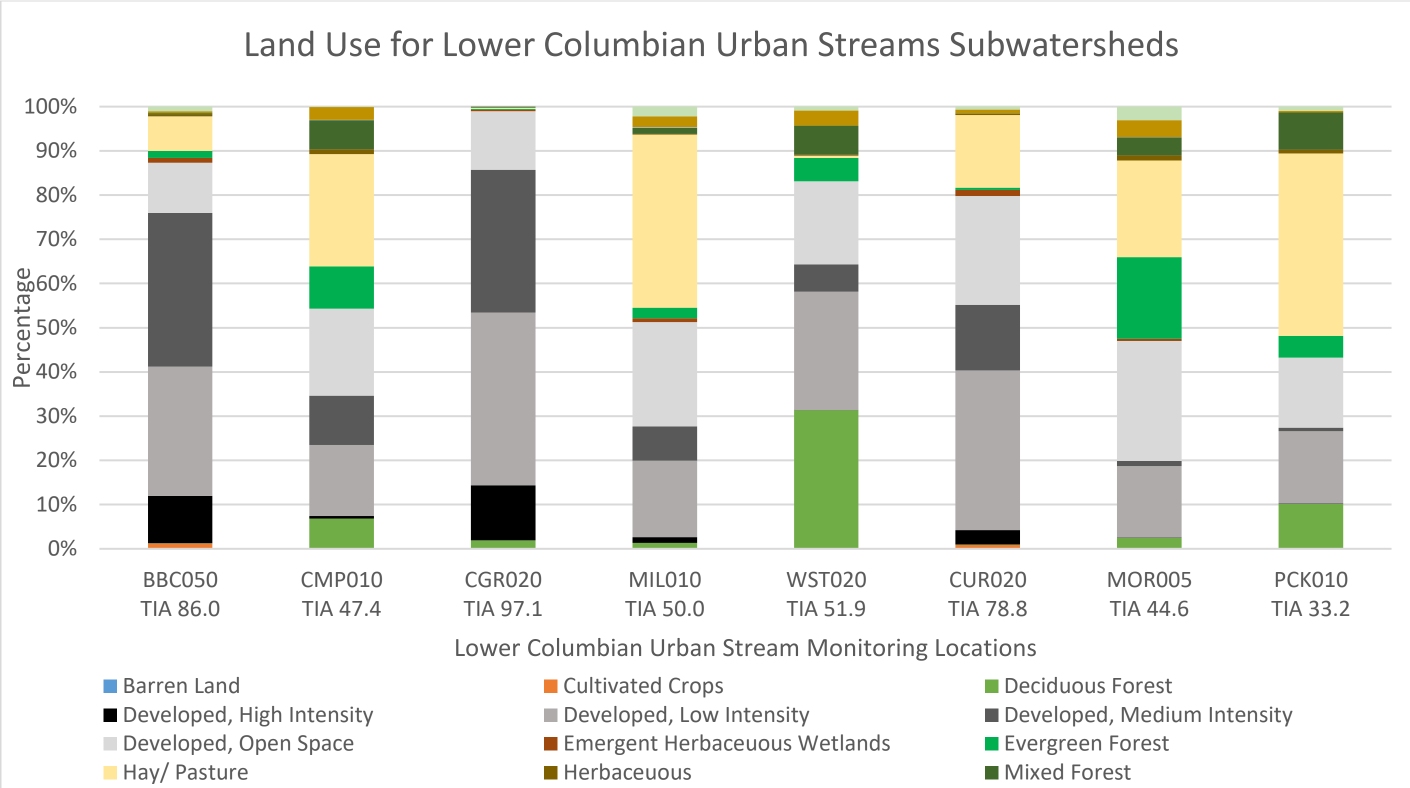


Figure 1. Land use for LCUS subwatersheds monitored for water year 2021, including Total Impervious Area (TIA %). Land cover data are derived from the 2016 National Land Cover Database (NLCD).

Flashiness, or frequency of high flows, of a stream is an important characteristic of the stream hydrologic regime that indicates likely presence of erosive flows and reflects how quickly and often flow in a waterbody increases and decreases during rainfall events. Urbanization is the primary cause of increased flashiness and hydrologic alterations. Increased stream flashiness in urban areas is typically a result of increased hardscape, soil compaction, and the increased hydraulic efficiency of traditional stormwater and flood management practices that are designed to quickly drain urban areas. Natural conditions may also contribute to stream flashiness. For example, regions with little attenuation of runoff, such as an area with clay soils or rock layers, typically have higher flashiness than areas with more permeable soils. (Schoonover et al., 2006). This LCUS study uses alternative interpretations of TQMean, Richard-Baker Index (RBI) and Flow Reversals based on continuous stage for analyses of flashiness of streams as defined in Figure 2. Konrad and Booth 2017, found that hydrologic metrics based on stage provide useful metrics of status and trends monitoring of urbanizing subwatersheds.

TQMean: The TQmean is the percent of days that stream stage is greater than the mean annual stage. Flashier streams have lower TQmean values.

RBI: Is a dimensionless index of stage oscillations relative to total flow, based on daily average stage measured per water year.

Flow reversals: The number of times that the stage rate changed from an increase to a decrease or vice versa during the year. Stage changes of less than 2% are not considered.

Figure 2. LCUS hydrology metric definitions derived from Booth and Konrad, 2017.

TQmean tends to decrease with increased urbanization and a value of less than about 0.27 is associated with non-supporting streams for salmon, while a TQmean of greater than 0.37 is associated with fully supporting streams (Clark County, 2022). All LCUS sites had a TQmean above 0.27. RBI and flow reversal values tend to increase with urbanization. An RBI value greater than 0.25 and a flow reversal value greater than 65 are typically associated with subwatershed that have a TIA greater than 20% (Booth and Konrad, 2017). Cougar Creek, at 97% TIA was the only site to have an RBI value greater than 0.25. Interestingly, Packard Creek at 33% TIA was the only LCUS site to have a flow reversal value greater than 65 (Table 1).

It appears that despite having all LCUS sites fall into the "Not Properly Functioning" (TIA > 15 - 20%) categories, the majority of the site hydrology may not be in the poor health category. Further analysis will be conducted in future monitoring years to identify regulating factors supporting site hydrology.

Table 1. Hydrology metrics of flashiness calculated by analyzing 15-minute continuous stage data.

Location Type	Stream Name	Location ID	Flow Metric Results (using stage as a surrogate for flow)		
			TQ mean	RBI	Reversals
Trend	Burnt Bridge Creek	BBC050	0.41	0.14	42
	Cougar Creek	CGR020	0.36	0.33	37
	Campen Creek	CMP010	0.39	0.21	39
	Mill Creek	MIL010	0.38	0.17	32
	Westover Creek	WST020	0.35	0.21	45
Status	Curtin Creek	CUR020	0.40	0.11	21
	Morgan Creek	MOR005	0.36	0.16	36
	Packard Creek	PCK010	0.37	0.25	70

Traffic intensity, as measured by vehicle trips per square mile (ADT), typically increases with urbanization and provides a robust urbanization metric. Traffic intensity is associated with both the level of urbanization and the presence of high traffic freeways and highways in rural areas. Low density urban residential areas tend to have much lower traffic and associated pollution than commercial, industrial and multifamily areas along arterial roadways.

Considering that much of the stormwater pollution in the MS4 comes from roads, traffic intensity is strongly associated with stormwater influence on streams in both urban and rural areas.

There is detailed estimated traffic count data for every road in Clark County, including cities, based on computer modeling by a regional transportation planning agency. The transportation model provides a detailed and uniform surrogate for potential stormwater impacts across Clark County. Figure 2 shows a general decreasing BIBI with increasing traffic intensity. It appears that BIBI scores in basins with an ADT value of 10,000 or greater typically fall into the "Poor" category. Considering that BIBI scores depend on a number of factors, including substrate and water quality, BIBI scores can be low in areas of low urbanization. However, BIBI scores are rarely better than poor in areas of intense urbanization.

All LCUS sites with an ADT greater than 10,000 fell into the "Poor" BIBI category (excludes Westover Creek with no ADT data). Sites with ADT less than 10,000 had "fair" BIBI scores.

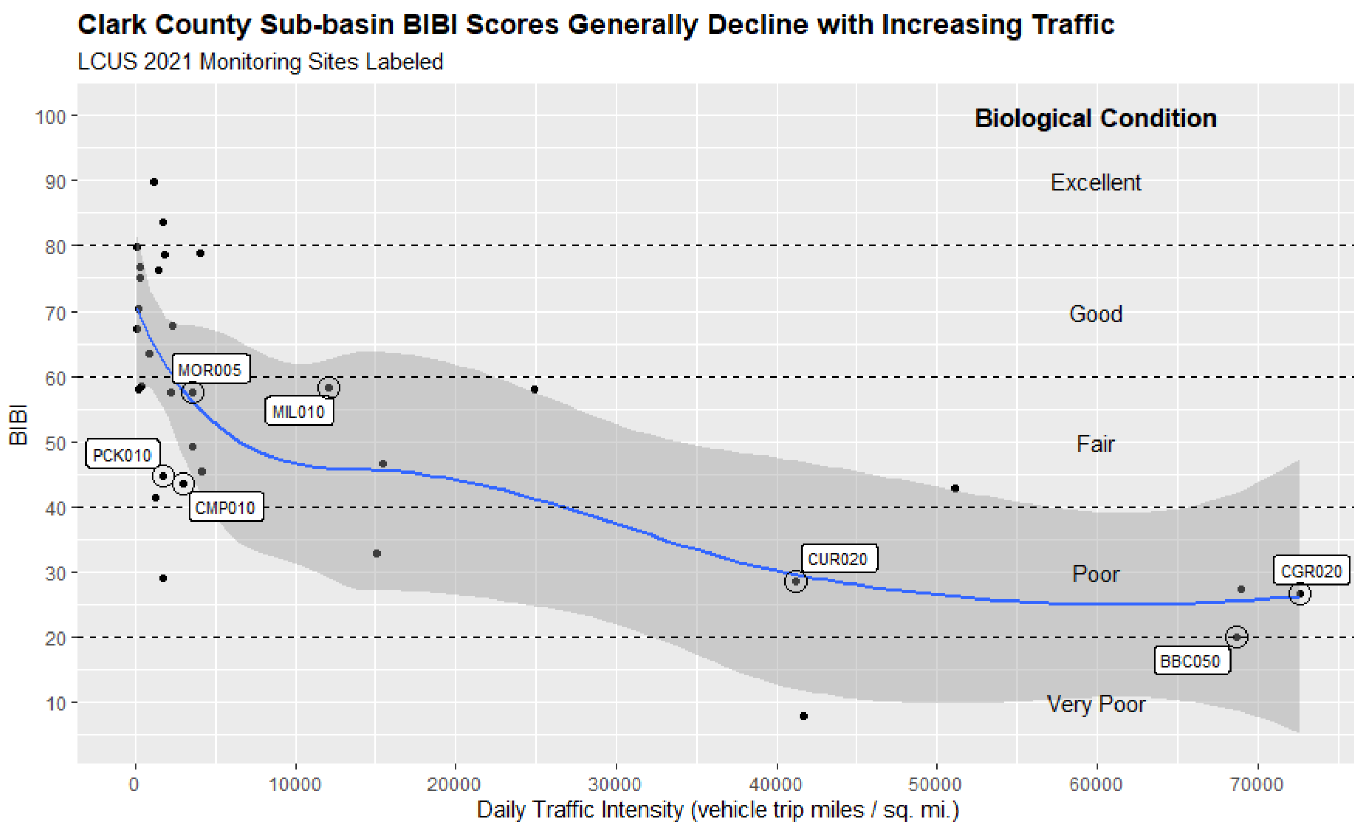


Figure 2. Comparison of available Clark County BIBI scores to sub-basin traffic intensity (Clark County, 2022).

Benthic macroinvertebrate communities provide a strong indicator of stream habitat quality and can be significantly influenced by changes to habitat associated with urban stream hydrology, water quality, embeddedness and stream temperature.

BIBI scores can also be a strong indicator of water quality problems that harm salmon. Two common problems are excessive temperature due to the lack of shade and toxic effects of urban stormwater runoff. Low BIBI scores can indicate factors other than hydrology that prevent a stream from supporting salmon and other sensitive aquatic life.

Clark County has used the BIBI score as a tool to quantify stream health for many years. Clark County stores all BIBI data in the Puget Sound Database (https://pugetsoundstreambenthos.org/) and has the original taxonomic counts converted to the 100-point system (Table 2). Streams having "Poor" BIBI scores (40 or less) are considered non-supporting for salmon habitat (Ecology, 1999). Four LCUS sites had a BIBI score of less than 40 (Table 3).

Table 2. BIBI Biological Condition Categories

Biological Condition	0 to 100 BIBI
Excellent	80 to 100
Good	60 to 80
Fair	40 to 60
Poor	20 to 40
Very Poor	0 to 20

Table 3. LCUS BIBI Scores.

	BBC050	CMP010	CGR020	MIL010	WST020	CUR020	MOR005	PCK010
BIBI Score	20	43	27	58	22	29	58	45
BIBI Catego	Very Poor	Fair	Poor	Fair	Poor	Poor	Fair	Fair

Taxa composition at all 2021 LCUS sites ranged from four to five on the EPA's Biological Condition Gradient (BCG). The BCG framework represents ecological conditions in terms of measurable ecological characteristics, or attributes, of an aquatic community in response to anthropogenic stressors (EPA, 2021).

