From:	Lindsay II, Jerry
To:	Vojin Janjic
Cc:	Doty Iv, Thomas; Doty, Walt; Huffman, Chad; Huffman, Chad; Norman, Carrie; Branton, Michele; Branton, Michele G.; Moore, Johnny; Johnny Moore (Science); Joshua Frazier; Courtney Thomason; Fortney, Jill M; Daffron, James Y; Phillips, Elizabeth C; Petrie, Roger; Mathews, Teresa; North, Todd; Goddard, Wesley; Schmitt, Marshall; SkipperDD; Directors Files (drx); betsy.brucken@ettp.doe.gov; Crow, Kevin R (KC4); Water Permits
Subject:	[EXTERNAL] NPDES PERMIT WQPP ANNUAL DATA AND EVALUATION REPORT Email 1 of 3
Date:	Monday, April 29, 2024 9:36:15 AM
Attachments:	image001.png

Letter and attachment will be sent in a total of 3 emails due to attachment size limitations.

Good Morning. Sent on behalf of the ORNL Site Office.

Please find the attached pdf of subject document titled, "**NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) PERMIT WATER QUALITY PROTECTION PLAN (WQPP) ANNUAL DATA AND EVALUATION REPORT**," dated April 27, 2024. A hard copy will not be sent. All distribution has been made.

Thank You,
Jerry Lindsay
Secretary III
ORNL Site Office
Office: 865.576.0855
LBYD FEDERAL
A contractor for the U.S. Department of Energy

From:	Lindsay II, Jerry
To:	Vojin Janjic
Cc:	Doty Iv, Thomas; Doty, Walt; Huffman, Chad; Huffman, Chad; Norman, Carrie; Branton, Michele; Branton, Michele G.; Moore, Johnny; Johnny Moore (Science); Joshua Frazier; Courtney Thomason; Fortney, Jill M; Daffron, James Y; Phillips, Elizabeth C; Petrie, Roger; Mathews, Teresa; North, Todd; Goddard, Wesley; Schmitt, Marshall; SkipperDD; Directors Files (drx); betsy.brucken@ettp.doe.gov; Crow, Kevin R (KC4); Water Permits
Subject:	[EXTERNAL] RE: NPDES PERMIT WQPP ANNUAL DATA AND EVALUATION REPORT Email 2 of 3
Date:	Monday, April 29, 2024 9:43:47 AM
Attachments:	image001.png

First half of the enclosure to the letter is attached.

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Jerry Lindsay
Secretary III
ORNL Site Office
Office: 865.576.0855
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A contractor for the U.S. Department of Energy

From: Lindsay II, Jerry <lindsayiija@ornl.gov>
Sent: Monday, April 29, 2024 10:36 AM
To: Vojin.Janjic@tn.gov
Cc: Doty Iv, Thomas <dotytw@ornl.gov>; Doty, Walt <Walt.Doty@science.doe.gov>; Huffman, Chad <huffmanck@ornl.gov>; Huffman, Chad <huffmanck@ornl.gov>; Norman, Carrie <normanca@ornl.gov>; Branton, Michele <brantonmg@ornl.gov>; Branton, Michele G. <michele.branton@science.doe.gov>; Moore, Johnny <moorejo@ornl.gov>; Johnny Moore (Science) <johnny.moore@science.doe.gov>; joshua.frazier@tn.gov; 'courtney.thomason@tn.gov' <courtney.thomason@tn.gov>; Fortney, Jill M <jill.fortney@science.doe.gov>; Daffron, James Y <james.daffron@orem.doe.gov>; Phillips, Elizabeth C <elizabeth.phillips@orem.doe.gov>; Petrie, Roger B <roger.petrie@orem.doe.gov>; Mathews, Teresa <mathewstj@ornl.gov>; North, Todd <northta@ornl.gov>; Goddard, Wesley <goddardwd@ornl.gov>; Schmitt, Marshall <schmittma@ornl.gov>; Skipper, David <skipperdd@ornl.gov>; Directors Files (drx) <dirfiles@ornl.gov>; betsy.brucken@ettp.doe.gov; Crow, Kevin <kevin.crow@orcc.doe.gov>; water.permits@tn.gov
Subject: NPDES PERMIT WQPP ANNUAL DATA AND EVALUATION REPORT Email 1 of 3

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Good Morning. Sent on behalf of the ORNL Site Office.

Please find the attached pdf of subject document titled, "**NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) PERMIT WATER QUALITY**

PROTECTION PLAN (WQPP) ANNUAL DATA AND EVALUATION REPORT,"
dated April 27, 2024. A hard copy will not be sent. All distribution has been made.

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Subject:	[EXTERNAL] RE: NPDES PERMIT WQPP ANNUAL DATA AND EVALUATION REPORT Email 1 of 3
Date:	Monday, April 29, 2024 9:46:44 AM
Attachments:	image001.png

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Jerry Lindsay
Secretary III
ORNL Site Office
Office: 865.576.0855
LBYD FEDERAL
A contractor for the U.S. Department of Energy

From: Lindsay II, Jerry <lindsayiija@ornl.gov>
Sent: Monday, April 29, 2024 10:36 AM
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Cc: Doty Iv, Thomas <dotytw@ornl.gov>; Doty, Walt <Walt.Doty@science.doe.gov>; Huffman, Chad <huffmanck@ornl.gov>; Huffman, Chad <huffmanck@ornl.gov>; Norman, Carrie <normanca@ornl.gov>; Branton, Michele <brantonmg@ornl.gov>; Branton, Michele G. <michele.branton@science.doe.gov>; Moore, Johnny <moorejo@ornl.gov>; Johnny Moore (Science) <johnny.moore@science.doe.gov>; joshua.frazier@tn.gov; 'courtney.thomason@tn.gov' <courtney.thomason@tn.gov>; Fortney, Jill M <jill.fortney@science.doe.gov>; Daffron, James Y <james.daffron@orem.doe.gov>; Phillips, Elizabeth C <elizabeth.phillips@orem.doe.gov>; Petrie, Roger B <roger.petrie@orem.doe.gov>; Mathews, Teresa <mathewstj@ornl.gov>; North, Todd <northta@ornl.gov>; Goddard, Wesley <goddardwd@ornl.gov>; Schmitt, Marshall <schmittma@ornl.gov>; Skipper, David <skipperdd@ornl.gov>; Directors Files (drx) <dirfiles@ornl.gov>; betsy.brucken@ettp.doe.gov; Crow, Kevin <kevin.crow@orcc.doe.gov>; water.permits@tn.gov
Subject: NPDES PERMIT WQPP ANNUAL DATA AND EVALUATION REPORT Email 1 of 3

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PROTECTION PLAN (WQPP) ANNUAL DATA AND EVALUATION REPORT,"
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Thank You,
Jerry Lindsay
Secretary III
ORNL Site Office
Office: 865.576.0855
LBYD FEDERAL
A contractor for the U.S. Department of Energy

Department of Energy
Office of Science
ORNL Site Office
P.O. Box 2008
Oak Ridge, Tennessee 37831-6269

April 27, 2024

Mr. Vojin Janjic
Tennessee Department of Environment and Conservation
Division of Water Resources
William R. Snodgrass Tennessee Tower
312 Rosa L. Parks Avenue, 11th Floor
Nashville, Tennessee 37219

Dear Mr. Janjic:

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) PERMIT WATER QUALITY PROTECTION PLAN (WQPP) ANNUAL DATA AND EVALUATION REPORT

Oak Ridge National Laboratory's (ORNL) NPDES permit includes a requirement for ORNL to implement a WQPP. ORNL's WQPP includes best management practices, environmental monitoring, and investigation activities aimed at detecting and abating water quality and/or biological community impairments in the streams that drain the ORNL site. Results from these activities are required to be evaluated and summarized in an annual report. Enclosed is the 2023 WQPP Annual Data and Evaluation Report.

If there are any questions or additional information required, please contact Walt Doty at DotyTW@ornl.gov.

Sincerely,

Johnny O. Moore, Manager
ORNL Site Office

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) PERMIT WATER QUALITY PROTECTION PLAN (WQPP) ANNUAL DATA AND EVALUATION REPORT

Enclosure

cc w/enclosure:
Josh Frazier, TDEC
Courtney A. Thomason, TDEC
Jill M. Fortney, SC-GCS
James Y. Daffron, EM-921
Elizabeth C. Phillips, EM-942
Roger B. Petrie, EM-921
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U.S. Department of Energy
Oak Ridge National Laboratory
Water Quality Protection Plan
NPDES Permit TN0002941
2023 Data and Evaluation Report

May 2024

Table of Contents

Figures

Tables

Acronyms and Abbreviations

AWQC	Ambient Water Quality Criterion
BMAP	Biological Monitoring and Abatement Program
BMP	Best Management Practice
CCC	Criterion Continuous Concentration
CCS	Chlorine Control Strategy
CCTV	Closed Circuit Television
CMC	Criterion Maximum Concentration
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CWA	Clean Water Act
DO	Dissolved Oxygen
DOE	US Department of Energy
dw	Dry Weight
E&SC	Erosion & Sediment Control
EPA	US Environmental Protection Agency
EPT	Ephemeroptera, Plecoptera, and Trichoptera (or mayflies, stoneflies, and caddisflies)
FCK	First Creek kilometer
FFK	Fifth Creek kilometer
HgT	Total Mercury
HFIR	High Flux Isotope Reactor
ICP-MS	Inductively Coupled Plasma Mass Spectrometry
IMP	Internal Monitoring Point
LC50	Lethal Effect Concentration for 50% of Exposed Population
LOEC	Lowest Observed Effect Concentration
MB	Melton Branch
MEK	Melton Branch kilometer
NOEC	No Observed Effect Concentration
NPDES	National Pollutant Discharge Elimination System
OLCF	Oak Ridge Leadership Computing Facility
OREIS	Oak Ridge Environmental Information System
OREM	Oak Ridge Environmental Management
ORNL	Oak Ridge National Laboratory
ORR	Oak Ridge Reservation
PCB	Polychlorinated Biphenyl
PWTC	Process Waste Treatment Complex
SDS	Safety Data Sheet
SNS	Spallation Neutron Source
SPMD	Semipermeable Membrane Device
STP	Sewage Treatment Plant
TDEC	Tennessee Department of Environment and Conservation
TMI	Tennessee Macroinvertebrate Index
TN CGP	Tennessee Construction General Permit
TP	Total Phosphorus
TRO	Total Residual Oxidant
WBK	Walker Branch Kilometer
WCK	White Oak Creek Kilometer
WET	Whole Effluent Toxicity
WOC	White Oak Creek
WOD	White Oak Dam
WOL	White Oak Lake
WRRP	Water Resources Restoration Program
WQC	Water Quality Criteria
WQPP	Water Quality Protection Plan

A. Components of Water Quality Protection Plan

In 2019, the U.S. Department of Energy (DOE) Oak Ridge National Laboratory (ORNL) National Pollutant Discharge Elimination System Permit (NPDES) required an update to the 2008 ORNL Water Quality Protection Plan (WQPP). This update was submitted to the Tennessee Department of Environment and Conservation (TDEC) in February 2020 and its components are as follows in Table 1. Since the required 2020 update, significant plan changes have been included in the subsequent annual WQPP reports. Due to more recent NPDES permit modifications, all references to radiological monitoring have been removed from this section.

Table 1. Components of WQPP

NPDES Permit Section	Title	Description
IV.A	Components of Water Quality Protection Plan	Synopsis of each section.
IV.B	Deadlines and Format for Submittals of the Division	Section IV.B provides the frequency and description of the reports that are submitted on a reoccurring basis.
IV.C	Aquatic Communities of the White Oak Creek Watershed	Section IV.C addresses the following items: bioassessment monitoring, fish population and community studies, and application of the EPA's stressor identification process.
IV.D	Mercury in the White Oak Creek Watershed	Section IV.D addresses the following items: investigation of mercury sources and abatement methods, mercury sampling in the water column and aquatic life bioaccumulation.
IV.E	Polychlorinated Biphenyls in the White Oak Creek Watershed	Section IV.E addresses the following items: investigation of PCB sources and abatement methods, PCB sampling in the water column and aquatic life bioaccumulation.
IV.F	Facility Monitoring Activities	Section IV.F addresses the following items: industrial and construction storm water pollution prevention, chlorine control strategies, cooling tower discharges, and whole effluent toxicity testing of outfalls.

Oak Ridge National Laboratory Water Quality Program

The DOE ORNL NPDES permit (TN0002941) was modified in February 2023. In June 2023, DOE submitted the ORNL NPDES permit renewal application to TDEC. The February 2023 modified NPDES permit includes requirements for discharging wastewaters from the two ORNL wastewater treatment facilities (the sewage treatment plant and the process waste treatment complex) and from more than 150 category outfalls (these are outfalls with non-process wastewaters such as cooling water, various condensates, sump discharges, and/or storm water components). The permit also requires the continued development and implementation of a WQPP in order to "efficiently utilize the facility's financial resources to measure its environmental impacts." Rather than prescribing rigid monitoring schedules, the ORNL WQPP is intended to be flexible and focuses on significant findings/impacts to the environment. The ORNL WQPP is implemented utilizing an *adaptive management* approach (Figure 1) whereby results of investigations are routinely evaluated and strategies for achieving goals are modified based on those evaluations. The goals established for the ORNL WQPP at this time are to meet the requirements of the NPDES permit, improve the quality of aquatic resources on the ORNL site, prevent further impacts to aquatic resources from current activities, identify the stressors that contribute to impairment of aquatic resources, use available resources efficiently, and communicate outcomes with decision makers and stakeholders.

The ORNL WQPP was first developed by DOE and approved by TDEC in 2008 with monitoring initiated in 2009. Periodic revisions to the WQPP have been submitted to TDEC since that time. The first ORNL WQPP incorporated several different site-wide monitoring plans that had been required under previous NPDES permits including a biological monitoring and abatement plan (BMAP), a chlorine control strategy (CCS), a storm water pollution prevention plan, a non-storm water best management practices plan, and the radiological monitoring plan. Combining multiple monitoring and reporting efforts into one has proven more efficient for DOE. As NPDES permit and other regulatory requirements have changed, so has the ORNL WQPP content.

In order to prioritize the stressors and/or contaminant sources that may be of greatest concern to water quality and to define conceptual models that would guide any special investigations, the ORNL WQPP strategy was developed using the Environmental Protection Agency's (EPA) Stressor Identification Guidance Document (EPA 2000). Figure 2 summarizes that process. The process involves three major steps for identifying the cause of any impairment:

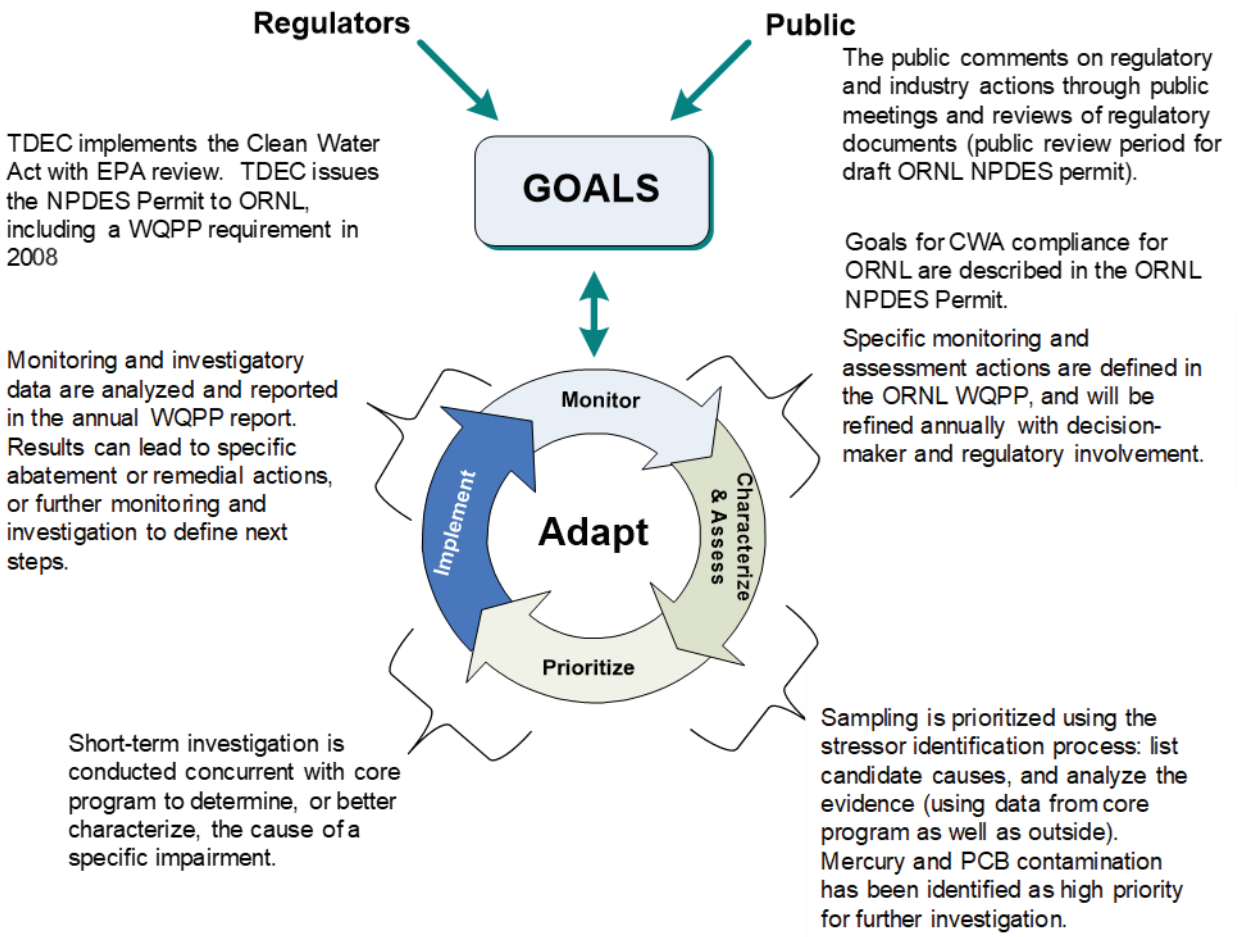
1. List candidate causes of impairment (based on historical data and a working conceptual model);
2. Analyze the evidence (using both case study and outside data); and
3. Characterize the causes.

The first two steps of the stressor identification process were initiated in 2009, focusing first on mercury impairment (Figure 2) and then on polychlorinated biphenyl (PCB) impairment because at the time the mercury and PCB concentrations in fish from White Oak Creek (WOC) were at or near human health risk thresholds (e.g., EPA ambient water quality criteria [AWQCs] and TDEC fish advisory limits). The sources of mercury to biota in the WOC watershed are mostly understood, providing a good basis from which to define an appropriate conceptual model for mercury contamination in WOC. A list of potential causes of PCB contamination was also developed. The

mercury and PCB water quality concerns at DOE ORNL are predominantly from past legacy site contamination currently being remediated under a separate regulatory driver, the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).

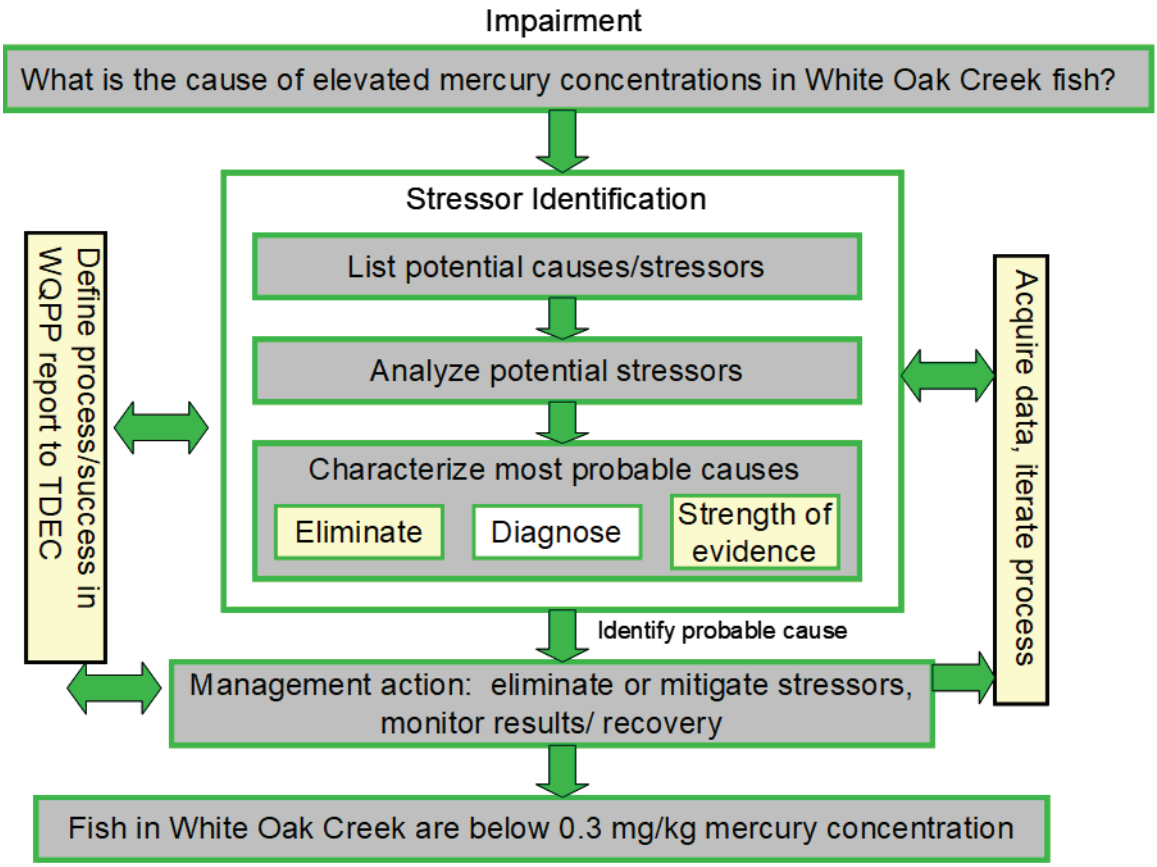
After potential causes were listed and the available evidence of mercury and PCB contamination in the WOC watershed was analyzed, additional investigations were initiated to characterize other causes of impairment. Special investigations were designed to examine specific source areas and to revise the conceptual model of the major contributors of impairment in the WOC watershed.

Since 2009, monitoring and investigation data collected under the ORNL WQPP have been analyzed, interpreted, reported, and compared with past results at least annually (per existing NPDES permit requirements). The significant findings of the ORNL WQPP monitoring and investigations are also reported annually in the Annual Site Environmental Report. The annual WQPP report provides an assessment of ORNL's receiving-stream watersheds and the impact of ongoing efforts to protect and restore those watersheds, as well as guides other efforts in improving the water quality in the watershed. As the ORNL WQPP monitoring, investigation, data analysis, and reporting has evolved since 2009, so has the corresponding timing of the ORNL WQPP Report. However, the detailed presentation of results of the annual monitoring and investigation included in the ORNL WQPP Report might be more effectively presented if only submitted to TDEC every 2 to 3 years, instead of on an annual basis as is required by the February 2023 modified NPDES permit. A longer period of data trending and analysis could prove to be more beneficial by helping to identify patterns, predict future trends, and develop effective strategies for planning and implementing additional studies and/or mitigation projects using adaptive management processes. When the WQPP first began, a presentation of WQPP actions and findings was delivered to TDEC in the non-report years. This presentation component may be a useful tool for collaborating with TDEC on WQPP activities without preparing a detailed data report each year. Therefore, DOE requests TDEC consider this ORNL WQPP report submission schedule modification when drafting the renewed NPDES permit.



Adapted from the US Environmental Protection Agency (EPA) stressor guidance document (EPA 2000). CWA = Clean Water Act, NPDES = National Pollutant Discharge Elimination System, ORNL = Oak Ridge National Laboratory, PCB = polychlorinated biphenyl, TDEC = Tennessee Department of Environment and Conservation, WQPP = Water Quality Protection Plan

Figure 1. Diagram of the adaptive management framework with stepwise planning specific to the ORNL WQPP.



Modified from Figure 1-1 in the US Environmental Protection Agency stressor guidance document (EPA 2000).
TDEC = Tennessee Department of Environment and Conservation, WQPP = water quality protection plan

Figure 2. Application of stressor identification guidance to address mercury impairment in the White Oak Creek watershed.

B. Deadlines and Format for Submittals to the Division

The ORNL WQPP Report is being submitted to satisfy annual reporting requirements listed in Table 2, which includes all reporting deadlines related to ORNL WQPP monitoring activities as required by the ORNL NPDES Permit.

Table 2. Submittal Deadlines for Reports – NPDES Permit

Narrative Condition Description	Schedule Date	Schedule Event Description	Description
Reporting Schedule	01-MAY-24	Annual Report	The facility shall submit an annual report which summarizes the sampling data for the previous reporting period (12 months). The facility shall allow access to the OREIS data accounts by TDEC staff that needs to process that sampling data
One-time Submittal	Requirement Met	Submittal of Current WQPP Plan	Submitted February 2020
One-time Submittal	Requirement Met	Submittal of proposal for nutrient study	The Nutrient Study report was submitted on February 1, 2022. This submittal fulfilled the commitments made in the Nutrient Study Proposal prepared in accordance with the 2019 NPDES Permit requirement under Part 1, which was submitted to TDEC on February 1, 2021.

Raw data sheets for the instream bioassessments are provided in Appendix 1 and 2 of this ORNL WQPP Annual Report.

Planned changes to the ORNL WQPP monitoring activities are reported in the ORNL WQPP Annual Report on May 1st, unless otherwise required by NPDES Permit (Table 2).

C. Aquatic Communities of the White Oak Creek Watershed

1. Introduction

Fish and benthic macroinvertebrate community structures are commonly used for biomonitoring studies in freshwater ecosystems because their life histories, abundances, and diversity allow for the detection of a broad spectrum of responses to environmental stress on relevant spatial and temporal scales. These same characteristics also make studies of these aquatic organisms useful for evaluating the ecological response to human-induced changes in their environment, such as changes in effluent discharges, thermal loading, and sedimentation either from the addition of a pollutant or the reduction or elimination of a pollutant via pollution abatement or remediation.

The close association of benthic macroinvertebrates with stream sediments, their relative immobility, and their sensitivity to changes in water quality make the study of these organisms a sensitive tool for evaluating the condition of a body of water. Fish communities include several trophic levels and species that are at or near the end of food chains and can therefore integrate the direct effects of water quality, as well as the indirect effects that water quality and habitat changes have on primary producers (periphyton) and primary consumers (benthic invertebrates) that fish use for food. In addition, fish spend their entire life cycles in aquatic habitats and are therefore more susceptible to changes in flow and connectivity. Furthermore, statements about the condition of the fish communities are easily understood by the general public.

Monitoring of the fish and benthic macroinvertebrate communities was initiated under the ORNL BMAP in 1986 to determine if the effluent limits established at ORNL protect and maintain the designated uses of WOC and its major tributaries, including the growth and propagation of fish and aquatic life. Studies of the fish and benthic macroinvertebrate communities in WOC watershed have effectively been used for assessing and documenting existing ecological conditions and changes in ecological conditions following completion of major abatement actions (e.g., chlorine reduction). Significantly altered or depauperate fish and macroinvertebrate communities have been found in WOC and its tributaries, though improvements in the communities have been documented for First Creek, Fifth Creek, Melton Branch, and WOC since 1986. Recent data continue to indicate mild to moderate impacts within and downstream of the main ORNL Campus.

The primary objectives of the Aquatic Communities monitoring task for the ORNL WQPP Annual Report, required by the NPDES permit, are to monitor the condition of the fish and benthic macroinvertebrate communities of the streams in the WOC watershed and to evaluate the response of the fish and macroinvertebrates to abatement actions. These objectives will also help meet the overall BMAP objective of determining whether the classified uses of the streams (i.e., growth and propagation of fish and aquatic life as well as recreation and irrigation) are being protected.

2. *Sample Locations and Frequency*

Table 3. Frequency and location of biological community and bioaccumulation sampling sites in the White Oak Creek watershed

Site[1]	Community Studies			Bioaccumulation			
	Macroinvertebrates						
	ORNL Protocols	TDEC Protocols	Fish	Sunfish Hg/PCB	Largemouth Bass Hg/PCB	Stoneroller Minnows Hg/PCB/ Metals	Total Hg
WCK 6.8	X	X	X				X
WCK 4.4			X				
WCK 4.1							X
WCK 3.9	X	X	X	X		X	
WCK 3.4			X				X
WCK 2.9				X			
WCK 2.3	X	X	X	X			X
WCK 1.5				X[2]	X[2]		X
FFK 1.0	X		X				
FFK 0.2	X	X	X				
FCK 0.8	X		X				
FCK 0.1	X	X	X				
MEK 1.4			X				
MEK 0.6	X[2]	X[2]	X[2]	X[2]			X
Frequency	Annual[3]	Annual[4]	Biannual[5]	Annual[3]	Annual[3]	Annual[3]	6x/yr

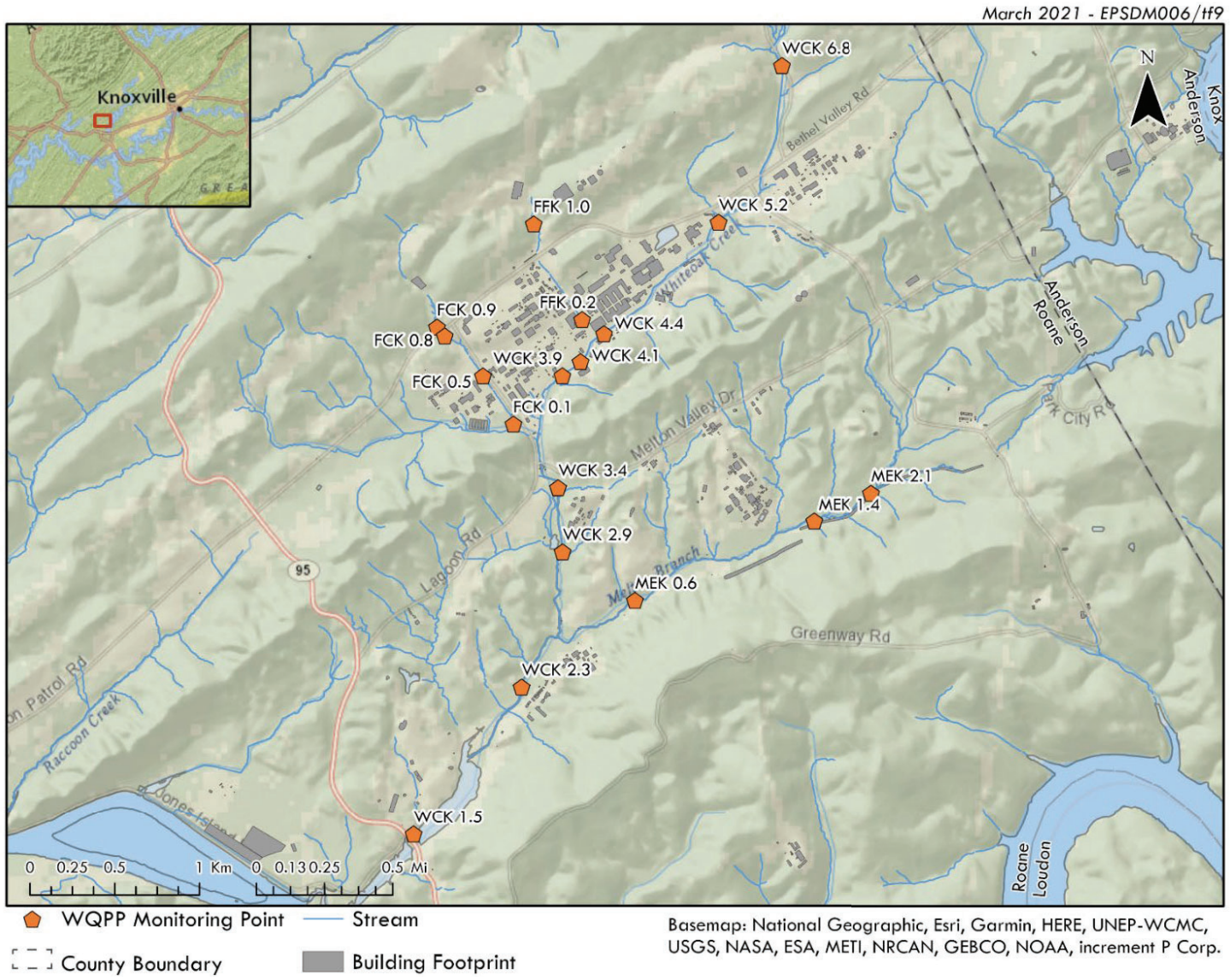
[1] WCK = White Oak Creek kilometer; WCK 1.5 = White Oak Lake; FFK = Fifth Creek kilometer; FCK = First Creek kilometer; MEK = Melton Branch kilometer. Reference sites used by BMAP not listed here include locations in Walker Branch (WBK 1.0), Ish Creek (ISK 1.0), Mill Branch (MBK 1.6), Brushy Fork (BFK 7.6), and Hinds Creek (HCK 20.6).

[2] Funded by the DOE Oak Ridge Environmental Management (OREM) Water Resources Restoration Program (WRRP).

[3] Samples collected in spring.

[4] Samples collected during low flow, high temperature conditions (August or September).

[5] Fish sampling at FFK 1.0 is annual in spring.



FCK = First Creek kilometer, FFK = Fifth Creek kilometer, WCK = White Oak Creek kilometer, MEK = Melton Branch kilometer

Figure 3. WQPP Monitoring Locations

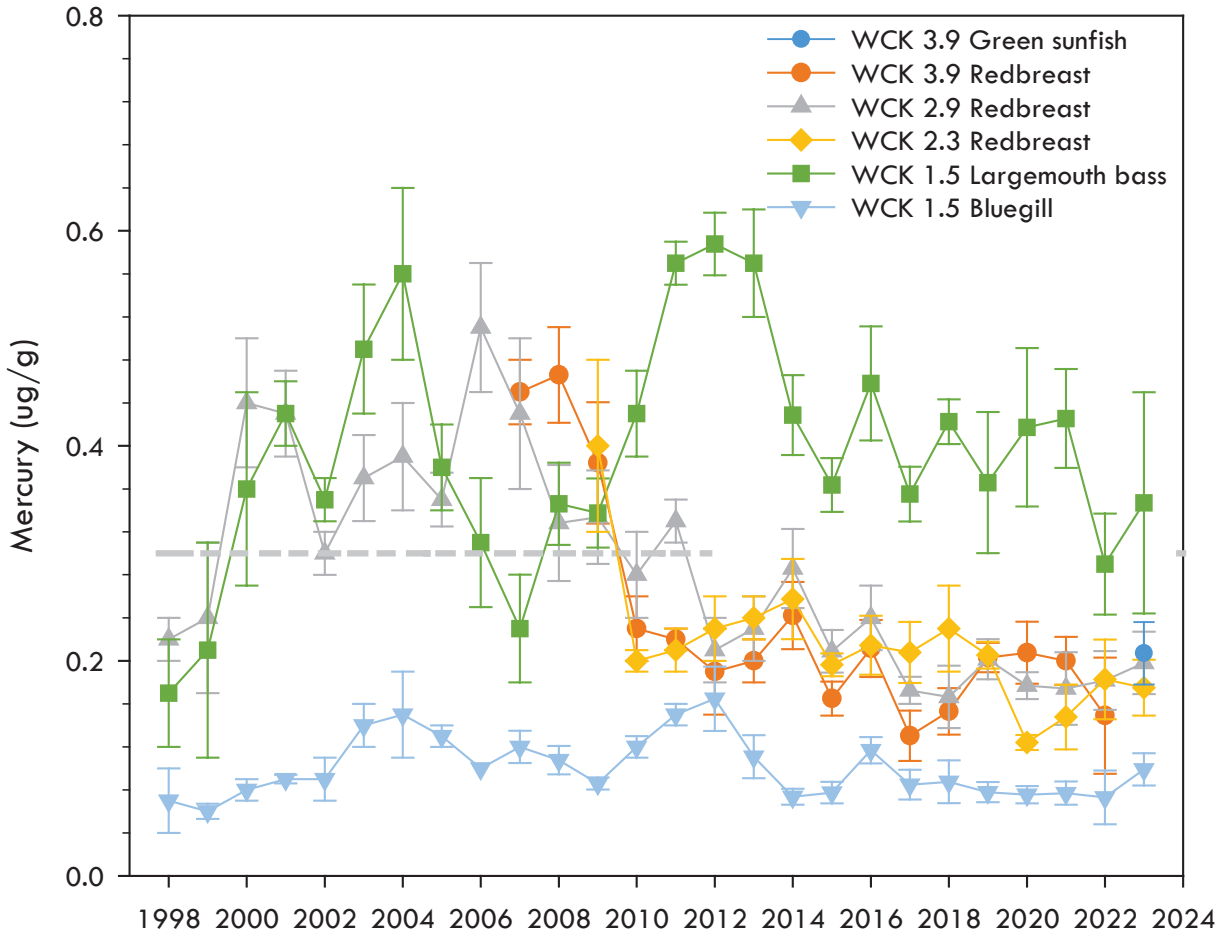
3. Bioaccumulation Studies

The bioaccumulation task for BMAP addresses two NPDES permit requirements at ORNL: (1) evaluate whether mercury at the site is contributing to a stream at a level that will adversely affect fish and other aquatic life or that will violate the recreational criteria and (2) monitor the status of PCB contamination in fish tissue in the WOC watershed. Concentrations of mercury in fish in the WOC watershed are monitored annually and are evaluated relative to the EPA AWQC of 0.3 μg/g in fish fillets, a concentration considered to be protective of human health and the environment. Concentrations of PCBs in fish fillets are also monitored annually and are evaluated relative to the TDEC fish advisory limit of 1 μg/g.

Bioaccumulation in Fish

Mean sunfish fillet concentrations in WOC stream sections have remained below the EPA-recommended fish-based mercury AWQC of 0.3 μg/g for a decade (Figure 4). Mean mercury concentrations in redbreast sunfish fillets collected from all stream sections in WOC averaged between 0.18 and 0.20 μg/g in 2023, which is similar to concentrations seen in 2022. Green sunfish (*Lepomis cyanellus*) were collected as an alternative to redbreast sunfish at WCK 3.9 in 2023, due to challenges in locating the latter. Mercury concentrations in green sunfish were similar to concentrations seen in redbreast sunfish in WOC stream over the past few years, averaging 0.21 μg/g in 2023. The overall downward trend in mercury concentrations in fish in this stream from 2007-2023 has been attributed to the decreases in aqueous mercury concentrations seen as a result of the treatment of a mercury-contaminated sump in 2007 (Mathews et al. 2013). Mercury concentrations in bluegill collected from WCK 1.5 remained similar to recent years, averaging 0.10 μg/g (Figure 4). Mean mercury concentrations in largemouth bass increased slightly from 0.29 μg/g in 2022 to 0.35 μg/g in 2023, a little above AWQC but remained lower than the past 15 years. Mercury concentrations in largemouth bass from WCK 1.5 remain higher than those in sunfish collected in stream sections of WOC because they feed at a higher trophic level and potentially because the habitat at that site is conducive to mercury methylation.

In 2023, PCB concentrations (defined as the sum of Aroclors 1248, 1254, and 1260) in fish collected throughout the WOC watershed remained within historical ranges at all stream sites, averaging below 0.4 μg/g (Figure 5). While these concentrations are above concentrations seen in fish collected from reference sites off the Oak Ridge Reservation (ORR), there are no federal guidelines for fish advisories for PCBs. PCB advisories may consider either acute, chronic non-cancer, or chronic cancer health risk, which leads to a wide range of difference across states (Cleary et al., 2021). Most recently the water quality criterion has been used to calculate the fish tissue concentration triggering impairment and a total maximum daily load (TDEC 2007); this concentration is 0.02 μg/g in fish fillets (TDEC 2010 a,b,c). The average PCB concentrations in fish in WOC (and across the Oak Ridge Reservation) exceed this conservative guideline (Figure 5), but recent work has shown that PCB concentrations have generally been declining in WOC sites at rates of up to ~1%/year through natural attenuation (Matson et al., 2022). Work to mitigate sources of PCBs within ORNL facilities (Section E) may increase these attenuation rates.



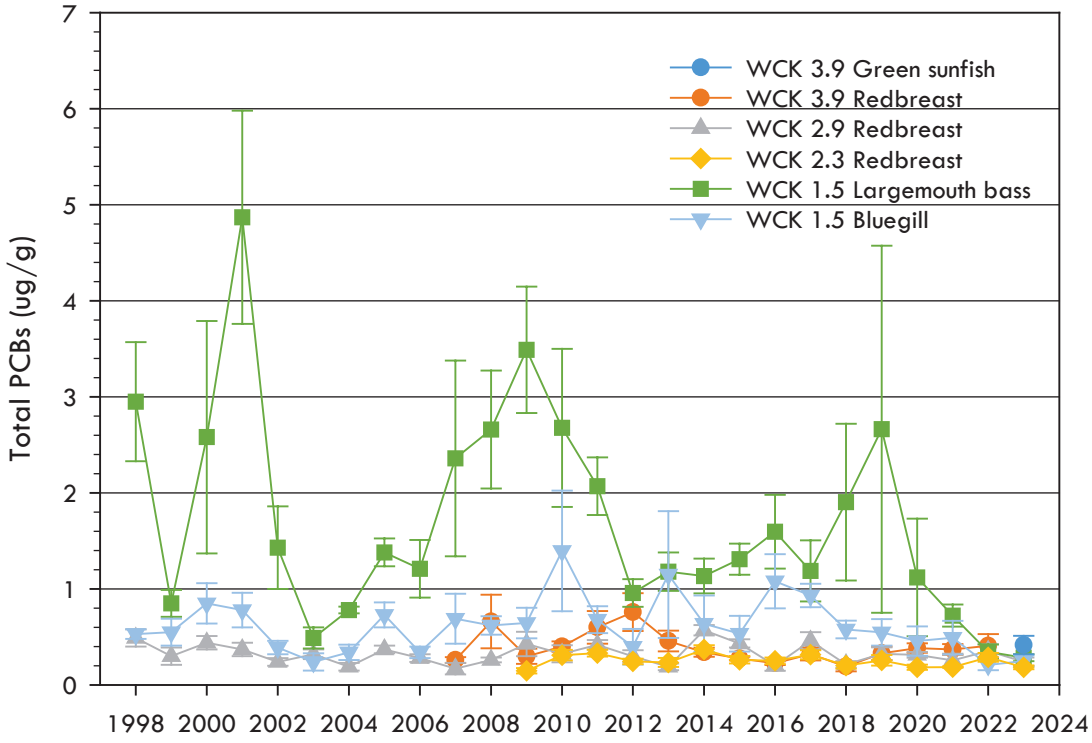
Notes:

1. Mean concentrations of Hg (± standard error, N = 6) in tissue taken from sampled fish.

2. Thee dashed grey line at 0.3 µg/g indicates the US Environmental Protection Agency ambient water quality criterion for mercury in fish tissue.

Acronym: *WCK = White Oak Creek kilometer*

Figure 4. Mean mercury concentrations in muscle tissue of sunfish and bass sampled from the White Oak Creek watershed, 1998–2023



Notes:

1. *Mean total PCB concentrations (± standard error, N = 6) found in fish fillets.*
2. *TDEC fish advisory PCB limit = 1 µg/g*

Acronyms: *PCB = polychlorinated biphenyl WCK = White Oak Creek kilometer*

Figure 5. Mean total PCB concentrations in fish sampled from the White Oak Creek watershed, 1998–2023

4. Benthic Macroinvertebrate Communities

Monitoring of benthic macroinvertebrate communities in WOC, First Creek, and Fifth Creek continued in 2023. Additionally, monitoring of the macroinvertebrate community in lower Melton Branch (Melton Branch kilometer [MEK] 0.6) continued under the DOE Oak Ridge Environmental Management (OREM) Water Resources Restoration Program (WRRP). Benthic macroinvertebrate samples are collected annually following TDEC protocols (since 2009), and protocols developed by ORNL staff (since 1987). The protocols developed by ORNL staff provide a long-term record (37 years) of spatial and temporal trends in invertebrate communities from which the effectiveness of pollution abatement and remedial actions taken at ORNL can be evaluated. The ORNL protocols also provide quantitative results that can be used to statistically evaluate changes in trends relative to historical conditions. The TDEC protocols provide a qualitative estimate of the condition of a macroinvertebrate community relative to a state-defined reference condition. Laboratory bench sheets and stream surveys can be found in Appendix 1 and 2.

General trends in the results of ORNL protocols indicated significant recovery in benthic macroinvertebrate communities since 1987, but community characteristics suggest that ecological impairment remains (Figure 6–Figure 8). Total taxonomic richness (i.e., the number of different species per sample) and richness of the pollution-intolerant taxa (i.e., the number of different mayfly, stonefly, and caddisfly species per sample or Ephemeroptera, Plecoptera, and Trichoptera [EPT] taxa richness) continued to be lower at downstream sites relative to respective upstream reference sites.

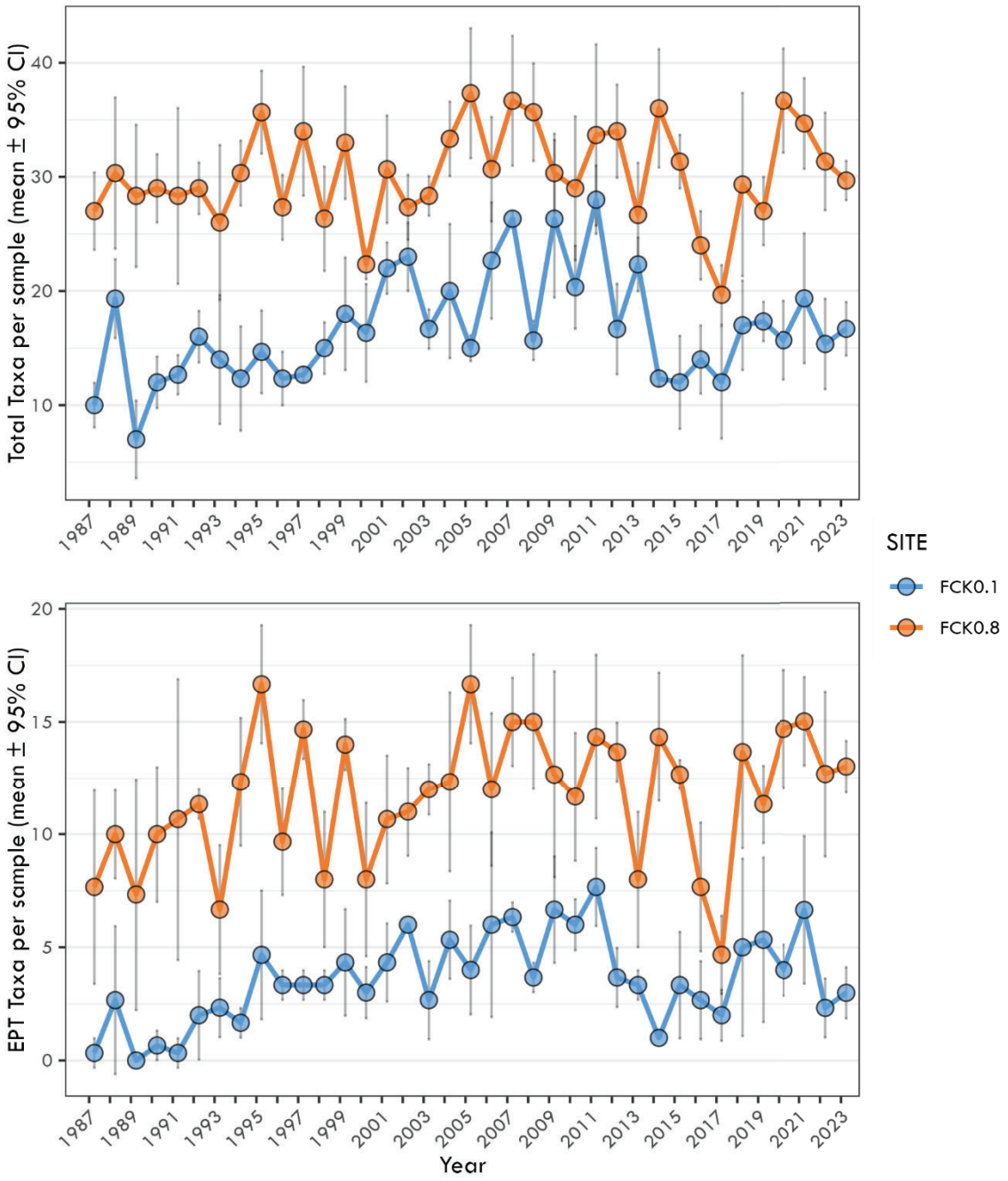
In lower First Creek (First Creek kilometer [FCK] 0.1), total taxa richness increased gradually in the 1990s and 2000s but was then lower for four years beginning in 2014 (Figure 6). Total taxa richness then increased at FCK 0.1 from 2018 to 2023, reaching values that were previously observed prior to 2014. Similarly, the number of pollution-intolerant EPT taxa decreased in 2012, and in 2014, EPT taxa richness was the lowest it had been since the early 1990s (Figure 6). After 2021 values being the highest in the past 10 years, EPT taxa richness values in 2022 and 2023 fell to pre-2018 levels. In upper First Creek (FCK 0.8), which serves as a reference for FCK 0.1, total taxa richness and EPT taxa richness declined for three consecutive years, from 2015 to 2017, before rebounding in 2018. Since 2018, total taxa richness and EPT taxa richness at FCK 0.8 both increased and have returned to pre-2015 levels (Figure 6). Low EPT taxa richness values observed over a 6-year period (2012 to 2017) at FCK 0.1 were mirrored only in some years at FCK 0.8 (i.e., EPT taxa richness was low at both sites in 2013, 2016, and 2017). This suggests that while climate or hydrological change may have influenced conditions within the entire stream (both FCK 0.1 and FCK 0.8), a more localized change may have also occurred in lower First Creek. If a change has occurred, it is not known whether it is related to a change in chemical conditions (e.g., change in water quality or the possible presence of a toxicant), physical conditions (e.g., unstable substrate, increased frequency of high discharge events), or natural variation. The increases in EPT taxa richness at both sites in 2023, while slight, suggest the potential for improving conditions, though further monitoring is necessary to determine whether the previously mentioned decline was due to an acute or a longer-term impact to the system.

Total taxa richness at Fifth Creek kilometer (FFK) 0.2 increased in the late 1980s and early 1990s, and then reached a fairly consistent level until exhibiting a large decrease between 2007 and 2008 (Figure 7), suggesting that conditions changed at the site during this time. Total taxa richness

returned to pre-decline levels over a period of about five years. Taxa richness decreased again over a four-year period (2018 to 2021) but increased slightly in 2022 and 2023 (Figure 7). EPT taxa richness at FFK 0.2 increased slowly from the late 1980s to early 2000s before decreasing for several years (~2003-2011). From 2011-2018, EPT taxa remained steady at around five EPT taxa/sample, but decreased in 2019 and remained low in 2020 and 2021 (three EPT taxa/sample), before increasing in 2022 (five EPT taxa/sample). In 2023, EPT taxa richness increased again to the highest value seen since 2002 (seven EPT taxa/sample). It is not known whether this increase will persist in future years or whether it instead reflects interannual variation in invertebrate community composition. Total and EPT richness values at FFK 1.0 (which serves as a reference for FFK 0.2) increased in 2023 compared to 2022 and have consistently remained higher than at FFK 0.2 since sampling began in 1987.

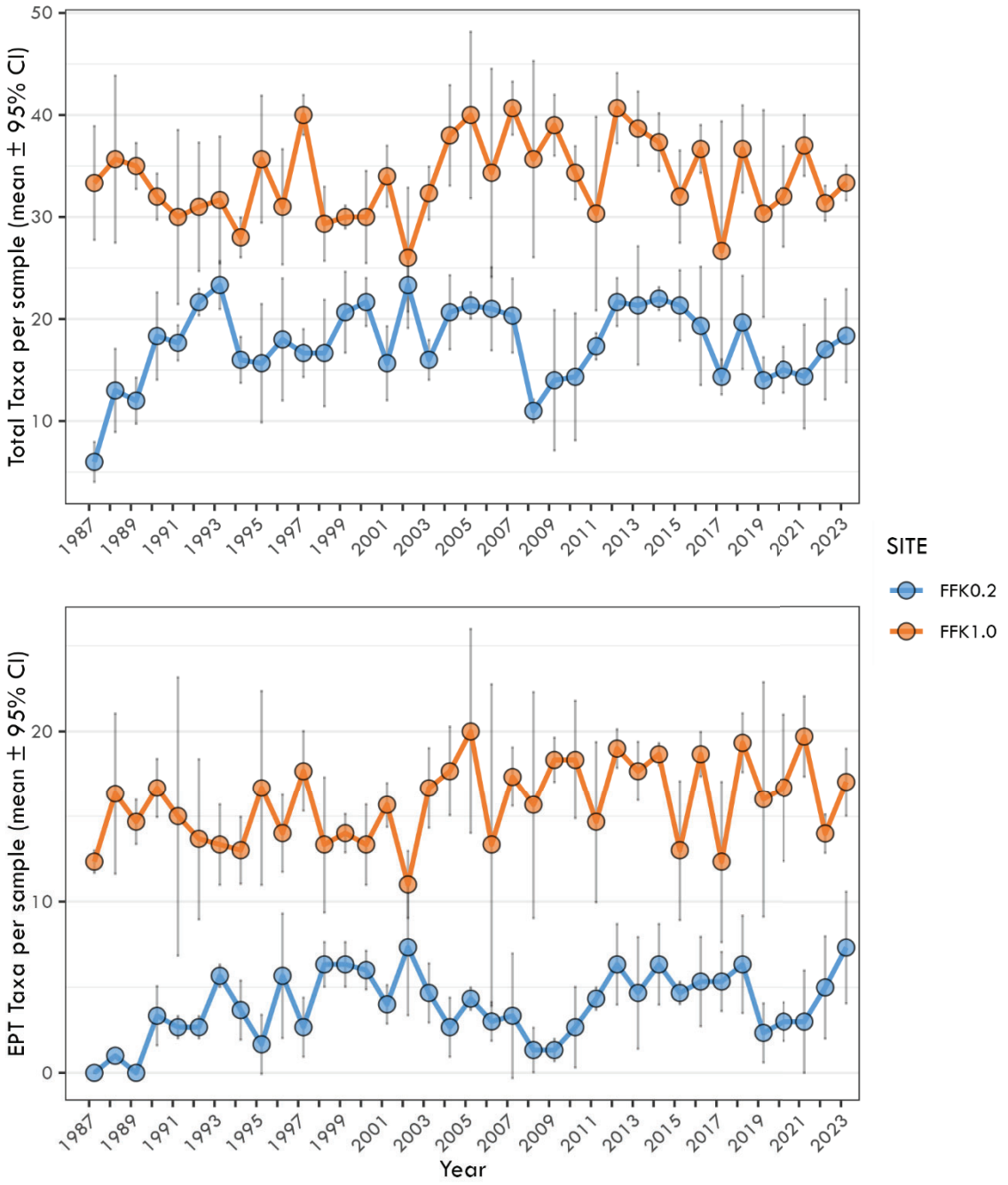
Invertebrate metric values for WCK 2.3 and WCK 3.9 continued to remain within the ranges of values found since the late 1990s and early 2000s, although total taxa richness and EPT taxa richness were lower at WCK 2.3 and WCK 3.9 over the past eight to nine years (Figure 8). As with FCK 0.1 and FFK 0.2, the total taxa richness and EPT taxa richness at WCK 2.3 and WCK 3.9 continued to be notably lower than at reference sites (WCK 6.8 and WBK 1.0). Neither total nor EPT taxa richness at WCK 3.9 have rebounded following large decline that began in 2015 and while increased richness values were observed in 2021, these values have since stabilized at a lower level in 2022 and 2023. We do not currently know the cause of the initial decline in 2015 or what has prevented the subsequent recovery, though as is the case in First Creek, changes in the chemical and physical conditions at WCK 3.9 may be contributing to these observed patterns. Since 2001 (except for one sampling event in 1987), Walker Branch has served as an additional reference site for WOC mainstem sites downstream of Bethel Valley Road (Figure 8). Comparisons of WCK 6.8 to WBK 1.0 show that communities in WCK 6.8 represent ideal reference conditions. Additionally, the comparison of Walker Branch to downstream sites in WOC show that these WOC communities remain impaired.

