Lower Columbia Urban Streams (LCUS) Annual Status Report – 2023-2024

Stormwater Action Monitoring

Receiving Waters

Prepared for Ecology on behalf of the Stormwater Workgroup by

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 will help evaluate regional progress toward reducing stormwater impacts on environmental health.

Summary Findings for 2023-2024

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

- Land Cover: All but three subwatersheds exceeded TIA values for Supporting conditions that are healthy for macroinvertebrates and salmonids (TIA > 15%).
- Flow Metrics (based on stage): TQmean values for five out of the eight LCUS WY2024 sites fell into "Supporting Salmonid Use."
- Total Impervious Area (TIA) and Daily Traffic Intensity (ADT): Subwatershed Benthic Index of Biotic Integrity (B-IBI) scores generally decline with increasing TIA and ADT traffic values > 20,000 daily trip miles per square mile.
- B-IBI: Taxa analysis showed moderate changes in composition due to replacement of some sensitive taxa by more tolerant taxa. All but one LCUS site fell into a "Poor" to "Very Poor" B-IBI category.
- Stream Temperature: No sites met state stream temperature criteria beneficial for salmonid use. Three of the eight LCUS sites exceeded their Washinton State aquatic life temperature criteria over 75% of the monitoring timeframe.
- Sediment: Metals (arsenic, cadmium, chromium, copper, lead and zinc) met freshwater sediment cleanup objectives.
- Habitat: Substrate embeddedness for all sites fell into the "Marginal to Poor" stream condition category. Three sites had "Poor or Very Poor" B-IBI scores with human disturbance index percentages > than 40. All sites had a 75% or greater riparian cover. The mostly "Poor" or Very Poor" B-IBI scores suggest other influences

McCormick Creek (MAC050) site

Why stream monitoring for stormwater management?

Stormwater management actions, implemented in the 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 2024 Stream Health Report.[1]

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. Water year 2024 is the fourth 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). This ongoing study is funded by the regional permittees. 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 suggest solutions to decrease the impacts of stormwater runoff on streams. Over time, LCUS 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[2] (WHSR) for physical habitat and biological measurements.

To better capture the stormwater related hydrologic, water and sediment chemistry changes, this study also monitors water level and temperature continuously for one full water year at each targeted sampling site (Appendix B).

LCUS streams health status in 2023-2024

Impervious surfaces and land use

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.

TIA data values were calculated using the National Land Cover Database (NLCD) 2023 Fractional Impervious Surface dataset. Analysis of the 2023 Fractional Impervious Surface dataset were found to be more accurate than the 2016 NCLD Imperviousness dataset which overestimated TIA values for LCUS site subwatersheds in previous LCUS annual reports.

In terms of the subwatershed condition for TIA, most water year 2024 LCUS sites range from low to a high degree of impervious surface (Figure 1). TIA for each LCUS subwatershed ranged from 7 to 50 percent when all developed land cover categories were added together within each monitoring site's drainage area. This means that the multiple

[1] https://gis.clark.wa.gov/portal/apps/storymaps/collections/bd031a62574642db8f98c2f9beed7776
[2] https://apps.ecology.wa.gov/publications/documents/0603203.pdf

subwatersheds of the LCUS study may have too much impervious area for supporting watershed conditions that are healthy for macroinvertebrates and salmon. Watersheds with greater than 15% TIA may be at risk for more adverse conditions affecting healthy biota in streams (EPA, 2018).

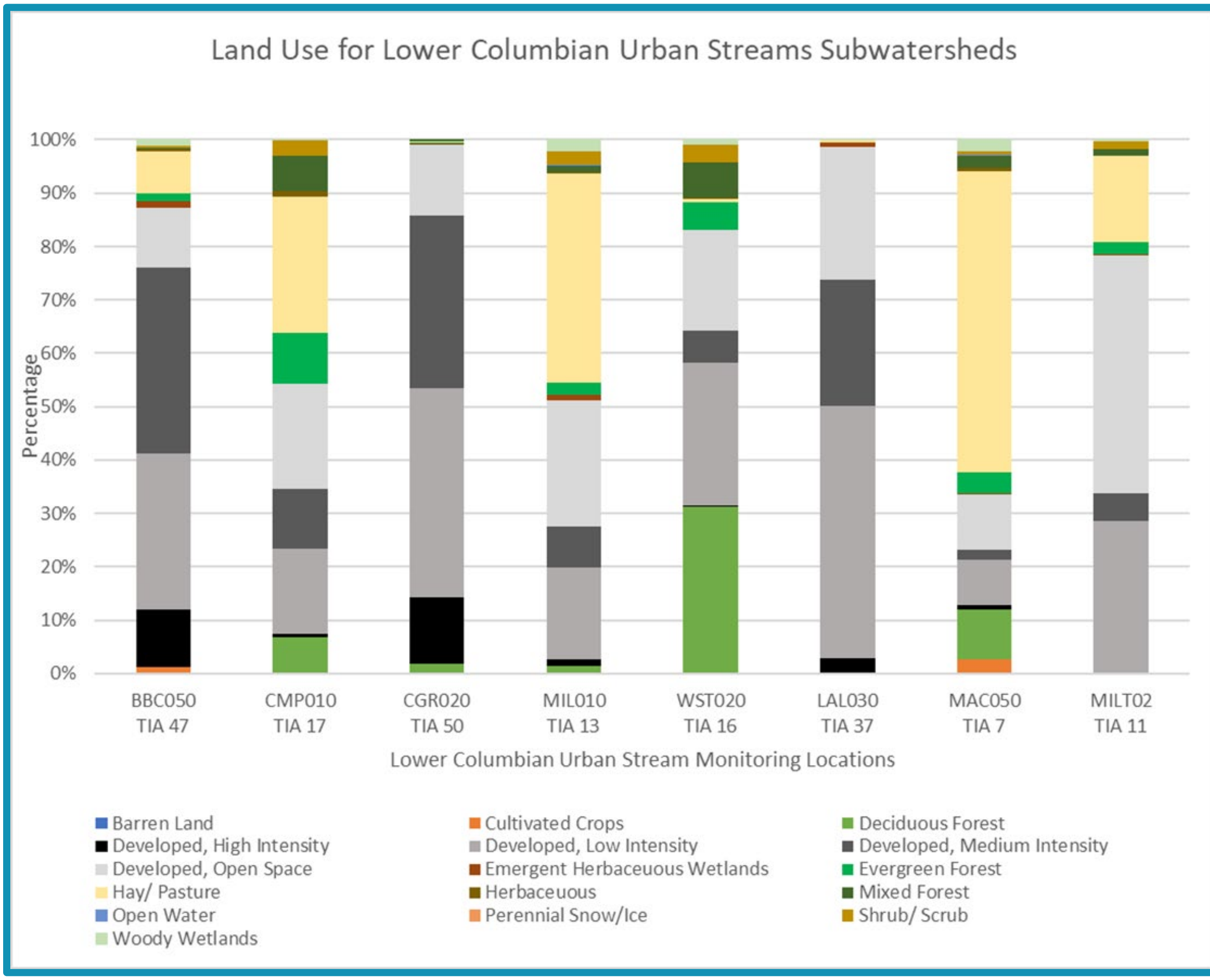

Figure 1. Land use for LCUS subwatersheds monitored for water year 2024, including Total Impervious Area (TIA %). Land cover is derived from the National Land Cover Database (NLCD) 2023 Fractional Impervious Surface dataset.

Hydrologic metrics

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.

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

RBI: An index of stage oscillations relative to total stage, based on daily average stage measured per water year.

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

For example, regions with little attenuation of runoff, such as areas with clay soils or rock layers, typically have higher flashiness compared to 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 the sidebar. Booth and Konrad (2017) found that hydrologic metrics based on stage provide useful metrics of status and trends monitoring of urbanizing subwatersheds.

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 of 0.37 or greater with the exception of Cougar Creek, Westover Creek and Mill Creek Trib 2. RBI and flow reversal values tend to increase with urbanization. RBI values greater than 0.25 and flow reversal values greater than 65 are typically associated with subwatershed that have a TIA greater than 20% (Booth and Konrad, 2017). Cougar Creek (TIA of 50%), LaLonde Creek (TIA of 37%) and interestingly Mill Creek Trib 2 (TIA of 13%) were the only sites to have an RBI value greater than 0.25.