A BCG range from four to five indicates that chemistry, habitat, and / or flow regime was altered from natural conditions. At the four to five BCG level, there are moderate changes in structure due to replacement of some sensitive ubiquitous taxa by more tolerant taxa (EPA, 2021). BIBI samples showed many more tolerant taxa, many taxa that are both lotic and lentic, and loss of sensitive taxa. This could be due in part macroinvertebrate populations showing stress from drought conditions (B. Wisseman, email message to Chad Hoxeng, May 5th, 2022).

Water temperatures have a large impact on the productivity and diversity of freshwater ecosystems. Anadromous species like salmon and steelhead require cool fresh waters throughout their life cycles (Figure 3).

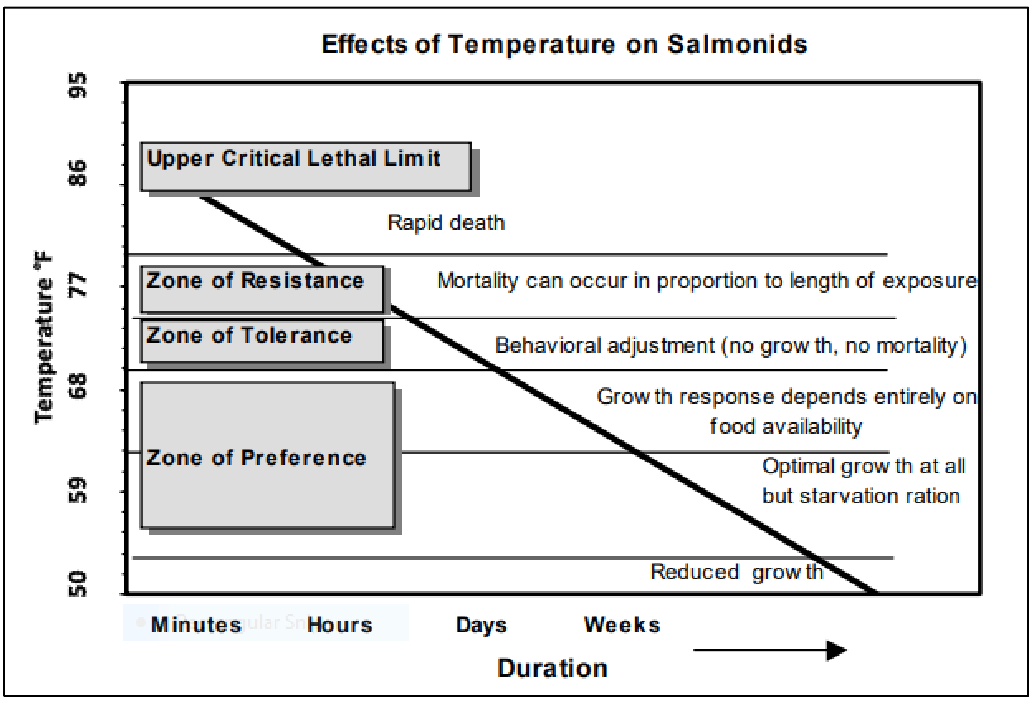


Figure 3. General biological effects of temperature on salmonids of the Pacific Northwest in relation to duration and magnitude of temperature (Sullivan et al. 2000).

Washington state aquatic life temperature criteria in freshwater to protect salmonids is based on the 7-day average of the daily maximum temperature (7-DADmax) measured from June 15 - September 15, or 93 days total monitoring period (Table 4).

No LCUS site met Washington State aquatic life temperature criteria for fresh water (Table 5). Seven out of the eight LCUS sites exceeded their Washington State aquatic life temperature criteria over 50 percent of the designated criteria period, suggesting that these streams are not supportive of salmonids.

Table 4. Washington State aquatic life temperature criteria in fresh water.

Category	Highest 7-DADMax
Char Spawning and Rearing	53.6°F
Core Summer Salmonid Habitat	60.8°F
Salmonid Rearing, and Migration Only	63.5°F
Salmonid Spawning, Rearing, and Migration	63.5°F
Nonanadromous Interior Redband Trout	64.4°F
Indigenous Warm Water Species	68.0°F

Table 5. Stream temperature (7-DADMax) of LCUS sites.

Location Type	Stream Name	Location ID	Max 7-DADMax	MaxDate	Max 7-DADDaily Difference	Max Date	Days >60.8	Days >63.5	Days >71.6	Days >73.4	Highest 7-DADMax Aquatic Life Criteria
Trend	Burnt Bridge Creek	BBC050	80.1	27-Jun-2021	10.7	27-Jun-2021	93	91.0	48.0	34.0	63.5
	Cougar Creek	CGR020	64.0	13-Aug-2021	5.2	25-Jul-2021	59	16.0	0.0	0.0	60.8
	Campen Creek	CMP010	73.6	28-Jun-2021	6.3	26-Jul-2021	92	77.0	13.0	4.0	63.5
	Mill Creek	MIL010	68.5	27-Jun-2021	5.0	26-Jun-2021	71	45.0	1.0	0.0	60.8
	Westover Creek	WST020	68.5	28-Jun-2021	4.7	19-Jun-2021	78	48.0	1.0	0.0	63.5
Status	Curtin Creek	CUR020	63.0	26-Jun-2021	5.8	26-Jun-2021	17	2.0	0.0	0.0	60.8
	Morgan Creek	MOR010	74.3	28-Jun-2021	7.4	26-Jun-2021	84	67.0	8.0	4.0	60.8
	Packard Creek	PCK010	70.7	27-Jun-2021	6.0	19-Jun-2021	85	65.0	3.0	1.0	63.5

Streambed sediment samples were collected once during the summer of 2021 from the stream substrate at all LCUS sites. Sieved sediment samples were analyzed for metals and organic contaminants, including PAHs and total organic carbon. Metals were detected at every site and were below freshwater sediment cleanup objectives. PAHs were detected at six of the eight LCUS monitoring locations. Naphthalene was the most common PAH detected and was found at five sites. BBC050 had the majority of highest PAHs values. LCUS sediment data can be found in Ecology's Environmental Information Management (EIM) database at https://ecology.wa.gov/Research-Data/Data-resources/Environmental-Information-Management-database.

Excessive fine-grained sediment in streams, as measured by embeddedness or the amount of fine sediment in gravel beds, has adverse effects on the biota that inhabit streams (Figure 4). Embeddedness for LCUS sites ranged from 55 to over 88 percent falling into the marginal and poor stream condition category (Table 6).

Habitat Parameter	Condition Category			
	Optimal	Suboptimal	Marginal	Poor
2.a Embeddedness (high gradient)	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.	Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment.	Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment.
SCORE ___	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

2a. Embeddedness--High Gradient

Figure 4. Embeddedness stream habitat embeddedness condition category (Environmental Protection Agency, 1998).

Table 6. Percent embeddedness for LCUS sites based on 121 in stream measurements.

Habitat Parameter	BBC050	CMP010	CGR020	MIL010	WST020	CUR020	MOR005	PCK010
Embeddedness	88	86	67	55	89	100	65	67

Human disturbance activities, such as vegetation removal, road building, construction near streambanks, litter and more are physical habitat stressors to streams and can negatively affect fish, macroinvertebrates, as well as human uses of the waterbody. Measuring the extent and intensity of human disturbance of streams using Watershed Health Monitoring Protocols gives an indication of the impact of human activities on the natural environment. All but one LCUS site (CUR020), had a "Poor" BIBI score with all having a human disturbance percentage greater than 25.

Riparian vegetation and cover are extremely important for healthy streams because of the many functions it serves including bank stabilization, fish habitat, food chain support, thermal cover and flood control. LCUS sites with greater than 85 percent riparian cover had "fair" BIBI scores and sites with less than 85 percent had "poor" BIBI scores.

Stream health changes over time: Are they improving?

Over time, the Southwest Washington Permittees and Ecology will use this study to track stream conditions as they may relate to stormwater management impacts on streams and evaluate overall and long-term effectiveness of municipal stormwater permits, land use changes and environmental regulations.

What in this year's findings are important for stormwater management?

As we continue to track regional conditions and identify key stressors impairing stream health, local officials and stormwater managers will be able to compare stream conditions and help prioritize and focus stormwater management practices. State and local agencies can use this information to develop regional protection, restoration strategies and evaluate the effectiveness of those programs.

Stormwater managers should review Table 7, determine what combinations of the key stressors are present in their jurisdictions, and then consider adjusting their management programs to address these stressors. Continued monitoring of trend and status site conditions will help establish reasonable expectations for good and poor biological conditions and help identify important stressors.

Table 7. List of important stressors identified in the LCUS study that effect overall stream health.

LCUS Summary Findings for WY2021
Imperviousness in all monitored subwatersheds are in the "Not Properly Functioning" category.
Most flow metrics are supportive of salmonid use.
BIBI taxa assemblages showed severe stress from drought.
No site met state stream temperature criteria beneficial for salmonid use.
Metals were below freshwater sediment cleanup standards.
Embeddedness for all sites fell into the “Marginal” and “Poor” category
Streams with human disturbance above 25 percent tend to have a "Poor" BIBI score.
Riparian cover less than 85 percent resulted in "Poor" BIBI scores.

Next step

The LCUS study design includes trend sites that will be monitored yearly and status sites that will be sampled at five-year intervals.

Reporting will include annual assessment of stressors that effect overall stream health. Over time, this study will provide enough data to categorize LCUS streams in good, fair, or poor condition. Trend analyses and risk assessments will be conducted every five years to identify the key stressors causing poor stream conditions in the region.

The long-term goals of the study are: to evaluate the status and trends of water quality and hydrology in surface waters draining subwatersheds primarily within urban and urbanizing areas under the jurisdiction of NPDES municipal stormwater permittees; and to evaluate the status and trends of in-stream biological health, sediment quality and in-stream/riparian habitat conditions that are primarily within urban and urbanizing areas under the jurisdiction of NPDES municipal stormwater permittees.

Data are available on EIM database with Study ID SAM_LCU.
Additional results are published in the Appendix.
For more information: SAM status & trends webpage

References

Baker, D. B., Richards, R. P., Loftus, T. T., & Kramer, J. W. (2004). A new flashiness index: Characteristics and applications to Midwestern Rivers and streams. Journal of the American Water Resources Association, 40, 503–522. https://doi.org/10.1111/j.1752- Beecher, H. A., Caldwell, B. A., DeMond, S. B., Seiler, D.

Booth, D. and C.P. Konrad. 2017. Hydrologic metrics for status-and trend monitoring in urban and urbanizing watersheds. Hydrological processes 31: 4507-4519.

Clark County, 2022. Clark county Watershed Inventory, Sub-Basin Prioritization and Catchment Selection for Stormwater Planning.

DeGasperi, C.L., Berge, H.B., Whiting, K.R., Burkey, J.J., Cassin J.L., Fuerstenberg, R.R. 2009. Linking hydrologic alteration to biological impairment in urbanizing streams of the Puget Lowland, Washington, USA. Journal of the American Water Resources Association, 45:512-533.

Ecology, Washington State Department of Ecology, 1999. The Relationship Between Stream Macroinvertebrates and Salmo in the Quilceda/Allen Drainage. https://apps.ecology.wa.gov/publications/documents/99311.pdf

Environmental Protection Agency (EPA) 2021. The Biological Condition Gradient (BCG). A model for Interpreting Anthropogenic Stress on the Aquatic Environment. https://www.epa.gov/sites/default/files/2021-03/documents/bcg-flyer-2021.pdf

Environmental Protection Agency (EPA) 2018. Per cent of Stream and Shoreline with 15% or More Impervious Cover within 30 Meters. https://enviroatlas.epa.gov/enviroatlas/DataFactSheets/pdf/ESN/Percstreamw15percentimperviousin30meters.pdf