Macroinvertebrate metrics for Melton Branch (MEK 0.6) suggested that total taxa and EPT taxa richness continued to be similar to the WBK 1.0 reference site in 2023, but lower than WCK 6.8 (Figure 8). However, other invertebrate community metrics at MEK 0.6 potentially sensitive to more specific types of pollutants, such as the density of pollution-intolerant and pollution-tolerant species (not shown), continued to fluctuate annually between comparable values and values below those of the reference sites. For the past eight years (2016-2023), EPT density was generally lower in MEK 0.6 than in WCK 6.8 and WBK 1.0 while the density of pollution-tolerant species (oligochaetes and chironomids) was higher in MEK 0.6 than those two reference sites.



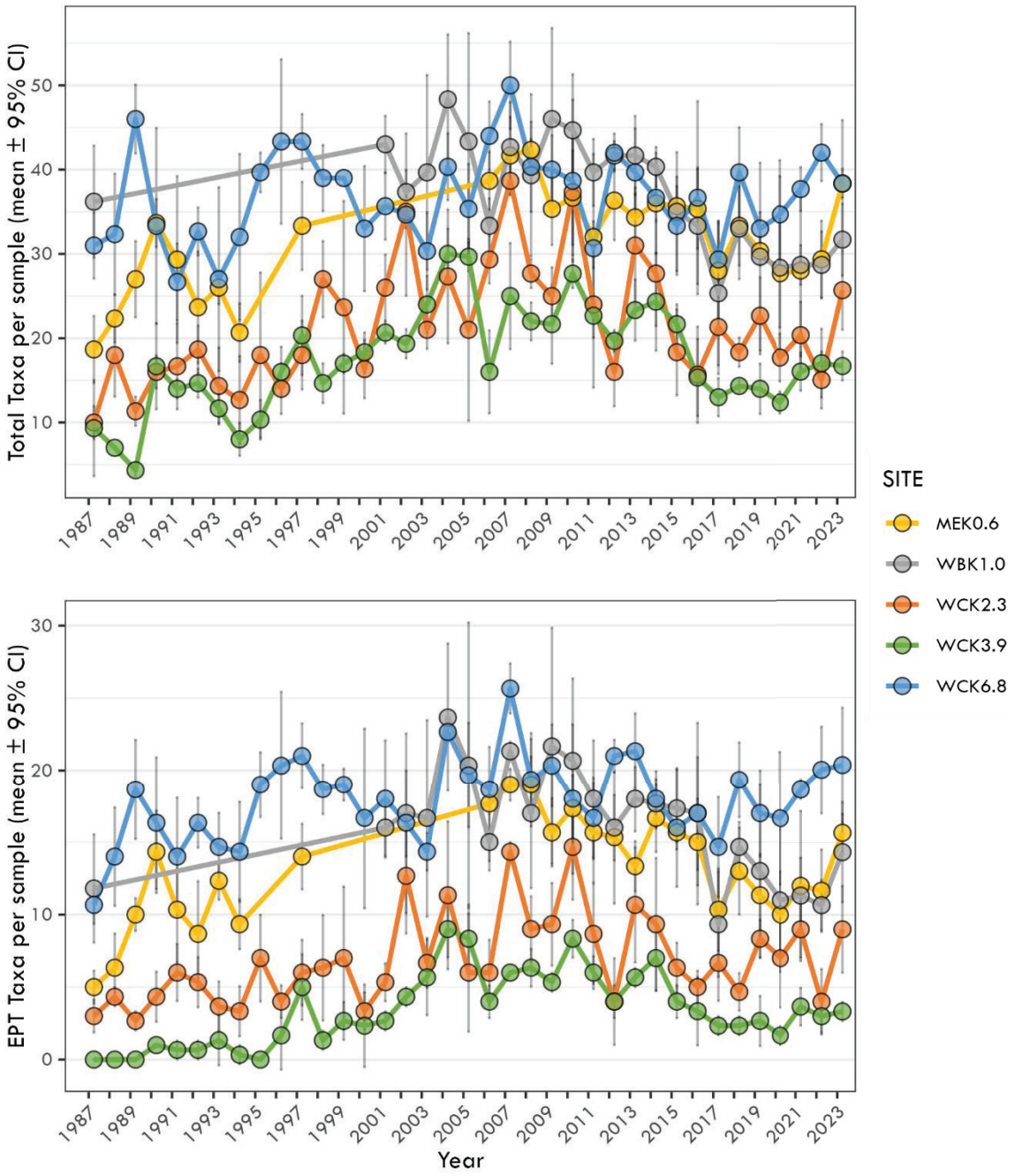
FCK = First Creek kilometer; CI = confidence interval

Figure 6. Benthic macroinvertebrate communities in First Creek (FCK 0.1 and 0.8): (top) total taxonomic richness (mean number of all taxa/sample ± confidence interval) and (bottom) taxonomic richness of the pollution-intolerant taxa, Ephemeroptera, Plecoptera, and Trichoptera (EPT) (mean number of EPT taxa/sample ± confidence interval), April sampling periods, 1987–2023; FCK 0.8 serves as a reference site.



FFK = Fifth Creek kilometer; CI = confidence interval

Figure 7. Benthic macroinvertebrate communities in Fifth Creek (FFK 0.2 and 1.0): (top) total taxonomic richness (mean number of all taxa/sample ± confidence interval) and (bottom) taxonomic richness of the pollution-intolerant taxa, Ephemeroptera, Plecoptera, and Trichoptera (EPT) (mean number of EPT taxa/sample ± confidence interval), April sampling periods, 1987–2023; FFK 1.0 serves as a reference site.



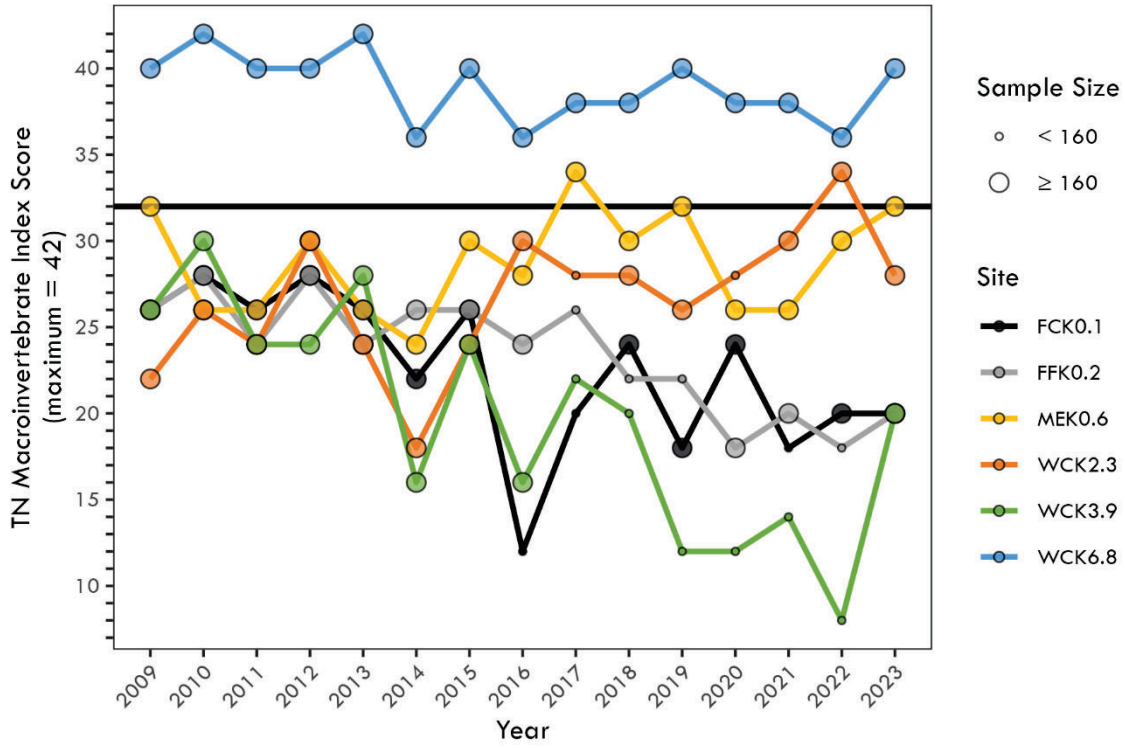
Acronyms: WCK = White Oak Creek kilometer; MEK = Melton Branch kilometer; WBK = Walker Branch kilometer; CI = confidence interval

Figure 8. Benthic macroinvertebrate communities in Walker Branch (WBK 1.0), Melton Branch (MEK 0.6), and White Oak Creek (WCK 6.8, 3.9, and 2.3): (top) total taxonomic richness (mean number of all taxa/sample ± confidence interval) and (bottom) taxonomic richness of the pollution-intolerant taxa, Ephemeroptera, Plecoptera, and Trichoptera (EPT) (mean number of EPT taxa/sample ± confidence interval), April sampling periods, 1987–2023; WCK 6.8 and WBK 1.0 serve as reference sites.

Based on TDEC protocols (TDEC 2021), scores for the Tennessee Macroinvertebrate Index (TMI) in 2023 rated the invertebrate communities at the reference site, WCK 6.8, and MEK 0.6 as at or above

biocriteria guidelines, while scores from FCK 0.1, FFK 0.2, WCK 2.3, and WCK 3.9 were below these guidelines (Figure 9, Table 4). Of the four sites below the biocriteria threshold, scores improved at two sites from 2022 to 2023 (WCK 3.9 and FFK 0.2), remained the same at one site (FCK 0.1), and declined at one site (WCK 2.3).

Low TMI scores in FCK 0.1, FFK 0.2, WCK 2.3, and WCK 3.9 were primarily due to low values for %EPT and EPT taxa richness (Table 4). However, all these sites had low percentages of oligochaetes and chironomids (worms and non-biting midges) and thus received high scores for this category (Table 4). WCK 6.8 received the highest attainable scores for all categories except for total taxa richness (Table 4).



Note: The black horizontal line shows the threshold for Tennessee Macroinvertebrate Index (TMI) scores; values above the threshold represent passing scores while those below do not.
Acronyms: FCK = First Creek kilometer, FFK = Fifth Creek kilometer, MEK = Melton Branch kilometer, WCK = White Oak Creek kilometer

Figure 9. Temporal trends in Tennessee Department of Environment and Conservation (TDEC) Macroinvertebrate Scores for White Oak Creek watershed streams (FCK 0.1; FFK 0.2; MEK 0.6; and WCK 6.8, 3.9, and 2.3), August sampling periods, 2009–2023. Samples that exceeded or failed to meet the minimum number of invertebrates are indicated by large or small point sizes, respectively.

Table 4. Tennessee Macroinvertebrate Index (TMI) metric values, metric scores, and index scores for White Oak Creek, First Creek, Fifth Creek, and Melton Branch, August 30, 2023[a,b]

Site[c]	Metric values							Metric scores							TMI[d]
	Taxa rich	EPT rich	%EPT	%OC	NCBI	%Cling	%TN Nuttol	Taxa rich	EPT rich	%EPT	%OC	NCBI	%Cling	%TN Nuttol	
WCK 2.3	26	5	29	22.4	5.3	44.8	53.6	4	2	4	6	4	4	4	28
WCK 3.9	14	3	37.4	12.9	5.1	12.3	38	2	0	4	6	4	0	4	20
WCK 6.8	29	14	55.6	3.7	2.9	76.6	13.1	4	6	6	6	6	6	6	40 [pass]
FCK 0.1	12	1	0	3.5	5.8	25.7	19.3	2	0	0	6	4	2	6	20
FFK 0.2	14	6	22.7	3.2	5.2	28.6	53.2	2	2	2	6	4	2	2	20
MEK 0.6	28	10	31.4	3.3	4.5	44.8	36.2	4	4	4	6	6	4	4	32 [pass]

[a]TMI metric calculations and scoring and index calculations are based on Tennessee Department of Environment and Conservation (TDEC) protocols for Ecoregion 67f: Tennessee Department of Environment and Conservation, 2021, *Quality System Standard Operating Procedures for Macroinvertebrate Stream Surveys*, TDEC Division of Water Pollution Control, Nashville, Tennessee. Available here.

[b]Taxa rich = Taxa richness; EPT rich = taxa richness of Ephemeroptera, Plecoptera, and Trichoptera (mayflies, stoneflies, and caddisflies); %EPT = EPT abundance excluding *Cheumatopsyche* spp.; %OC = percent abundance of oligochaetes (worms) and chironomids (nonbiting midges); NCBI = North Carolina Biotic Index; %Cling = percent abundance of taxa that build fixed retreats or otherwise attach to substrate surfaces in flowing water; %TN Nuttol. = percent abundance of nutrient-tolerant organisms.

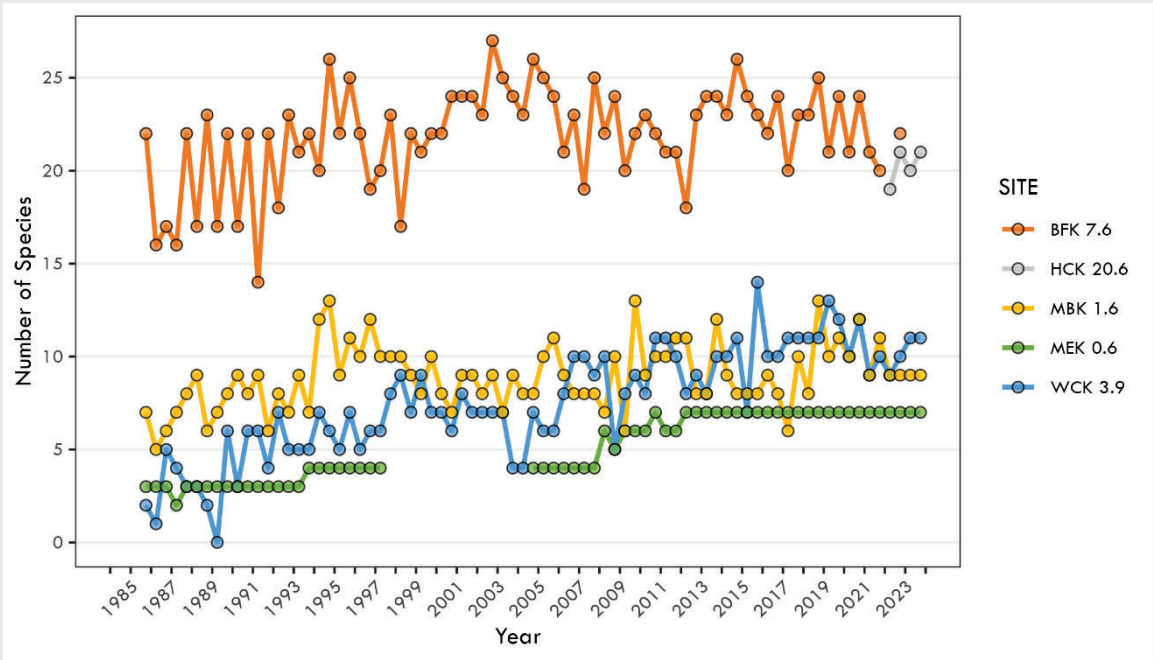
[c]WCK = White Oak Creek kilometer; FCK = First Creek kilometer; FFK = Fifth Creek kilometer; MEK = Melton Branch kilometer.

[d]TMI = Tennessee Macroinvertebrate Index score. TMI is the total index score and higher index scores indicate higher quality conditions. A score of ≥ 32 is considered to pass biocriteria guidelines.

5. Fish Communities

Monitoring of the fish communities in WOC and its major tributaries continued in 2023. Fish community surveys were conducted at 11 sites in the WOC watershed, including 5 sites in the main channel, 2 sites in First Creek, 2 sites in Fifth Creek, and 2 sites in Melton Branch. Reference streams located on the ORR or within the city of Oak Ridge (Brushy Fork {historical}, Hinds Creek, Ish Creek, and Mill Branch) were also sampled as reference sites for comparison.

In the WOC watershed, the fish community continued to be slightly degraded in 2023 compared with communities in reference streams. Sites closest to outfalls within the ORNL campus had lower species richness (number of species) (Figure 10), and fewer pollution-sensitive species than a slightly larger reference site (Hinds Creek) and more closely resembled values found in a smaller reference reach (Mill Branch). WOC sites also had more pollution-tolerant species and elevated densities (number of fish per square meter) and biomass of pollution-tolerant species compared with reference streams (Table 5 and Table 7). Likewise, tributary sites (First Creek, Fifth Creek, and Melton Branch) also exhibited higher densities of pollution-tolerant fish species compared to a reference site (Ish Creek). Seasonal fluctuations in diversity and density are expected and may explain some of the variability seen at these sites. However, the combination of these factors often indicates degraded water quality and/or habitat conditions. Overall, the fish communities in both WOC and tributary sites adjacent to and downstream of ORNL outfalls continued to be negatively affected by ORNL effluent in 2023 relative to reference streams and upstream sites.



Acronyms:
BFK = Brushy Fork kilometer, MEK = Melton Branch kilometer, MBK = Mill Branch kilometer, WCK = White Oak Creek kilometer, HCK = Hinds Creek kilometer

Figure 10. Fish species richness (number of species) in upper White Oak Creek and lower Melton Branch compared with two reference streams, Brushy Fork and Mill Branch, 1985–2023. Access to Brushy Fork was limited in spring 2022 and in 2023 and no samples were collected at those times.

Table 5. Fish species richness, density (fish/m²), and biomass (g fish/m²; in parentheses) in White Oak Creek and reference sites (Mill Branch, and Hinds Creek), March - April 2023.

Species	Sites[a] WCK 2.3	WCK 3.4	WCK 3.9	WCK 4.4	WCK 6.8	MBK 1.6	HCK 20.6
Minnows							
Largescale stoneroller	<0.01	0.90	2.05	1.09	0.01	0.02	0.44
Campostoma oligolepis	(0.02)	(4.37)	(3.03)	(1.27)	(0.03)	(0.02)	(4.35)
Bigeye shiner	-	-	-	-	-	-	0.01
Hybopsis amblops							(0.02)
Striped shiner	0.38	0.81	0.76	0.06	-	0.04	0.34
Luxilus chrysocephalus	(2.34)	(2.98)	(2.92)	(0.48)		(0.17)	(1.73)
Scarlet shiner	0.01	-	-	-	-	-	-
Lythrurus fasciolaris	(0.02)						
Tennessee dace	-	-	-	-	-	<0.01	-
Chrosomus tennesseensis						(0.01)	
Bluntnose minnow	-	-	-	-	-	-	0.04
Pimephales notatus							(0.14)
Western blacknose dace	-	0.07	0.28	0.89	1.14	0.18	0.09
Rhinichthys obtusus		(0.21)	(0.73)	(0.69)	(2.41)	(0.29)	(0.21)
Creek chub	-	-	-	0.02	0.05	0.06	<0.01
Semotilus atromaculatus				(0.14)	(0.35)	(0.41)	(0.02)
Suckers							
White sucker	-	-	-	-	-	-	<0.01
Catostomus commersonii							(0.01)
Northern hogsucker	0.01	0.02	0.08	-	-	-	0.02
Hypentelium nigricans	(0.10)	(0.31)	(0.37)				(2.03)
Black redhorse	-	-	-	-	-	-	<0.01
Moxostoma duquesnei							(0.11)
Catfishes							
Yellow bullhead	<0.01	-	-	-	-	-	-
Ameirus natalis	(0.02)						
Livebearers							
Western mosquitofish	0.02	0.05	0.01	0.01	-	-	<0.01
Gambusia affinis	(0.02)	(0.03)	(<0.01)	(0.01)			(<0.01)
Sculpins							
Banded sculpin	-	-	-	-	0.37	-	0.28
Cottus carolinae					(1.21)		(1.15)
Sunfishes							
Redbreast sunfish	0.01	-	-	-	-	0.01	<0.01
Lepomis auritus	(0.36)					(0.29)	(0.01)
Green sunfish	0.02	0.09	0.04	0.01	-	<0.01	<0.01
Lepomis cyanellus	(0.15)	(0.77)	(0.60)	(0.45)		(0.21)	(0.08)

Table 5. Fish species richness, density (fish/m²), and biomass (g fish/m²; in parentheses) in White Oak Creek and reference sites (Mill Branch, and Hinds Creek), March - April 2023 (continued).

Species	Sites[a] WCK 2.3	WCK 3.4	WCK 3.9	WCK 4.4	WCK 6.8	MBK 1.6	HCK 20.6
Warmouth sunfish	0.05	-	-	-	-	-	-
Lepomis gulosus	(0.61)						
Bluegill	0.05	0.01	0.13	0.09	-	0.06	0.01
Lepomis macrochirus	(0.51)	(0.02)	(0.65)	(0.83)		(0.73)	(0.05)
Redear sunfish	0.01	-	0.01	-	-	-	-
Lepomis microlophus	(0.12)		(0.06)				
Largemouth bass	0.01	<0.01	0.01	-	-	-	<0.01
Micropterus salmoides	(0.79)	(0.03)	(0.18)				(0.16)
Perches							
Greenside darter	-	-	-	-	-	-	0.01
Etheostoma blenniodes							(0.05)
Blueside darter	-	-	-	-	-	-	0.01
Etheostoma jessiae							(0.02)
Stripetail darter	0.04	0.08	0.11	0.07	-	0.06	0.06
Etheostoma kennicotti	(0.05)	(0.09)	(0.14)	(0.14)		(0.08)	(0.06)
Redline darter	-	-	-	-	-	-	0.03
Etheostoma rufilineatum							(0.04)
Snubnose darter	0.17	0.23	0.11	-	-	-	0.11
Etheostoma simoterum	(0.20)	(0.31)	(0.17)				(0.15)
Logperch	0.02	-	-	-	-	-	-
Percina caproides	(0.10)						
TOTAL							
Species richness	**15**	**10**	**11**	**8**	**4**	**9**	**20**
Density	**0.80**	**2.27**	**3.59**	**2.24**	**1.57**	**0.42**	**1.45**
Biomass	**5.41**	**9.14**	**8.86**	**4.01**	**3.99**	**2.40**	**10.40**

[a]WCK = White Oak Creek kilometer, MBK = Mill Branch kilometer, HCK = Hinds Creek kilometer.

Table 6. Fish species richness, density (fish/m²), and biomass (g fish/m²; in parentheses) in First Creek, Fifth Creek, Melton Branch and a reference site (Ish Creek), May 2023.

	Sites[a]						
Species	**FCK0.1**	**FCK0.8**	**FFK0.2**	**FFK1.0**	**MEK0.6**	**MEK1.4**	**ISK1.0**
Minnows							
Largescale stoneroller	0.04	0.01	0.06	-	0.95	0.30	0.12
Campostoma oligolepis	(0.07)	(0.02)	(1.00)		(1.96)	(0.97)	(0.36)
Striped shiner	0.08	-	-	-	1.37	0.35	0.28
Luxilus chrysocephalus	(0.46)				(3.27)	(0.96)	(1.64)
Western blacknose dace	0.26	1.56	2.29	3.11	0.92	0.85	0.15
Rhinichthys obtusus	(0.76)	(1.43)	(4.00)	3.26	(1.57)	(1.38)	(0.44)
Creek chub	-	-	-	-	0.15	0.04	0.14
Semotilus atromaculatus					(0.47)	(0.09)	(0.78)
Catfishes							
Yellow bullhead	-	-	-	-	-	-	0.02
Ameiurus natalis							(0.19)
Sculpins							
Banded sculpin	-	0.11	-	0.12	-	-	0.04
Cottus carolinae		(0.45)		(0.98)			(0.44)
Sunfishes							
Redbreast sunfish	-	-	-	-	0.12	0.04	0.05
Lepomis auritus					(2.13)	(1.29)	(0.36)
Green sunfish	0.23	-	-	-	-	-	0.02
Lepomis cyanellus	(1.55)						(0.19)
Bluegill	-	-	-	-	-	-	<0.01
Lepomis macrochirus							(0.04)
Perches							
Stripetail darter	-	-	-	-	0.30	0.01	-
Etheostoma kennicotti					(0.30)	(0.01)	
Snubnose darter	0.04	-	-	-	0.24	-	0.01
Etheostoma simoterum	(0.07)				(0.19)		(0.03)
TOTAL							
Species richness	**5**	**3**	**2**	**2**	**7**	**6**	**9**
Density	**0.65**	**1.69**	**2.35**	**3.23**	**4.05**	**1.58**	**0.84**
Biomass	**2.91**	**1.90**	**5.00**	**4.25**	**9.90**	**4.71**	**4.47**

[a]FCK = First Creek kilometer, FFK = Fifth Creek kilometer, MEK = Melton Branch kilometer, ISK = Ish Creek kilometer.

Table 7. Fish species richness, density (fish/m²), and biomass (g fish/m²; in parentheses) in White Oak Creek and reference sites (Mill Branch, and Hinds Creek), September - November 2023.

Species	Sites[a] WCK 2.3	WCK 3.4	WCK 3.9	WCK 4.4	WCK 6.8	MBK 1.6	HCK 20.6
Lampreys							
American brook lamprey	-	-	-	-	-	-	0.01
Lampetra appendix							(0.06)
Minnows							
Largescale stoneroller	0.08	0.96	1.75	0.92	-	0.05	2.12
Campostoma oligolepis	(0.37)	(3.43)	(1.64)	(1.48)		(0.34)	(10.25)
Striped shiner	0.01	1.09	0.83	0.33	-	0.04	0.23
Luxilus chrysocephalus	(0.17)	(2.20)	(4.32)	(2.61)		(0.23)	(0.82)
Bigeye chub	-	-	-	-	-	-	0.06
Hybopsis amblops							(0.11)
Scarlet shiner	0.16	-	-	-	-	-	0.03
Lythrurus fasciolaris	(0.13)						(0.01)
Bluntnose minnow	-	-	-	-	-	-	0.02
Pimephales notatus							(0.04)
Western blacknose dace	-	0.04	0.36	0.73	1.35	0.18	0.13
Rhinichthys obtusus		(0.11)	(0.69)	(1.45)	(2.45)	(0.29)	(0.23)
Creek chub	-	-	0.01	0.05	0.11	0.05	0.03
Semotilus atromaculatus			(0.02)	(1.06)	(0.59)	(0.37)	(0.08)
Suckers							
White sucker	-	-	-	-	-	-	0.02
Catostomus commersonii							(0.05)
Northern hogsucker	0.01	0.04	0.02	-	-	-	0.06
Hypentelium nigricans	(0.04)	(0.87)	(0.02)				(0.96)
Black redhorse	-	-	-	-	-	-	0.02
Moxostoma duquesnei							(0.25)
Livebearers							
Western mosquitofish	0.08	0.13	0.03	0.15	-	-	-
Gambusia affinis	(0.05)	(0.07)	(0.02)	(0.03)			
Sculpins							
Banded sculpin	-	-	-	-	0.33	-	0.53
Cottus carolinae					(1.18)		(1.43)
Sunfishes							
Rock bass	-	-	-	-	-	-	0.01
Ambloplites rupestris							(0.47)
Redbreast sunfish	0.03	-	-	-	-	<0.01	-
Lepomis auritus	(0.49)					(0.11)	
Green sunfish	0.03	0.28	0.09	-	-	<0.01	<0.01
Lepomis cyanellus	(0.16)	(0.82)	(1.14)			(0.12)	(0.11)
Warmouth	0.02	-	-	-	-	-	-
Lepomis gulosus	(0.39)						

Table 7. Fish species richness, density (fish/m²), and biomass (g fish/m²; in parentheses) in White Oak Creek and reference sites (Mill Branch, and Hinds Creek), September - November 2023 (continued).

Species	Sites[a] WCK 2.3	WCK 3.4	WCK 3.9	WCK 4.4	WCK 6.8	MBK 1.6	HCK 20.6
Bluegill	0.06	0.03	0.17	0.09	-	0.02	0.02
Lepomis macrochirus	(0.81)	(0.18)	(0.94)	(0.76)		(0.44)	(0.09)
Longear sunfish	-	-	-	-	-	-	<0.01
Lepomis megalotus							(0.02)
Redear sunfish	0.01	-	0.01	0.05	-	-	-
Lepomis microlophus	(0.05)		(0.01)	(0.11)			
Hybrid sunfish	-	-	-	-	-	-	<0.01
							(0.02)
Spotted bass	-	-	-	-	-	0.02	-
Micropterus punctulatus						(0.26)	
Largemouth bass	0.01	-	-	-	-	-	0.01
Micropterus salmoides	(0.07)						(0.07)
			Perches				
Greenside darter	-	-	-	-	-	-	0.02
Etheostoma blenniodes							(0.07)
Blueside darter	-	-	-	-	-	-	0.04
Etheostoma jessiae							(0.07)
Stripetail darter	0.02	0.09	0.11	0.01	-	0.04	0.09
Etheostoma kennicotti	(0.03)	(0.10)	(0.17)	(0.02)		(0.04)	(0.09)
Redline darter	-	-	-	-	-	-	0.03
Etheostoma rufilineatum							(0.04)
Snubnose darter	0.03	0.48	0.10	-	-	-	0.19
Etheostoma simoterum	(0.24)	(0.47)	(0.16)				(0.20)
Logperch	0.02	-	-	-	-	-	-
Percina caproides	(0.18)						
TOTAL							
Species richness	14	9	11	8	3	9	20
Density	0.84	3.14	3.48	2.33	1.79	0.39	3.64
Biomass	3.17	8.24	9.31	7.53	4.22	2.21	15.49

[a]WCK = White Oak Creek kilometer, MBK = Mill Branch kilometer, HCK = Hinds Creek kilometer.

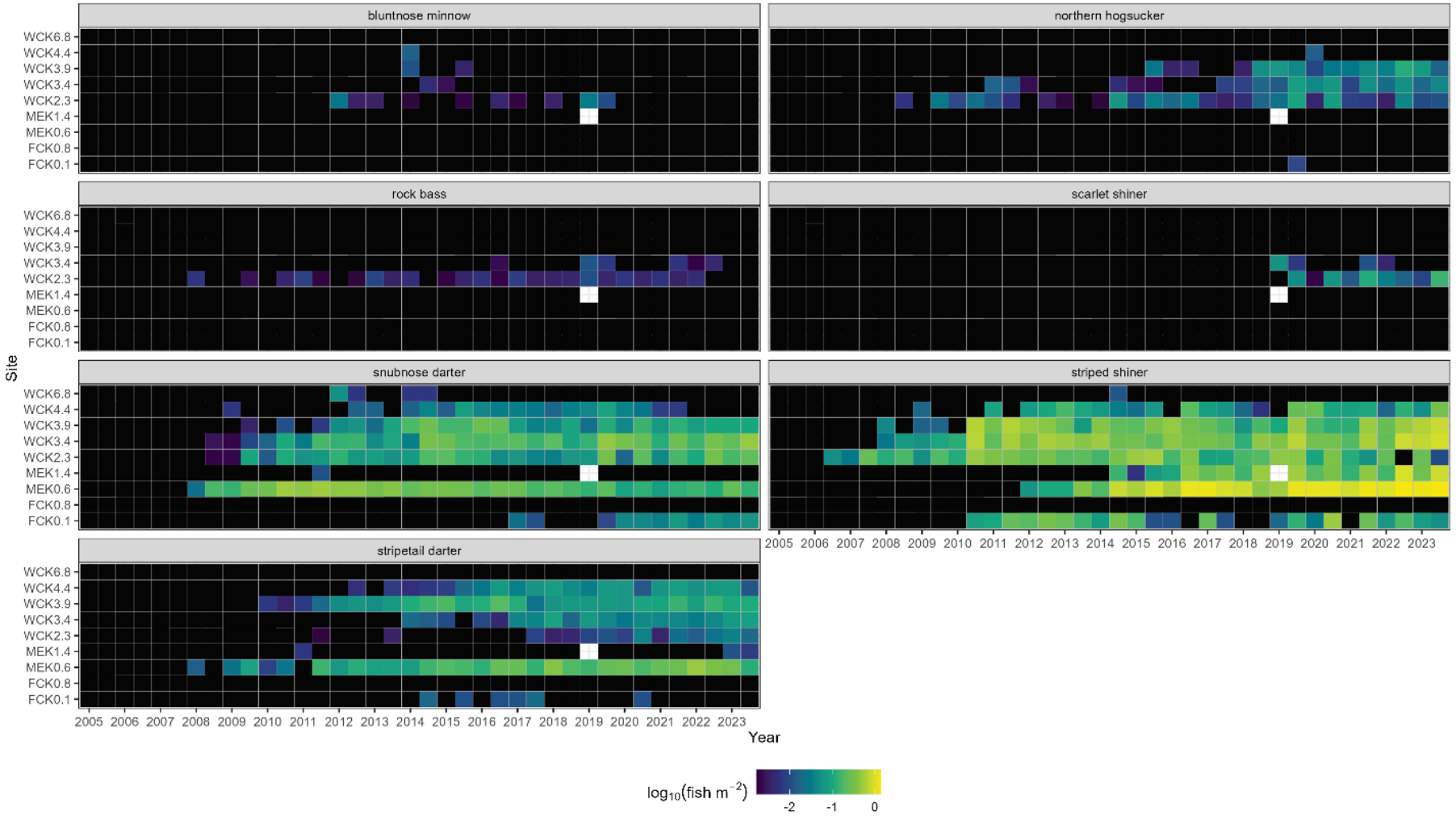
Table 8. Fish species richness, density (fish/m²), and biomass (g fish/m²; in parentheses) in First Creek, Fifth Creek, Melton Branch and a reference site (Ish Creek), October - November 2023.

	Sites[a]					
Species	**FCK0.1**	**FCK0.8**	**FFK0.2**	**MEK0.6**	**MEK1.4**	**ISK1.0**
			Minnows			
Largescale stoneroller	0.29	-	0.17	0.12	0.34	0.05
Campostoma oligolepis	(0.37)		(1.31)	(0.31)	(0.78)	(0.12)
Striped shiner	0.05	-	-	1.47	0.90	0.61
Luxilus chrysocephalus	(0.45)			(2.31)	(1.89)	(1.99)
Bluntnose minnow	-	-	-	-	-	0.06
Pimephales notatus						(0.17)
Western blacknose dace	0.42	2.01	2.83	0.80	1.29	0.15
Rhinichthys obtusus	(0.63)	(1.32)	(5.60)	(0.87)	(1.14)	(0.47)
Creek chub	0.01	-	-	0.14	0.44	0.08
Semotilus atromaculatus	(0.02)			(0.65)	(1.56)	(0.76)
			Catfishes			
Yellow bullhead	-	-	-	-	-	0.14
Ameiurus natalis						(1.02)
			Sculpins			
Banded sculpin	-	0.16	0.02	-	-	0.05
Cottus carolinae		(0.63)	(0.10)			(0.44)
			Sunfishes			
Redbreast sunfish	-	-	-	0.04	0.01	0.42
Lepomis auritus				(0.35)	(0.14)	(3.29)
Green sunfish	0.03	-	-	-	-	0.12
Lepomis cyanellus	(0.24)					(1.79)
Bluegill	0.02	-	-	-	-	0.01
Lepomis macrochirus	(0.09)					(0.03)
Spotted bass	-	-	-	-	-	0.01
Micropterus punctulatus						(0.07)
			Perches			
Stripetail darter	-	-	-	0.12	0.01	-
Etheostoma kennicotti				(0.10)	(0.01)	
Snubnose darter	0.06	-	-	0.13	-	0.01
Etheostoma simoterum	(0.10)			(0.09)		(0.02)
TOTAL						
Species richness	**7**	**2**	**3**	**7**	**6**	**12**
Density	**0.87**	**2.17**	**3.02**	**2.82**	**2.99**	**1.68**
Biomass	**1.90**	**1.95**	**7.02**	**4.68**	**5.51**	**10.17**

[a]FCK = First Creek kilometer, FFK = Fifth Creek kilometer, MEK = Melton Branch kilometer, ISK = Ish Creek kilometer.

A project to introduce fish species that were not found in the WOC watershed but that exist in similar systems on the ORR and that may have historically existed in WOC was initiated in 2008 with the stocking of seven such native species. Continuing reproduction has been noted for five of the species initially stocked, and several species have expanded their ranges downstream and even upstream from initial introduction sites to establish new reproducing populations (Figure 11). In general, introduced species have had more difficulty establishing populations at upstream sites in both WOC and Melton Branch. This is likely due to numerous structures located within the watershed that act as barriers to upstream fish migration. One exception to the apparent difficulty of expansion is the striped shiner (*Luxilus chrysocephalus*), which has expanded into upper Melton Branch, upper WOC, and lower First Creek. Introductions to supplement the small populations of those fish species at some locations were continued at sites within the watershed in 2019. At that time, an additional species, scarlet shiner (*Lythrurus fasciolaris*), was introduced into lower WOC where it continues to exist and is showing signs of continued reproduction. Some species appear less abundant such as rock bass (*Ambloplites rupestris*) however, this species does not occur in large densities throughout its range and values observed in community surveys are consistent with other locations on the ORR. Bluntnose minnows (*Pimephales notatus*) were present in the lower end of WOC before introductions began and have been observed in White Oak Lake (WOL) but reproducing populations seem to be unable to establish in the more stream-like portions of the watershed at this time.

The introductions have enhanced species richness at almost all sample locations within the watershed and indicate the capacity of this watershed to support increased fish diversity of some species. These populations still seem to be limited by impassible barriers such as dams, weirs, and culverts, and by limited access to source populations further downstream in the Clinch River below WOL.



Note: A log10 transformation was used to aid in visualizing differences in fish densities between sites and survey periods. Black cells indicate that no introduced fish were captured during a survey where other resident fish were captured. White cells indicate that no fish (introduced or resident) were captured during a survey.

Figure 11. Density of seven native fish species introduced into the White Oak Creek watershed from 2007-2023.

D. Mercury in the White Oak Creek Watershed

The DOE mission-driven research activities that took place at ORNL from the 1950s-1960s were focused on using mercury for pilot-scale isotope separation work that predominantly took place in Buildings 3503, 3592, 4501, and 4505. As a result, most of the legacy mercury contamination on-site has been found in underground piping, infrastructure, soil, groundwater, stormwater runoff, and surface water at ORNL in the general area of these buildings. Since that time, two of the buildings, Buildings 3503 and 3592, have been removed, though much of the underground infrastructure (e.g., various utility piping) from the buildings remains in place. Buildings 4501 and 4505 are still in active service today, even though the mercury research work undertaken in those buildings stopped decades ago. All of these buildings where known legacy mercury research took place are located just north of WOC, with Buildings 4501 and 4505 located just east of Fifth Creek and Building 3503 and 3592 footprints located just west of Fifth Creek, in the Central part of ORNL main campus. Just west of these buildings, and just north of WOC, there were a pair of settling ponds used for holding process wastewaters from these legacy mercury research buildings that have also been removed. The flows captured by the settling ponds were re-routed to the PWTC/X12 for treatment in the 1990s. This area of ORNL campus, near where the ponds used to be, is another area of focus for legacy mercury monitoring in the WOC watershed. Figure 12 depicts these areas of ORNL main campus with known legacy mercury contamination along with the point source locations that are currently being monitored for mercury as a part of the NPDES permit WQPP requirements.

Today, legacy mercury at ORNL continues to be remediated and monitored as a part of the CERCLA processes. DOE also performs additional legacy mercury monitoring/reporting which at this time is required by the NPDES permit WQPP requirements. Since mercury is an ecological and water quality stressor, the existing mercury investigation and characterization done as a part of WQPP helps to better inform stakeholders on management decisions. Therefore, mercury remains a priority for WQPP investigation. This additional legacy mercury surface water monitoring required by the WQPP both in-stream and at point sources and non-point sources at ORNL is summarized in the rest of this section.

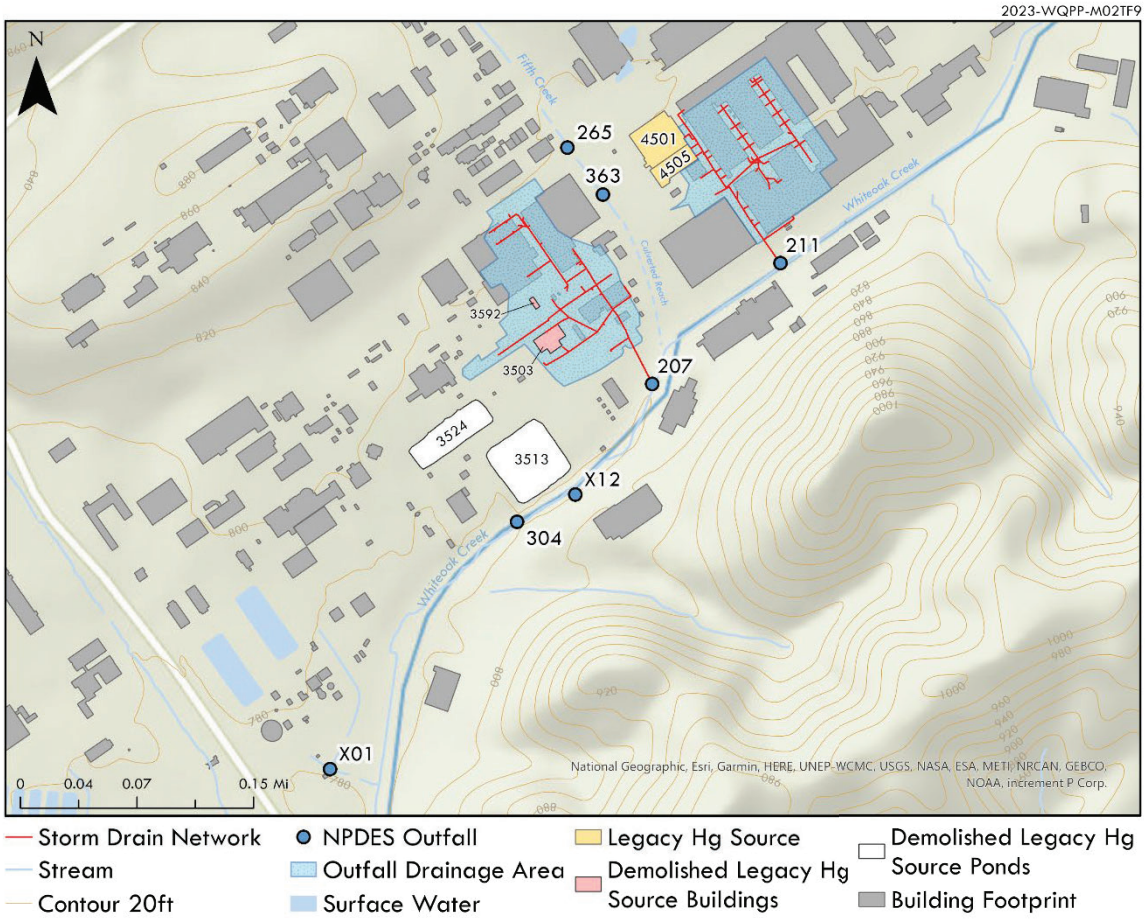


Figure 12. Treatment Plant and other Point Source Outfalls Monitored for Mercury at ORNL - 2023

1. Mercury in Ambient Water

In-stream ambient mercury monitoring has been required at ORNL under NPDES permits since 1986. However, since that time the physical locations and types of sampling done as a part of the in-stream monitoring efforts has changed. In the most recent NPDES permit WQPP *Mercury in the White Oak Creek Watershed* section, in-stream mercury monitoring was required to be coordinated with point source outfall monitoring at both of the on-site ORNL wastewater treatment facilities (STP/X01 and PWTC/X12). This in-stream ambient mercury monitoring data is presented here in this section and is also uploaded periodically throughout the year into the Oak Ridge Environmental Information System (OREIS).

Aqueous in-stream mercury monitoring in the WOC watershed continued in 2023 with quarterly sampling at three in-stream sites throughout the WOC watershed: WCK 1.5, WCK 3.4, and WCK 4.4. The aqueous in-stream mercury monitoring was done at these three locations using 24-hr-composite samples. The results of the in-stream 2023 sampling efforts are shown in Figure 13. Samples collected for this in-stream monitoring effort tend to be most representative of seasonal-base flow conditions (dry weather, clear flow), since historical sampling results show that mercury concentrations are typically higher under these conditions yielding a more conservative estimate of

mercury concentration in-stream. The 24-hr-composite sample results of in-stream mercury monitoring tend to be a more accurate representation of the data over time.

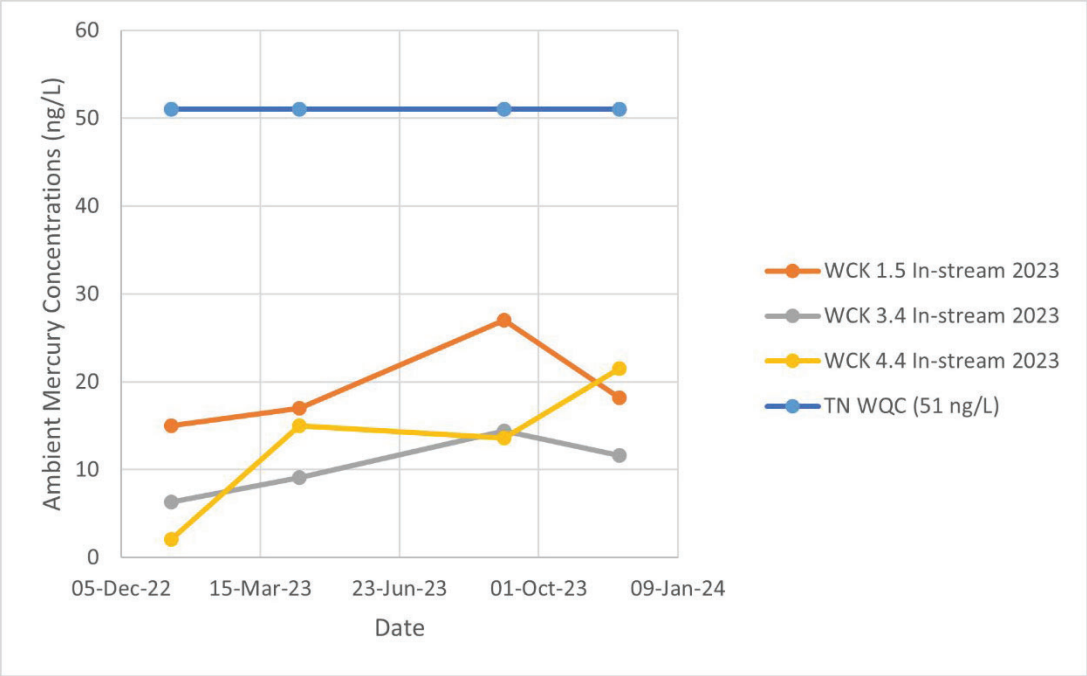


Figure 13. In-stream 24-Hr-Composite Sample Results for Mercury at ORNL - 2023

Historically, ORNL used grab samples for in-stream monitoring prior to the NPDES permit WQPP requirement to "coordinate the in-stream mercury sampling with the wastewater treatment plant mercury sampling". Both the historical mercury grab sample results and the 24-hr-composite mercury sampling results at these in-stream monitoring sites coordinated with the wastewater treatment plant monitoring required by the NPDES permit from 2023 are depicted in Figure 14. This in-stream data is now being coordinated with the wastewater treatment plant sampling and is also submitted quarterly to TDEC in the monthly DMRs, as required by the NPDES permit, as well as is loaded into OREIS periodically throughout the year. The wastewater treatment plant mercury sampling is discussed in later in ***Section 2 – Water Quality Protection Plan Mercury Monitoring – Treatment Plants.***

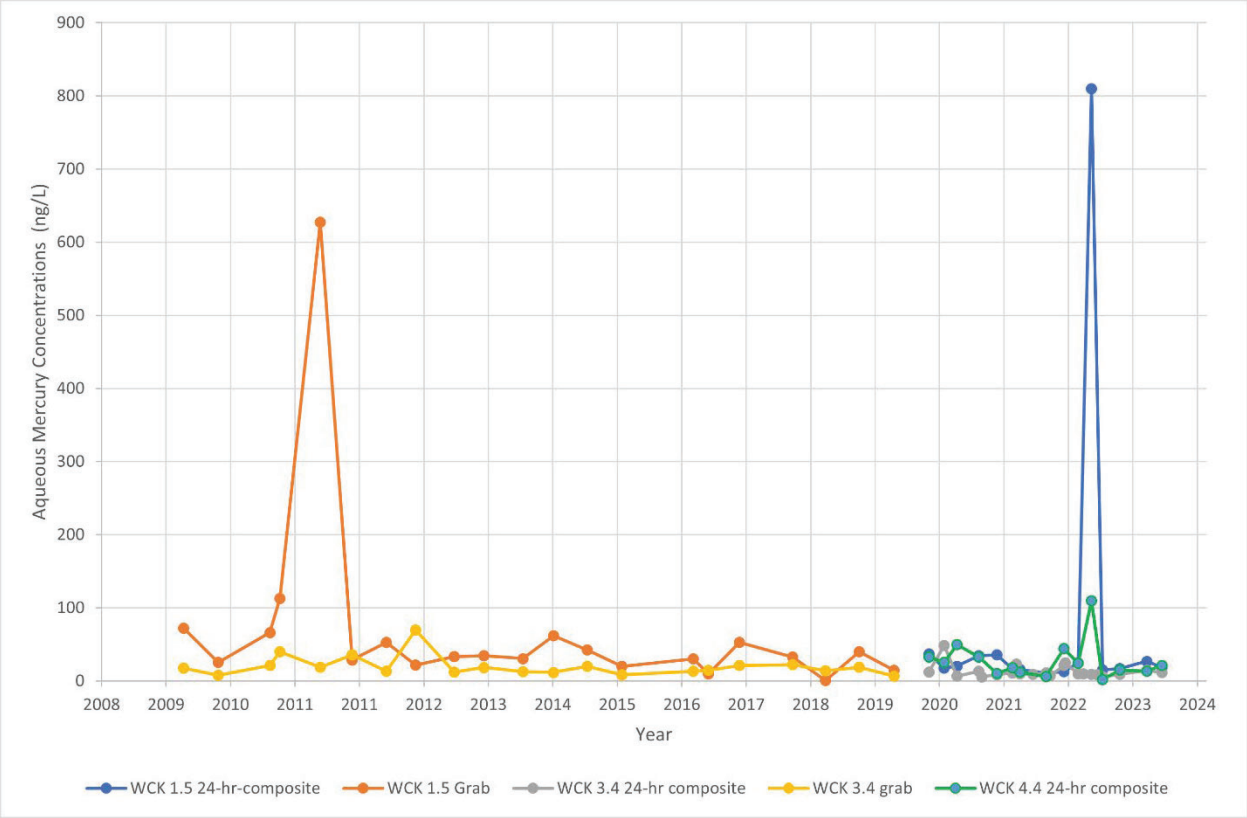


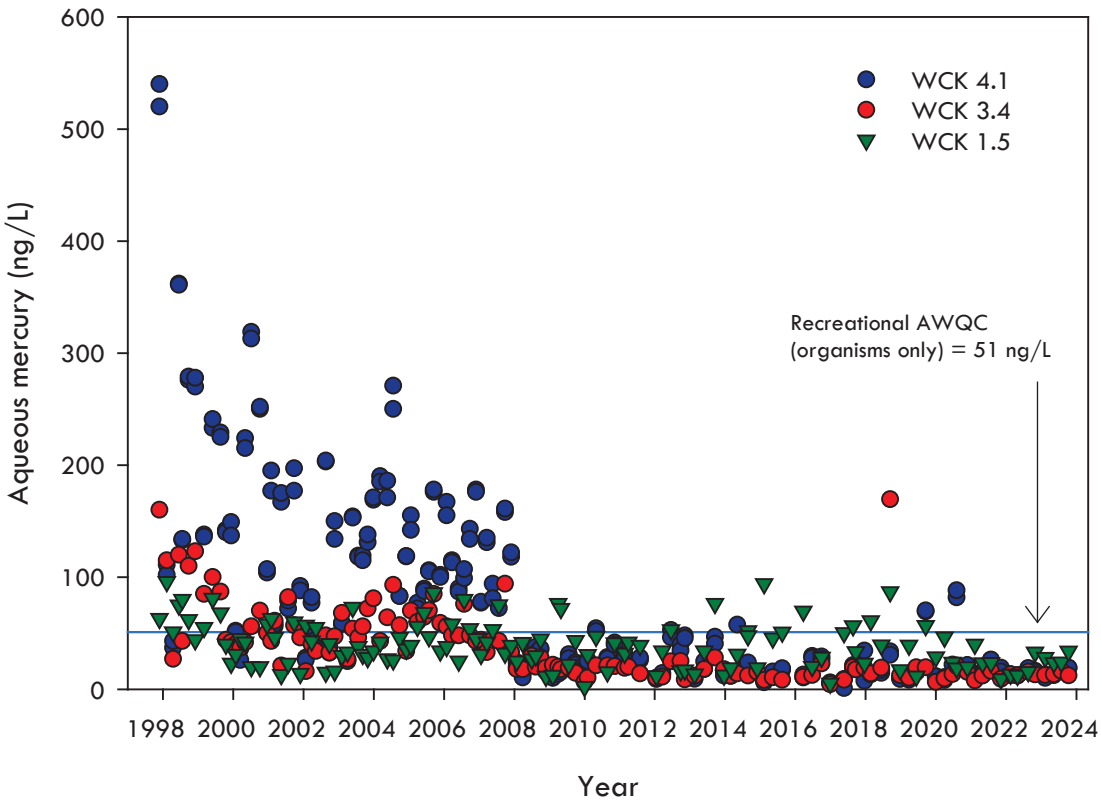
Figure 14. In-stream Grab and 24-Hr-Composite Total Mercury Unfiltered Sample Results - NPDES Permit ORNL 2009 - 2023

Figure 14 depicts in-stream mercury sampling results indicating a slight decreasing trend in aqueous mercury concentrations from 2009 to the present. However, the higher than typical in-stream mercury grab sample result (627 ng/L) obtained in 2011 at WCK 1.5 is believed to be associated with structural improvement work done on the berm of White Oak Dam (WOD) that took place around that same time frame of sampling, causing a greater than normal concentration of suspended solids in the sample. In addition, the other outlier data point from more recent in-stream 24-hr-composite mercury sampling (810 ng/L) taken in 2022 at WCK 1.5 also had a much higher than usual suspended solids concentrations in the sample. It is thought that the disturbance of water/sediment matrices at WCK 1.5 near/at the time of sampling events coupled with the mercury being more particle-bound is the cause of the increased mercury measurements in both these incidents.

