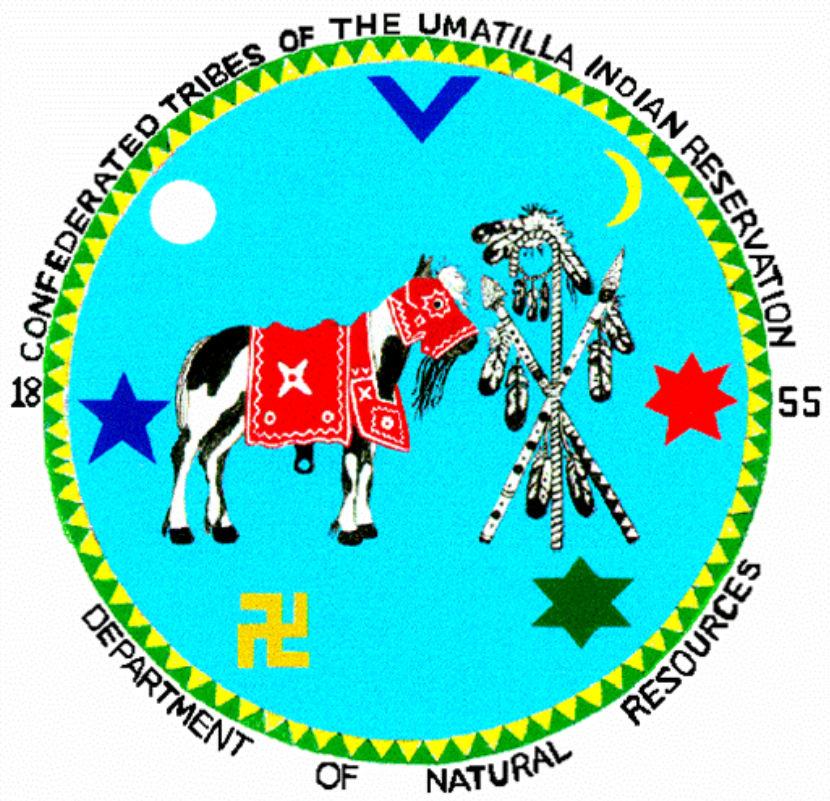
WATER QUALITY MONITORING STRATEGY FOR THE CONFEDERATED TRIBES OF THE UMATILLA INDIAN RESERVATION



Date issued: June 8, 2022
Time period this strategy covers: FY 2022 thru FY 2026
Tribal contact: Troy Baker, Water Resources Program Manager
phone: (541) 429-7288
email: troybaker@ctuir.org

I. Introduction

Three Tribes make up the Confederated Tribes of the Umatilla Indian Reservation (CTUIR): Cayuse, Umatilla, and Walla Walla. The people of the three Tribes once occupied 6.4 million acres in northeastern Oregon and southeastern Washington. These lands include both sides of the Columbia River from the Columbia Plateau to the Blue Mountains and beyond with a complex river network of the Snake, Yakima, John Day, Grande Ronde, Umatilla, Walla Walla Rivers and other Columbia River tributaries. In 1855, the Tribes and the United States Government negotiated a Treaty in which the Tribes "ceded," or surrendered possession of, much of the 6.4 million acres in exchange for a Reservation homeland. The CTUIR also reserved rights in the Treaty to fish at "usual and accustomed" sites, and to hunt and gather traditional foods and medicines on public lands within the ceded area.

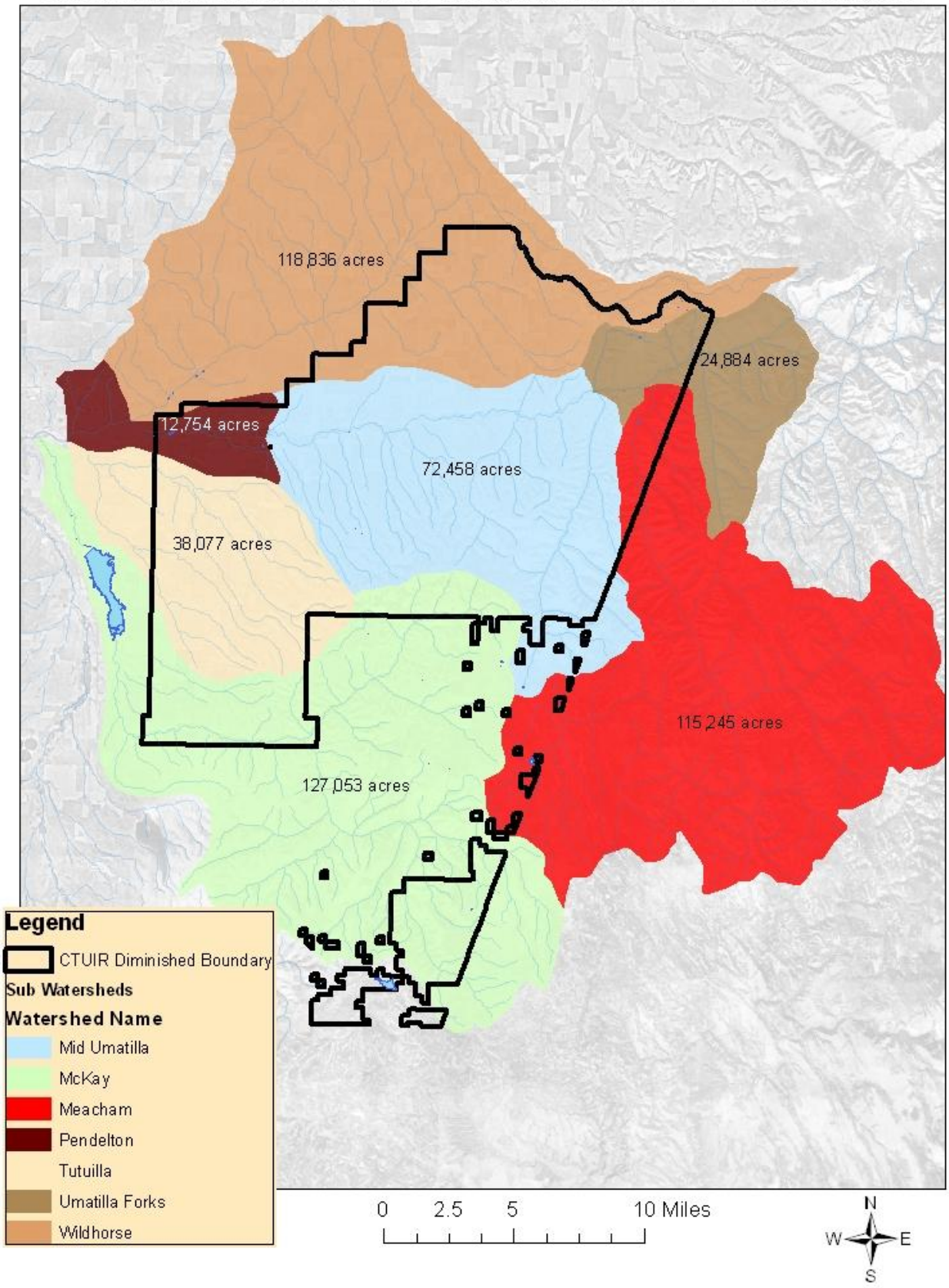
Currently, the Umatilla Indian Reservation (UIR) has:

- 179,957 acres, with
- 0 acres of tidelands and 0 miles of shoreline.
- 7 watersheds ranging from 12,754 acres to 127,053 acres; see map below.
- 496 miles of rivers and streams.
- 92 acres of lakes
- 1,428 acres of wetlands, excluding tidelands.
- at least 2 major potable aquifer systems on the Reservation.