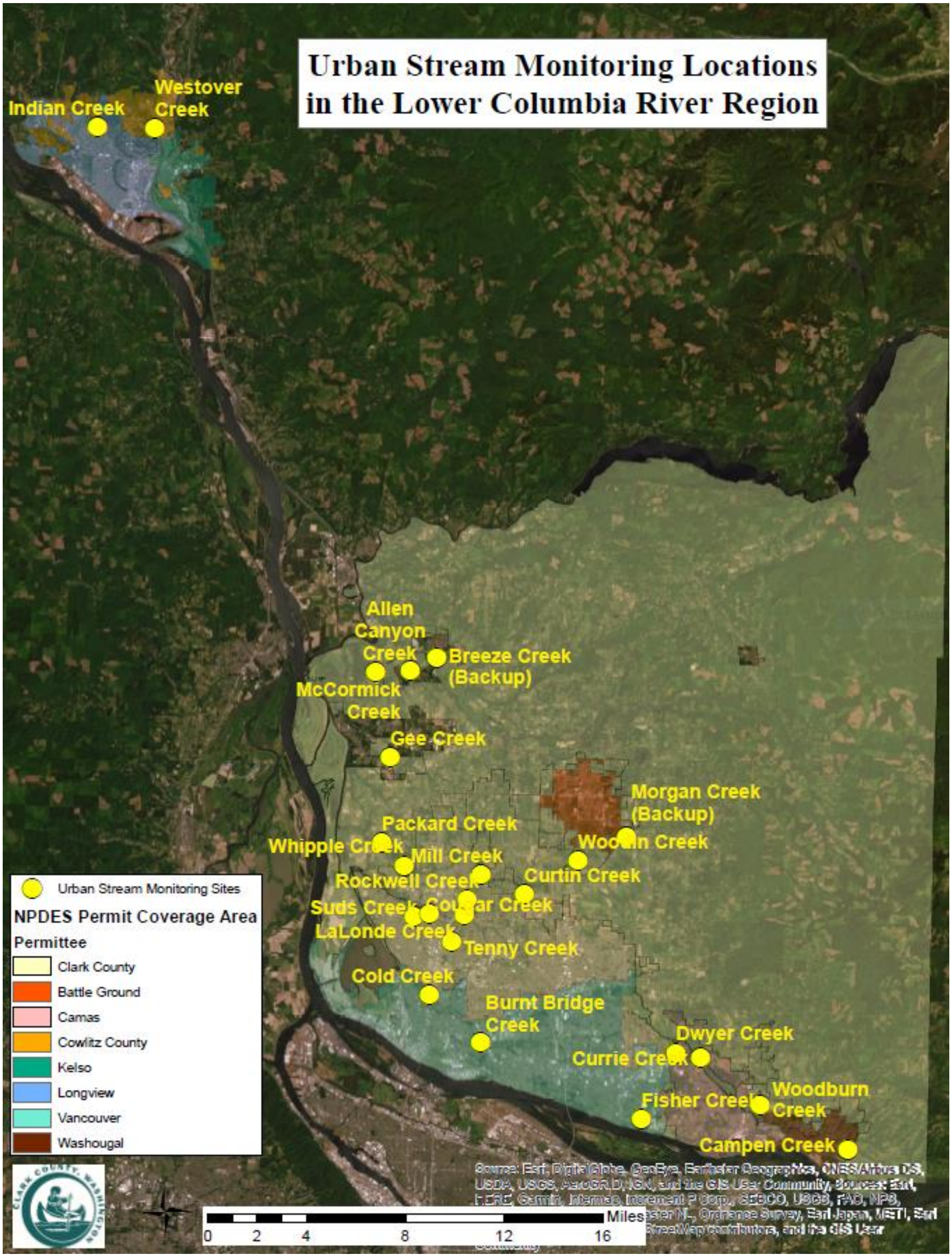
Environmental Protection Agency (EPA) 1998. Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates, and Fish Second Edition. https://www3.epa.gov/region1/npdes/merrimackstation/pdfs/ar/AR-1164.pdf

Konrad, C. P., Brasher, A. M. D., & May, J. T. 2008. Assessing streamflow characteristics as limiting factors on benthic invertebrate assemblages in streams across the western United States. Freshwater Biology, 53, 1983–1998. https://doi.org/10.1111/j.1365-2427.2008. 02024.x

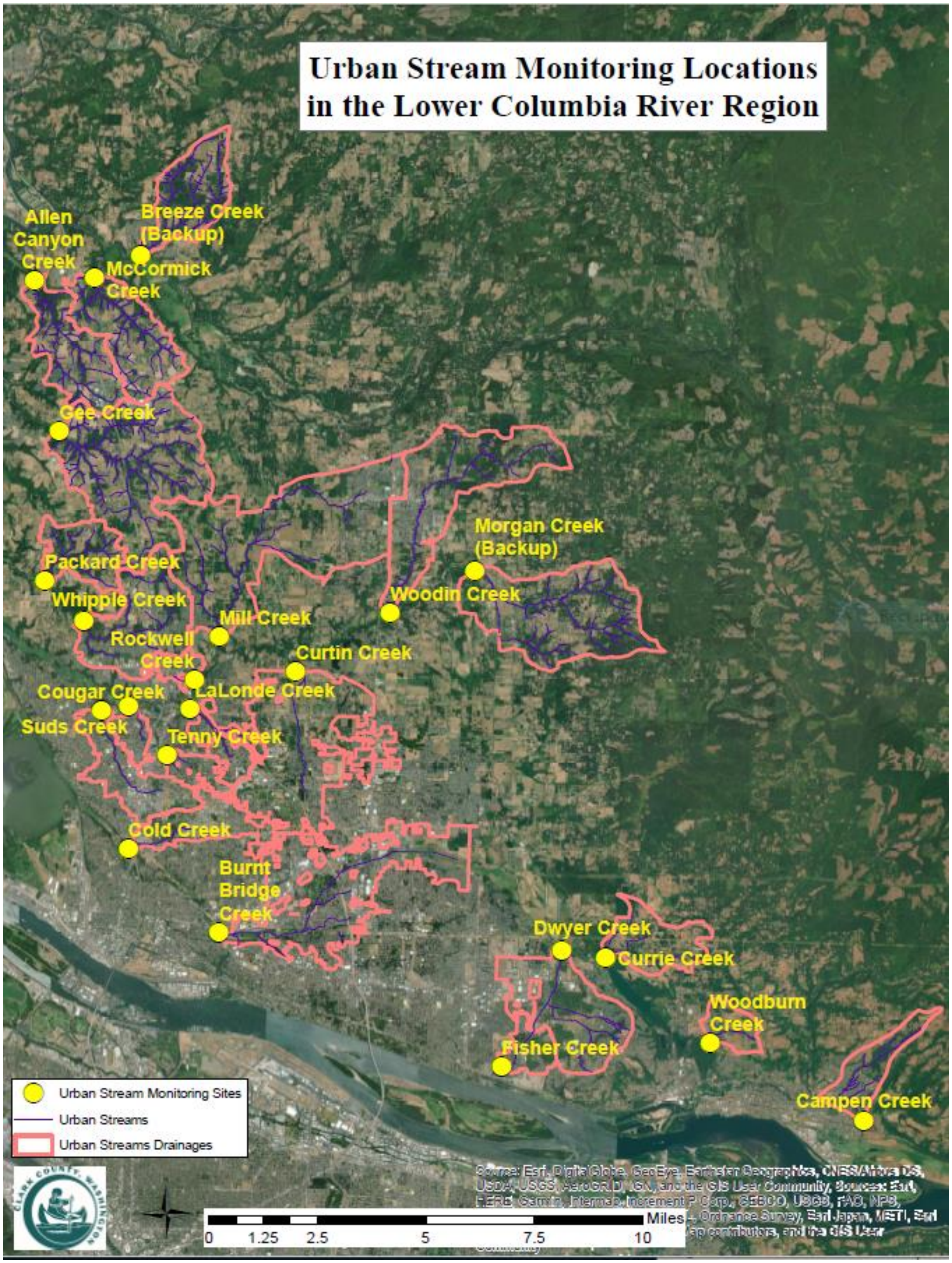
Schoonover, J., B. Lockaby and B. Helms. 2006. Impacts of Land Cover on Stream Hydrology in the West Georgia Piedmont, USA. J. Environ. Qual. 35: 2123-2131.

Sullivan, K., Martin, D., Cardwell, R., Toll, J and Duke S., 2000. An Analysis of the Effects of Temperature on Salmonids of the Pacific Northwest with Implications for Selecting Temperature Criteria. http://ww.w.krisweb.com/biblio/gen_sei_sullivanetal_2000_tempfinal.pdf

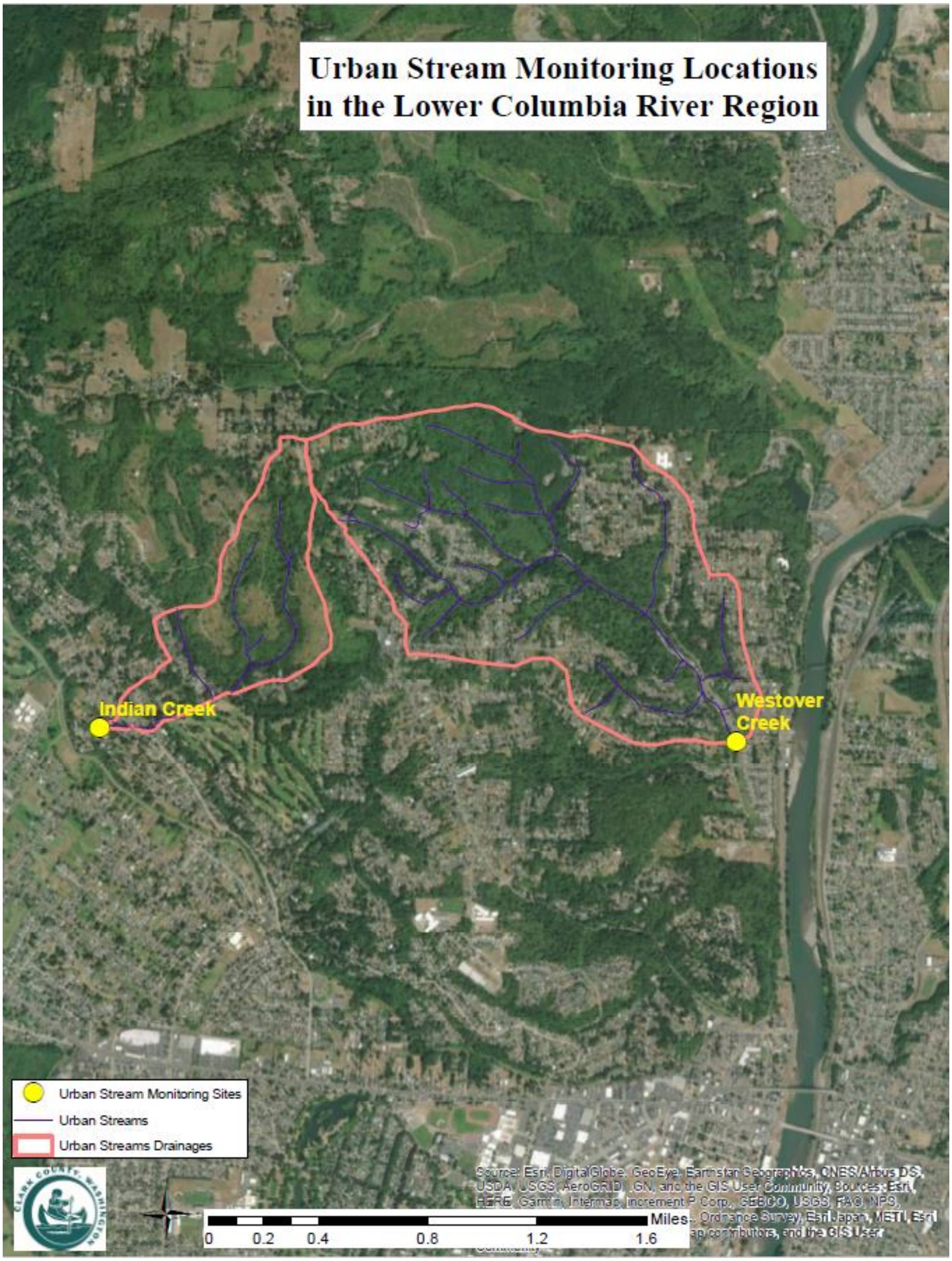
Appendix A. LCUS permittee areas, monitoring sites and associated drainage areas.



Map of urban stream monitoring locations and study boundaries in the Lower Columbia River Basin.



Map of urban stream monitoring locations and associated drainage catchments in Clark County.



Map of urban stream monitoring locations and associated drainage catchments in Cowlitz County.

Appendix B. Continuous time series data (conductivity, stage and temperature) for LCUS sites for water year 2021.