It appears that despite having most LCUS sites having too much TIA to support healthy biota in streams, much 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	Location Name	Location ID	TQ mean	RBI	Reversals
Trend	Burnt Bridge Creek	BBC050	0.41	0.15	40
	Cougar Creek	CGR020	0.33	0.44	49
	Campen Creek	CMP010	0.42	0.23	44
	Mill Creek	MIL010	0.39	0.19	34
	Westover Creek	WST020	0.36	0.20	56
Status	LaLonde Creek	LAL030	0.38	0.26	29
	McCormick Creek	MAC050	0.43	0.16	28
	Mill Creek Trib 2	MILT02	0.34	0.29	28

B-IBI

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.

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

Clark County has used the B-IBI score as a tool to quantify stream health for many years.

Clark County stores all B-IBI data in the Puget Sound Database[3] and has the original taxonomic counts converted to the 100-point system (Table 2). Streams having "Poor" B-IBI scores (40 or less) are considered non-supporting for salmon habitat (Ecology, 1999). Three LCUS sites had a B-IBI score of less than 40 (Table 3).

Table 2. B-IBI Biological Condition Categories

Biological Condition	0 to 100 B-IBI
Excellent	80 to 100
Good	60 to 80
Fair	40 to 80
Poor	20 to 40
Very Poor	0 to 20

[3] https://pugetsoundstreambenthos.org/

Table 3. LCUS B-IBI Scores

Location ID	BBC050	CMP010	CGR020	MIL010	WST020	LAL030	MAC050	MILT02
B-IBI Score	8	28	18	54	17	16	29	26
B-IBI Category	Very Poor	Poor	Very Poor	Fair	Very Poor	Very Poor	Poor	Poor

Taxa composition at all 2023 LCUS sites ranged from four to six 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 six indicates that chemistry, habitat, and/or flow regime was altered from natural conditions. At the four to six BCG level, there are moderate to extreme changes in structure due to replacement of some sensitive ubiquitous taxa by more tolerant taxa (EPA, 2021). Compared to healthier streams, water year 2023 B-IBI samples showed many more tolerant taxa, many taxa that are both lotic and lentic, and loss of sensitive taxa.

Traffic Intensity and B-IBI

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 scores with increasing traffic intensity. It appears that BIBI scores in basins with an ADT value of 20,000 or greater typically fall into the "Poor" category.

Considering that BIBI scores depend on several factors, including substrate and water quality, BIBI scores can be low in areas of low urbanization (e.g. land under intensive agricultural use). However, BIBI scores are rarely better than poor in areas of intense urbanization.

All LCUS sites with an ADT greater than 20,000 had a "Poor" or "Very Poor" BIBI score (excludes Westover Creek with no ADT data). Most sites with ADT less than 20,000 had "Fair" BIBI scores.

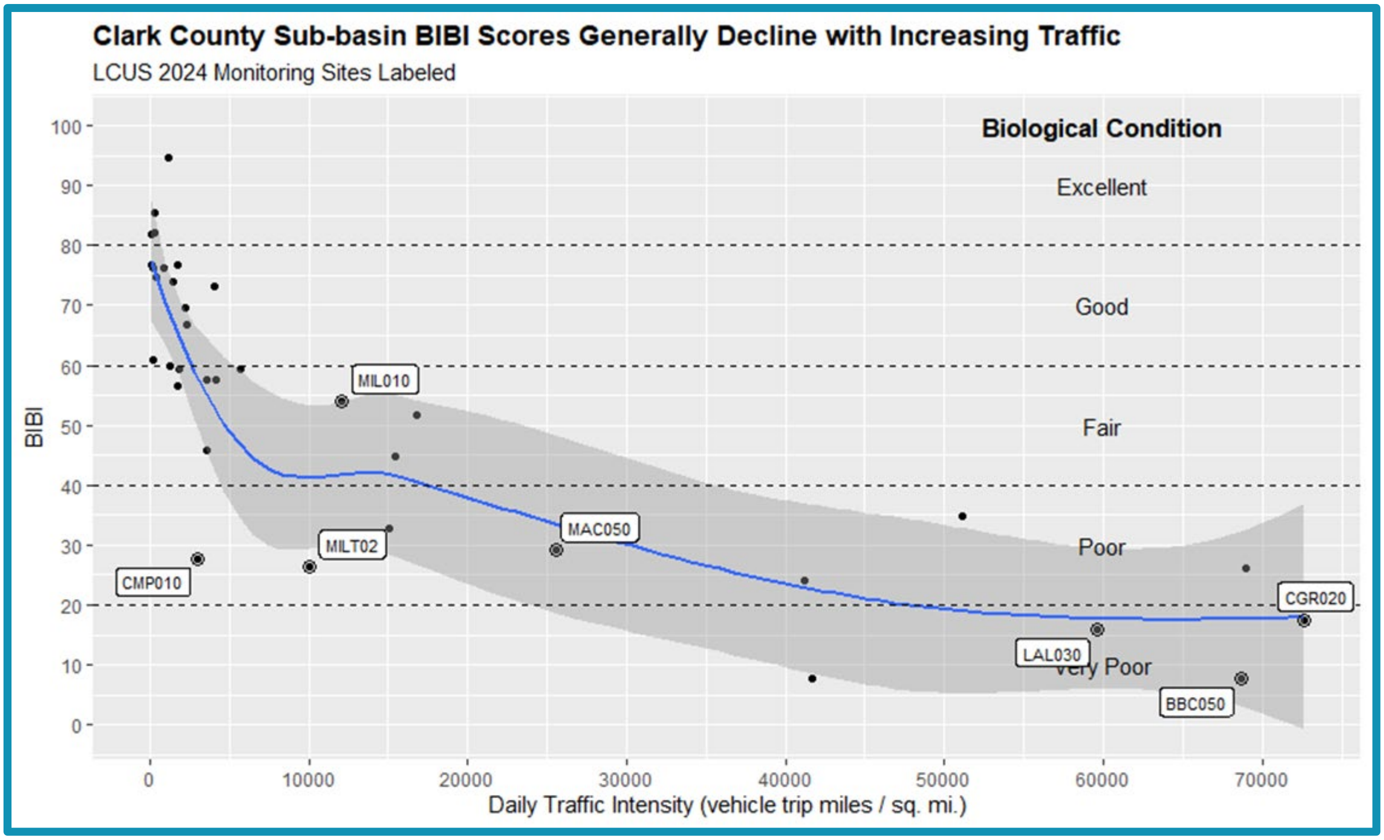

Figure 2. Comparison of available Clark County B-IBI scores to sub-basin traffic intensity (Clark County, 2024)

Stream Temperature

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

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, equaling a 93-day total monitoring period (Table 4).

No LCUS site met Washington State aquatic life temperature criteria for fresh water (Table 5). Five out of the eight LCUS sites exceeded their Washington State aquatic life temperature criteria over 70 percent of the designated 93-day criteria period, suggesting that these streams are not supportive of salmonids.