Additional in-stream grab samples are also taken and analyzed for mercury using different analytical methods at other in-stream locations in the WOC watershed (see WQPP Section C – Aquatic Communities in the WOC Watershed Table 3) at different time intervals throughout the year, though these results are initiated from the bioaccumulation study. These additional mercury grab sample monitoring results required by the bioaccumulation study are presented in Figure 15 and are also uploaded throughout the year into OREIS.

In 2023, 24-hr-composite aqueous mercury concentrations were all below WQC at all ambient (in-stream) sites that were monitored (Figure 13). Also, this was the case at all of the other in-stream ambient mercury monitoring sites where mercury grab samples were taken as well during 2023.

The only in-stream locations where both mercury grab samples and 24-hr-composite mercury samples were taken, evaluated, and can be compared with one another in 2023 is at WCK 1.5 and WCK 3.4, and the average ambient mercury concentrations measured were similar. At WCK 1.5 the in-stream 24-hr-composite average ambient mercury concentration in 2023 was 19.3 ng/L, compared with the in-stream grab sample average aqueous mercury concentration of 27.44 ng/L. In addition, at WCK 3.4 the in-stream 24-hr-composite average ambient mercury concentration in 2023 was 10.3 ng/L, compared with the in-stream grab sample average ambient mercury concentration of 13.60 ng/L.



Note: The blue line at 51 ng/L shows the Tennessee Recreational Water Quality Criteria for Water and Organisms.
Acronym: WCK = White Oak Creek kilometer

Figure 15. Total aqueous mercury concentrations from grab samples taken at sites in WOC downstream from ORNL associated with the bioaccumulation study, 1998-2023

2. Water Quality Protection Plan Mercury Monitoring – Treatment Plants

The Sewage Treatment Plant (STP) and the Process Waste Treatment Complex (PWTC) outfall numbers (X01 and X12, respectively) are monitored for mercury quarterly and reported to TDEC in the monthly DMRs, as required by the NPDES permit and also are loaded into OREIS. Twenty-four-hour composite samples are taken at both locations and flows are also recorded.

Concentrations of mercury in discharges from STP/Outfall X01 averaged 2.0 ng/L in 2023, while PWTC/Outfall X12 mercury concentrations averaged 48.75 ng/L. The STP/Outfall X01 trends in total mercury concentration from 2009 – 2023 are shown in Figure 16. In addition, Figure 17 depicts trends in PWTC/X12 total mercury concentrations from 2009 through 2023.

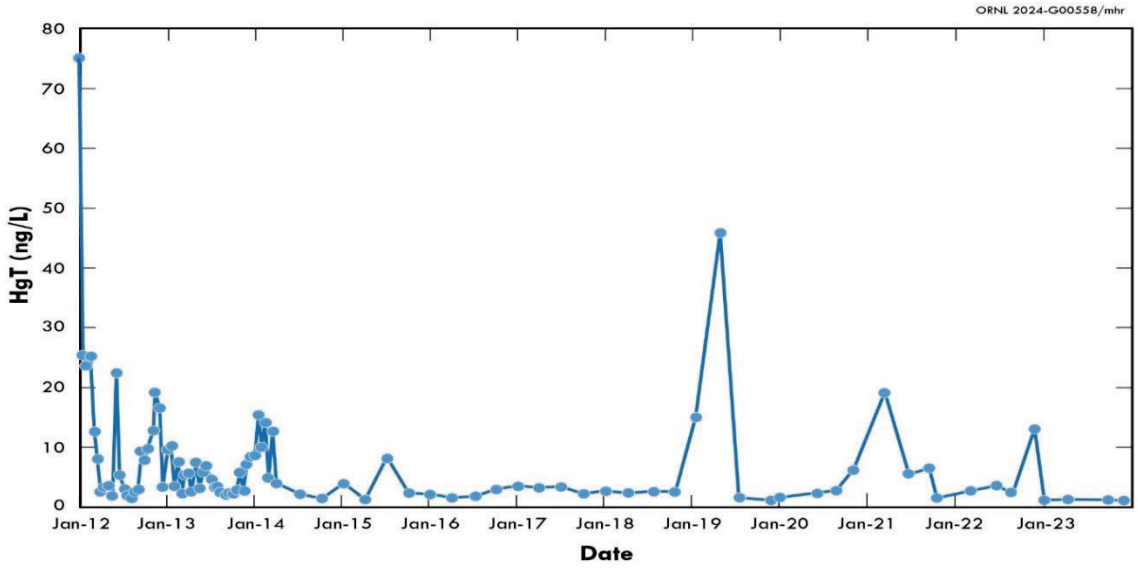
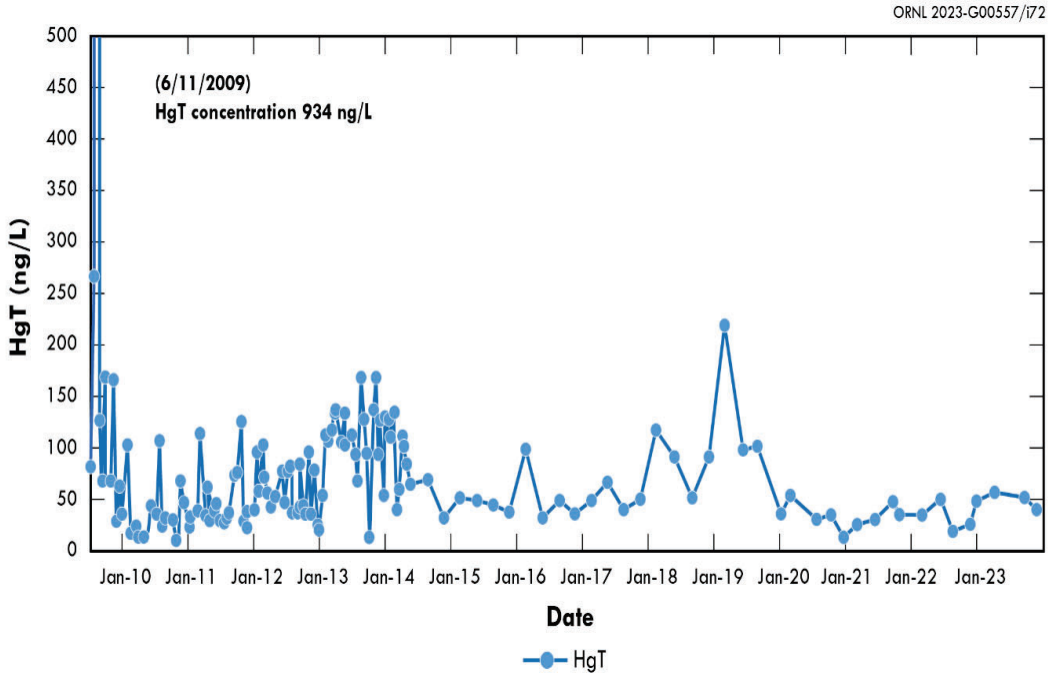


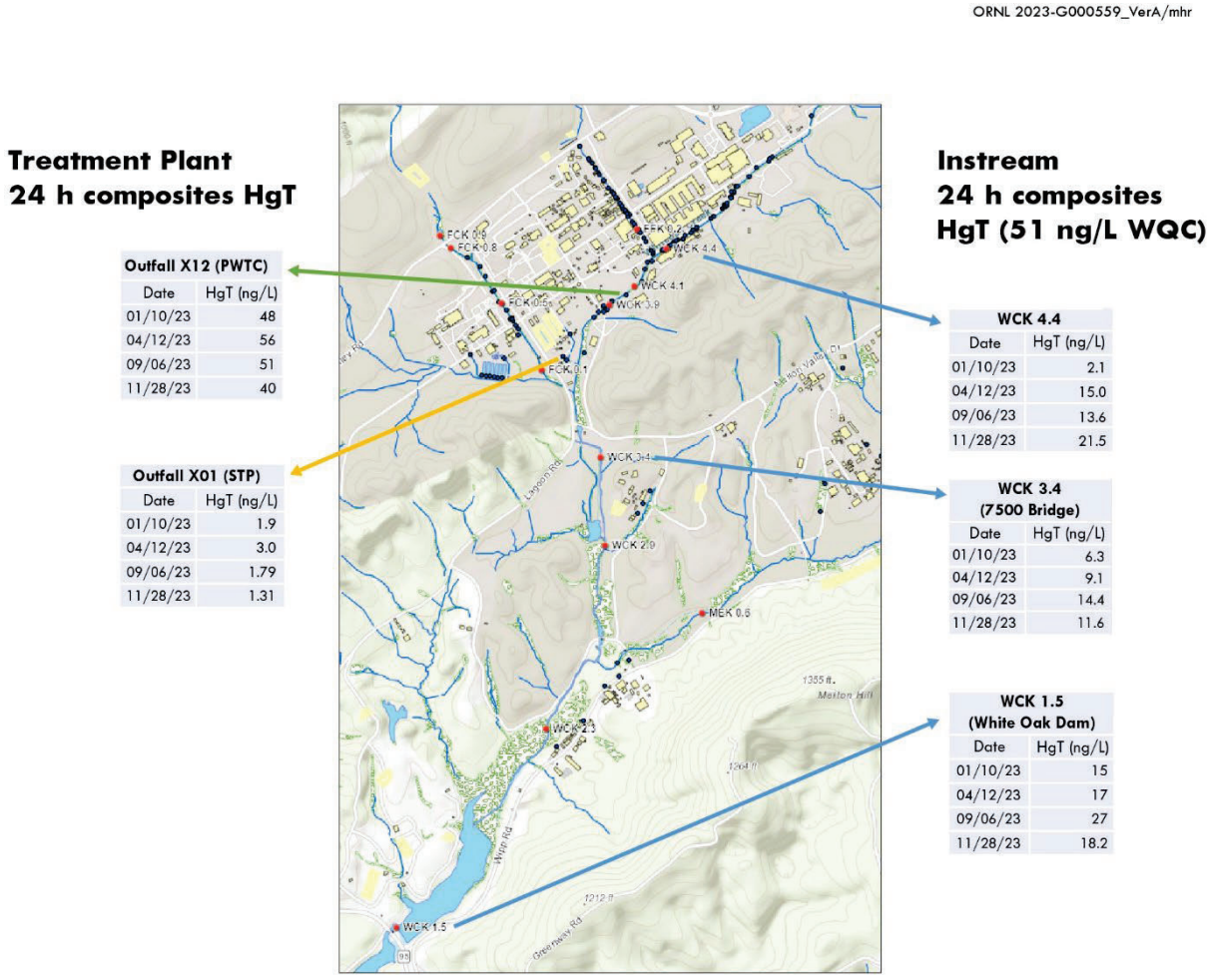
Figure 16. Total Mercury Concentration (HgT) at STP/Outfall X01, 2012-2023



Acronym: WCK = White Oak Creek kilometer

Figure 17. Total Mercury Concentration (HgT) at PWTC/Outfall X12, 2009–2023

As previously mentioned, dry weather 24-hr-composite sampling is done quarterly at the two treatment plant outfalls (STP/X01 and PWTC/X12) and is required to be coordinated with mercury sampling at in-stream locations. The three instream ambient mercury sampling locations in 2023 were: WCK 4.4 (upstream of the two treatment plant outfalls); WCK 3.4 (at the 7500 Bridge monitoring station which is downstream ORNL central campus and both wastewater-treatment-plant outfalls); and WCK1.5/X15 (at WOD). This data is presented in detail in Figure 18 below.



Acronyms: PWTC = Process Waste treatment Complex, WCK = White Oak Creek Kilometer, STP = Sewage Treatment Plant, HgT = Total Unfiltered Mercury Concentration

Figure 18. Coordination of Treatment Plant Sampling with In-Stream Sampling Sites at ORNL – 2023

3. Legacy Mercury Outfall Point Source and Non-Point Source Monitoring

Legacy mercury contamination since the 1950's exists throughout ORNL in various environmental media, including surface water and stormwater runoff, as well as being found in various infrastructure, and is being monitored and remediated under CERCLA. However, as a part of the NPDES permit WQPP mercury requirements, a review of mercury sources is to be conducted in addition to mercury monitoring of point source outfalls and non-point source runoff at ORNL. This additional legacy mercury investigation focuses on the handful of outfalls located in known legacy

mercury contaminated areas in the central part of ORNL main campus and is undertaken in order to help to better delineate mercury sources on-site, as well as to potentially help identify and prioritize future abatement actions in these locations.

In 2023, point source dry weather mercury monitoring was undertaken as a part of the NPDES permit WQPP requirements. The focus area of this investigation was predominantly along WOC and portions of Fifth Creek at the following Outfalls: 207, 211, 265, 304, and 363 (Figure 12). In past years, much of the point source mercury monitoring done under the WQPP has focused on Outfalls 207 and 211, which generally have been the outfall locations at ORNL with the highest historical mercury concentrations recorded, and this continued to be the case in 2023. Discharged water volumes (and therefore mercury fluxes) from Outfall 211 are typically higher than those from Outfall 207, and again in 2023 this was true. Figure 19 and Figure 21 show trends in dry weather mercury sampling from Outfalls 207 and 211. Also in 2023, point source mercury monitoring was performed at Outfalls 265, 304, and 363; these outfalls have shown mercury discharges of interest in the past likely due to the prevalence of mercury used historically in nearby buildings and from other legacy mercury sources in these areas. However, in 2023 Outfall 265 had no dry weather flow recorded and the dry weather mercury concentrations at Outfalls 304 and 363 were low. In 2023, the average ambient mercury concentrations at Outfall 304 were 4.94 ng/L and 45.3 ng/L at Outfall 363.

Non-point source mercury monitoring was also undertaken in 2023 as required by the NPDES permit WQPP mercury requirements. Semi-annual wet weather sampling at Outfalls 207, 211, 265, 304, and 363 was completed. Trends in wet weather unfiltered (more conservative) mercury sampling results at Outfalls 207 and 211 are presented in Figure 20 and Figure 22 below. In addition, the average wet weather unfiltered mercury sampling results in 2023 were approximately 8.25 ng/L at Outfall 265, 8.65 ng/L at Outfall 304, and 21.85 ng/L at Outfall 363.

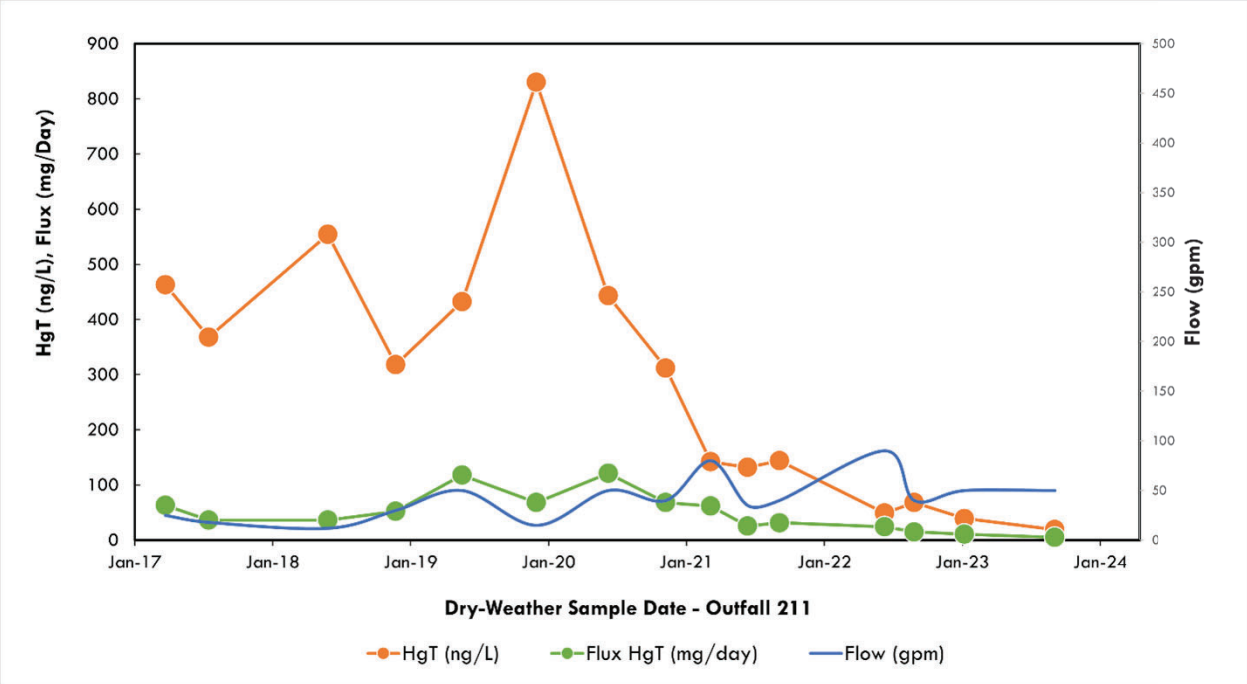


Figure 19. Outfall 211 Dry-Weather flowrate, Total Mercury Concentration (unfiltered), and Flux 2017-2023

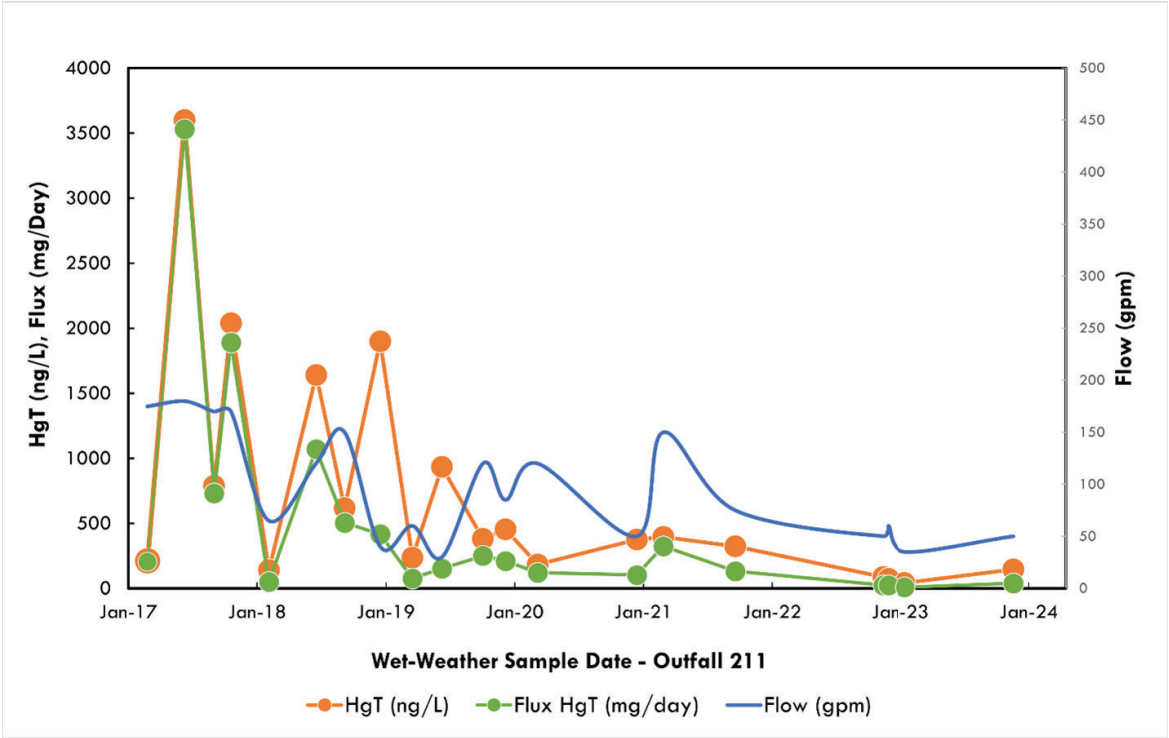


Figure 20. Outfall 211 Wet-Weather Flowrate, Total Mercury Concentration (unfiltered), and Flux 2017-2023

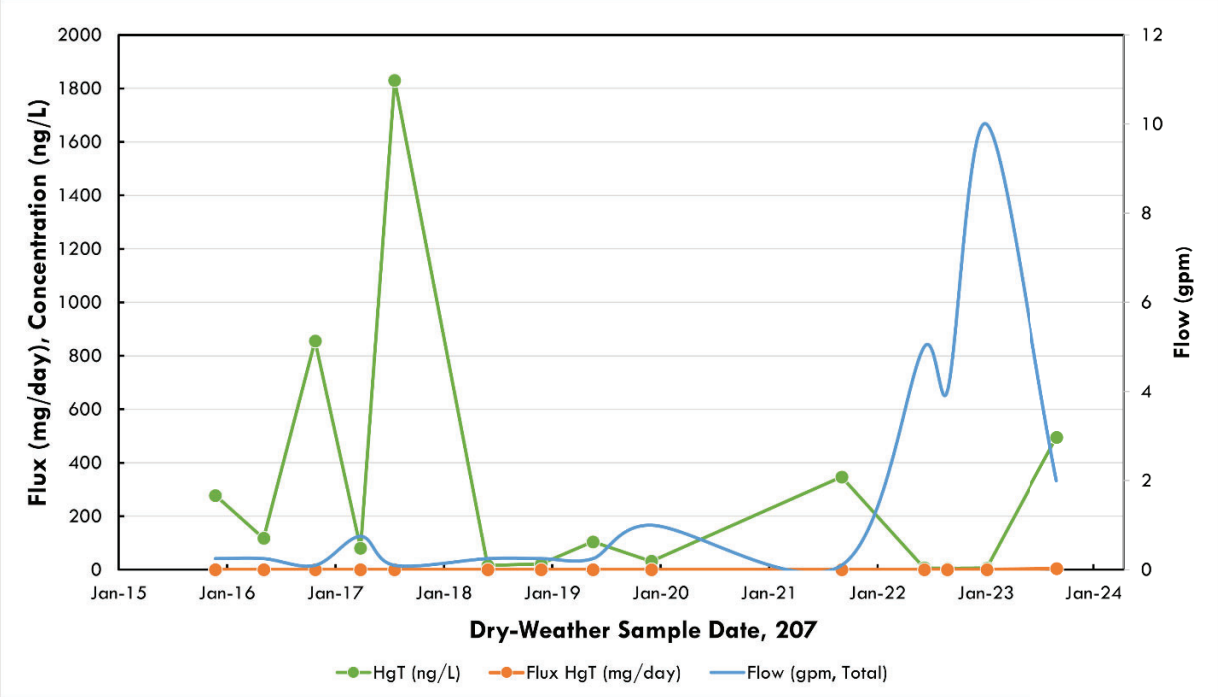


Figure 21. Outfall 207 Dry-Weather Flowrate, Total Mercury Concentration (unfiltered), and Flux 2016-2023

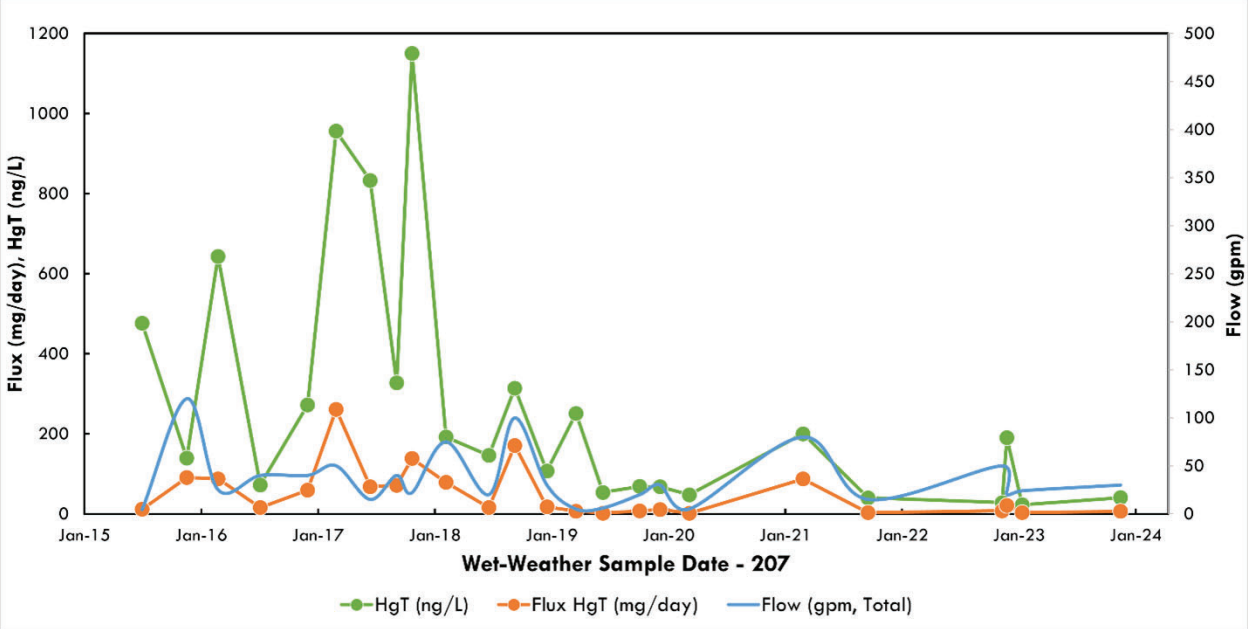


Figure 22. Outfall 207 Wet-Weather Flowrate, Total Mercury Concentration (unfiltered), and Flux 2015-2023

Since a water leak nearby Outfall 265 was fixed in September 2014, there has been minimal dry weather flows sampled at this outfall. In addition, subsequent monitoring since this water utility

isolation confirms that Outfall 265 is no longer a significant source of mercury to Fifth Creek and WOC. However, flows and mercury concentrations could change once the Translational Research Capability construction project is completed. Due to the persistence of elemental mercury, its volatility, and the complexity of its interactions in piping and soil, mercury continues to be monitored and assessed at the outfalls mentioned in this section. Therefore, Outfalls 207, 211, 265, 304, and 363 will continue to be part of the WQPP mercury monitoring point source and non-point source program in 2024. In addition, with all of the redevelopment activities taking place at ORNL on main campus concurrently with the beginning of deactivation and demolition associated with legacy CERCLA remediation efforts, additional point source outfalls and non-point sources will be considered for future mercury monitoring under WQPP.

E. Polychlorinated Biphenyls in the White Oak Creek Watershed

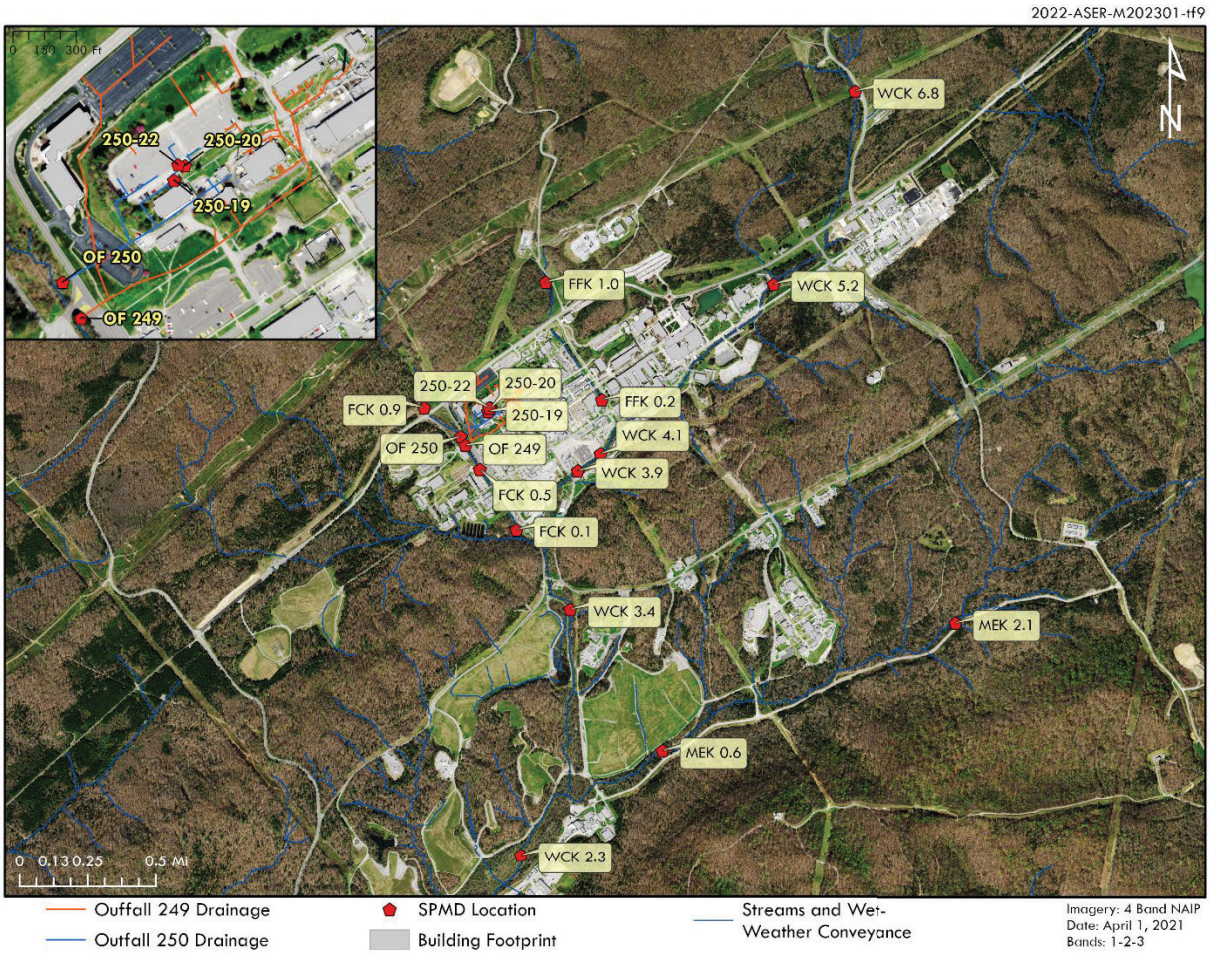
PCBs are a family of chlorinated aromatic hydrocarbons that have been extensively used in electrical equipment, such as transformers and capacitors, because of their dielectric properties, chemical stability, and fire resistance. PCBs have also been used in industry as fluids for heat transfer systems, fire retardants, and plasticizers. There have been known PCB releases in soil, sediment, surface water, stormwater, and wastes at ORNL due to legacy use and contamination since the 1940s. In addition, there has been historical use of PCBs on-site at ORNL in various pre-1980 building materials, past and present-day oil-filled electrical equipment, past application of waste oil to roads, and from legacy spills in the environment. Over time, it has become known that PCBs can be harmful due to their persistent nature in the environment. Because PCBs are relatively insoluble in water and highly soluble in lipids, they can accumulate in body fats of humans and animals. For this reason, PCBs are closely monitored and studied in surface waters, stormwater, and biota at ORNL since the 1980's under various regulatory drivers. In general, all legacy PCB remediation efforts at ORNL are regulated and carried out under CERCLA.

Surface water monitoring in the WOC watershed located on-site at ORNL has historically shown that PCBs have been below method report limits in surface water using EPA-approved analytical methods. However, at the same time the water samples were evaluated, the PCB fish tissue concentrations in largemouth bass in WOL also showed that PCBs were bioaccumulating in fish at levels of concern which were above TDEC and EPA fish tissue targets. These PCB concentrations in fish tissue confirmed elevated PCB exposures from groundwater or surface water, but because the fish are mobile, source identification was not possible.

Because EPA-approved methods for detecting PCBs in water have historically proven to lack the sensitivity needed to quantify PCBs in WOC waters, ORNL has met the NPDES permit requirements for monitoring PCBs in the water column by utilizing passive sampling devices called semi-permeable membrane devices (SPMDs). SPMDs are thin plastic sleeves filled with oil in which PCBs are soluble. Because SPMDs are deployed at a given site for 4 weeks and have a high affinity for PCBs, in addition to overcoming the limitations associated with relatively high quantitation levels of water analytical methods, they allow for a time-integrated semiquantitative index of the relative PCB concentrations in the water column (compared to a "snapshot" value that would be obtained from a conventional surface water grab sample). The semi-quantitative data obtained from these SPMD devices makes them a useful tool for tracking down potential PCB sources in the WOC watershed.

The original objective of the PCB WQPP requirements highlighted in the 2008 NPDES permit were to identify the stream reaches, outfalls, or sediment areas that were contributing to elevated PCB levels in the watershed. The original PCB SPMD deployment/sampling effort is shown in Figure 23. Over the past 13 years, ORNL's PCB monitoring efforts using SPMDs have identified upper parts of First Creek as a source of PCBs to the WOC watershed, particularly in the storm drain network leading to Outfall 250. The locations of elevated PCBs at ORNL in the WOC watershed have not changed even after repeated SPMD deployment/monitoring efforts throughout the site in these same locations over the years. The most recent PCB monitoring was done in 2022 where SPMDs were again deployed throughout the WOC watershed and in the streams leading to WOC, repeating the original deployments done in 2009 and 2010 (Figure 23) in order to determine whether there have been any changes in PCB sources to the watershed. Forage fish were also collected at three sites in First Creek to examine PCB exposure to biota in the stream. The 2022 SPMD deployment

data showed very similar spatial patterns when compared to the original deployments in 2009 and 2010. First Creek, again, had the highest concentrations of PCBs in SPMD sampling devices (Figure 24). The Outfall 250 storm drain network, particularly the location at 250-19, consistently remains the greatest contributor of PCBs to the First Creek watershed. PCB concentrations in forage fish in First Creek decrease with downstream distance from this outfall. While SPMDs are semi-quantitative, allowing for a relative assessment of PCB sources to the stream, the overall concentrations in the SPMDs were comparable to those in previous years, suggesting that there have been no major changes in aqueous PCB concentrations in this watershed over the past decade.



Acronyms: MEK: Melton Branch Kilometer FCK = First Creek kilometer, WCK = White Oak Creek Kilometer

Figure 23. Locations of monitoring points for First Creek source investigation, 2022

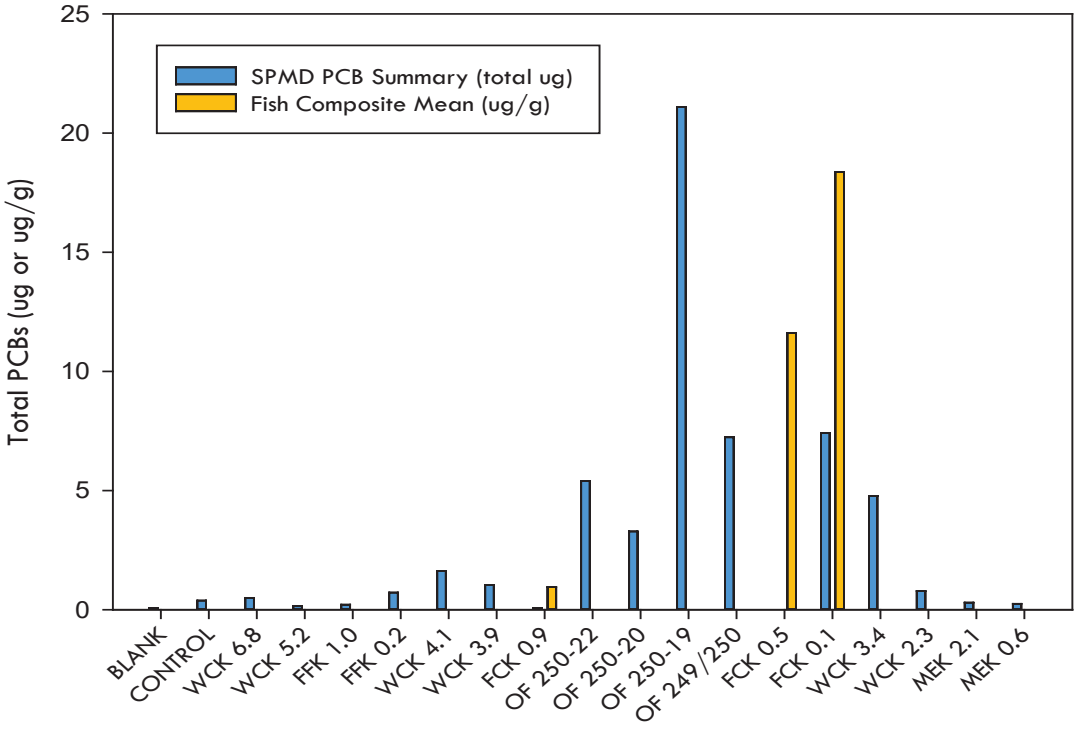


Figure 24. Total PCB content (ug) in semipermeable membrane devices deployed throughout the White Oak Creek watershed. Also shown are PCB concentrations in composites (n=3) of whole-body forage fish collected at sites in First Creek.

Due to the consistent PCB results yielded from the SPMDs year after year all throughout the WOC watershed, with the greatest concentrations of PCBs found particularly in the Outfall 250 storm drain network, ORNL decided to undertake a closed-circuit television (CCTV) investigation of the Outfall 250 storm drain system in 2023 which is currently underway. The upper reaches of the Outfall 250 storm drain network are right underneath the area where Building 2000 and Building 2001 were demolished. Both buildings had known sources of PCBs used in their building materials (exterior paint), though it is not known exactly if this is predominantly the sole source of PCBs in this area. Results from the CCTV investigation will be evaluated once the study is completed, and any significant findings will be presented in the 2024 WQPP.

F. Facility Monitoring Activities

1. Stormwater Surveillance and Construction Activities

Discharges of stormwater from ORNL are carried by an extensive storm drain piping system, as well as through channels, ditches, swales, and similar structures. Stormwater outfalls at ORNL are permitted under ORNL NPDES Permit No. TN0002941. Storm water drainage areas at ORNL are inspected twice per year as directed by the NPDES Permit WQPP requirements. In addition, construction sites at ORNL with greater than 1 acre of land disturbance are required to obtain coverage under the Tennessee General NPDES Permit for Storm Water Discharges Associated with Construction Activity (TN CGP). As required by the TN CGP, Level 1 certified erosion and sedimentation control (E&SC) inspectors perform the E&SC inspections during construction activities. Additionally, ORNL requires construction projects that are performed by subcontractors and disturb less than 1 acre to have Level 1 certified E&SC inspectors perform inspections. ORNL has a Best Management Practices (BMP) plan that identifies how to minimize impacts to stormwater at ORNL. This document is currently in the process of being reviewed and updated.

Land use within stormwater drainage areas at ORNL is typical of office/industrial/research settings with surface features that include laboratories, support facilities, paved areas, and grassy lawns. In addition, ORNL employs an extensive safety materials management system which includes proper tracking, handling, and storage of materials to ensure the potential to impact stormwater is minimal. More importantly, ORNL has numerous regulations that are being followed for materials handling, waste management, storage, and disposal that help ensure minimal stormwater risk. Outdoor materials storage areas can be located temporarily in many places at ORNL, but most activity involving the movement and storage of outdoor material takes place in the 7000 area, which is located on the east end of the ORNL site and where most of the craft and maintenance shops are located. Smaller outdoor storage areas are located throughout the facility in and around loading docks and material delivery areas at laboratory and office buildings. The types of materials stored outside, as noted in field inspections, include finished metal items (pipes and parts); equipment awaiting use, disposal, or repair; aging infrastructure; and construction equipment and material.

There are very few pollutants from current ORNL research laboratory operations present or expected to be present in stormwater discharges apart from on-going construction, grounds maintenance, and utility operations. Even though ORNL is an active cleanup site with legacy contamination, regulated both under CERCLA and the Atomic Energy Act (for radiological constituents), legacy pollutants found in ORNL stormwater have been historically minimal. Therefore, monitoring of stormwater sources will continue to be performed through the NPDES permit WQPP required semi-annual drainage area inspections and construction site inspections, while other new or emerging contaminants of concern may be investigated through the WQPP adaptive management process.

2. Total Residual Oxidants Control Strategy

Potable water at ORNL comes from the City of Oak Ridge Department of Public Works water treatment plant and distribution system. ORNL uses potable water for drinking, in sanitary systems, for housekeeping, in numerous research processes, and in once-through cooling and recirculating cooling systems located all throughout the site. The City of Oak Ridge currently utilizes chlorine as a

final disinfectant prior to discharge of potable water throughout their water distribution system network. Some residual chlorine remains in the water distribution system potable water (and even the used water) at ORNL at levels which can be potentially toxic to fish or other aquatic life if the potable/used waters are discharged into surface waters. This is especially true in those surface waters with low flows and low volume which are similar to those located in the WOC watershed at ORNL. Typically, any residual chlorine that may be present in sanitary wastewaters routed for treatment at the STP is consumed in reactions with other substances within the collection system and treatment processes. In addition, any residual chlorine in process wastewaters routed to the PWTC for treatment is removed during treatment by the final activated carbon filtration process.

Currently as required by the NPDES permit, DOE is required to monitor TRO levels at twelve different in-stream locations twice a month. These in-stream TRO monitoring results are submitted to TDEC in the monthly DMR, as well as are uploaded periodically to OREIS. In addition to the in-stream TRO monitoring undertaken on-site, DOE also began implementing a strategy to monitor and control residual oxidant from point sources into surface waters at ORNL under the NPDES permit required WQPP Total Residual Oxidants (TRO) Control Strategy, also known as the Chlorine Control Strategy (CCS). As a part of this strategy, DOE regularly monitors oxidant levels at point source outfalls with known potential chlorine/bromine sources. DOE's NPDES Permit established an action level of 1.2 grams per day (g/day) of TRO loading for outfalls monitored as a part of this control strategy. If the action level is exceeded at an outfall, an investigation into the root cause of the elevated TRO levels is required, as well as removal/treatment of TRO sources to reduce oxidant loading to below action levels.

Cooling tower discharges are monitored as a part of this strategy at ORNL since they have the potential to be larger sources of residual chlorine/bromine. Chlorine- and bromine-based chemicals are typically added to supply water to control bacterial growth in cooling towers. Chlorine and bromine residuals may remain in the blowdown water from cooling towers if they are not evaporated or are not consumed by bacterial growth. As the cooling towers lose water by evaporation, higher conductivity (caused by an increase in the concentration of minerals) triggers a blowdown, resulting in a discharge that may contain residual chlorine and bromine. Therefore, cooling tower point source discharges at ORNL are treated using a form of dechlorination to ensure residual oxidant levels are less than the action level. Historically, a combination of sodium sulfite tablet feeders and/or liquid dechlorinators have been used to help reduce the potential of TRO in cooling tower discharges at ORNL. In some cases, pretreatment systems have been installed in order to enhance the effectiveness of the primary dechlorination tablet feeders. These additional potassium sulfite and sodium bisulfite pretreatment TRO reduction solutions have been included in multiple cooling tower locations at ORNL. Some cooling tower outfalls are also equipped with a secondary tablet feeder at the outfall itself.

In 2023, TRO continued to be monitored at those outfalls with known potential residual chlorine/bromine sources. TRO was monitored more frequently (twice a month) at those outfalls that receive either cooling tower discharges or once-through cooling water discharges. Less frequent monitoring was also conducted at other outfalls relative to their potential to contribute oxidant load to the receiving water (such as semi-monthly, monthly, quarterly, or semi-annually if flow was present). Frequencies of monitoring are evaluated and modified as oxidant loads, as well as potential chlorine/bromine sources, change at a particular outfall. In 2023, 388 TRO measurements were taken in twenty-five point-source locations as a part of the CCS at ORNL. In

addition to the point source monitoring, 288 semi-monthly in-stream measurements were also taken as required by the TRO in-stream monitoring required by the NPDES permit. Although TRO was detected on nineteen occasions during point-source outfall monitoring in 2023, no TRO was detected at any of the twelve in-stream monitoring locations (Table 9).

Table 9. Overview of 2023 Chlorine Control Strategy

Chlorine Control Monitoring Summary	Count
TRO Sampling Events	676
TRO Non-Detects	604
Instream TRO Exceedances	0
Outfall TRO Detects	19
Outfall Action Level TRO Exceedances	19

TRO Monitoring Results and Corrective Actions

There are many activities that take place at ORNL in response to point-source TRO monitoring and may include source investigations, source elimination, addition of pretreatment dechlorination systems, emergency repairs, and dechlorination system adjustments (summarized in Table 10). In addition to the point source outfall TRO monitoring done as a part of this program, non-process waters just upstream of dechlorination boxes are also checked periodically in key locations to assess oxidant loads in drainage systems. This is to ensure the dechlorinators are working as designed. Inspections of tablet feeders are also conducted under this program multiple times a week to ensure that the sodium sulfite tablet feeders are refilled, in good condition, and that any fouled tablets are removed for disposal. In addition, as a Stormwater BMP, DOE proactively dechlorinates any potential residual chlorine/bromine sources or leaks on-site prior to discharge in the WOC watershed to reduce risk of harm to aquatic life and the environment.

A summary of the 2023 TRO outfall monitoring detections greater than 1.2 g/day are listed in Table 10. TRO loads in the table are calculated using the TRO grab sample and instantaneous flow reading. On-going investigations and actions taken in response to TRO monitoring in 2023 are briefly described below.

Outfall 014 – Outfall 014 discharges cooling tower blowdown from cooling towers 4510 and 4521. In order to better identify the sources of any potential TRO detections, these towers are now being monitored separately, prior to their confluence at Outfall 014. In 2021, a liquid potassium sulfite pretreatment dechlorinator was also added to both tower discharges to help improve TRO levels. There have been no action level TRO detections since the installation of this additional pretreatment dechlorination system.

Outfall 210 - A liquid sodium bisulfite dechlorinator located inside Building 4508 is used to treat potential residual chlorine/bromine discharges to Outfall 210. The liquid dechlorinator treats once-through cooling water from instrumentation that cannot use the recirculating cooling water system. In 2023, TRO was detected at Outfall 210 on several occasions resulting from an ongoing sodium bisulfite liquid feed pump failure. Therefore, Outfall 210 was principally dechlorinated with tablets

and a more robust tablet dechlorination method has since been deployed in the Outfall 210 drainage system until the liquid dechlorinator feed pump can be repaired. Repairs of the liquid dechlorinator are expected to take place in 2024.

Outfall 211 - Outfall 211 is monitored under CCS due to having a source of residual chlorine/bromine (once-through cooling water). Outfall 211 receives cooling water from multiple small sources. Two dechlorinator boxes have been installed in a weir located at the point where outfall 211 discharges to WOC. Each box is designed to treat chlorinated discharges at flow rates up to 50 gpm. In 2023, flows ranged from 35 to 65 gpm and TRO levels ranged from 0.3 to 2.5 mg/L TRO upstream of the dechlorinator. However, in 2023 there was one TRO exceedance at Outfall 211 downstream of the dechlorinator. TRO was measured at 0.4 mg/L in 45 gpm of flow, resulting in approximately a load of 98 grams of oxidant. During this sampling event, TRO was also measured at 0.8 mg/L in the pipe upstream of the dechlorinator, which is an indication that the exceedance was caused by degraded or depleted sodium sulfite tablets in the dechlorinator box. Therefore, dechlorination box system adjustments were made at this outfall.

Outfall 227 - Outfall 227 receives cooling tower blowdown discharges from multiple cooling towers in Buildings 5600 and 5511. There were no TRO exceedances at Outfall 227 in 2023. Primary dechlorination occurs inside Building 5600, and a secondary dechlorination box has been installed at the outfall prior to discharge into WOC which is continually utilized as backup dechlorinator. Combined use of two dechlorination boxes enables approximately 4 mg/L TRO to be removed before cooling tower discharges enter the creek. In order to better pinpoint dechlorination device issues, TRO is typically monitored both upstream and downstream of secondary dechlorination at Outfall 227. Monitoring results from 2023 indicate that TRO discharges could have exceeded the action level at the outfall on six instances without the use of secondary dechlorination at this location.

Outfall 231 - Outfall 231 is also monitored under this program and in 2023 TRO was detected twice from an unknown source. The detections did not appear to coincide with other field parameters checked from the samples; for example, one detection occurred at 120 gpm of flow while the other occurred at 20 gpm. Therefore, Outfall 231 will continue to be monitored and be dechlorinated with tablets until the source can be identified and eliminated. Investigation of the Outfall 231 residual TRO source is on-going.

Outfall 267 - Outfall 267 typically discharges non-chlorinated condensates and stormwater to Fifth Creek and is also monitored under this program. In 2023, TRO was detected at this outfall during each quarterly sample event. There was a known potable water leak in the area that was identified as a potential source of chlorine to the storm drainage system/Outfall 267 in late 2023, however the TRO persisted at the outfall even after the line was repaired. Building 3144 has a storm drain connection that is currently being investigated as a potential source of TRO. Therefore, Outfall 267 is being dechlorinated with tablets until the source of the residual chlorine is identified and removed.

Outfall 314 – Cooling tower blowdown to Outfall 314 is dechlorinated with sodium sulfite tablets from the dechlorinator box located at the discharge pipe from the 6018 cooling tower. All other routine wastewater loads with potential oxidants have been eliminated from this drainage network, resulting in the removal of the liquid dechlorination system that previously treated discharges to Outfall 314. In 2023, TRO was detected 3 times at outfall 314. One instance is believed to be related

to degraded sodium sulfite tablets that were ineffective in treating the cooling tower discharges and the tablets were replaced. The other two occasions were investigated and found to be related to a one-time sump pumping of basement waters from Building 6000 that has since stopped.

Outfall 363 - Outfall 363 receives discharges from multiple cooling towers. Historical data have shown that residual oxidants tend to remain in discharges even after primary dechlorination at the tower/building sources. Therefore since 2017, additional sodium sulfite tablet bags have been placed at the Outfall 363 discharge for use as a secondary dechlorination device. In 2023, monitoring efforts upstream and downstream of secondary treatment identified seven instances when primary dechlorination would have been insufficient. However, on two occasions in 2023 there were TRO detections exceeding the action level and it was found during investigation that the dechlorination tablets were degraded/depleted and dechlorination tablet system adjustments were made.

Table 10. Total residual oxidant mitigation summary - 2023

Outfall	Date	TRO (mg/L)	Flow (gpm)	Load (g/day)	Receiving Stream	Downstream Water Kilometer	Downstream Instream Monitoring Point	Source/Notes/Actions
210	3/16/2023	2.2	40	477.51	WOC	WCK 4.1	X18	Once-through cooling liquid dechlorination system was inoperable in 2023 due to pump failure. Dechlorination was facilitated with sodium sulfite tablets until pump can be put back into service.
210	4/21/2023	2.0	25	269.82	WOC	WCK 4.1	X18	
210	6/29/2023	0.3	25	36.52	WOC	WCK 4.1	X18	
210	7/24/2032	1.8	15	147.18	WOC	WCK 4.1	X18	
210	9/18/2023	0.3	20	30.53	WOC	WCK 4.1	X18	
210	11/27/2023	1.7	45	417.00	WOC	WCK 4.1	X18	
210	12/7/2023	1.2	35	228.94	WOC	WCK 4.1	X18	
211	7/24/2023	0.4	45	98.12	WOC	WCK 4.4	X22	Once-through cooling water is present in this drainage network. Flows are dechlorinated at the end of the pipe with tablets.
231	11/27/2023	1.3	120	850.35	WOC	WCK 4.4	X25	Sodium sulfite tablets were placed in a bucket at outfall.
231	12/22/2023	0.1	20	7.63	WOC	WCK 4.4	X25	
267	1/6/2023	0.1	25	13.63	FFK	FFK 0.1	X20	Source unknown but suspected as coming from drainage in Bldg. 3144.
267	5/17/2023	1.2	3	18.81	FFK	FFK 0.1	X20	
267	8/21/2023	0.1	5	2.73	FFK	FFK 0.1	X20	
267	10/16/2023	0.8	15	67.05	FFK	FFK 0.1	X20	
314	1/6/2023	0.1	45	24.53	WOC	WCK 4.4	X26	Foundation sump pumping of chlorinated water which was redirected and dechlorinated with tablets.
314	1/27/2023	0.7	20	76.31	WOC	WCK 4.4	X26	
314	5/26/2023	0.3	1	1.64	WOC	WCK 4.4	X26	Cooling tower tablet dechlorination failure. Tablets were replaced.
363	7/10/2023	1.5	20	163.53	FFK	FFK 0.1	X20	Cooling tower blowdown dechlorination system failure. Sodium sulfite tablets were placed at the end of pipe.
363	8/21/2023	1.6	20	173.34	FFK	FFK 0.1	X20	

Acronyms:
FFK = Fifth Creek Kilometer, TRO = Total Residual Oxidant, WCK = White Oak Creek Kilometer, WOC = White Oak Creek

3. Cooling Tower Temperature Effects on Ecological Communities

The NPDES permit WQPP requirements for Cooling Tower Temperature Effects on Ecological Communities are to monitor temperature relative to TDEC's water quality criteria for the protection of fish and aquatic life and to document quantities of cooling water chemicals relative to toxicity from safety data sheets (SDS). Table 11 and Figure 25 depict the outfalls with cooling tower system discharges at ORNL, their locations, and the nearest in-stream sampling points. Table 11 also includes the proposed locations for cooling tower systems under construction.

Table 11. Cooling Tower Discharges at ORNL.