AQUARIUS Time-Series

Aquatic Informatics Data Management Software
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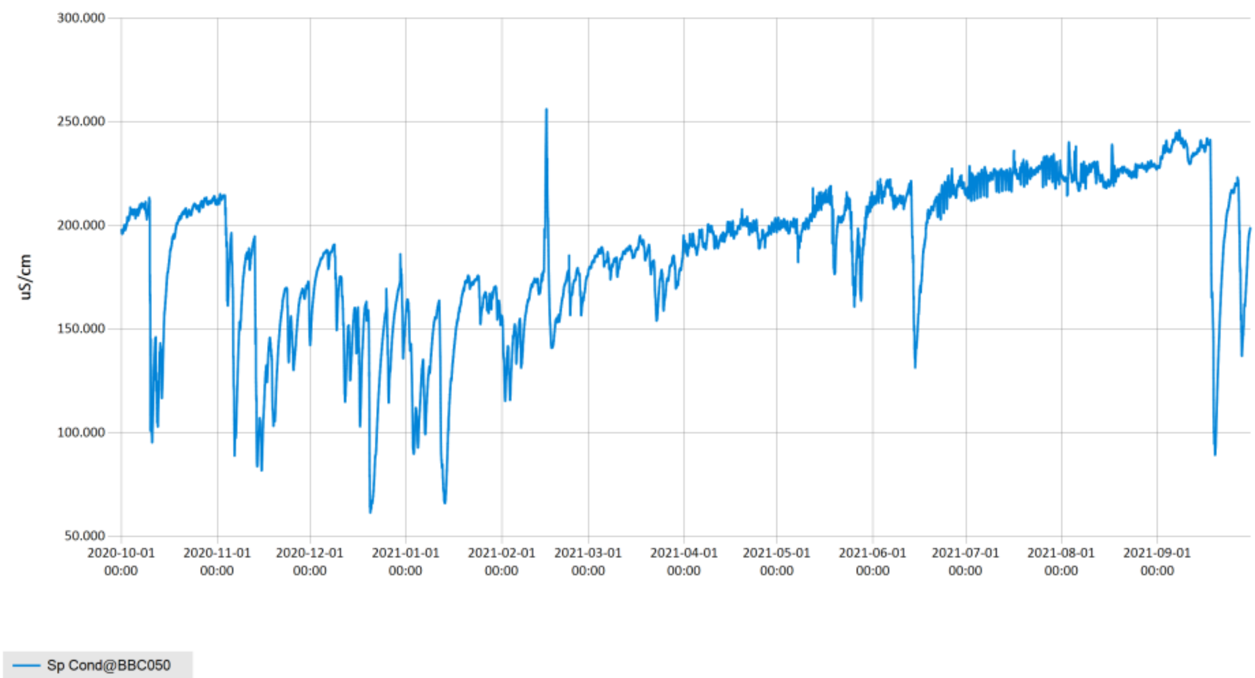
Time Series Data Report
15-minute Sp Cond (µs/cm) at Burnt Bridge Creek (BBC050) Water Year 2021

Jun 17, 2022 | 1 of 1

Period Selected: 2020-10-01 00:00 - 2021-09-30 23:59 UTC Offset: -08:00



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Time Series Data Report
15-minute Sp Cond (µs/cm) at Campen Creek (CMP010) Water Year 2021

Jun 17, 2022 | 1 of 1

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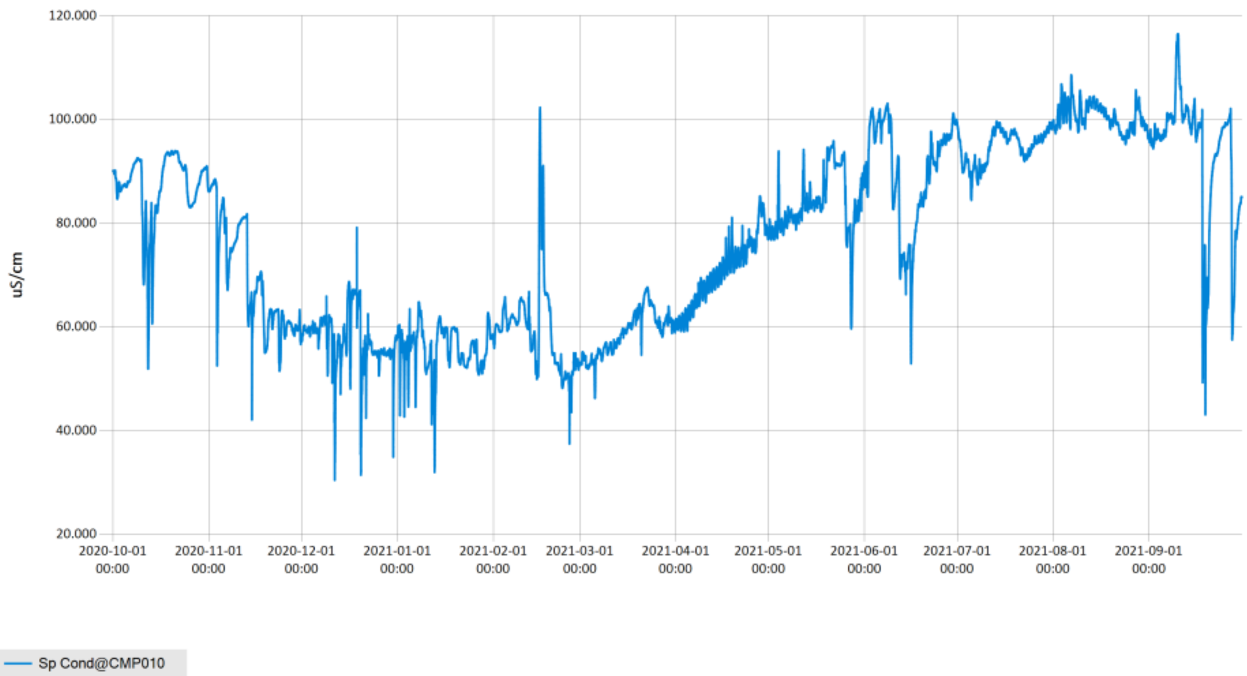

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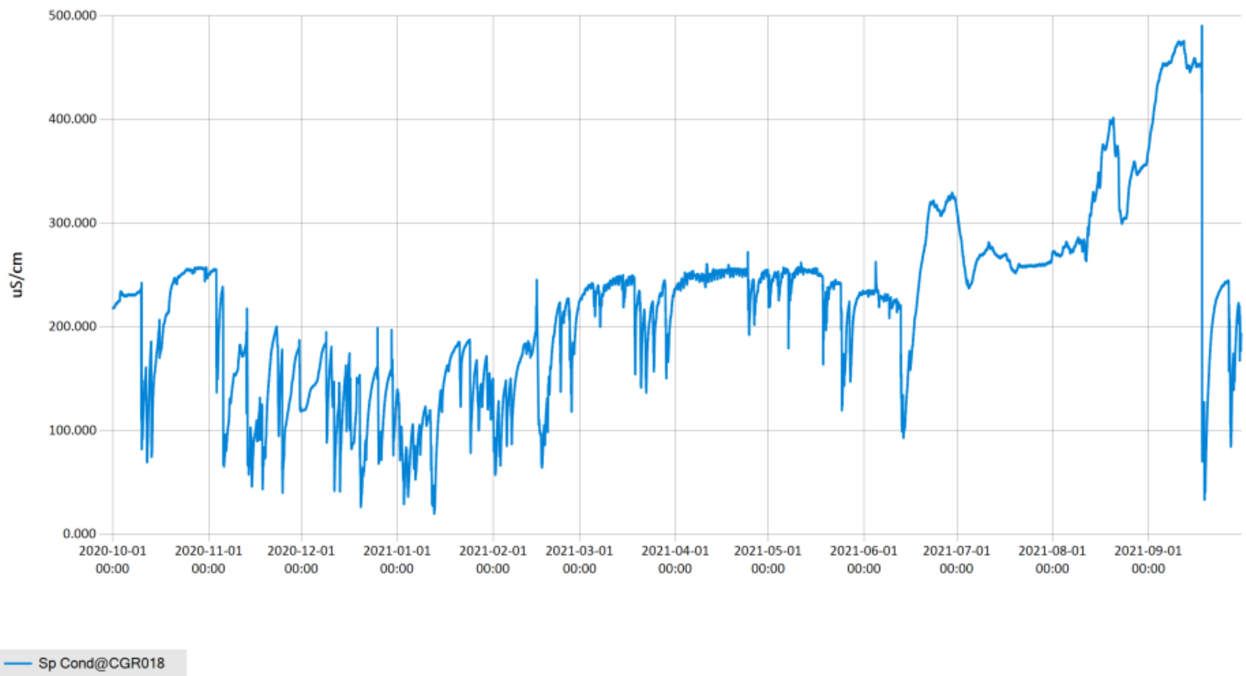

Time Series Data Report
15-minute Sp Cond (µs/cm) at Curtin Creek (CUR020) Water Year 2021

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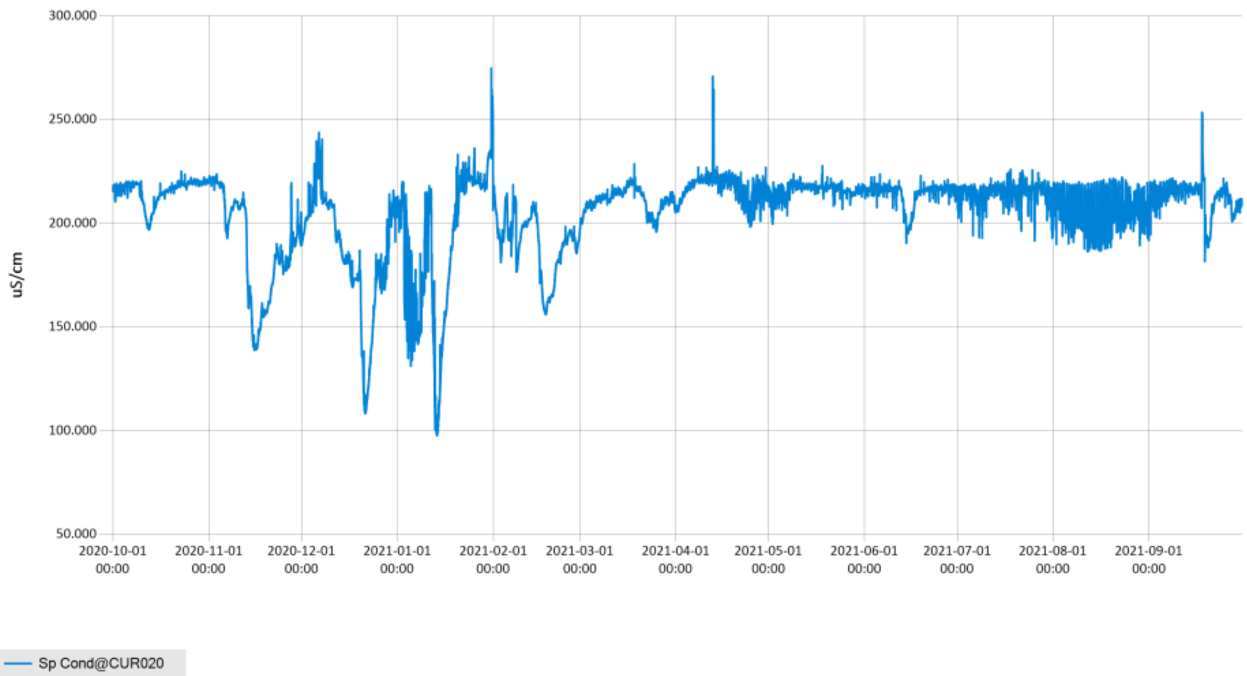

Time Series Data Report
15-minute Sp Cond (µs/cm) at Mill Creek (MIL010) Water Year 2021

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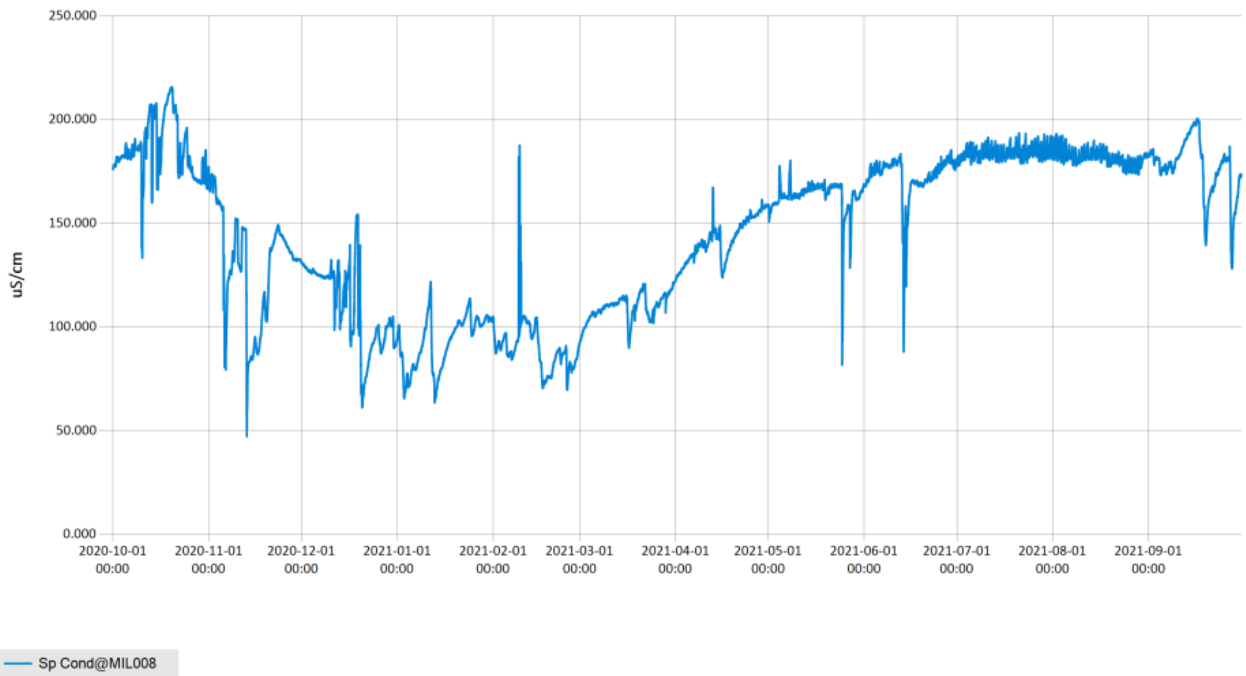

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Time Series Data Report
15-minute Sp Cond (µs/cm) at Morgan Creek (MOR005) Water Year 2021