This monitoring strategy focuses on the following parameters:

- temperature
- turbidity
- total suspended solids
- conductivity
- pH
- dissolved oxygen
- phosphorus
- nitrogen
- metals
- bacteria
- aquatic habitat
- macroinvertebrates

Important environmental issues are cold, clean, pure, abundant water for Tiicham, the earth and all who walk upon it. Anadromous fish populations are of special concern, as is surface water for cultural/spiritual use in traditional sweat houses.


Subwatersheds of the Umatilla Indian Reservation
118,836 acres
24,884 acres
12,754 acres
72,458 acres
38,077 acres
115,245 acres
127,053 acres
Legend
CTUIR Diminished Boundary
Sub Watersheds
Watershed Name
Mid Umatilla
McKay
Meacham
Pendelton
Tutuilla
Umatilla Forks
Wildhorse
0 2.5 5 10 Miles
N
W
E
S

II. Water Quality Monitoring Goals & Objectives

DNR Mission Statement:
To protect, restore, and enhance the First Foods - water, salmon, deer, cous, and huckleberry - for the perpetual cultural, economic, and sovereign benefit of the CTUIR. We will accomplish this utilizing traditional ecological and cultural knowledge and science to inform: 1) population and habitat management goals and actions; and 2) natural resource policies and regulatory mechanisms.

Water Resources Program Mission Statement:
To ensure that ground and surface waters are available to satisfy CTUIR treaty rights, the needs of CTUIR members, and the citizens of the Umatilla Indian Reservation. Water Resources will accomplish this by implementing CTUIR Water Code procedures and regulations to promote sustainable water use and management.

The CTUIR monitoring program is in the Department of Natural Resources (DNR). This department is composed of the following programs (listed in order of First Foods):

- Administration
- Cultural Resources Protection
- First Foods Policy
- Water Resources
- Fisheries
- Wildlife
- Range, Agriculture, and Forestry
- Energy and Environmental Sciences

The CTUIR has been monitoring waters for at least 30 years.

The goals for water quality monitoring in the Umatilla River Basin include:

- identifying water quality parameters that exceed standards
- identifying locations where water quality is impaired
- determining the effectiveness of management changes and restoration activities implemented for the purpose of improving water quality
- determining stream conditions relative to water quality regulations and anadromous fish needs

Since the last approved Monitoring Strategy, CTUIR has added 2 continuous monitoring locations using YSI EXO1 and EXO3 multi-parameter probes which record temperature, conductivity, dissolved oxygen, pH, and turbidity. These stations were put in place to investigate if they could replace the ISCO stations which collect daily composite water samples for lab analysis.

Monitoring Objectives	
Program Area	**Objectives**
Overall Water Quality Program	1. Inventory and quantify existing water quality conditions for major parameters that may adversely impact beneficial uses for waters of the Umatilla Indian Reservation. 2. Address River Vision data gaps related to Touchstone Water and Water Quality. 3. Establish a monitoring network for multiple water quality parameters that is adequate to track changes to water quality condition over time. 4. Determine implementation effectiveness of the Umatilla River Basin TMDL/WQMP and CTUIR TMDL/WQMP. 5. Assess whether water quality criteria are being met and beneficial uses are being supported for waterbodies across the reservation. 6. Develop and refine water quality standards.
Nonpoint Source Program	1. Identify waters needing water quality improvement. 2. Setup and complete the collection of pre-treatment measures for effectiveness monitoring of specific instream, riparian, and watershed restoration projects for water quality improvement and anadromous fisheries populations. 3. Determine the effectiveness of individual NPS projects in meeting water quality criteria and supporting beneficial uses. 4. Evaluate cumulative watershed impacts from best management practice (BMP) installation.

III. Monitoring Design

Monitoring Design					
Program Area	**Design**	**# Sites**	**Frequency**	**Resources (optional)**	**Brief Program Description**
Overall Water Quality	Fixed station network for Turbidity (Isco)	3	Daily composite of 4 samples (every 6 hours)	1 FTE for 3 months	Daily composite samples for Turbidity, Conductivity, and Total Suspended Solids
	Fixed station network for Temperature seasonal	24 Water and 3 Air (for 2022)	May-October, hourly recording	1 FTE for 1 month	13 projects conduct temperature monitoring at different intervals to meet their data needs
	Fixed station network for Temperature year round	56 Water and 5 Air (for 2022)	Daily hourly recording	1 FTE for 2 months	13 projects conduct temperature monitoring at different intervals to meet their data needs
	Quarterly monitoring	27	4 times per year	1 FTE for 2 months	Reservation wide monitoring for base parameters, plus other parameters as funding allows
	Continuous monitoring multi-parameter sonde	2	Hourly recording	1 FTE for 1 month	Continuous monitoring at Reservation boundaries
	Special projects	Varies; as needed	Varies	Varies	Random monitoring as water quality condition questions arise
	Habitat monitoring	Varies	Varies	Varies	Monitoring by Fisheries program
	Macroinvertebrate	Varies	Varies	Varies	Monitoring by Fisheries program
NPS Effectiveness Monitoring	Restoration projects	Varies	Varies	Varies	Monitoring for restoration effectiveness as planned in project design
	BMP projects	Varies; as needed	Varies	Varies	Monitoring for BMP effectiveness as need arises

Brief Program Description:

Turbidity, Conductivity and Total Suspended Solids (TSS)

The CTUIR currently monitors turbidity, conductivity and TSS through the use of composite samplers manufactured by ISCO at three sites including the Umatilla River at Gibbon, Meacham Creek, and Isqúulktpe Creek (Meacham Creek will be re-established in 2022). In the record setting February 2020 floods, three sites were permanently lost: Umatilla River at the West Reservation boundary, Umatilla River at Yoakum, and Wildhorse Creek. The water samples collected from these sites are analyzed by CTUIR staff for turbidity, TSS and conductivity. Quarterly monitoring sites are also analyzed for turbidity with an YSI EXO1 multi-parameter sonde. Continuous monitoring of turbidity and conductivity with an YSI EXO1 multipara meter sonde occurs at 2 sites. Additional incidental monitoring may take place in association with specific project activity such as macroinvertebrate sampling or fish sampling.