Receiving Tributary	Outfalls with Cooling Tower Discharges	Cooling Towers	Instream Sampling Point (s)
WOC	014	4510/4521 Cooling Towers	X23 Downstream
WOC	204	2539 LLLW Evaporator	X28
WOC	227	5600/5511 Cooling Towers	X23
WOC	231	5800/OLCF5 Cooling Towers	X23
MB	281	7902 (HFIR)	Up/Downstream 281
WOC	314	6018 Cooling Tower	Upstream 314/X23
Fifth Creek	363	5300/5309 Cooling Towers	Up/Downstream 363
WOC	435	8913 (SNS)*	435IMP1
WOC	732 (under construction)	New Tower System for SIPRC Project	WCK 5.2/Upstream 314
Fifth Creek	265 (under construction)	New Tower System for TRC Project	X19

*Note: The SNS cooling tower discharges are included in this assessment, however their discharge is monitored above a retention basin at 435IMP1. They do not contribute as directly to WOC stream temperatures.
Acronyms: WOC = White Oak Creek, MB = Melton Branch, 435 IMP1 = Outfall 435 Internal Monitoring Point, OLCF5 = Oak Ridge Leadership Computing Facility; HFIR = High Flux Isotope Reactor; SNS = Spallation Neutron Source; LLLW = Low Level Liquid Waste

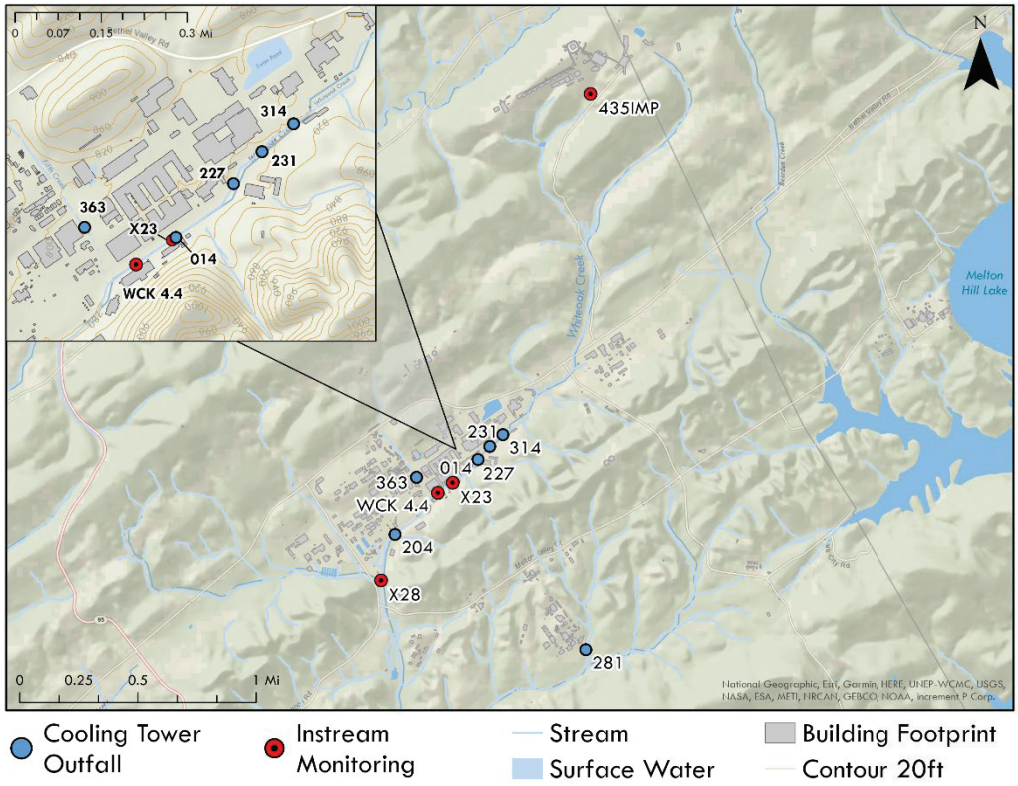
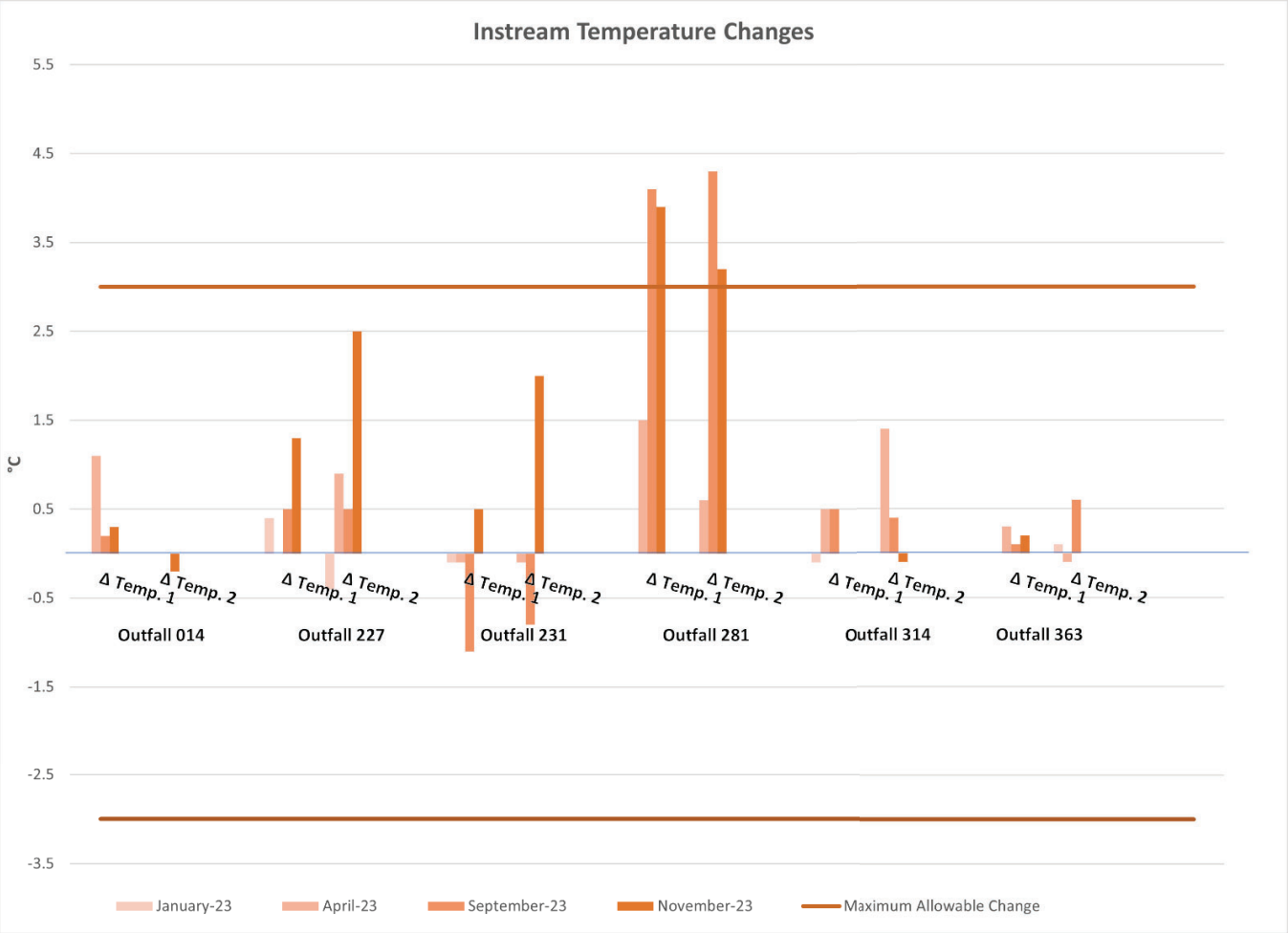


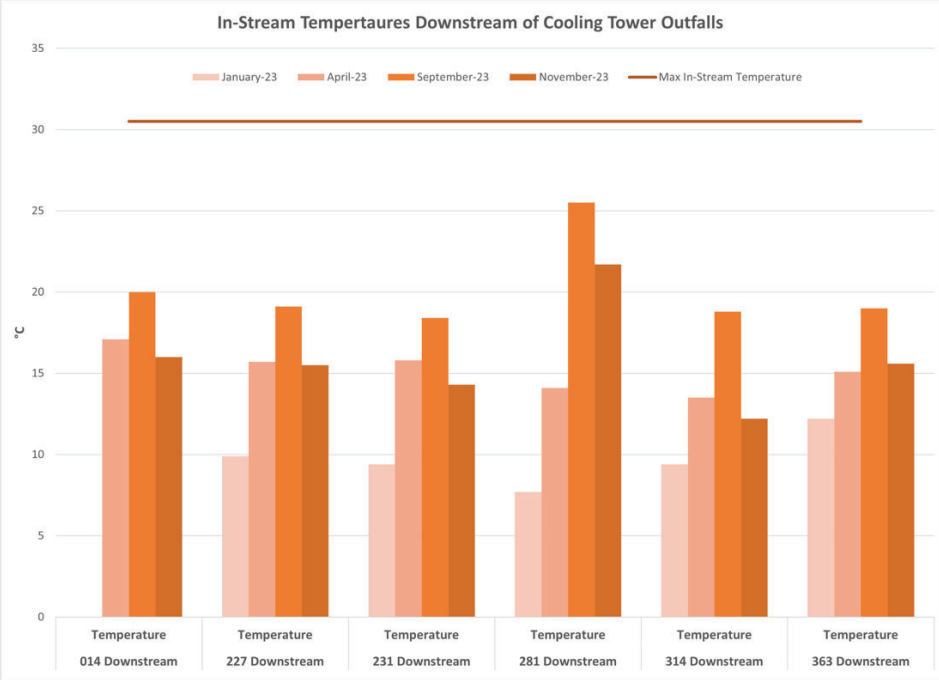
Figure 25. Cooling Tower Outfalls and Corresponding In-stream Sampling Locations

While it is recognized that cooling tower blowdown discharges will elevate the temperatures of the receiving waters, the NPDES permit WQPP requirements are that these discharges should not change the temperature of the receiving water by more than 3°C relative to an upstream control point (at ORNL, this control point is generally just upstream of the discharge). Additionally, the discharge should not cause the temperature of the receiving stream to exceed 30.5°C and the maximum rate of temperature change due to the discharge alone in the stream should not exceed 2°C per hour. Figure 26 - Figure 28 depict the various results of the quarterly instream temperature monitoring changes at those outfalls that have significant cooling tower discharges at ORNL.



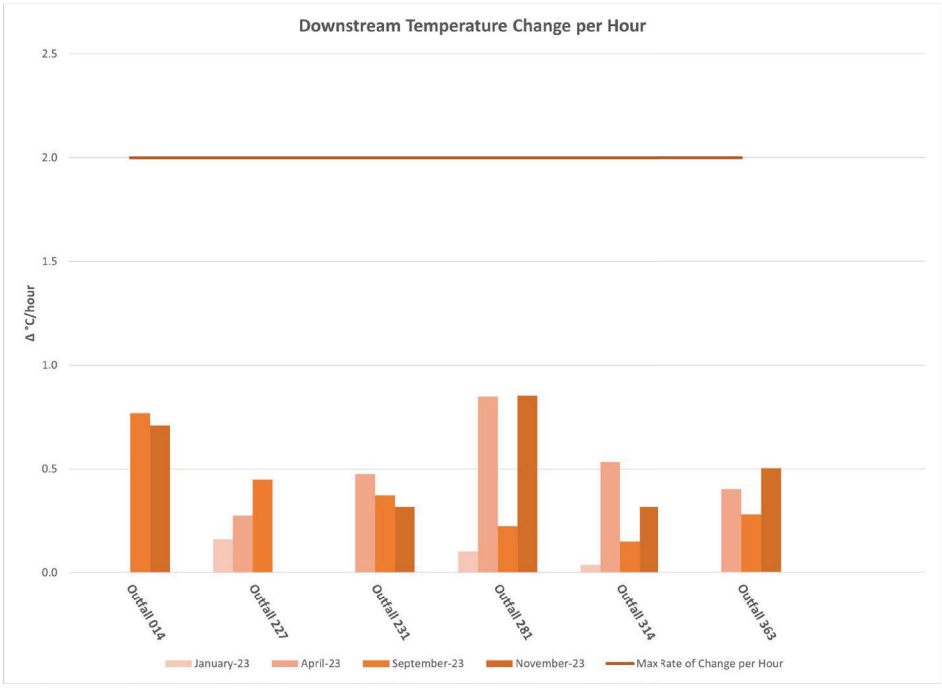
Note: Temperature samples are taken twice per sampling event, so each event has two calculated temperature differences.

Figure 26. Calculated differences in temperatures from upstream and downstream of the outfalls receiving cooling tower discharges compared to the 3°C limit



Note: There was no flow from Outfall 014 in the January 2023 sample.

Figure 27. Downstream temperatures from outfalls that receive cooling tower discharges compared to the 30.5°C limit



Note: Missing data bars reflect occurrences where there was no change in the downstream temperature or there was no flow from the outfall.

Figure 28. Calculated in-stream temperature rate of change downstream of monitored outfalls compared to the 2°C/hour limit

In-stream temperature impacts in 2023 from cooling tower blowdown discharges have been within the requirements noted in the NPDES permit for nearly all of the major cooling tower outfalls monitored at ORNL. As shown in Figure 26 - Figure 28, the temperature impacts of cooling tower discharge at outfalls 014, 227, 231, 314, and 363 have been minimal and within the required ranges: within 3°C change in temperature in-stream, below 30.5°C in-stream, and maintaining the rate of temperature change below 2°C/hr. However, Outfall 281 challenged the in-stream temperature change limits on a few occasions in 2023.

Outfall 281 discharges cooling tower blowdown from the High Flux Isotope Reactor (HFIR) complex to a tributary of Melton Branch. This tributary of Melton Branch has historically low baseflows, such that most flow is from the outfall non-process wastewater. The temperature trends at outfall 281 in 2023 resemble historical monitoring and various operational and engineering changes have been explored and implemented to moderate the temperature of the effluent discharged to the stream from this outfall. Extensive operational changes were undertaken in the past to reduce the temperature of the effluent discharged through Outfall 281, such as taking the cooling tower blowdown from the "cool" side of the tower (i.e., the return side) instead of the warmer supply water side. This change has proven effective in keeping the downstream temperature below 30.5°C, as well as maintaining the rate of temperature change below 2°C/hr. Additionally, the cooling tower blowdown line has also been equipped with a heat exchanger to assist in lowering blowdown temperatures in the warmer months. Also, the flow path for blowdown discharges has been lengthened and widened to provide additional dispersal for cooling the discharges before they reach the tributary.

Despite these operational and engineering changes, the cooling tower discharge temperatures still resulted in a slightly greater than 3°C change in temperature in-stream during the cooler months of 2023. Although downstream temperatures taken from Outfall 281 were under 30.5°C and rate of temperature change did not exceed 2°C/hour, Outfall 281 did exhibit the highest rate of change in between upstream and downstream temperatures among all the monitored outfalls. These trends in 2023 are attributed to the high flowrate of blowdown relative to the lower baseflow of the Melton Branch tributary and the extremely dry weather during sampling time. If these trends persist at this location, additional measures to cool the cooling tower discharges during low baseflow periods may be explored.

The NPDES permit WQPP section on Cooling Tower Temperature Effects on Ecological Communities also requires that cooling tower water chemicals be documented relative to the toxicity in the SDS. Therefore, ORNL's cooling tower operators and engineers annually review and supply estimated dosing information for each cooling tower complex and current SDS's for each chemical used in the cooling towers. Appendix 3 describes the changes in these chemicals from the past year, as well as provides the chemical dosing and the toxicity information extracted directly from the SDS forms.

4. Whole Effluent Toxicity Outfall Monitoring

In accordance with the requirements of the DOE ORNL NPDES Permit *Part 1.A Effluent Limitations and Monitoring Requirements* and *Part III.E Biomonitoring Requirements/Chronic* sections, annual toxicity testing was performed in 2023 at both the Sewage Treatment Plant (Outfall X01) and the Process Waste Treatment Complex (Outfall X12) discharges and results are discussed below.

The chronic toxicity of effluent from the ORNL Sewage Treatment Plant (Outfall X0l) was evaluated through 7-day chronic toxicity tests performed on June 21-28, 2023. Tests were conducted with fathead minnow larvae (*Pimephales promelas*) and water fleas (*Ceriodaphnia dubia*) on three separate 24-hour flow-proportional composite samples of effluent. There were no reductions in fecundity (water fleas) or growth (fathead minnows) greater than or equal to 25 percent compared to the control. The ORNL permit states that toxicity will be demonstrated if the IC25 is less than or equal to the permit limit (44.3%). No toxicity was observed in either water fleas or fathead minnows.

Table 12. Sewage Treatment Plant/X01 2023 Toxicity Testing Results.

Outfall	Test Organism	IC25 Result
X01	Fathead minnow	>100%
X01	Ceriodaphnia dubia	>100%

The chronic toxicity of effluent from the ORNL Process Waste Treatment Complex (Outfall X12) was evaluated through 7-day chronic toxicity tests performed on June 21-28, 2023. Tests were conducted with fathead minnow larvae (*Pimephales promelas*) and water fleas (*Ceriodaphnia dubia*) on three separate 24-hour flow-proportional composite samples of the effluent. There were no reductions in fecundity (water fleas) or growth (fathead minnows) greater than or equal to 25 percent compared to the control. The ORNL permit states that toxicity will be demonstrated if the IC25 is less than or equal to the permit limit (44.3%). No toxicity was observed in either water fleas or fathead minnows.

Table 13. Process Wastewater Treatment Complex/X12 2023 Toxicity Testing Results

Outfall	Test Organism	IC25 Result
X12	Fathead minnow	>100%
X12	Ceriodaphnia dubia	>100%

In addition, the TDEC Division of Water Resources performed an NPDES Permit Compliance Evaluation Inspection (CEI) at ORNL on June 23, 2023, and as a part of that inspection included a supplementary toxicity test at both X01 and X12. This additional toxicity test included both a 3-Brood daphnia (*Ceriodaphnia dubia)* Survival and Reproduction Test and a 7-Day fathead minnow (*Pimephales promelas)* Larval Survival and Growth Test on effluent from both Outfall X01 and Outfall X12. The toxicity test results concluded that both outfalls demonstrated an IC25 of greater than 100 percent of effluent for both species at both on-site wastewater treatment facilities (STP/X01 and PWTC/X12), confirming no toxicity in either X01 or X12 discharges.

5. Additional Monitoring and Investigations Undertaken in 2023 Under WQPP

Periodically, outside of the prescriptive NPDES permit WQPP requirements, DOE does additional planning, monitoring, and investigation as a part of the adaptive management processes integrated into the WQPP. These additional efforts have helped DOE maximize complicated operations, maintenance, and design strategies at ORNL to minimize impacts to the WOC watershed. Ultimately these additional studies help provide DOE a flexible regulatory arena to help improve the water quality in the watershed.

The significant findings of the additional monitoring/investigations done in 2023 focused on copper and selenium studies at point source cooling tower discharges and in-stream locations in the WOC watershed. Additionally, in-stream nutrient monitoring continued in 2023. A summary of the results of the additional monitoring is presented in the following sections. The data from these additional studies is also uploaded at least annually into OREIS.

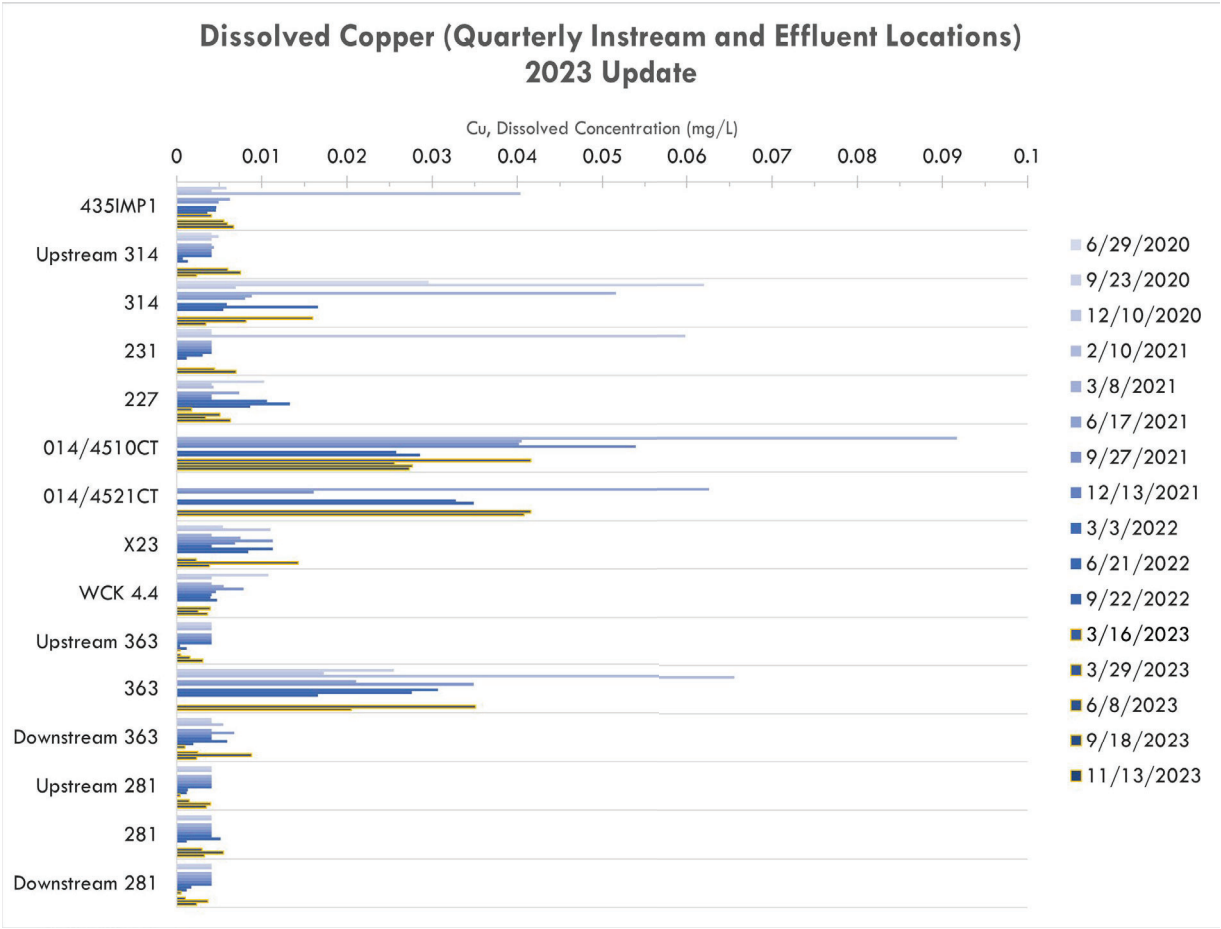
Copper in Cooling Tower Discharges

Cooling towers are frequently used at ORNL for meeting large cooling demands primarily for centralized building cooling, computing cooling, and for cooling used for miscellaneous research activities. Past monitoring and investigations have indicated that cooling tower discharges have been a source of potential water quality issues in the watershed. In 2007, toxicity tests of water from the Building 5600 and Building 4510 cooling towers identified reproductive impacts in *Ceriodaphnia.* Continued investigation suggested elevated metals may be the cause of this test results, due to *Ceriodaphnia's* sensitivity to metals like copper and zinc. Therefore, additional metals have been monitored at various cooling tower outfalls and at different in-stream locations throughout ORNL since 2008.

Analysis of metals in-stream in the WOC watershed suggest cooling tower discharges may potentially have been a large contributor of elevated copper results in the past due to their large volume of discharges as well as the copper infrastructure used within the cooling systems. Considerable collaboration has taken place over the years with cooling tower engineers/designers, chemists, and environmental compliance staff to explore various operational performance improvements for blowdown chemicals and dosing of the cooling towers, as well as for opportunities to enhance cooling tower designs with the goal of reducing impact to the receiving streams. As a result, several cooling tower chemicals and dosing regimens have changed, and new cooling tower systems are now designed to eliminate the use of copper components exposed to water within the tower system.

Copper monitoring at various in-stream locations and cooling tower discharge point source outfalls continued with quarterly sampling in 2023. In-stream and cooling tower point source dissolved copper monitoring results from 2020 – 2023 are presented in Figure 29. The monitoring results listed in the figure are arranged from most upstream to downstream (top to bottom) in the WOC watershed in order to show the impacts of point source cooling tower discharge on the receiving stream. Note that Figure 29 does not include an in-stream criteria for toxicity comparison since both ambient in-stream and point source concentrations are presented. Also, the Outfall 014 samples were taken directly at the discharge boxes of the cooling tower blowdown, instead of at Outfall 014 in order to better discern the impacts from each cooling tower separately entering this Outfall. This direct sampling approach of the blowdown tends to result in the higher observed

concentrations of copper because the blowdown is not mixed with other non-process waters like it typically would be at the end of an outfall pipe, yielding a more conservative result.



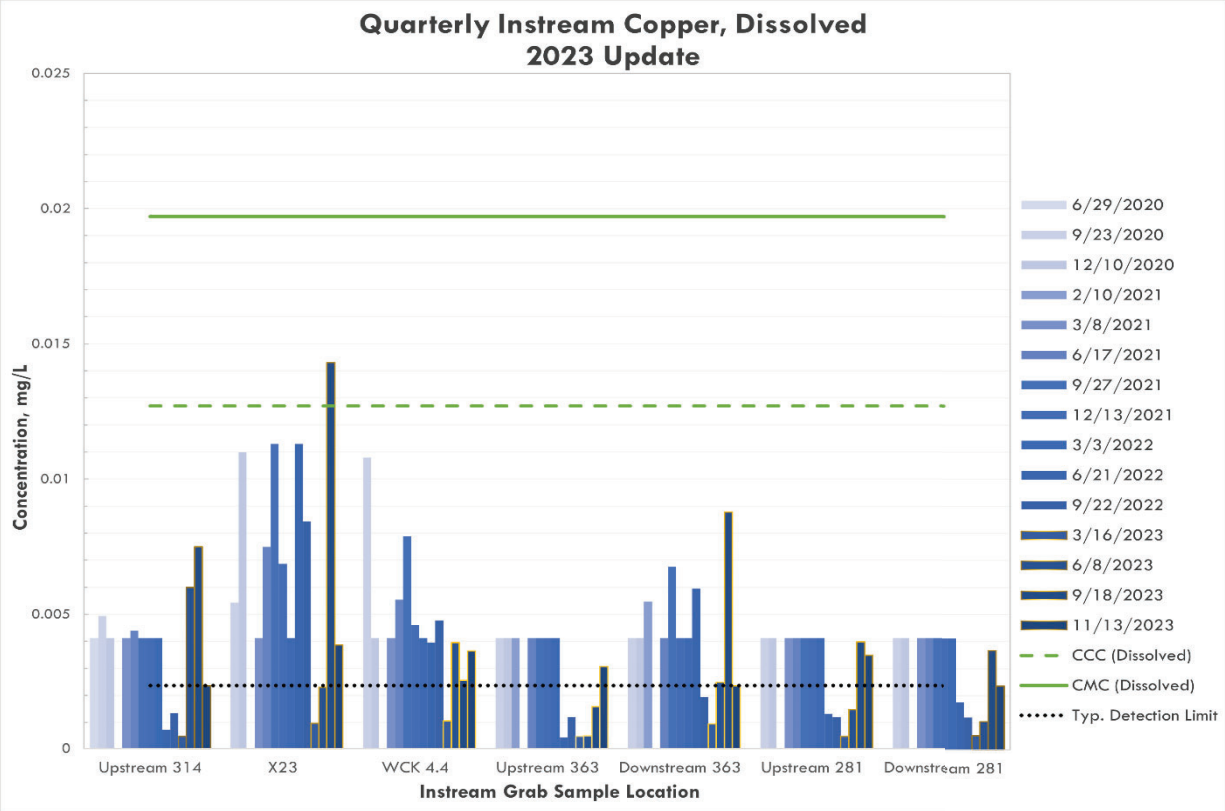
Note: *Detection Limit = 0.00412 mg/L*
Acronyms: *WCK = White Oak Creek Kilometer; 435IMP1 = Outfall 435 Integrated Monitoring Point; CT = Cooling Tower*

Figure 29. Ambient in-stream and effluent point source copper concentrations in WOC watershed (2023 values highlighted)

Low in-stream concentrations of dissolved copper continue to be observed throughout the WOC watershed in 2023. Both in-stream and cooling tower outfall point source dissolved copper concentrations have been trending downward in recent years, however, there is not a clear understanding of the exact reason for this.

Dissolved copper concentrations were analyzed at in-stream monitoring locations again in 2023 as shown in Figure 30. The Tennessee Water Quality Criteria (WQC) was included on the chart for comparison. The Tennessee WQC for dissolved copper has a Criterion Maximum Criteria (CMC) of 13 ug/L (0.013 mg/L) and a Criterion Continuous Criteria (CCC) of 9 ug/L (0.009 mg/L). However, for WOC and its tributaries, these values presented in Figure 30 are adjusted for a hardness of 150 mg/L as $CaCO_3$ as described in TDEC Rule 0400-40-03-.03(3)(g), making the dissolved CMC 19.7 ug/L (0.0197 mg/L) and CCC 12.7 ug/L (0.0127 mg/L).

Figure 30 arranges the in-stream dissolved copper concentrations from upstream to downstream of cooling tower discharges at ORNL from 2020 to 2023. The dissolved copper monitoring results generally show ambient in-stream copper levels well below the WQC in nearly all locations in 2023. These downward in-stream copper trends were in line with the downward trends from point source cooling tower discharges seen in Figure 29 in 2023.



Acronyms: *WCK = White Oak Creek Kilometer; CCC = Criterion Continous Concentration; CMC = Criterion Maximum Concentration*

Figure 30. Instream dissolved copper concentrations upstream and downstream of cooling tower discharges, 2020-2023 (2023 values highlighted).

There is one quarterly sample of dissolved copper measured that is just above the CCC (12.7 ug/L) at the in-stream monitoring point X23, which is immediately downstream of outfall 014. Outfall 014 principally discharges cooling tower blowdown from the Building 4510 and Building 4521 cooling towers. After investigation, it was determined that the slightly elevated dissolved copper concentration measured at X23 was predominantly due to hotter and drier weather that took place in September 2023, resulting in lower creek flows and increased blowdown frequencies from the cooling towers. According to the National Oceanic & Atmospheric Administration (NOAA 2023) September 2023 was an abnormally warm, dry month in the region. A combination of the lower creek flows and the higher volume of cooling tower blowdown discharges that took place during this month likely resulted in slightly elevated dissolved copper levels at X23, though this did not actually increase in the amount of copper dissolved in the blowdown. In fact, dissolved copper concentrations in the Building 4510 and Building 4521 cooling tower blowdown samples remained relatively steady, if not slightly decreased during the September 2023 sampling event.

In addition, it appears in Figure 30 that in-stream monitoring station X23 has had elevated dissolved copper concentrations since 2020 when compared to the other in-stream monitoring locations throughout the WOC watershed, likely due to its location of being just downstream of nearly all of the main campus cooling towers.

It is expected that additional monitoring of metals will continue at selected in-stream and point source cooling tower discharge outfall locations in order to evaluate the influence of cooling towers on in-stream metal concentrations in the WOC watershed.

Selenium in Cooling Tower Discharges

Selenium is a metalloid that has been monitored at various locations for over a decade at ORNL. Throughout these monitoring efforts, selenium has never been present in concentrations that warrant any additional investigation. However, it has more recently been included in some studies as a part of the WQPP in 2023 due to slightly elevated in-stream levels found during NPDES permit application background monitoring efforts in 2022. Since the WQPP has an adaptive management component, a more aggressive sampling effort was undertaken in 2023 in an attempt to identify and eventually reduce/eliminate the sources of selenium in the WOC watershed. Therefore, selenium monitoring at in-stream locations, as well as at point source cooling tower discharges, was undertaken in 2023 and results are presented in this section.

Quarterly selenium monitoring took place in 2023 at various cooling tower point source locations throughout the WOC watershed (see Figure 25) and is summarized in Table 14. The 2023 quarterly grab samples were attempted during cooling tower blowdown events. However, the absence of blowdown flow during a sampling event may result in a deferred sample for that quarter, as may be depicted in Figure 31 below. The results of the 2023 point source monitoring appear to confirm the presence of selenium at those outfalls that have cooling tower discharges.

Table 14. Total Selenium monitoring average quarterly grab sample results at point source locations in 2023.

Location	Units	Minimum Concentration	Average (Chronic) Concentration	Maximum (Acute) Concentration
Outfall 227	mg/L	< 0.0031	0.012	0.024
Outfall 231	mg/L	< 0.0031	0.019	0.028
Outfall 281	mg/L	< 0.0031	0.005	0.008
Outfall 314	mg/L	< 0.0031	0.010	0.029
Outfall 363	mg/L	< 0.0031	0.010	0.026
Cooling Tower 4510 Box (Outfall 014)	mg/L	0.030	0.045	0.056
Cooling Tower 4521 Box (Outfall 014)	mg/L	0.024	0.047	0.070

Note: the detection limit for these samples is 0.0031 mg/L.

Figure 31 depicts the total selenium values from quarterly grab sampling at both cooling tower point source effluent discharges and at in-stream sample locations in 2022 - 2023. The monitoring results listed in the figure are arranged from most upstream to downstream (top to bottom) in the WOC watershed to show the impacts of point source cooling tower discharge on the receiving

stream. The results start from up-to-downstream locations in WOC (435IMP1 to WCK 4.4), then Fifth Creek (up and downstream of 363), and then a tributary to Melton Branch (up and downstream of 281). Note that Figure 31 does not include in-stream water quality criteria for comparison since both ambient in-stream and point source concentrations are presented. Also, the Outfall 014 samples were taken directly at the discharge boxes of the cooling tower blowdown instead of at Outfall 014 in order to better discern the impacts from each cooling tower separately. This direct sampling approach of the blowdown tends to result in greater concentrations of selenium because the blowdown is not mixed with other non-process waters like it typically would be at the end of an outfall pipe, yielding a more conservative result.

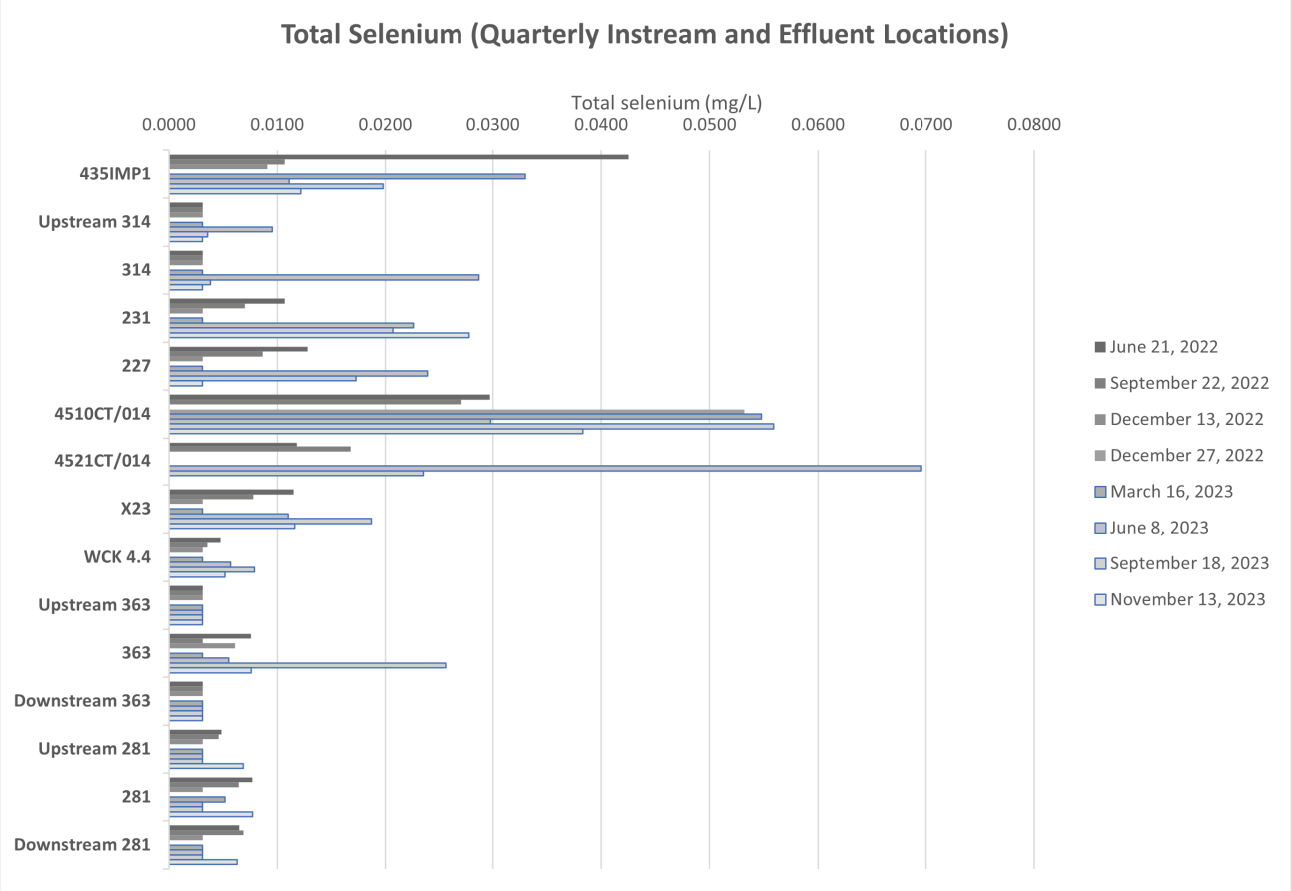


Figure 31. Total Selenium results measured in quarterly in-stream and at effluent point source locations on White Oak Creek, Fifth Creek, and a tributary to Melton Branch in 2022 and 2023 (2023 values highlighted).

It appears from Figure 31 that all monitored cooling tower point source outfalls contained slightly elevated concentrations of selenium when compared to in-stream background concentrations except for Outfall 281, which discharges cooling tower blowdown from HFIR to a tributary to Melton Branch. While selenium is detected in-stream at this location, it does not appear to be influenced by cooling tower blowdown. In fact, the concentrations of selenium remained unchanged from the up and downstream measurements around Outfall 281. Moreover, Outfall 281 discharges a considerably lower concentration of selenium than other outfalls that discharge cooling tower blowdown.

The elevated point source selenium concentrations seen in Figure 31 at 4510CT and 4521CT, both cooling towers that discharge to Outfall 014, were expected since the samples were taken directly at the tower discharge dechlorination boxes not at the outfall discharge to the creek. However, since these locations are still the highest concentrations of selenium found at any of the point sources, additional investigation here is warranted.

In addition, there is slightly elevated selenium concentrations at the 435IMP1 monitoring location, which is located upstream of the stormwater retention pond that receives stormwater discharges and cooling tower blowdown from the nearby Spallation Neutron Source (SNS) research facility. Water from this pond travels some distance underground in the stormwater drainage system and eventually discharges into WOC at point source outfall 435 (near the WOC headwaters). Samples are taken here instead of directly at the Outfall 435 in order to more accurately represent the SNS discharges.

Any impact from selenium in cooling tower blowdown is most apparent in-stream at both the WCK 4.4 and X23 in-stream locations. X23 is immediately downstream of Outfall 014, which discharges blowdown from the 4510/4521 cooling towers and WCK 4.4 is also about 400 feet downstream of the X23 in-stream location. There are no cooling tower discharges to WOC between these two points.

Total selenium in Fifth Creek was monitored up and downstream from Outfall 363, which discharges cooling tower blowdown from the 5300/5309 cooling towers. Elevated selenium was not observed in Fifth Creek during the 2023 monitoring effort, but total selenium appears to increase slightly throughout the year at the Outfall 363 discharge.

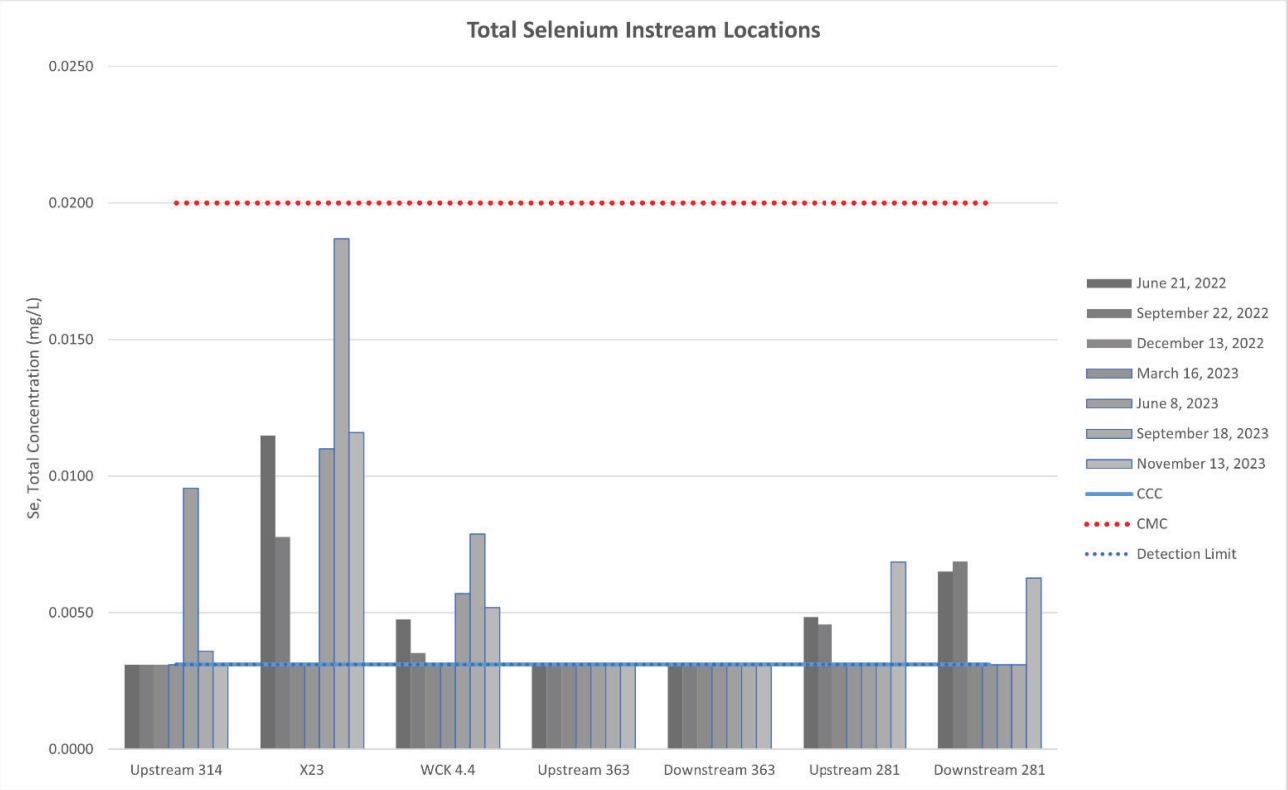


Figure 32. Total selenium measured quarterly in-stream across White Oak Creek, Fifth Creek, and the tributary to Melton Branch compared against the CCC and CMC 2022 - 2023.

In-stream total selenium results from quarterly grab sampling in-stream in 2022 - 2023 is depicted in Figure 32 and compared to both the Tennessee WQC CCC and CMC. The detection limit achieved in the 2023 samples equaled the CCC (0.0031 mg/L). There were no exceedances of the Tennessee WQC CMC anywhere in the WOC watershed in 2022 or 2023. However, the X23 in-stream monitoring location tends to have the highest total selenium concentrations which may be explained due its proximity to the 4510/4521 cooling towers discharge. The discharges from these towers also have the highest concentration measured of total selenium during the warmer months of the year, which may correspond to the greater cooling demand required by these cooling towers during the warmer months resulting in more frequent blowdown events.

The in-stream total selenium results in WOC (upstream of Outfall 314 to WCK 4.4) saw consistent exceedances of the CCC in 2023, even at the most upstream location. However, there were no exceedances of the CCC in Fifth Creek, which receives cooling tower blowdown from the 5300/5309 cooling towers through Outfall 363. Also, the only exceedances of the CCC in the Melton Branch tributary is present in both the upstream and downstream Outfall 281 samples, which might mean that the CCC may not be achievable in this stream reach of the WOC watershed.

Even though there has recently been some elevated in-stream selenium concentrations identified in recent investigations, TDEC Rule 0400-40-03-.03(3)(g)(3) states that for selenium, *"The numeric water criteria for selenium are applicable for all purposes, but for water quality assessment,* ***fish tissue values may be used to confirm or refute impacts to aquatic life*** *in accordance with and using the values from EPA's Final Criterion: Aquatic Life Ambient Water Quality Criterion for Selenium*

- *Freshwater (June 30, 2016)."* The fish tissue criteria from EPA's final criterion are reproduced below (Table 15):

Table 15. EPA Freshwater Fish Tissue Criteria for selenium [expressed as mg/kg of dry weight (dw)]

Egg-Ovary (mg/kg dw)	Whole Body (mg/kg dw)	Muscle (mg/kg dw)
15.1	8.5	11.3

As a part of the extensive BMAP efforts that have taken place at ORNL for many years, forage fish are collected annually in the WOC watershed in order to evaluate exposure to trace elements, including selenium. Largescale stonerollers (*Campostoma oligolepis*) are common forage fish in east Tennessee. They are abundant, short-lived, and relatively sedentary and are therefore used as biosentinels to monitor short term changes in contaminant exposure at a given site. They are also important prey items for larger fish, and so serve as an indicator of wildlife exposure and risk. Thirty individual stonerollers of similar size and weight are collected and separated into three 10-fish samples which were each homogenized for analysis. Tissues are analyzed by Inductively Coupled Plasma Mass Spectrometry (ICP-MS) on a wet weight basis. Table 16 shows selenium concentrations (ug/g) in stonerollers collected at in-stream location WCK 3.9 (downstream of the major cooling tower blowdown loads on WOC) from 2018-2023. During this time period, average estimated dry weight selenium concentrations in whole body fish ranged between 1.72 - 3.35 ug/g, well below the EPA whole body criterion for selenium of 8.5 ug/g.

Table 16. Selenium concentrations in whole-body composites of largescale stonerollers collected at WCK 3.9.

Year	Units	Maximum Tissue Conc. (wet weight)	Avg. Tissue Conc. (wet weight)	Est. Maximum Tissue Conc. (dry weight)	Est. Avg. Tissue Conc. (dry weight)
2018	ug/g	0.42	0.41	2.10	2.05
2019	ug/g	0.35	0.34	1.75	1.72
2020	ug/g	0.46	0.43	2.30	2.15
2021	ug/g	0.65	0.60	3.25	3.00
2022	ug/g	0.48	0.45	2.40	2.27
2023	ug/g	0.83	0.67	4.15	3.35

Note: Samples were analyzed and reported on a wet weight basis. For comparison with the EPA tissue criterion for Se, dry weight concentrations were estimated by multiplying the wet weight values by a factor of 5 (based on an assumed 80% tissue moisture content). mg/kg = ug/g.

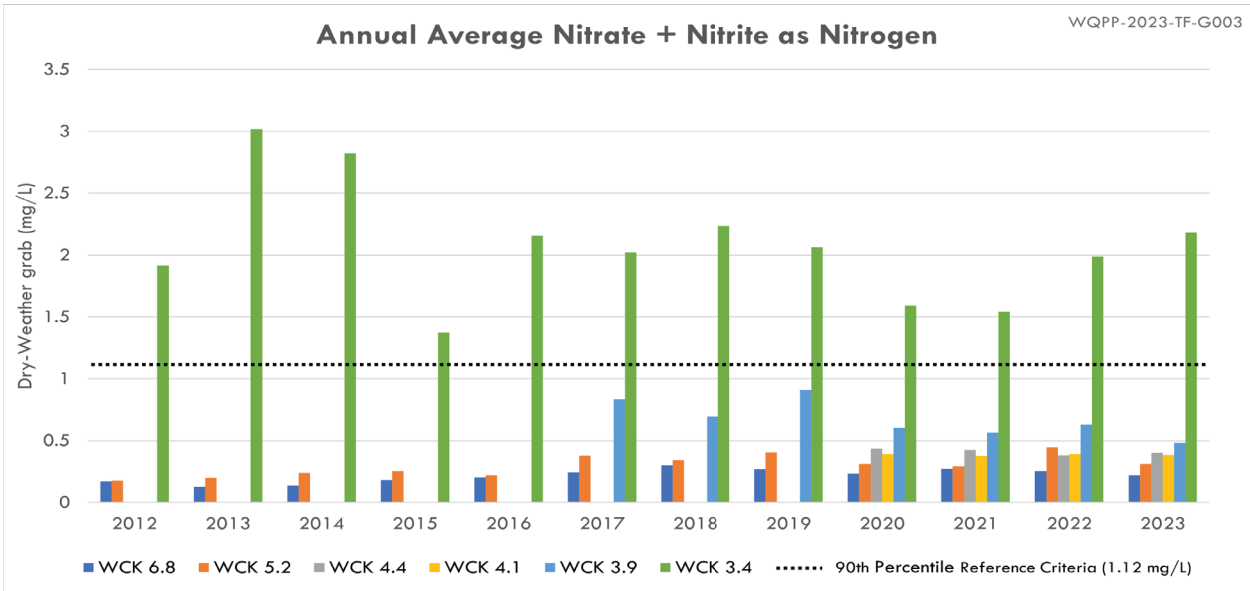
The general trend of elevated total selenium in cooling tower blowdown point-source outfalls, as well as in downstream in-stream monitoring locations, suggests that cooling towers may be the principal contributor of selenium to the WOC watershed. Treatment chemicals used in the cooling towers may therefore be the potential source of the elevated selenium and it is probable that different chemical treatments used in the different cooling towers might explain the difference in

selenium concentrations observed at these different locations. Investigation into the differences in cooling tower treatment chemicals, as well as cooling tower point source and in-stream monitoring of selenium is expected to continue in 2024.

Nutrient Monitoring

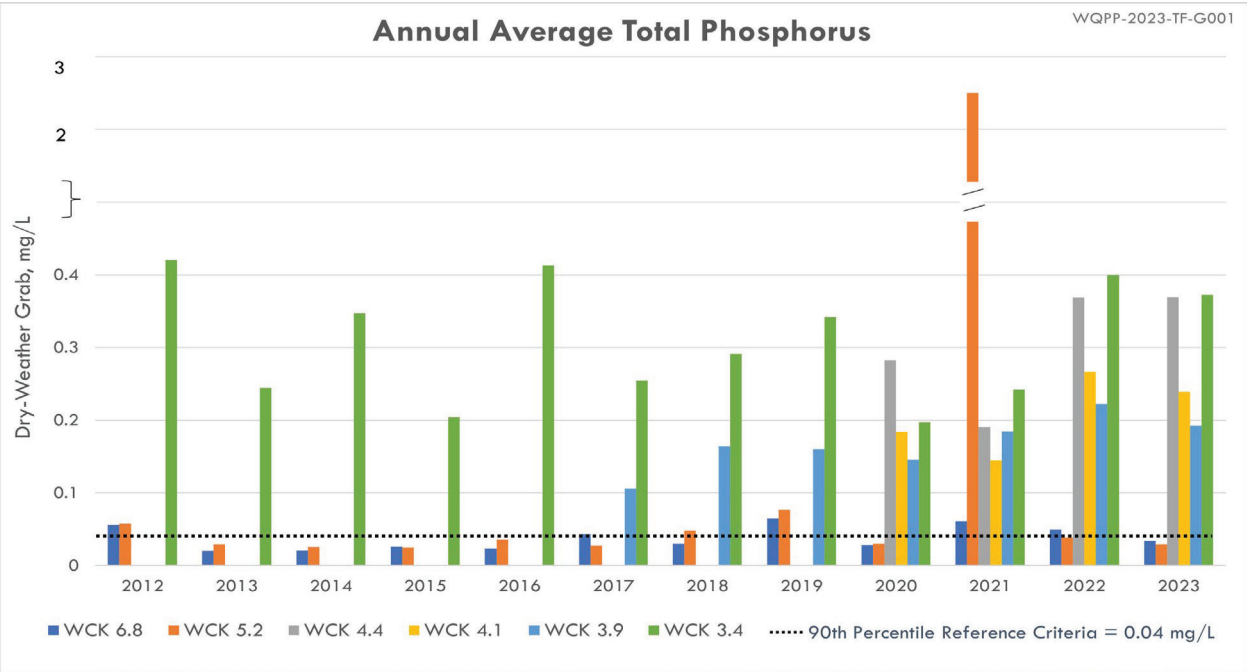
Nutrients have been routinely monitored at various ambient in-stream and effluent/point source locations in both dry and wet-weather conditions since 2012 as a part of the WQPP. Additionally, nutrient monitoring has supported numerous projects and initiatives for various purposes. In 2020/2021, a Nutrient Study was conducted to fulfill previous NPDES permit requirements and was submitted to TDEC in 2022. Furthermore, additional point source monitoring was conducted at the existing STP (Outfall X01) to aid in developing design criteria for the new STP currently under construction. Quarterly nutrient monitoring continued in 2023 at various in-stream monitoring sites to maintain a background dataset for supporting the NPDES permit application. Annual average and long-term average concentrations for nitrate/nitrite and phosphorus at in-stream monitoring locations are presented in Figure 33 – Figure 36. On all figures, reference concentration values from the TDEC publication, "*Development of Regionally Based Interpretations of Tennessee's Narrative Nutrient Criterion"* (Tennessee's Plan for Nutrient Criteria Development, Rev. Sept 2019, TN Dept. of Environment and Conservation, Watershed Planning Unit, Division of Water Resources) are shown for comparison (depicted as dashed lines). The reference values are the 90th percentile of the data set for wadeable reference streams in level IV ecoregion 67f.

Annual average dry weather concentrations for nitrate/nitrite and phosphorus at in-stream WOC watershed monitoring stations for 2012 to 2023 are depicted in Figure 33 and Figure 34, respectively. These figures depict increasing nutrient concentrations from upstream (WCK 6.8 – reference site) to downstream (WCK 3.4 - below both treatment facility's effluent discharges and downstream of the main ORNL campus), as expected due to the presence of numerous operations and research facilities with non-process wastewater and industrial stormwater discharges. Higher concentrations of both nutrients are observed at WCK 3.4. In calculating the average concentrations, the detection levels were used for those individual values that were below the detection level from the laboratory. When the laboratory identified a result as an estimate, the estimated value was used.



Acronym: *WCK = White Oak Creek Kilometer*
Note: Grab samples collected quarterly (Q). Period of record for locations WCK 4.1, WCK 4.4: Q2 2020–Q4 2023. Period of record for all other locations: Q2 2012–Q4 2023

Figure 33. Average annual nitrate + nitrite concentrations at in-stream locations in the White Oak Creek watershed

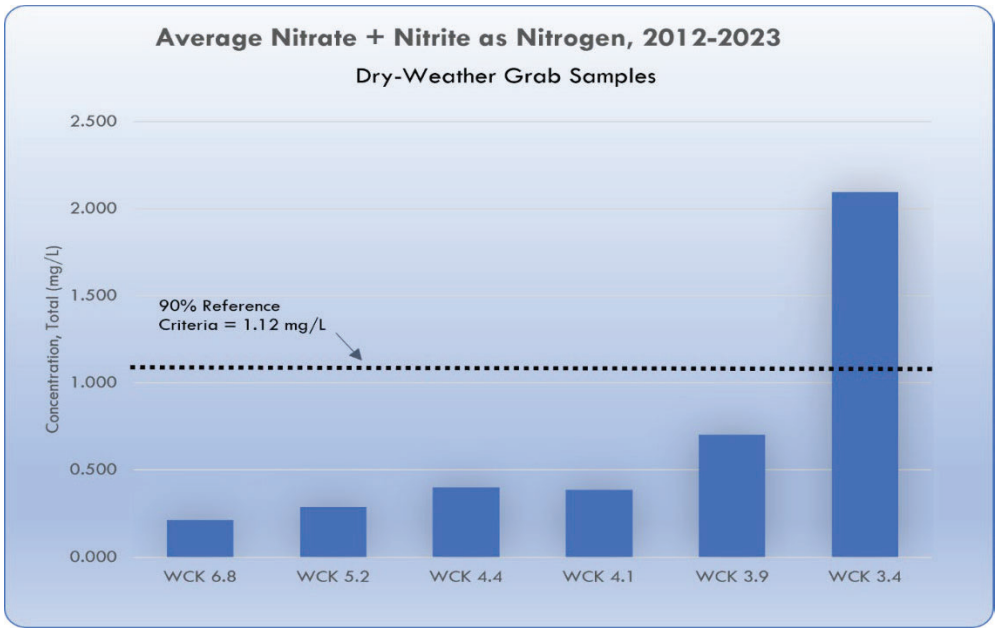


Acronym: *WCK = White Oak Creek Kilometer*
Note: Grab samples collected quarterly (Q). Period of record for locations WCK 4.1, WCK 4.4: Q2 2020–Q4 2023. Period of record for all other locations: Q2 2012–Q4 2023

Figure 34. Average annual total phosphorus (TP) concentrations at in-stream locations in the White Oak Creek watershed.

The May 2021 total phosphorus concentration at the WCK 5.2 in-stream monitoring site depicted in Figure 34 which resulted in a higher than typical annual average is believed to be an outlier based on its location. WCK 5.2 is some distance downstream of the drainage from the east end of the ORNL campus where numerous craft facilities are located, but upstream of the central ORNL facility. Investigations conducted at the time did not identify any possible cause of this unusually high value.

