Sampling and Analysis Plan

Volunteer Water Quality Monitoring:

Upper Deschutes Subbasin Water Quality Monitoring Project

Submitted to: Nick Haxton-Evans

Prepared by:
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Upper Deschutes Watershed Council
June 2025

State of Oregon
DEQ Department of Environmental Quality

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Project Approvals

Prepared by:

_____ **Date:** _____

Lauren Mork, Monitoring Program Manager, Upper Deschutes Watershed Council

Prepared by:

_____ **Date:** _____

Casey Schuder, Stream Restoration Project Manager, Upper Deschutes Watershed Council

Reviewed by:

_____ **Date:** _____

Ben Hamilton, DEQ Quality Assurance Officer (QAO)

Approved by:

_____ **Date:** _____

Nick Haxton-Evans, Volunteer Monitoring Program Coordinator

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1. Project Management

1.1. Distribution List

The following individuals and their organizations will receive a copy of this SAP (Table 1). The most current version of this Sampling and Analysis Plan (SAP) will be publicly accessible on the UDWC website at www.restorethedeschutes.org or by contacting the DEQ QAO listed in Table 1.

Table 1 Distribution List

Name	Phone	Email
Lauren Mork, UDWC Monitoring Program Manager	541-382-6103 x4	lmork@restorethedeschutes.org
Casey Schuder, UDWC Stream Restoration Project Manager	541-382-6103 x6	cschuder@restorethedeschutes.org
Ben Stout, ODFW Mitigation and Enhancement (M&E) Program Biologist	541-388-6363	Jesse.B.Stout@coho2.dfw.state.or.us
Nick Haxton-Evans, DEQ Volunteer Monitoring Program Coordinator	971-806-2462	nick.haxton-evans@deq.oregon.gov
Ben Hamilton, DEQ Field QAO	503-839-6551	benjamin.t.hamilton@deq.oregon.gov

1.2. Project/Task Organization

Water quality monitoring under the Upper Deschutes Subbasin Water Quality Monitoring Project is implemented by UDWC and ODFW staff (Table 2). UDWC and ODFW contract with consultants for macroinvertebrate monitoring (UDWC) and sample identification (UDWC and ODFW; Table 3). Other staff, contractors, and volunteers may also be recruited to implement water quality monitoring.

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Table 2 Key Personnel and Sampling Organizations

Name	Project Title/Responsibility	Contact Information
Lauren Mork	Monitoring Program Manager, Upper Deschutes Watershed Council: Updates project guidance, supervises project implementation; performs data management, analysis, and report writing.	541-382-6103 x 4
Casey Schuder	Stream Restoration Project Manager, Upper Deschutes Watershed Council: Supports Monitoring Program Manager; performs data management, analysis, and report writing.	541-382-6103 x 6
Seasonal Monitoring Technician	Seasonal Monitoring Technician, Upper Deschutes Watershed Council: Implements water quality monitoring under supervision of Monitoring Program Manager.	N/A
Ben Stout	M & E Program Biologist, Oregon Department of Fish and Wildlife: Plans, organizes, gathers equipment, and conducts field work. Packages macroinvertebrate samples and sends to lab. Organizes and analyzes data. Analyzes macroinvertebrate and water temperature data and writes reports.	541-388-6363
Jerry George	District Fisheries Biologist, Oregon Department of Fish and Wildlife: Plans, organizes, gathers equipment, and conducts field work. Packages macroinvertebrate samples and sends to lab. Organizes and analyzes data. Analyzes macroinvertebrate and water temperature data and writes reports.	541-388-6363

Table 3 Analytical Organizations

Organization	Contact	Email & Phone	Address
Aquatic Biology Associates, Inc.	Bob Wisseman, Senior Scientist	541-740-1568; bob@aquaticbio.com	3490 NW Deer Run St. Corvallis, OR 97330 www.aquaticbio.com
CASM Environmental, LLC	Zee Mazzacano, Owner and Principal Scientist	503-490-0389; casmenvironmental@gmail.com	5914 SE Knight St. Portland, OR 97206 www.casmenvironmental.com
Cole Ecological, Inc	Mike Cole, President and Senior Scientist	503-939-7428; mikebcole@comcast.net	15 Bank Row, Suite B Greenfield, MA 01301 www.coleecological.com

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1.3. Problem Definition/Background

In the upper Deschutes and Little Deschutes Subbasins more than 166 miles of waterways are listed as water quality limited under Section 303(d) of the Clean Water Act (ODEQ, 2020). Extreme flow modification (extreme high and low flows) associated with irrigation storage and diversions is the single most important factor limiting water quality (UDWC, 2003), although other factors likely also contribute to impaired water quality.

To address water quality impairment, local, state and federal partners have worked collaboratively since the late 1990s to improve instream flows and restore aquatic habitat in four priority watersheds within the Upper Deschutes subbasin; the Upper Deschutes River, Middle Deschutes River, Tumalo Creek, and Whychus Creek watersheds. With the listing of the Oregon Spotted Frog (OSF) under the Endangered Species Act in 2014, the Little Deschutes River watershed, included within OSF designated critical habitat, has become a new focal geography for habitat restoration and monitoring. Stream flow and habitat restoration efforts aim to improve water quality, fish habitat, and OSF habitat, and ultimately to achieve water quality conditions that support removal of these reaches from the 303(d) list.

Water quality monitoring in the Upper Deschutes subbasin tracks changes in stream flow and provides focused monitoring efforts to provide baseline information, fill data gaps, report on water quality status and trends, evalute changes in water quality associated with stream flow and aquatic habitat restoration, and support future TMDL development and implementation. Water quality monitoring in the Upper Deschutes subbasin creates a foundation from which restoration partners and water managers can develop effective water quality protection, restoration, and management efforts. The goals of the project are to provide water quality data to:

1. Assess water temperature in the Upper Deschutes River, Little Deschutes River, Fall River, Spring River, Middle Deschutes River, Tumalo Creek, and Whychus Creek, in relation to state water quality criteria;
2. Evaluate the effect of stream flow and instream habitat restoration on water temperature;
3. Quantify and refine the relationship between stream flow and temperature at key locations in the Middle Deschutes River, Tumalo Creek, and Whychus Creek;
4. Identify and update the stream flow needed at key locations to maintain water temperatures below the state standard;
5. Support future TMDL development and implementation;
6. Characterize the macroinvertebrate community in the upper Deschutes River, Fall River, Little Deschutes River and Whychus Creek;
7. Evaluate changes to the macroinvertebrate community relating to stream flow and instream habitat restoration; and
8. Communicate improvements in water temperature and macroinvertebrate indicators, ecological and social benefits of those changes, and stream flow restoration targets that will maximize those benefits to partners and the public to cultivate community support for stream flow and instream habitat restoration.

Water quality monitoring by UDWC, ODFW, and partners operating under this SAP also aims to document changes in water temperature and other parameters over the course of implementation of the Deschutes Basin Habitat Conservation Plan (DBHCP) finalized in 2020 (Biota Pacific, 2020). The DBHCP specifies minimum stream flow requirements in the five priority watersheds and a maximum water temperature requirement in Whychus Creek.

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Beginning in 2017, flows in the upper Deschutes River were increased from 20 cfs to 100 cfs during the winter water storage season downstream of Wickiup Reservoir. By 2028, winter flows will be increased to a minimum of 300 cfs, and by 2033 winter flows will be increased to a minimum of 400-500 cfs. In Whychus Creek, the DBHCP requires continuous temperature monitoring from April through October at River Mile 6.0, and annual review of 7-day average daily maximum water temperature by U.S. Fish and Wildlife Service and the National Marine Fisheries Service ("the Services") beginning in 2023 (Year 1 following NMFS' permit issuance in 2022) to evaluate whether incremental reduction in peak summer temperatures is observed. Per the DBHCP, a maximum 7DADM stream temperature exceeding 20°C for more than a week in 2031 or 2032 (Year 9 and Year 10 following permit issuance) will prompt consideration of other factors that could be affecting water temperature and identification of additional conservation measures to reduce or mitigate for high peak water temperatures.

1.4. Project/Task Description

Stream Temperature Monitoring

UDWC implements continuous temperature monitoring annually from April through September on the Deschutes River (6 monitoring stations) and Tumalo Creek (1 monitoring station) and from April through October on Whychus Creek (11 monitoring stations), when altered flows have the greatest effect on stream temperature and when temperature criteria for essential fish life cycle functions are most often exceeded (Table 4). UDWC will contract with ODFW to conduct continuous temperature monitoring at additional sites in the upper Deschutes River, Little Deschutes River, Spring River and Fall River for two years (2025-2026). UDWC and monitoring partners operating under this SAP will use HOBO TidbiT or Pro V2 continuous temperature dataloggers to record stream temperature hourly during deployment. Water temperature monitoring equipment is audited pre-, post-, and during deployment, and data is managed consistent with state QAQC requirements and with guidance detailed in this SAP. UDWC and ODFW will use the seven-day average daily maximum (7DADM) stream temperature to evaluate stream temperature status and trends and will summarize methods and findings in technical reports.

Table 4 Temperature Monitoring Annual Timeline

Temperature Monitoring Annual Timeline	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Submit NIST traceable water quality monitoring equipment to ODEQ		X										
Train seasonal in Upper Deschutes Subbasin SAP protocols and procedures				X								
Audit dataloggers and initialize if needed (pre-deployment)			X	X								
Maintain complete audit data records in spreadsheet software or equivalent			X	X	X	X	X	X	X	X		
Deploy and audit dataloggers (field audits)				X	X	X	X	X	X	X		
Retrieve dataloggers										X		
Download and format data											X	
Audit dataloggers (post-deployment)											X	
Grade data; populate data into DEQ submission template and submit; format data for public use and post on UDWC website											X	X
Analyze data, interpret and report findings	X	X	X	X	X							
Post and distribute technical reports, including on UDWC website						X						

Macroinvertebrate Monitoring

UDWC monitors macroinvertebrate communities in Whychus Creek annually in August utilizing partner staff and community volunteer support. In 2025 and 2026, UDWC will contract with ODFW to monitor macroinvertebrate communities in the upper Deschutes River, Little Deschutes River, and Fall River (Table 5). Samples will be collected utilizing Riffle Targeted (RT), Proportional Multihabitat (PM) and Stovepipe Sampling (SS) protocols in

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locations affected by prior flow restoration and locations where aquatic habitat restoration has occurred or will occur in the future. Macroinvertebrate samples and data will be managed consistent with standard practices and following DEQ QAPP guidance. UDWC, ODFW, and contractors will summarize methods and findings in technical reports.