Temperature

Stream temperature monitoring is conducted by several programs within DNR and OIT to address various objectives. Staff from WRP design, coordinate, implement, and QA/QC the data for temperature monitoring efforts of the CTUIR. In total, this effort encompasses 13 separate projects with a total of 80 loggers for 2022, both on and off Reservation (see table 2). Based on the sampling objectives and the risk of getting washed away during high flows, the sites may be year round or summer/fall high temperature only, collecting hourly data.

Quarterly monitoring

WRP began quarterly monitoring in 2004 at 27 fixed sites within Reservation boundaries four times per year, in approximately February, May, August, and November (see Table 1). Quarterly sampling involves taking field measurements of turbidity, dissolved oxygen, pH, water temperature, and conductivity with an YSI EXO1 multipara meter sonde, along with the collection of water column samples for laboratory testing. For 2022-2026, WRP will test for E.coli, total nitrogen, total phosphorus, and total Kjeldahl nitrogen at all 27 quarterly monitoring sites. In addition, 4 of the 27 sites will be tested for arsenic to better quantify the metals levels in those streams. During the May sampling, all 27 sites will be tested for low level mercury.

Continuous monitoring with multipara meter sonde

WRP installed an YSI EXO1 multipara meter sonde at The Umatilla River at East Boundary in 2014. Multiple problems with vandalism have occurred at this site. The site was relocated downstream in 2021 due to damage at the site from the February 2020 floods. Attempts have been made to connect this site to the GOES satellite (Geostationary Operational Environmental Satellite operated by NOAA) to collect real-time data. Problems with power and sun exposure have prevented the successful connection to the GOES satellite. Currently, the data from this site is offloaded manually. WRP installed an YSI EXO3 multipara meter sonde at the Umatilla River at West Boundary in 2018. This site is currently uploading data to the GOES satellite (Geostationary Operational Environmental Satellite operated by NOAA). The data is retrieved weekly by the CTUIR server.

Both sites collect hourly data for pH, temperature, conductivity, turbidity, and dissolved oxygen.

Special Projects

When the results of quarterly monitoring indicate further testing is needed, or water quality questions are brought to WRP, special projects are developed as a short term water quality investigation. In the past, special projects have included E. coli investigations to determine the source of E. coli contamination, an in-depth water quality characterization of Lake Hiyuumptipin (Indian Lake) in 2007, and TSS monitoring for NPDES permit compliance at the South Fork Walla Walla River Hatchery.

Habitat monitoring

Site Level Habitat Surveys: CTUIR implements site level habitat surveys using a combination of Columbia Habitat Monitoring Program (CHaMP) and Action Effectiveness Monitoring (AEM) data collection methodology (CHAMP 2016). Habitat sample site lengths are equal to 20x the established average bankfull width of the stream. Habitat surveys consist of a simultaneous topographical and auxiliary data survey. Auxiliary data is collected at the channel unit, transect, and site level. The topographic survey is processed through a suite of GIS tools that were created for the CHaMP program. CHaMP and AEM methods provide standardized metrics that can be used to measure response variables in salmonid habitat. Metrics generated from habitat surveys are referenced in the 2019 Biological Effectiveness Monitoring Annual Progress Report (Costi et al 2019).

Rapid Instream Physical Habitat Assessments

In 2019, a new method was tested at select sites, and will be implemented in 2022 or 2023. These methods are based on the Physical Habitat Monitoring Strategy (PHaMS) (Jones et al 2015), which is based on the CTUIR River Vision (Jones et al 2011) and First Foods paradigm (Quaempts et al 2018) and reinforces the Tribe's capacity to develop and implement sound science in support of the Tribal community. A subset of physical habitat monitoring methods were selected to streamline the on the ground sampling protocols for evaluating restoration effectiveness. This approach's intent is to characterize in-stream fish habitat under the Geomorphology touchstone (Table 3) utilizing metrics with high correlation to increased habitat suitability values in a more efficient on the ground data collection effort.

Macroinvertebrate monitoring

CTUIR uses a combination of drift sampling in accordance with Columbia Habitat Monitoring Program (CHaMP) methodology, and targeted riffle sampling as described in Benthic Macroinvertebrates (Peck et al. 2006). Macroinvertebrate sampling for the Meacham Creek Restoration Project has been contracted to Hermiston Agricultural Research & Extension Center, Oregon State University, David Wooster.

Restoration Projects

Restoration projects are often designed with a water quality monitoring component. The number of monitoring sites, sampling frequency, and resources necessary to complete the monitoring varies with each restoration project. Currently, stream temperature is monitored at 9 sites as part of the Meacham Creek restoration project to provide both inventory information and to detect project effectiveness. These temperature loggers are operated from June to September to measure maximum stream temperatures and diurnal fluctuations.

BMP projects

To measure BMP effectiveness, water quality samples are taken before and after BMP implementation at select BMP projects, as needs arise and funding allows.

Table 1: CTUIR monitoring site locations for various sample methods in the Umatilla River Basin

Monitoring Site	River Mile	Sample Method (1)
Umatilla River d/s East UIR Boundary	79.3	Q, I
Umatilla River at Imeques fish facility	78.4	C
Meacham Creek at Bingham Rd Bridge	0.25	Q, I
Isqúulktpe Creek at USGS gage	2.0	Q, I
Buckaroo Cr at UPRR bridge off Cayuse Rd	0.3	Q
Umatilla River at Thorn Hollow Bridge	71.9	Q
Coonskin Creek at Cayuse Road	0.3	Q
Umatilla River abv Cayuse Bridge	66.1	Q
Moonshine Creek at Cayuse Road	1.0	Q
Cottonwood Creek at Cayuse Road	1.36	Q
Unnamed Tributary abv Minthorn Springs at Cayuse Road	0.9	Q
Mission Creek at Wa Wa Ne Lane	0.3	Q
Umatilla River at Hwy 331 Bridge	58.5	Q
Umatilla River at West UIR Boundary	55.2	Q, C
Wildhorse Creek above Eagle Creek	24.0	Q
Spring Hollow Creek at LaCourse Rd	1.7	Q
Crawford Hollow Creek at Mann Rd	1.6	Q
Patawa Creek at Goad Road	2.5	Q
South Coyote Creek at Goad Road	0.8	Q
Tutuilla Creek at Goad Road	5.9	Q
NF McKay Creek at USGS gage	0.5	Q
McKay Creek at McKay Creek Rd Br	21.7	Q
McKay Creek west of Sumac Grade Rd	17.7	Q
McKay Cr at West UIR Boundary (Stanley)	14.9	Q
Jennings Creek above Lake Hiyuumptipin	0.2	Q
Lake Hiyuumptipin boat ramp	NA	Q
East Unnamed Trib to Lake below culvert	0.2	Q
Lake Hiyuumptipin at spillway	NA	Q

(1) I – ISCO water sampler; Q – Quarterly Monitoring site; C – Continuous using YSI sonde