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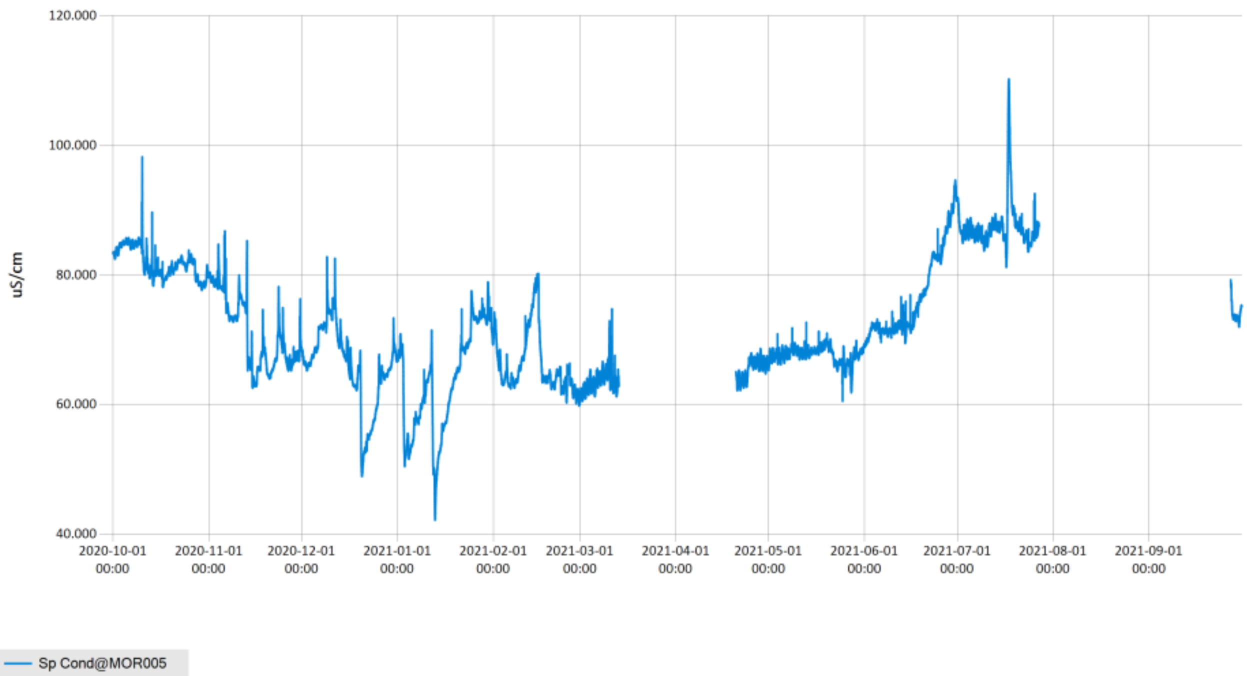

Time Series Data Report
15-minute Sp Cond (µs/cm) at Packard Creek (PCK010) Water Year 2021

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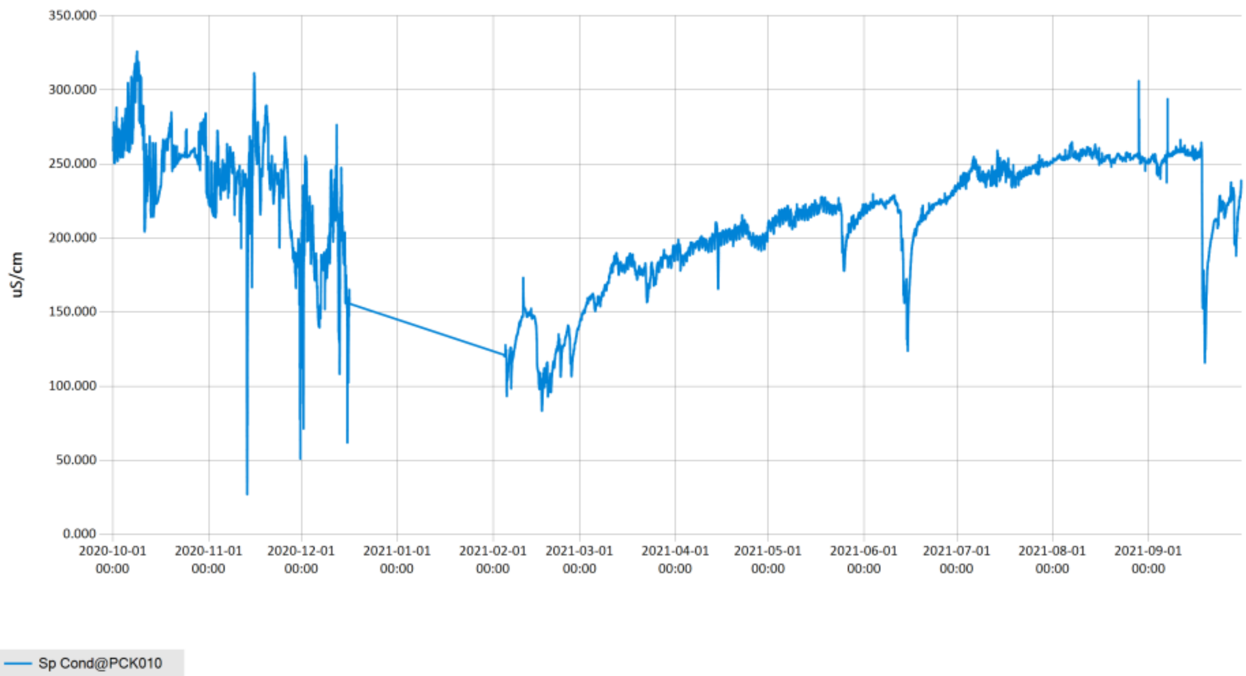

Time Series Data Report
15-minute Sp Cond (µs/cm) at Westover Creek (WST020) Water Year 2021

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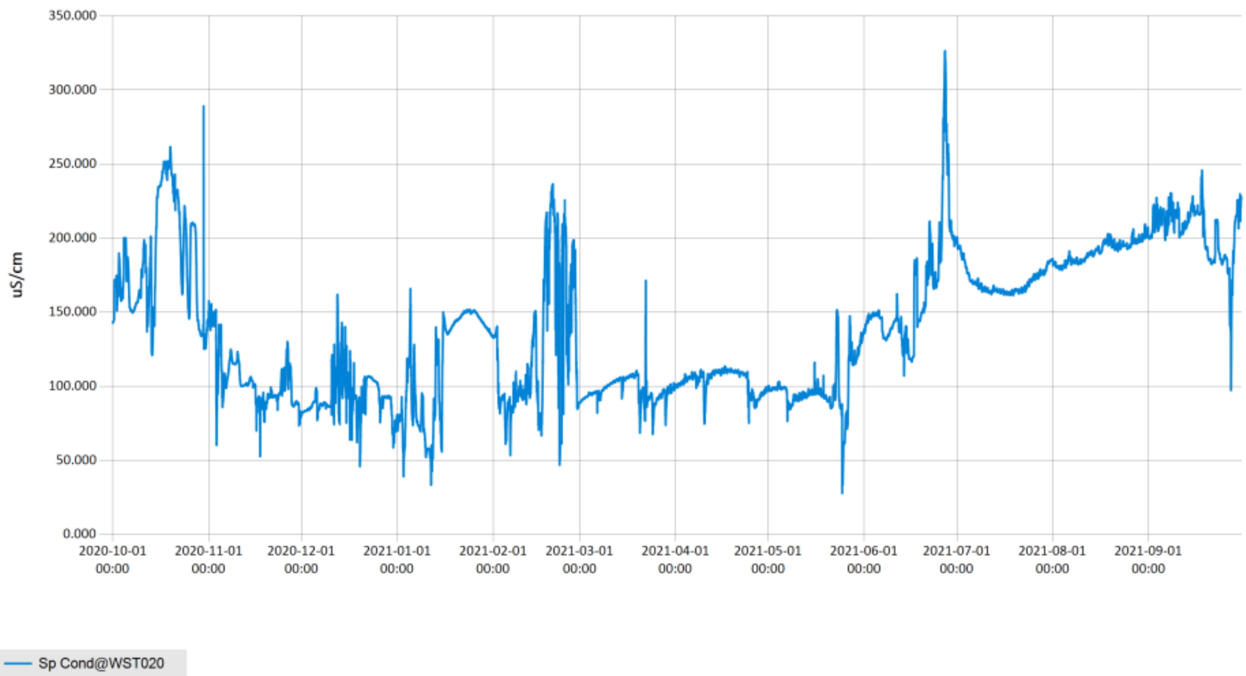

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Time Series Data Report
15-minute Stage (ft.) at Burnt Bridge Creek (BBC050) Water Year 2021

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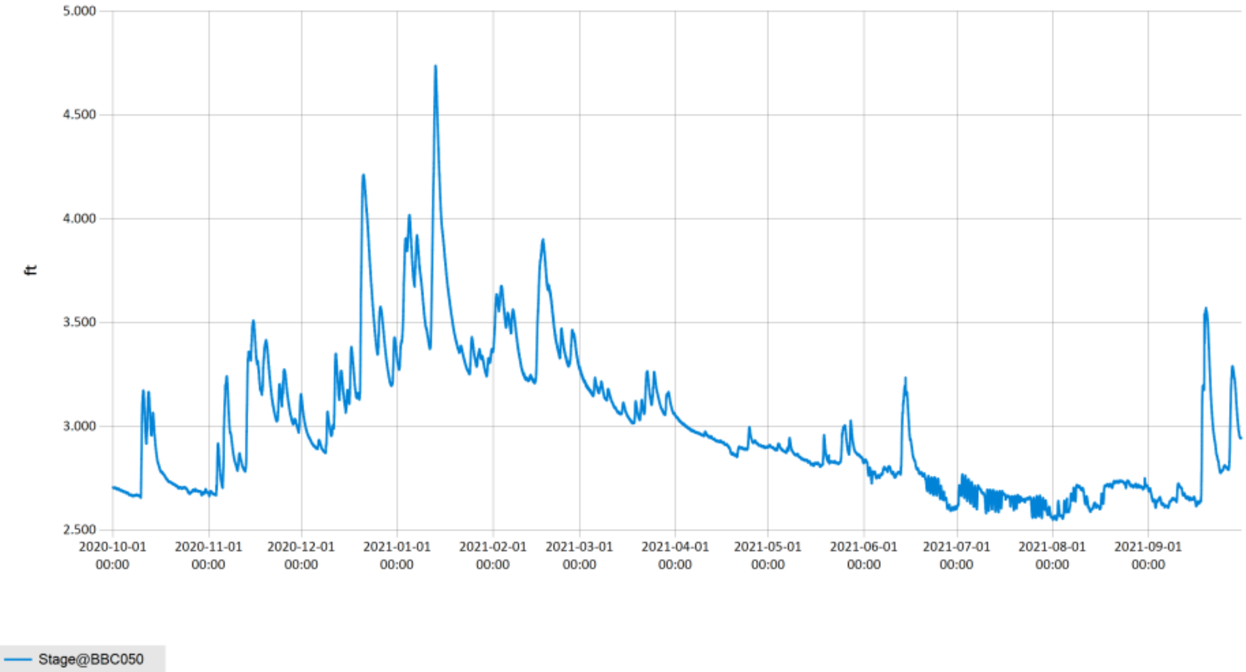
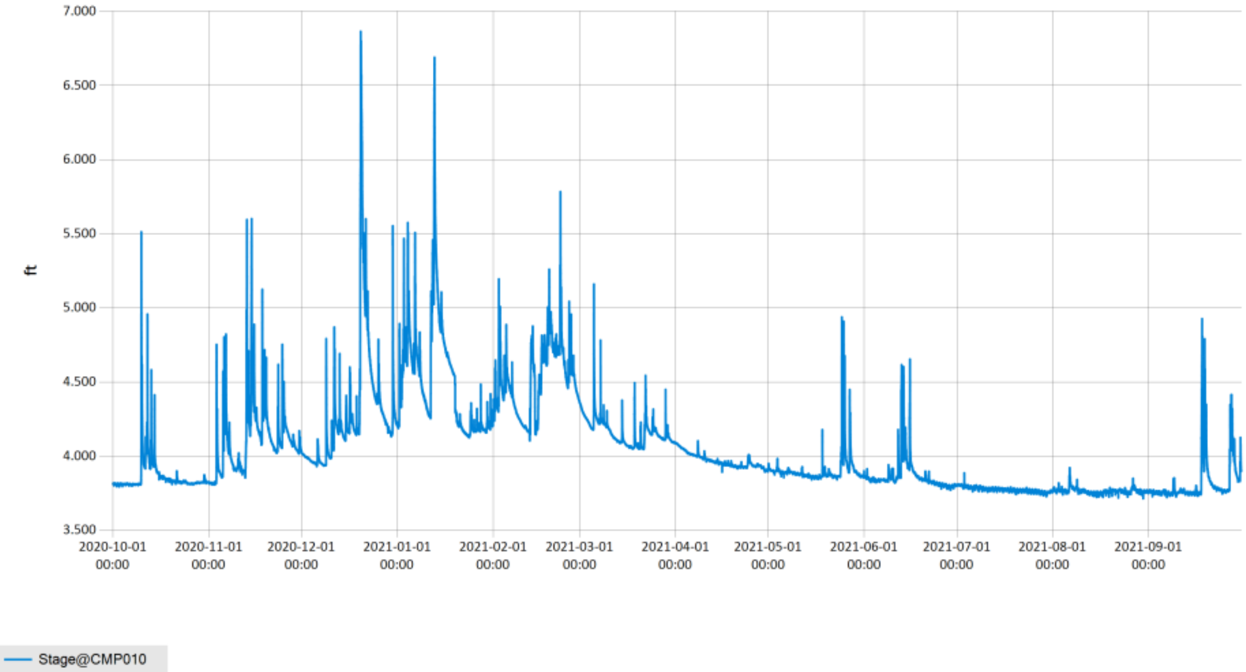