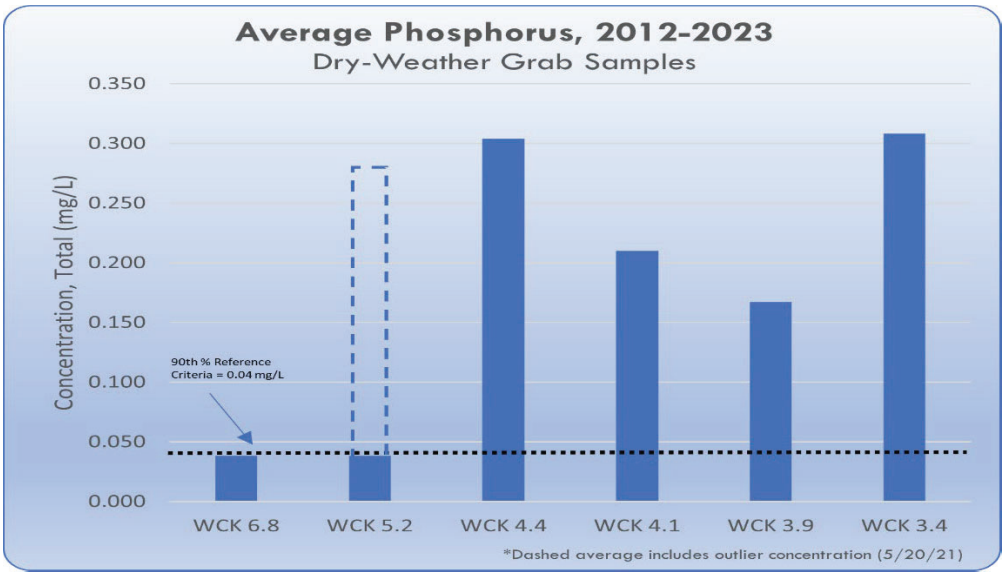
Long-term average concentrations of nitrate/nitrite and phosphorus are also presented in Figure 35 and Figure 36, respectively. As depicted in Figure 35, the long-term average nitrate/nitrite concentrations are below the reference criteria at all sites except WCK 3.4, the most downstream monitoring site, where nitrogen contributions from the STP are significant. Planned upgrades to the STP facility are expected to improve nitrogen contributions upon completion in 2024/2025.



Acronym: *WCK = White Oak Creek Kilometer*
Note: Grab samples collected quarterly (Q). Period of record for locations WCK 4.1, WCK 4.4: Q2 2020–Q4 2023. Period of record for all other locations: Q2 2012–Q4 2023

Figure 35. Long-term average nitrate + nitrite concentrations from quarterly grab samples at instream locations on White Oak Creek

Long-term average phosphorus concentrations shown in Figure 36 are generally above the reference criteria at nearly all in-stream locations, suggesting that reference criteria determined for the sub-ecoregion may not be appropriate or achievable for the WOC watershed. However, phosphates used in several cooling tower systems throughout ORNL, as well as phosphorus from the STP effluent, do contribute to these elevated concentrations. Planned upgrades to the STP facility are expected to improve phosphorus contributions to the watershed.



Acronym: *WCK = White Oak Creek Kilometer*
Note: Grab samples collected quarterly (Q). Period of record for locations WCK 4.1, WCK 4.4: Q2 2020–Q4 2023. Period of record for all other locations: Q2 2012–Q4 2023

Figure 36. Long-term average total phosphorus concentrations from quarterly grab samples at in-stream locations on White Oak Creek

Reduction of nutrients in the WOC watershed is anticipated after the completion of STP upgrades. Re-evaluation of nutrient contributions may occur as part of the on-going investigations of impairment to the WOC watershed, particularly if benthic macroinvertebrate studies indicate nutrients as a potential contributor to impairment. In-stream nutrient monitoring will continue quarterly within WOC and its tributaries in 2024.

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TDEC. 2010b. Proposed Total Maximum Daily Loads (TMDLs) for Polychlorinated Biphenyls (PCBs) and Chlordane in Watts Bar Reservoir: Watts Bar Lake Watershed (HUC 06010201), Lower Clinch River Watershed (HUC 06010207), and Emory River Watershed (HUC 06010208), Loudon, Meigs, Morgan, Rhea, and Roane Counties, Tennessee. TDEC, Division of Water Pollution Control, Nashville, Tennessee.

TDEC. 2010c. Proposed Total Maximum Daily Loads (TMDLs) for Polychlorinated Biphenyls (PCBs) in Fort Loudoun Reservoir: Fort Loudoun Lake Watershed (HUC 06010201), Blount, Knox, and Loudon Counties, Tennessee. TDEC, Division of Water Pollution Control, Nashville, Tennessee.

G. Appendices

Appendix 1. Benthic Macroinvertebrate Laboratory Bench Sheets

BENTHIC MACROINVERTEBRATE LABORATORY BENCH SHEET (FRONT)

Page 1 of 1

Project Name: OKWL BMAP	Sorted by: RM	Date Started: 11/13/2023	Date Finished: 11/13/2023	Hours: 2
Stream Name: First Creek	Taxonomist: WSW	Date Started: 1/25/2024	Date Finished: 1/24/2024	Hours: 3
Site Name: FCK 0.1 Rep No.: 1 Date: 4/17/2023	Chain-of-Custody Number: FC01-0423-1		Number of Containers: 1 Vial	

Taxon	Number	Ck. no.[a]	Total no.[b]
Ephemeroptera			
Baetis	2	3	5
Stenacron	1	0	1
Plecoptera			
Trichoptera			
Cheumatopsyche	1	0	1
Coleoptera			
Dubiraphia	1	1	2
Psephenus herricki	15	0	15
Optioservus	16	0	16
Stenelmis	10	0	10
Column 1 total	46	4	50

Taxon	Number	Ck.no.[a]	Total no.[b]
Odonata			
Boyeria	1	0	1
Stylogomphus albistylus	2	0	2
Diptera			
Chironomidae (pupae)	0	1	1
Orthocladiinae	5	1	6
Tanypodinae	1	0	1
Chironomini	14	2	16
Tanytarsini	4	0	4
Dixella	1	0	1
Simulium	1	0	1
Other Taxa			
Oligochaeta	16	1	17
Gammarus	40	1	41
Cambaridae	1	0	1
Column 2 total	86	6	92
Total sample number	132	10	142

[a]Number of organisms in QA check vial.

[b]Total number of organisms corrected for number in check vial. This number is derived by multiplying the check vial number (Ck. no.) by the proportion of pans checked during sorting QA, and then adding to number (no.).

Entered Date: 1/26/2024 Entered By: WSW
Checked Date: 2/21/2024 Checked By: BH

BENTHIC MACROINVERTEBRATE LABORATORY BENCH SHEET (BACK)

Site Name:	Rep No.:	Date:
FCK 0.1	1	4/17/2023

Total Number of Organisms 142	Total Number of Taxa 19

Proportion of Pans Checked 6Y/3N

QC / Sorting:

Checked by: WSW Date: 11/13/2023

Sorting efficiency

(Sorting efficiency = Number in check vial (Ck. No.)) Number originally sorted (No.) H 100)

90%

(∃90% Sample passes or < 90% sample fails)

Action taken:

QC / Taxonomy:

Checked by: _____ Date: _____

Original identification	Verification identification

Subsampled?	Explain:
Yes _____	
No X	

General comments:

BENTHIC MACROINVERTEBRATE LABORATORY BENCH SHEET (FRONT)

Page 1 of 1

Project Name: ORNL BMAP			Sorted by: RM	Date Started: 12/4/2023	Date Finished: 12/4/2023 Hours: 4
Stream Name: First Creek			Taxonomist: WSW	Date Started: 1/24/2024	Date Finished: 1/29/2024 Hours: 6
Site Name: FCK 0.1	Rep No.: 2	Date: 4/17/2023	Chain-of-Custody Number: FC01-0423-2		Number of Containers: 1 Vial

Taxon	Number	Ck. no.[a]	Total no.[b]
Ephemeroptera			
Eurylophella	2	0	2
Baetis	5	0	5
Plecoptera			
Trichoptera			
Coleoptera			
Optioservus	85	1	86
Stephanus herricki	29	0	29
Ectopria	3	0	3
Stenelmis	6	0	6
Column 1 total	130	1	131

Taxon	Number	Ck.no.[a]	Total no.[b]
Odonata			
Stylogomphus albistylus	2	0	2
Boyeria	1	0	1
Diptera			
Orthocladiinae	8	1	9
Tanypodinae	1	1	2
Chironomini	25	0	25
Tanytarsini	1	0	1
Chironomidae (pupae)	3	0	3
Other Taxa			
Elimia	4	0	4
Gammarus	135	0	135
Oligochaeta	13	0	13
Column 2 total	193	2	195
Total sample number	323	3	326

[a]Number of organisms in QA check vial.

[b]Total number of organisms corrected for number in check vial. This number is derived by multiplying the check vial number (Ck. no.) by the proportion of pans checked during sorting QA, and then adding to number (no.).

Entered Date: 1/30/2024 Entered By: BH
Checked Date: 2/21/2024 Checked By: BH

BENTHIC MACROINVERTEBRATE LABORATORY BENCH SHEET (BACK)

Site Name:	Rep No.:	Date:
FCK 0.1	2	4/17/2023

Total Number of Organisms 326	Total Number of Taxa 16

Proportion of Pans Checked ~~7~~ 6N

QC / Sorting:

Checked by: WSW Date: 12/4/2023

Sorting efficiency

(Sorting efficiency = Number in check vial (Ck. No.)) Number originally sorted (No.) H 100)

98%

(∃90% Sample passes or < 90% sample fails)

Action taken:

QC / Taxonomy:

Checked by: _____ Date: _____

Original identification	Verification identification

Subsampled?	Explain:
Yes _____	
No X	

General comments:

BENTHIC MACROINVERTEBRATE LABORATORY BENCH SHEET (FRONT)

Page 1 of 1

Project Name: ORNL BMAP	Sorted by: RM	Date Started: 12/5/2023	Date Finished: 12/5/2023	Hours: 3
Stream Name: First Creek	Taxonomist: WSW	Date Started: 1/29/2024	Date Finished: 1/30/2024	Hours: 5
Site Name: FCK 0.1 Rep No.: 3 Date: 4/17/2023	Chain-of-Custody Number: FC01-0423-3		Number of Containers: 1 Vial	

Taxon	Number	Ck. no.[a]	Total no.[b]
Ephemeroptera			
Baetis	4	0	4
Plauditus plauditus	1	0	1
Plecoptera			
Trichoptera			
Pycnopsyche	1	0	1
Cheumatopsyche	1	0	1
Coleoptera			
Optioservus	76	0	76
Stephanus herricki	17	0	17
Stenelmis	2	0	2
Column 1 total	102	0	102

Taxon	Number	Ck.no.[a]	Total no.[b]
Odonata			
Stylogomphus albistylus	1	0	1
Diptera			
Orthocladiinae	7	0	7
Chironomini	4	0	4
Tanytarsini	0	1	1
Chironomidae (pupae)	2	0	2
Other Taxa			
Gammarus	77	0	77
Oligochaeta	16	0	16
Elimia	15	0	15
Column 2 total	122	1	123
Total sample number	224	1	225

[a]Number of organisms in QA check vial.

[b]Total number of organisms corrected for number in check vial. This number is derived by multiplying the check vial number (Ck. no.) by the proportion of pans checked during sorting QA, and then adding to number (no.).

Entered Date: 1/30/2024 Entered By: BH

Checked Date: 2/21/2024 Checked By: BH

BENTHIC MACROINVERTEBRATE LABORATORY BENCH SHEET (BACK)

Site Name: FCK0.1	Rep No.: 3	Date: 4/17/2023
Total Number of Organisms 225		Total Number of Taxa 15
Proportion of Pans Checked 6Y/4N		

QC / Sorting:

Checked by: WSW Date: 12/5/2023

Sorting efficiency

(Sorting efficiency = Number in check vial (Ck. No.)) Number originally sorted (No.) H 100)

99%

(∃90% Sample passes or < 90% sample fails)

Action taken:

QC / Taxonomy:

Checked by: _____ Date: _____

Original identification	Verification identification

Subsampled?	Explain:
Yes _____	
No X	

General comments:

BENTHIC MACROINVERTEBRATE LABORATORY BENCH SHEET (FRONT)

Page 1 of 1

Project Name:	Sorted by:	Date Started:	Date Finished:	Hours:
ORNL BMAP	RM	8/11/2023	8/11/2023	3
Stream Name:	**Taxonomist:**	**Date Started:**	**Date Finished:**	**Hours:**
First Creek	WSW	8/15/2023	8/16/2023	5
Site Name: / **Rep No.:** / **Date:**	**Chain-of-Custody Number:**		**Number of Containers:**	
FCK 0.8 / 1 / 4/17/2023	FC08-0423 -1		1 Vial	

Taxon	Number	Ck. no.[a]	Total no.[b]
Ephemeroptera			
Acentrella	8	0	8
Baetis	4	0	4
Stenacron	2	0	2
Habrophlebiodes	16	0	16
Diphetor	5	0	5
Plecoptera			
Leuctra	22	1	23
Perlesta	1	0	1
Tallaperla	4	0	4
Trichoptera			
Polycentropus	12	0	12
Cheumatopsyche	5	0	5
Neophylax	2	0	2
Glossosoma	1	0	1
Diplectrona modesta	3	0	3
Coleoptera			
Optioservus	15	0	15
Psephenus herricki	8	0	8
Stenelmis	1	0	1
Anchytarsus bicolor	1	0	1
Column 1 total	110	1	111

Taxon	Number	Ck.no.[a]	Total no.[b]
Odonata			
Stylogomphus albistylus	1	0	1
Diptera			
Orthocladiinae	6	1	7
Tanypodinae	7	1	8
Chironomini	9	0	9
Simulium	1	0	1
Antocha	2	0	2
Chironomidae (pupae)	1	0	1
Other Taxa			
Oligochaeta	18 ~~22~~	8 ~~8~~	26
Ephemia	38	0	38
Gammarus	112	0	112
Sialis	2	0	2
Lirceus	2	0	2
Turbellaria	1	0	1
	200		
Column 2 total	~~204~~	10	210
Total sample number	310	11	321

[a]Number of organisms in QA check vial.

[b]Total number of organisms corrected for number in check vial. This number is derived by multiplying the check vial number (Ck. no.) by the proportion of pans checked during sorting QA, and then adding to number (no.).

Entered Date: 8/16/2023 Entered By: WSW

Checked Date: 2/21/2024 Checked By: BH

BENTHIC MACROINVERTEBRATE LABORATORY BENCH SHEET (BACK)

Site Name:	Rep No.:	Date:
FCK 0.8	1	4/17/2023

Total Number of Organisms	321	Total Number of Taxa	30

Proportion of Pans Checked 3 1/2 W

QC / Sorting:

Checked by: WSW Date: 8/11/2023

Sorting efficiency

(Sorting efficiency = Number in check vial (Ck. No.)) Number originally sorted (No.) H 100)

94%

(∃90% Sample passes or < 90% sample fails)

Action taken:

QC / Taxonomy:

Checked by: _____ Date: _____

Original identification	Verification identification

Subsampled?	Yes _____ No X	Explain:

General comments:

BENTHIC MACROINVERTEBRATE LABORATORY BENCH SHEET (FRONT)

Page 1 of 1

Project Name: ORNL BMAP	Sorted by: RM	Date Started: 8/14/2023	Date Finished: 8/14/2023 Hours: 4
Stream Name: First Creek	Taxonomist: WSW	Date Started: 8/16/2023	Date Finished: 8/21/2023 Hours: 6
Site Name: FCK0.8 Rep No.: 2 Date: 4/17/2023	Chain-of-Custody Number: FC08-0423-2		Number of Containers: 1 Vial

Taxon	Number	Ck. no.[a]	Total no.[b]
Ephemeroptera			
Habrophlebiodes	2	3	5
Acentrella	15	1	16
Baetis	21	0	21
Ephemerella	7	0	7
Diphetor	2	0	2
Plecoptera			
Tallaperla	44	2	46
Perlesta	0	1	1
Leuctra	8	0	8
Trichoptera			
Rhyacophila	1	0	1
Cheumatopsyche	4	0	4
Lepidostoma	1	0	1
Polycentropus	1	0	1
Coleoptera			
Optioservus	15	1	16
Psephenus herricki	6	0	6
Stenelmis	2	0	2
Microcylloepus	1	0	1
Ectopria	3	0	3
Column 1 total	133	8	141

Taxon	Number	Ck.no.[a]	Total no.[b]
Odonata			
Diptera			
Simulium	9	2	11
Orthocladiinae	6	2	8
Tanypodinae	9	0	9
Chironomini	18	1	19
Tanytarsini	3	0	3
Chironomidae (pupae)	3	0	3
Pseudolimnophila	1	0	1
Antocha	1	0	1
Other Taxa			
Oligochaeta	9	3	12
Turbellaria	0	1	1
Gammarus	217	1	218
Elimia	52	0	52
Nigronia serricornis	1	0	1
Nemertea	1	0	1
Column 2 total	330	10	340
Total sample number	463	18	481

[a]Number of organisms in QA check vial.

[b]Total number of organisms corrected for number in check vial. This number is derived by multiplying the check vial number (Ck. no.) by the proportion of pans checked during sorting QA, and then adding to number (no.).

Entered Date: 8/21/2023 Entered By: WSW
Checked Date: 2/21/2024 Checked By: BH

BENTHIC MACROINVERTEBRATE LABORATORY BENCH SHEET (BACK)

Site Name:	Rep No.:	Date:
FCK0.8	2	4/17/2023

Total Number of Organisms	481	Total Number of Taxa	31

Proportion of Pans Checked 3Y/2W

QC / Sorting:

Checked by: WSW Date: 8/14/2023

Sorting efficiency

(Sorting efficiency = Number in check vial (Ck. No.)) Number originally sorted (No.) H 100)

94%

(∃90% Sample passes or < 90% sample fails)

Action taken:

QC / Taxonomy:

Checked by: _____ Date: _____

Original identification	Verification identification

Subsampled?	Yes ____ No X	Explain:

General comments:

BENTHIC MACROINVERTEBRATE LABORATORY BENCH SHEET (FRONT)

Page 1 of 1

Project Name:	Sorted by:	Date Started:	Date Finished:	Hours:
ORWL BMAP	BH	8/14/2023	8/16/2023	8
Stream Name:	**Taxonomist:**	**Date Started:**	**Date Finished:**	**Hours:**
First Creek	WSW	12/19/2023	12/21/2023	10
Site Name: / **Rep No.:** / **Date:**	**Chain-of-Custody Number:**		**Number of Containers:**	
FCK0.8 / 3 / 4/17/2023	FC08-0423-3		1 Vial	

Taxon	Number	Ck. no.[a]	Total no.[b]
Ephemeroptera			
Habrophlebiodes	9	1	10
Acentrella	1	1	2
Eurylophella	4	0	4
Baetis	22	0	22
Plauditus	18	0	18
Maccaffertium	1	0	1
Diphetor	2	0	2
Plecoptera			
Leuctra	12	2	14
Tallaperla	41	0	41
Isoperla	1	0	1
Trichoptera			
Rhyacophila	0	1	1
Cheumatopsyche	17	0	17
Diplectrona modesta	9	0	9
Polycentropus	8	0	8
Coleoptera			
Optioservus	33	0	33
Psephenus herricki	9	0	9
Stenelmis	4	0	4
Column 1 total	191	5	196

Taxon	Number	Ck.no.[a]	Total no.[b]
Odonata			
Stylogomphus albistylus	4	0	4
Diptera			
Simulium	12	3	15
Chironomidae (pupae)	1	1	2
Orthocladiinae	10	3	13
Tanypodinae	4	3	7
Chironomini	37	0	37
Other Taxa			
Oligochaeta	8	10	18
Gammarus	264	0	264
Elimia	48	0	48
Nigronia serricornis	2	0	2
Lyrceus	2	0	2
Column 2 total	392	20	412
Total sample number	583	25	608

[a]Number of organisms in QA check vial.

[b]Total number of organisms corrected for number in check vial. This number is derived by multiplying the check vial number (Ck. no.) by the proportion of pans checked during sorting QA, and then adding to number (no.).

Entered Date: 1/3/2024 Entered By: WSW

Checked Date: 2/21/2024 Checked By: BH

BENTHIC MACROINVERTEBRATE LABORATORY BENCH SHEET (BACK)

Site Name:	Rep No.:	Date:
FCK0.8	3	4/17/2023

Total Number of Organisms 608	Total Number of Taxa 28

Proportion of Pans Checked 5Y/6N

QC / Sorting:

Checked by: WSW Date: 8/16/2023

Sorting efficiency

(Sorting efficiency = Number in check vial (Ck. No.)) Number originally sorted (No.) H 100)

96 %

(∃90% Sample passes or < 90% sample fails)

Action taken:

QC / Taxonomy:

Checked by: _____ Date: _____

Original identification	Verification identification

Subsampled?	Explain:
Yes ____	
No X	

General comments:

BENTHIC MACROINVERTEBRATE LABORATORY BENCH SHEET (FRONT)

Page 1 of 1

Project Name:	Sorted by:	Date Started:	Date Finished:	Hours:
OKWL BMAP	RM	9/7/2023	9/7/2023	4
Stream Name:	**Taxonomist:**	**Date Started:**	**Date Finished:**	**Hours:**
Fifth Creek	WSW	1/19/2024	1/22/2024	5
Site Name: / **Rep No.:** / **Date:**	**Chain-of-Custody Number:**		**Number of Containers:**	
FFK 0.2 / 1 / 4/17/2023	FF02-0423-1		1 Vial	

Taxon	Number	Ck. no.[a]	Total no.[b]
Ephemeroptera			
Baetis	7	2	9
Stenacron	7	0	7
Ephemerella	3	0	3
Plauditus	1	0	1
Plecoptera			
Trichoptera			
Cheumatopsyche	36	0	36
Diplectrona modesta	3	0	3
Lype diversa	1	0	1
Glossosoma	1	0	1
Polycentropus	1	0	1
Coleoptera			
Stenelmis	5	1	6
Optioservus	41	0	41
Column 1 total	106	3	109

Taxon	Number	Ck.no.[a]	Total no.[b]
Odonata			
Diptera			
Chironomidae (pupae)	2	1	3
Orthocladiinae	49	2	51
Tanytarsini	1	0	1
Dicranota	1	0	1
Antocha	1	0	1
Other Taxa			
Oligochaeta	22	0	22
Limnius	127	0	127
Cambarus	1	0	1
Column 2 total	204	3	207
Total sample number	310	6	316

[a]Number of organisms in QA check vial.

[b]Total number of organisms corrected for number in check vial. This number is derived by multiplying the check vial number (Ck. no.) by the proportion of pans checked during sorting QA, and then adding to number (no.).

Entered Date: 1/22/2024 Entered By: WSW

Checked Date: 2/21/2024 Checked By: BH

BENTHIC MACROINVERTEBRATE LABORATORY BENCH SHEET (BACK)

Site Name:	Rep No.:	Date:
FFK0.2	1	4/17/2023

Total Number of Organisms 316	Total Number of Taxa 19

Proportion of Pans Checked 3Y/2N

QC / Sorting:

Checked by: WSW Date: 9/7/2023

Sorting efficiency

(Sorting efficiency = Number in check vial (Ck. No.)) Number originally sorted (No.) H 100)

96%

(∃90% Sample passes or < 90% sample fails)

Action taken:

QC / Taxonomy:

Checked by: _____ Date: _____

Original identification	Verification identification

Subsampled?	Explain:
Yes _____ No X	

General comments:

BENTHIC MACROINVERTEBRATE LABORATORY BENCH SHEET (FRONT)

Page 1 of 1

Project Name: ORNL BMAP	Sorted by: RM	Date Started: 12/6/2023	Date Finished: 12/6/2023 Hours: 3
Stream Name: Fifth Creek	Taxonomist: WSW	Date Started: 1/22/2024	Date Finished: 1/23/2024 Hours: 3
Site Name: ~~FFK0.2~~ FFK 0.2 Rep No.: 2 Date: 4/17/2023	Chain-of-Custody Number: FF02-0423-2		Number of Containers: 1 Vial

Taxon	Number	Ck. no.[a]	Total no.[b]
Ephemeroptera			
Stenacron	7	1	8
Ephemerella	2	0	2
Eurylophella	1	0	1
Plecoptera			
Trichoptera			
Cheumatopsyche	1	0	1
Coleoptera			
Optioservus	19	1	20
Stenelmis	1	0	1
Column 1 total	31	2	33

Taxon	Number	Ck.no.[a]	Total no.[b]
Odonata			
Diptera			
Antocha	1	0	1
Orthocladiinae	20	3	23
Chironomini	50	0	50
Tanytarsini	8	0	8
Other Taxa			
Oligochaeta	13	1	14
Hirudinea	63	0	63
Gammarus	1	0	1
Branchiura sowerbyi	3	0	3
Column 2 total	159	4	163
Total sample number	190	6	196

[a]Number of organisms in QA check vial.

[b]Total number of organisms corrected for number in check vial. This number is derived by multiplying the check vial number (Ck. no.) by the proportion of pans checked during sorting QA, and then adding to number (no.).

Entered Date: 1/23/2024 Entered By: WSW

Checked Date: 2/21/2024 Checked By: BH

BENTHIC MACROINVERTEBRATE LABORATORY BENCH SHEET (BACK)

Site Name:	Rep No.:	Date:
FFK 0.2	2	4/17/2023

Total Number of Organisms 196	Total Number of Taxa 14

Proportion of Pans Checked 5X/4W

QC / Sorting:

Checked by: WSW Date: 12/6/2023

Sorting efficiency

(Sorting efficiency = Number in check vial (Ck. No.)) Number originally sorted (No.) H 100)

94%

(∃90% Sample passes or < 90% sample fails)

Action taken:

QC / Taxonomy:

Checked by: _____ Date: _____

Original identification	Verification identification

Subsampled?	Explain:
Yes _____ No X	

General comments:

BENTHIC MACROINVERTEBRATE LABORATORY BENCH SHEET (FRONT)

Page 1 of 1

Project Name:	Sorted by:	Date Started:	Date Finished:	Hours:
ORNL BMAP	RM	12/7/2023	12/7/2023	4
Stream Name:	**Taxonomist:**	**Date Started:**	**Date Finished:**	**Hours:**
Fifth Creek	WSW	1/23/2024	1/25/2024	8
Site Name: / **Rep No.:** / **Date:**	**Chain-of-Custody Number:**		**Number of Containers:**	
FFK 0.2 / 3 / 4/17/2023	FF02-0423-3		1 Vial	

Taxon	Number	Ck. no.[a]	Total no.[b]
Ephemeroptera			
Baetis	41	0	41
Ephemerella	6	0	6
Stenacron	6	0	6
Plauditus	5	0	5
Plecoptera			
Leuctra	1	0	1
Trichoptera			
Glossosoma	0	1	1
Cheumatopsyche	48	0	48
Rhyacophila	1	0	1
Chimarra	1	0	1
Coleoptera			
Optioservus	83	0	83
Stenelmis	5	0	5
Column 1 total	197	1	198

Taxon	Number	Ck.no.[a]	Total no.[b]
Odonata			
Diptera			
Orthocladiinae	167	5	172
Chironomini	5	0	5
Chironomidae (pupae)	7	0	7
Antocha	2	0	2
Hemerodromia	1	0	1
Other Taxa			
Lirceus	90	0	90
Oligochaeta	16	0	16
Nemertea	1	0	1
Nematoda	1	0	1
Nigronia fasciatus	1	0	1
Cambaridae	1	0	1
Column 2 total	292	5	297
Total sample number	489	6	495

[a]Number of organisms in QA check vial.

[b]Total number of organisms corrected for number in check vial. This number is derived by multiplying the check vial number (Ck. no.) by the proportion of pans checked during sorting QA, and then adding to number (no.).

Entered Date: 1/25/2024 Entered By: BH

Checked Date: 2/21/2024 Checked By: BH

BENTHIC MACROINVERTEBRATE LABORATORY BENCH SHEET (BACK)

Site Name:	Rep No.:	Date:
EFK0.2	3	4/17/2023

Total Number of Organisms 495	Total Number of Taxa _____

Proportion of Pans Checked 4Y/3N

QC / Sorting:

Checked by: WSW Date: 12/7/2023

Sorting efficiency

(Sorting efficiency = Number in check vial (Ck. No.)) Number originally sorted (No.) H 100)

_____

(∃90% Sample passes or < 90% sample fails)

Action taken:

QC / Taxonomy:

Checked by: _____ Date: _____

Original identification	Verification identification

Subsampled?	Yes_____ No X	Explain:

General comments:

BENTHIC MACROINVERTEBRATE LABORATORY BENCH SHEET (FRONT)

Page 1 of 1

Project Name:	Sorted by:	Date Started:	Date Finished:	Hours:
ORNL BMAP	RM	8/15/2023	8/15/2023	4
Stream Name:	**Taxonomist:**	**Date Started:**	**Date Finished:**	**Hours:**
Fifth Creek	WSW	12/21/2023	1/5/2024	8
Site Name: / **Rep No.:** / **Date:**	**Chain-of-Custody Number:**		**Number of Containers:**	
FFK 1.0 / 1 / 4/17/2023	FF10-0423-1		1 Vial	

Taxon	Number	Ck. no.[a]	Total no.[b]
Ephemeroptera			
Plauditus	4	3	7
Ephemerella	27	0	27
Baetis	16	0	16
Habrophlebiodes	17	0	17
Acentrella	1	0	1
Diphetor	15	0	15
Acerpenna	1	0	1
Eurylophella	1	0	1
Plecoptera			
Leuctra	142	6	148
Tallaperla	6	1	7
Perlesta	4	0	4
Amphinemura	3	0	3
Trichoptera			
Polycentropus	10	0	10
Agapetus	2	0	2
Ochrotrichia	7	0	7
Cheumatopsyche	5	0	5
Neophylax	1	0	1
Rhyacophila	2	0	2
Diplectrona modesta	13	0	13
Coleoptera			
Anchytarsus	22	0	22
Optioservus	10	0	10
Ectopria	1	0	1
Stenelmis	2	0	2
Column 1 total	312	10	322

Taxon	Number	Ck.no.[a]	Total no.[b]
Odonata			
Diptera			
Simulium	17	1	18
Orthocladinae	25	2	27
Tanypodinae	15	1	16
Chironomini	1	1	2
Tanytarsini	31	1	32
Tipula	1	0	1
Chironomidae (pupae)	5	0	5
Pseudolimnophila	2	0	2
Other Taxa			
Lirceus	93	4	97
Hydrachnidia	0	1	1
Oligochaeta	3	0	3
Sialis	1	0	1
Column 2 total	194	11	205
Total sample number	506	21	527

[a]Number of organisms in QA check vial.

[b]Total number of organisms corrected for number in check vial. This number is derived by multiplying the check vial number (Ck. no.) by the proportion of pans checked during sorting QA, and then adding to number (no.).

Entered Date: 1/8/2024 Entered By: WSW
Checked Date: 2/21/2024 Checked By: BH

BENTHIC MACROINVERTEBRATE LABORATORY BENCH SHEET (BACK)

Site Name:	Rep No.:	Date:
EFK1-O	1	4/17/2023

Total Number of Organisms 527	Total Number of Taxa 35

Proportion of Pans Checked 3Y/3N

QC / Sorting:

Checked by: WSW Date: 8/15/2023

Sorting efficiency

(Sorting efficiency = Number in check vial (Ck. No.)) Number originally sorted (No.) H 100)

92%

(∃90% Sample passes or < 90% sample fails)

Action taken:

QC / Taxonomy:

Checked by: _____ Date: _____

Original identification	Verification identification

Subsampled?	Explain:
Yes _____ No X	

General comments:

BENTHIC MACROINVERTEBRATE LABORATORY BENCH SHEET (FRONT)

Page 1 of 1

Project Name:			Sorted by:	Date Started:	Date Finished:	Hours:
ORNL BMAP			RM	8/16/2024	8/16/2024	4
Stream Name:			**Taxonomist:**	**Date Started:**	**Date Finished:**	**Hours:**
Fifth Creek			WSW	1/9/2024	1/18/2024	10
Site Name:	**Rep No.:**	**Date:**	**Chain-of-Custody Number:**		**Number of Containers:**	
FFK 1.0	2	4/17/2023	FF10-0423-2		1 Vial	

Taxon	Number	Ck. no.[a]	Total no.[b]
Ephemeroptera			
Ephemerella	32	0	32
Hybrophlebiodes	18	0	18
Baetis	31	0	31
Diphetor	20	0	20
Plecoptera			
Tallaperla	10	0	10
Amphinemura	3	0	3
Eccoptura xanthenes	6	0	6
Leuctra	171	0	171
Trichoptera			
Neophylax	12	0	12
Polycentropus	11	0	11
Agapetus	1	0	1
Dolophilodes modesta	29	0	29
Ochrotrichia	10	0	10
Cheumatopsyche	13	0	13
Hydroptila	1	0	1
Goera	1	0	1
Coleoptera			
Optioservus	7	0	7
Anchytarsus bicolor	4	0	4
Column 1 total	380	0	380

Taxon	Number	Ck.no.[a]	Total no.[b]
Odonata			
Diptera			
Tipula	1	0	1
Orthocladiinae	78	0	78
Tanypodinae	14	0	14
Chironomini	10	0	10
Tanytarsini	30	0	30
Chironomidae (pupae)	9	0	9
Simulium	15	0	15
Pseudolimnophila	1	0	1
Antocha	1	0	1
Other Taxa			
Lirceus	77	1	78
Oligochaeta	4	0	4
Hydrachnidia	3	0	3
Ferrissia	2	0	2
Turbellaria	2	0	2
Column 2 total	247	1	248
Total sample number	627	1	628

[a]Number of organisms in QA check vial.

[b]Total number of organisms corrected for number in check vial. This number is derived by multiplying the check vial number (Ck. no.) by the proportion of pans checked during sorting QA, and then adding to number (no.).

Entered Date: 1/18/2024 Entered By: BH

Checked Date: 2/21/2024 Checked By: BH

BENTHIC MACROINVERTEBRATE LABORATORY BENCH SHEET (BACK)

Site Name:	Rep No.:	Date:
FFK 1.0	2	4/17/2023

Total Number of Organisms 628	Total Number of Taxa 32

Proportion of Pans Checked 5Y/2W

QC / Sorting:

Checked by: WSW Date: 8/16/2024

Sorting efficiency

(Sorting efficiency = Number in check vial (Ck. No.)) Number originally sorted (No.) H 100)

99 %

(∃90% Sample passes or < 90% sample fails)

Action taken:

QC / Taxonomy:

Checked by: _____ Date: _____

Original identification	Verification identification

Subsampled?	Explain:
Yes _____ No X	

General comments:

BENTHIC MACROINVERTEBRATE LABORATORY BENCH SHEET (FRONT)

Page 1 of 1

Project Name:	Sorted by:	Date Started:	Date Finished:	Hours:
ORNL BMAP	RM BH	8/10/2023	8/17/2023	6
Stream Name:	**Taxonomist:**	**Date Started:**	**Date Finished:**	**Hours:**
Fifth Creek	WSW	1/8/2024	1/9/2024	9
Site Name: / **Rep No.:** / **Date:**	**Chain-of-Custody Number:**		**Number of Containers:**	
FFK 1.0 / 3 / 4/17/2023	FF10-0423-3		1 Vial	

Taxon	Number	Ck. no.[a]	Total no.[b]
Ephemeroptera			
Baetis	19	2	21
Ephemerella	32	0	32
Plauditus	10	0	10
Habrophlebiodes	5	0	5
Diphetor	2	0	2
Plecoptera			
Leuctra	172	6	178
Perlesta	14	0	14
Tallaperla	25	0	25
Amphinemura	8	0	8
Trichoptera			
Agapetus	11	1	12
Hydropsyche	7	0	7
Diplectrona modesta	7	0	7
Cheumatopsyche	5	0	5
Rhyacophila	1	0	1
Ochrotrichia	3	0	3
Glossosoma	3	0	3
Coleoptera			
Optioservus	92	2	94
Ectopria	2	0	2
Column 1 total	418	11	429

Taxon	Number	Ck.no.[a]	Total no.[b]
Odonata			
Diptera			
Hexatoma	0	1	1
Simulium	32	6	38
Orthocladdinae	21	2	23
Tanypodinae	19	0	19
Chironomini	1	0	1
Tanytarsini	14	2	16
Antocha	3	0	3
Chironomidae (pupae)	2	0	2
Other Taxa			
Lirceus	40	5	45
Oligochaeta	34	4	38
Turbellaria	1	3	4
Nematoda	1	0	1
Nemertea	2	0	2
Ferrissia	1	0	1
Hydrachnidia	1	0	1
Column 2 total	172	23	195
Total sample number	~~588~~ 590	34	~~622~~ 624

[a]Number of organisms in QA check vial.

[b]Total number of organisms corrected for number in check vial. This number is derived by multiplying the check vial number (Ck. no.) by the proportion of pans checked during sorting QA, and then adding to number (no.).

Entered Date: 1/9/2024 Entered By: WSW

Checked Date: 2/21/2024 Checked By: BH

BENTHIC MACROINVERTEBRATE LABORATORY BENCH SHEET (BACK)

Site Name: FFK 1.0	Rep No.: 3	Date: 4/17/2023
Total Number of Organisms 622		Total Number of Taxa 33
Proportion of Pans Checked 4X/0W		

QC / Sorting:

Checked by: RM Date: 8/17/2024

Sorting efficiency

(Sorting efficiency = Number in check vial (Ck. No.)) Number originally sorted (No.) H 100)

94%

(∃90% Sample passes or < 90% sample fails)

Action taken:

QC / Taxonomy:

Checked by: _____ Date: _____

Original identification	Verification identification

Subsampled?	Explain:
Yes _____ No X	

General comments:

BENTHIC MACROINVERTEBRATE LABORATORY BENCH SHEET (FRONT)

Page 1 of 1

Project Name: ORNL BMAP	Sorted by: BH	Date Started: 8/28/2023	Date Finished: 8/29/2023 Hours: 7
Stream Name: Walker Branch	Taxonomist: WSW	Date Started: 2/12/2024	Date Finished: 2/13/2024 Hours: 14
Site Name: WBK1.0 Rep No.: 1 Date: 4/17/2023	Chain-of-Custody Number: WB10-0423-1		Number of Containers: 1 Vial

Taxon	Number	Ck. no.[a]	Total no.[b]
Ephemeroptera			
Baetis	13	0	13
Plauditus	64	0	64
Habrophlebiodes	6	0	6
Stenonema	2	0	2
Plecoptera			
Leuctra	357	2	359
Tallaperla	9	0	9
Haploperla	5	0	5
Amphinemura	1	0	1
Eccoptura xanthenes	1	0	1
Trichoptera			
Diplectrona modesta	8	0	8
Neophylax	1	0	1
Brachycentrus	5	0	5
Polycentropus	3	0	3
Wormaldia	3	0	3
Rhyacophila	7	0	7
Lype diversa	1	0	1
Ochrotrichia	1	0	1
Coleoptera			
Optioservus	23	1	24
Anchytarsus bicolor	3	0	3
Psephenus herricki	1	0	1
Oulimnius latiusculus	9	0	9
Ectopria	1	0	1
Stenelmis	1	0	1
Column 1 total	525	3	528

Taxon	Number	Ck.no.[a]	Total no.[b]
Odonata			
Stylogomphus albistylus	2	0	2
Diptera			
Simulium	43	1	44
Chironomidae (pupae)	1	0	1
Dixa	3	0	3
Ceratopogonidae	1	0	1
Chelifera	2	0	2
Orthocladiinae	53	1	54
Tanypodinae	18	0	18
Chironomini	32	0	32
Tanytarsini	16	0	16
Other Taxa			
Oligochaeta	8	0	8
Gammarus	293	0	293
Elimia	17	0	17
Column 2 total	489	2	491
Total sample number	1014	5	1019

[a]Number of organisms in QA check vial.

[b]Total number of organisms corrected for number in check vial. This number is derived by multiplying the check vial number (Ck. no.) by the proportion of pans checked during sorting QA, and then adding to number (no.).

Entered Date: 2/14/2024 Entered By: BH
Checked Date: 2/21/2024 Checked By: BH

BENTHIC MACROINVERTEBRATE LABORATORY BENCH SHEET (BACK)

Site Name:	Rep No.:	Date:
WBK1.0	1	4/17/2023

Total Number of Organisms 1019 | Total Number of Taxa 36

Proportion of Pans Checked 3Y/2N

QC / Sorting:

Checked by: WSW Date: 8/29/2023

Sorting efficiency

(Sorting efficiency = Number in check vial (Ck. No.)) Number originally sorted (No.) H 100)

99%

(∃90% Sample passes or < 90% sample fails)

Action taken:

QC / Taxonomy:

Checked by: _____ Date: _____

Original identification	Verification identification

Subsampled? Yes_____ No X

Explain:

General comments:

BENTHIC MACROINVERTEBRATE LABORATORY BENCH SHEET (FRONT)

Page 1 of 1

Project Name: ORNL BMAP	Sorted by: BH	Date Started: 8/30/2023	Date Finished: 8/30/2023	Hours: ~~2.5~~
Stream Name: Walker Branch	Taxonomist: WSW	Date Started: 2/13/2024	Date Finished: 2/13/2024	Hours: 6
Site Name: WBK 1.0 / Rep No.: 2 / Date: 4/17/2023	Chain-of-Custody Number: WB10-0423-2		Number of Containers: 1 Vial	

Taxon	Number	Ck. no.[a]	Total no.[b]
Ephemeroptera			
Hybrophlebiodes	4	0	4
Baetis	2	0	2
Habrophlebia vibrans	1	0	1
Plauditus	6	0	6
Plecoptera			
Tallaperla	26	1	27
Leuctra	123	1	124
Haploperla	2	0	2
Amphinemura	1	0	1
Trichoptera			
Brachycentrus	2	0	2
Rhyacophila	2	0	2
Diplectrona modesta	2	0	2
Polycentropus	4	0	4
Lype diversa	1	0	1
Wormaldia	1	0	1
Agapetus	1	0	1
Coleoptera			
Anchytarsus bicolor	2	0	2
Oulimnius latiusculus	3	0	3
Optioservus	12	0	12
Psephenus herricki	1	0	1
Column 1 total	196	2	198

Taxon	Number	Ck.no.[a]	Total no.[b]
Odonata			
Stylogomphus albistylus	1	0	1
Diptera			
Orthocladiinae	8	0	8
Tanypodinae	15	0	15
Chironomini	7	0	7
Tanytarsini	11	1	12
Simulium	8	0	8
Hemerodromia	1	0	1
Chironomidae pupae	1	0	1
Other Taxa			
Gammarus	57	1	58
Elimia	17	0	17
Cambaridae	2	0	2
Column 2 total	128	2	130
Total sample number	324	4	328

[a]Number of organisms in QA check vial.

[b]Total number of organisms corrected for number in check vial. This number is derived by multiplying the check vial number (Ck. no.) by the proportion of pans checked during sorting QA, and then adding to number (no.).

Entered Date: 2/14/2024 Entered By: BH
Checked Date: 2/21/2024 Checked By: BH

BENTHIC MACROINVERTEBRATE LABORATORY BENCH SHEET (BACK)

Site Name: WBK 1.0	Rep No.: 2	Date: 4/17/2023
Total Number of Organisms 328		Total Number of Taxa 30
Proportion of Pans Checked 1Y/1N		

QC / Sorting:

Checked by: WSW Date: 8/30/2023

Sorting efficiency

(Sorting efficiency = Number in check vial (Ck. No.)) Number originally sorted (No.) H 100)

97 %

(∃90% Sample passes or < 90% sample fails)

Action taken:

QC / Taxonomy:

Checked by: _____ Date: _____

Original identification	Verification identification

Subsampled?	Explain:
Yes _____	
No X	

General comments:

BENTHIC MACROINVERTEBRATE LABORATORY BENCH SHEET (FRONT)

Page 1 of 1

Project Name:	Sorted by:	Date Started:	Date Finished:	Hours:
ORNL BMAP	BH	8/30/2023	9/1/2023	~~X~~ 5
Stream Name:	**Taxonomist:**	**Date Started:**	**Date Finished:**	**Hours:**
Walker Branch	WSW	2/14/2024	2/14/2024	9
Site Name: / **Rep No.:** / **Date:**	**Chain-of-Custody Number:**		**Number of Containers:**	
WBK 1.0 / 3 / 4/17/2023	WB10-0423-3		1 Vial	

Taxon	Number	Ck. no.[a]	Total no.[b]
Ephemeroptera			
Baetis	23	0	23
Plauditus	47	0	47
Ephemerella	4	0	4
Habrophlebiodes	3	0	3
Plecoptera			
Leuctra	104	3	107
Tallaperla	196	1	197
Amphinemura	2	0	2
Trichoptera			
Brachycentrus	11	0	11
Diplectrona modesta	7	0	7
Polycentropus	2	0	2
Ochrotrichia	3	0	3
Coleoptera			
Optioservus	25	1	26
Anchytarsus bicolor	1	0	1
Oulimnius latiusculus	8	0	8
Ectopria	4	0	4
Psephenus herricki	5	0	5
Column 1 total	445	5	450

Taxon	Number	Ck.no.[a]	Total no.[b]
Odonata			
Stylogomphus albistylus	2	0	2
Diptera			
Chironomidae (pupae)	9	1	10
Simulium	14	0	14
Orthocladiinae	8	0	8
Tanypodinae	9	0	9
Chironomini	15	0	15
Tanytarsini	68	4	72
Dixella	1	0	1
Other Taxa			
Elimia	32	1	33
Oligochaeta	5	0	5
Gammarus	140	0	140
Nemertea	1	0	1
Turbellaria	1	0	1
Column 2 total	305	6	311
Total sample number	750	11	761

[a]Number of organisms in QA check vial.

[b]Total number of organisms corrected for number in check vial. This number is derived by multiplying the check vial number (Ck. no.) by the proportion of pans checked during sorting QA, and then adding to number (no.).

Entered Date: 2/14/2024 Entered By: BH

Checked Date: 2/21/2024 Checked By: BH

BENTHIC MACROINVERTEBRATE LABORATORY BENCH SHEET (BACK)

Site Name: WBK 1.0	Rep No.: 3	Date: 4/17/2023
Total Number of Organisms 761		Total Number of Taxa 29
Proportion of Pans Checked 3Y / 3N		

QC / Sorting:

Checked by: WSW Date: 9/1/2023

Sorting efficiency

(Sorting efficiency = Number in check vial (Ck. No.)) Number originally sorted (No.) H 100)

97%

(∃90% Sample passes or < 90% sample fails)

Action taken:

QC / Taxonomy:

Checked by: _____ Date: _____

Original identification	Verification identification

Subsampled?	Explain:
Yes _____ No X	

General comments:

BENTHIC MACROINVERTEBRATE LABORATORY BENCH SHEET (FRONT)

Page 1 of 1

Project Name:	Sorted by:	Date Started:	Date Finished:	Hours:
ORNL	RM	12/11/2023	12/11/2023	5
Stream Name:	**Taxonomist:**	**Date Started:**	**Date Finished:**	**Hours:**
White Oak Creek	WSW	2/14/2024	2/20/2024	14
Site Name: / **Rep No.:** / **Date:**	**Chain-of-Custody Number:**		**Number of Containers:**	
WCK2.3 / 1 / 4/17/2023	WC23-0423-1		1 Vial	

Taxon	Number	Ck. no.[a]	Total no.[b]
Ephemeroptera			
Baetis	33	2	35
Caenis	54	4	58
Maccaffertium	5	0	5
Eurylophella	1	0	1
Habrophlebia vibrans	1	0	1
Plecoptera			
Amphinemura	7	0	7
Perlesta	1	0	1
Allocapnia	4	0	4
Isoperla	1	0	1
Taeniopteryx	1	0	1
Trichoptera			
Cheumatopsyche	1	0	1
Coleoptera			
Stenelmis	38	2	40
Optioservus	34	1	35
Psephenus herricki	6	0	6
Dubiraphia	3	0	3
Column 1 total	190	9	199

Taxon	Number	Ck.no.[a]	Total no.[b]
Odonata			
Diptera			
Chironomidae (pupae)	34	3	37
Orthocladiinae	472	34	506
Tanypodinae	2	0	2
Chironomini	56	4	60
Tanytarsini	213	15	228
Ceratopogonidae	2	0	2
Hemerodromia	1	0	1
Other Taxa			
Nematoda	8	4	12
Oligochaeta	8	1	9
Branchiura sowerbyi	1	0	1
Nemertea	1	0	1
Lirceus	5	0	5
Physella	1	0	1
Hydrachnidia	2	0	2
Column 2 total	806	61	867
Total sample number	996	70	1066

[a]Number of organisms in QA check vial.

[b]Total number of organisms corrected for number in check vial. This number is derived by multiplying the check vial number (Ck. no.) by the proportion of pans checked during sorting QA, and then adding to number (no.).

Entered Date: 2/20/2024 Entered By: WSW

Checked Date: 2/21/2024 Checked By: BH

BENTHIC MACROINVERTEBRATE LABORATORY BENCH SHEET (BACK)

Site Name: WCK 2.3	Rep No.: 1	Date: 4/17/2023
Total Number of Organisms 1066		Total Number of Taxa 29
Proportion of Pans Checked 3Y/2N		

QC / Sorting:

Checked by: WSW Date: 12/11/2023

Sorting efficiency

(Sorting efficiency = Number in check vial (Ck. No.)) Number originally sorted (No.) H 100)

90%

(∃90% Sample passes or < 90% sample fails)

Action taken:

QC / Taxonomy:

Checked by: _____ Date: _____

Original identification	Verification identification

Subsampled?	Explain:
Yes _____ No X	

General comments:

BENTHIC MACROINVERTEBRATE LABORATORY BENCH SHEET (FRONT)

Page 1 of 1

Project Name:	Sorted by:	Date Started:	Date Finished:	Hours:
ORNL BMAP	RM	12/12/2023	12/13/2023	6
Stream Name:	**Taxonomist:**	**Date Started:**	**Date Finished:**	**Hours:**
White Oak Creek	WSW	2/20/2024	2/21/2023	10
Site Name: / **Rep No.:** / **Date:**	**Chain-of-Custody Number:**		**Number of Containers:**	
WCK 2-3 / 2 / 04/17/2023	WC23-0423-2		1 Vial	

Taxon	Number	Ck. no.[a]	Total no.[b]
Ephemeroptera			
Caenis	90	1	91
Baetis	8	0	8
Stenacron	1	0	1
Eurylophella	5	0	5
Habrophlebiodes	1	0	1
Maccaffertium	4	0	4
Paraleptophlebia	2	0	2
Plecoptera			
Perlesta	1	0	1
Amphinemura	1	0	1
Trichoptera			
Cheumatopsyche	1	0	1
Coleoptera			
Stenelmis	8	0	8
Optioservus	2	0	2
Rubiyaphia	4	0	4
Column 1 total	128	1	129

Taxon	Number	Ck.no.[a]	Total no.[b]
Odonata			
Diptera			
Chironomidae (pupae)	25	3	28
Tipula	1	0	1
Orthocladiinae	239	16	255
Tanypodinae	3	2	5
Chironomini	44	1	45
Tanytarsini	196	22	218
Hemerodromia	3	0	3
Ceratopogonidae	1	0	1
Other Taxa			
Nemertea	0	1	1
Nigronia serricornis	2	0	2
Lirceus	4	0	4
Oligochaeta	8	0	8
Corbicula fluminea	3	0	3
Physella	3	0	3
Column 2 total	532	45	577
Total sample number	660	46	706

[a]Number of organisms in QA check vial.

[b]Total number of organisms corrected for number in check vial. This number is derived by multiplying the check vial number (Ck. no.) by the proportion of pans checked during sorting QA, and then adding to number (no.).

Entered Date: 2-21-24 Entered By: Brandon Hambrick

Checked Date: 2-21-24 Checked By: Brandon Hambrick

BENTHIC MACROINVERTEBRATE LABORATORY BENCH SHEET (BACK)

Site Name:	Rep No.:	Date:
WCK2.3	2	4/17/2023

Total Number of Organisms 706 | **Total Number of Taxa** 27

Proportion of Pans Checked 2Y/1N

QC / Sorting:

Checked by: WSU Date: 12/13/2023

Sorting efficiency

(Sorting efficiency = Number in check vial (Ck. No.)) Number originally sorted (No.) H 100)

91%

(∃90% Sample passes or < 90% sample fails)

Action taken:

QC / Taxonomy:

Checked by: _____ Date: _____

Original identification	Verification identification

Subsampled? Yes_____ No X

Explain:

General comments:

BENTHIC MACROINVERTEBRATE LABORATORY BENCH SHEET (FRONT)

Page 1 of 1

Project Name:	Sorted by:	Date Started:	Date Finished:	Hours:
ORNL BMAP	RM	12/13/2023	12/14/2023	4
Stream Name:	**Taxonomist:**	**Date Started:**	**Date Finished:**	**Hours:**
White Oak Creek	WSW	2/21/2024	2/21/2024	8
Site Name: / **Rep No.:** / **Date:**	**Chain-of-Custody Number:**		**Number of Containers:**	
WCK2-3 / 3 / 4/17/2023	WC23-0423-3		1 Vial	

Taxon	Number	Ck. no.[a]	Total no.[b]
Ephemeroptera			
Baetis	1	1	2
Caenis	58	1	59
Eurylophella	3	0	3
Maccaffertium	1	0	1
Plecoptera			
Amphinemura	1	0	1
Trichoptera			
Rhyacophila	1	0	1
Coleoptera			
Stenelmis	10	1	11
Optioservus	2	0	2
Dubiraphia	2	0	2
Column 1 total	79	3	82

Taxon	Number	Ck.no.[a]	Total no.[b]
Odonata			
Stylogomphus albistylus	1	0	1
Argia	1	0	1
Diptera			
Chironomidae (pupae)	15	1	16
Orthocladiinae	253	3	256
Tanypodinae	6	1	7
Chironomini	37	1	38
Tanytarsini	155	8	163
Ceratopogonidae	2	0	2
Other Taxa			
Hydrachnidia	0	1	1
Cambaridae	1	0	1
Lirceus	3	0	3
Oligochaeta	9	0	9
Column 2 total	483	15	498
Total sample number	562	18	580

[a]Number of organisms in QA check vial.

[b]Total number of organisms corrected for number in check vial. This number is derived by multiplying the check vial number (Ck. no.) by the proportion of pans checked during sorting QA, and then adding to number (no.).