Table 2: CTUIR Temperature monitoring locations 2021

Stream	Location	Year Round Type	Est. River Mile	CTUIR Project (1)
NF Umatilla River	downstream of Coyote Cr	---	2.7	UBNPME
Umatilla River	downstream of Forks at Corporation	---	87.5	UBNPME
Umatilla River	at Bar M Ranch	---	80.5	UBNPME
Umatilla River	upstream of Ryan Cr	---	80.25	UBNPME
Umatilla River	downstream of Ryan Cr near UIR bndry	Water	80.2	WRP
Umatilla River	near UIR East boundary / ISCO	Water	79.3	MUSSEL
Umatilla River	near UIR East boundary / ISCO; AIR	---	79.3	WRP
Umatilla River	at Imeques facility fish trap	Water	78.4	UBNPME
Meacham Creek	at Duncan lower site	Water	11.6	MSHE
Meacham Creek	Control above Habitat project	Water	9.75	BioMonitoring
Meacham Creek	near Treatment 1; AIR	AIR	5.7	WRP
Meacham Creek	Treatment 1	Water	5.6	BioMonitoring
Meacham Creek	Treatment 2	Water	3.2	BioMonitoring
Boston Canyon Cr	at Bonifer Pond off Meacham Cr	Water	2	MSHE
Meacham Creek	at new USGS gage / fish trap	Water	1.3	UBNPME
Isqúulktpe Creek	abv Little Isqúulktpe Cr	---	7	WILDLIFE
Isqúulktpe Creek	above end of road	---	5.5	WILDLIFE
Isqúulktpe Creek	above end of road; AIR	---	5.5	WILDLIFE
Isqúulktpe Creek	above Bachelor Canyon	---	3.8	WILDLIFE
Isqúulktpe Creek	at USGS gage	Water	2.0	WILDLIFE
Isqúulktpe Creek	at USGS gage; AIR	---	2.0	WRP
Isqúulktpe Creek	near mouth; AIR	AIR	0.1	WRP
Umatilla River	at Thorn Hollow fish facility	---	72	UBNPME
Umatilla River	Wujek Control	Water	69.5	BioMonitoring
Umatilla River	upstream of Coonskin Cr	Water	67.2	WRP
Umatilla River	upstream of Coonskin Cr; AIR	AIR	67.2	WRP
Umatilla River	Wujek Treatment	Water	67	BioMonitoring
Umatilla River	above Cayuse Bridge	Water	66.1	MSHE
Umatilla River	above Minthorn Springs	Water	63.1	MSHE
Minthorn Springs	fish facility in pump house spring box	Water	62.3	LAMPREY
Minthorn Springs	north of facility; AIR	AIR	62.4	WRP
Wildhorse Creek	off Hwy 335 bridge abutment	Water	6.9	MUSSEL
Umatilla River	above Mission Falls	Water	59.05	MSHE
Umatilla River	downstream of Hwy 331 / Mission levee	Water	57.1	WRP
Umatilla River	at west UIR boundary near ODFW pen	Water	55.3	WRP
Umatilla River	at west fish facility at YSI West site	Water	55.25	WRP
Umatilla River	at City's water Intake facility	Water	54.1	WRP
Umatilla River	at RV park below SE 8th St in Pendleton	Water	53.2	WRP
Umatilla River	downstream of McKay Cr off levee	Water	49.7	WRP
NF McKay Creek	near upper cabin at Bell Cow Cr	---	4.5	UBNPME
NF McKay Creek	at old USGS gage building	---	0.5	UBNPME
McKay Creek	off McKay Cr Rd bridge	---	21.7	UBNPME

McKay Creek	off bridge just below Sumac Rd	---	17.7	UBNPME
McKay Creek	off bridge on Rockwell Rd	---	12.4	UBNPME
Umatilla River	upstream of Reith bridge	Water	47.9	WRP
West Birch Creek	off Yellow Jacket Rd at bridge	Water	5.85	HABITAT
West Birch Creek	at Hwy 395 bridge	Water	2	HABITAT
Pearson Creek	above East Birch Cr	Water	0.15	HABITAT
East Birch Creek	below Pearson Cr	Water	9.7	HABITAT
East Birch Creek	in Pilot Rock at stream gage	Water	0.03	HABITAT
West Birch Creek	in Pilot Rock below gage	Water	0.1	HABITAT
Birch Creek	in Pilot Rock below confluence	Water	15.95	HABITAT
Birch Creek	at Hoeft Road	Water	10.11	HABITAT
Birch Creek	at Korvola Road	Water	3.4	HABITAT
Birch Creek	P4 Control down from Korvola Rd	Water	2.7	BioMonitoring
Birch Creek	down from Taylor Br near fish trap	Water	0.3	HABITAT
Umatilla River	at Forth property near Coombs Canyon	Water	46.1	HABITAT
Umatilla River	at Becker property off L&W Lane	Water	43.1	HABITAT
Umatilla River	near Barnhart	---	41.8	UBNPME
Umatilla River	near Barnhart; AIR	AIR	41.8	WRP
Umatilla River	at Yoakum Bridge at gage	Water	36.2	WRP
Umatilla River	at Cottonwood Bend in Hermiston	Water	13.1	LAMPREY
Umatilla River	at Three Mile Dam East	Water	3.6	PASSAGE
Umatilla River	at I-82 lamprey fish trap	Water	1.75	LAMPREY
Walla Walla River	lower site near Wallula Junction	Water	5.3	Mussel
SF Walla Walla Rv	across from facility	Water	5.1	HATCHERY O&M
SF Touchet River	RM 7 Project Control	Water	8.5	BioMonitoring
SF Touchet River	RM 7 Project Treatment	Water	7.1	BioMonitoring
Indian Creek	off Philberg Road	Water	0.2	Mussel
Granite Creek	Control	Water	1.3	BioMonitoring
Granite Creek	Treatment	Water	12.4	BioMonitoring
Desolation Creek	Control 2	Water	25.4	BioMonitoring
Desolation Creek	Treatment 2	Water	18	BioMonitoring
NF John Day River	at lower gold dredge campsite	Water	110.7	Mussel
NF John Day River	off Hwy 395 near NF-015 Road	Water	93.7	Water Rights

(1) UBNPME – Umatilla Basin Natural Production Monitoring and Evaluation; MSHE – Multi Scale Hyporheic Exchange; WRP – Water Resources Program

Table 3: Select methods and metrics to represent Geomorphology in the Fish Habitat field data collection protocol.