Table 5 Macroinvertebrate Monitoring Annual Timeline

Macroinvertebrate Monitoring Annual Timeline	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Conduct pre sampling planning, coordination and site selection			X	X	X	X	X	X				
Conduct macroinvertebrate sampling						X	X	X	X			
Send samples to lab for identification and preliminary analysis								X	X	X	X	X
Conduct analysis and interpret and report on findings	X	X										
Submit data to ODEQ			X	X						X	X	X
Post and distribute reports, including on UDWC website			X								X	X

1.5. Data Quality Objectives and Criteria

Continuous Temperature Data

UDWC and ODFW will measure accuracy of continuous temperature dataloggers by comparing datalogger temperature measurements to NIST-certified thermometer measurements during pre- and post-deployment warm and cold water baths as described in Section 2.5, Quality Control. UDWC and ODFW will measure precision of continuous temperature datalogger sensors by comparing NIST thermometer measurements recorded during field audits with the temperature recorded by the datalogger at the time of the NIST thermometer measurement.

UDWC and ODFW water quality monitoring data quality objectives for precision and accuracy correspond to ODEQ grades A (A ≤± 0.5°C; P ≤± 0.5°C) and B (A ≤± 1.0°C; P ≤± 2.0°C) as specified in the DEQ Volunteer Monitoring QAPP version 3.0, updated July 8, 2021 (DEQ QAPP; DEQ, 2021), and in the DEQ Data Quality Matrix (DEQ, 2013). Data that do not meet these accuracy and precision criteria will be downgraded to a lower data quality level and will not be used in analysis and reporting.

Macroinvertebrate Data

The Cole Ecological project manager will recheck 10% of sorted samples to determine whether the sorting efficacy data quality objective of a 95% organism removal rate is achieved. A second taxonomist will perform quality checks of taxonomic data by re-inspecting 10% of the sample lot.

Aquatic Biology Associates, Inc., has demonstrated a sorting efficacy of ≥95% through numerous QA/QC comparisons over 45 years. Quality checks of taxonomic data are not included in the contract for the macroinvertebrate monitoring described in this SAP.

Data quality objectives for taxonomic data are as follows:

- >95% similarity between project and QC taxonomists, as determined by the Bray-Curtis Similarity Index.
- <15% Percent Taxonomic Disagreement (PTD)

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- <5% Percent Difference in Enumeration

Representativeness

UDWC and ODFW will control representativeness by using well-defined sampling and sample handling procedures defined in this SAP and in the DEQ Water Monitoring and Assessment Mode of Operations Manual (DEQ MOM; DEQ 2023) Sampling locations have been selected to accurately represent the range of conditions in project watersheds. Continuous temperature dataloggers will be deployed in well-mixed riffles or pools to be representative of water column water quality conditions and minimize the effects of variation. Macroinvertebrate sampling reaches were selected to represent and capture the range of aquatic habitat conditions and restoration actions in project watersheds: including main, side, and off-channel habitat types; from most degraded to greatest complexity; and from reaches that have experienced only the effects of stream flow and hydrograph restoration, to reaches where high disturbance, valley-reset habitat restoration projects have been implemented.

Comparability

UDWC and ODFW will ensure comparability with similar continuous temperature monitoring projects by following standard methodologies described in this SAP and in the DEQ MOM. UDWC and ODFW will ensure comparability with similar macroinvertebrate monitoring projects by following the Oregon Department of Environmental Quality procedures for Oregon's wadable streams (ODEQ, 2009), standard proportional multihabitat protocols (Barbour et al., 2006; USEPA, 2009; Ode et al., 2016), and stovepipe sampling techniques (DiFranco, 2014).

Completeness

UDWC and ODFW will conduct more field audits of temperature dataloggers than the minimum deployment and retrieval audits required to ensure we obtain sufficient QC records to assign data quality levels.

1.6. Training Requirements and Certification

UDWC and ODFW project staff bring extensive experience in aquatic and water quality monitoring; qualifications are detailed below. Staff will train together in continuous temperature QA/QC procedures and protocols to ensure consistent application across individuals and organizations. UDWC and ODFW will contract with CASM Environmental, LLC. And Cole Ecological, Inc., and Aquatic Biology Associates, Inc., respectively, for training in macroinvertebrate sampling protocols (UDWC) and for sample identification (UDWC and ODFW).

Project Staff

UDWC

Monitoring Program Manager
Lauren Mork, Monitoring Program Manager, has led UDWC's stream flow and habitat restoration effectiveness monitoring work since 2010. Lauren holds a MS in Environmental Sciences and Policy from Northern Arizona University, and a BA from Earlham College.

Stream Restoration Project Manager

Casey Schuder, Stream Restoration Project Manager, joined the UDWC in 2023 with over 15 years of aquatic monitoring experience in the Deschutes Basin. Casey provides support for multiple projects under UDWC's monitoring program.

Seasonal Monitoring Technician

UDWC's seasonal monitoring technician will be trained by the Monitoring Program Manager to ensure data collection and audits follow QA/QC protocols and standard procedures. Training will take place prior to, during, and after data logger deployment, and will consist of hands-on, one-on-one training for all aspects of data collection, QA/QC, and auditing procedures.

ODFW

District Fisheries Biologist, Deschutes Watershed District Office

Jerry George, District Fish Biologist, brings 23 years of experience in aquatic ecology and 10 years of experience in study design and project management.

M & E Program Biologist, Deschutes Watershed District Office

Ben Stout, M & E Program Biologist, brings 15 years of experience in aquatic ecology and 11 years of database management experience.

1.7. Documentation and Records

Approved versions of this document and any subsequent revisions will be distributed to those listed in Table 1 by the DEQ QAO or their designee. Documents for the Upper Deschutes Subbasin Water Quality Monitoring Project will be maintained and revised by UDWC staff. For all monitoring under this SAP, UDWC and ODFW will retain physical or electronic documents and records for at least ten years (Table 6).

Table 6 Controlled Documents

Document or Record Name and Description	Storage Location	Storage Time
DEQ Quality Assurance Project Plan (QAPP) (v.3.0): DEQ04-LAB-0047-QAPP project description and assurance procedures	DEQ Internet Page	10 years
Upper Deschutes Subbasin Water Quality Monitoring Project SAP Version 4.0, May 2025: Specific sampling information for UDWC and monitoring partners	DEQ Laboratory and UDWC secure cloud storage; ODFW secure server	10 years
DEQ Water Monitoring and Assessment Mode of Operations Manual, DEQ03-LAB-0036-SOP: DEQ Standard Operating Procedures manual detailing water quality monitoring methods	UDWC secure cloud storage	10 years
Equipment Notebooks or electronic equivalent: Records of quality control checks, calibrations and maintenance	UDWC office or secure cloud storage; ODFW office and secure server	10 years
Continuous Water Temperature Data Files: Paper field logs and/or electronic files documenting all continuous water temperature metadata, raw field data, and QA/QC records	UDWC office or secure cloud storage; ODFW office and secure server	10 years

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Document or Record Name and Description	Storage Location	Storage Time
Macroinvertebrate Data Files: electronic versions of sampling data sheets, chain of custody files, and complete macroinvertebrate data files from analytical laboratories	UDWC office or secure cloud storage; ODFW office and secure server	10 years

2. Data Generation and Acquisition

2.1. Sampling Process Design

Continuous Temperature

Continuous temperature monitoring in the Upper Deschutes subbasin has been designed to provide information about daily and seasonal variations in water temperature in relation to water management for irrigation and in relation to stream flow and habitat restoration. Continuous temperature monitoring locations were selected to collect temperature data at key locations that provide information about water temperature: 1) upstream of irrigation diversions and otherwise unaffected by water management for irrigation; 2) downstream of points of diversion where stream flow increases when water is protected instream; 3) upstream and downstream of reaches where habitat restoration was or is planned or has been implemented; and 4) to capture longitudinal differences in water temperature throughout each watershed, including at the downstream extent of reaches of interest and the downstream extent of Whychus Creek. Continuous monitoring stations have been established in fixed locations to support comparability of long-term baseline and trend data.

Water temperature data provide important information about the suitability of aquatic habitat for native fish, frogs, and other organisms, including species federally listed as threatened or endangered under the Endangered Species Act (Mid-Columbia summer steelhead, Oregon Spotted Frog, bull trout), Oregon Conservation Strategy species (redband trout), as well as Chinook salmon reintroduced into Whychus Creek in 2009 (following summer steelhead reintroduction in 2007).

Stream flow restoration actions are selected and designed to achieve the greatest reductions in summer stream temperatures that exceed the state temperature standard for rearing and migrating trout and salmon. UDWC conducts continuous temperature monitoring to evaluate temperature status and trends in the context of stream flow restoration in the upper and middle Deschutes River and in Tumalo Creek during irrigation season, from April through September, after irrigation is turned on until just before it is shut off. UDWC conducts continuous temperature monitoring in Whychus Creek during irrigation season and during spawning seasons for Chinook salmon and summer steelhead, from April through October. ODFW conducts continuous temperature monitoring in the upper Deschutes River, Little Deschutes River, Fall River and Spring River year-round. Dataloggers record measurements hourly in all rivers, tributaries, and habitats monitored.