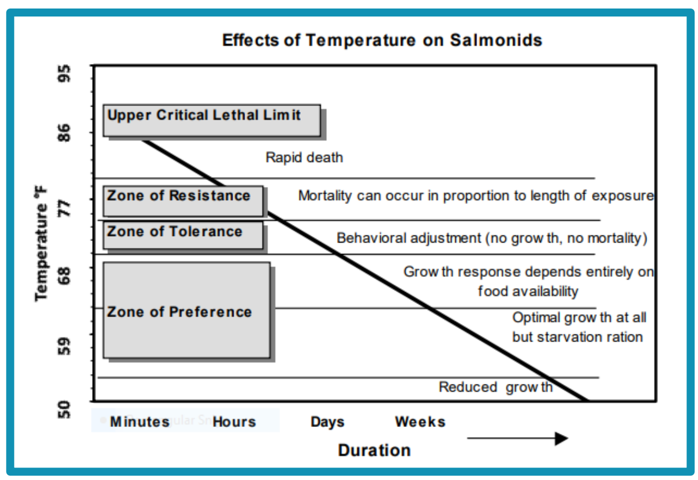

Figure 3. General biological effects of temperature on salmonids of the Pacific Northwest in relation to duration and magnitude of temperature (Sullivan, et al., 2000)

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

Category	Highest 7-DAD Max
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 WY2024 sites

Location Type	Location Name	Location ID	Max 7-DAD Max (°F)	Max Date	Max 7-DAD Daily Difference (°F)	Max Date	Days above 60.8°F	Days above 63.5°F	Days above 71.6°F	Days above 73.4°F	Highest 7-DADMax Aquatic Life (°F)
Trend	Burnt Bridge Creek	BBC050	74.8	July 17	8.3	July 17	92	88	30	19	63.5
	Cougar Creek	CGR020	63.1	July 8	4.4	July 7	48	4	0	0	60.8
	Campen Creek	CMP010	73.9	July 8	10.4	June 21	91	82	18	5	63.5
	Mill Creek	MIL010	66.6	July 8	5.4	July 7	67	31	0	0	60.8
	Westover Creek	WST020	68.2	July 8	6.2	July 6	82	46	0	0	63.5
Status	LaLonde Creek	LAL030	61.3	July 8	4.4	July 7	14	1	0	0	63.5
	McCormick Creek	MAC050	71.5	July 7	7.0	June 19	89	77	5	0	63.5
	Mill Creek Trib 2	MILT02	66.5	July 10	5.9	July 7	67	32	0	0	63.5

Stream Sediment and Habitat Conditions

Streambed sediment samples were collected once during the summer of 2023 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 three of the eight LCUS monitoring locations (BBC050, CGR020 and WST020). BBC050 had the highest PAHs values. LCUS sediment data can be found in Ecology's Environmental Information Management (EIM) database.[4]

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 (Table 6). Embeddedness for LCUS sites ranged from 57 to over 90 percent, falling into the marginal to poor stream condition category (Table 7).

[4] https://ecology.wa.gov/research-data/data-resources/environmental-information-management-database

Table 6. Stream habitat embeddedness condition categories from Environmental Protection Agency (1998)

Embeddedness Condition Category	Optimal	Suboptimal	Marginal	Poor
Description	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.

Table 7. Percent embeddedness for WY2024 LCUS sites based on 121 in stream substrate measurements per stream

Location ID	BBC050	CMP010	CGR020	MIL010	WST020	LAL030	MAC050	MILT02
Embeddedness (%)	68	79	59	56	90	87	39	90
Condition Category	Marginal	Marginal	Poor	Marginal	Poor	Poor	Suboptimal	Poor

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. Four LCUS sites (BBC050, CGR020, WST020 and MAC050), had either a "Poor" or "Very Poor" BIBI score while also having a human disturbance percentage greater than 35.

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. Only LCUS site MIL010 with greater than 80 percent riparian vegetation cover had "Fair" BIBI scores. All other water year 2024 LCUS sites had high percentages of riparian cover but had either had "Poor" and "Very Poor" BIBI scores. These results are likely due to other additional urban stressors affecting overall stream health.

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 protections, restoration strategies and evaluate the effectiveness of those programs.

Stormwater managers should review Table 8, 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 8. List of important stressors identified in the LCUS study that affect overall stream health

LCUS Summary Findings for WY2024
Imperviousness in all but three WY2024 LCUS subwatershed was greater than 15%, indicating subwatershed conditions are not healthy for supporting macroinvertebrates and salmon (TIA > 15%).
Most flow metrics interpreted using stage are supportive of salmonid use at five out of the eight WY2024 LCUS sites.
Benthic invertebrate taxa analysis showed moderate changes in composition due to replacement of some sensitive taxa by more tolerant taxa. All but one WY2024 LCUS sites fell into the “Poor” or “Very Poor” BIBI category.
B-IBI scores generally decline with increasing TIA and ADT traffic values > 20,000 daily trip miles per square mile.
LCUS sites failed to meet state stream temperature criteria beneficial for salmonid use.
Sediment metals met freshwater sediment cleanup standards.
Substrate embeddedness for all sites fell into the “Marginal to Poor” stream condition category.
Streams with human disturbance percentages greater than 35 have "Poor to Very Poor" B-IBI scores.
All LCUS sites had a 75 percent or greater riparian cover. All but one LCUS site fell into the “Poor” or “Very Poor” BIBI category suggesting other urban influences other than riparian cover may be affecting stream health.

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 an annual assessment of stressors that affect 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 in the EIM database with Study ID SAM_LCU.

Additional results are published in the Appendix.

For more information, including past status reports, visit the SAM status & trends webpage.

References

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

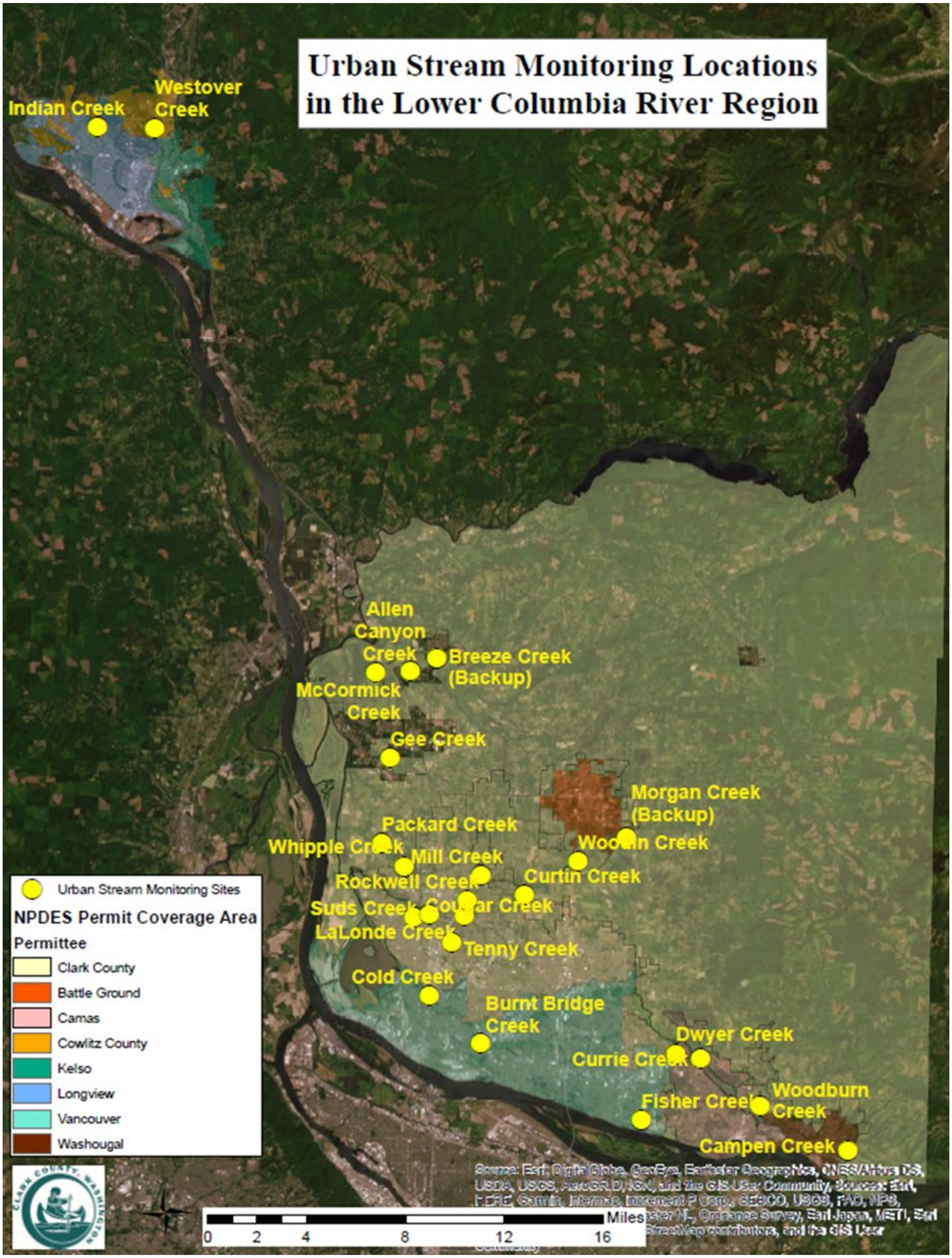

Figure A 1. Map of urban stream monitoring locations and study boundaries in the Lower Columbia River Basin