Time Series Data Report
15-minute Stage (ft.) at Campen Creek (CMP010) Water Year 2021

Jun 17, 2022 | 1 of 1

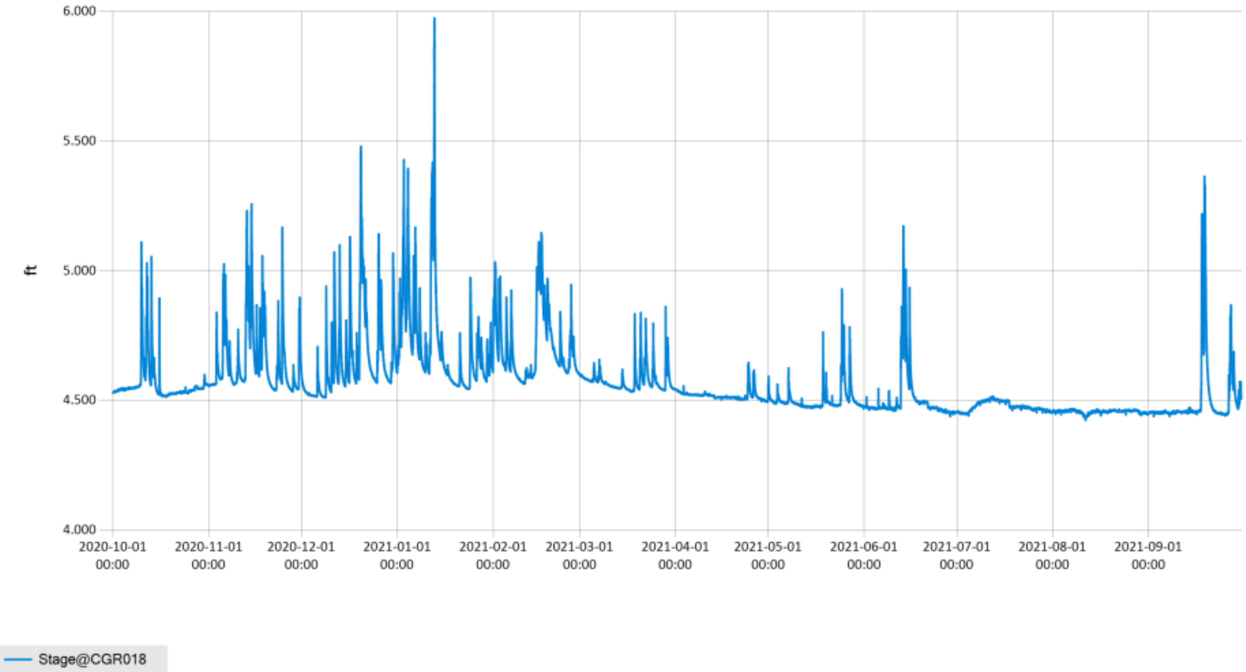
Period Selected: 2020-10-01 00:00 - 2021-09-30 23:59 UTC Offset: -08:00



Time Series Data Report
15-minute Stage (ft.) at Cougar Creek (CGR020) Water Year 2021

Jun 17, 2022 | 1 of 1

Period Selected: 2020-10-01 00:00 - 2021-09-30 23:59 UTC Offset: -08:00



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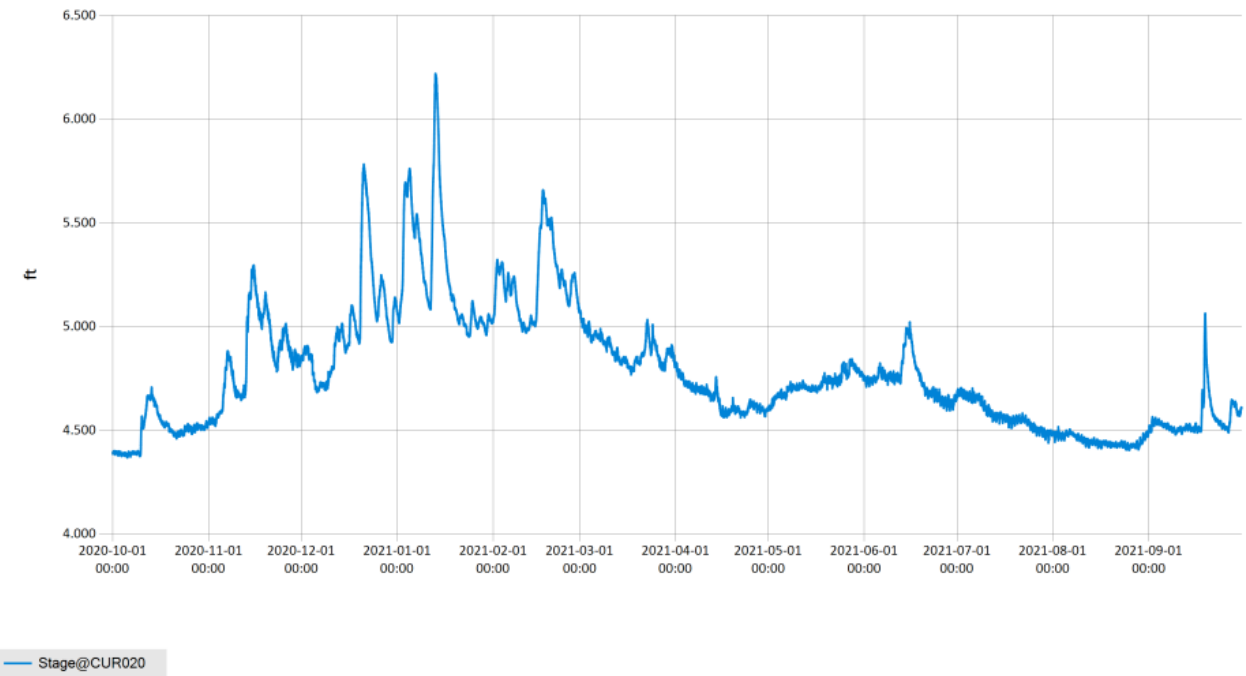
Time Series Data Report
15-minute Stage (ft.) at Curtin Creek (CUR020) Water Year 2021

Period Selected: 2020-10-01 00:00 - 2021-09-30 23:59 UTC Offset: -08:00



AQUARIUS Time-Series

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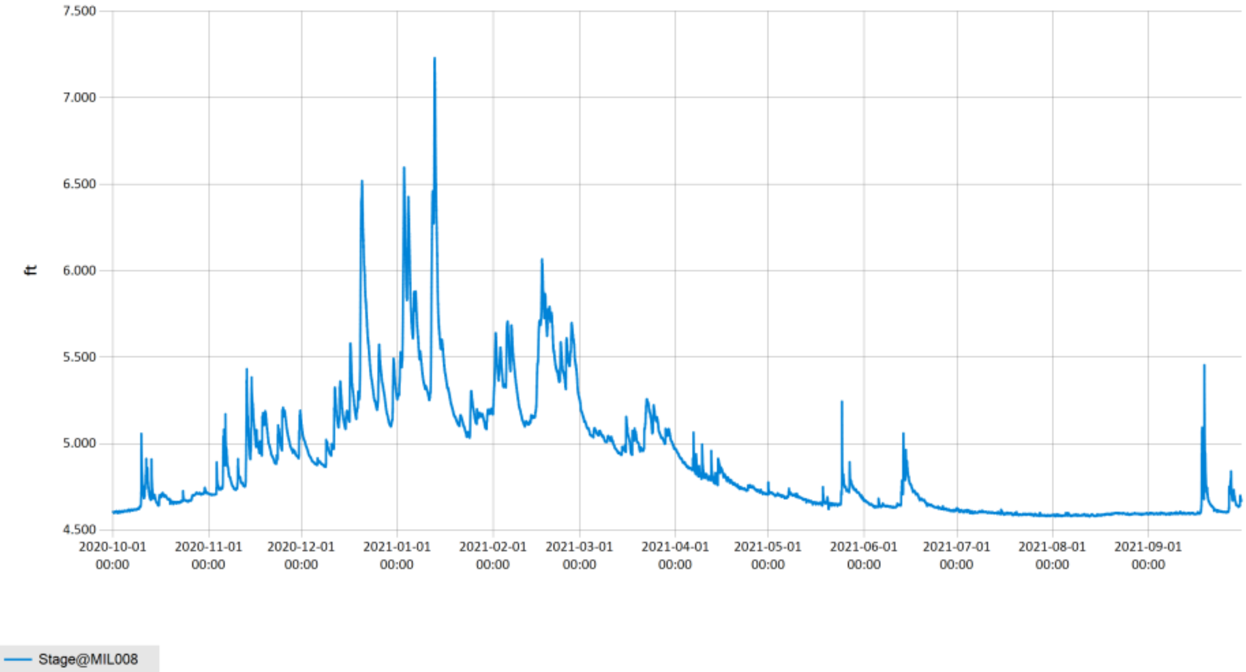
Time Series Data Report
15-minute Stage (ft.) at Mill Creek (MIL010) Water Year 2021

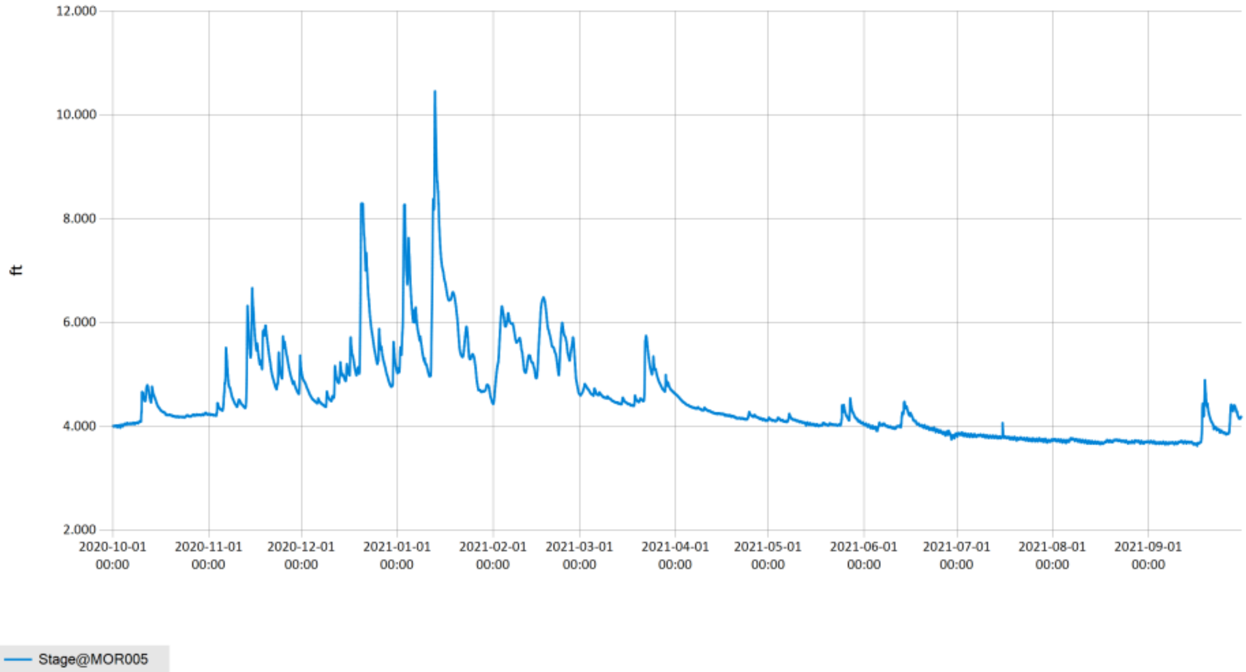
Period Selected: 2020-10-01 00:00 - 2021-09-30 23:59 UTC Offset: -08:00



Time Series Data Report
15-minute Stage (ft.) at Morgan Creek (MOR005) Water Year 2021