UDWC collected multi-parameter water quality data from 2006-2009, including dissolved oxygen and pH. Recognizing that stream flow restoration actions that reduce stream temperature will also increase dissolved oxygen, UDWC discontinued multi-parameter water quality monitoring in Upper Deschutes subbasin reaches in 2010.

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Macroinvertebrate Sampling

Benthic macroinvertebrates are a standard indicator of watershed health and are commonly used to detect stream temperature exceedances, pollution, and habitat alteration. UDWC and ODFW monitor macroinvertebrate communities to provide information about baseline stream conditions, trends over time, and changes in macroinvertebrate communities in reaches where stream flow and habitat restoration projects are implemented.

Whychus Creek

Macroinvertebrate monitoring sites on Whychus Creek were selected to be co-located with stream temperature monitoring stations; within unrestored reaches where future habitat restoration is planned; and within reaches where habitat restoration has been implemented (Table 7). All Whychus Creek macroinvertebrate monitoring sites experience the effects of stream flow restoration at the Three Sisters Irrigation District diversion. UDWC conducts macroinvertebrate sampling using single-habitat riffle-targeted (RT) and proportional multihabitat (PM) protocols. The sampling protocol to be used at each site is selected to support comparability over time and to provide information about the complete macroinvertebrate assemblage in pre- and post-restoration project reaches where restoration has been designed to restore a range of habitat conditions; sampling protocol for a given site may vary between years. UDWC collects macroinvertebrate samples from Whychus Creek over two days in August, when the stream is at base flow and water and air temperatures are highest, representing the most degraded stream conditions. The ORDEQ PREDATOR predictive model and Index of Biotic Integrity (IBI) is applied to RT samples. Taxonomic and ecological traits assessed for all sample communities include: community temperature and fine sediment optima; tolerance/sensitivity to fine sediment, pollution, and disturbance; functional feeding group; habit (locomotion); generation time (voltinism); flow (rheophily) and temperature association; and maximum body length.

Upper Deschutes, Little Deschutes, and Fall River

ODFW will collect benthic macroinvertebrate samples during summer months in 2025 and 2026 at six sites on the mainstem Deschutes River between Wickiup Dam and Bend, and at four tributary sites divided between the Little Deschutes River and Fall River (Table 7). Mainstem sampling locations were selected based on access and to represent the longitudinal changes in the biotic community. Samples located in the warm, surface-water-driven Little Deschutes River (2 sites) and cold, groundwater-fed Fall River (2 sites) were selected to provide refence data for mainstem sampling sites affected by changes in water management implemented in accordance with Deschutes Basin Habitat Conservation Plan conservation measures; these sites also represent the range of habitat conditions and corresponding macroinvertebrate communities in Upper Deschutes subbasin tributaries. Macroinvertebrate samples from mainstem and tributary reaches will be collected according to the PNAMP riffle-targeted (RT) sampling protocol (Hayslip, 2007), using 500 µm mesh D-frame kick nets to collect eight replicated kick samples yielding one, 8 ft^2 composite sample. ODFW macroinvertebrate samples will be labeled and preserved in 95% ethyl-alcohol for laboratory analysis.

Benthic macroinvertebrate monitoring will also be conducted in 12 off-channel habitats (6 per year in 2025 and in 2026) selected to be representative of available habitat, including oxbows, sloughs, side channels, alcoves and

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percolation channels, using the stovepipe sampling protocol. Macroinvertebrate data will be used to document and evaluate total abundance, EPT taxa richness, and diversity as calculated using the Shannon Weaver Diversity Index.

Table 7 Summary of Sampling Locations. Macroinvertebrate sampling protocols are abbreviated as RT (Riffle-Targeted); PM (Proportional Multihabitat); SS (Stovepipe Sampler).

DEQ Station ID	Organizational Site ID	Latitude/Longitude	Station Description	Parameters
Continuous Temperature				
28996	WC_000-25	44.45944, -121.33669	Whychus Creek Mouth	Continuous Temperature
36043	WC_001-50	44.44491, -121.34543	d/s Alder Springs	Continuous Temperature
35391	WC_006-00	44.41875, -121.38635	u/s Rd. 6360	Continuous Temperature
39474	WC_008-50	44.391278, -121.40618	d/s Rimrock Ranch	Continuous Temperature
39473	WC_010-25	44.371534, -121.41587	u/s Rimrock Ranch	Continuous Temperature
40424	WC_018-25	44.32689, -121.49913	d/s end DBLT property	Continuous Temperature
40425	WC_019-50	44.31855, -121.515	d/s Camp Polk Bridge on DBLT property	Continuous Temperature
35389	WC_024-25	44.28836, -121.54182	City Park gage	Continuous Temperature
35387	WC_026-00	44.27362, -121.55481	Rd. 4606 footbridge	Continuous Temperature
24318	WC_030-25	44.23401, -121.5669	OWRD gauge	Continuous Temperature
40426	WC_038-00	44.19229, -121.6639	Rd. 1514	Continuous Temperature
10508	DR_133-50	44.3597, -121.29378	Lower Bridge	Continuous Temperature
39475	DR_160-00	44.11767, -121.33326	d/s Tumalo boulder field	Continuous Temperature
26657	DR_160-25	44.11501, -121.33904	u/s Tumalo Creek	Continuous Temperature
40423	DR_164-75	44.07733, -121.30592	u/s Riverhouse Hotel	Continuous Temperature
10684	DR_181-50	43.9308, -121.41107	Benham Falls footbridge	Continuous Temperature
29406	DR_217-25	43.74075, -121.60672	Pringle Falls Experimental Station	Continuous Temperature
25833/31157	TC_000-25	44.11567, -121.34031	Tumalo Creek Mouth	Continuous Temperature
To Be Assigned	DR_207-75	43.77412698, -121.52276645	2025 RM 207.75 Dead Slough Adjacent	Continuous Temperature
To Be Assigned	DR_202-00	43.79223093, -121.50350547	2025 RM 202 Adjacent	Continuous Temperature

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DEQ Station ID	Organizational Site ID	Latitude/Longitude	Station Description	Parameters
To Be Assigned	DR_196-50	43.82749163, -121.47497724	2025 RM 196.5 Adjacent	Continuous Temperature
To Be Assigned	DR_181-25	43.9354908, -121.40996547	2026 RM 181.25 Benham Wetland Adjacent	Continuous Temperature
To Be Assigned	DR_179-50	43.94760766, -121.427161	2026 RM 179.5 Slough Camps Adjacent	Continuous Temperature
To Be Assigned	DR_177-50	43.96087108, -121.40975677	2026 RM 177.5 Dillon Falls Adjacent	Continuous Temperature
To Be Assigned	DR_176-50	43.9723192, -121.40943632	2026 RM 176.5 Near Aspen Camp Adjacent	Continuous Temperature
To Be Assigned	DR_175-00	43.98355, -121.401673	2026 RM 175 Near Lava Island Adjacent	Continuous Temperature
To Be Assigned	DR_Sunriver	43.919473, -121.445696	Deschutes River in Sunriver, Forest Road 600	Continuous Temperature
To Be Assigned	DR_Besson	43.88029, -121.46334	Deschutes River at Besson boat launch	Continuous Temperature
To Be Assigned	DR_FallR_ds	43.81824, -121.49649	Downstream of Fall River	Continuous Temperature
To Be Assigned	DR_FallR_us	43.78727, -121.51539	Deschutes River upstream of Fall River	Continuous Temperature
To Be Assigned	SR	43.87141, -121.46474	Spring River off Besson Road	Continuous Temperature
To Be Assigned	LDR	43.753956, -121.485049	Little Deschutes River at Bridge Drive	Continuous Temperature
To Be Assigned	FR	43.78953, -121.51471	Fall River just upstream of Deschutes River	Continuous Temperature
To Be Assigned	DR_207-75_OC	43.770597, -121.525548	Dead Slough	Continuous Temperature
To Be Assigned	DR_205-75_OC	43.78314885, -121.517847	LPSP SW Oxbow	Continuous Temperature
To Be Assigned	DR_202-00_OC	43.790761, -121.50293097	RM 202	Continuous Temperature
To Be Assigned	DR_196-50_OC	43.826729, -121.476105	RM 196.5	Continuous Temperature
To Be Assigned	DR_189-50_OC	43.87749998, -121.46308432	RM 189.5	Continuous Temperature
To Be Assigned	DR_190-00_OC	43.87896, -121.45694616	RM 190 Near Sunriver Airport	Continuous Temperature
To Be Assigned	DR_181-25_OC	43.93589202, -121.40740134	Benham Wetland	Continuous Temperature
To Be Assigned	DR_179-50_OC	43.94780812, -121.433049	West Slough Camp	Continuous Temperature