Touchstone	Objective	Method	Metrics
Geomorphology	Instream channel complexity and fish habitat creation and diversity	Channel Segment Classification	Length and number of side channels within site, braided channel ratio
		Channel Unit Classification	Count of channel units by type Tier I and Tier 2
		Measuring Large Wood Pieces	Large Wood Counts and Volumes by Site and Channel Unit
		Modified Topographic Point Collection	Wetted Area by site and channel unit type, unit type percent, frequency and ratio, thalweg profile, pool depth calculations

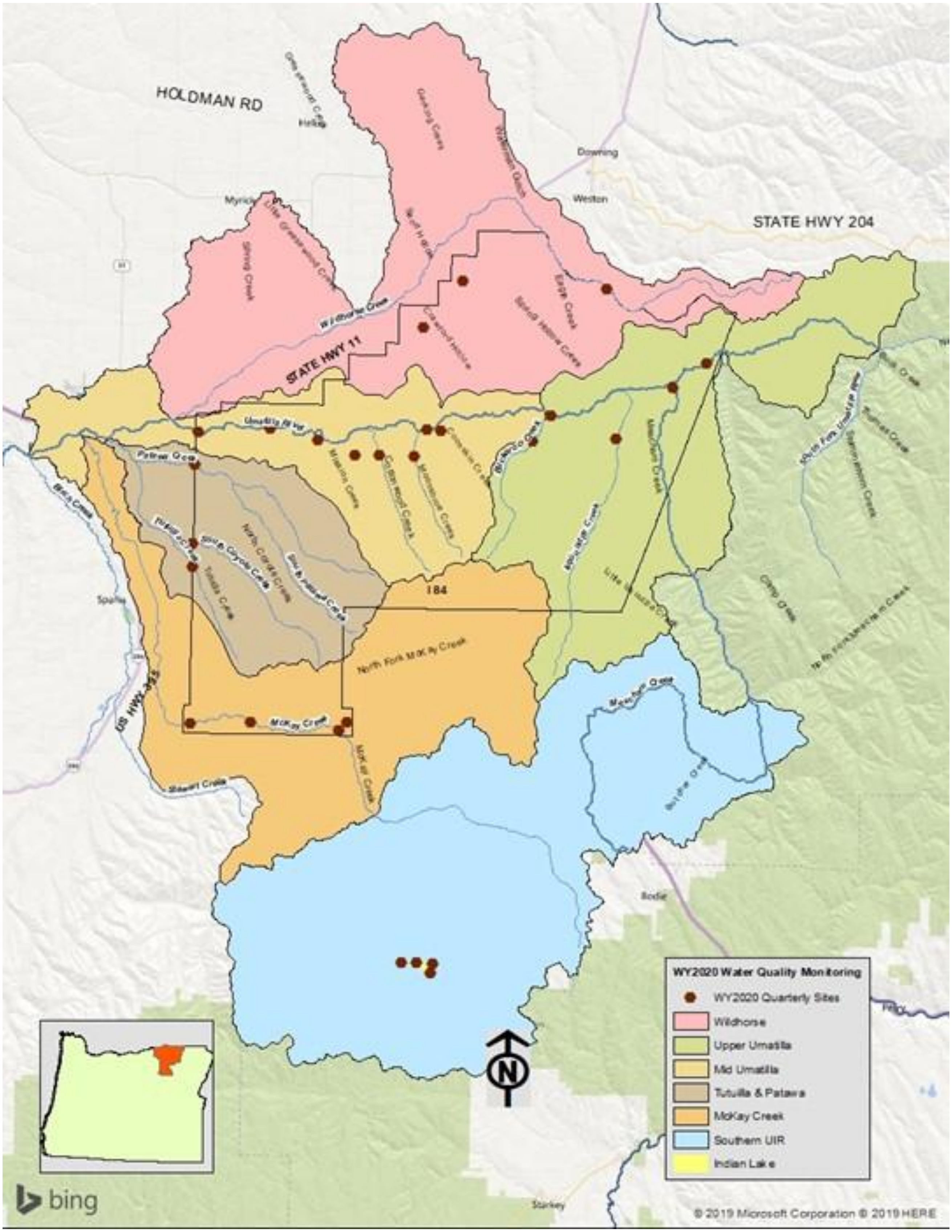

HOLDMAN RD
STATE HWY 204
STATE HWY 11
Downing
Weston
I 84
WY2020 Water Quality Monitoring
WY2020 Quarterly Sites
Wildhorse
Upper Umatilla
Mid Umatilla
Tutuilla & Patawa
McKay Creek
Southern UIR
Indian Lake
© 2019 Microsoft Corporation © 2019 HERE

Figure 1: Quarterly Monitoring Sites

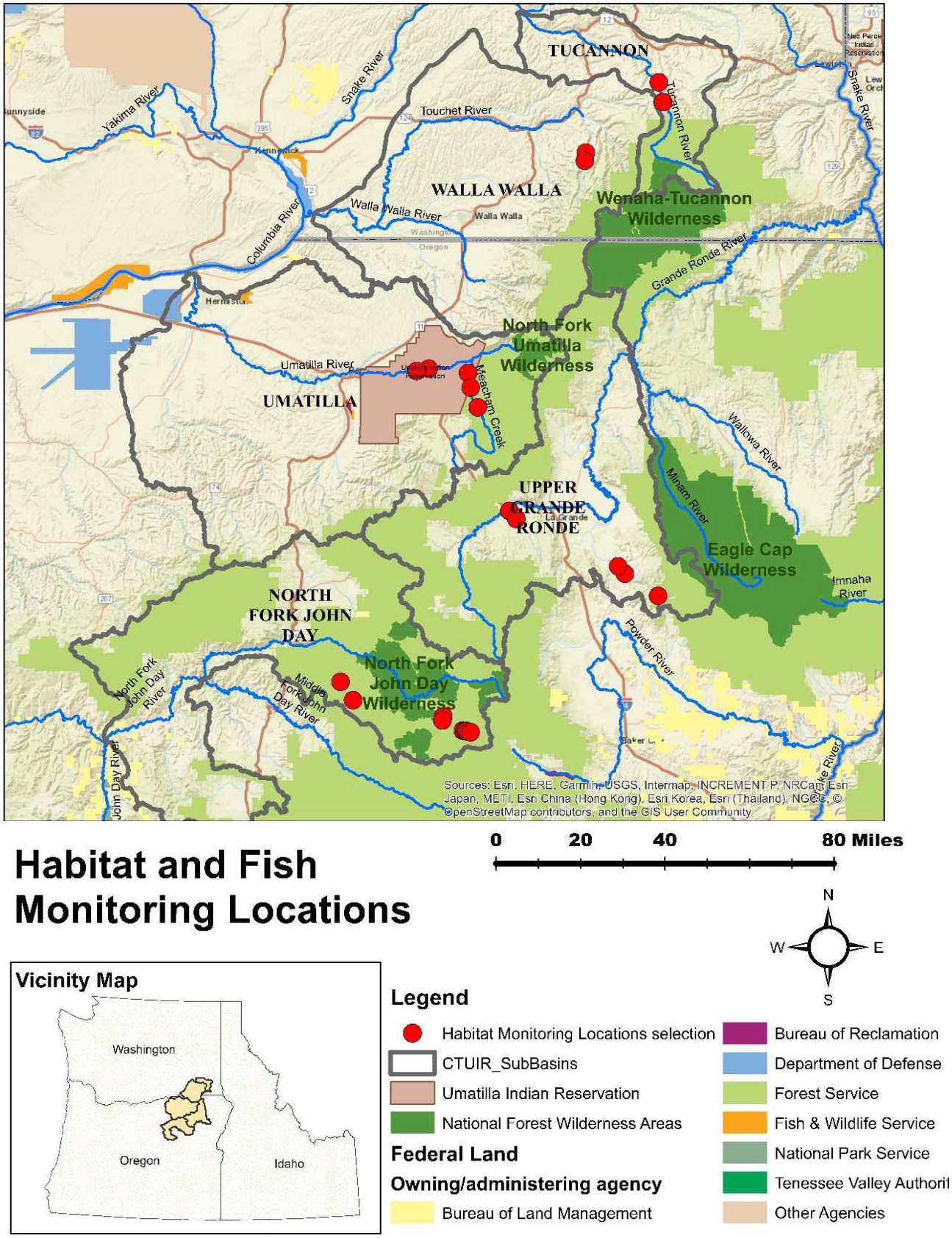


Figure 2. Monitoring locations across the five Confederated tribes of the Umatilla Indian Reservation subbasins.