Jun 13, 2022 | 1 of 1

Period Selected: 2020-10-01 00:00 - 2021-09-30 23:59 UTC Offset: -08:00



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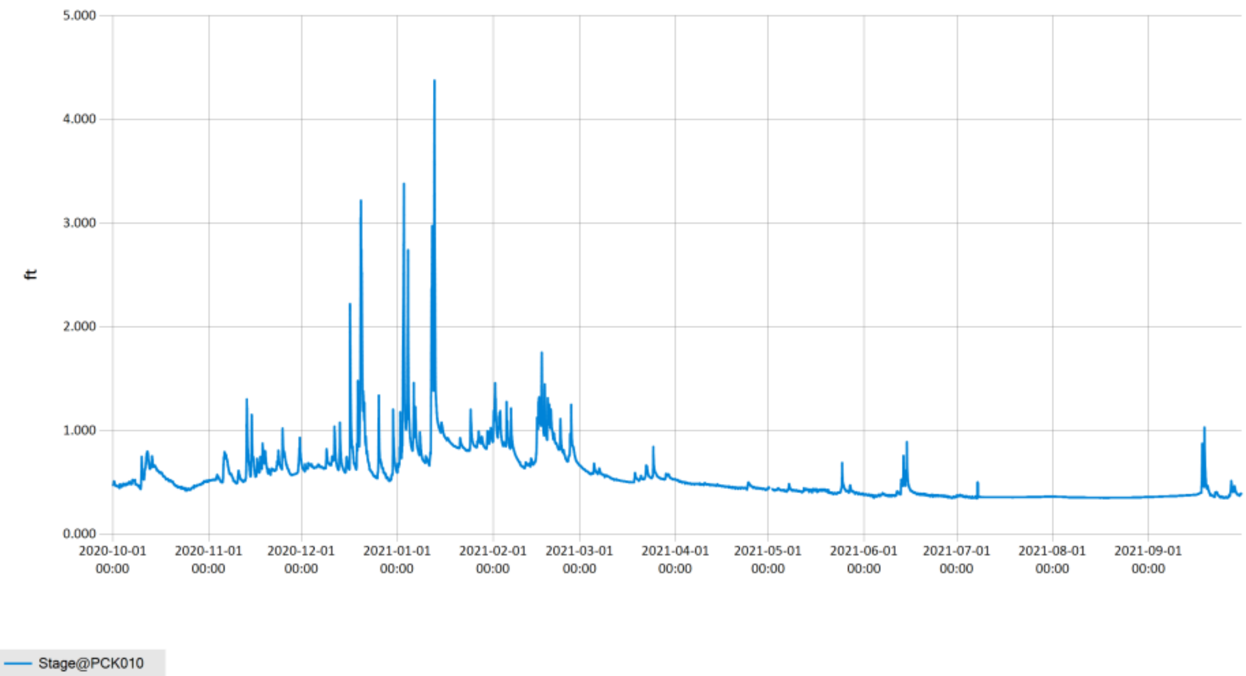
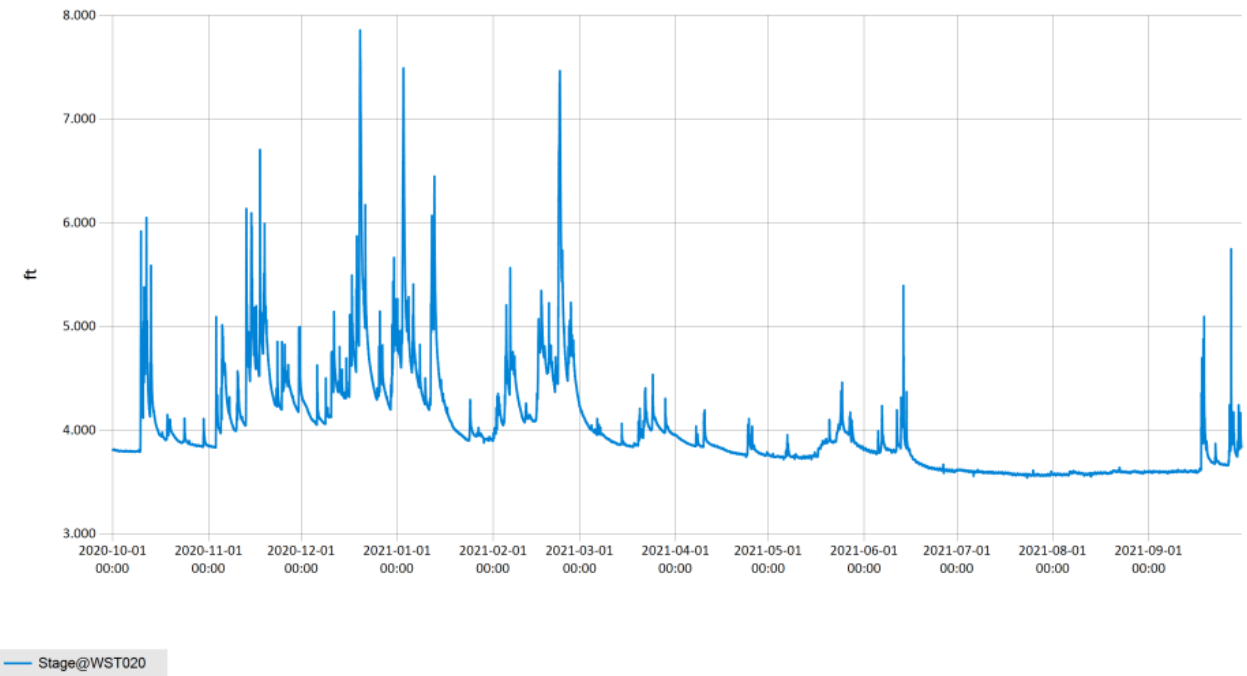
Time Series Data Report
15-minute Stage (ft.) at Packard Creek (PCK010) Water Year 2021

Period Selected: 2020-10-01 00:00 - 2021-09-30 23:59 UTC Offset: -08:00



Time Series Data Report
15-minute Stage (ft.) at Westover Creek (WST020) Water Year 2021

Period Selected: 2020-10-01 00:00 - 2021-09-30 23:59 UTC Offset: -08:00



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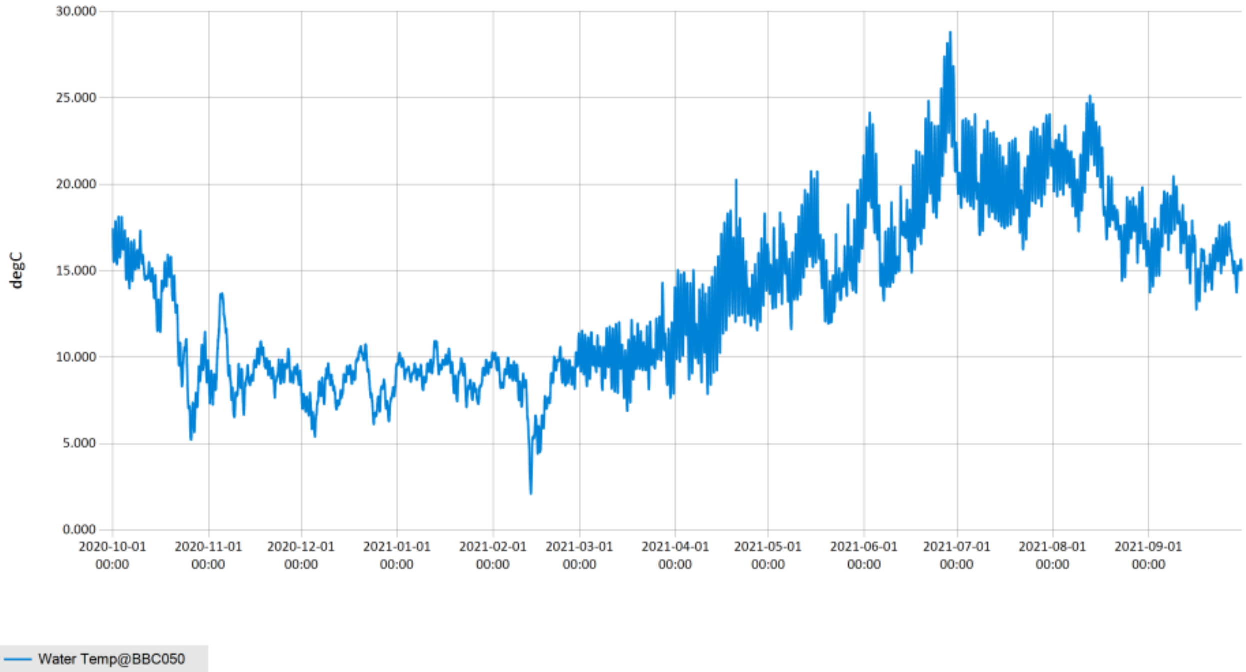
Time Series Data Report
15-minute Water Temp (deg C) at Burnt Bridge Creek (BBC050) Water Year 2021

Period Selected: 2020-10-01 00:00 - 2021-09-30 23:59 UTC Offset: -08:00



AQUARIUS Time-Series

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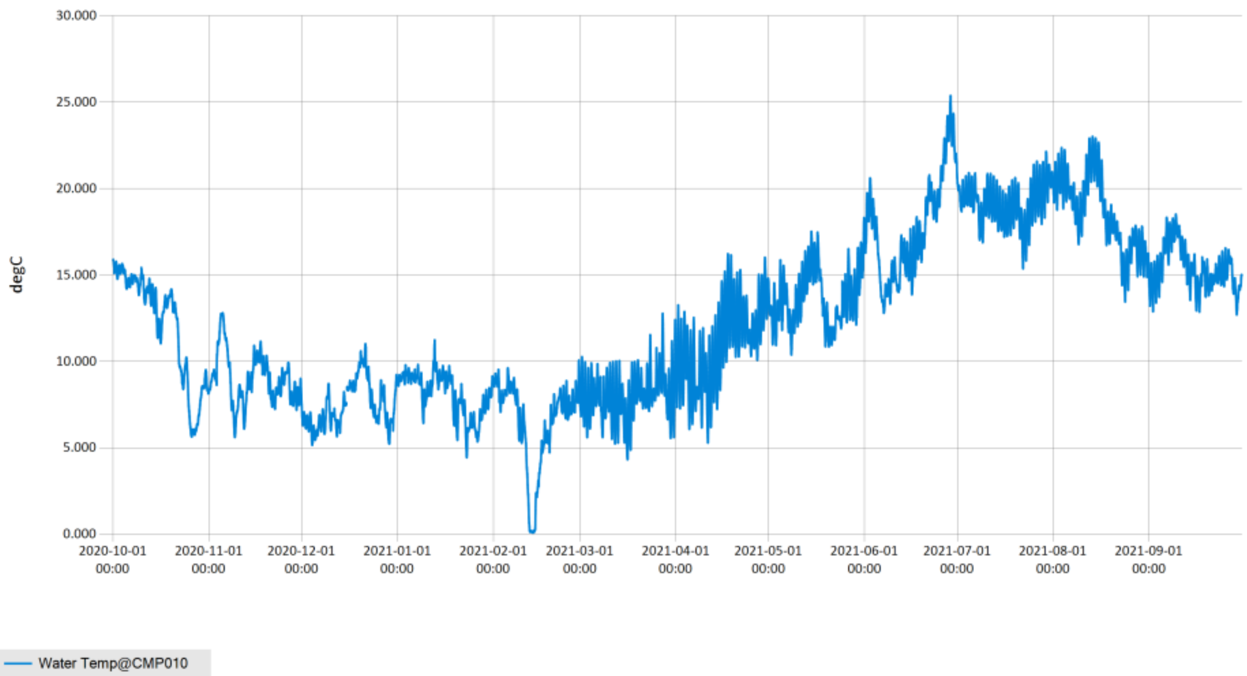
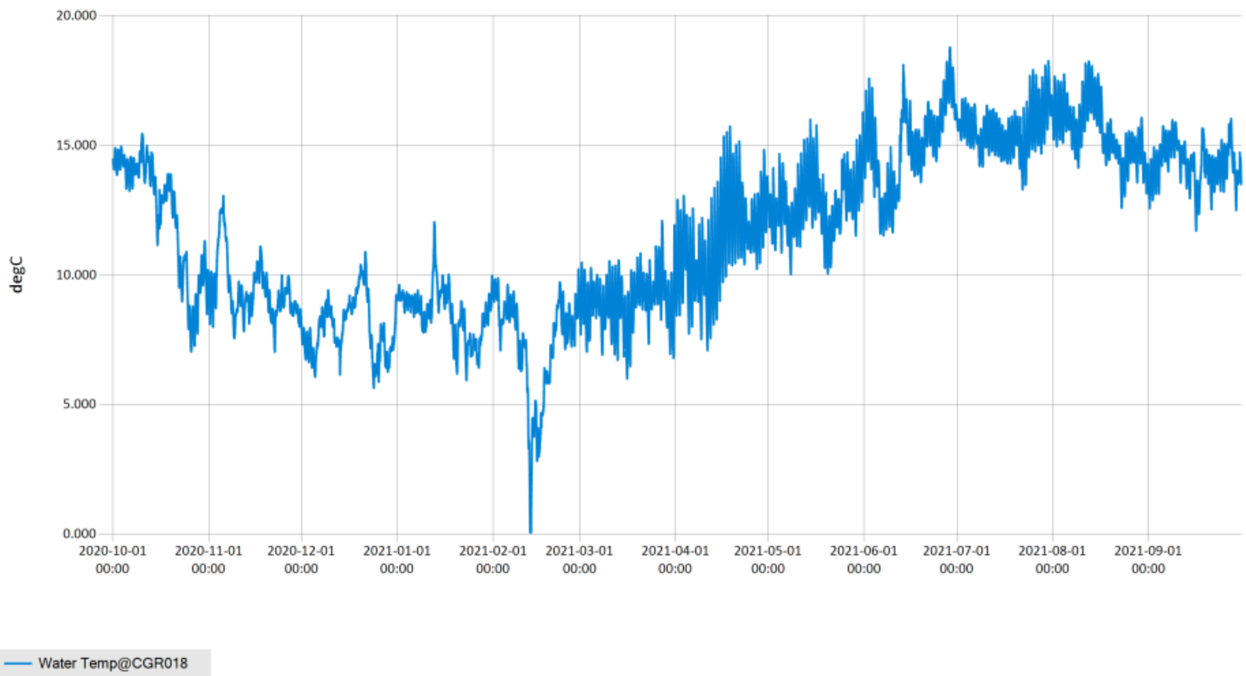
Time Series Data Report
15-minute Water Temp (deg C) at Campen Creek (CMP010) Water Year 2021