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DEQ Station ID	Organizational Site ID	Latitude/Longitude	Station Description	Parameters
To Be Assigned	DR_179-50_OC	43.94680021, -121.42436721	East Slough Camp	Continuous Temperature
To Be Assigned	DR_177-50_OC	43.960059, -121.408814	Dillon Falls	Continuous Temperature
To Be Assigned	DR_176-50_OC	43.97159941, -121.4083644	RM 176.5 Near Aspen Camp	Continuous Temperature
To Be Assigned	DR_175-00_OC	43.98272495, -121.40090258	RM 175 Near Lava Island Falls	Continuous Temperature
Macroinvertebrate Sampling				
36043	WC0150	44.446681, -121.347270	Alder Springs	RT
35391	WC0600	44.418750, -121.386350	6360 Road	RT
39474	WC0850-1	44.391278, -121.406182	Rimrock Ranch Downstream	PM
39474	WC0850-2	44.3896285, -121.4067909	Rimrock Ranch Downstream	PM
To Be Assigned	WC0900-1	44.384198, -121.407892	Rimrock Ranch	RT
To Be Assigned	WC0900-2	44.3842622, -121.4086833	Rimrock Ranch	PM
39473	WC1025-1	44.371534, -121.415865	Rimrock Ranch Upstream	PM
39473	WC1025-2	44.3735189, -121.4134032	Rimrock Ranch Upstream	PM
39473	WC1025-3	44.3709120, -121.4153237	Rimrock Ranch Upstream	PM
To Be Assigned	WC1100-2	44.364587, -121.421706	Whychus Canyon Reach 4	PM
To Be Assigned	WC1100-5	44.3617780, -121.4285605	Whychus Canyon Reach 4	PM
To Be Assigned	WC1150	44.3585617, -121.4301579	Whychus Canyon Reach 3	PM
To Be Assigned	WC1175	44.3533947, -121.4362442	Whychus Canyon Reach 2	PM
To Be Assigned	WC1200	44.3506534, -121.4422900	Whychus Canyon Reach 2	PM
To Be Assigned	WC1250	44.3447387, -121.4467385	Whychus Canyon Reach 2	PM
40424	WC 1825	44.32689, -121.49913	Camp Polk Downstream	RT
40425	WC1950	44.318741, -121.514961	Camp Polk Upstream	RT

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DEQ Station ID	Organizational Site ID	Latitude/Longitude	Station Description	Parameters
35389	WC2425	44.287806, -121.544229	Creekside Park	RT
35387	WC2600-1	44.273220, -121.555200	4606 Road/Floodplain	PM
To Be Assigned	Fall River 18	43.791492, -121.520518	Fall River	RT
To Be Assigned	Fall River 19	43.784227, -121.598043	Fall River	RT
To Be Assigned	Little Deschutes 16	43.753956, -121.485049	Little Deschutes River	RT
To Be Assigned	Little Deschutes 17	43.701829, -121.502824	Little Deschutes River	RT
To Be Assigned	Main Deschutes 8	44.01518, -121.355164	River Rim Park	RT
To Be Assigned	Main Deschutes 9	43.98447, -121.399648	Lave Island Falls	RT
To Be Assigned	Main Deschutes 10	43.94116, -121.415299	Benham Falls	RT
To Be Assigned	Main Deschutes 11	43.8816, -121.464113	Besson Camp	RT
To Be Assigned	Main Deschutes 12	43.6886, -121.674569	Tenino boat ramp	RT
To Be Assigned	Main Deschutes 13	43.76032, -121.580551	Tetherow boat ramp	RT
To Be Assigned	DR_207-75_OC	43.770597, -121.525548	RM 207.75 Dead Slough	SS
To Be Assigned	DR_205-75_OC	43.78314885, -121.517847	RM 205.75 LPSP SW Oxbow	SS
To Be Assigned	DR_202-00_OC	43.790761, -121.50293097	RM 202	SS
To Be Assigned	DR_196.50_OC	43.826729, -121.476105	RM 196.5	SS
To Be Assigned	DR_189-50_OC	43.87749998, -121.46308432	RM 189.5	SS
To Be Assigned	DR_190-00_OC	43.87896, -121.45694616	RM 190 Near Sunriver Airport	SS
To Be Assigned	DR_181-25_OC	43.93589202, -121.40740134	RM 181.25 Benham Wetland	SS
To Be Assigned	DR_179-50_OC	43.94780812, -121.433049	RM 179.5 West Slough Camp	SS
To Be Assigned	DR_179-25_OC	43.94680021, -121.42436721	RM 179.25 East Slough Camp	SS
To Be Assigned	DR_177-50_OC	43.960059,	RM 177.5 Dillon Falls	SS

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DEQ Station ID	Organizational Site ID	Latitude/Longitude	Station Description	Parameters
		-121.408814		
To Be Assigned	DR_176-50_OC	43.97159941, -121.4083644	RM 176.5 Near Aspen Camp	SS
To Be Assigned	DR_175-00_OC	43.98272495, -121.40090258	RM 175 Near Lava Island Falls	SS

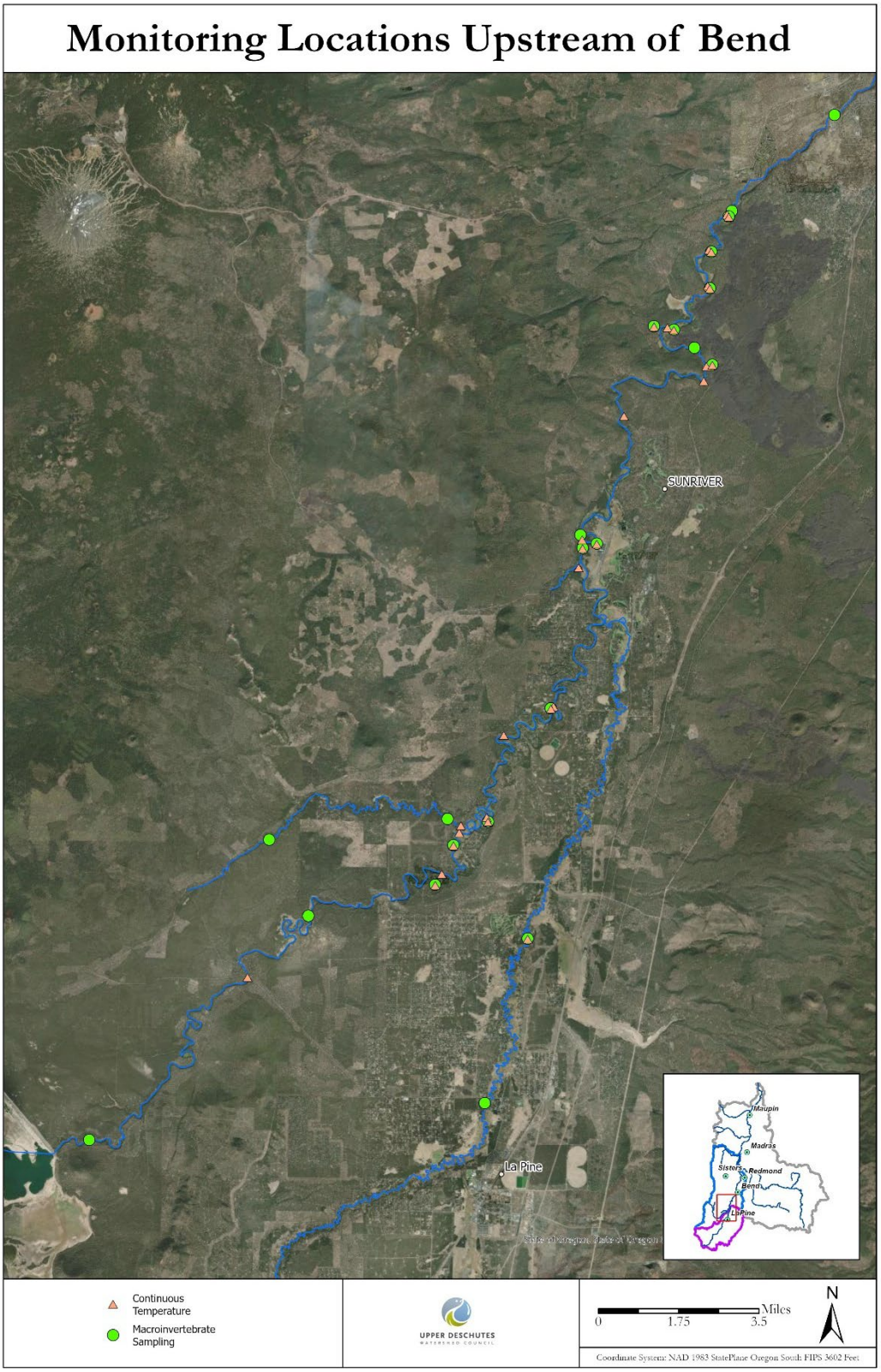

Figure 1 Upper Deschutes Subbasin Water Quality Monitoring Sites: Upstream of the City of Bend