Entered Date: 2/22/2024 Entered By: WSW
Checked Date: 2/22/2024 Checked By: WSW

BENTHIC MACROINVERTEBRATE LABORATORY BENCH SHEET (BACK)

Site Name:	Rep No.:	Date:
WCK 2-3	3	4/17/2023

Total Number of Organisms 580 | **Total Number of Taxa** 21

Proportion of Pans Checked 4W/1W

QC / Sorting:

Checked by: WSW Date: 12/14/2023

Sorting efficiency

(Sorting efficiency = Number in check vial (Ck. No.)) Number originally sorted (No.) H 100)

96%

(∃90% Sample passes or < 90% sample fails)

Action taken:

QC / Taxonomy:

Checked by: _____ Date: _____

Original identification	Verification identification

Subsampled? Yes _____ No X

Explain:

General comments:

BENTHIC MACROINVERTEBRATE LABORATORY BENCH SHEET (FRONT)

Page 1 of 1

Project Name:	Sorted by:	Date Started:	Date Finished:	Hours:
ORNL BMAP	KM	12/18/2023	12/18/2023	3
Stream Name:	**Taxonomist:**	**Date Started:**	**Date Finished:**	**Hours:**
White Oak Creek	WSW	1/30/2024	1/31/2024	5
Site Name: / **Rep No.:** / **Date:**	**Chain-of-Custody Number:**		**Number of Containers:**	
WCK39 / 1 / 4/17/2023	WC39-0423-1		1 Vial	

Taxon	Number	Ck. no.[a]	Total no.[b]
Ephemeroptera			
Baetis	20	0	20
Plauditus	1	0	1
Plecoptera			
Amphinemura	1	0	1
Trichoptera			
Cheumatopsyche	48	4	52
Coleoptera			
Optioservus	20	0	20
Stenelmis	8	0	8
Column 1 total	98	4	102

Taxon	Number	Ck.no.[a]	Total no.[b]
Odonata			
Diptera			
Orthocladiinae	83	7	90
Chironomini	4	1	5
Tanytarsini	3	1	4
Chironomidae (pupae)	7	0	7
Simulium	3	0	3
Other Taxa			
Nematoda	2	0	2
Turbellaria	8	0	8
Nemertea	4	0	4
Oligochaeta	15	0	15
Lirceus	2	0	2
Ferrissia	1	0	1
Pleurocera	12	0	12
Column 2 total	144	9	153
Total sample number	242	13	255

[a]Number of organisms in QA check vial.

[b]Total number of organisms corrected for number in check vial. This number is derived by multiplying the check vial number (Ck. no.) by the proportion of pans checked during sorting QA, and then adding to number (no.).

Entered Date: 1/31/2024 Entered By: WSW

Checked Date: 1/31/2024 Checked By: WSW

BENTHIC MACROINVERTEBRATE LABORATORY BENCH SHEET (BACK)

Site Name:	Rep No.:	Date:
WCK 3.9	1	4/17/2023

Total Number of Organisms 255	Total Number of Taxa 18

Proportion of Pans Checked 4/4

QC / Sorting:

Checked by: WSW Date: 12/18/2023

Sorting efficiency

(Sorting efficiency = Number in check vial (Ck. No.)) Number originally sorted (No.) H 100)

90%

(∃90% Sample passes or < 90% sample fails)

Action taken:

QC / Taxonomy:

Checked by: _____ Date: _____

Original identification	Verification identification

Subsampled?	Explain:
Yes _____ No X	

General comments:

BENTHIC MACROINVERTEBRATE LABORATORY BENCH SHEET (FRONT)

Page 1 of 1

Project Name: ORNL BMAP	Sorted by: RM	Date Started: 12/15/2023	Date Finished: 12/19/2023 Hours: 2
Stream Name: White Oak Creek	Taxonomist: WSW	Date Started: 2/1/2024	Date Finished: 2/1/2024 Hours: 5
Site Name: WCK 3.9 Rep No.: 2 Date: 4/17/2023	Chain-of-Custody Number: WC39-0423-2		Number of Containers: 1 Vial

Taxon	Number	Ck. no.[a]	Total no.[b]
Ephemeroptera			
Baetis	35	1	36
Plecoptera			
Trichoptera			
Cheumatopsyche	36	1	37
Wormaldia	1	0	1
Coleoptera			
Stenelmis	4	1	5
Optioservus	22	0	22
Psephenus herricki	2	0	2
Column 1 total	100	3	103

Taxon	Number	Ck.no.[a]	Total no.[b]
Odonata			
Diptera			
Chironomidae (pupae)	11	1	12
Hemerodromia	0	1	1
Tipula	1	0	1
Orthocladiinae	139	11	150
Chironomini	13	0	13
Tanytarsini	4	4	8
Simulium	1	0	1
Other Taxa			
Oligochaeta	13	0	13
Lirceus	1	0	1
Nematoda	1	0	1
Pleuroceva	4	0	4
Column 2 total	188	17	205
Total sample number	288	20	308

[a]Number of organisms in QA check vial.

[b]Total number of organisms corrected for number in check vial. This number is derived by multiplying the check vial number (Ck. no.) by the proportion of pans checked during sorting QA, and then adding to number (no.).

Entered Date: 2/1/2024 Entered By: WSW

Checked Date: 2/22/2024 Checked By: WSW

BENTHIC MACROINVERTEBRATE LABORATORY BENCH SHEET (BACK)

Site Name:	Rep No.:	Date:
WCK 3.9	2	4/17/2023

Total Number of Organisms 308 | Total Number of Taxa 17

Proportion of Pans Checked 2x/1N

QC / Sorting:

Checked by: WSW Date: 12/19/2023

Sorting efficiency

(Sorting efficiency = Number in check vial (Ck. No.)) Number originally sorted (No.) H 100)

91%

(∃90% Sample passes or < 90% sample fails)

Action taken:

QC / Taxonomy:

Checked by: _____ Date: _____

Original identification	Verification identification

Subsampled? Yes_____ No X

Explain:

General comments:

BENTHIC MACROINVERTEBRATE LABORATORY BENCH SHEET (FRONT)

Page 1 of 1

Project Name:	Sorted by:	Date Started:	Date Finished:	Hours:
White Oak Creek ORNL BMAP	RM	12/20/2023	12/20/2023	2
Stream Name:	**Taxonomist:**	**Date Started:**	**Date Finished:**	**Hours:**
White Oak Creek	WSW	2/1/2024	2/5/2024	3
Site Name: / **Rep No.:** / **Date:**	**Chain-of-Custody Number:**	**Number of Containers:**		
WCK 3.9 / 3 / 4/17/2023	WC39-0423-3	2 vials (1 OT + 1 Ref)		

Taxon	Number	Ck. no.[a]	Total no.[b]
Ephemeroptera			
Baetis	10	1	11
Acerpenna	1	0	1
Plecoptera			
Trichoptera			
Cheumatopsyche	27	0	27
Coleoptera			
Optioservus	5	0	5
Stenelmis	1	0	1
Column 1 total	44	1	45

Taxon	Number	Ck.no.[a]	Total no.[b]
Odonata			
Argia	1	0	1
Stylogomphus albistylus	1	0	1
Diptera			
Chironomidae (pupae)	5	1	6
Simulium	1	0	1
Orthocladiinae	47	6	53
Chironomini	2	0	2
Tanytarsini	1	0	1
Antocha	2	0	2
Other Taxa			
Cambarus	2	0	2
Oligochaeta	5	0	5
Column 2 total	67	7	74
Total sample number	111	8	119

[a]Number of organisms in QA check vial.

[b]Total number of organisms corrected for number in check vial. This number is derived by multiplying the check vial number (Ck. no.) by the proportion of pans checked during sorting QA, and then adding to number (no.).

Entered Date: 2/5/2024 Entered By: WSW

Checked Date: 2/21/2024 Checked By: BH

BENTHIC MACROINVERTEBRATE LABORATORY BENCH SHEET (BACK)

Site Name:	Rep No.:	Date:
WCK 39	3	4/17/2023

Total Number of Organisms 119 | Total Number of Taxa _____

Proportion of Pans Checked 2Y/1W

QC / Sorting:

Checked by: WSW Date: 12/20/2023

Sorting efficiency

(Sorting efficiency = Number in check vial (Ck. No.)) Number originally sorted (No.) H 100)

90%

(∃90% Sample passes or < 90% sample fails)

Action taken:

QC / Taxonomy:

Checked by: _____ Date: _____

Original identification	Verification identification

Subsampled? Yes_____ No X

Explain:

General comments:

BENTHIC MACROINVERTEBRATE LABORATORY BENCH SHEET (FRONT)

Project Name:	Sorted by:	Date Started:	Date Finished:	Hours:
ORNL BMAP	BH	8/17/2023	8/21/2023	6.5
Stream Name:	**Taxonomist:**	**Date Started:**	**Date Finished:**	**Hours:**
White Oak Creek	WSV	2/5/2024	2/7/2024	7
Site Name: / **Rep No.:** / **Date:**	**Chain-of-Custody Number:**		**Number of Containers:**	
WCK 6.8 / 1 / 4/17/2023	WC68-0423-1		1 Vial	

Taxon	Number	Ck. no.[a]	Total no.[b]	Taxon	Number	Ck.no.[a]	Total no.[b]
Ephemeroptera				**Odonata**			
Plauditus	4	3	7				
Paraleptophlebia	12	0	12				
Ephemera	1	0	1				
Isonychia	7	0	7				
Acentrella	57	0	57	**Diptera**			
Ephemerella	8	0	8	Chironomidae (pupae)	0	1	1
Baetis	30	0	30	Orthocladiinae	27	1	28
Habrophlebiodes	23	0	23	Tanypodinae	5	0	5
Eurylophella	1	0	1	Chironomini	11	0	11
Stenacron	5	0	5	Tanytarsini	7	0	7
				Dixa	1	0	1
Plecoptera				Tipula	1	0	1
Leuctra	78	4	82	Simulium	8	0	8
Amphinemura	2	0	2				
Taeniopteryx	4	0	4				
Sweltsa	1	0	1				
Acroneuria	1	0	1				
Trichoptera							
Rhyacophila	10	1	11				
Diplectrona modesta	9	0	9				
Neophylax	10	0	10				
Polycentropus	3	0	3				
Glossosoma	5	0	5	**Other Taxa**			
Cheumatopsyche	3	0	3	Oligochaeta	3	1	4
Psilotreta	2	0	2	Elimia	34	1	35
Agapetus	1	0	1	Lirceus	9	0	9
Goera	1	0	1	Crangonyx	1	0	1
Coleoptera							
Optioservus	24	1	25				
Psephenus herricki	12	2	14				
Stenelmis	2	2	4				
Anchytarsus bicolor	1	0	1				
				Column 2 total	107	4	111
Column 1 total	317	13	330	Total sample number	424	17	441

[a]Number of organisms in QA check vial.

[b]Total number of organisms corrected for number in check vial. This number is derived by multiplying the check vial number (Ck. no.) by the proportion of pans checked during sorting QA, and then adding to number (no.).

Entered Date: 2/7/2024 Entered By: WSV
Checked Date: 2/21/2024 Checked By: BH

BENTHIC MACROINVERTEBRATE LABORATORY BENCH SHEET (BACK)

Site Name:	Rep No.:	Date:
WCK 6.8	1	4/17/2023

Total Number of Organisms 441	Total Number of Taxa 40

Proportion of Pans Checked 5Y/0N

QC / Sorting:

Checked by: WSW Date: 8/21/2023

Sorting efficiency

(Sorting efficiency = Number in check vial (Ck. No.)) Number originally sorted (No.) H 100)

96%

(∃90% Sample passes or < 90% sample fails)

Action taken:

QC / Taxonomy:

Checked by: _____ Date: _____

Original identification	Verification identification

Subsampled?	Explain:
Yes _____ No X	

General comments:

BENTHIC MACROINVERTEBRATE LABORATORY BENCH SHEET (FRONT)

Page 1 of 1

Project Name: ORNL BMAP	Sorted by: BH	Date Started: 8/21/2023	Date Finished: 8/22/2023	Hours: 6.5	
Stream Name: White Oak Creek	Taxonomist: WSW	Date Started: 2/7/2024	Date Finished: 2/8/2024	Hours: 4	
Site Name: WCK6.8 Rep No.: 2 Date: 4/17/2023	Chain-of-Custody Number: WC68-0423-2		Number of Containers: 1 Vial		

Taxon	Number	Ck. no.[a]	Total no.[b]	Taxon	Number	Ck.no.[a]	Total no.[b]
Ephemeroptera				**Odonata**			
Acentrella	59	1	60				
Stenacron	12	0	12				
Ephemerella	2	0	2				
Isonychia	1	0	1				
Habrophlebiodes	17	0	17	**Diptera**			
Baetis	8	0	8	Orthocladiinae	5	1	6
Paraleptophlebia	4	0	4	Tanypodinae	1	0	1
Plauditus	3	0	3	Chironomini	2	0	2
				Tanytarsini	4	0	4
				Simulium	2	0	2
Plecoptera							
Leuctra	69	0	69				
Amphinemura	1	0	1				
Tallaperla	1	0	1				
Trichoptera							
Cheumatopsyche	2	0	2				
Agapetus	3	0	3				
Rhyacophila	5	0	5				
Psilotreta	1	0	1				
Polycentropus	3	0	3	**Other Taxa**			
Chimarra	1	0	1	Lirceus	4	0	4
				Oligochaeta	3	0	3
				Elimia	39	0	39
Coleoptera							
Anchytarsus bicolor	1	0	1				
Psephenus herricki	11	0	11				
Stenelmis	3	0	3				
Oulimnius latiusculus	1	0	1				
Optioservus	13	0	13				
Ectopria	1	0	1				
				Column 2 total	60	1	61
Column 1 total	222	1	223	Total sample number	282	2	284

[a]Number of organisms in QA check vial.

[b]Total number of organisms corrected for number in check vial. This number is derived by multiplying the check vial number (Ck. no.) by the proportion of pans checked during sorting QA, and then adding to number (no.).

Entered Date: 2/8/2024 Entered By: BH
Checked Date: 2/21/2024 Checked By: BH

BENTHIC MACROINVERTEBRATE LABORATORY BENCH SHEET (BACK)

Site Name:	Rep No.:	Date:
WCK 6.8	2	4/17/2023

Total Number of Organisms 284	Total Number of Taxa 31

Proportion of Pans Checked 5Y/0N

QC / Sorting:

Checked by: ~~QQ/O~~ WSW Date: 8/21/2023

Sorting efficiency

(Sorting efficiency = Number in check vial (Ck. No.)) Number originally sorted (No.) H 100)

99%

(∃90% Sample passes or < 90% sample fails)

Action taken:

QC / Taxonomy:

Checked by: _____ Date: _____

Original identification	Verification identification

Subsampled?	Explain:
Yes ____ No X	

General comments:

BENTHIC MACROINVERTEBRATE LABORATORY BENCH SHEET (FRONT)

Page 1 of 1

Project Name:	Sorted by:	Date Started:	Date Finished:	Hours:
OKNL BMAP	WBH	8/22/2023	8/28/2023	10
Stream Name:	**Taxonomist:**	**Date Started:**	**Date Finished:**	**Hours:**
White Oak Creek	WSW	2/8/2024	2/12/2024	20
Site Name: / **Rep No.:** / **Date:**	**Chain-of-Custody Number:**		**Number of Containers:**	
WCK6.8 / 3 / 4/17/2023	WC68-0423-3		1 vial	

Taxon	Number	Ck. no.[a]	Total no.[b]
Ephemeroptera			
Acentrella	140	5	145
Fabrophlebiodes	85	0	85
Isonychia	13	0	13
Plauditus	52	0	52
Ephemerella	37	0	37
Baetis	65	0	65
Eurylophella	1	0	1
Plecoptera			
Leuctra	462	4	466
Taeniopteryx	87	0	87
Amphinemura	29	0	29
Acroneuria	4	0	4
Haploperla	4	0	4
Trichoptera			
Rhyacophila	14	1	15
Psidotreta	1	0	1
Polycentropus	16	0	16
Glossosoma	3	0	3
Agapetus	6	0	6
Triaenodes	1	0	1
Brachycentrus	14	0	14
Diplectrona modesta	12	0	12
Coleoptera			
Optioservus	29	1	30
Anchytarsus bicolor	12	0	12
Microcylloepus	2	0	2
Stenelmis	11	0	11
Ectopria	2	0	2
Psephenus herricki	5	0	5
Column 1 total	1107	11	1118

Taxon	Number	Ck.no.[a]	Total no.[b]
Odonata			
Stylogomphus albistylus	4	0	4
Diptera			
Chironomidae (pupae)	9	1	10
Simulium	196	2	198
Orthocladiinae	37	0	37
Tanypodinae	42	1	43
Chironomini	13	0	13
Tanytarsini	50	1	51
Pseudolimnophila	2	0	2
Dixa	1	0	1
Tipula	2	0	2
Other Taxa			
Oligochaeta	37	0	37
Hydrachnidia	1	0	1
Lirceus	58	0	58
Elimia	76	0	76
Nematoda	4	0	4
Cambaridae	1	0	1
Turbellaria	2	0	2
Nigronia serricornis	2	0	2
Column 2 total	537	5	542
Total sample number	1644	16	1660

[a]Number of organisms in QA check vial.

[b]Total number of organisms corrected for number in check vial. This number is derived by multiplying the check vial number (Ck. no.) by the proportion of pans checked during sorting QA, and then adding to number (no.).

Entered Date: 2/12/2024 Entered By: WSW

Checked Date: 2/21/2024 Checked By: BH

BENTHIC MACROINVERTEBRATE LABORATORY BENCH SHEET (BACK)

Site Name:	Rep No.:	Date:
WCK6.8	3	4/17/2023

Total Number of Organisms 1660	Total Number of Taxa 44

Proportion of Pans Checked 4(4/4W)

QC / Sorting:

Checked by: WSW Date: 8/28/2023

Sorting efficiency

(Sorting efficiency = Number in check vial (Ck. No.)) Number originally sorted (No.) H 100)

98%

(∃90% Sample passes or < 90% sample fails)

Action taken:

QC / Taxonomy:

Checked by: _____ Date: _____

Original identification	Verification identification

Subsampled?	Explain:
Yes _____	
No X	

General comments:

BENTHIC MACROINVERTEBRATE LABORATORY BENCH SHEET (FRONT)

Page 1 of 1

Project Name: ORNL RMAP	Sorted by: RM	Date Started: 12/16/2023	Date Finished: 12/23/2023 Hours: 4
Stream Name: First Creek	Taxonomist: WSW	Date Started: 2/24/2024	Date Finished: 3/14/2024 Hours: 8
Site Name: FCK0.1 Rep No.: T Date: 8/30/2023	Chain-of-Custody Number: FC08-0823-T		Number of Containers: 1 Vial

Taxon	Number	Ck. no.[a]	Total no.[b]
Ephemeroptera			
Plecoptera			
Chloroperlidae			2
Trichoptera			
Cheumatopsyche			2
Coleoptera			
Stenelmis			5
Optioservus			40
Psephenus herricki			7
Column 1 total			54

Taxon	Number	Ck.no.[a]	Total no.[b]
Odonata			
Stylogomphus albistylus			3
Diptera			
Polypedilum			3
Conchapelopia			2
Other Taxa			
Gammarus			111
Elimia			25
Pleurocera			1
Fevrissia			1
Lumbriculidae			2
Column 2 total			148
Total sample number			202

[a]Number of organisms in QA check vial.

[b]Total number of organisms corrected for number in check vial. This number is derived by multiplying the check vial number (Ck. no.) by the proportion of pans checked during sorting QA, and then adding to number (no.).

Entered Date: 3/14/2024 Entered By: WSW
Checked Date: 3/14/2024 Checked By: WSW

BENTHIC MACROINVERTEBRATE LABORATORY BENCH SHEET (BACK)

Site Name:	Rep No.:	Date:
FCK0.1T	1	8/30/2023

Total Number of Organisms _____ **Total Number of Taxa** _____

Proportion of Pans Checked _____

QC / Sorting:

Checked by: _____ **Date:** _____

Sorting efficiency

(Sorting efficiency = Number in check vial (Ck. No.)) Number originally sorted (No.) H 100)

_____

(∃90% Sample passes or < 90% sample fails)

Action taken:

QC / Taxonomy:

Checked by: _____ **Date:** _____

Original identification	Verification identification

Subsampled? **Yes** X **No** _____

Explain: TDEC protocols, 8 of 28 cells picked

General comments:

BENTHIC MACROINVERTEBRATE LABORATORY BENCH SHEET (FRONT)

Page 1 of 1

Project Name: ORNL BMAP	Sorted by: Rm	Date Started: 12/26/2023	Date Finished: 12/26/2023	Hours: 3
Stream Name: Fifth Creek	Taxonomist: WSW	Date Started: 2/24/2024	Date Finished: 3/14/2024	Hours: 8
Site Name: FFK 0.2T Rep No.: 1 Date: 8/30/2023	Chain-of-Custody Number: FF02-0823-T		Number of Containers: 1 Vial	

Taxon	Number	Ck. no.[a]	Total no.[b]
Ephemeroptera			
Baetis			41
Stenacron			4
Diphetor			2
Plecoptera			
Trichoptera			
Cheumatopsyche			106
Chimarra			2
Hydropsyche			1
Coleoptera			
Stenelmis			5
Optioservus			44
Column 1 total			165

Taxon	Number	Ck.no.[a]	Total no.[b]
Odonata			
Stylogomphus albistylus			1
Diptera			
Antocha			1
Simulium			9
Rheocricotopus			
Other Taxa			
Lircus			46
Lumbriculidae			6
Column 2 total			55
Total sample number			220

[a]Number of organisms in QA check vial.

[b]Total number of organisms corrected for number in check vial. This number is derived by multiplying the check vial number (Ck. no.) by the proportion of pans checked during sorting QA, and then adding to number (no.).

Entered Date: 3/14/2024 Entered By: BH

Checked Date: 3/14/2024 Checked By: WSW

BENTHIC MACROINVERTEBRATE LABORATORY BENCH SHEET (BACK)

Site Name: FFK 0.2T	Rep No.: 1	Date: 8/30/2023
Total Number of Organisms 220		Total Number of Taxa 14
Proportion of Pans Checked _____		

QC / Sorting:

Checked by: _____ Date: _____

Sorting efficiency

(Sorting efficiency = Number in check vial (Ck. No.)) Number originally sorted (No.) H 100)

_____

(∃90% Sample passes or < 90% sample fails)

Action taken:

QC / Taxonomy:

Checked by: _____ Date: _____

Original identification	Verification identification
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

Subsampled? Yes X No _____

Explain: TDEC protocols 16 of 28 cells picked

General comments:

BENTHIC MACROINVERTEBRATE LABORATORY BENCH SHEET (FRONT)

Page 1 of 1

Project Name:	Sorted by:	Date Started:	Date Finished:	Hours:
ORNL BMAP	RM	12/21/2023	12/21/2023	4
Stream Name:	**Taxonomist:**	**Date Started:**	**Date Finished:**	**Hours:**
White Oak Creek	WSW	2/22/2024	3/14/2024	8
Site Name: / **Rep No.:** / **Date:**	**Chain-of-Custody Number:**		**Number of Containers:**	
WCK2.3T / 1 / 8/30/2023	WC23-0823-T		1 via	

Taxon	Number	Ck. no.[a]	Total no.[b]
Ephemeroptera			
Baetis			15
Maccaffertium			12
Caenis			25
Plecoptera			
Eccoptura xanthenes			1
Trichoptera			
Cheumatopsyche			1
Coleoptera			
Stenelmis			55
Optioservus			10
Ectopria			2
Column 1 total			121

Taxon	Number	Ck.no.[a]	Total no.[b]
Odonata			
Argia			2
Diptera			
Chironomidae (pupal)			4
Ablabesmyia			11
Conchapelopia			8
Natarsia			2
Cryptochironomus			1
Microtendipes			1
Tanytarsus			2
Cricotopus / Orthocladius			2
Other Taxa			
Camparidae			1
Corbicula fluminea			10
Nigronia serricornis			1
Lirceus			5
Sialis			1
Branchiura sowerbi			2
Nemertea			1
Tubificidae			3
Lumbriculidae			5
Column 2 total			62
Total sample number			183

[a]Number of organisms in QA check vial.

[b]Total number of organisms corrected for number in check vial. This number is derived by multiplying the check vial number (Ck. no.) by the proportion of pans checked during sorting QA, and then adding to number (no.).

Entered Date: 2-28-24 Entered By: BH

Checked Date: 3/14/2024 Checked By: WSW

BENTHIC MACROINVERTEBRATE LABORATORY BENCH SHEET (BACK)

Site Name:	Rep No.:	Date:
WCK2.3T	1	8/30/2023

Total Number of Organisms 183 | **Total Number of Taxa** 24

Proportion of Pans Checked _____

QC / Sorting:

Checked by: _____ Date: _____

Sorting efficiency

(Sorting efficiency = Number in check vial (Ck. No.)) Number originally sorted (No.) H 100)

_____

(∃90% Sample passes or < 90% sample fails)

Action taken:

QC / Taxonomy:

Checked by: _____ Date: _____

Original identification	Verification identification

Subsampled? Yes X

No _____

Explain: TDEC protocols 8 of 28 cells picked

General comments:

BENTHIC MACROINVERTEBRATE LABORATORY BENCH SHEET (FRONT)

Page 1 of 1

Project Name: ORNL BMAP	Sorted by: RM	Date Started: 12/22/2023	Date Finished: 12/22/2023 Hours: 4
Stream Name: White Oak Creek	Taxonomist: WSW	Date Started: 2/22/2024	Date Finished: 3/14/2024 Hours: 8
Site Name: WCK3.9T Rep No.: 1 Date: 8/30/2023	Chain-of-Custody Number: WC39-0823-T		Number of Containers: 1 Vial

Taxon	Number	Ck. no.[a]	Total no.[b]
Ephemeroptera			
Baetis			60
Plecoptera			
Trichoptera			
Cheumatopsyche			23
Hydropsyche			1
Coleoptera			
Stenelmis			4
Optioservus			13
Column 1 total			101

Taxon	Number	Ck.no.[a]	Total no.[b]
Odonata			
Diptera			
Brillia			1
Polypedilum			1
Rheotanytarsus			1
Orthocladius			1
Other Taxa			
Gambarus			6
Pleurocera			16
Corbicula fluminea			18
Nigronia serricornis			1
Lumbriculidae			17
Column 2 total			62
Total sample number			163

[a]Number of organisms in QA check vial.

[b]Total number of organisms corrected for number in check vial. This number is derived by multiplying the check vial number (Ck. no.) by the proportion of pans checked during sorting QA, and then adding to number (no.).

Entered Date: 3/14/2024 Entered By: WSW
Checked Date: 3/14/2024 Checked By: WSW

BENTHIC MACROINVERTEBRATE LABORATORY BENCH SHEET (BACK)

Site Name:	Rep No.:	Date:
WCK 3.9 T	1	8/30/2023

Total Number of Organisms 163	Total Number of Taxa 14

Proportion of Pans Checked _____

QC / Sorting:

Checked by: _____ Date: _____

Sorting efficiency

(Sorting efficiency = Number in check vial (Ck. No.)) Number originally sorted (No.) H 100)

_____

(∃90% Sample passes or < 90% sample fails)

Action taken:

QC / Taxonomy:

Checked by: _____ Date: _____

Original identification	Verification identification

Subsampled?	Explain:
Yes X No _____	TDEC protocols 20 of 28 cells picked

General comments:

BENTHIC MACROINVERTEBRATE LABORATORY BENCH SHEET (FRONT)

Project Name:	Sorted by:	Date Started:	Date Finished:	Hours:
ORNL BMAP	Rm	12/27/2023	12/27/2023	3
Stream Name:	**Taxonomist:**	**Date Started:**	**Date Finished:**	**Hours:**
White Oak Creek	WSW	2/23/2024	2/24/2024	8
Site Name: / **Rep No.:** / **Date:**	**Chain-of-Custody Number:**		**Number of Containers:**	
WCK 6.8T / 1 / 8/30/2023	WC 68-0823-T		1 Vial	

Taxon	Number	Ck. no.[a]	Total no.[b]
Ephemeroptera			
Stenacron			2
Isonychia			9
Ephemerella			1
Plecoptera			
Leuctra			59
Tallaperla			18
Sweltsa			2
Eccoptura xanthenes			1
Trichoptera			
Dolophilodes modesta			20
Lype diversa			1
Cheumatopsyche			6
Polycentropus			1
Hydropsyche			2
Rhyacophila			1
Glossosoma			2
Coleoptera			
Anchytarsus bicolor			20
Optioservus			24
Stenelmis			2
Psephenus herricki			5
Ectopria			1
Column 1 total			177

Taxon	Number	Ck.no.[a]	Total no.[b]
Odonata			
Stylogomphus albistylus			1
Diptera			
Pseudolimnophila			2
Simulium			3
Conchapelopia			3
Trissopelopia			3
Parametriocnemus			1
Other Taxa			
Lirceus			5
Cambarus			5
Elimia			14
Lumbriculidae			1
Column 2 total			37
Total sample number			214

[a]Number of organisms in QA check vial.

[b]Total number of organisms corrected for number in check vial. This number is derived by multiplying the check vial number (Ck. no.) by the proportion of pans checked during sorting QA, and then adding to number (no.).

Entered Date: 3/14/2024 Entered By: WSW
Checked Date: 3/14/2024 Checked By: WSW

BENTHIC MACROINVERTEBRATE LABORATORY BENCH SHEET (BACK)

Site Name:	Rep No.:	Date:
WCK6.8T	1	8/30/2023

Total Number of Organisms 214 | **Total Number of Taxa** 29

Proportion of Pans Checked _____

QC / Sorting:

Checked by: _____ Date: _____

Sorting efficiency

(Sorting efficiency = Number in check vial (Ck. No.)) Number originally sorted (No.) H 100)

_____

(∃90% Sample passes or < 90% sample fails)

Action taken:

QC / Taxonomy:

Checked by: _____ Date: _____

Original identification	Verification identification

Subsampled? Yes X No _____

Explain: TDEC Protocols 8 of 28 cells picked

General comments:

BENTHIC MACROINVERTEBRATE LABORATORY BENCH SHEET (FRONT)

Page 1 of 1

Project Name:		Sorted by:	Date Started:	Date Finished:	Hours:
WKRP1		RM	9/27/2023	9/27/2023	3
Stream Name:		**Taxonomist:**	**Date Started:**	**Date Finished:**	**Hours:**
Melton Branch		WSW	2/24/2024	3/14/2024	8
Site Name:	**Rep No.:** **Date:**	**Chain-of-Custody Number:**		**Number of Containers:**	
MEK0.6T	8/30/2023	MEO6-0823-T		1 Vial	

Taxon	Number	Ck. no.[a]	Total no.[b]
Ephemeroptera			
Isonychia			28
Baetis			18
Diphetor			2
Maccaffertium			2
Plecoptera			
Leuctra			2
Perlesta			3
Trichoptera			
Cheumatopsyche			41
Chimarra			6
Dyctiogna modesta			4
Neophylax			1
Coleoptera			
Optioservus			35
Stenelmis			18
Anchytarsus bicolor			1
Psephenus herricki			10
Column 1 total			171

Taxon	Number	Ck.no.[a]	Total no.[b]
Odonata			
Argia			2
Stylogomphus albistylus			1
Diptera			
Antocha			4
Atrichopogon			1
Polypedilum			3
Corynoneura			2
Other Taxa			
Nigronia fasciatus			2
Nigronia serricornis			4
Lirceus			3
Cambarus			2
Corydalus cornutus			2
Corbicula fluminea			2
Elimia			1
Pleurocera			8
Lumbriculidae			2
Column 2 total			39
Total sample number			210

[a]Number of organisms in QA check vial.

[b]Total number of organisms corrected for number in check vial. This number is derived by multiplying the check vial number (Ck. no.) by the proportion of pans checked during sorting QA, and then adding to number (no.).

Entered Date: 3/14/2024 Entered By: WSW

Checked Date: 3/14/2024 Checked By: WSW

BENTHIC MACROINVERTEBRATE LABORATORY BENCH SHEET (BACK)

Site Name: MEK0.6T	Rep No.: 1	Date: 8/30/2023
Total Number of Organisms 210		Total Number of Taxa 29
Proportion of Pans Checked _____		

QC / Sorting:

Checked by: _____ Date: _____

Sorting efficiency

(Sorting efficiency = Number in check vial (Ck. No.)) Number originally sorted (No.) H 100)

_____

(∃90% Sample passes or < 90% sample fails)

Action taken:

QC / Taxonomy:

Checked by: _____ Date: _____

Original identification	Verification identification
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

Subsampled?	Explain:
Yes X No _____	TDEC protocols 11 of 28 cells picked

General comments:

Appendix 2. Macroinvertebrate Stream Data

STREAM SURVEY INFORMATION (see protocol E for detailed information and BSERT for Completing E-Form)

DWR Station ID:	**Samplers:** NJONES + TJeff	
Monitoring Location Name: WOR2.3	**Date:** 8-30-23 **Time:** 1340	
Monitoring Location:	**Organization:**	Drainage Area:
County:	Ecoregion:	u/s ECO:
Latitude:	HUC:	WS Grp:
Longitude:	WBID:	Field Log #:

Project Name: ☐ Watershed ☐ 303(d) ☐ Antideg ☐ ECO ☐ FECO Other:

Project ID: TNPR

Activity Type: ☑ Sample ☐ QC Sample ☐ Habitat ☐ QC habitat ☐ QC ID

Sample Status: ☑Collected ☐Seasonally Dry ☐Frequently Dry ☐No Channel
☐Too Deep (Not Wadeable) ☐Too Deep (Temporary) ☐Permanent Barrier ☐Fenced
☐Landowner Denial: ☐Temporary Barrier ☐Posted Plan to revisit? ☐Yes ☐No

Flow Conditions: ☐Dry ☑Isolated Pools ☐Stagnant ☐Low ☐Moderate ☐High ☐Bankful ☐Flooding

Chemicals/Bacteria: ☑None ☐Routine ☐Nutrient ☐Metals ☐*E. coli* ☐Organics ☐Other_____

Field Parameters: Meter(s) Used: YSI PRODSS

pH (su)	8.02		Dissolved Oxygen %	96.9	
Conductivity (umhos)	473.7	490.2	Turbidity ~~(NTU)~~ (FNU)	1.80	
Temperature (C°)	23.4		TDS (mg/L)	317	
Dissolved Oxygen (ppm = mg/L)	8.28		Flow (cfs)	NM 8.1026	

Meter Problems?_____

Photos Taken? ☐ No ☑Yes: Description: _____

Previous 48 hours precipitation: ☐Unknown ☐None ☐Slight ☐Moderate ☐Heavy ☐Flooding
Air Temperature (°F) _____

Physical Characteristics & Light Penetration:

Gradient (sample reach): ☐Flat ☐Low ☐Moderate ☐High ☐Cascades

Average Stream Width: ☐Very Small (<1.5yd) ☐Small (1.5-3yd) ☐Med. (3-10yd) ☐Large (10-25yd) ☐Very Large (>25yd)

Maximum Stream Depth: ☐Shallow (<0.3yd) ☐Medium (0.3-0.6yd) ☐Deep (0.6 – 1yd) ☐Very Deep(>1yd)

% Canopy Cover Estimated for Reach: _____% # w/out

% Canopy Cover Measured (mid-reach): 1 u/s + 1 d/s + 2 LDB + 1 RDB = Total/384*100 96.10%

Channel Characteristics:

Bank Height: _____ (yd.) High Water Mark: _____(yd.)

Bank Slope LDB: ☐Deeply incised ☐Bluff/Wall ☐Undercut ☐Sloughing ☐Steep terrain ☐Gentle Slope

Bank Slope RDB: ☐Deeply incised ☐Bluff/Wall ☐Undercut ☐Sloughing ☐Steep terrain ☐Gentle Slope

Manmade Modification: ☐None ☐Rip-Rap ☐Cement ☐Gabions ☐Channelized ☐Dam ☐Dredging ☐Bridge ☐ATV

Stream Characteristics:

Sediment Deposits: ☐None ☐Slight ☐Moderate ☐Excessive ☐Blanket

Sediment Type: ☐None ☐Sand ☐Silt ☐Mud ☐Clay ☐Sludge ☐Mn Precipitant ☐Orange Flocculent

Turbidity: ☐Clear ☐Slightly Turbid ☐Muddy ☐Milky ☐Tannic ☐Planktonic Algae ☐Dyed

Foam/Surface Sheen: ☐None ☐Nutrient ☐Surfactant ☐Bacteria

Algae: ☐None ☐Slight ☐Moderate ☐High ☐Choking **Type**: ☐Diatoms ☐Green ☐Filamentous ☐Blue-green

Department of Environment & Conservation

TDEC-DWR Stream Survey Field Sheet (Back)

DWR Station ID: WC1023 Date: 8-30-23 Assessors: N Jones + T Jett

Dominate Substrate: (More than 25%) Select up to 4

Riffle	Run	Pool
☐ Boulders (>10")	☐ Boulders (>10")	☐ Boulders (>10")
☐ Cobble (2.5-10")	☐ Cobble (2.5-10")	☐ Cobble (2.5-10")
☐ Gravel (0.1-2.5")	☐ Gravel (0.1-2.5")	☐ Gravel (0.1-2.5")
☐ Bedrock	☐ Bedrock	☐ Bedrock
☐ Sand	☐ Sand	☐ Sand
☐ Silt (not gritty)	☐ Silt (not gritty)	☐ Silt (not gritty)
☐ Clay (Slick)	☐ Clay (Slick)	☐ Clay (Slick)

Surrounding Land Uses (list additional land uses under comments)

☐ Forest	☐ Grazing	☐ Stormwater	☐ STP/WWTP	☐ Construction
☐ Wetland	☐ Row Crops	☐ Urban	☐ Industry	☐ Impoundment
☐ Park	☐ CAFO/Dairy	☐ Commercial	☐ Mining/Dredging	☐ ATV/OHV
☐ Hay/Fields	☐ Logging	☐ Residential	☐ Road/Hwy/RR	☐ Golf Course

Observed Human Disturbance to Stream: Blank (not observed) S (Slight) M (Moderate) H (High)

Riparian Loss		**Logging**		**Industry**		**ATV/OHV**	
Channelization		Urban		Mining/ Dredging		Golf Course	
Active Grazing		Commercial		Road/Hwy/RR		Garbage/Trash	
Row Crops		Residential		Construction		Landfill	
CAFO/Dairy		STP/WWTP		Impoundment		Water Withdrawal	

Other Stream Information and Stressors: Six kicks w/ rectangle net

Stream Sketch: (include road name or landmark, flow direction, reach distance, distance from bridge or road, sampling points, tributaries, outfalls, livestock access, riparian, potential impacts, north arrow, immediate land use, buildings, etc.) Use additional sheet if necessary.

HABITAT ASSESSMENT FIELD SHEET- MODERATE TO HIGH GRADIENT STREAMS (FRONT)

See Protocol E for detailed descriptions and rank information). See BSERT for instructions on completing e-form)

DWR Station ID:		**Habitat Assessment By:** N. Jones	
Monitoring Location Name WQ23		**Date:** 8/30/18	**Time:** 1340
Monitoring Location		**Field Log Number:** EN-5407	
HUC	WS Group.	Ecoregion	QC. ☐ Duplicate ☐ Consensus

	Optimal	**Suboptimal**	**Marginal**	**Poor**
1. Epifaunal Substrate/ Available Cover	Over 70% of stream reach has natural stable habitat suitable for colonization by fish and/or macroinvertebrates Four or more productive habitats are present	Natural stable habitat covers 40-70% of stream reach Three or more productive habitats present (If near 70% and more than 3 go to optimal)	Natural stable habitat covers 20 -40% of stream reach or only 1-2 productive habitats present (If near 40% and more than 2 go to suboptimal)	Less than 20% stable habitat, lack of habitat is obvious, substrate unstable or lacking
SCORE 11	20 19 18 17 16	15 14 13 12 (11)	10 9 8 7 6	5 4 3 2 1
Comments	pool rock, LWD, undercut banks, 40-70%			
2.Embeddedness of Riffles	Gravel, cobble, and boulders 0-25% surrounded by fine sediment Layering of cobble provides diversity of niche space If near 25% drop to suboptimal if riffle not layered cobble	Gravel, cobble and boulders 25-50% surrounded by fine sediment Niches in bottom layers of cobble compromised If near 50% & riffles not layered cobble drop to marginal	Gravel, cobble, and boulders are 50-75% surrounded by fine sediment Niche space in middle layers of cobble is starting to fill with fine sediment	Gravel, cobble, and boulders are more than 75% surrounded by fine sediment Niche space is reduced to a single layer or is absent
SCORE (1) N/A	20 19 18 17 16	15 14 13 (12) 11 N/A	10 9 8 7 6	5 4 3 2 (1) absent
Comments	riffles absent due to beaver impoundment downstream, ~40%, not			
3. Velocity/ Depth Regime	All four velocity/depth regimes present (slow-deep, ✓ slow-shallow, ✓ fast-deep, X fast-shallow) X	Only 3 of the 4 regimes present (if fast-shallow is missing score lower) If slow-deep missing score 15	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low)	Dominated by 1 velocity/depth regime Others regimes too small or infrequent to support aquatic populations
SCORE 7	20 19 18 17 16	15 14 13 12 11	10 9 8 (7) 6	5 4 3 2 1
Comments	only slow-deep + slow-shallow are present			
4. Sediment Deposition	Sediment deposition affects less than 5% of stream bottom in quiet areas New deposition on islands and point bars is absent or minimal	Sediment deposition affects 5-30% of stream bottom Slight deposition in pool or slow areas Some new deposition on islands and point bars Move to marginal if build-up approaches 30%	Sediment deposition affects 30-50% of stream bottom Sediment deposits at obstruction, constrictions and bends Moderate pool deposition	Heavy deposits of fine material, increased bar development, more than 50% of the bottom changing frequently, pools almost absent due to substantial sediment deposition
SCORE 7	20 19 18 17 16	15 14 13 12 11	10 9 8 (7) 6	5 4 3 2 1
Comments	very little on islands, mostly pools, ~50%			
5. Channel Flow Status.	Water reaches base of both lower banks and streambed is covered by water throughout reach Minimal productive habitat is exposed	Water covers ≥ 75% of streambed or 25% of productive habitat is exposed	Water covers 25-75% of streambed and/or productive habitat is mostly exposed	Very little water in channel and mostly present as standing pools Little or no productive habitat due to lack of water
SCORE 20	(20) 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Comments				

sampled area that would be a riffle if beaver impoundment was not present

Department of Environment & Conservation

HABITAT ASSESSMENT FIELD SHEET- MODERATE TO HIGH GRADIENT STREAMS (BACK)

DWR Station ID WCK2.3 Date 8-30-23 Assessors N. Jones

	Optimal	Suboptimal	Marginal	Poor
6. Channel Alteration	Channelization, dredging rock removal, 4-wheel or livestock activity (past or present) absent or minimal, natural meander pattern NO artificial structures in reach Upstream or downstream structures do not affect reach	Channelization, dredging 4-wheel or livestock activity up to 40% Channel has stabilized If larger reach, channelization is historic and stable Artificial structures in or out of reach do not affect natural flow patterns	Channelization, dredging 4-wheel or livestock activity 40-80% (or less that has not stabilized) Artificial structures in or out of reach may have slight affect.	Over 80% of reach channelized, dredged or affected by 4-wheelers or livestock Instream habitat greatly altered or removed Artificial structures have greatly affected flow pattern
SCORE 20	(20) 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Comments				
7. Frequency of re-oxygenation zones. Use frequency of riffle or bends for category Rank by quality	Occurrence of re-oxygenation zones relatively frequent, ratio of distance between areas divided by average stream width <7.1	Occurrence of re-oxygenation zones infrequent, distance between areas divided by average stream width is 7 - 15	Occasional re-oxygenation area The distance between areas divided by average stream width is over 15 and up to 25	Generally all flat water or flat bedrock, little opportunity for re-oxygenation Distance between areas divided by average stream width >25
SCORE 1	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 (1)
Comments	pools only, no swift moving water present			
8. Bank Stability (score each bank) Determine left or right side by facing downstream	Banks stable, evidence of erosion or bank failure absent or minimal, little potential for future problems <5% of bank affected	Moderately stable, infrequent, small areas of erosion mostly healed over 5-30% of bank in reach has areas of erosion If approaching 30% score marginal if banks steep	Moderately unstable, 30-60 % of bank in reach has areas of erosion, high erosion potential during floods, If approaching 60% score poor if banks steep	Unstable, many eroded area, raw areas frequent along straight sections and bends, obvious bank sloughing, 60-100% of bank has erosional scars
SCORE 7 (LB)	Left Bank 10 9	8 (7) 6	5 4 3	2 1 0
SCORE 6 (RB)	Right Bank 10 9	8 7 (6)	5 4 3	2 1 0
Comments	some undercutting + active erosion on both banks, RDB slightly worse			
9. Vegetative Protective (score each bank) includes vegetation from top of bank to base of bank Determine left or right side by facing downstream	More than 90% of the bank covered by undisturbed vegetation All 4 classes (mature trees, understory trees, shrubs, groundcover) are represented and allowed to grow naturally All plants are native	70-90% of the bank covered by undisturbed vegetation One class may not be well represented. Disruption evident but not effecting full plant growth Non-natives are rare (< 30%)	50-70% of the bank covered by undisturbed vegetation Two classes of vegetation may not be well represented Non-native vegetation may be common (30-50%)	Less than 50% of the bank covered by undisturbed vegetation or more than 2 classes are not well represented or most vegetation has been cropped Non-native vegetation may dominate (> 50%)
SCORE 8 (LB)	Left Bank 10 9	(8) 7 6	5 4 3	2 1 0
SCORE 8 (RB)	Right Bank 10 9	(8) 7 6	5 4 3	2 1 0
Comments	non-natives present			
10. Riparian Vegetative Zone Width (score each bank.) Zone begins at top of bank	Average width of riparian zone > 18 meters Unpaved footpaths may score 9 if run-off potential is negligible	Average width of riparian zone 12-18 meters Score high if areas < 18 meters are small or are minimally disturbed	Average width of riparian zone 6-11 meters Score high if areas less than 12 meters are small or are minimally disturbed	Average width of riparian zone <6 meters Score high if areas less than 6 meters are small or are minimally disturbed
SCORE 10 (LB)	Left Bank (10) 9	8 7 6	5 4 3	2 1 0
SCORE 10 (RB)	Right Bank (10) 9	8 7 6	5 4 3	2 1 0
Comments				

Total Score 128 116 Comparison to Ecoregion Guidelines (circle): ABOVE or (BELOW)
If score is below guidelines , result of (circle) Natural Conditions or Human Disturbance
Describe: beaver impoundment + sedimentation

STREAM SURVEY INFORMATION (see protocol E for detailed information and BSERT for Completing E-Form)

DWR Station ID: WCK 3.9	**Samplers:** N.JONES & T. Jeff	
Monitoring Location Name:	**Date:** 8-30-23 **Time:** 1456	
Monitoring Location:	**Organization:**	Drainage Area:
County:	Ecoregion:	u/s ECO:
Latitude:	HUC:	WS Grp:
Longitude:	WBID:	Field Log #:

Project Name: ☐ Watershed ☐ 303(d) ☐ Antideg ☐ ECO ☐ FECO Other:

Project ID: TNPR

Activity Type: ☑ Sample ☐ QC Sample ☐ Habitat ☐ QC habitat ☐ QC ID

Sample Status: ☑Collected ☐Seasonally Dry ☐Frequently Dry ☐No Channel
☐Too Deep (Not Wadeable) ☐Too Deep (Temporary) ☐Permanent Barrier ☐Fenced
☐Landowner Denial: ☐Temporary Barrier ☐Posted Plan to revisit? ☐Yes ☐No

Flow Conditions: ☐Dry ☑Isolated Pools ☐Stagnant ☐Low ☐Moderate ☐High ☐Bankful ☐Flooding

Chemicals/Bacteria: ☑None ☐Routine ☐Nutrient ☐Metals ☐*E. coli* ☐Organics ☐Other_____

Field Parameters: Meter(s) Used: YSI PRODSS

pH (su)	8.37		Dissolved Oxygen %	92.8	
Conductivity (umhos)	478.7	504 SPC	Turbidity ~~(NTU)~~ FNU	2.63	
Temperature (C°)	22.4		TDS (mg/L)	327	
Dissolved Oxygen (ppm = mg/L)	8.04		Flow (cfs)	4.8	15 CFS

Meter Problems?_____

Photos Taken? ☐ No ☑Yes: Description: _____

Previous 48 hours precipitation: ☐Unknown ☐None ☐Slight ☐Moderate ☐Heavy ☐Flooding
Air Temperature (°F) _____

Physical Characteristics & Light Penetration:

Gradient (sample reach): ☐Flat ☐Low ☐Moderate ☐High ☐Cascades

Average Stream Width: ☐Very Small (<1.5yd) ☐Small (1.5-3yd) ☐Med. (3-10yd) ☐Large (10-25yd) ☐Very Large (>25yd)

Maximum Stream Depth: ☐Shallow (<0.3yd) ☐Medium (0.3-0.6yd) ☐Deep (0.6 – 1yd) ☐Very Deep(>1yd)

% Canopy Cover Estimated for Reach: _____% #W/out

% Canopy Cover Measured (mid-reach): 5 u/s + 3 d/s + 5 LDB + 5 RDB = Total/384*100 81.8%

Channel Characteristics:

Bank Height: _____ (yd.) High Water Mark: _____(yd.)

Bank Slope LDB: ☐Deeply incised ☐Bluff/Wall ☐Undercut ☐Sloughing ☐Steep terrain ☐Gentle Slope

Bank Slope RDB: ☐Deeply incised ☐Bluff/Wall ☐Undercut ☐Sloughing ☐Steep terrain ☐Gentle Slope

Manmade Modification: ☐None ☐Rip-Rap ☐Cement ☐Gabions ☐Channelized ☐Dam ☐Dredging ☐Bridge ☐ATV

Stream Characteristics:

Sediment Deposits: ☐None ☐Slight ☐Moderate ☐Excessive ☐Blanket

Sediment Type: ☐None ☐Sand ☐Silt ☐Mud ☐Clay ☐Sludge ☐Mn Precipitant ☐Orange Flocculent

Turbidity: ☐Clear ☐Slightly Turbid ☐Muddy ☐Milky ☐Tannic ☐Planktonic Algae ☐Dyed

Foam/Surface Sheen: ☐None ☐Nutrient ☐Surfactant ☐Bacteria

Algae: ☐None ☐Slight ☐Moderate ☐High ☐Choking **Type**: ☐Diatoms ☐Green ☐Filamentous ☐Blue-green

TDEC-DWR Stream Survey Field Sheet (Back)

DWR Station ID: WC139 Date: 8-30-23 Assessors: NJ JG ST TJCH

Dominate Substrate: (More than 25%) Select up to 4

Riffle	Run	Pool
☐ Boulders (>10")	☐ Boulders (>10")	☐ Boulders (>10")
☐ Cobble (2.5-10")	☐ Cobble (2.5-10")	☐ Cobble (2.5-10")
☐ Gravel (0.1-2.5")	☐ Gravel (0.1-2.5")	☐ Gravel (0.1-2.5")
☐ Bedrock	☐ Bedrock	☐ Bedrock
☐ Sand	☐ Sand	☐ Sand
☐ Silt (not gritty)	☐ Silt (not gritty)	☐ Silt (not gritty)
☐ Clay (Slick)	☐ Clay (Slick)	☐ Clay (Slick)

Surrounding Land Uses (list additional land uses under comments)

☐ Forest	☐ Grazing	☐ Stormwater	☐ STP/WWTP	☐ Construction
☐ Wetland	☐ Row Crops	☐ Urban	☐ Industry	☐ Impoundment
☐ Park	☐ CAFO/Dairy	☐ Commercial	☐ Mining/Dredging	☐ ATV/OHV
☐ Hay/Fields	☐ Logging	☐ Residential	☐ Road/Hwy/RR	☐ Golf Course

Observed Human Disturbance to Stream: Blank (not observed) S (Slight) M (Moderate) H (High)

Riparian Loss		**Logging**		**Industry**		**ATV/OHV**	
Channelization		Urban		Mining/ Dredging		Golf Course	
Active Grazing		Commercial		Road/Hwy/RR		Garbage/Trash	
Row Crops		Residential		Construction		Landfill	
CAFO/Dairy		STP/WWTP		Impoundment		Water Withdrawal	

Other Stream Information and Stressors: Six kicks @ w/ rectangle net

Stream Sketch: (include road name or landmark, flow direction, reach distance, distance from bridge or road, sampling points, tributaries, outfalls, livestock access, riparian, potential impacts, north arrow, immediate land use, buildings, etc.) Use additional sheet if necessary.