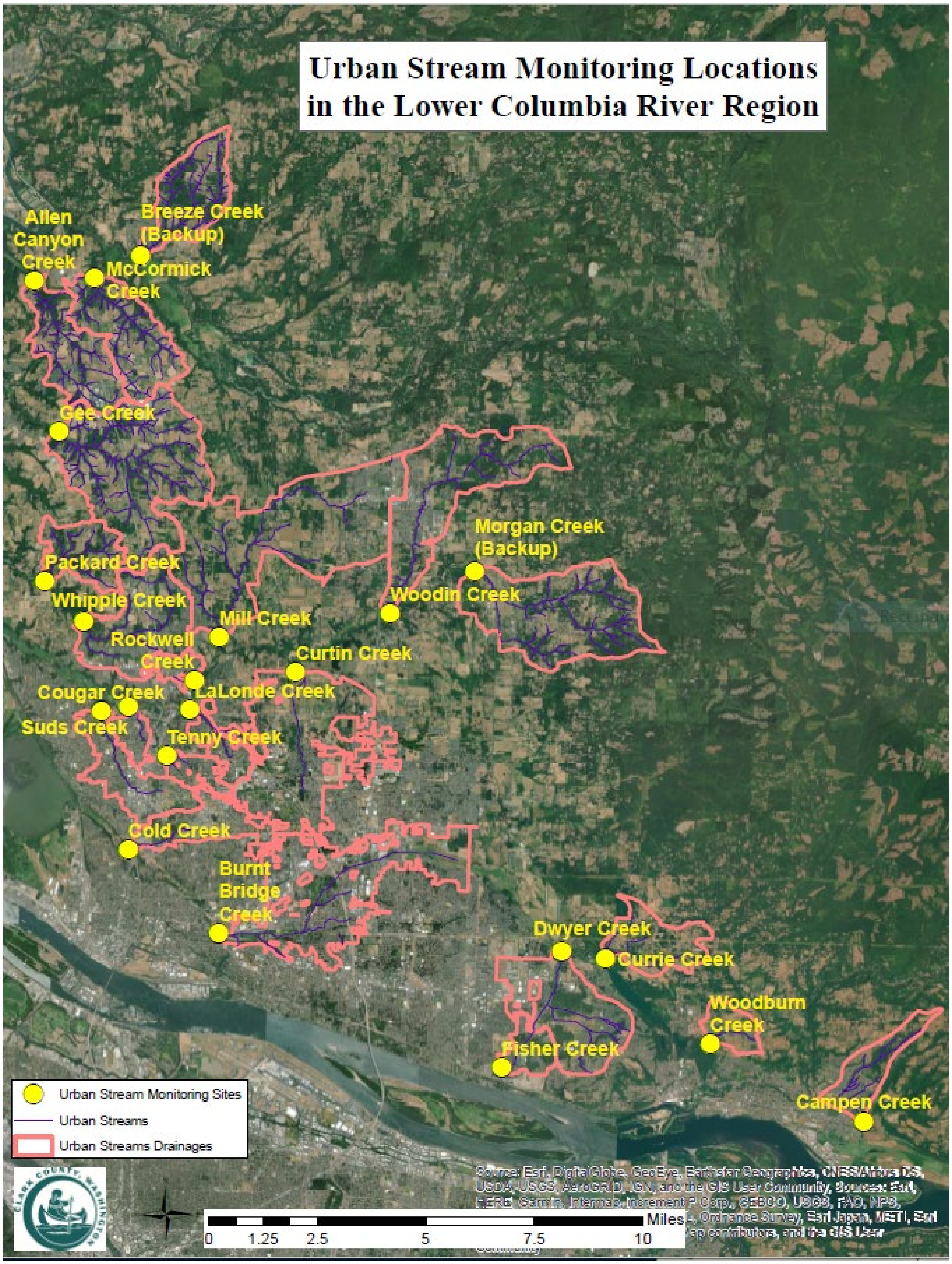

Figure A 2. Map of urban stream monitoring locations and associated drainage catchments in Clark County

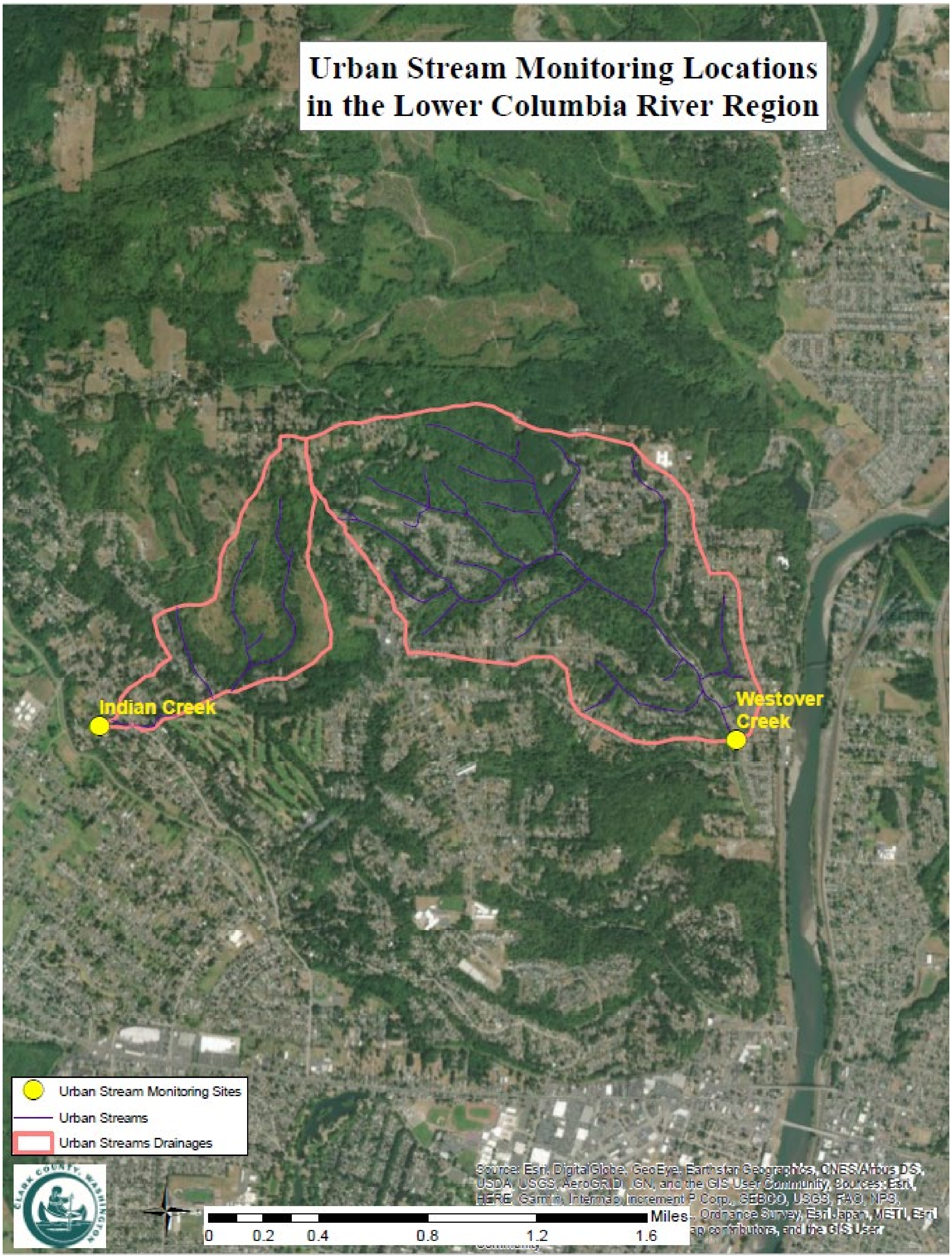

Figure A 3. Map of urban stream monitoring locations and associated drainage catchments in Cowlitz County