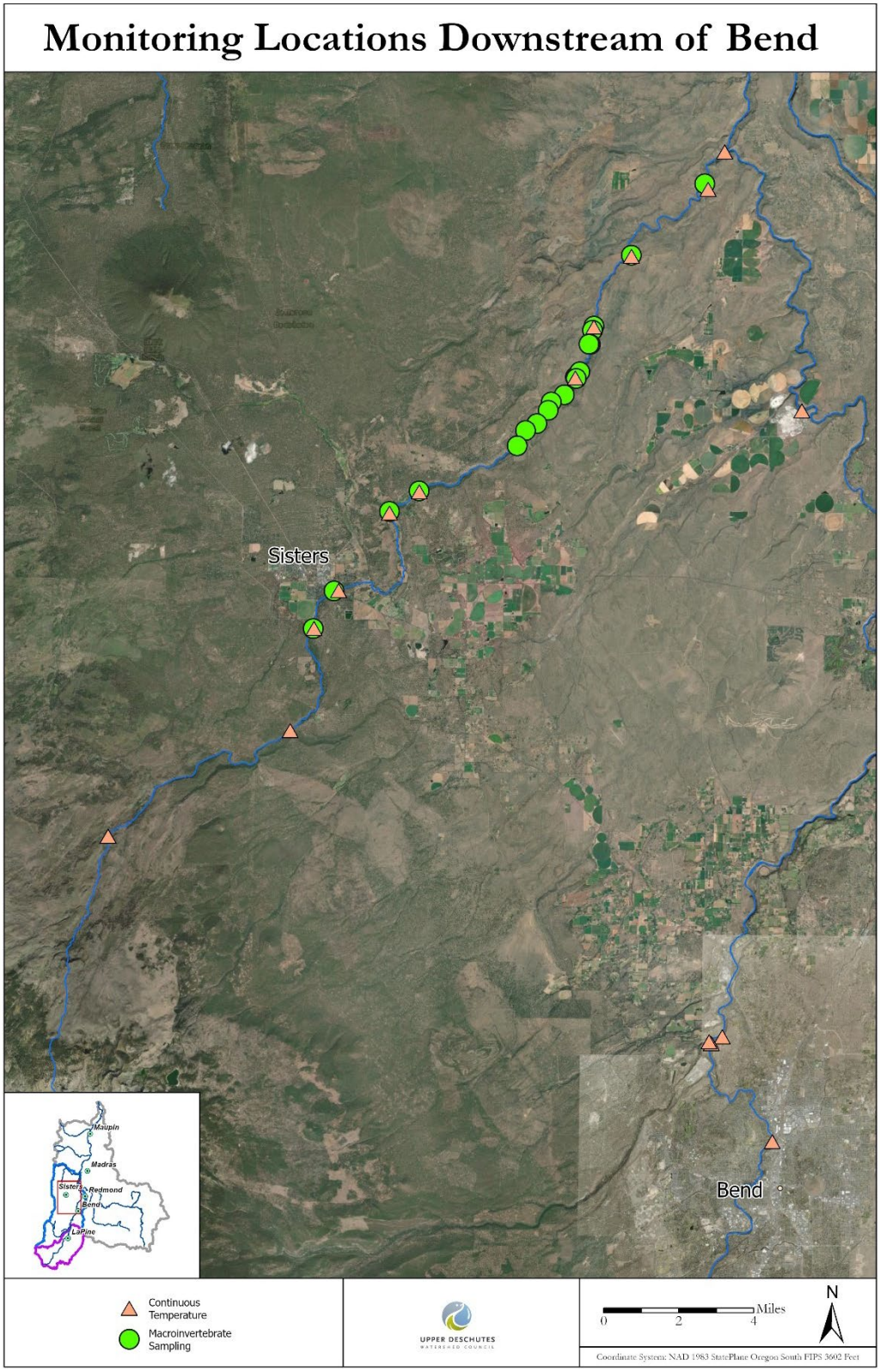

Figure 2 Upper Deschutes Subbasin Water Quality Monitoring Sites: Downstream of the City of Bend

2.2. Sampling Methods

Continuous Temperature Monitoring

At all continuous temperature monitoring stations, water temperature will be recorded hourly using HOBO TidbiT 400 Max and V2 Pro dataloggers. Site-specific deployment locations will be selected to ensure dataloggers remain anchored to streamside vegetation or infrastructure for the duration of the monitoring season and to ensure dataloggers are positioned where they will record representative stream temperatures. TidbiT dataloggers will be installed in housings fabricated from flexible corrugated loom tubing to avoid direct contact between the datalogger and the substrate and to avoid direct solar radiation and will be deployed using cables anchored to streamside vegetation or infrastructure. HOBO V2 Pro dataloggers will be deployed on cables at one monitoring station (DR_181-50) where the elongated shape of the datalogger reduces accumulation of aquatic vegetation from a large logjam upstream.

UDWC and ODFW will audit dataloggers pre-deployment, during deployment, and post-deployment to support assessment of datalogger accuracy and precision, following the methods detailed below.

Continuous Temperature Datalogger Audit Methods

Continuous temperature dataloggers will be audited pre- and post-deployment to ensure accuracy per the DEQ QAPP, Section 2.5, Quality Control. Dataloggers will be audited in the field to ensure precision: 1) at deployment; 2) monthly or more frequently at publicly accessible locations to ensure dataloggers are in the water, including audits before and after the July 4th holiday; and 3) at retrieval.

Audits entail measuring and recording water temperature in the same location as a datalogger using a handheld digital thermometer NIST-certified annually by DEQ per the DEQ QAPP, (DEQ04-LAB-0057-QAPP, Section 2.7, Instrument Calibration and Frequency). The NIST thermometer cable will be visually inspected at each use and battery function confirmed per the DEQ QAPP Section 2.6., Instrument/Equipment Testing, Inspection, and Maintenance.

Pre-and Post-deployment Audit Equipment

- NIST-certified digital thermometer
- NIST thermometer log book
- Pre- and post-deployment data form (“PrePostAudits”; Appendix A) in Excel
- Continuous temperature dataloggers
- Cooler (large enough to accommodate all dataloggers, water to submerge dataloggers, and the addition of ice)
- Ice
- Large spoon for stirring
- HOBOconnect app installed on computer or phone for TidbiT dataloggers
- Computer with HOBOware software installed for V2 Pro dataloggers
- Onset Shuttle for V2 Pro dataloggers

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Pre- and Post-deployment Audits

1. Configure all TidbiT and V2 Pro dataloggers to record at 1-minute intervals.
2. Fill a cooler with 21°C (lukewarm) water.
3. Submerge all dataloggers in warm bath and allow 15 minutes to equilibrate with water temperature.
4. Record NIST temperature, in degrees C to the nearest 0.1°C, on the minute, for ten minutes.
5. With NIST probe in warm bath, add ice and stir until water temperature is ~10°C.
6. Let dataloggers rest in cold bath for 1 hour.
7. Record NIST temperature on the minute for ten minutes.
8. Download, save, and review data files.
9. Enter data to complete PrePostAudits data form.
10. Delete data files from app.

Field Audit Equipment

- NIST thermometer
- Extra 9-volt battery
- Smart phone, or watch set to atomic time
- Field audit data form “FieldAudits” in Excel on smart phone or tablet (Appendix A)
- Paper copy of field audit data form “FieldAuditsPrint”(Appendix A)
- Previous year’s field log to facilitate deployment of same datalogger at same monitoring location (only applicable at deployment)
- Pen
- Screwdriver with torx bits (2 bits)
- Extra TidbiT datalogger in fabricated housing with hose clamps (pre-deployment audit completed)
- Extra V2 Pro datalogger (pre-deployment audit completed)
- Extra fabricated deployment cable assembly with sliding weight and torx bolt anchoring element; or chain, combination lock, and hardware

All Field Audits

1. Set NIST digital thermometer to display Celsius degrees.
2. Immerse probe in water and allow temperature to stabilize.
3. When auditing continuous temperature data loggers, place the probe as close as safely possible to the thermistor on the continuous monitoring device so measured temperature differences will not be the result of spatial variation.
4. When auditing continuous temperature data loggers, do not remove the datalogger from the water between five minutes before the hour and one minute after the hour to avoid the datalogger recording an air temperature on the hour. Be conscious of measuring temperature within 15 minutes before the hour or after the hour to reduce the amount of time between NIST thermometer temperature measurement and datalogger temperature record. This is more important when flows are low, air temperatures are high, and stream temperature can change by more than two degrees in a half-hour.
5. Complete all fields in electronic or paper audit form.
6. Rinse probe with clean tap water prior to storage.

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Deployment and Audit

1. In the HOBOConnect app, configure TidbiT datalogger to record at 1-minute intervals, starting at next interval, with Bluetooth always off to conserve battery.
2. Immediately on arrival at deployment location, immerse TidbiT datalogger secured to housing and cable.
3. Anchor cable to streamside vegetation or infrastructure adjacent to riffle or pool in well-mixed primary channel to anchor cable to streamside vegetation or infrastructure to deploy datalogger in well-mixed primary channel.
4. Immerse NIST probe in water and allow temperature to stabilize
5. After 5-10 minutes, open app, remove datalogger from water, and press TidbiT button to activate Bluetooth and detect datalogger.
6. Compare datalogger temperature in app display to NIST thermometer temperature. If the difference between the two temperatures is > 0.5°C, return datalogger to water and allow more time for sensor to acclimate. Repeat step 5.
7. When difference between the NIST thermometer temperature and the datalogger temperature is < 0.5°C, record time and both temperatures in data form.
8. Re-configure datalogger to record at 1-hour intervals, starting at next interval, with Bluetooth off.
9. Return TidbiT to water.
10. Complete remaining fields in electronic or paper audit form.
11. If data were recorded on paper audit form, on return to office, enter data into electronic audit form.

Monthly Audits

Data will be downloaded from TidbiT loggers at each audit and the resulting data files retained in secure cloud storage until all data have been entered into the DEQ Continuous [Temperature] Template for submission to DEQ.

1. Immediately on arrival, immerse NIST probe in water and allow temperature to stabilize.
2. Check the time. If not within five minutes before the hour or one minute after, open HOBOconnect app, remove Tidbit from water and press button to activate Bluetooth connection.
3. Record time, NIST thermometer temperature, and TidbiT temperature.
4. Download data from TidbiT. In app interface, review data file.
5. In app interface, check TidbiT battery level. If low, deploy backup TidbiT logger and retrieve the logger with the low battery.
6. In app interface, confirm TidbiT is logging.
7. Replace TidbiT in water.
8. Complete remaining fields in audit form.
9. On return to office, if data were recorded on paper audit form, enter data into electronic audit form.
10. On return to office, share data files and sync completed audit form to save in secure cloud storage or on server and review saved data files.
11. Delete data files from app.

Retrieval and Audit

1. Immediately on arrival, immerse NIST probe in water and allow temperature to stabilize.
2. Check the time. If not within five minutes before the hour or one minute after, open HOBOconnect app, remove Tidbit from water and push button to activate Bluetooth connection.

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3. Record time, NIST thermometer temperature, and TidbiT temperature.
4. Download data from TidbiT. In app interface, review data file.
5. Complete remaining fields in audit form.
6. On return to office, if data were recorded on paper audit form, enter data into electronic audit form.
7. enter data into electronic audit form.
8. On return to office, share data files and sync completed audit form to save in secure cloud storage or on server and review saved data files.
9. Delete data files from app.

Continuous Temperature Datalogger Deployment Methods

Equipment

Deployment equipment for each continuous temperature monitoring station includes:

- Fabricated deployment cable assembly with sliding weight and torx bolt anchoring element
- Screwdriver with torx bit
- TidbiT datalogger in fabricated housing with hose clamps, or
- V2 Pro datalogger
- All equipment listed under “Field Audit Equipment” above.