Department of Environment & Conservation

HABITAT ASSESSMENT FIELD SHEET- MODERATE TO HIGH GRADIENT STREAMS (FRONT)

See Protocol E for detailed descriptions and rank information). See BSERT for instructions on completing e-form)

DWR Station ID:		**Habitat Assessment By:** Nichols	
Monitoring Location Name WW39		**Date:** 8-30-23	**Time:** 1456
Monitoring Location		**Field Log Number:** TN-5140	
HUC	WS Group	Ecoregion.	QC ☐ Duplicate ☐ Consensus

	Optimal	**Suboptimal**	**Marginal**	**Poor**
1. Epifaunal Substrate/ Available Cover	Over 70% of stream reach has natural stable habitat suitable for colonization by fish and/or macroinvertebrates Four or more productive habitats are present	Natural stable habitat covers 40-70% of stream reach Three or more productive habitats present (If near 70% and more than 3 go to optimal)	Natural stable habitat covers 20 -40% of stream reach or only 1-2 productive habitats present (If near 40% and more than 2 go to suboptimal)	Less than 20% stable habitat, lack of habitat is obvious, substrate unstable or lacking
SCORE 11	20 19 18 17 16	15 14 13 12 (11)	10 9 8 7 6	5 4 3 2 1
Comments	gravel riffle, not wad, pool rock			
2.Embeddedness of Riffles	Gravel, cobble, and boulders 0-25% surrounded by fine sediment Layering of cobble provides diversity of niche space If near 25% drop to suboptimal if riffle not layered cobble	Gravel, cobble and boulders 25-50% surrounded by fine sediment Niches in bottom layers of cobble compromised If near 50% & riffles not layered cobble drop to marginal	Gravel, cobble, and boulder s are 50-75% surrounded by fine sediment Niche space in middle layers of cobble is starting to fill with fine sediment	Gravel, cobble, and boulders are more than 75% surrounded by fine sediment Niche space is reduced to a single layer or is absent
SCORE 10	20 19 18 17 16	15 14 13 12 (11)	(10) 9 8 7 6	5 4 3 2 1
Comments	50-60%, not layered			
3. Velocity/ Depth Regime	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow)	Only 3 of the 4 regimes present (if fast-shallow is missing score lower) If slow-deep missing score 15	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low)	Dominated by 1 velocity/depth regime Others regimes too small or infrequent to support aquatic populations.
SCORE 18	20 19 (18) 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Comments	all present, slow-shallow dominant			
4. Sediment Deposition	Sediment deposition affects less than 5% of stream bottom in quiet areas New deposition on islands and point bars is absent or minimal	Sediment deposition affects 5-30% of stream bottom Slight deposition in pool or slow areas Some new deposition on islands and point bars Move to marginal if build-up approaches 30%	Sediment deposition affects 30-50% of stream bottom Sediment deposits at obstruction, constructions and bends. Moderate pool deposition	Heavy deposits of fine material, increased bar development, more than 50% of the bottom changing frequently, pools almost absent due to substantial sediment deposition
SCORE 12	20 19 18 17 16	15 14 13 (12) 11	10 9 8 7 6	5 4 3 2 1
Comments	bars/islands & pools, 25%			
5. Channel Flow Status.	Water reaches base of both lower banks and streambed is covered by water throughout reach Minimal productive habitat is exposed	Water covers > 75% of streambed or 25% of productive habitat is exposed	Water covers 25-75% of streambed and/or productive habitat is mostly exposed	Very little water in channel and mostly present as standing pools Little or no productive habitat due to lack of water
SCORE 20	(20) 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Comments				

HABITAT ASSESSMENT FIELD SHEET- MODERATE TO HIGH GRADIENT STREAMS (BACK)

DWR Station ID WCK839 Date 8-30-23 Assessors N. Jones

	Optimal	Suboptimal	Marginal	Poor
6. Channel Alteration	Channelization, dredging rock removal, 4-wheel or livestock activity (past or present) absent or minimal; natural meander pattern NO artificial structures in reach Upstream or downstream structures do not affect reach	Channelization, dredging 4-wheel or livestock activity up to 40% Channel has stabilized If larger reach, channelization is historic and stable Artificial structures in or out of reach do not affect natural flow patterns	Channelization, dredging 4-wheel or livestock activity 40-80% (or less that has not stabilized) Artificial structures in or out of reach may have slight affect	Over 80% of reach channelized, dredged or affected by 4-wheelers or livestock Instream habitat greatly altered or removed Artificial structures have greatly affected flow pattern
SCORE 5	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Comments				
7. Frequency of re-oxygenation zones. Use frequency of riffle or bends for category Rank by quality	Occurrence of re-oxygenation zones relatively frequent; ratio of distance between areas divided by average stream width <7 1	Occurrence of re-oxygenation zones infrequent, distance between areas divided by average stream width is 7 - 15	Occasional re-oxygenation area The distance between areas divided by average stream width is over 15 and up to 25	Generally all flat water or flat bedrock, little opportunity for re-oxygenation Distance between areas divided by average stream width >25
SCORE 13	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Comments	a few riffles upstream			
8. Bank Stability (score each bank) Determine left or right side by facing downstream	Banks stable, evidence of erosion or bank failure absent or minimal, little potential for future problems <5% of bank affected	Moderately stable, infrequent, small areas of erosion mostly healed over 5-30% of bank in reach has areas of erosion If approaching 30% score marginal if banks steep	Moderately unstable, 30-60 % of bank in reach has areas of erosion; high erosion potential during floods, If approaching 60% score poor if banks steep	Unstable, many eroded area, raw areas frequent along straight sections and bends, obvious bank sloughing, 60-100% of bank has erosional scars
SCORE 9 (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE 9 (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
Comments	RDB undercut + active erosion			
9. Vegetative Protective (score each bank) Includes vegetation from top of bank to base of bank Determine left or right side by facing downstream	More than 90% of the bank covered by undisturbed vegetation All 4 classes (mature trees, understory trees, shrubs, groundcover) are represented and allowed to grow naturally All plants are native	70-90% of the bank covered by undisturbed vegetation One class may not be well represented Disruption evident but not effecting full plant growth Non-natives are rare (< 30%)	50-70% of the bank covered by undisturbed vegetation Two classes of vegetation may not be well represented Non-native vegetation may be common (30-50%)	Less than 50% of the bank covered by undisturbed vegetation or more than 2 classes are not well represented or most vegetation has been cropped Non-native vegetation may dominate (> 50%)
SCORE 7 (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE 7 (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
Comments	no thinning of vegetation this year, non-natives present			
10. Riparian Vegetative Zone Width (score each bank) Zone begins at top of bank	Average width of riparian zone > 18 meters Unpaved footpaths may score 9 if run-off potential is negligible	Average width of riparian zone 12-18 meters Score high if areas < 18 meters are small or are minimally disturbed	Average width of riparian zone 6-11 meters Score high if areas less than 12 meters are small or are minimally disturbed	Average width of riparian zone <6 meters. Score high if areas less than 6 meters are small or are minimally disturbed
SCORE 9 (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE 9 (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
Comments				

Total Score 133 Comparison to Ecoregion Guidelines (circle) ABOVE or BELOW
If score is below guidelines , result of (circle) Natural Conditions or Human Disturbance
Describe

STREAM SURVEY INFORMATION (see protocol E for detailed information and BSERT for Completing E-Form)

DWR Station ID:	**Samplers:** N Jones + T Bordeau	
Monitoring Location Name: NCK18	**Date:** 8-10-23 **Time:** 1109	
Monitoring Location:	**Organization:**	Drainage Area:
County:	Ecoregion:	u/s ECO:
Latitude:	HUC:	WS Grp:
Longitude:	WBID:	Field Log #:

Project Name: ☐ Watershed ☐ 303(d) ☐ Antideg ☐ ECO ☐ FECO Other:

Project ID: TNPR

Activity Type: ☑ Sample ☐ QC Sample ☐ Habitat ☐ QC habitat ☐ QC ID

Sample Status: ☑Collected ☐Seasonally Dry ☐Frequently Dry ☐No Channel
☐Too Deep (Not Wadeable) ☐Too Deep (Temporary) ☐Permanent Barrier ☐Fenced
☐Landowner Denial: ☐Temporary Barrier ☐Posted Plan to revisit? ☐Yes ☐No

Flow Conditions: ☐Dry ☑Isolated Pools ☐Stagnant ☐Low ☐Moderate ☐High ☐Bankful ☐Flooding

Chemicals/Bacteria: ☑None ☐Routine ☐Nutrient ☐Metals ☐*E. coli* ☐Organics ☐Other_____

Field Parameters: Meter(s) Used: YSI ProDSS

pH (su)	8.11		Dissolved Oxygen %	92.9	
Conductivity (umhos) ~~total~~ SPC	269.6	313.6	Turbidity (~~NTU~~) FNU	1.53	
Temperature (C°)	17.7		TDS (mg/L)	204	
Dissolved Oxygen (ppm = mg/L)	8.84		Flow (cfs)		

Meter Problems?_____

Photos Taken? ☐ No ☑Yes: Description: _____

Previous 48 hours precipitation: ☐Unknown ☐None ☐Slight ☐Moderate ☐Heavy ☐Flooding
Air Temperature (°F) _____

Physical Characteristics & Light Penetration:

Gradient (sample reach): ☐Flat ☐Low ☐Moderate ☐High ☐Cascades

Average Stream Width: ☐Very Small (<1.5yd) ☐Small (1.5-3yd) ☐Med. (3-10yd) ☐Large (10-25yd) ☐Very Large (>25yd)

Maximum Stream Depth: ☐Shallow (<0.3yd) ☐Medium (0.3-0.6yd) ☐Deep (0.6 – 1yd) ☐Very Deep(>1yd)

% Canopy Cover Estimated for Reach: _____%

% Canopy Cover Measured (mid-reach): 0 u/s + 1 d/s + 0 LDB + 0 RDB = Total/384*100 #WIAT 99.32

Channel Characteristics:

Bank Height: _____ (yd.) High Water Mark: _____(yd.)

Bank Slope LDB: ☐Deeply incised ☐Bluff/Wall ☐Undercut ☐Sloughing ☐Steep terrain ☐Gentle Slope

Bank Slope RDB: ☐Deeply incised ☐Bluff/Wall ☐Undercut ☐Sloughing ☐Steep terrain ☐Gentle Slope

Manmade Modification: ☐None ☐Rip-Rap ☐Cement ☐Gabions ☐Channelized ☐Dam ☐Dredging ☐Bridge ☐ATV

Stream Characteristics:

Sediment Deposits: ☐None ☐Slight ☐Moderate ☐Excessive ☐Blanket

Sediment Type: ☐None ☐Sand ☐Silt ☐Mud ☐Clay ☐Sludge ☐Mn Precipitant ☐Orange Flocculent

Turbidity: ☐Clear ☐Slightly Turbid ☐Muddy ☐Milky ☐Tannic ☐Planktonic Algae ☐Dyed

Foam/Surface Sheen: ☐None ☐Nutrient ☐Surfactant ☐Bacteria

Algae: ☐None ☐Slight ☐Moderate ☐High ☐Choking **Type**: ☐Diatoms ☐Green ☐Filamentous ☐Blue-green

Department of Environment & Conservation

TDEC-DWR Stream Survey Field Sheet (Back)

DWR Station ID: WCW18 Date: 8-30-23 Assessors: N Jones + T. Bordeau

Dominate Substrate: (More than 25%) Select up to 4

Riffle	Run	Pool
☐ Boulders (>10")	☐ Boulders (>10")	☐ Boulders (>10")
☐ Cobble (2.5-10")	☐ Cobble (2.5-10")	☐ Cobble (2.5-10")
☐ Gravel (0.1-2.5")	☐ Gravel (0.1-2.5")	☐ Gravel (0.1-2.5")
☐ Bedrock	☐ Bedrock	☐ Bedrock
☐ Sand	☐ Sand	☐ Sand
☐ Silt (not gritty)	☐ Silt (not gritty)	☐ Silt (not gritty)
☐ Clay (Slick)	☐ Clay (Slick)	☐ Clay (Slick)

Surrounding Land Uses (list additional land uses under comments)

☐ Forest	☐ Grazing	☐ Stormwater	☐ STP/WWTP	☐ Construction
☐ Wetland	☐ Row Crops	☐ Urban	☐ Industry	☐ Impoundment
☐ Park	☐ CAFO/Dairy	☐ Commercial	☐ Mining/Dredging	☐ ATV/OHV
☐ Hay/Fields	☐ Logging	☐ Residential	☐ Road/Hwy/RR	☐ Golf Course

Observed Human Disturbance to Stream: Blank (not observed) S (Slight) M (Moderate) H (High)

Riparian Loss		**Logging**		**Industry**		**ATV/OHV**	
Channelization		Urban		Mining/ Dredging		Golf Course	
Active Grazing		Commercial		Road/Hwy/RR		Garbage/Trash	
Row Crops		Residential		Construction		Landfill	
CAFO/Dairy		STP/WWTP		Impoundment		Water Withdrawal	

Other Stream Information and Stressors:

Stream Sketch: (include road name or landmark, flow direction, reach distance, distance from bridge or road, sampling points, tributaries, outfalls, livestock access, riparian, potential impacts, north arrow, immediate land use, buildings, etc.) Use additional sheet if necessary.

HABITAT ASSESSMENT FIELD SHEET- MODERATE TO HIGH GRADIENT STREAMS (FRONT)

See Protocol E for detailed descriptions and rank information). See BSERT for instructions on completing e-form)

DWR Station ID:		**Habitat Assessment By:** Nolles	
Monitoring Location Name WCK 1.8		**Date:** 8-30-23	**Time:** 1109
Monitoring Location		**Field Log Number:** EN-2401	
HUC	WS Group	Ecoregion	QC ☐ Duplicate ☐ Consensus

	Optimal	Suboptimal	Marginal	Poor
1. Epifaunal Substrate/ Available Cover	Over 70% of stream reach has natural stable habitat suitable for colonization by fish and/or macroinvertebrates Four or more productive habitats are present	Natural stable habitat covers 40-70% of stream reach Three or more productive habitats present (If near 70% and more than 3 go to optimal)	Natural stable habitat covers 20 -40% of stream reach or only 1-2 productive habitats present (If near 40% and more than 2 go to suboptimal)	Less than 20% stable habitat, lack of habitat is obvious, substrate unstable or lacking
SCORE 20	(20) 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Comments	cobble riffle, root wad, pool rock, bedrock channels			
2.Embeddedness of Riffles	Gravel, cobble, and boulders 0-25% surrounded by fine sediment Layering of cobble provides diversity of niche space If near 25% drop to suboptimal if riffle not layered cobble	Gravel, cobble and boulders 25-50% surrounded by fine sediment Niches in bottom layers of cobble compromised If near 50% & riffles not layered cobble drop to marginal	Gravel, cobble, and boulder s are 50-75% surrounded by fine sediment Niche space in middle layers of cobble is starting to fill with fine sediment	Gravel, cobble, and boulders are more than 75% surrounded by fine sediment Niche space is reduced to a single layer or is absent
SCORE 16	20 19 18 17 (16)	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Comments	~20%, some layering			
3. Velocity/ Depth Regime	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, X fast-shallow)	Only 3 of the 4 regimes present (if fast-shallow is missing score lower) If slow-deep missing score 15	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low)	Dominated by 1 velocity/depth regime Others regimes too small or infrequent to support aquatic populations
SCORE 14	20 19 18 17 16	15 (14) 13 12 11	10 9 8 7 6	5 4 3 2 1
Comments	fast-shallow dominant			
4. Sediment Deposition	Sediment deposition affects less than 5% of stream bottom in quiet areas New deposition on islands and point bars is absent or minimal	Sediment deposition affects 5-30% of stream bottom Slight deposition in pool or slow areas Some new deposition on islands and point bars Move to marginal if build-up approaches 30%	Sediment deposition affects 30-50% of stream bottom Sediment deposits at obstruction, constrictions and bends Moderate pool deposition	Heavy deposits of fine material, increased bar development, more than 50% of the bottom changing frequently, pools almost absent due to substantial sediment deposition
SCORE 11	20 19 18 17 16	15 14 13 12 (11)	10 9 8 7 6	5 4 3 2 1
Comments	some of riffle has filled in excessive gravel deposition (now back riffle) significant in pools, 30%			
5. Channel Flow Status.	Water reaches base of both lower banks and streambed is covered by water throughout reach Minimal productive habitat is exposed	Water covers > 75% of streambed or 25% of productive habitat is exposed	Water covers 25-75% of streambed and/or productive habitat is mostly exposed	Very little water in channel and mostly present as standing pools Little or no productive habitat due to lack of water
SCORE 20	(20) 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Comments				

HABITAT ASSESSMENT FIELD SHEET- MODERATE TO HIGH GRADIENT STREAMS (BACK)

DWR Station ID WCU18 Date 8-2023 Assessors N. Jones

	Optimal	Suboptimal	Marginal	Poor
6. Channel Alteration	Channelization, dredging rock removal, 4-wheel or livestock activity (past or present) absent or minimal, natural meander pattern NO artificial structures in reach Upstream or downstream structures do not affect reach	Channelization, dredging 4-wheel or livestock activity up to 40% Channel has stabilized If larger reach, channelization is historic and stable Artificial structures in or out of reach do not affect natural flow patterns	Channelization, dredging 4-wheel or livestock activity 40-80% (or less that has not stabilized) Artificial structures in or out of reach may have slight affect	Over 80% of reach channelized, dredged or affected by 4-wheelers or livestock Instream habitat greatly altered or removed Artificial structures have greatly affected flow pattern
SCORE 20	(20) 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Comments				
7. Frequency of re-oxygenation zones. Use frequency of riffle or bends for category Rank by quality	Occurrence of re-oxygenation zones relatively frequent, ratio of distance between areas divided by average stream width <7 1	Occurrence of re-oxygenation zones infrequent; distance between areas divided by average stream width is 7 - 15	Occasional re-oxygenation area The distance between areas divided by average stream width is over 15 and up to 25	Generally all flat water or flat bedrock, little opportunity for re-oxygenation Distance between areas divided by average stream width >25
SCORE 20	(20) 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Comments	Regional			
8. Bank Stability (score each bank) Determine left or right side by facing downstream	Banks stable, evidence of erosion or bank failure absent or minimal, little potential for future problems <5% of bank affected	Moderately stable; infrequent, small areas of erosion mostly healed over 5-30% of bank in reach has areas of erosion If approaching 30% score marginal if banks steep	Moderately unstable, 30-60 % of bank in reach has areas of erosion; high erosion potential during floods, If approaching 60% score poor if banks steep	Unstable, many eroded area, raw areas frequent along straight sections and bends, obvious bank sloughing, 60-100% of bank has erosional scars
SCORE 9 (LB)	Left Bank 10 (9)	8 7 6	5 4 3	2 1 0
SCORE 8 (RB)	Right Bank 10 9	(8) 7 6	5 4 3	2 1 0
Comments	2RB Some active erosion DS bifle			
9. Vegetative Protective (score each bank) includes vegetation from top of bank to base of bank Determine left or right side by facing downstream	More than 90% of the bank covered by undisturbed vegetation All 4 classes (mature trees, understory trees, shrubs, groundcover) are represented and allowed to grow naturally All plants are native	70-90% of the bank covered by undisturbed vegetation One class may not be well represented Disruption evident but not effecting full plant growth Non-natives are rare (< 30%)	50-70% of the bank covered by undisturbed vegetation Two classes of vegetation may not be well represented Non-native vegetation may be common (30-50%)	Less than 50% of the bank covered by undisturbed vegetation or more than 2 classes are not well represented or most vegetation has been cropped Non-native vegetation may dominate (> 50%)
SCORE 8 (LB)	Left Bank 10 9	(8) 7 6	5 4 3	2 1 0
SCORE 8 (RB)	Right Bank 10 9	(8) 7 6	5 4 3	2 1 0
Comments				
10. Riparian Vegetative Zone Width (score each bank) Zone begins at top of bank	Average width of riparian zone > 18 meters Unpaved footpaths may score 9 if run-off potential is negligible	Average width of riparian zone 12-18 meters Score high if areas < 18 meters are small or are minimally disturbed	Average width of riparian zone 6-11 meters Score high if areas less than 12 meters are small or are minimally disturbed	Average width of riparian zone <6 meters. Score high if areas less than 6 meters are small or are minimally disturbed
SCORE 9 (LB)	Left Bank 10 9	8 7 6	5 4 3	2 (1) 0
SCORE 10 (RB)	Right Bank (10) 9	8 7 6	5 4 3	2 1 0
Comments				

Total Score 105 Comparison to Ecoregion Guidelines (circle) (ABOVE) or BELOW
If score is below guidelines , result of (circle): Natural Conditions or Human Disturbance
Describe.

STREAM SURVEY INFORMATION (see protocol E for detailed information and BSERT for Completing E-Form)

DWR Station ID: First Creek 0.1	**Samplers:** N. JONES, T. JETT	
Monitoring Location Name:	**Date:** 8-30-23 **Time:** 1424	
Monitoring Location:	**Organization:**	Drainage Area:
County:	Ecoregion:	u/s ECO:
Latitude:	HUC:	WS Grp:
Longitude:	WBID:	Field Log #:

Project Name: ☐ Watershed ☐ 303(d) ☐ Antideg ☐ ECO ☐ FECO Other:

Project ID: TNPR

Activity Type: ☑ Sample ☐ QC Sample ☐ Habitat ☐ QC habitat ☐ QC ID

Sample Status: ☑Collected ☐Seasonally Dry ☐Frequently Dry ☐No Channel
☐Too Deep (Not Wadeable) ☐Too Deep (Temporary) ☐Permanent Barrier ☐Fenced
☐Landowner Denial: ☐Temporary Barrier ☐Posted Plan to revisit? ☐Yes ☐No

Flow Conditions: ☐Dry ☑Isolated Pools ☐Stagnant ☐Low ☐Moderate ☐High ☐Bankful ☐Flooding

Chemicals/Bacteria: ☑None ☐Routine ☐Nutrient ☐Metals ☐*E. coli* ☐Organics ☐Other_____

Field Parameters: Meter(s) Used: YSI PRODSS

pH (su)	8.06		Dissolved Oxygen %	90.6	
Conductivity (umhos)	320.3	351.1 SPC	Turbidity ~~(NTU)~~ FNU	1.77	
Temperature (C°)	20.4		TDS (mg/L)	228	
Dissolved Oxygen (ppm = mg/L)	8.15		Flow (cfs)	0.2	

Meter Problems?_____

Photos Taken? ☐ No ☑Yes: Description: _____

Previous 48 hours precipitation: ☐Unknown ☐None ☐Slight ☐Moderate ☐Heavy ☐Flooding
Air Temperature (°F) _____

Physical Characteristics & Light Penetration:

Gradient (sample reach): ☐Flat ☐Low ☐Moderate ☐High ☐Cascades

Average Stream Width: ☐Very Small (<1.5yd) ☐Small (1.5-3yd) ☐Med. (3-10yd) ☐Large (10-25yd) ☐Very Large (>25yd)

Maximum Stream Depth: ☐Shallow (<0.3yd) ☐Medium (0.3-0.6yd) ☐Deep (0.6 – 1yd) ☐Very Deep(>1yd)

% Canopy Cover Estimated for Reach: _____%

% Canopy Cover Measured (mid-reach): 1 u/s + 0 d/s + 0 LDB + 0 RDB = Total/384*100 99.3 #u/s/ds

Channel Characteristics:

Bank Height: _____ (yd.) High Water Mark: _____(yd.)

Bank Slope LDB: ☐Deeply incised ☐Bluff/Wall ☐Undercut ☐Sloughing ☐Steep terrain ☐Gentle Slope

Bank Slope RDB: ☐Deeply incised ☐Bluff/Wall ☐Undercut ☐Sloughing ☐Steep terrain ☐Gentle Slope

Manmade Modification: ☐None ☐Rip-Rap ☐Cement ☐Gabions ☐Channelized ☐Dam ☐Dredging ☐Bridge ☐ATV

Stream Characteristics:

Sediment Deposits: ☐None ☐Slight ☐Moderate ☐Excessive ☐Blanket

Sediment Type: ☐None ☐Sand ☐Silt ☐Mud ☐Clay ☐Sludge ☐Mn Precipitant ☐Orange Flocculent

Turbidity: ☐Clear ☐Slightly Turbid ☐Muddy ☐Milky ☐Tannic ☐Planktonic Algae ☐Dyed

Foam/Surface Sheen: ☐None ☐Nutrient ☐Surfactant ☐Bacteria

Algae: ☐None ☐Slight ☐Moderate ☐High ☐Choking **Type:** ☐Diatoms ☐Green ☐Filamentous ☐Blue-green

TDEC-DWR Stream Survey Field Sheet (Back)

DWR Station ID: FCW.1 Date: 8-30-23 Assessors: N. Jones T. Jett

Dominate Substrate: (More than 25%) Select up to 4

Riffle	Run	Pool
☐ Boulders (>10")	☐ Boulders (>10")	☐ Boulders (>10")
☐ Cobble (2.5-10")	☐ Cobble (2.5-10")	☐ Cobble (2.5-10")
☐ Gravel (0.1-2.5")	☐ Gravel (0.1-2.5")	☐ Gravel (0.1-2.5")
☐ Bedrock	☐ Bedrock	☐ Bedrock
☐ Sand	☐ Sand	☐ Sand
☐ Silt (not gritty)	☐ Silt (not gritty)	☐ Silt (not gritty)
☐ Clay (Slick)	☐ Clay (Slick)	☐ Clay (Slick)

Surrounding Land Uses (list additional land uses under comments)

☐	Forest	☐	Grazing	☐	Stormwater	☐	STP/WWTP	☐	Construction
☐	Wetland	☐	Row Crops	☐	Urban	☐	Industry	☐	Impoundment
☐	Park	☐	CAFO/Dairy	☐	Commercial	☐	Mining/Dredging	☐	ATV/OHV
☐	Hay/Fields	☐	Logging	☐	Residential	☐	Road/Hwy/RR	☐	Golf Course

Observed Human Disturbance to Stream: Blank (not observed) S (Slight) M (Moderate) H (High)

Riparian Loss		**Logging**		**Industry**		**ATV/OHV**	
Channelization		Urban		Mining/ Dredging		Golf Course	
Active Grazing		Commercial		Road/Hwy/RR		Garbage/Trash	
Row Crops		Residential		Construction		Landfill	
CAFO/Dairy		STP/WWTP		Impoundment		Water Withdrawal	

Other Stream Information and Stressors:

4 kicks w/ rectangle net

Stream Sketch: (include road name or landmark, flow direction, reach distance, distance from bridge or road, sampling points, tributaries, outfalls, livestock access, riparian, potential impacts, north arrow, immediate land use, buildings, etc.) Use additional sheet if necessary.

HABITAT ASSESSMENT FIELD SHEET- MODERATE TO HIGH GRADIENT STREAMS (FRONT)

See Protocol E for detailed descriptions and rank information). See BSERT for instructions on completing e-form)

DWR Station ID:		**Habitat Assessment By:** NJ/MS	
Monitoring Location Name FCK01		**Date:** 6-20-23	**Time:** 1424
Monitoring Location		**Field Log Number:** ELN-5467	
HUC	WS Group	Ecoregion	QC. ☐ Duplicate ☐ Consensus

	Optimal	**Suboptimal**	**Marginal**	**Poor**
1. Epifaunal Substrate/ Available Cover	Over 70% of stream reach has natural stable habitat suitable for colonization by fish and/or macroinvertebrates Four or more productive habitats are present	Natural stable habitat covers 40-70% of stream reach Three or more productive habitats present (If near 70% and more than 3 go to optimal)	Natural stable habitat covers 20 -40% of stream reach or only 1-2 productive habitats present (If near 40% and more than 2 go to suboptimal)	Less than 20% stable habitat, lack of habitat is obvious, substrate unstable or lacking
SCORE 16	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Comments	cobbled gravel riffle, root wad, undercut bank, pool rock, >70%			
2.Embeddedness of Riffles	Gravel, cobble, and boulders 0-25% surrounded by fine sediment Layering of cobble provides diversity of niche space If near 25% drop to suboptimal if riffle not layered cobble	Gravel, cobble and boulders 25-50% surrounded by fine sediment Niches in bottom layers of cobble compromised If near 50% & riffles not layered cobble drop to marginal	Gravel, cobble, and boulders are 50-75% surrounded by fine sediment Niche space in middle layers of cobble is starting to fill with fine sediment	Gravel, cobble, and boulders are more than 75% surrounded by fine sediment Niche space is reduced to a single layer or is absent.
SCORE 14	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Comments	30%, not layered			
3. Velocity/ Depth Regime	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow)	Only 3 of the 4 regimes present (if fast-shallow is missing score lower) If slow-deep missing score 15	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low)	Dominated by 1 velocity/depth regime Others regimes too small or infrequent to support aquatic populations
SCORE 11	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Comments	fast-deep missing, slow-deep dominant			
4. Sediment Deposition	Sediment deposition affects less than 5% of stream bottom in quiet areas New deposition on islands and point bars is absent or minimal	Sediment deposition affects 5-30% of stream bottom Slight deposition in pool or slow areas Some new deposition on islands and point bars Move to marginal if build-up approaches 30%	Sediment deposition affects 30-50% of stream bottom Sediment deposits at obstruction, constrictions and bends Moderate pool deposition	Heavy deposits of fine material, increased bar development, more than 50% of the bottom changing frequently, pools almost absent due to substantial sediment deposition
SCORE 6	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Comments	MIS + POS, >50%			
5. Channel Flow Status.	Water reaches base of both lower banks and streambed is covered by water throughout reach Minimal productive habitat is exposed	Water covers > 75% of streambed or 25% of productive habitat is exposed	Water covers 25-75% of streambed and/or productive habitat is mostly exposed	Very little water in channel and mostly present as standing pools Little or no productive habitat due to lack of water
SCORE 20	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Comments				

HABITAT ASSESSMENT FIELD SHEET- MODERATE TO HIGH GRADIENT STREAMS (BACK)

DWR Station ID FCW0.1 Date 8/30/23 Assessors N. Jones

	Optimal	Suboptimal	Marginal	Poor
6. Channel Alteration 15	Channelization, dredging rock removal, 4-wheel or livestock activity (past or present) absent or minimal, natural meander pattern NO artificial structures in reach Upstream or downstream structures do not affect reach	Channelization, dredging 4-wheel or livestock activity up to 40% Channel has stabilized If larger reach, channelization is historic and stable Artificial structures in or out of reach do not affect natural flow patterns	Channelization, dredging 4-wheel or livestock activity 40-80% (or less that has not stabilized.) Artificial structures in or out of reach may have slight affect	Over 80% of reach channelized, dredged or affected by 4-wheelers or livestock Instream habitat greatly altered or removed Artificial structures have greatly affected flow pattern
SCORE	20 19 18 17 16	(15) 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Comments				
7. Frequency of re-oxygenation zones. Use frequency of riffle or bends for category Rank by quality 13	Occurrence of re-oxygenation zones relatively frequent, ratio of distance between areas divided by average stream width <7 1	Occurrence of re-oxygenation zones infrequent, distance between areas divided by average stream width is 7 - 15	Occasional re-oxygenation area The distance between areas divided by average stream width is over 15 and up to 25	Generally all flat water or flat bedrock, little opportunity for re-oxygenation Distance between areas divided by average stream width >25
SCORE	20 19 18 17 16	15 14 (13) 12 11	10 9 8 7 6	5 4 3 2 1
Comments	gravel riffle, some bends			
8. Bank Stability (score each bank) Determine left or right side by facing downstream	Banks stable, evidence of erosion or bank failure absent or minimal, little potential for future problems <5% of bank affected	Moderately stable, infrequent, small areas of erosion mostly healed over 5-30% of bank in reach has areas of erosion If approaching 30% score marginal if banks steep	Moderately unstable, 30-60 % of bank in reach has areas of erosion, high erosion potential during floods, If approaching 60% score poor if banks steep	Unstable, many eroded area, raw areas frequent along straight sections and bends, obvious bank sloughing, 60-100% of bank has erosional scars
SCORE 7 (LB)	Left Bank 10 9	8 (7) 6	5 4 3	2 1 0
SCORE 6 (RB)	Right Bank 10 9	(8) 7 6	5 4 3	2 1 0
Comments	some erosion in both banks, LB more undercutting			
9. Vegetative Protective (score each bank) includes vegetation from top of bank to base of bank Determine left or right side by facing downstream	More than 90% of the bank covered by undisturbed vegetation All 4 classes (mature trees, understory trees, shrubs, groundcover) are represented and allowed to grow naturally All plants are native	70-90% of the bank covered by undisturbed vegetation One class may not be well represented Disruption evident but not effecting full plant growth Non-natives are rare (< 30%)	50-70% of the bank covered by undisturbed vegetation Two classes of vegetation may not be well represented Non-native vegetation may be common (30-50%)	Less than 50% of the bank covered by undisturbed vegetation or more than 2 classes are not well represented or most vegetation has been cropped Non-native vegetation may dominate (> 50%)
SCORE 6 (LB)	Left Bank 10 9	8 7 (6)	5 4 3	2 1 0
SCORE 6 (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
Comments	mature trees lacking			
10. Riparian Vegetative Zone Width (score each bank) Zone begins at top of bank	Average width of riparian zone > 18 meters Unpaved footpaths may score 9 if run-off potential is negligible	Average width of riparian zone 12-18 meters Score high if areas < 18 meters are small or are minimally disturbed	Average width of riparian zone 6-11 meters Score high if areas less than 12 meters are small or are minimally disturbed	Average width of riparian zone <6 meters Score high if areas less than 6 meters are small or are minimally disturbed
SCORE 2 (LB)	Left Bank 10 9	8 7 6	5 4 3	(2) 1 0
SCORE 10 (RB)	Right Bank (10) 9	8 7 6	5 4 3	2 1 0
Comments				

Total Score 134 Comparison to Ecoregion Guidelines (circle). ABOVE or BELOW
If score is below guidelines , result of (circle). Natural Conditions or Human Disturbance
Describe:

STREAM SURVEY INFORMATION (see protocol E for detailed information and BSERT for Completing E-Form)

DWR Station ID: FFK 0.2	**Samplers:** NJ JMS HT JH	
Monitoring Location Name:	**Date:** 8-30-22 **Time:** 1527	
Monitoring Location:	**Organization:**	Drainage Area:
County:	Ecoregion:	u/s ECO:
Latitude:	HUC:	WS Grp:
Longitude:	WBID:	Field Log #:

Project Name: ☐ Watershed ☐ 303(d) ☐ Antideg ☐ ECO ☐ FECO Other:

Project ID: TNPR

Activity Type: ☑ Sample ☐ QC Sample ☐ Habitat ☐ QC habitat ☐ QC ID

Sample Status: ☑ Collected ☐ Seasonally Dry ☐ Frequently Dry ☐ No Channel
☐ Too Deep (Not Wadeable) ☐ Too Deep (Temporary) ☐ Permanent Barrier ☐ Fenced
☐ Landowner Denial: ☐ Temporary Barrier ☐ Posted Plan to revisit? ☐ Yes ☐ No

Flow Conditions: ☐ Dry ☑ Isolated Pools ☐ Stagnant ☐ Low ☐ Moderate ☐ High ☐ Bankful ☐ Flooding

Chemicals/Bacteria: ☑ None ☐ Routine ☐ Nutrient ☐ Metals ☐ *E. coli* ☐ Organics ☐ Other_____

Field Parameters: Meter(s) Used: YSI ProDSS

pH (su)	8.11		Dissolved Oxygen %	95.4	
Conductivity (umhos)	374.7	332.9 SPC	Turbidity ~~(NTU)~~ (FNU)	4.62	
Temperature (C°)	19.2		TDS (mg/L)	243	
Dissolved Oxygen (ppm = mg/L)	8.81		Flow (cfs)	NM 1.504	

Meter Problems?_____

Photos Taken? ☐ No ☑ Yes: Description: _____

Previous 48 hours precipitation: ☐ Unknown ☐ None ☐ Slight ☐ Moderate ☐ Heavy ☐ Flooding
Air Temperature (°F) _____

Physical Characteristics & Light Penetration:

Gradient (sample reach): ☐ Flat ☐ Low ☐ Moderate ☐ High ☐ Cascades

Average Stream Width: ☐ Very Small (<1.5yd) ☐ Small (1.5-3yd) ☐ Med. (3-10yd) ☐ Large (10-25yd) ☐ Very Large (>25yd)

Maximum Stream Depth: ☐ Shallow (<0.3yd) ☐ Medium (0.3-0.6yd) ☐ Deep (0.6 – 1yd) ☐ Very Deep(>1yd)

% Canopy Cover Estimated for Reach: _____%

% Canopy Cover Measured (mid-reach): 2 u/s + 0 d/s + 0 LDB + 2 RDB = Total/384*100 #Wont 97.3%

Channel Characteristics:

Bank Height: _____ (yd.) High Water Mark: _____(yd.)

Bank Slope LDB: ☐ Deeply incised ☐ Bluff/Wall ☐ Undercut ☐ Sloughing ☐ Steep terrain ☐ Gentle Slope

Bank Slope RDB: ☐ Deeply incised ☐ Bluff/Wall ☐ Undercut ☐ Sloughing ☐ Steep terrain ☐ Gentle Slope

Manmade Modification: ☐ None ☐ Rip-Rap ☐ Cement ☐ Gabions ☐ Channelized ☐ Dam ☐ Dredging ☐ Bridge ☐ ATV

Stream Characteristics:

Sediment Deposits: ☐ None ☐ Slight ☐ Moderate ☐ Excessive ☐ Blanket

Sediment Type: ☐ None ☐ Sand ☐ Silt ☐ Mud ☐ Clay ☐ Sludge ☐ Mn Precipitant ☐ Orange Flocculent

Turbidity: ☐ Clear ☐ Slightly Turbid ☐ Muddy ☐ Milky ☐ Tannic ☐ Planktonic Algae ☐ Dyed

Foam/Surface Sheen: ☐ None ☐ Nutrient ☐ Surfactant ☐ Bacteria

Algae: ☐ None ☐ Slight ☐ Moderate ☐ High ☐ Choking **Type:** ☐ Diatoms ☐ Green ☐ Filamentous ☐ Blue-green

TDEC-DWR Stream Survey Field Sheet (Back)

DWR Station ID: FFK0.2	Date: 8-30-23	Assessors: N Jones + T. Jett

Dominate Substrate: (More than 25%) Select up to 4

Riffle	**Run**	**Pool**
☐ Boulders (>10")	☐ Boulders (>10")	☐ Boulders (>10")
☐ Cobble (2.5-10")	☐ Cobble (2.5-10")	☐ Cobble (2.5-10")
☐ Gravel (0.1-2.5")	☐ Gravel (0.1-2.5")	☐ Gravel (0.1-2.5")
☐ Bedrock	☐ Bedrock	☐ Bedrock
☐ Sand	☐ Sand	☐ Sand
☐ Silt (not gritty)	☐ Silt (not gritty)	☐ Silt (not gritty)
☐ Clay (Slick)	☐ Clay (Slick)	☐ Clay (Slick)

Surrounding Land Uses (list additional land uses under comments)

☐ Forest	☐ Grazing	☐ Stormwater	☐ STP/WWTP	☐ Construction
☐ Wetland	☐ Row Crops	☐ Urban	☐ Industry	☐ Impoundment
☐ Park	☐ CAFO/Dairy	☐ Commercial	☐ Mining/Dredging	☐ ATV/OHV
☐ Hay/Fields	☐ Logging	☐ Residential	☐ Road/Hwy/RR	☐ Golf Course

Observed Human Disturbance to Stream: Blank (not observed) S (Slight) M (Moderate) H (High)

Riparian Loss		**Logging**		**Industry**		**ATV/OHV**	
Channelization		Urban		Mining/ Dredging		Golf Course	
Active Grazing		Commercial		Road/Hwy/RR		Garbage/Trash	
Row Crops		Residential		Construction		Landfill	
CAFO/Dairy		STP/WWTP		Impoundment		Water Withdrawal	

Other Stream Information and Stressors:

6 kicks w/ rectangle net

Stream Sketch: (include road name or landmark, flow direction, reach distance, distance from bridge or road, sampling points, tributaries, outfalls, livestock access, riparian, potential impacts, north arrow, immediate land use, buildings, etc.) Use additional sheet if necessary.

Department of Environment & Conservation

HABITAT ASSESSMENT FIELD SHEET- MODERATE TO HIGH GRADIENT STREAMS (FRONT)

See Protocol E for detailed descriptions and rank information). See BSERT for instructions on completing e-form)

DWR Station ID:		**Habitat Assessment By:** NJMB	
Monitoring Location Name FFK0.2-		**Date:** 8-30-23	**Time:** 1527
Monitoring Location		**Field Log Number:** 2W-5410	
HUC	WS Group	Ecoregion	QC ☐ Duplicate ☐ Consensus

	Optimal	**Suboptimal**	**Marginal**	**Poor**
1. Epifaunal Substrate/ Available Cover	Over 70% of stream reach has natural stable habitat suitable for colonization by fish and/or macroinvertebrates Four or more productive habitats are present	Natural stable habitat covers 40-70% of stream reach Three or more productive habitats present (If near 70% and more than 3 go to optimal)	Natural stable habitat covers 20 -40% of stream reach or only 1-2 productive habitats present (If near 40% and more than 2 go to suboptimal)	Less than 20% stable habitat, lack of habitat is obvious, substrate unstable or lacking
SCORE 12	20 19 18 17 16	15 14 13 (12) 11	10 9 8 7 6	5 4 3 2 1
Comments	cobble/bedrock in the interstitial crevices past rock ~70%			
2.Embeddedness of Riffles	Gravel, cobble, and boulders 0-25% surrounded by fine sediment Layering of cobble provides diversity of niche space If near 25% drop to suboptimal if riffle not layered cobble	Gravel, cobble and boulders 25-50% surrounded by fine sediment Niches in bottom layers of cobble compromised If near 50% & riffles not layered cobble drop to marginal.	Gravel, cobble, and boulders are 50-75% surrounded by fine sediment Niche space in middle layers of cobble is starting to fill with fine sediment	Gravel, cobble, and boulders are more than 75% surrounded by fine sediment Niche space is reduced to a single layer or is absent
SCORE B	20 19 18 17 16	15 14 (13) 12 11	10 9 8 7 6	5 4 3 2 1
Comments	~40%, somewhat			
3. Velocity/ Depth Regime	All four velocity/depth regimes present (slow-deep, ✓ slow-shallow, fast-deep, X fast-shallow)	Only 3 of the 4 regimes present (if fast-shallow is missing score lower) If slow-deep missing score 15	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low)	Dominated by 1 velocity/depth regime Others regimes too small or infiequent to support aquatic populations
SCORE 11	20 19 18 17 16	15 14 13 12 (11)	10 9 8 7 6	5 4 3 2 1
Comments	deep-fast-deep lacking, slow-deep dominant			
4. Sediment Deposition	Sediment deposition affects less than 5% of stream bottom in quiet areas New deposition on islands and point bars is absent or minimal	Sediment deposition affects 5-30% of stream bottom Slight deposition in pool or slow areas Some new deposition on islands and point bars Move to marginal if build-up approaches 30%	Sediment deposition affects 30-50% of stream bottom. Sediment deposits at obstruction, constrictions and bends Moderate pool deposition	Heavy deposits of fine material, increased bar development, more than 50% of the bottom changing frequently, pools almost absent due to substantial sediment deposition
SCORE 11	20 19 18 17 16	15 14 13 12 (11)	10 9 8 7 6	5 4 3 2 1
Comments	pools filling in w/ gravel/sand ~30%			
5. Channel Flow Status.	Water reaches base of both lower banks and streambed is covered by water throughout reach Minimal productive habitat is exposed	Water covers > 75% of streambed or 25% of productive habitat is exposed	Water covers 25-75% of streambed and/or productive habitat is mostly exposed	Very little water in channel and mostly present as standing pools Little or no productive habitat due to lack of water
SCORE 20	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Comments				

HABITAT ASSESSMENT FIELD SHEET- MODERATE TO HIGH GRADIENT STREAMS (BACK)

DWR Station ID 17K02 Date 8-2023 Assessors N. Jones

	Optimal	Suboptimal	Marginal	Poor
6. Channel Alteration	Channelization, dredging rock removal, 4-wheel or livestock activity (past or present) absent or minimal, natural meander pattern NO artificial structures in reach Upstream or downstream structures do not affect reach	Channelization, dredging 4-wheel or livestock activity up to 40% Channel has stabilized If larger reach, channelization is historic and stable Artificial structures in or out of reach do not affect natural flow patterns	Channelization, dredging 4-wheel or livestock activity 40-80% (or less that has not stabilized) Artificial structures in or out of reach may have slight affect	Over 80% of reach channelized, dredged or affected by 4-wheelers or livestock Instream habitat greatly altered or removed Artificial structures have greatly affected flow pattern
SCORE 15	20 19 18 17 16	(15) 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Comments				
7. Frequency of re-oxygenation zones. Use frequency of riffle or bends for category Rank by quality	Occurrence of re-oxygenation zones relatively frequent, ratio of distance between areas divided by average stream width <7 1	Occurrence of re-oxygenation zones infrequent, distance between areas divided by average stream width is 7 - 15	Occasional re-oxygenation area The distance between areas divided by average stream width is over 15 and up to 25	Generally all flat water or flat bedrock, little opportunity for re-oxygenation Distance between areas divided by average stream width >25
SCORE 13	20 19 18 17 16	15 14 (13) 12 11	10 9 8 7 6	5 4 3 2 1
Comments	very little little habitat in historical reach; same DS			
8. Bank Stability (score each bank) Determine left or right side by facing downstream	Banks stable; evidence of erosion or bank failure absent or minimal, little potential for future problems <5% of bank affected	Moderately stable, infrequent, small areas of erosion mostly healed over 5-30% of bank in reach has areas of erosion. If approaching 30% score marginal if banks steep	Moderately unstable, 30-60 % of bank in reach has areas of erosion; high erosion potential during floods, If approaching 60% score poor if banks steep	Unstable, many eroded area, raw areas frequent along straight sections and bends, obvious bank sloughing, 60-100% of bank has erosional scars
SCORE 6 (LB)	Left Bank 10 9	8 7 (6)	5 4 3	2 1 0
SCORE 6 (RB)	Right Bank 10 9	(8) 7 6	5 4 3	2 1 0
Comments	Some undercutting/exposed roots more on LB			
9. Vegetative Protective (score each bank) includes vegetation from top of bank to base of bank Determine left or right side by facing downstream	More than 90% of the bank covered by undisturbed vegetation All 4 classes (mature trees, understory trees, shrubs, groundcover) are represented and allowed to grow naturally All plants are native	70-90% of the bank covered by undisturbed vegetation One class may not be well represented Disruption evident but not effecting full plant growth Non-natives are rare (< 30%)	50-70% of the bank covered by undisturbed vegetation Two classes of vegetation may not be well represented Non-native vegetation may be common (30-50%)	Less than 50% of the bank covered by undisturbed vegetation or more than 2 classes are not well represented or most vegetation has been cropped Non-native vegetation may dominate (> 50%)
SCORE 5 (LB)	Left Bank 10 9	8 7 6	(5) 4 3	2 1 0
SCORE 4 (RB)	Right Bank 10 9	8 7 6	5 (4) 3	2 1 0
Comments	Winter creeper, ivy common, no mature trees RB			
10. Riparian Vegetative Zone Width (score each bank) Zone begins at top of bank 4	Average width of riparian zone > 18 meters Unpaved footpaths may score 9 if run-off potential is negligible	Average width of riparian zone 12-18 meters Score high if areas < 18 meters are small or are minimally disturbed	Average width of riparian zone 6-11 meters. Score high if areas less than 12 meters are small or are minimally disturbed	Average width of riparian zone <6 meters Score high if areas less than 6 meters are small or are minimally disturbed
SCORE 4 (LB)	Left Bank 10 9	8 7 6	5 (4) 3	2 1 0
SCORE 4 (RB)	Right Bank 10 9	8 7 6	5 4 3	2 (1) 0
Comments				

Total Score _____ Comparison to Ecoregion Guidelines (circle): ABOVE or BELOW
If score is below guidelines , result of (circle). Natural Conditions or Human Disturbance
Describe:

STREAM SURVEY INFORMATION (see protocol E for detailed information and BSERT for Completing E-Form)

DWR Station ID:	**Samplers:** N. JONES + T. SCOTT	
Monitoring Location Name: MEK0.6	**Date:** 8-30-23 **Time:** 1256	
Monitoring Location:	**Organization:**	Drainage Area:
County:	Ecoregion:	u/s ECO:
Latitude:	HUC:	WS Grp:
Longitude:	WBID:	Field Log #:

Project Name: ☐ Watershed ☐ 303(d) ☐ Antideg ☐ ECO ☐ FECO Other:

Project ID: TNPR

Activity Type: ☑ Sample ☐ QC Sample ☐ Habitat ☐ QC habitat ☐ QC ID

Sample Status: ☑Collected ☐Seasonally Dry ☐Frequently Dry ☐No Channel
☐Too Deep (Not Wadeable) ☐Too Deep (Temporary) ☐Permanent Barrier ☐Fenced
☐Landowner Denial: ☐Temporary Barrier ☐Posted Plan to revisit? ☐Yes ☐No

Flow Conditions: ☐Dry ☑Isolated Pools ☐Stagnant ☐Low ☐Moderate ☐High ☐Bankful ☐Flooding

Chemicals/Bacteria: ☑None ☐Routine ☐Nutrient ☐Metals ☐*E. coli* ☐Organics ☐Other_____

Field Parameters: Meter(s) Used: YSI ProDSS

pH (su)	7.75		Dissolved Oxygen %	93.1	
Conductivity (umhos)	520	536**	Turbidity ~~(NTU)~~ (FNU)	1.99	
Temperature (C°)	23.5		TDS (mg/L)	349	
Dissolved Oxygen (ppm = mg/L)	7.89		Flow (cfs)	0.2	

Meter Problems?_____

Photos Taken? ☐ No ☑Yes: Description: _____

Previous 48 hours precipitation: ☐Unknown ☐None ☐Slight ☐Moderate ☐Heavy ☐Flooding
Air Temperature (°F) _____

Physical Characteristics & Light Penetration:

Gradient (sample reach): ☐Flat ☐Low ☐Moderate ☐High ☐Cascades

Average Stream Width: ☐Very Small (<1.5yd) ☐Small (1.5-3yd) ☐Med. (3-10yd) ☐Large (10-25yd) ☐Very Large (>25yd)

Maximum Stream Depth: ☐Shallow (<0.3yd) ☐Medium (0.3-0.6yd) ☐Deep (0.6 – 1yd) ☐Very Deep(>1yd)

% Canopy Cover Estimated for Reach: _____%

% Canopy Cover Measured (mid-reach): 4 u/s + 2 d/s + 2 LDB + 1 RDB = Total/384*100 93.9% #W/OUT

Channel Characteristics:

Bank Height: _____ (yd.) High Water Mark: _____(yd.)

Bank Slope LDB: ☐Deeply incised ☐Bluff/Wall ☐Undercut ☐Sloughing ☐Steep terrain ☐Gentle Slope

Bank Slope RDB: ☐Deeply incised ☐Bluff/Wall ☐Undercut ☐Sloughing ☐Steep terrain ☐Gentle Slope

Manmade Modification: ☐None ☐Rip-Rap ☐Cement ☐Gabions ☐Channelized ☐Dam ☐Dredging ☐Bridge ☐ATV

Stream Characteristics:

Sediment Deposits: ☐None ☐Slight ☐Moderate ☐Excessive ☐Blanket

Sediment Type: ☐None ☐Sand ☐Silt ☐Mud ☐Clay ☐Sludge ☐Mn Precipitant ☐Orange Flocculent

Turbidity: ☐Clear ☐Slightly Turbid ☐Muddy ☐Milky ☐Tannic ☐Planktonic Algae ☐Dyed

Foam/Surface Sheen: ☐None ☐Nutrient ☐Surfactant ☐Bacteria

Algae: ☐None ☐Slight ☐Moderate ☐High ☐Choking **Type**: ☐Diatoms ☐Green ☐Filamentous ☐Blue-green

TN Department of Environment & Conservation

TDEC-DWR Stream Survey Field Sheet (Back)

DWR Station ID: MER0.6 Date: 8-30-23 Assessors: N. Jones

Dominate Substrate: (More than 25%) Select up to 4

Riffle	Run	Pool
☐ Boulders (>10")	☐ Boulders (>10")	☐ Boulders (>10")
☐ Cobble (2.5-10")	☐ Cobble (2.5-10")	☐ Cobble (2.5-10")
☐ Gravel (0.1-2.5")	☐ Gravel (0.1-2.5")	☐ Gravel (0.1-2.5")
☐ Bedrock	☐ Bedrock	☐ Bedrock
☐ Sand	☐ Sand	☐ Sand
☐ Silt (not gritty)	☐ Silt (not gritty)	☐ Silt (not gritty)
☐ Clay (Slick)	☐ Clay (Slick)	☐ Clay (Slick)

Surrounding Land Uses (list additional land uses under comments)

☐ Forest	☐ Grazing	☐ Stormwater	☐ STP/WWTP	☐ Construction
☐ Wetland	☐ Row Crops	☐ Urban	☐ Industry	☐ Impoundment
☐ Park	☐ CAFO/Dairy	☐ Commercial	☐ Mining/Dredging	☐ ATV/OHV
☐ Hay/Fields	☐ Logging	☐ Residential	☐ Road/Hwy/RR	☐ Golf Course

Observed Human Disturbance to Stream: Blank (not observed) S (Slight) M (Moderate) H (High)

Riparian Loss		**Logging**		**Industry**		**ATV/OHV**	
Channelization		Urban		Mining/ Dredging		Golf Course	
Active Grazing		Commercial		Road/Hwy/RR		Garbage/Trash	
Row Crops		Residential		Construction		Landfill	
CAFO/Dairy		STP/WWTP		Impoundment		Water Withdrawal	

Other Stream Information and Stressors:

4 kicks w/ rectangle net

Stream Sketch: (include road name or landmark, flow direction, reach distance, distance from bridge or road, sampling points, tributaries, outfalls, livestock access, riparian, potential impacts, north arrow, immediate land use, buildings, etc.) Use additional sheet if necessary.

HABITAT ASSESSMENT FIELD SHEET- MODERATE TO HIGH GRADIENT STREAMS (FRONT)

See Protocol E for detailed descriptions and rank information). See BSERT for instructions on completing e-form)

DWR Station ID:		**Habitat Assessment By:** N. Jones	
Monitoring Location Name MEK0.6		**Date:** 8-20-23	**Time:** 1250
Monitoring Location		**Field Log Number:** FLN-5407	
HUC.	WS Group	Ecoregion.	QC ☐ Duplicate ☐ Consensus

	Optimal	**Suboptimal**	**Marginal**	**Poor**
1. Epifaunal Substrate/ Available Cover	Over 70% of stream reach has natural stable habitat suitable for colonization by fish and/or macroinvertebrates Four or more productive habitats are present	Natural stable habitat covers 40-70% of stream reach Three or more productive habitats present (If near 70% and more than 3 go to optimal.)	Natural stable habitat covers 20 -40% of stream reach or only 1-2 productive habitats present (If near 40% and more than 2 go to suboptimal.)	Less than 20% stable habitat, lack of habitat is obvious, substrate unstable or lacking
SCORE 17	20 19 18 (17) 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Comments	cobble riffle, mat wad, pool rock/bedrock, iWD, >70%			
2.Embeddedness of Riffles	Gravel, cobble, and boulders 0-25% surrounded by fine sediment Layering of cobble provides diversity of niche space If near 25% drop to suboptimal if riffle not layered cobble	Gravel, cobble and boulders 25-50% surrounded by fine sediment Niches in bottom layers of cobble compromised If near 50% & riffles not layered cobble drop to marginal	Gravel, cobble, and boulder s are 50-75% surrounded by fine sediment Niche space in middle layers of cobble is starting to fill with fine sediment	Gravel, cobble, and boulders are more than 75% surrounded by fine sediment Niche space is reduced to a single layer or is absent
SCORE 14	20 19 18 17 16	15 (14) 13 12 11	10 9 8 7 6	5 4 3 2 1
Comments	~30%, layered			
3. Velocity/ Depth Regime	All four velocity/depth regimes present (slow-deep, ✓ slow-shallow, fast-deep, X fast-shallow) ✓	Only 3 of the 4 regimes present (if fast-shallow is missing score lower) If slow-deep missing score 15	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low)	Dominated by 1 velocity/depth regime Others regimes too small or infrequent to support aquatic populations
SCORE 13	20 19 18 17 16	15 14 (13) 12 11	10 9 8 7 6	5 4 3 2 1
Comments	fast-deep lacking slow-shallow dominant			
4. Sediment Deposition	Sediment deposition affects less than 5% of stream bottom in quiet areas New deposition on islands and point bars is absent or minimal	Sediment deposition affects 5-30% of stream bottom Slight deposition in pool or slow areas Some new deposition on islands and point bars Move to marginal if build-up approaches 30%	Sediment deposition affects 30-50% of stream bottom Sediment deposits at obstruction, constrictions and bends. Moderate pool deposition	Heavy deposits of fine material, increased bar development, more than 50% of the bottom changing frequently, pools almost absent due to substantial sediment deposition
SCORE 7	20 19 18 17 16	15 14 13 12 11	10 9 8 (7) 6 (none OA)	5 4 3 2 1
Comments	gravel/sand filling in throughout reach, no islands/bars, 50%			
5. Channel Flow Status.	Water reaches base of both lower banks and streambed is covered by water throughout reach Minimal productive habitat is exposed	Water covers >75% of streambed or 25% of productive habitat is exposed	Water covers 25-75% of streambed and/or productive habitat is mostly exposed	Very little water in channel and mostly present as standing pools Little or no productive habitat due to lack of water
SCORE 20	(20) 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Comments				

HABITAT ASSESSMENT FIELD SHEET- MODERATE TO HIGH GRADIENT STREAMS (BACK)

DWR Station ID MEL016 Date 8-30-23 Assessors N. Jones

	Optimal	Suboptimal	Marginal	Poor
6. Channel Alteration	Channelization, dredging rock removal, 4-wheel or livestock activity (past or present) absent or minimal, natural meander pattern NO artificial structures in reach Upstream or downstream structures do not affect reach	Channelization, dredging 4-wheel or livestock activity up to 40% Channel has stabilized If larger reach, channelization is historic and stable Artificial structures in or out of reach do not affect natural flow patterns	Channelization, dredging 4-wheel or livestock activity 40-80% (or less that has not stabilized) Artificial structures in or out of reach may have slight affect	Over 80% of reach channelized, dredged or affected by 4-wheelers or livestock Instream habitat greatly altered or removed Artificial structures have greatly affected flow pattern
SCORE 15	20 19 18 17 16	(15) 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Comments				
7. Frequency of re-oxygenation zones. Use frequency of riffle or bends for category Rank by quality	Occurrence of re-oxygenation zones relatively frequent; ratio of distance between areas divided by average stream width <7 1	Occurrence of re-oxygenation zones infrequent, distance between areas divided by average stream width is 7 - 15	Occasional re-oxygenation area The distance between areas divided by average stream width is over 15 and up to 25	Generally all flat water or flat bedrock, little opportunity for re-oxygenation Distance between areas divided by average stream width >25
SCORE 8	20 19 18 17 16	15 14 13 12 11	10 9 (8) 7 6	5 4 3 2 1
Comments	Occasional, no longer high-quality cobble riffle-River quality			
8. Bank Stability (score each bank) Determine left or right side by facing downstream	Banks stable, evidence of erosion or bank failure absent or minimal, little potential for future problems <5% of bank affected	Moderately stable, infrequent, small areas of erosion mostly healed over 5-30% of bank in reach has areas of erosion. If approaching 30% score marginal if banks steep	Moderately unstable, 30-60 % of bank in reach has areas of erosion; high erosion potential during floods, If approaching 60% score poor if banks steep	Unstable, many eroded area, raw areas frequent along straight sections and bends, obvious bank sloughing, 60-100% of bank has erosional scars
SCORE 8 (LB)	Left Bank 10 9	(8) 7 6	5 4 3	2 1 0
SCORE 6 (RB)	Right Bank 10 9	8 7 (6)	5 4 3	2 1 0
Comments	Some undercutting, especially in RB			
9. Vegetative Protective (score each bank) includes vegetation from top of bank to base of bank Determine left or right side by facing downstream	More than 90% of the bank covered by undisturbed vegetation All 4 classes (mature trees, understory trees, shrubs, groundcover) are represented and allowed to grow naturally All plants are native	70-90% of the bank covered by undisturbed vegetation One class may not be well represented Disruption evident but not effecting full plant growth Non-natives are rare (< 30%)	50-70% of the bank covered by undisturbed vegetation Two classes of vegetation may not be well represented Non-native vegetation may be common (30-50%)	Less than 50% of the bank covered by undisturbed vegetation or more than 2 classes are not well represented or most vegetation has been cropped Non-native vegetation may dominate (> 50%)
SCORE 8 (LB)	Left Bank 10 9	(8) 7 6	5 4 3	2 1 0
SCORE 8 (RB)	Right Bank 10 9	(8) 7 6	5 4 3	2 1 0
Comments	non-natives <30%, all classes present			
10. Riparian Vegetative Zone Width (score each bank) Zone begins at top of bank	Average width of riparian zone > 18 meters Unpaved footpaths may score 9 if run-off potential is negligible	Average width of riparian zone 12-18 meters Score high if areas < 18 meters are small or are minimally disturbed	Average width of riparian zone 6-11 meters Score high if areas less than 12 meters are small or are minimally disturbed	Average width of riparian zone <6 meters Score high if areas less than 6 meters are small or are minimally disturbed.
SCORE 10 (LB)	Left Bank (10) 9	8 7 6	5 4 3	2 1 0
SCORE 7 (RB)	Right Bank 10 9	8 (7) 6	5 4 3	2 1 0
Comments	~30', then mowed grass			

Total Score 141 Comparison to Ecoregion Guidelines (circle): (ABOVE) or BELOW
If score is below guidelines , result of (circle) Natural Conditions or Human Disturbance
Describe

Appendix 3. Cooling Tower Chemical Dosing and Toxicity, 2023

Most ORNL cooling towers discharge to outfalls, and these cooling towers are listed by Outfall number along with their chemical dosing information provided by updated SDS forms in Table 3A in Appendix 3.