Appendix B. Continuous time series data (stage and temperature) for LCUS sites for water year 2024

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Time Series Data Report
15-minute Stage (ft.) and Water Temperature (°C) at Burnt Bridge Creek (BBC050) WY2024

Jun 26, 2025 | 1 of 1

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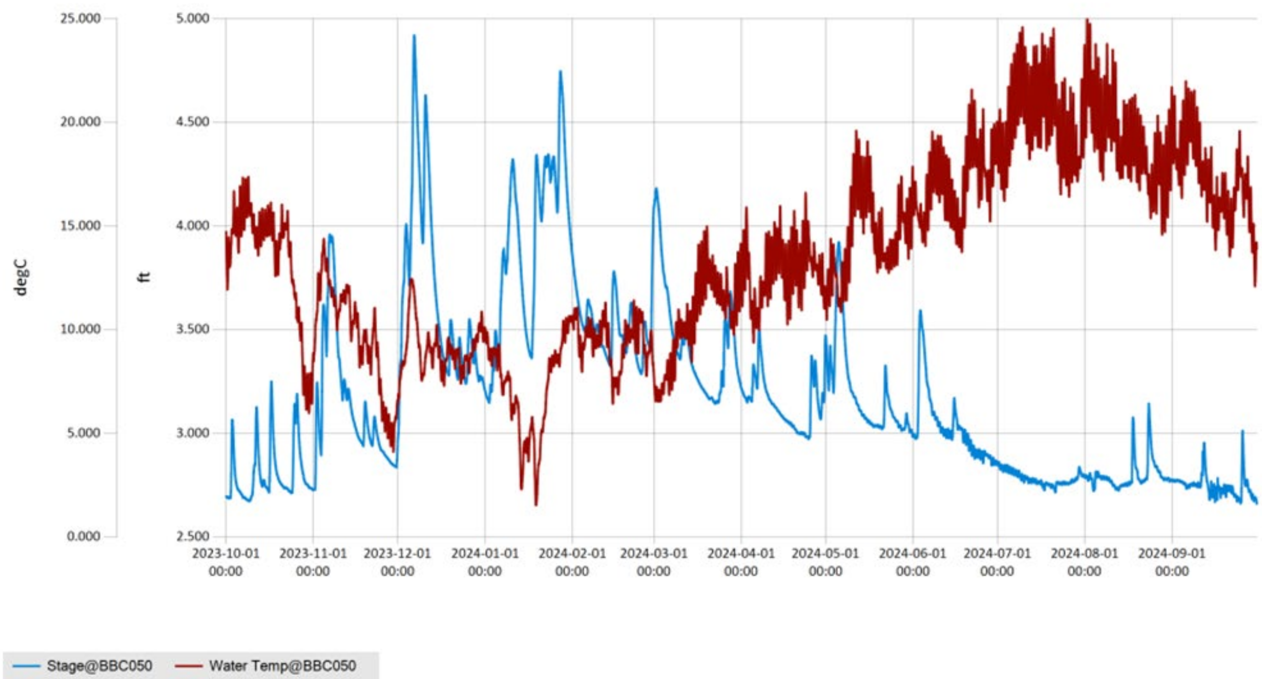

https://clark.wa.gov/public-works/stream-flow-and-precipitation-data

Figure B 1. 15-minute stage and temperature at Burnt Bridge Creek

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Time Series Data Report
15-minute Stage (ft.) and Water Temperature (°C) at Campen Creek (CMP010) WY2024

Jun 27, 2025 | 1 of 1

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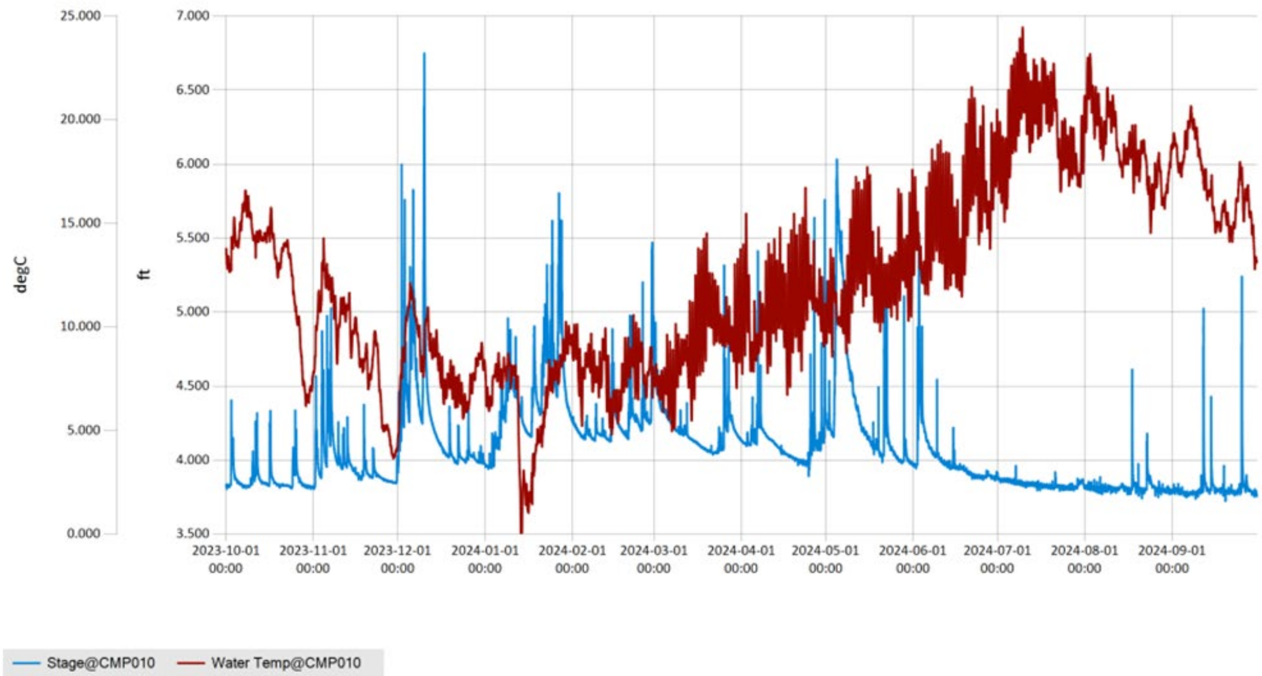

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Figure B 2. 15-minute stage and temperature at Campen Creek