Site Selection and Datalogger Deployment

UDWC and ODFW will consider the following criteria in selecting site-specific locations for deploying dataloggers:

1. Before deploying continuous monitoring devices, anticipate any future flow fluctuations.
2. Stations should be accessible by surveyors in waders and wading boots for auditing purposes, yet difficult for general public access.
3. Install the continuous monitoring device:
    a. In a shaded location: canopy cover or some other feature such as large woody debris can provide shade; the intention for this measure is to avoid direct solar warming of the continuous monitoring device.
    b. Downstream of a riffle or in a pool or glide that exhibits well-mixed conditions: placing the continuous monitoring device downstream of a riffle ensures complete mixing of the water.
    c. With sufficient water depth for the duration of the sampling window.
4. Locate appropriate anchoring structure: Select an anchoring structure (tree or built infrastructure) that is:
    a. Inconspicuous and/or inaccessible for the public;
    b. Where the deployment cable and datalogger will be least visible;
    c. Which is likely to remain stationary throughout the continuous monitoring device deployment period; and,
    d. Which will not interfere with water quality measurements.
5. Loop cable around selected anchoring structure and secure by threading cable into anchoring element and securing with torx bolt.
6. Ideally, install continuous monitoring devices one meter below the surface, or, in shallow water, halfway between surface and substrate, such that they are completely submerged, but not in contact with the substrate; slide weight along cable to adjust position of datalogger in water column.

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7. Record the serial number of each continuous monitoring device at each monitoring station. When possible, deploy the same continuous monitoring device at the same station each year.
8. Adjustments in sensor location may be necessary if the initial location becomes dewatered, and the continuous monitoring device must be moved to an active, flowing channel. Make notes of such relocations in the audit form.

Benthic Macroinvertebrate Sampling

Riffle-targeted Protocol (RT)

Benthic macroinvertebrates will be collected from riffle habitats according to the DEQ protocol for Oregon's wadeable streams detailed in the DEQ Water Monitoring and Assessment Mode of Operations Manual ("DEQ MOM", DEQ90-LAB-0036-SOP; ODEQ, 2023). Reach lengths are calculated as 40 times the average wetted width of the active channel (minimum 500 ft [150 m], maximum 1000 ft [300 m]). The upstream and downstream limit of each reach, and where applicable turning points along the channel, are flagged by UDWC staff prior to sampling. One sample consists of eight individual net sets, each collected in a 1 ft^2 area of riffle habitat using a D-frame kick net with 500 µm mesh and a 1 ft (0.3 m) opening. In reaches with eight or more riffles, a single net set is taken in each of eight randomly selected riffles; in reaches with fewer than eight riffles, two net sets are taken in each of four randomly selected riffles. Substrate composition is assessed at each sampling point during data analysis.

Proportional Multihabitat Protocol (PM)

To better assess the macroinvertebrate community in the heterogeneous habitats created in many reaches during restoration, UDWC may use a proportional multihabitat protocol (Barbour et al., 2006; USEPA, 2009; Ode et al., 2016) in reaches where habitat restoration projects have been implemented, and may use this protocol pre-restoration in reaches slated for restoration to provide baseline data for future comparison. Reach lengths will be calculated and flagged as described for RT sampling above; at sites where both RT and PM samples will be taken, two teams will sample the reach simultaneously, moving upstream as a unit to avoid disturbing the streambed and macroinvertebrate community upstream of a sampling location. Before collecting samples, PM sampling teams will walk along the extent of the sampling reach to determine relative proportions of different instream habitats.

Stovepipe Sampler Protocol (SS)

Macroinvertebrate sampling in off-channel habitats will be conducted using a stovepipe sampler and 500 µm sieve. Eight, 1 ft^2 subsamples will be composited into each sample (DiFranco, 2014).

2.3. Sample handling and custody

Continuous Temperature

Whychus Creek

Continuous temperature dataloggers will be deployed within the first two weeks of April to document stream temperatures during the overlap in steelhead spawning season and irrigation season. Data will be downloaded from TidbiT dataloggers at each field audit and at datalogger retrieval, and resulting data files saved in cloud

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storage or on a secure server and retained until QC for all continuous temperature data for that year has been completed. Dataloggers will be retrieved not later than the last week of October, for a total deployment duration of not more than 7 months.

Middle and Upper Deschutes Watersheds (UDWC)

Continuous temperature dataloggers will be deployed in the second half of April following initiation of flow diversion for the new irrigation season. Data will be downloaded from TidbiT dataloggers at each field audit and at datalogger retrieval, and resulting data files retained until QC for all continuous temperature data for that year has been completed. Dataloggers on the Deschutes River downstream of irrigation diversions will be retrieved not later than September 30th to ensure loggers are retrieved before flows rise. Dataloggers in the Deschutes River upstream of irrigation diversions will be retrieved not later than mid-October, for a total deployment duration of not more than 7 months. Data will be downloaded from V2 Pro dataloggers in the office following retrieval.

Upper and Little Deschutes Watersheds (ODFW)

Continuous temperature dataloggers will be deployed in March 2025 in the mainstem Upper Deschutes River (7 dataloggers), tributaries including Fall River, Spring River, and Little Deschutes River (3 dataloggers), and off-channel habitats (6 dataloggers). Dataloggers in off-channel habitats will be deployed for a single year of monitoring then moved to six new off-channel sites for the second year of monitoring (2026). Data will be downloaded from TidbiT dataloggers at bimonthly field audits and at datalogger retrieval, and resulting data files retained until QC for all continuous temperature data for that year has been completed. Dataloggers will be retrieved not later than March 2027, for a total deployment duration of two years.

Macroinvertebrate Sampling

Whychus Creek Samples (RT and PM)

Following sample collection, composited samples will be transferred to a 1 L Nalgene sample jar half-filled with 80% ethanol as a preservative. Jars will be filled no more than 2/3 full; sample material will be divided among multiple jars if needed. CASM Environmental replaces the 80% ethanol in all jars with fresh ethanol within 72 hours to ensure preservation. Labels written in pencil, including site name, date and time of collection, collectors, and sample jar number, will be placed inside each jar and taped on the outside of each jar following the DEQ protocol (ODEQ, 2009). CASM Environmental delivers sample jars and a completed chain of custody form (Appendix A) to the Cole Ecological, Inc. lab.

Little Deschutes Samples (SS)

Composited macroinvertebrate samples will be transferred in the field to a 1 L Nalgene sample jar half-filled with 95% alcohol and returned to the lab for storage. Field preservative will be decanted off and replaced with fresh preservative within a week of collecting the sample. For samples with significant organic matter the process of replacing the alcohol will be repeated until the alcohol no longer turns a green or brown color after a week of contact with the sample to prevent reduction of the alcohol concentration to < 70% and resulting decomposition of the bugs. Labels written in pencil, including site name, date and time of collection, collectors, and sample jar number, will be placed inside each jar and taped on the outside of each jar following the DEQ protocol (ODEQ,

2009). Transport of samples and delivery of a completed chain of custody form to Aquatic Biology Associates, Inc. will be pre-arranged.

2.4. Analytical Methods

Continuous temperature analytical methods will conform to the standard methods defined in the DEQ QAPP and detailed in the DEQ MOM (ODEQ, 2023; Table 8).

Samples are identified by Cole Ecological, Inc. (www.coleecological.com) and by Aquatic Biology Associates, Inc. (www.aquaticbio.com) in their respective laboratories following DEQ standard operating procedures for macroinvertebrate identification and using Caton gridded trays. Each sample is first sub-sampled to a target count of 500 individuals by splitting the sample into equal aliquots; individual aliquots are selected randomly, and all organisms in each are picked out. An aliquot in which the target number is reached is picked to completion, which explains differences in organismal abundance between samples. Organisms are identified to the lowest practical taxonomic level using the standard taxonomic effort recommended by the Pacific Northwest Aquatic Monitoring Partnership (level 2; Wisseman et al 2024 in review). Samples will be preserved with ethanol and will be disposed of appropriately after being analyzed, following local waste disposal guidelines.

Table 8 Summary of Analytical Parameters and Methods

Sample Type	Parameter	Equipment	Reference Method
Field Measurement	Water Temperature	NIST Traceable Thermometer	DEQ MOM procedures (DEQ 2023)
Composite Sample	Benthic Macroinvertebrates	Caton Gridded Tray	DEQ MOM procedures (DEQ 2023)

2.5. Quality Control

Continuous Temperature

UDWC and ODFW will measure accuracy of continuous temperature datalogger sensors by comparing datalogger temperature measurements and NIST thermometer measurements recorded on the minute for ten minutes in warm and cold baths during pre- and post-deployment audits per the DEQ QAPP, Section 2.5, Quality Control, and per the DEQ MOM (ODEQ, 2009). Precision of continuous temperature datalogger sensors is measured by comparing NIST thermometer measurements recorded during field audits with the temperature recorded by the datalogger at the time of the NIST thermometer measurement.

Macroinvertebrate Sampling

One field duplicate sample will be collected per macroinvertebrate survey. Ten percent of macroinvertebrate samples will be cross-checked by a second taxonomist.

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2.6. Instrument/Equipment Testing, Inspection, and Maintenance Requirements

UDWC and ODFW will maintain and inspect equipment used for continuous temperature monitoring and macroinvertebrate sampling according to the standards described in the DEQ QAPP (Table 9).

Table 9 Continuous Temperature Equipment Testing, Inspection, and Maintenance Requirements

Equipment	Inspection Frequency	Type of Inspection
NIST traceable thermometer	Pre- and post-monitoring inspection; annual accuracy check	Visual inspection of unit, cables, battery function (unit turns on)
TidbiT and V2 Pro dataloggers	Pre- and post-monitoring	Visual inspection of logger, O-ring inside battery cover, boot
D-frame Kick Net and Stovepipe Sampler 500 µm mesh/sieve	At beginning and end of each sampling site	Inspect mesh or sieve for rips or clinging organisms

2.7. Instrument Calibration and Frequency

Equipment used for continuous temperature monitoring is calibrated according to the DEQ QAPP (Table 10).