IV. Core and Supplemental Water Quality Indicators

The following is a description of water quality parameters that have been considered for inclusion to the CTUIR water quality monitoring program.

A. Temperature and Rationale for Monitoring

Water temperature is a critical parameter for cold water biota and a limiting factor for anadromous salmonids. Temperature has been identified as a parameter that is functionally linked to streamside shade, channel morphology and ground water input and as such is a good surrogate for land-use influences on water quality. Temperature is considered to be the most ubiquitous and limiting NPS pollution parameter in the Umatilla River Basin. (Umatilla/Willow Subbasin Plan, 2004)

B. Turbidity and Rationale for Monitoring

Turbidity is an indicator of the property of water that causes light to become scattered or absorbed. Turbidity limits recreational use of the water body and impacts aquatic organisms by limiting sight feeding capability, abrading sensitive organs, covering non-mobile life history forms (e.g. salmonid eggs) and impeding primary productivity in the form of aquatic algae and photosynthetic plants. High turbidity is also associated with adverse affects to municipal drinking water supplies as seen with the seasonal restrictions applied by the City of Pendleton.

A relationship can be established between turbidity and the concentration of total suspended solids (TSS). This relationship must be established for each specific monitoring site by developing a rating curve. Since it is relatively simple to analyze a water sample for turbidity, this relationship with TSS adds utility to the measurement of turbidity. Total load of suspended sediment can then be related to turbidity through this relationship if stream discharge is known.

C. Sediment and Rationale for Monitoring

Suspended sediment load and bedload are a result of both natural and human influenced erosional processes. These processes can be influenced by human activity in a way that may cause sediment loads to exceed standards. High levels of bedload movement and load can alter aquatic invertebrate populations and assemblages, adversely impact salmonid eggs by covering and limiting oxygen supply to them, and cause stream morphology alterations that affect large areas of the watershed.

Total suspended sediment (TSS) is a measure of the concentration of all inorganic material (non-combustible) being carried in the water column. TSS is measured at the CTUIR laboratory for each water sample taken by the ISCO's. Each TSS measurement is then related to a turbidity measurement.

D. Conductivity and Rationale for Monitoring

Specific conductance is a measure of the ability of water to conduct electrical current. Conductivity increases proportionally with concentrations of dissolved solids. The utility of this measure is in developing an approximated relationship between conductivity and total dissolved solids (TDS), although this must be developed for each specific monitoring site. TDS is a measure of the concentration of ions in

the water column that is determined by the chemical make up of the weathering geology and the rate of evaporation. Conductivity measures are used as a very general indicator of water quality limitations. Specific conductivity in excess of 2000 μmhos/cm indicates a TDS level that is too high for most freshwater fish.

E. Fish Habitat and Rationale for Monitoring

Fish Habitat metrics are monitored to evaluate the effectiveness of in-stream treatments in Meacham Creek and other planned projects implemented by the Fisheries Program, and thus help to improve habitat conditions for anadromous and resident fishes. In most of the Umatilla Subbasin fish production and abundance is limited to a great extent by the availability of quality essential fish habitat, especially in terms of water temperature regimes, cover, and woody debris. Several projects are focused on the restoration of this habitat using standard techniques for riparian and in-stream habitat modification. There is a great need to understand the benefits of these management actions on target species, but this question is complicated by 1) environmental variability, 2) concurrent hatchery, harvest, hydrosystem, and habitat actions, and 3) problems of scale associated with the large movement rates of focal species.

F. Dissolved Oxygen and Rationale for Monitoring

Dissolved oxygen (DO) is a critical parameter for aquatic life. DO is intimately linked to other water quality parameters, such as temperature, and has been monitored throughout the Umatilla River Basin, including the Umatilla Indian Reservation.

Several indicators will be used to determine when and where DO concentrations do not meet water quality standards. Absolute concentration of DO in a water body is directly related to temperature, and high water temperatures may indicate a problem with DO. Another related indicator if DO is oxygen demand. High oxygen demand and DO deficiencies can be related to algal blooms or high loads of decomposing organic matter. High oxygen demand has also been associated with high sedimentation.

G. pH and Rationale for Monitoring

Stream pH measures the acidity of a stream and the concentration of hydrogen and hydroxide ions in the water. Aquatic organisms have a particular range of pH in which they can flourish. pH affects the growth stages of the stream habitat. pH is affected by other parameters, such as temperature, nutrients and algal growth.

H. Nutrients and Rationale for Monitoring

Nutrients are essential to the health and diversity of our surface waters. However, in elevated concentrations, nutrients can cause an excessive growth of plant life or can result in potential human health risks. Chronic nutrient over-enrichment of a water body can lead to the following consequences: low dissolved oxygen, fish kills, algal blooms, overabundance of macrophytes, likely increased sediment accumulation rates, and species shifts of both flora and fauna. EPA has completed some case studies in a few areas and has issued guidance on primary nutrient parameters to be considered for water column concentration including nitrate, nitrite, total phosphorus, total Kjeldahl nitrogen, Chlorophyll *a*, and turbidity.

I. Pathogens and Rationale for Monitoring

Coliforms bacteria are found in the intestinal tract of warm-blooded animals but can also be associated with natural plant material. Total coliform bacteria can be divided into a few subgroups, some of which cause diseases in humans. Fecal coliform are able to grow at a high temperatures, compared to other

forms of coliforms. *E. coli* coliform, another subgroup of the total coliform bacteria, is a bacterium that only grows in the digestive tract of warm-blooded animals, and that cause diseases.

J. Metals and Rationale for Monitoring

Heavy metals in a stream are generally persistent and hazardous to any aquatic organism and to human health. Metals such as mercury, lead, chromium, and cadmium may originate in industrial discharges, runoff from streets, mining activities, leachate from landfills, and other sources. Agricultural activities can contribute to heavy metal pollution as these elements are contained in some pesticides and as trace ingredients of fertilizer. The polluting potential of heavy metals depends not only on their concentration in water but also on the form in which they are present. The conditions favoring the formation of metal ions (e.g., a low pH value for many metals) increase the risk of contamination. The precipitation of heavy metals or their absorption in sediment or suspended particles can also pose a long-term risk as heavy metal ions can be liberated if conditions favorable to solubilization occur.