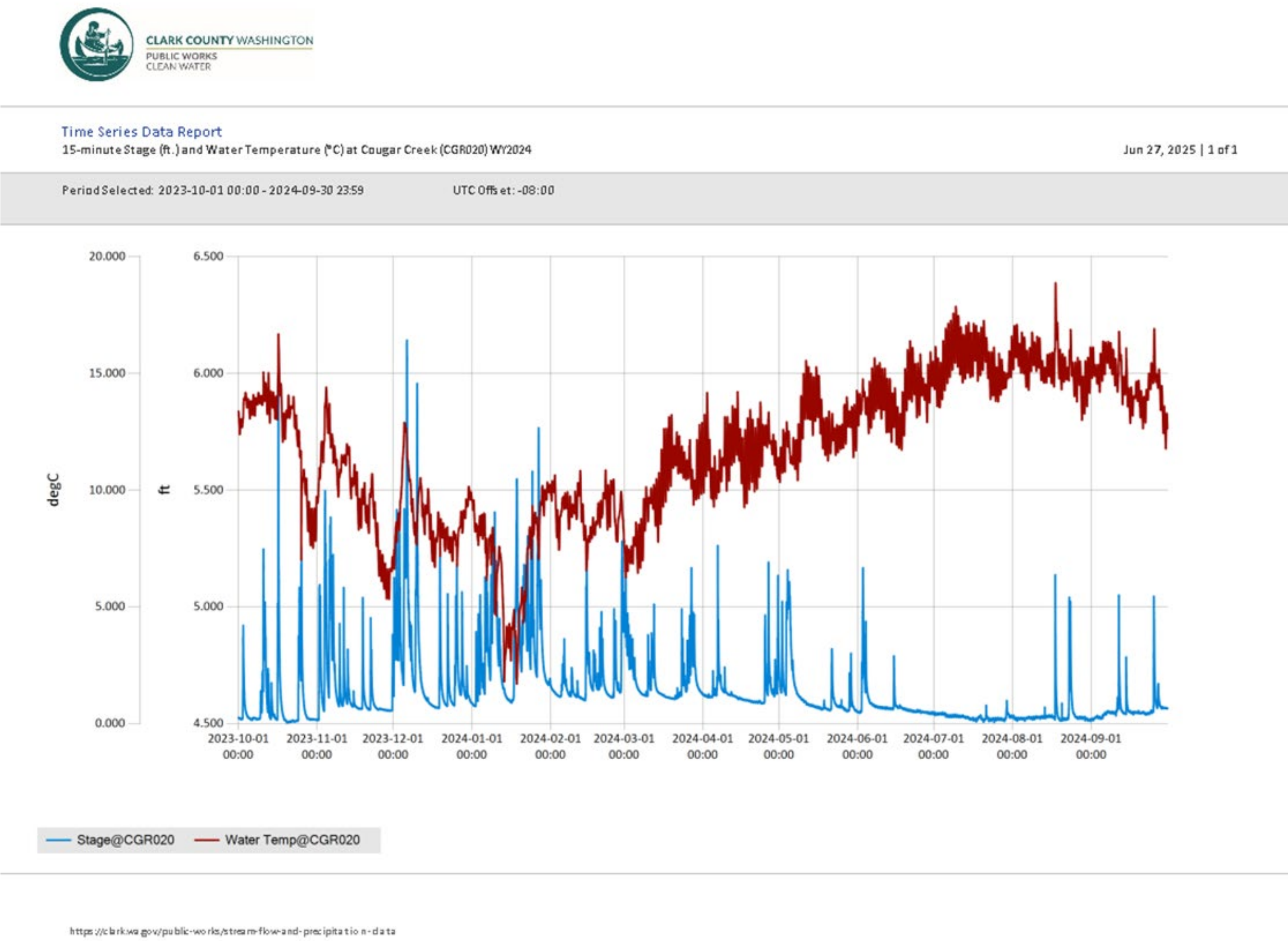

Figure B 3. 15-minute stage and temperature at Cougar Creek

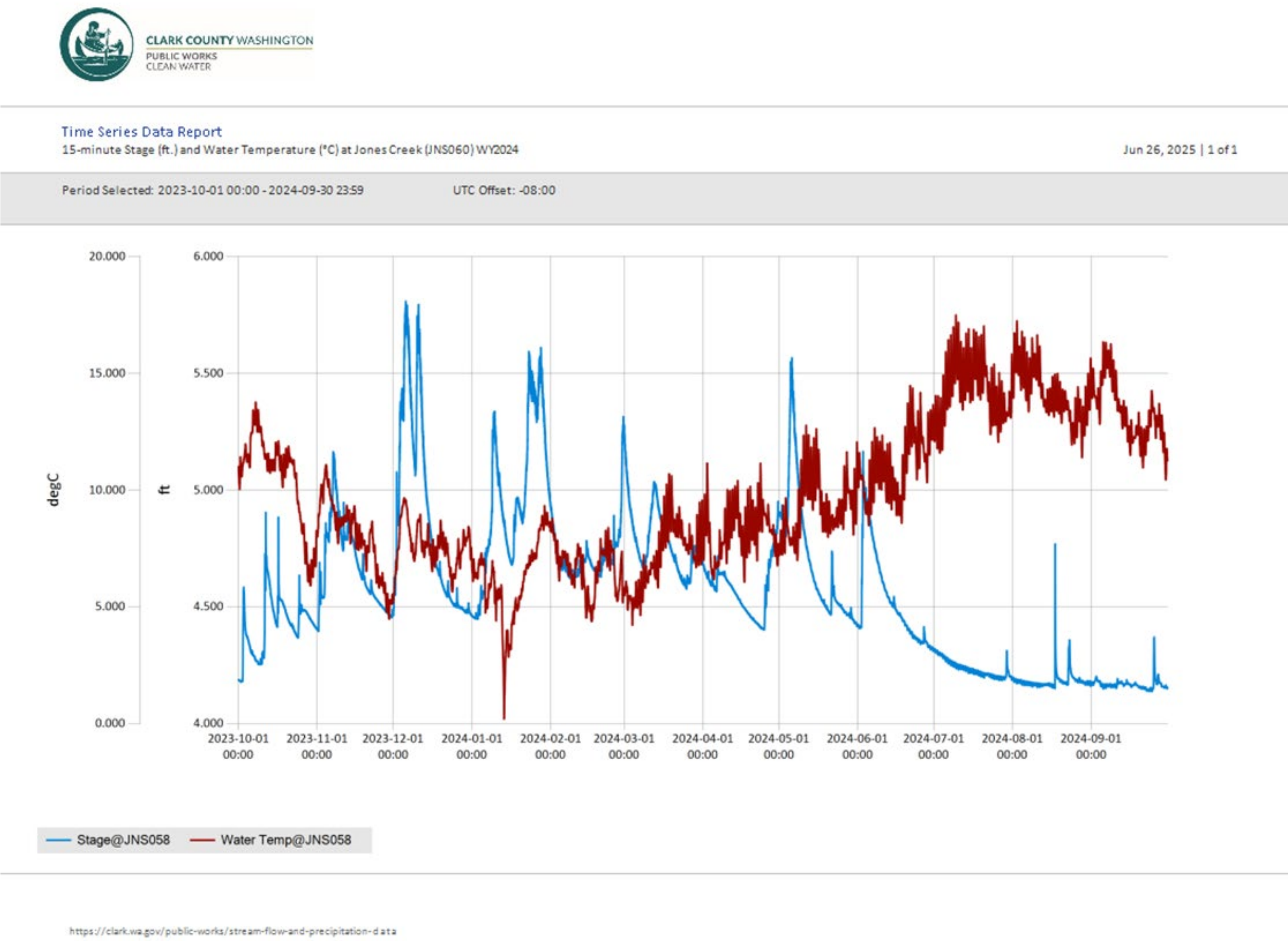

Figure B 4. 15-minute stage and temperature at Jones Creek

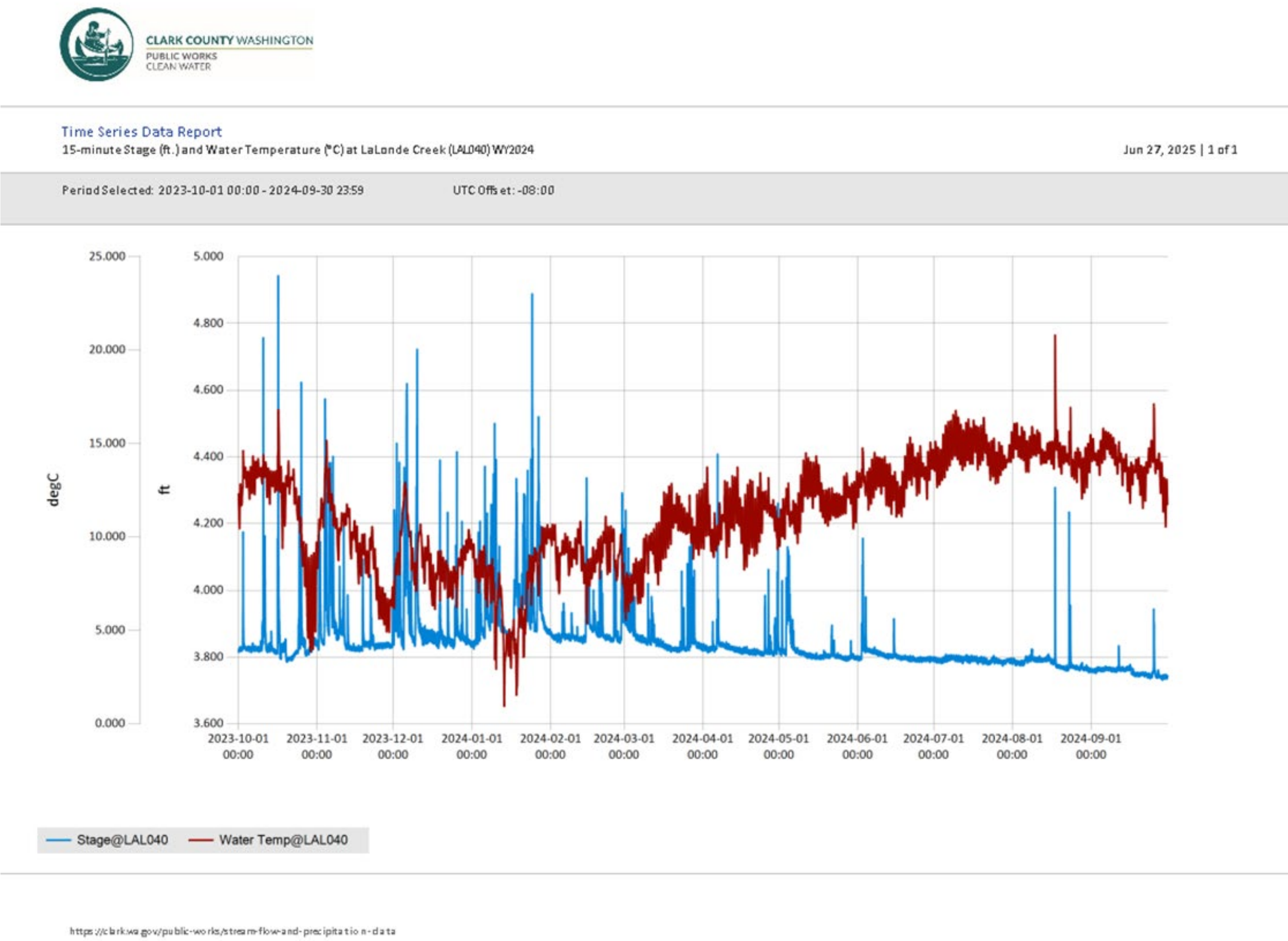

Figure B 5. 15-minute stage and temperature at LaLonde Creek

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Time Series Data Report
15-minute Stage (ft.) and Water Temperature (°C) at McCormick Creek (MAC050) WY2024