Table 10 Continuous Temperature Monitoring Equipment Calibration and Frequency

Equipment	Standard	Calibration Frequency	Responsible Party
NIST traceable thermometer	NIST certified thermometer at 5, 10, 15, 20, and 25°C	Annual check or when > 0.5°C difference from NIST-certified thermometer	DEQ provides verification for Program-loaned equipment

2.8. Inspection and Acceptance of Supplies and Consumables

UDWC and ODFW will store continuous temperature dataloggers, NIST thermometers, and coolers in their respective offices when not deployed, and will maintain dataloggers consistent with manufacturer specifications. CASM Environmental will supply D-frame kick nets and other macroinvertebrate sampling equipment for Whychus Creek sampling, and will store these in their home office storage. ODFW will store D-frame kick nets, stovepipe samplers, and other macroinvertebrate sampling equipment in their Bend, Oregon office. Additional equipment needed for macroinvertebrate sampling includes the following:

- 95% ethanol preservative

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- 1 L Sample jars
- Sample jar labels
- Field data sheets, pencils, clipboards
- Waders (chest-high or hip boots)

2.9. Non-direct Measurements

UDWC and ODFW will follow non-direct measurement procedures detailed in the DEQ QAPP, Section 2.9, Data Management.

2.10. Data Management

Data Management

Approved versions of this SAP will be distributed to those listed in Table 1 by the DEQ QAO. UDWC, ODFW, and contractors will manage data using the following practices:

Monitoring Stations

UDWC and ODFW will determine if new monitoring locations are more than a quarter mile from existing monitoring stations. If so, UDWC or ODFW personnel will record the latitude, longitude, and coordinate datum for any new monitoring locations and provide a detailed map with the spatial location of monitoring locations needing a new station to the DEQ Volunteer Monitoring Coordinator.

Data Acquisition

UDWC and ODFW will use standard procedures and survey forms (paper or electronic) documented in this SAP to conduct QA/QC measures, collect samples, and record data. Survey forms include fields for metadata, including how (protocol), when, and where samples and data are collected or recorded, by whom, and for what purpose (project). The UDWC Monitoring Program Manager, Restoration Project Manager, Seasonal Monitoring Technician, and Restoration and Monitoring Intern, and the ODFW District Fish Biologist, M & E Program Biologist, and ODFW interns may all conduct QA/QC, collect samples, and record data.

Data File Management

UDWC and ODFW will record QA/QC and monitoring data in instrument and field log books or in standard survey forms (paper or electronic). Following each QA audit, field audit, or sampling event, written data recorded in instrument and field logs and on survey forms will be reviewed for completeness and errors, digitized, and stored electronically. Following each field audit or sampling event where data is recorded electronically in spreadsheet software, the electronic data file will be saved in the UDWC secure cloud file storage platform or the ODFW database and secure server.

For continuous temperature monitoring, the individual who collects and records the data is responsible for reviewing, digitizing, filing, and saving the resulting electronic files. The UDWC Monitoring Program Manager and

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ODFW M & E Program Biologist are responsible for ensuring data are reviewed, digitized, filed, and stored electronically.

For Whychus Creek macroinvertebrate sampling, CASM Environmental is responsible for reviewing and digitizing survey datasheets and providing them to the UDWC Monitoring Program Manager, who will file them in UDWC's cloud storage; Cole Ecological, Inc. is responsible for completing sample identification, PREDATOR model result, and Index of Biological Integrity result electronic datasheets using spreadsheet software and providing these to CASM Environmental, who will submit them to the UDWC Monitoring Program Manager.

For Upper Deschutes River, tributary, and off-channel macroinvertebrate sampling, the M & E Program Biologist is responsible for reviewing, digitizing and filing macroinvertebrate survey datasheets; Aquatic Biology Associates, Inc. is responsible for completing sample identification, PREDATOR model result, and Index of Biological Integrity result electronic datasheets using spreadsheet software and providing these to the ODFW M & E Program Biologist.

Data Storage and Sharing

UDWC will store electronic data files in a secure cloud storage platform, which also serves to back up data. ODFW will store project data in a database at the Oregon Department of Fish and Wildlife Bend office and on ODFW secure servers. Access to the ODFW database is limited to ODFW employees, but data will be shared with partners and UDWC. Raw data will be available to the public upon formal data request.

UDWC and ODFW will download the current version of the DEQ Continuous Temperature Data Submission template from the DEQ website annually and will enter all raw continuous temperature data and associated metadata for submission to DEQ, following guidance provided in the DEQ QAPP. UDWC will also grade and trim continuous temperature data and post graded and trimmed data on the UDWC website. UDWC and ODFW will submit macroinvertebrate data to DEQ. Technical reports summarizing Whychus Creek monitoring findings will be submitted to OWEB and posted on the UDWC website.

Data Analysis

UDWC and ODFW use spreadsheet software and R open-source statistical software to analyze continuous temperature data. For Whychus Creek macroinvertebrate data, Cole Ecological, Inc. uses R open-source statistical software to run the PREDATOR model, and CASM Environmental uses PAST 4.0 statistical software for additional analyses. For Upper Deschutes, tributary, and off-channel habitat data, Aquatic Biology Associates, Inc. uses a proprietary package in R open-source statistical software for macroinvertebrate data analysis; ODFW uses spreadsheet software and R open-source statistical software for additional macroinvertebrate data analysis.

3. Assessment and Oversight

UDWC and ODFW will follow Assessment and Oversight guidance provided in the DEQ QAPP.

3.1. Assessment and Response Actions

Continuous Temperature Data

The UDWC Monitoring Program Manager and ODFW M & E Program Biologist will grade continuous temperature data using pre- and post-deployment (comparison with standards; accuracy) and field audit (replicate measurements; precision) NIST thermometer measurements, and will review the resulting grades to identify data where the difference between the temperature recorded by the datalogger and that recorded using the NIST thermometer is greater than 2.0°C, and the associated data quality graded lower than B, per the DEQ Data Quality Matrix (DEQ04-LAB-0003-QAG, Version 5.0). Only data receiving A or B grades for quality will be submitted to DEQ and used for analysis unless the basis for the data acceptability is approved and documented by the UDWC Monitoring Program Manager or ODFW M & E Program Biologist and ODEQ Volunteer Monitoring Program Coordinator.

Where data quality is lower than A, the UDWC Monitoring Program Manager and ODFW M & E Program Biologist will compare respective pre- and post-deployment and field audit log records to datalogger temperature records to evaluate possible factors contributing to temperature differences and will identify actions to reduce these. Corrective actions may include improvement of equipment deployment and maintenance techniques, modification of procedures and protocols, and re-training in procedures and protocols.

Macroinvertebrate Data

To evaluate sampling and sub-sampling and identification precision, CASM Environmental and Cole Ecological, Inc. will compare macroinvertebrate field and lab duplicates to assess sampling and sub-sampling variability. A second taxonomist at Cole Ecological will re-identify 10% of samples to assess variability between taxonomists. Results will be compiled and included with macroinvertebrate data.

3.2. Reports to Management

UDWC and ODFW staff recording continuous temperature data will report results of accuracy and precision tests (pre- and post- deployment and field audits, respectively) in the appropriate instrument log or survey or data form.

Once continuous temperature data are graded, the UDWC Monitoring Project Manager and ODFW M & E Program Biologist will communicate continuous temperature grades to field staff. CASM Environmental and macroinvertebrate laboratories will include the results of precision assessments in final data files submitted to the UDWC Monitoring Project Manager and ODFW M & E Program Biologist.

4. Data Validation and Usability

4.1. Data Review, Validation, and Verification

UDWC and ODFW will follow procedures detailed in DEQ QAPP Section 4.1, Data Review, Validation, and Verification. Specifically, all continuous temperature and macroinvertebrate data will be reviewed by the UDWC Monitoring Project Manager and ODFW M & E Program Biologist to determine if it meets project objectives stated in this SAP (Section 1.5, Data Quality Objectives and Criteria). The UDWC Monitoring Project Manager and ODFW

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M & E Program Biologist will make the determination to accept, qualify, or reject data. Accepted and qualified data will be submitted to DEQ.

4.2. Validation and Verification Methods

UDWC and ODFW will follow procedures detailed in DEQ QAPP Section 4.2, Validation and Verification Methods.

Continuous Temperature Monitoring

UDWC monitoring staff conducting pre- and post- deployment and field audits may include the Monitoring Program Manager, Restoration Project Manager, Seasonal Monitoring Technician, or Restoration and Monitoring Intern. ODFW monitoring staff conducting pre- and post- deployment and field audits may include the District Biologist, M & E Program Biologist, or ODFW seasonal interns. The individual conducting any audit will complete the data fields in the associated log or survey form and review the form for completeness and data reasonableness (i.e., that values entered are plausible) after each audit and initial the form to certify completion. The UDWC Monitoring Program Manager and ODFW M & E Program Biologist will review audit data completed by staff who are conducting an audit for the first time, including evaluating data quality where data are available to do so.

For pre- and post-deployment audits, datalogger temperature records will be entered into the electronic PrePostAudits form following download of audit data, and data quality corresponding to data quality levels specified in the DEQ Data Quality Matrix, Version 5, will be calculated and assigned using formulas saved in the form. For field audits, data quality corresponding to data quality levels specified in the DEQ Data Quality Matrix, Version 5, will be calculated and assigned when NIST thermometer and datalogger temperature measurements are entered into the electronic FieldAudits form, using formulas saved in the form, either when data are entered into an electronic form in the field or when they are transcribed from a paper form in the office following each field audit event.