Metals have acceptable limits defined within the Tribal Standards, proposed in order to protect some aquatic species and to avoid bioaccumulation. WRP monitors water column samples to understand and assist with the attainment of metal standards on the Reservation. The sampling plan has been refined using the results from extensive sampling in the past due to budget limitations. The metals sampling has been limited to arsenic at 4 sites and low level mercury for one sampling per year (May quarterly sampling).

K. Macroinvertebrates and Rationale for Monitoring

An examination of macroinvertebrate communities plays an important role in understanding water quality conditions. They serve important roles in both aquatic and terrestrial food webs and perform many ecosystem functions including decomposition, nutrient cycling, pollination, seed dispersal, provide a linkage between the stream and riparian area, and are a main staple for many fish. Measuring their type and abundance is also a useful bio-assessment tool because of their rapid generation times and relatively small home range. Effectiveness of project actions are more quickly reflected in macroinvertebrate population changes than other classes of biological species.

Frequency of Monitoring

A. Temperature

Four different types of thermographs (all manufactured by Onset) are being used to record stream temperatures depending upon age of temperature logger and program. Annually all devices are set to record data on an hourly basis. Seasonal loggers record during the summer field season, at a minimum between June 1 and October 31. Field audits are conducted mid-summer and data is downloaded for analysis at the end of every monitoring season. Year round loggers are deployed the entire year, with field checks in the spring, summer, and fall. Data is downloaded twice a year. Year round loggers run a higher risk of instrument loss during high flow events.

B. Turbidity

The ISCO water samplers collect daily composite samples. Each daily sample is a collection of 4 individual samples taken every 6 hours. Samples are collected on a 3-week basis and taken to the CTUIR Laboratory and analyzed for turbidity, total suspended solids, and conductivity. The 3 ISCO stations located within the Umatilla Indian Reservation are at the Umatilla River at East Boundary, Meacham Creek, and Isqúulktpe Creek, and are collected for the entire year. (The February 2020 floods caused a permanent loss of 3 ISCO monitoring stations).

Quarterly sampling in February, May, August, and November includes a field reading of turbidity using an YSI EXO1 multi-parameter sonde.

Continuous monitoring with an YSI EXO1 or EXO3 multi-parameter sonde includes turbidity and occurs at Umatilla River at East Boundary and Umatilla River at West Boundary. The sondes are set to record at 1 hour intervals.

C. Sediment

Water samples collected by the ISCO samplers are analyzed for TSS. The frequency of sampling is described above, under B. Turbidity.

D. Conductivity

Water samples collected by the ISCO samplers are analyzed for specific conductivity. The frequency of sampling is described under B. Turbidity.

Quarterly sampling in February, May, August, and November includes a field reading of conductivity using an YSI EXO1 multi-parameter sonde.

Continuous monitoring with an YSI EXO1 or EXO3 multi-parameter sonde includes conductivity and occurs at Umatilla River at East Boundary and Umatilla River at West Boundary. The sondes are set to record at 1 hour intervals.

E. Fish Habitat

Habitat surveys are performed every summer, with locations selected from habitat restoration project control and treatment sites using guidance from the CTUIR biomonitoring site selection protocol (Stillwater 2012).

F. Dissolved Oxygen

Quarterly sampling in February, May, August, and November includes a field reading of dissolved oxygen using an YSI EXO1 multi-parameter sonde.

Continuous monitoring with an YSI EXO1 or EXO3 multi-parameter sonde includes dissolved oxygen and occurs at Umatilla River at East Boundary and Umatilla River at West Boundary. The sondes are set to record at 1 hour intervals.

G. pH

Quarterly sampling in February, May, August, and November includes a field reading of pH using an YSI EXO1 multi-parameter sonde.

Continuous monitoring with an YSI EXO1 or EXO3 multi-parameter sonde includes pH and occurs at Umatilla River at East Boundary and Umatilla River at West Boundary. The sondes are set to record at 1 hour intervals.

H. Nutrients

Quarterly sampling in February, May, August, and November includes a laboratory analyzed water sample for total nitrogen, total phosphorus, and total kjeldahl nitrogen.

I. Pathogens

Quarterly sampling in February, May, August, and November includes a laboratory analyzed water sample for E. coli. Random water samples for E. coli analysis are taken on an as needed basis.

J. Metals

Quarterly sampling in February, May, August, and November includes a laboratory analyzed water sample for arsenic at 4 of the quarterly sampling locations. During the May quarterly sampling collection, all sites are analyzed for low level mercury.

K. Macroinvertebrates

Some form of macroinvertebrate monitoring will be conducted annually, in locations selected for habitat restoration projects. The Biomonitoring Project in the CTUIR DNR Fisheries program is undergoing a staffing change, and the macroinvertebrate monitoring will most likely be contracted to David Wooster at the Hermiston Agricultural Research and Extension Center.

Indicator Sampled by Water Resource Type and Program Area										
Water Resource Type and/or CWA Program Area and/or Monitoring Objectives	DO	Temperature	pH	Turbidity	Nutrients (TP/ TN)	Habitat	Macro inverts.	Pathogens	Conductivity	Flow
Overall Water Quality	X	X	X	X	X	X	X	X	X	X
NPS Effectiveness Monitoring	X	X	X	X	X	X	X	X	X	X

V. Quality Assurance

Quality Assurance Documents			
Type	**Title**	**Completion Date**	**EPA Approval/Date**
SOP	Protocol: Benthic Macroinvertebrates Sampling for CTUIR Biological Monitoring of Fish Habitat Action Effectiveness v2.0 https://www.monitoringresources.org/Document/Protocol/Details/3451	2020	N/A
SOP	Protocol: Drift Macroinvertebrates Sampling for Biological Monitoring of Fish Habitat Action Effectiveness v1.0 https://www.monitoringresources.org/Document/Protocol/Details/3400	2018	N/A
SOP	Protocol: Site Level Stream Habitat Assessment Survey v1.0 https://www.monitoringresources.org/Document/Protocol/Details/1955	2019	N/A
SOP	Scientific protocol for salmonid habitat surveys within the Columbia Habitat Monitoring Program (CHaMP)	2013	N/A
SOP	Physical habitat monitoring strategy (PHaMS) for reach-scale effectiveness monitoring: U.S. Geological Survey Open-File Report 2015-1069, http://dx.doi.org/10.3133/ofr20151069.	2015	N/A
QAPP	CTUIR Surface Water QAPP	January 2007	2007
SOP	Water Quality Monitoring Guide Book, The Oregon Plan for Salmon and Watersheds	2001	N/A
SOP	USFS Sampling Procedures for Analysis of Isco Collected Samples	1997	N/A
Operators Manual	EXO User Manual Item#603789REF, Revision K	2020	N/A
Operators Manual	Model 3700 Portable Sampler Instruction Manual, ISCO	1996	N/A

VI. Data Management

The CTUIR OIT Department/GIS Program is responsible for data management for the Tribe.