Jun 27, 2025 | 1 of 1

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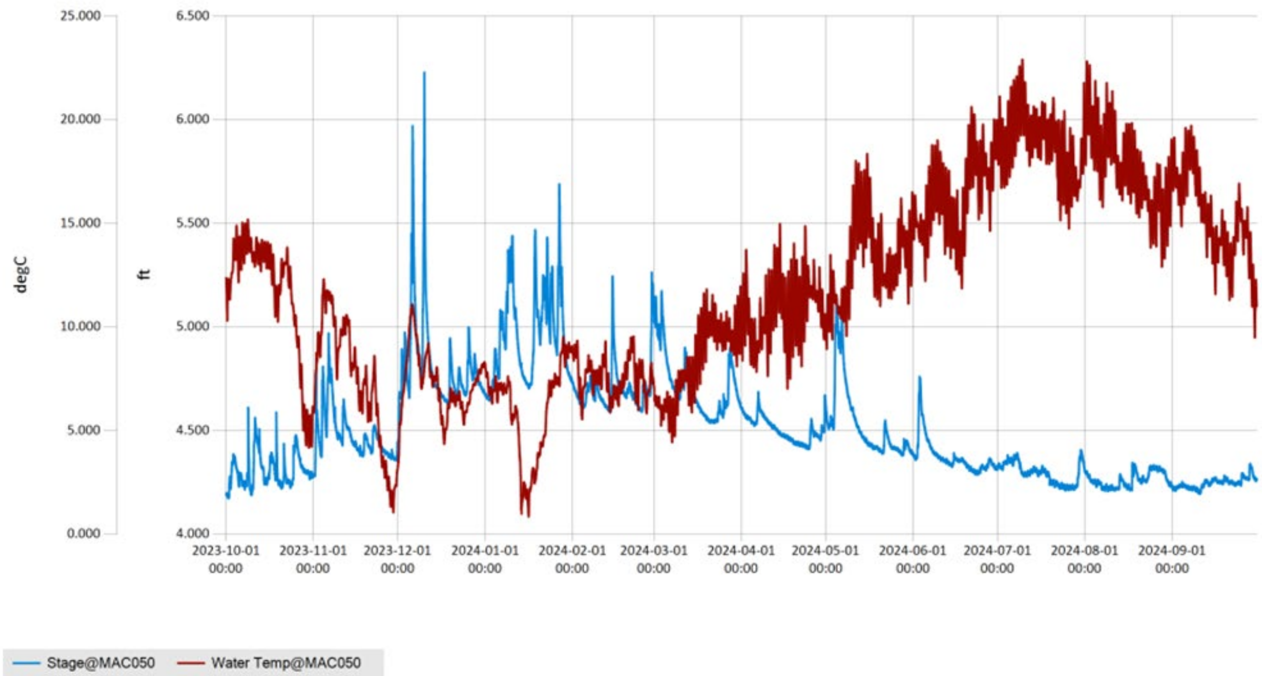

https://clark.wa.gov/public-works/stream-flow-and-precipitation-data

Figure B 6. 15-minute stage and temperature at McCormick Creek

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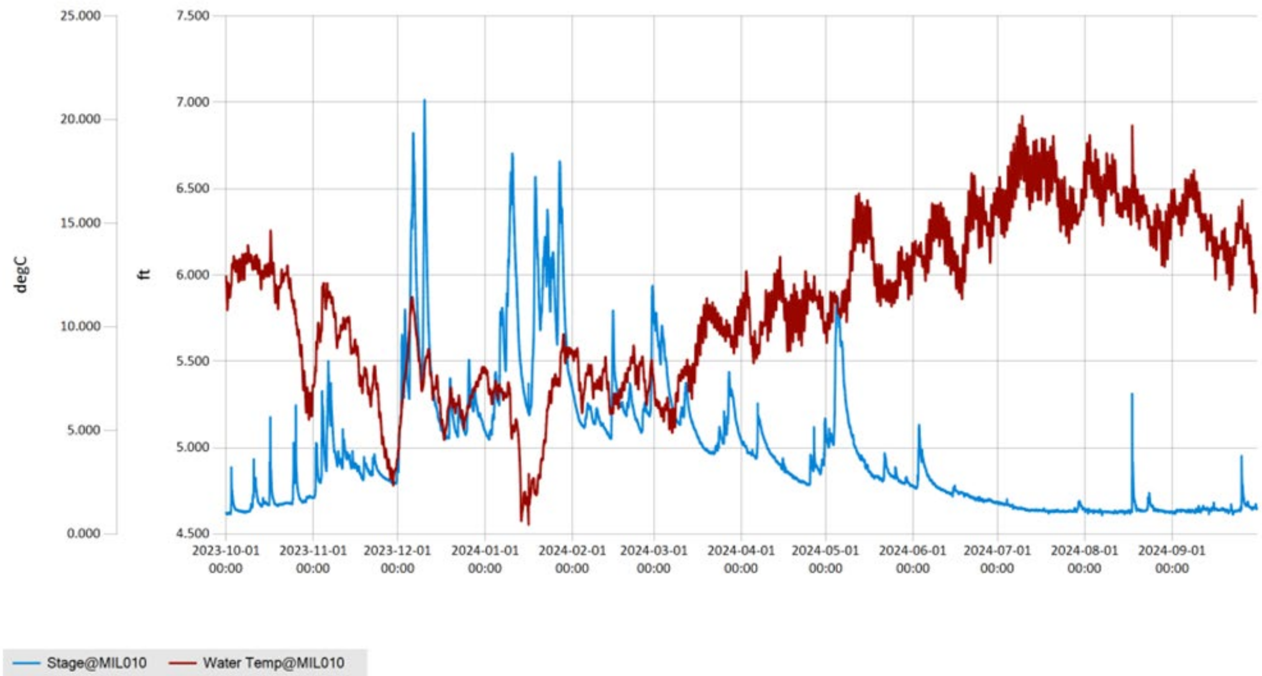
Time Series Data Report
15-minute Stage (ft.) and Water Temperature (°C) at Mill Creek (MIL010) WY2024