The UDWC Monitoring Program Manager, Restoration Project Manager, Seasonal Monitoring Technician, or Restoration and Monitoring Intern, and the ODFW M & E Program Biologist and seasonal interns, may all enter continuous temperature data and associated QA data in their respective DEQ Continuous Temperature Data Submission Templates (available at https://www.oregon.gov/deq/wq/Pages/WQ-Monitoring-Resources.aspx). The UDWC Monitoring Program Manager and ODFW M & E Program Biologist will systematically review all data entered in their Data Submission Templates by anyone other than themselves. Where data is transcribed from paper forms to electronic forms or entered from electronic forms or downloaded continuous temperature data files into the Data Submission Template, the UDWC Monitoring Program Manager and ODFW M & E Program Biologist will each compare 10% of data records transcribed or entered to the corresponding original records.

Macroinvertebrate Monitoring

UDWC's Monitoring Program Manager contracts with CASM Environmental, LLC for macroinvertebrate sampling, analysis and reporting. CASM Environmental, LLC trains partner and community volunteers recruited by UDWC in macroinvertebrate sampling protocols and oversees sample collection by volunteers. CASM Environmental reviews all sample datasheets for completeness and reasonableness within two weeks following sample

collection. The ODFW M & E Program Biologist reviews mainstem Upper Deschutes River, tributary, and off-channel macroinvertebrate sample datasheets for completeness and reasonableness following each sampling event.

CASM Environmental subcontracts with Cole Ecological for macroinvertebrate sample identification, data entry and management, and PREDATOR model analysis, and ODFW contracts with Aquatic Biology Associates, Inc. Highly trained and experienced taxonomists from both labs holding PhD or MS degrees review macroinvertebrate sample ID and data, and determine data quality, according to updated quality assurance plans.

4.3. Reconciliation with Data Quality Objectives

UDWC will follow procedures outlined in DEQ QAPP Section 4.3, Reconciliation with Data Quality Objectives.

5. Revision History

Table 11. Revision History

Revision	Date	Changes	Editor
1.0	05/06/2002	Original QAPP Document. Electronic version is on file in UDWC cloud storage.	Nancy Breuner
2.0	2006	Major revisions throughout document, routine review, migrated to new template, sampling locations and parameters updated. Electronic version is on file in UDWC cloud storage.	Lesley Jones
3.0	2008	Full review and revision. Electronic version is on file in UDWC cloud storage.	Lesley Jones
3.1	02/05/2015	Addendum added to UDWC 2008 QAPP, updating sites and water quality parameters monitored, and equipment used. Electronic version is on file in UDWC cloud storage.	Lauren Mork
4.0	05/23/2025	Migrated UDWC 2008 QAPP to DEQ SAP template updated June 27, 2023; full review and major revisions throughout document including updating project partners and sites and water quality parameters monitored.	Lauren Mork and Casey Schuder

6. References

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Table 11 Continuous Temperature Datalogger PrePostAudits Form

Warm bath: 10 measurements at ~21°C; Cold bath: 10 measurements at ~10°C											
Surveyor	**Activity Date**	**Activity Time**	**Equipment Location Name**	**Equipment ID #**	**Equipment Result Value**	**Equipment Result Unit**	**Reference Result Value**	**Reference Result Unit**	**Reference ID #**	**Difference**	**Data Quality**

Table 12 Continuous Temperature Datalogger FieldAudits Form

River Mile ID	DEQ ID	Site Description	Datalogger Serial #	Date (M/D/YY)	Time	NIST Temp (°C)	TidbiT Temp (°C)	Difference	Data Quality	V2 Pro Flashing (Y/N)	NIST #	All Fields Complete? (surveyor (initial)	Notes

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Figure 3 Macroinvertebrate Riffle Targeted Protocol Datasheet

Riffle Targeted Sampling

Site ID _____ Date _____

Sampled by: _____

Start time: End time: Air temp.: °C Water temp.: °C

# of riffles sampled: _____ # of kicks composited: 8 x 1 ft² # sample jars _____

Duplicate collected? ___ yes ___ no If yes, total # duplicate jars _____ _

Water odors: none / organic / rotten eggs / fishy / chlorine / petroleum / other (describe):

Water appearance: clear / turbid / milky / dark brown / foamy / oily sheen / other (describe):

Dominant land use: Forest / agriculture (crops / pasture) / urban (industrial / residential) / other:
_
Extent of algae covering submerged materials: none / 1-25% / 25-50% / 50-75% / 75-100%
_
Type of algae: none / close-growing / filamentous (i.e. strands >2") / floating clumps

Water depth. Each cell in column must be filled in at every riffle sampled.								
Parameter	**Riffle 1**	**Riffle 2**	**Riffle 3**	**Riffle 4**	**Riffle 5**	**Riffle 6**	**Riffle 7**	**Riffle 8**
Wetted width								
Depth @ ¼ wetted width								
Depth @ ½ wetted width								
Depth @ ¾ wetted width								

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Substrate (estimate % each type present; each column should add to 100%)								
% composition of riffle	Riffle 1	Riffle 2	Riffle 3	Riffle 4	Riffle 5	Riffle 6	Riffle 7	Riffle 8
Bedrock (continuous rock)								
Boulder (> 12 in.; larger than basketball)								
Cobble (2.5-12 in.; tennis ball to basketball)								
Gravel (0.6-2.5 in.; marble to tennis ball)								
Sand (< 0.6 in.; smaller than marble)								
Silt/clay/muck (fine particles)								
Woody debris (must be immersed)								
Other (describe)								
Total (100%)								

Additional notes or observations (including other wildlife noted):

Figure 4 Macroinvertebrate Proportional Multihabitat Protocol Datasheet

Proportional Multihabitat Sampling

Site ID _____ Date _____

Sampled by: _____

Start time: End time: Air temp.: °C Water temp.: °C

Proportional Multihabitat # of net sets composited: 10 x 1 ft² # sample jars _____

Water odors: none / organic / rotten eggs / fishy / chlorine / petroleum / other (describe):

Water appearance: clear / turbid / milky / dark brown / foamy / oily sheen / other (describe):

Dominant land use: Forest / agriculture (crops/pasture) / urban (industrial/residential) / other:

Extent of algae covering substrate: none / 1-25% / 25-50% / 50-75% / 75-100%

Type of algae: none / close-growing / filamentous (i.e. strands >2") / floating clumps

Habitat type determination		
habitat type	% coverage in reach (should total 100%)	# net sets (should total 10)
bedrock/boulder (continuous rock/> basketball)		
Cobble (tennis ball to basketball)		
Gravel (marble to tennis ball)		
sand/silt (< marble or fine particles)		
filamentous algae (long, flowing strands)		
aquatic vegetation (forbs rooted or floating in wetted channel		
wood (small wood tangles or LWD in wetted channel)		
rootwads (tangles of live roots extruding into flowing channel below undercut banks)		
TOTAL		

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Habitat & flow type at each net set		
Net set #	habitat (bedrock/boulder, cobble, gravel, sand/silt, filamentous algae, vegetation, wood, rootwad	flow type (riffle, run, glide, pool)
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

Water depth (feet/inches) Each cell in column must be filled in for each net set taken										
Parameter	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10
Wetted width										
Depth @ ¼ wetted width										
Depth @ ½ wetted width										
Depth @ ¾ wetted width										

Additional observations (including other wildlife noted):

Figure 5 Cole Ecological, Inc. Chain-of-Custody Form

Lab Name	Cole Ecological	**Client:**		**CE Project Number:**		**Instructions to client:**	
Macroinvertebrate Samples		**Client Address:**		**Destination CE Lab:**		*Please fill out, print, sign and send with samples*	
Chain-of-Custody Form		**Client Contact Name:**		**CE Lab Contact:**		*Email electronic version to mikebcole@comcast.net*	
		Client Contact Phone:		**CE Contact Phone:**		*Add additional rows to table, as needed*	
		Client Contact Email:		**CE Contact Email:**			

Client Sample Code identifies each individual sample collected and is a required field, while the station code idenitifies the sample location(s) from which (one or more) samples were collected and is optional

Count	CE Sample Code	Client Sample Code	Station Code	Waterbody Name	Collection Date	Habitat	# Sample Vessels	Duplicate Sample?	Sampling Method	Client Sample Notes
	EXAMPLE	*HGBM01-01-11*	*HGBMO1*	*Hinesburg Brook*	*9/19/01*	*riffle*	*2*	*N*	*8-kick composite*	
1	*PLEASE LEAVE*									
2	*THIS COLUMN*									
3	*BLANK*									
4										
5										
6										
7										
8										
9										
10										
11										
12										
13										
14										
15										
16										
17										
18										
19										
						TOTAL # JARS	**0**			

SIGNATURES:

Relinquished By/Affiliation:	Date:	Comments:	Exhange 1
Received By/Affiliation:	Date:	Comments:	
Relinquished By/Affiliation:	Date:	Comments:	Exhange 2
Received By/Affiliation:	Date:	Comments:	
Relinquished By/Affiliation:	Date:	Comments:	Exhange 3
Received By/Affiliation:	Date:	Comments:	

Figure 6 Aquatic Biology Associates, Inc. Sample Log

Sample Log

Client:
Contact person:
Phone :
e-mail:
Project name:
Date sent:

Waterbody	Station	Date	Replicate	Number of Sample Bottles	Sampler	Mesh size	Area sampled	State	County	Latitude(decimal)	Longitude (decimal)	Elevation (m)
e.g Sun Creek	@ mouth	9/14/2009	NA	2	D-frame net	500 micron	8 square feet	OR	Klamath	43.267893	-122.56829	1530

You may add columns and rows to better reflect your project and sample information.
Each row listing is considered to be a separate sample. Replicates will be analyzed separately and mean abundances and metrics calculated along with individual replicate abundances and metrics.
Basic location information is appreciated for taxa distribution records and museum labels (State, County, Latitude, Longitude, Elevation).

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