Data Management				
Water Resource Type and/or CWA Program Area and/or Monitoring Objectives	**Data Management –on site**	**WQX**	**Land use data**	**Geo-referencing**
Overall Water Quality	Comprehensive Data Management System (CDMS) CTUIR GIS	CTUIR GIS uploads the data from CDMS to WQX once a year, in December/January.	CTUIR OIT-GIS is responsible for land use data. USGS topo maps 1:24,000. Bing imagery 1:1000	Yes, sample locations are mapped using GPS points in ArcGIS.
NPS Effectiveness Monitoring	Comprehensive Data Management System (CDMS) CTUIR GIS	CTUIR GIS uploads the data from CDMS to WQX once a year, in December/January.	CTUIR OIT-GIS is responsible for land use data. USGS topo maps 1:24,000. Bing imagery 1:1000	Yes, sample locations are mapped using GPS points in ArcGIS.

VII. Data Analysis/Assessment

The CTUIR uses the CTUIR GIS department database (CDMS) to store and manage data. Reports are derived from the CDMS to analyze data for the CTUIR Tribal Assessment Report and other reports to funding agencies as well as the CTUIR leadership and staff.

We also use data from the following sources:

Partners' Data	
Source	**Type**
US Geological Services	Flow
US Bureau of Reclamation	Flow
Oregon Water Resources Department	Flow
National Weather Service	Rainfall, air temperature
Columbia Plateau Conservation Research Center (CPCRC)	Rainfall, air temperature
USDA Agriculture Research Service (ARS)	Rainfall, air temperature
National Water and Climate Center (NWCC)	Snow telemetry network (SNOTEL)
US Forest Service	Stream temperature
Oregon Dept. of Fish & Wildlife	Stream temperature

The Tribe currently follows the following document for analysis of attainment of water quality standards:
Confederated Tribes of the Umatilla Indian Reservation
Listing Methodology for the Tribal List of Water Quality Limited Streams
April 7, 2009

VIII. Reporting

Tribal Reports			
Report	**Timeframe**	**Entities receiving copies of the report**	**Comments**
Tribal Assessment Report	Bi-Annual on odd years	EPA	Incorporates reporting requirements of CWA Sections 303(d), 305(b), and 314
Surface Water Quality Report for the CTUIR	Annual	CTUIR DNR Director, CTUIR DNR Program Managers, Tribal Water Commission	Includes quarterly, continuous multi-parameter sonde, and ISCO data.
Fish Habitat Enhancement Biological Effectiveness Annual Progress Report	Annual	BPA	Includes reporting of monitoring results related to fish habitat and macroinvertebrate projects
Umatilla Basin Natural Production Monitoring and Evaluation Project Annual Progress Report	Annual	BPA	Includes temperature reporting

IX. Programmatic Evaluation

The CTUIR uses the River Vision to review existing monitoring programs and identify data gaps. This process does address programmatic coordination and evaluate the effectiveness of monitoring and assessment programs.

Each program does evaluate its data needs and identify gaps and priorities that may be changing due to resource limitations, new and emerging issues and changing program objectives. This occurs as part of our Annual Work Plan process. This is part of a continuous improvement feedback loop.

The CTUIR Water Monitoring Strategy will be updated every 5 years, or sooner if there are major changes.

X. General Support and Infrastructure

	Staffing	Training	Equipment	Lab resources
Current objectives or programs	# of FTEs: Water Quality Technician, Water Quality Specialist, Water Quality Coordinator, Fisheries Biologist, Fisheries Technicians, Database Manager	Various, depending upon position needs	Isco 3700 Water Sampler; YSI EXO1 and EXO3 multi-parameter sondes and handheld units; Onset HOBO Water Temperature Pro v2, TidbiT v2, and Bluetooth MX2203 and MX2201 TidbiT models; Onset Hobo shuttle; IPhones; Solar panels; Yagi antennas; Water Log Storm3-GOES Turn Key system; Hach 2100 Turbidimeter; Vacuum manifold assembly; drying oven; Sartorius balance scales; Hach Model 44600 Conductivity meter; 2-3 GSA vehicles; desktop computers; laptop computers; hand and power tools.	Daily composite samples are analyzed in house for turbidity, conductivity, and TSS. Samples are sent to outside labs for turbidity, nutrients, metals, and pathogens. Turbidity and conductivity are also analyzed on site with the YSI EXO1 sonde during Quarterly Monitoring. DO, temperature, pH, habitat, macroinvertebrates, and flow are identified in house by staff and/or contractors.
Future (all objectives)	GIS Technician Lab technician	GIS, statistics, lab analysis for nutrients and metals	boat with electric motor	Toxins, nutrients, metals, pathogens DNR-EESP lab is working towards certification for water sample analysis.

References

CHaMP (Columbia Habitat Monitoring Program). 2016. Scientific protocol for salmonid habitat surveys within the Columbia Habitat Monitoring Program. Prepared by CHaMP for the Bonneville Power Administration, Portland, Oregon.

Costi, K., and A. Wildbill, and G.E. Shippentower 2019. Fish Habitat Enhancement Biological Effectiveness Monitoring, 2019 Annual Progress Report. Confederated Tribes of the Umatilla Indian Reservation, 46411 Ti'Mine Way, Pendleton, OR. Report submitted to Bonneville Power Administration, Project No. 2009-014-00 Contract 73982 REL 83

DeBano, S. and Wooster, D., 2004. Umatilla/Willow subbasin plan. Northwest Power and Conservation Council, Portland, Oregon.

Jones, K.L., Poole, G.C., Quaempts, E.J., O'Daniel, S. and Beechie, T.J., 2011. The Umatilla River Vision. Confederated Tribes of the Umatilla Indian Reservation, Department of Natural Resources.

Jones, K.L., O'Daniel, S.J., Beechie, T.J., Zakrajsek, J. and Webster, J.G., 2015. Physical Habitat Monitoring Strategy (PHAMS) for reach-scale restoration effectiveness monitoring. US Department of the Interior, US Geological Survey.

Peck, D.V., Herlihy, A.T., Hill, B.H., Hughes, R.M., Kaufmann, P.R., Klemm, D.J., Lazorchak, J.M., McCormick, F.H., Peterson, S.A., Ringold, P.L., Magee, T., & Cappaert, M.R. 2006. Benthic Macroinvertebrates. Environmental Protection Agency. Pages 203-223

Quaempts, E.J., Jones, K.L., O'Daniel, S.J., Beechie, T.J. and Poole, G.C., 2018. Aligning environmental management with ecosystem resilience. Ecology and Society, 23(2).

Stillwater Sciences. 2012. Biological effectiveness monitoring and evaluation plan for fisheries habitat enhancement in CTUIR subbasins. Draft Report. Prepared by Stillwater Sciences, Portland, Oregon for Confederated Tribes of the Umatilla Indian Reservation, Pendleton, Oregon.