Jun 27, 2025 | 1 of 1

Period Selected: 2023-10-01 00:00 - 2024-09-30 23:59 UTC Offset: -08:00



https://clark.wa.gov/public-works/stream-flow-and-precipitation-data

Figure B 7. 15-minute stage and temperature at Mill Creek

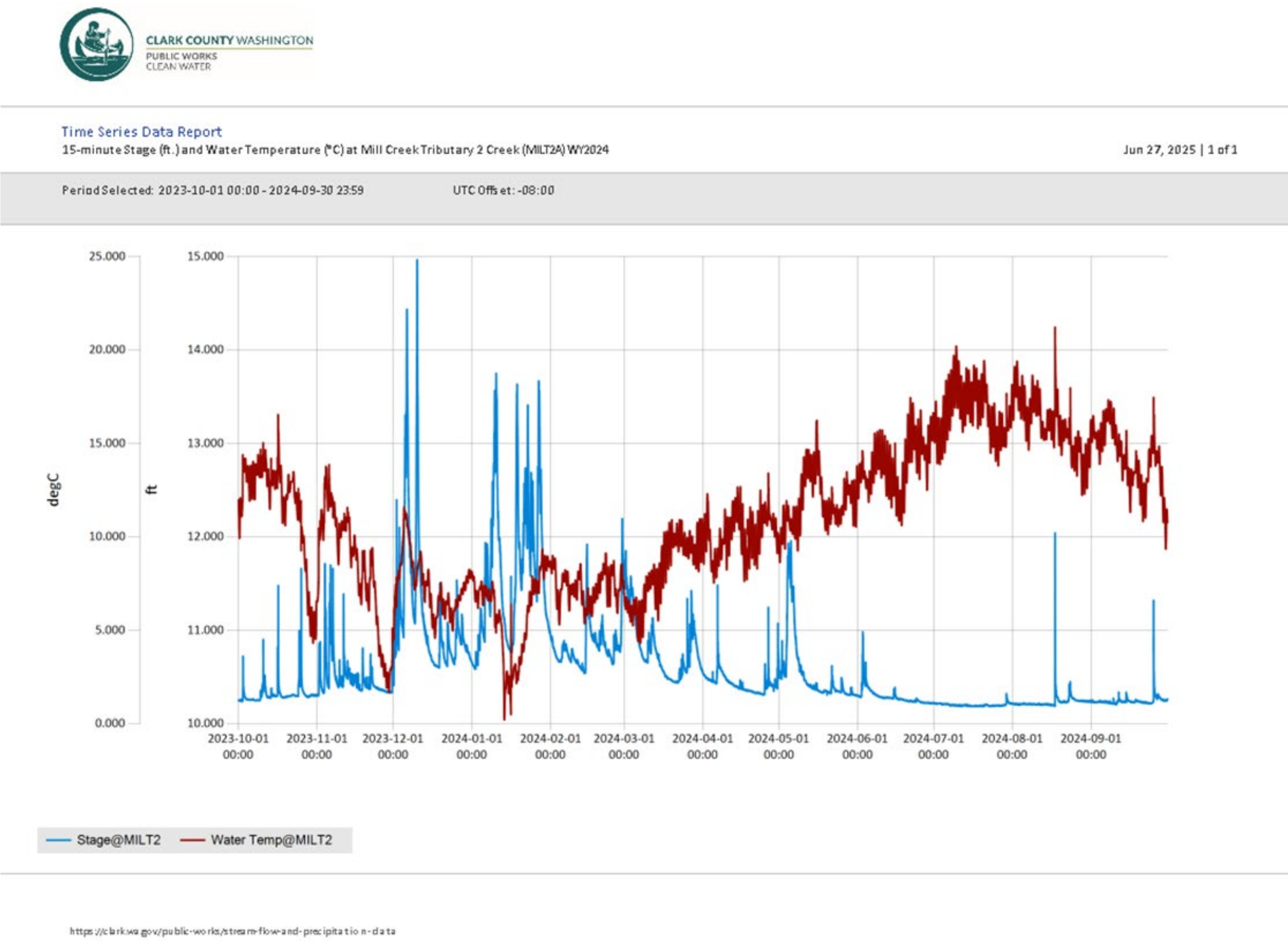


Figure B 8. 15-minute stage and temperature at Mill Creek Tributary

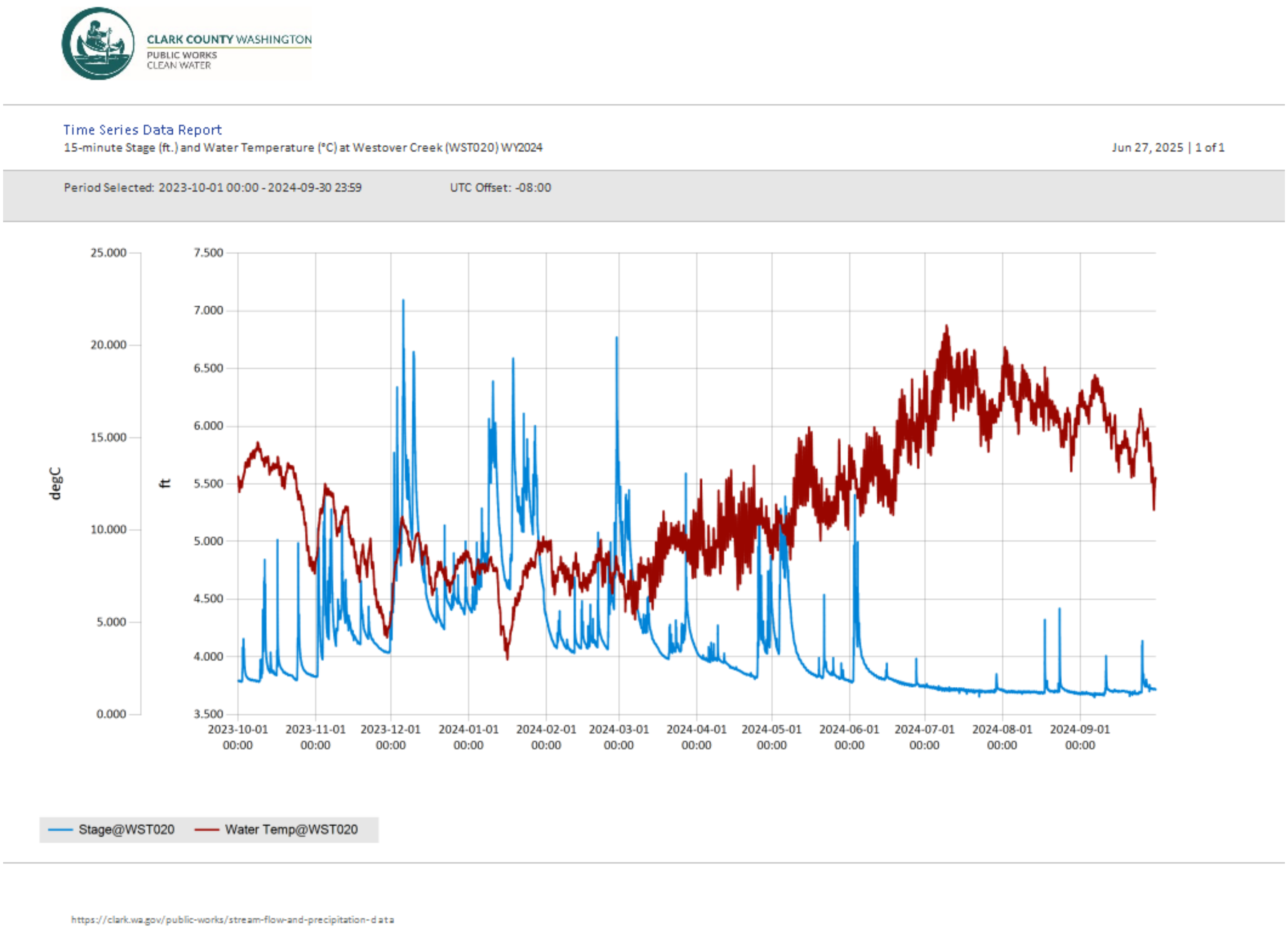


Figure B 9. 15-minute stage and temperature at Westover Creek