Period Selected: 2020-10-01 00:00 - 2021-09-30 23:59 UTC Offset: -08:00



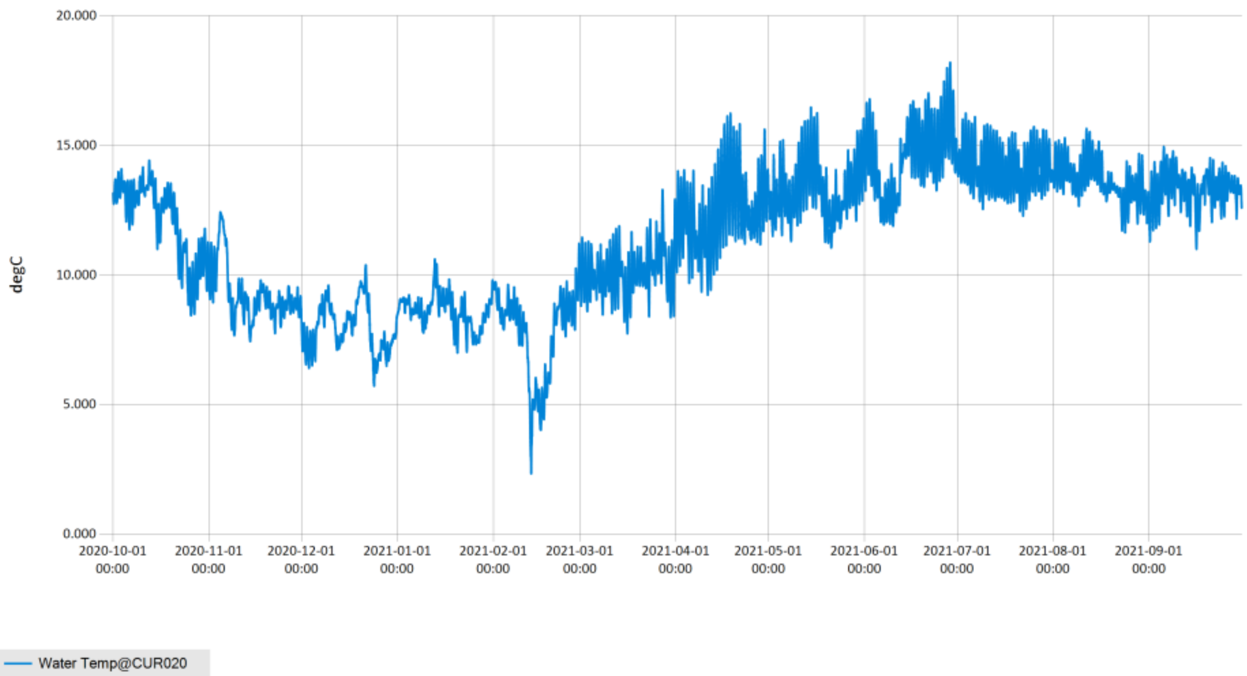
Time Series Data Report
15-minute Water Temp (deg C) at Cougar Creek (CGR020) Water Year 2021

Period Selected: 2020-10-01 00:00 - 2021-09-30 23:59 UTC Offset: -08:00



Time Series Data Report
15-minute Water Temp (deg C) at Curtin Creek (CUR020) Water Year 2021

Period Selected: 2020-10-01 00:00 - 2021-09-30 23:59 UTC Offset: -08:00



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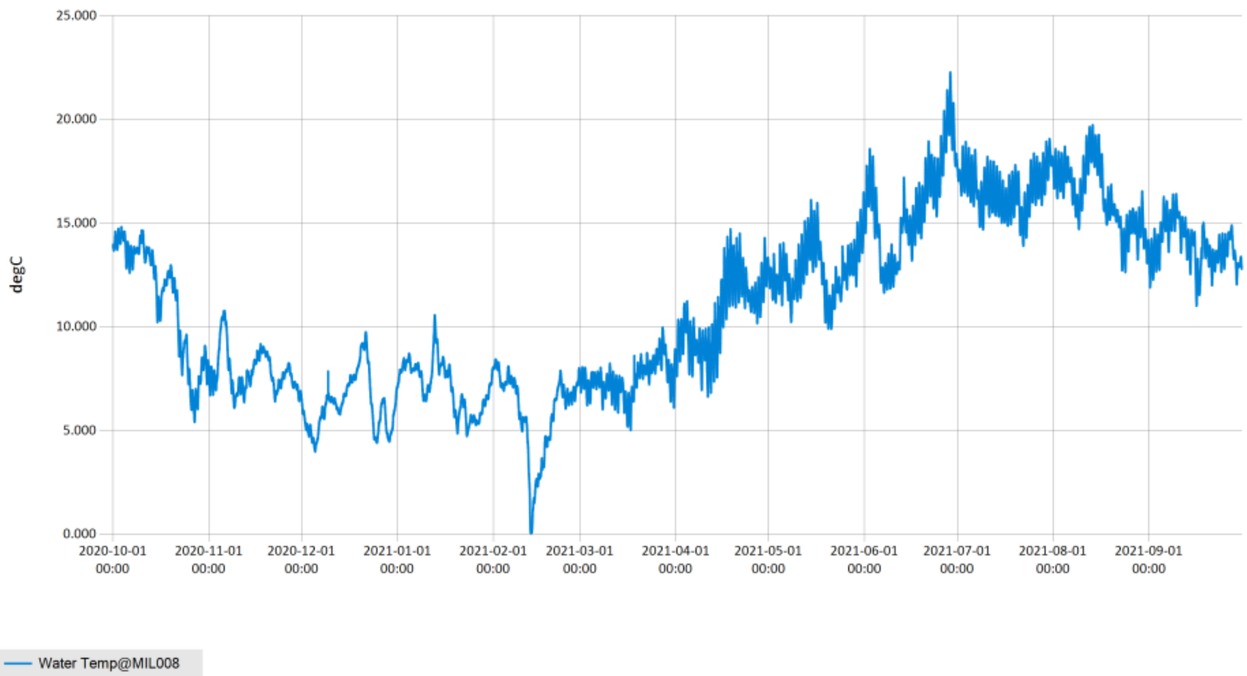
Time Series Data Report
15-minute Water Temp (deg C) at Mill Creek (MIL010) Water Year 2021

Period Selected: 2020-10-01 00:00 - 2021-09-30 23:59 UTC Offset: -08:00

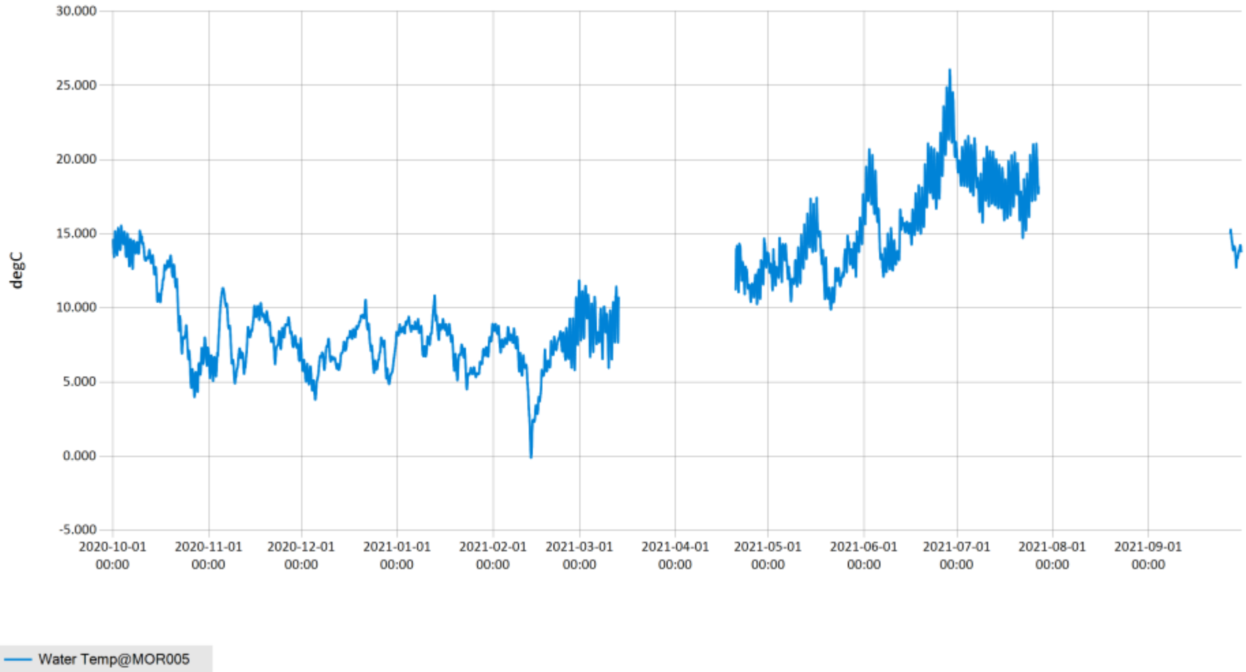


Time Series Data Report

15-minute Water Temp (deg C) at Morgan Creek (MOR005) Water Year 2021

Jun 13, 2022 | 1 of 1

Period Selected: 2020-10-01 00:00 - 2021-09-30 23:59 UTC Offset: -08:00



AQUARIUS Time-Series

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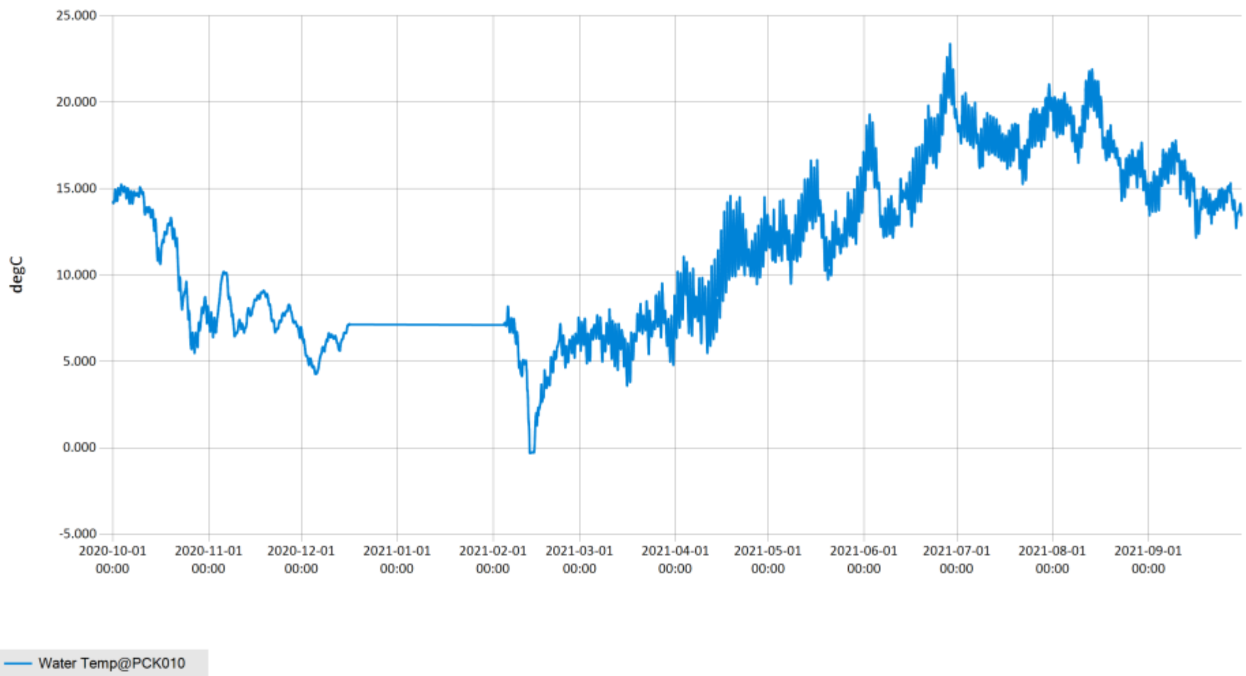
Time Series Data Report
15-minute Water Temp (deg C) at Packard Creek (PCK010) Water Year 2021

Period Selected: 2020-10-01 00:00 - 2021-09-30 23:59 UTC Offset: -08:00



AQUARIUS Time-Series

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Time Series Data Report
15-minute Water Temp (deg C) at Westover Creek (WST020) Water Year 2021

Period Selected: 2020-10-01 00:00 - 2021-09-30 23:59 UTC Offset: -08:00