The form of toxicity information available on SDS forms varies. The updated SDS format usually gives toxicities for fish: Oncorhynchus mykiss (rainbow trout) and for *Pimephales promelas* (fathead minnow), and for aquatic invertebrates *Daphnia magna* (water flea) and *Ceriodaphnia dubia*. Occasionally SDS forms supply toxicity information for a species alternative to rainbow trout such as bluegill sunfish, which are also included. Occasionally there is **no information (NI**). Chemical toxicity effect information terms and abbreviations found on SDS sheets are defined below:

> ***Lowest Observed Effect Concentration (LOEC)*** is the lowest tested concentration that is significantly different from the control.
> ***No Observed Effect Concentration (NOEC)*** is the highest concentration immediately below the LOEC which has no statistically significant effect ($p < 0.05$) compared to a control within a given exposure period.
> ***Lethal Effect Concentration (LC50*** or ***LD50***) is the median concentration that is lethal for 50% of the exposed population.
> ***Median Effective Concentration (EC50)*** is the median concentration that immobilizes 50 % of the population.

Cooling Tower Dosing Information Changes in 2023

In 2023, engineering personnel at HFIR reported that Nalco 7408 had been replaced with CoreChem 40% Sodium Bisulfite for dechlorination purposes in 2012. The change in chemical product was due to the lower cost of the CoreChem product. An updated SDS was provided and the dosing information has been updated in Table 3A for Outfall 281.

In 2021, tower 2535 became operational and began discharging to Outfall 204. However, this tower did not operate in 2023 and is not included in Appendix 3. The nearby 2539 tower did operate in 2023 and chemical dosing information is included in Table 3A.

As once-through cooling loads were eliminated in the 6000-area buildings, the liquid dechlorination system that dechlorinated those flows and cooling tower blowdown was also removed from service and the cooling tower was equipped with a box dechlorinator to treat tower blowdown routed to Outfall 314. Accordingly, the liquid dechlorination chemical has been removed from Outfall 314 in Table 3A and replaced with DeNora D-Chlor sodium sulfite tablet information.

Appendix 3 Table 3A

2023 Cooling Tower Chemical Dosing

Outfall Number	Tower Location	Discharges to (waterbody)	Tower Cells	Volume of Tower Basin (gal)	Summer or Winter	Water Volume Circulated Through Basin (gal)	Chemical Name & Use	Parameters of Concern (SDS listed)	Frequency of Use	Chemical Injection Frequency	Chemical Feed (ppm)	Control Range (ppm)	Chemical Concentration Discharged (ppm)	Dischage Rate to Drain (gpm)	Toxicity (SDS): Fathead Minnow	Toxicity (SDS): Ceriodaphnia Dubia	Toxicity (SDS): Daphnia Magna	Toxicity (SDS): Rainbow Trout (or alternate listed)
204	2539	WOC	1	1000	Summer & Winter	1000-1500	GN-8143 Corrosion Inhibitor	<= 5% sodium 4-chloro-5-alkylbenzotriazolide and sodium 5-chloro-4-alkylbenzotriazolide and sodium 4-chloro-7-alkylbenzotriazolide and sodium 5-chloro-6-alkylbenzotriazolide	Routine	Weekly	maintain 1.0 to 2.0 ppm molybdenum, pH range 8-9	maintain 1.0 to 2.0 ppm molybdenum, pH range 8-9			96 hr LC50 393.5 mg/L; 96 hr NOEL 250 mg/L	NI	48 hr LC50 1414 mg/L; 48 hr NOEL 1000 mg/L	96 hr LC50 164.9 mg/L; 96 hr NOEL 125 mg/L
204	2539	WOC	1	1000	Summer & Winter	1000-1500	Bleach, biocide	12.5-15% Sodium hypochlorite, 0.67-0.95% Sodium Hydroxide	Routine	Weekly	8 oz total = 0.25-1.0 ppm free chlorine	0.2 - 1.0 ppm			NI	NI	48 hr LC50 1.0 mg/L	48 hr LC50 Bluegill 0.6 mg/L
204	2539	WOC	1	1000	Summer & Winter	1000-1500	USA BlueBook Sodium Sulfite Tablets, Dechlorination	35% Sodium sulfite, 65% Inert Ingredients	Routine	Weekly	8 per 50 gpm discharge	Place 6-10 tablets in ditch	NA	NA	NI	NI	48 hr LC50 440 mg/L	Carassius auratus 96 hr LD50 100 mg/L
227	5511	WOC	8	30000	Summer	8417	CL49 Biocide	5-10% Sodium chlorosulfamate, 7-13%Sodium bromosulfamate, and 5-10% Sodium hydroxide; pH 13.6 at 20 C.	Routine	3/day	10	0.5-1.5, as halogen	<10	20	48 hr LC508.5 mg/L; 7-day NOEC	48 hr LC50 4.8mg/L; 7-dayNOEC > 10	48 hr LC50 4.8mg/L	NI; Bluegill Sunfish 96 hrLC50 3.8 mg/L
227	5511	WOC	8	30000	Winter	8417	CL49 Biocide	5-10% Sodium chlorosulfamate, 7-13%Sodium bromosulfamate, and 5-10% Sodium hydroxide; pH 13.6 at 20 C.	Routine	2/day	10	0.5-1.5, as halogen	<10	20	48 hr LC508.5 mg/L; 7-day NOEC	48 hr LC50 4.8mg/L; 7-dayNOEC > 10	48 hr LC50 4.8mg/L	NI; Bluegill Sunfish 96 hrLC50 3.8 mg/L
227	5511	WOC	8	30000	Summer	8417	CL2062 Biocide	20% 2-2-Dibromo-3-nitrilopropionamide	Routine	2/week	75	75	<75	20	NI	NI	48hr EC50 0.86mg/L	96hr LC50 2.3mg/L
227	5511	WOC	8	30000	Winter	8417	CL2062 Biocide	20% 2-2-Dibromo-3-nitrilopropionamide	Routine	1/week	75	75	<75	20	NI	NI	48hr EC50 0.86mg/L	96hr LC50 2.3mg/L
227	5511	WOC	8	30000	Summer	8417	Quadrasperse CL5898	3-7% of 2-PHosphono-1,2,4-butane tricarboxylic acid; 1-5 % of Benzotriazole; pH 3.8 at 20 C. Decomposes to oxides of phosphorus and sulfur.	Routine	Equals Blowdown Frequency	100-130	100-130	100-130	20	96hr LC50 2739mg/L	48hr LC50 1786mg/L	NI	NI
227	5511	WOC	8	30000	Winter	8417	Quadrasperse CL5898	3-7% of 2-PHosphono-1,2,4-butane tricarboxylic acid; 1-5 % of Benzotriazole; pH 3.8 at 20 C. Decomposes to oxides of phosphorus and sulfur.	Routine	Equals Blowdown Frequency	100-130	100-130	100-130	20	96hr LC50 2739mg/L	48hr LC50 1786mg/L	NI	NI
227	5511	WOC	8	30000	Summer	8417	CL401 biosurfactant	no hazardous components listed; oxides of carbon upon decomposition	Routine	Equals Blowdown Frequency	5 to 10	5 to 10	<10	20	96hr LC50 87mg/L	48hr LC50 600mg/L	NI	NI
227	5511	WOC	8	30000	Winter	8417	CL401 biosurfactant	no hazardous components listed; oxides of carbon upon decomposition	Routine	Equals Blowdown Frequency	5 to 10	5 to 10	<10	20	96hr LC50 87mg/L	48hr LC50 600mg/L	NI	NI
227	5511	WOC	8	30000	Summer & Winter	8417	De Nora D-CHLOR, Dechlorination	92.3% Na2SO3	Routine	Primary 4-column tablet box				20	NI	NI	48 hr LC50 440mg/L	Goldfish 96 hrLD50 100 mg/L
227	5600	WOC	6	90000	Summer	14520	CL49 Biocide	5-10% Sodium chlorosulfamate, 7-13% Sodium bromosulfamate, and 5-10% Sodium hydroxide; pH 13.6 at 20 C.	Routine	3/day	10	0.5-1.5, as halogen	<10	34.6	48 hr LC508.5 mg/L; 7-day NOEC2.5 mg/L	48 hr LC50 4.8mg/L; 7-dayNOEC > 10mg/L	48 hr LC50 4.8mg/L	NI; Bluegill Sunfish 96 hrLC50 3.8 mg/L
227	5600	WOC	6	90000	Winter	14520	CL49 Biocide	5-10% Sodium chlorosulfamate, 7-13% Sodium bromosulfamate, and 5-10% Sodium hydroxide; pH 13.6 at 20 C.	Routine	2/day	10	0.5-1.5, as halogen	<10	34.6	48 hr LC508.5 mg/L; 7-day NOEC2.5 mg/L	48 hr LC50 4.8mg/L; 7-dayNOEC > 10mg/L	48 hr LC50 4.8mg/L	NI; Bluegill Sunfish 96 hrLC50 3.8 mg/L
227	5600	WOC	6	90000	Summer	14520	CL2062 Biocide	20% 2-2-Dibromo-3-nitrilopropionamide	Routine	2/week	75	75	<75	34.6	NI	NI	48hr EC50 0.86mg/L	96hr LC50 2.3mg/L
227	5600	WOC	6	90000	Winter	14520	CL2062 Biocide	20% 2-2-Dibromo-3-nitrilopropionamide	Routine	1/week	75	75	<75	34.6	NI	NI	48hr EC50 0.86mg/L	96hr LC50 2.3mg/L
227	5600	WOC	6	90000	Summer	14520	Quadrasperse CL5898	3-7% of 2-PHosphono-1,2,4-butane tricarboxylic acid; 1-5 % of Benzotriazole; pH 3.8 at 20 C. Decomposes to oxides of phosphorus and sulfur.	Routine	Equals Blowdown Frequency	100-130	100-130	100-130	34.6	96hr LC50 2739mg/L	48hr LC50 1786mg/L	NI	NI
227	5600	WOC	6	90000	Winter	14520	Quadrasperse CL5898	3-7% of 2-PHosphono-1,2,4-butane tricarboxylic acid; 1-5 % of Benzotriazole; pH 3.8 at 20 C. Decomposes to oxides of phosphorus and sulfur.	Routine	Equals Blowdown Frequency	100-130	100-130	100-130	34.6	96hr LC50 2739mg/L	48hr LC50 1786mg/L	NI	NI
227	5600	WOC	6	90000	Summer	14520	CL401 biosurfactant	no hazardous components listed; oxides of carbon upon decomposition	Routine	Equals Blowdown Frequency	5 to 10	5 to 10	<10	34.6	96hr LC50 87mg/L	48hr LC50 600mg/L	NI	NI
227	5600	WOC	6	90000	Winter	14520	CL401 biosurfactant	no hazardous components listed; oxides of carbon upon decomposition	Routine	Equals Blowdown Frequency	5 to 10	5 to 10	<10	34.6	96hr LC50 87mg/L	48hr LC50 600mg/L	NI	NI
227	5600	WOC	6	90000	Summer & Winter	14520	De Nora D-CHLOR, Dechlorination	92.3% Na2SO3	Routine	Primary 4-column tablet box				34.6	NI	NI	48 hr LC50 440mg/L	Goldfish 96 hrLD50 100 mg/L

WOC = White Oak Creek
MB = Melton Branch
FFK = Fifth Creek

NOEC = No Effect Concentration
NI = No Information

2023 Cooling Tower Chemical Dosing

Outfall Number	Tower Location	Discharges to (waterbody)	Tower Cells	Volume of Tower Basin (gal)	Summer or Winter	Water Volume Circulated Through Basin (gal)	Chemical Name & Use	Parameters of Concern (SDS listed)	Frequency of Use	Chemical Injection Frequency	Chemical Feed (ppm)	Control Range (ppm)	Chemical Concentration Discharged (ppm)	Dischage Rate to Drain (gpm)	Toxicity (SDS): Fathead Minnow	Toxicity (SDS): Ceriodaphnia Dubia	Toxicity (SDS): Daphnia Magna	Toxicity (SDS): Rainbow Trout (or alternate listed)
231	5800	WOC	6	50000	Summer	11490	CL49 Biocide	5-10% Sodiumchlorosulfamate, 7-13% Sodium bromosulfamate, and 5-10% Sodium hydroxide; pH 13.6 at 20C.	Routine	3/day	10	0.5-1.5, as halogen	<10	27.3	48 hrLC50 8.5mg/L; 7-day NOEC2.5 mg/L	48 hr LC50 4.8mg/L; 7-dayNOEC > 10mg/L	48 hrLC50 4.8mg/L	NI; Bluegill Sunfish 96 hrLC50 3.8mg/L
231	5800	WOC	6	50000	Winter	11490	CL49 Biocide	5-10% Sodiumchlorosulfamate, 7-13% Sodium bromosulfamate, and 5-10% Sodium hydroxide; pH 13.6 at 20C.	Routine	2/day	10	0.5-1.5, as halogen	<10	27.3	48 hrLC50 8.5mg/L; 7-day NOEC2.5 mg/L	48 hr LC50 4.8mg/L; 7-dayNOEC > 10mg/L	48 hrLC50 4.8mg/L	NI; Bluegill Sunfish 96 hrLC50 3.8mg/L
231	5800	WOC	6	50000	Summer	11490	CL2062 Biocide	20% 2-2-Dibromo-3-nitrilopropionamide	Routine	2/week	75	75	<75	27.3	NI	NI	48hr EC50 0.86mg/L	96hr LC50 2.3mg/L
231	5800	WOC	6	50000	Winter	11490	CL2062 Biocide	20% 2-2-Dibromo-3-nitrilopropionamide	Routine	1/week	75	75	<75	27.3	NI	NI	48hr EC50 0.86mg/L	96hr LC50 2.3mg/L
231	5800	WOC	6	50000	Summer	11490	Quadrasperse CL5898	3-7% of 2-PHosphono-1,2,4-butane tricarboxylic acid; 1-5 % of Benzotriazole; pH 3.8 at 20 C. Decomposes to oxides of phosphorus and sulfur.	Routine	Equals Blowdown Frequency	100-130	100-130	100-130	27.3	96hr LC50 2739mg/L	48hr LC50 1786mg/L	NI	NI
231	5800	WOC	6	50000	Winter	11490	Quadrasperse CL5898	3-7% of 2-PHosphono-1,2,4-butane tricarboxylic acid; 1-5 % of Benzotriazole; pH 3.8 at 20 C. Decomposes to oxides of phosphorus and sulfur.	Routine	Equals Blowdown Frequency	100-130	100-130	100-130	27.3	96hr LC50 2739mg/L	48hr LC50 1786mg/L	NI	NI
231	5800	WOC	6	50000	Summer	11490	CL401 biosurfactant	no hazardous components listed; oxides of carbon upon decomposition	Routine	Equals Blowdown Frequency	5 to 10	5 to 10	<10	27.3	96hr LC50 87mg/L	48hr LC50 600mg/L	NI	NI
231	5800	WOC	6	50000	Winter	11490	CL401 biosurfactant	no hazardous components listed; oxides of carbon upon decomposition	Routine	Equals Blowdown Frequency	5 to 10	5 to 10	<10	27.3	96hr LC50 87mg/L	48hr LC50 600mg/L	NI	NI
231	5800	WOC	6	50000	Summer & Winter	11490	De Nora D-CHLOR, Dechlorination	92.3% Na2SO3	Routine	4-column tablet box				27.3			48 hrLC50 440mg/L	Goldfish 96 hrLD50 100mg/L
231	OLCF5	WOC	20	74,391	Fall 2020 - August 2021 Passivation	20,000	CL5660 Passivation	10-30% Sulfuric Acid; 1-5% 2-PHosphono-1-2-4-butane tricarboxylic acid	Non-routine, Passivation	As Needed	150 ppm (as needed to maintain pH 7.0-7.5)	pH 7.0 -7.5	150 ppm	As needed during passivation	96 hr LC50 2410mg/L	48 hr LC50 1708 mg/L	NI	NI
231	OLCF5	WOC	20	74,391	Fall 2020 - August 2021 Passivation	20,000	CL1495	10-30% Potassium phosphate, tribasic; 5-10 % Tetrapotassium pyrophosphate	Non-routine, Passivation	As Needed	100-120 ppm	20-25 ppm Orthophosphate	100-120 ppm	As needed during passivation	96 hr LC50 1768mg/L	48 hr LC501048 mg/L	NI	NI
231	OLCF5	WOC	20	74,391	Fall 2020 - August 2021 Passivation	20,000	CL49 Biocide	5-10% Sodiumchlorosulfamate; 7-13% Sodium bromosulfamate; 5-10% Sodium hydroxide	Non-routine, Passivation	As Needed	5 ppm (as needed to maintain 0.3-0.7ppm Free Chlorine Residual)	0.3 - 0.7ppm Free Chlorine	<10	As needed during passivation	48 hrLC50 8.5mg/L; 7-day NOEC2.5 mg/L	48 hr LC50 4.8mg/L; 7-dayNOEC > 10mg/L	48 hrLC50 4.8mg/L	NI; Bluegill Sunfish 96 hrLC50 3.8mg/L
231	OLCF5	WOC	20	74,391	Fall 2020 - August 2021 Passivation	20,000	CL2062 Microbiocide	20% 2-2- Dibromo-3-nitrilopropionamide	Non-routine, Passivation	7-10 days (after blowdown)	75	75	<75	As needed during passivation	NI	NI	48hr EC50 0.86mg/L	96hr LC50 2.3mg/L
231	OLCF5	WOC	20	74,391	Summer & Winter	20,000	BL1254 Dechlorination	30-60 % Potassium Sulfite	Routine	Equals Blowdown Frequency	0-28	0-28	<28	200	96h LC50 2333mg/L	48hr LC50 884mg/L	NI	NI
231	OLCF5	WOC	20	74,391	Summer	20,000	CL49 Biocide	5-10% Sodiumchlorosulfamate, 7-13% Sodium bromosulfamate, and 5-10% Sodium hydroxide; pH 13.6 at 20 C.	Routine	3/day	10	0.5-1.5, as halogen	<10	TBD. Variable as these new towers come online	48 hrLC50= 8.5mg/L	NI	48 hrLC50= 4.8mg/L	NI
231	OLCF5	WOC	20	74,391	Winter	20,000	CL49 Biocide	5-10% Sodiumchlorosulfamate, 7-13% Sodium bromosulfamate, and 5-10% Sodium hydroxide; pH 13.6 at 20 C.	Routine	2/day	10	0.5-1.5, as halogen	<10	200	48 hrLC50= 8.5mg/L	NI	48 hrLC50= 4.8mg/L	NI
231	OLCF5	WOC	20	74,391	Summer	20,000	CL2062 Biocide	20% 2-2-Dibromo-3-nitrilopropionamide	Routine	2/week	75	75	<75	200	NI	NI	48hr EC50 0.86mg/L	96hr LC50 2.3mg/L
231	OLCF5	WOC	20	74,391	Winter	20,000	CL2062 Biocide	20% 2-2-Dibromo-3-nitrilopropionamide	Routine	1/week	75	75	<75	200	NI	NI	48hr EC50 0.86mg/L	96hr LC50 2.3mg/L
231	OLCF5	WOC	20	74,391	Summer	20,000	Quadrasperse CL5898	3-7% of 2-PHosphono-1,2,4-butane tricarboxylic acid; 1-5 % of Benzotriazole; pH 3.8 at 20 C. Decomposes to oxides of phosphorus and sulfur.	Routine	Equals Blowdown Frequency	100-130	100-130	100-130	200	96hr LC50 2739mg/L	48hr LC50 1786mg/L	NI	NI
231	OLCF5	WOC	20	74,391	Winter	20,000	Quadrasperse CL5898	3-7% of 2-PHosphono-1,2,4-butane tricarboxylic acid; 1-5 % of Benzotriazole; pH 3.8 at 20 C. Decomposes to oxides of phosphorus and sulfur.	Routine	Equals Blowdown Frequency	100-130	100-130	100-130	200	96hr LC50 2739mg/L	48hr LC50 1786mg/L	NI	NI
231	OLCF5	WOC	20	74,391	Summer	20,000	CL401 biosurfactant	no hazardous components listed; oxides of carbon upon decomposition	Routine	Equals Blowdown Frequency	5 to 10	5 to 10	<10	200	96hr LC50 87mg/L	48hr LC50 600mg/L	NI	NI
231	OLCF5	WOC	20	74,391	Winter	20,000	CL401 biosurfactant	no hazardous components listed; oxides of carbon upon decomposition	Routine	Equals Blowdown Frequency	5 to 10	5 to 10	<10	200	96hr LC50 87mg/L	48hr LC50 600mg/L	NI	NI

WOC = White Oak Creek
MB = Melton Branch
FFK = Fifth Creek

NOEC = No Effect Concentration
NI = No Information

2023 Cooling Tower Chemical Dosing

Outfall Number	Tower Location	Discharges to (waterbody)	Tower Cells	Volume of Tower Basin (gal)	Summer or Winter	Water Volume Circulated Through Basin (gal)	Chemical Name & Use	Parameters of Concern (SDS listed)	Frequency of Use	Chemical Injection Frequency	Chemical Feed (ppm)	Control Range (ppm)	Chemical Concentration Discharged (ppm)	Dischage Rate to Drain (gpm)	Toxicity (SDS): Fathead Minnow	Toxicity (SDS): Ceriodaphnia Dubia	Toxicity (SDS): Daphnia Magna	Toxicity (SDS): Rainbow Trout (or alternate listed)
231	OLCF5	WOC	20	74,391	Summer & Winter	20,000	BL1254 Dechlorination	30-60 % Potassium Sulfite	Routine	Equals Blowdown Frequency	0-28	0-28	<28	200	96h LC50 2333mg/L	48hr LC50 884mg/L	NI	NI
281	HFIR 7902	MB	4	100,000	Summer	400,000	NALCO 3DT461: CW treatment, corrosion, scale inhibitor	10-30% Tripotassium phosphate; 1-5% Sodium Tolytriazole; .1-1% Potassium hydroxide. pH 11.5-13. TOC 86,000 mg/L, COD 180,000 mg/L.	Routine	routine		dye at 95 +/- 3 ppm, translates to phosphate at 10-15 ppm. Degrades outside pH range 6.5-8.0	10-15 ppm	25-125	NI	48 hr NOEC 1,080 ml/l; 48 hr LC50 1994 mg/l	NI	96 hr NOEC 500 mg/l; 96 hr LC50 660 mg/l
281	HFIR 7902	MB	4	100,000	Winter	400,000	NALCO 3DT461: CW treatment, corrosion, scale inhibitor	10-30% Tripotassium phosphate; 1-5% Sodium Tolytriazole; .1-1% Potassium hydroxide. pH 11.5-13. TOC 86,000 mg/L, COD 180,000 mg/L.	Routine	routine		dye at 95 +/- 3 ppm, translates to phosphate at 10-15 ppm. Degrades outside pH range 6.5-8.0	10-15 ppm	25-125	NI	48 hr NOEC 1,080 ml/l; 48 hr LC50 1994 mg/l	NI	96 hr NOEC 500 mg/l; 96 hr LC50 660 mg/l
281	HFIR 7902	MB	4	100,000	Summer	400,000	Sulfuric acid: pH adjustment	pH <1 at 25 C	Routine	routine		6.8-7.2 pH (operating)	6.0-9.0 pH	25-125	NI	NI	NI	NI
281	HFIR 7902	MB	4	100,000	Winter	400,000	Sulfuric acid: pH adjustment	pH <1 at 25 C	Routine	routine		6.8-7.2 pH (operating)	6.0-9.0 pH	25-125	NI	NI	NI	NI
281	HFIR 7902	MB	4	100,000	Summer	400,000	NALCO 7346: Biocide	54.2% 1-Bromo-3-Chloro-5,5-Dimethyl-Hydantoin; 28.9% 1,3-Dichloro-5-5-Dimethylhydantoin; 15.9% 1,3-Dichloro-5-Ethyl-5-Methylhydantoin	Routine	routine		Tablet feeder set to mid-range 0.3-0.8	</= 0.05 ppm total chlorine to Outfall 281	25-125	96 hr LC50: 0.71 mg/L; 7-day NOEC: 0.5 mg/L	7-day NOEC 0.25 mg/l	48 hr LC50 1.1 mg/l; 48 hr NOEC .63 mg/l	96 hr LC50 0.5 mg/l
281	HFIR 7902	MB	4	100,000	Winter	400,000	NALCO 7346: Biocide	54.2% 1-Bromo-3-Chloro-5,5-Dimethyl-Hydantoin; 28.9% 1,3-Dichloro-5-5-Dimethylhydantoin; 15.9% 1,3-Dichloro-5-Ethyl-5-Methylhydantoin	Routine	routine		Tablet feeder set to mid-range 0.3-0.8	</= 0.05 ppm total chlorine to Outfall 281	25-125	96 hr LC50: 0.71 mg/L; 7-day NOEC: 0.5 mg/L	7-day NOEC 0.25 mg/l	48 hr LC50 1.1 mg/l; 48 hr NOEC .63 mg/l	96 hr LC50 0.5 mg/l
281	HFIR 7902	MB	4	100,000	Summer and Winter	400,000	Sodium sulfite tablets dechlorination	92 % sodium sulfite	Routine	Routine	n/a	n/a	NI	25-125	NI	NI	48 hr LC50 440 mg/l	96 hr LC50 Goldfish 100 mg/l
281	HFIR 7902	MB	4	100,000	2x/year cleaning	400,000	Nalsperse 7348.11: Bio Dispersant	Decomposition to oxides of carbon	Non-routine	1-2/yr		38.2 ppm (15-gal total)	15-gal total	25-125	96 hr LC50: > 1000 mg/l	48 hr LC50 240 mg/l	48 hr LC50 > 1000 mg/l	96 hr LC50 > 1000 mg/l
281	HFIR 7902	MB	4	100,000	1x/year cleaning	400,000	Nalclean Inhibited HCL 8940.11; tower walls only	30-60 % hydrochloric acid; corrosive; pH 1.5	Non-routine	1-2/yr		10-gal total; 2.4 ppm	.05 ppm	25-125	NI	NI	48 hr LC50 7383 mg/l; 48 hr NOEC 3600 mg/l	96 hr LC50 1673 mg/l; 96 hr NOEC 1296 mg/l
281	HFIR 7902	MB	4	100,000	1x/year cleaning	400,000	Bleach: annual cleaning for algal growth, tower walls only	12.5% NaClO, sodium hypochlorite; corrosive, very toxic	Non-routine	1-2/yr		2.4 ppm	.05 ppm	25-125	NI	NI	NI	NI
281	HFIR 7902	MB	4	100,000	2x/year cleaning	400,000	Biodispersant 73551; dispersant and detergent	10-30% Polyalkylene glycol	Non-routine	1-2/yr		10-gal total	13.7 ppm	25-125	96 hr LC50 996 mg/l; 7-day NOEC 250 mg/l	48 hr LC50 1320 mg/l; 7-day NOEC 125 mg/l	NI	96 hr LC50 & NOEC > 1000 mg/l
281	HFIR 7902	MB	4	100,000	2x/year cleaning	400,000	Anti-foam, Nalco 71D5 Plus	30-60% Straight Run Middle Distillate; 10-30% Hydrotreated Light Distillate (petroleum);10-30% Polypropylene Glycol; 1-5% Stearic Acid; 1-5% 1-Octanol; 1-5% Fatty Alkyl Polyglycol; 1-5% Aliphatic alcohol	Non-routine	1-2/yr		2-gal total		25-125	96 hr LC50 190 mg/l; 96 hr NOEC 100 mg/L	48 hr LC50 4.32 mg/l; 7-day NOEC 0.19 - 1.5 mg/L	48 hr LC50 220 mg/l; 48 hrs NOEC 16 mg/L	96 hr LC50 310 mg/l; 96 hr NOEC <78 mg/L
281	HFIR 7902	MB	4	100,000	Summer	400,000	Core Chem 40% Solution +/- Sodium Bisulfite Dechlorination	30%-50% Sodium Hydrogen Sulfite, <1% Sodium Sulfite, <4% Sodium Sulfate	Routine	Routine			</= 0.05 ppm total chlorine to Outfall 281	25-125	NI	NI	NI	96 hr LC50 240 ppm Mosquitofish
281	HFIR 7902	MB	4	100,000	2x/year cleaning	400,000	Towebrom 960; microbiocide alternative to bleach for algae	60-100% Sodium Dichloroisocyanurate; 5-10% Sodium Bromide; 1-5% Inorganic salt	Non-routine	1-2/yr		100-200 lbs (2.4 ppm)	.05 ppm	25-125	96 hr LC50 0.7 mg/l (50% active ingredient)	48 hr LC50 1.02 mg/l	48 hrs LC50 2.5 mg/l (50% active ingredient)	NI
314	6018	WOC	2	18000	Summer	7000	CL49 Biocide	5-10% Sodiumchlorosulfamate, 7-13% Sodium bromosulfamate, and 5-10% Sodium hydroxide; pH 13.6 at 20C.	Routine	3/day	10	0.5-1.5, as halogen	<10	3.7	48hr LC50 8.5 mg/L; 7-day NOEC 2.5mg/L	48hr LC50 4.8mg/L; 7-day NOEC > 10 mg/L	48 hrLC50 4.8mg/L	NI; Bluegill Sunfish 96 hrLC50 3.8mg/L
314	6018	WOC	2	18000	Winter	7000	CL49 Biocide	5-10% Sodiumchlorosulfamate, 7-13% Sodium bromosulfamate, and 5-10% Sodium hydroxide; pH 13.6 at 20C.	Routine	2/day	10	0.5-1.5, as halogen	<10	3.7	48hr LC50 8.5 mg/L; 7-day NOEC 2.5mg/L	48hr LC50 4.8mg/L; 7-day NOEC > 10 mg/L	48 hrLC50 4.8mg/L	NI; Bluegill Sunfish 96 hrLC50 3.8mg/L
314	6018	WOC	2	18000	Summer	7000	Quadrasperse CL5898	3-7% of 2-PHosphono-1,2,4-butane tricarboxylic acid; 1-5 % of Benzotriazole; pH 3.8 at 20 C. Decomposes to oxides of phosphorus and sulfur.	Routine	Equals Blowdown Frequency	100-130	100-130	100-130	3.7	96hr LC50 2739mg/L	48hr LC50 1786mg/L	NI	NI
314	6018	WOC	2	18000	Winter	7000	Quadrasperse CL5898	3-7% of 2-PHosphono-1,2,4-butane tricarboxylic acid; 1-5 % of Benzotriazole; pH 3.8 at 20 C. Decomposes to oxides of phosphorus and sulfur.	Routine	Equals Blowdown Frequency	100-130	100-130	100-130	3.7	96hr LC50 2739mg/L	48hr LC50 1786mg/L	NI	NI

WOC = White Oak Creek
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2023 Cooling Tower Chemical Dosing

Outfall Number	Tower Location	Discharges to (waterbody)	Tower Cells	Volume of Tower Basin (gal)	Summer or Winter	Water Volume Circulated Through Basin (gal)	Chemical Name & Use	Parameters of Concern (SDS listed)	Frequency of Use	Chemical Injection Frequency	Chemical Feed (ppm)	Control Range (ppm)	Chemical Concentration Discharged (ppm)	Dischage Rate to Drain (gpm)	Toxicity (SDS): Fathead Minnow	Toxicity (SDS): Ceriodaphnia Dubia	Toxicity (SDS): Daphnia Magna	Toxicity (SDS): Rainbow Trout (or alternate listed)
314	6018	WOC	2	18000	Summer & Winter	7000	De Nora D-CHLOR, Dechlorination	92.3% Na2SO3	Routine	4-column tablet box				3.7	NI	NI	48 hr LC50 440mg/L	Goldfish 96 hrLD50 100 mg/L
363	5300	FFK	4	30000	Summer	4440	CL49 Biocide	5-10% Sodium chlorosulfamate, 7-13% Sodium bromosulfamate, and 5-10% Sodium hydroxide; pH 13.6 at 20 C.	Routine	3/day	10	0.5-1.5, as halogen	<10	10.6	48 hr LC50 8.5 mg/L; 7-day NOEC 2.5 mg/L	48 hr LC50 4.8 mg/L; 7-day NOEC > 10 mg/L	48 hr LC50 4.8 mg/L	NI; Bluegill Sunfish 96 hr LC50 3.8 mg/L
363	5300	FFK	4	30000	Winter	4440	CL49 Biocide	5-10% Sodium chlorosulfamate, 7-13% Sodium bromosulfamate, and 5-10% Sodium hydroxide; pH 13.6 at 20 C.	Routine	2/day	10	0.5-1.5, as halogen	<10	10.6	48 hr LC50 8.5 mg/L; 7-day NOEC 2.5 mg/L	48 hr LC50 4.8 mg/L; 7-day NOEC > 10 mg/L	48 hr LC504.8 mg/L	NI; Bluegill Sunfish 96 hr LC50 3.8 mg/L
363	5300	FFK	4	30000	Summer	4440	CL2062 Biocide	20% 2-2-Dibromo-3-nitrilopropionamide	Routine	2/week	75	75	<75	10.6	NI	NI	48hr EC50 0.86mg/L	96hr LC50 2.3mg/L
363	5300	FFK	4	30000	Winter	4440	CL2062 Biocide	20% 2-2-Dibromo-3-nitrilopropionamide	Routine	1/week	75	75	<75	10.6	NI	NI	48hr EC50 0.86mg/L	96hr LC50 2.3mg/L
363	5300	FFK	4	30000	Summer	4440	Quadrasperse CL5898	3-7% of 2-Phosphono-1,2,4-butane tricarboxylic acid; 1-5 % of Benzotriazole; pH 3.8 at 20 C. Decomposes to oxides of phosphorus and sulfur.	Routine	Equals Blowdown Frequency	100-130	100-130	100-130	10.6	96hr LC50 2739mg/L	48hr LC50 1786mg/L	NI	NI
363	5300	FFK	4	30000	Winter	4440	Quadrasperse CL5898	3-7% of 2-Phosphono-1,2,4-butane tricarboxylic acid; 1-5 % of Benzotriazole; pH 3.8 at 20 C. Decomposes to oxides of phosphorus and sulfur.	Routine	Equals Blowdown Frequency	100-130	100-130	100-130	10.6	96hr LC50 2739mg/L	48hr LC50 1786mg/L	NI	NI
363	5300	FFK	4	30000	Summer	4440	CL401 biosurfactant	no hazardous components listed; oxides of carbon upon decomposition = acute health hazard	Routine	Equals Blowdown Frequency	5 to 10	5 to 10	<10	10.6	96hr LC50 87mg/L	48hr LC50 600mg/L	NI	NI
363	5300	FFK	4	30000	Winter	4440	CL401 biosurfactant	no hazardous components listed; oxides of carbon upon decomposition = acute health hazard	Routine	Equals Blowdown Frequency	5 to 10	5 to 10	<10	10.6	96hr LC50 87mg/L	48hr LC50 600mg/L	NI	NI
363	5300	FFK	4	30000	Summer & Winter	4440	De Nora D-CHLOR Dechlorination	92.3% Na2SO3	Routine	4-column tablet box					NI	NI	48 hr LC50440 mg/L	Goldfish 96hr LD50 100mg/L
363	5309	FFK	8	80000	Summer	13000	CL49 Biocide	5-10% Sodium chlorosulfamate, 7-13% Sodium bromosulfamate, and 5-10% Sodium hydroxide; ph13.6 at 20 C.	Routine	3/day	10	0.5-1.5, as halogen	<10	7.7 each (4 towers)	48 hrLC50 8.5mg/L; 7-day NOEC2.5 mg/L	48 hr LC50 4.8mg/L; 7-day NOEC > 10mg/L	48 hr LC504.8 mg/L	NI; Bluegill Sunfish 96hr LC50 3.8mg/L
363	5309	FFK	8	80000	Winter	13000	CL49 Biocide	5-10% Sodium chlorosulfamate, 7-13% Sodium bromosulfamate, and 5-10% Sodium hydroxide; ph13.6 at 20 C.	Routine	2/day	10	0.5-1.5, as halogen	<10	7.7 each (4 towers)	48 hrLC50 8.5mg/L; 7-day NOEC2.5 mg/L	48 hr LC50 4.8mg/L; 7-day NOEC > 10mg/L	48 hr LC504.8 mg/L	NI; Bluegill Sunfish 96hr LC50 3.8mg/L
363	5309	FFK	8	80000	Summer	13000	CL2062 Biocide	20% 2-2-Dibromo-3-nitrilopropionamide	Routine	2/week	75	75	<75	7.7 each (4 towers)	NI	NI	48hr EC50 0.86mg/L	96hr LC50 2.3mg/L
363	5309	FFK	8	80000	Winter	13000	CL2062 Biocide	20% 2-2-Dibromo-3-nitrilopropionamide	Routine	1/week	75	75	<75	7.7 each (4 towers)	NI	NI	48hr EC50 0.86mg/L	96hr LC50 2.3mg/L
363	5309	FFK	8	80000	Summer	13000	Quadrasperse CL5898	3-7% of 2-Phosphono-1,2,4-butane tricarboxylic acid; 1-5 % of Benzotriazole; pH 3.8 at 20 C. Decomposes to oxides of phosphorus and sulfur.	Routine	Equals Blowdown Frequency	100-130	100-130	100-130	7.7 each (4 towers)	96hr LC50 2739mg/L	48hr LC50 1786mg/L	NI	NI
363	5309	FFK	8	80000	Winter	13000	Quadrasperse CL5898	3-7% of 2-Phosphono-1,2,4-butane tricarboxylic acid; 1-5 % of Benzotriazole; pH 3.8 at 20 C. Decomposes to oxides of phosphorus and sulfur.	Routine	Equals Blowdown Frequency	100-130	100-130	100-130	7.7 each (4 towers)	96hr LC50 2739mg/L	48hr LC50 1786mg/L	NI	NI
363	5309	FFK	8	80000	Summer	13000	CL401 biosurfactant	no hazardous components listed; oxides of carbon upon decomposition	Routine	Equals Blowdown Frequency	5 to 10	5 to 10	<10	7.7 each (4 towers)	96hr LC50 87mg/L	48hr LC50 600mg/L	NI	NI
363	5309	FFK	8	80000	Winter	13000	CL401 biosurfactant	no hazardous components listed; oxides of carbon upon decomposition	Routine	Equals Blowdown Frequency	5 to 10	5 to 10	<10	7.7 each (4 towers)	96hr LC50 87mg/L	48hr LC50 600mg/L	NI	NI
363	5309	FFK	8	80000	Summer & Winter	13000	De Nora D-CHLOR, Dechlorination	92.3% Na2SO3	Routine	4-column tablet box				7.7 each (4 towers)	NI	NI	48 hr LC50440 mg/L	Goldfish 96hr LD50 100mg/L
014	4510	WOC	2	70,000	Summer	14400	CL49 Biocide	5-10% Sodium chlorosulfamate, 7-13% Sodium bromosulfamate, and 5-10% Sodium hydroxide; pH 13.6at 20 C.	Routine	3/day	<10	0.5-1.5, as halogen	<10	24.5	48 hr LC508.5 mg/L; 7-day NOEC2.5 mg/L	48 hr LC50 4.8mg/L; 7-dayNOEC > 10mg/L	48 hrLC50 4.8mg/L	NI; Bluegill Sunfish 96 hrLC50 3.8mg/L
014	4510	WOC	2	70000	Winter	14400	CL49 Biocide	5-10% Sodium chlorosulfamate, 7-13% Sodium bromosulfamate, and 5-10% Sodium hydroxide; pH 13.6at 20 C.	Routine	2/day	<10	0.5-1.5, as halogen	<10	24.5	48 hr LC508.5 mg/L; 7-day NOEC2.5 mg/L	48 hr LC50 4.8mg/L; 7-dayNOEC > 10mg/L	48 hrLC50 4.8mg/L	NI; Bluegill Sunfish 96 hrLC50 3.8mg/L
014	4510	WOC	2	70000	Summer	14400	CL2062 Biocide	20% 2-2-Dibromo 3 nitrilopropionamide	Routine	2/week	75	75	<75	24.5	NI	NI	48hr EC50 0.86mg/L	96hr LC50 2.3mg/L
014	4510	WOC	2	70000	Winter	14400	CL2062 Biocide	20% 2-2-Dibromo 3 nitrilopropionamide	Routine	1/week	75	75	<75	24.5	NI	NI	48hr EC50 0.86mg/L	96hr LC50 2.3mg/L

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2023 Cooling Tower Chemical Dosing

Outfall Number	Tower Location	Discharges to (waterbody)	Tower Cells	Volume of Tower Basin (gal)	Summer or Winter	Water Volume Circulated Through Basin (gal)	Chemical Name & Use	Parameters of Concern (SDS listed)	Frequency of Use	Chemical Injection Frequency	Chemical Feed (ppm)	Control Range (ppm)	Chemical Concentration Discharged (ppm)	Dischage Rate to Drain (gpm)	Toxicity (SDS): Fathead Minnow	Toxicity (SDS): Ceriodaphnia Dubia	Toxicity (SDS): Daphnia Magna	Toxicity (SDS): Rainbow Trout (or alternate listed)
014	4510	WOC	2	70000	Summer	14400	Quadrasperse CL5898	3-7% of 2-PHosphono-1,2,4-butane tricarboxylic acid; 1-5 % of Benzotriazole; pH 3.8 at 20 C. Decomposes to oxides of phosphorus and sulfur.	Routine	Equals Blowdown Frequency	100-130	100-130	100-130	24.5	96hr LC50 2739mg/L	48hr LC50 1786mg/L	NI	NI
014	4510	WOC	2	70000	Winter	14400	Quadrasperse CL5898	3-7% of 2-PHosphono-1,2,4-butane tricarboxylic acid; 1-5 % of Benzotriazole; pH 3.8 at 20 C. Decomposes to oxides of phosphorus and sulfur.	Routine	Equals Blowdown Frequency	100-130	100-130	100-130	24.5	96hr LC50 2739mg/L	48hr LC50 1786mg/L	NI	NI
014	4510	WOC	2	70000	Summer	14400	CL401 biosurfactant	No hazardous components listed; oxides of carbon upon decomposition	Routine	Equals Blowdown Frequency	5 to 10	5 to 10	<10	24.5	96hr LC50 87mg/L	48hr LC50 600mg/L	NI	NI
014	4510	WOC	2	70000	Winter	14400	CL401 biosurfactant	No hazardous components listed; oxides of carbon upon decomposition	Routine	Equals Blowdown Frequency	5 to 10	5 to 10	<10	24.5	96hr LC50 87mg/L	48hr LC50 600mg/L	NI	NI
014	4510	WOC	2	70000	Summer & Winter	14400	BL1254 Dechlorination	30-60 % Potassium Sulfite	Routine	Equals Blowdown Frequency	0-28	0-28	<28	24.5	96h LC50 2333mg/L	48hr LC50 884mg/L	NI	NI
014	4510	WOC	2	70000	Summer & Winter	14400	De Nora D-CHLOR, Dechlorination	92.3% Na2SO3	Routine	4-column tablet box				24.5	NI	NI	48 hrLC50 440mg/L	Goldfish 96 hrLD50 100mg/L
014	4521	WOC	2	47000	Summer	4800	CL49 Biocide	5-10% Sodium chlorosulfamate, 7-13% Sodium bromosulfamate, and 5-10% Sodium hydroxide; pH 13.6at 20 C.	Routine	3/day	10	0.5-1.5, as halogen	<10	8.2	48 hr LC508.5 mg/L; 7-day NOEC2.5 mg/L	48 hr LC50 4.8mg/L; 7-dayNOEC > 10mg/L	48 hrLC50 4.8mg/L	Bluegill Sunfish 96 hrLC50 3.8mg/L
014	4521	WOC	2	47000	Winter	4800	CL49 Biocide	5-10% Sodium chlorosulfamate, 7-13% Sodium bromosulfamate, and 5-10% Sodium hydroxide; pH 13.6at 20 C.	Routine	2/day	10	0.5-1.5, as halogen	<10	8.2	48 hr LC508.5 mg/L; 7-day NOEC2.5 mg/L	48 hr LC50 4.8mg/L; 7-dayNOEC > 10mg/L	48 hrLC50 4.8mg/L	Bluegill Sunfish 96 hrLC50 3.8mg/L
014	4521	WOC	2	47000	Summer	4800	CL2062 Biocide	20% 2-2-Dibromo 3-nitrilopropionamide	Routine	2/week	75	75	<75	8.2	NI	NI	48hr EC50 0.86mg/L	96hr LC50 2.3mg/L
014	4521	WOC	2	47000	Winter	4800	CL2062 Biocide	20% 2-2-Dibromo 3-nitrilopropionamide	Routine	1/week	75	75	<75	8.2	NI	NI	48hr EC50 0.86mg/L	96hr LC50 2.3mg/L
014	4521	WOC	2	47000	Summer	4800	Quadrasperse CL5898	3-7% of 2-PHosphono-1,2,4-butane tricarboxylic acid; 1-5 % of Benzotriazole; pH 3.8 at 20 C. Decomposes to oxides of phosphorus and sulfur.	Routine	Equals Blowdown Frequency	100-130	100-130	100-130	8.2	96hr LC50 2739mg/L	48hr LC50 1786mg/L	NI	NI
014	4521	WOC	2	47000	Winter	4800	Quadrasperse CL5898	3-7% of 2-PHosphono-1,2,4-butane tricarboxylic acid; 1-5 % of Benzotriazole; pH 3.8 at 20 C. Decomposes to oxides of phosphorus and sulfur.	Routine	Equals Blowdown Frequency	100-130	100-130	100-130	8.2	96hr LC50 2739mg/L	48hr LC50 1786mg/L	NI	NI
014	4521	WOC	2	47000	Summer	4800	CL401 biosurfactant	no hazardous components listed; oxides of carbon upon decomposition	Routine	Equals Blowdown Frequency	5 to 10	5 to 10	<10	8.2	96hr LC50 87mg/L	48hr LC50 600mg/L	NI	NI
014	4521	WOC	2	47000	Winter	4800	CL401 biosurfactant	no hazardous components listed; oxides of carbon upon decomposition	Routine	Equals Blowdown Frequency	5 to 10	5 to 10	<10	8.2	96hr LC50 87mg/L	48hr LC50 600mg/L	NI	NI
014	4521	WOC	2	47000	Summer & Winter	4800	De Nora D-CHLOR, Dechlorination	92.3% Na2SO3	Routine	4-column tablet box				8.2	NI	NI	48 hrLC50 440mg/L	Goldfish 96 hrLD50 100mg/L
435INT1	8913 (CNDW)	WOC (SNS Pond)	2	28800	Summer	14,400	Sulfuric acid: pH adjustment	93-98 % sulfuric acid: pH <1 at 25 C	Routine	Continuous	450, 8.0 pH	NA	70	70	NI	NI	NI	Gambusia affinis 96 hrs LC50 42 mg/l
435INT1	8913 (CNDW)	WOC (SNS Pond)	2	28800	Winter	7,200	Sulfuric acid: pH adjustment	93-98 % sulfuric acid: pH <1 at 25 C	Routine	Continuous	450, 8.0 pH	NA	70	70	NI	NI	NI	Gambusia affinis 96 hr LC50 42 mg/l
435INT1	8913 (CNDW)	WOC (SNS Pond)	2	28800	Summer	14400	NALCO 7346: biocide	54.2 % 1 Bromo-3-Chloro-5,5-Dimethyl-Hydantoin; 28.9% 1,3-Dichloro-5,5-Dimethylhydantoin; 15.9% 1,3-Dichloro-5-Ethyl-5-Methylhydantoin	Routine	Continuous	0.2-0.4	0.2	70	70	96 hr LC50 0.71 mg/l; 7-day NOEC 0.50 mg/l 7-day	7-day NOEC: 0.25 mg/l	48 hr LC50 and EC50: 1.1 mg/l; 48 hr NOEC: 0.63 mg/l 48 hrs	96 hr LC50 0.5 mg/l
435INT1	8913 (CNDW)	WOC (SNS Pond)	2	28800	Winter	7200	NALCO 7346: biocide	54.2 % 1 Bromo-3-Chloro-5,5-Dimethyl-Hydantoin; 28.9% 1,3-Dichloro-5,5-Dimethylhydantoin; 15.9% 1,3-Dichloro-5-Ethyl-5-Methylhydantoin	Routine	Continuous	0.2-0.4	0.1	70	70	96 hr LC50 0.71 mg/l; 7-day NOEC 0.50 mg/l 7-day	7-day NOEC: 0.25 mg/l	48 hr LC50 and EC50: 1.1 mg/l; 48 hr NOEC: 0.63 mg/l 48 hrs	96 hr LC50 0.5 mg/l
435INT1	8913 (CNDW)	WOC (SNS Pond)	2	28800	Summer	14400	NALCO Towerbrom 960: biocide	60-100% Sodium Dichloroisocyanurate; 5-10% Sodium Bromide; 1-5% Inorganic salt	Non-routine	As needed	1	0.2	70	70	96 hr LC50 0.7 mg/l (50% active ingredient)	48 hr LC50 1.02 mg/l	48 hrs LC50 2.5 mg/l (50% active ingredient)	NI
435INT1	8913 (CNDW)	WOC (SNS Pond)	2	28800	Winter	7200	NALCO Towerbrom 960: biocide	60-100% Sodium Dichloroisocyanurate; 5-10% Sodium Bromide; 1-5% Inorganic salt	Non-routine	As needed	1	0.1	70	70	96 hr LC50 0.7 mg/l (50% active ingredient)	48 hr LC50 1.02 mg/l	48 hrs LC50 2.5 mg/l (50% active ingredient)	NI
435INT1	8913 (CNDW)	WOC (SNS Pond)	2	28800	Summer	14400	NALCO 3DT231: corrosion and deposit inhibitor	1-5% Phosphoric acid; 1-5% Sulfuric Acid; 1-5 % Substituted aromatic amine. Evolves oxides of carbon.	Routine	Continuous	115	115	70	70	96 hr NOEC 1800 mg/l; LC50 2387 mg/L	48 hr LOEC 1800 mg/l; 48 hr LC50 2208 mg/l	NI	96 hr NOEC 500 mg/l; 96 hr LC50 758 mg/l

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2023 Cooling Tower Chemical Dosing

Outfall Number	Tower Location	Discharges to (waterbody)	Tower Cells	Volume of Tower Basin (gal)	Summer or Winter	Water Volume Circulated Through Basin (gal)	Chemical Name & Use	Parameters of Concern (SDS listed)	Frequency of Use	Chemical Injection Frequency	Chemical Feed (ppm)	Control Range (ppm)	Chemical Concentration Discharged (ppm)	Dischage Rate to Drain (gpm)	Toxicity (SDS): Fathead Minnow	Toxicity (SDS): Ceriodaphnia Dubia	Toxicity (SDS): Daphnia Magna	Toxicity (SDS): Rainbow Trout (or alternate listed)
435INT1	8913 (CNDW)	WOC (SNS Pond)	2	28800	Winter	7200	NALCO 3DT231: corrosion and deposit inhibitor	1-5% Phosphoric acid; 1-5% Sulfuric Acid; 1-5 % Substituted aromatic amine. Evolves oxides of carbon.	Routine	Continuous	115	115	70	70	96 hr NOEC 1800 mg/l; LC50 2387 mg/L	48 hr LOEC 1800 mg/l; 48 hr LC50 2208 mg/l	NI	96 hr NOEC 500 mg/l; 96 hr LC50 758 mg/l
435INT1	8913 (CNDW)	WOC (SNS Pond)	2	28800	Summer	14400	NALCO 7408: dechlorination	30-60% Sodium Bisulfite, corrosive	Routine	Continuous	0.5 - 1.0	0.5 - 1.0	70	70	7-day and 96 hr NOEC 250 mg/l	7-day NOEC 250 mg/l	48 hr NOEC 250 mg/L; 48 hr LC50 119 mg/l active substance vs 275 mg/l product	96 hr LC50 > 100 mg/l
435INT1	8913 (CNDW)	WOC (SNS Pond)	2	28800	Winter	7200	NALCO 7408: dechlorination	30-60% Sodium Bisulfite, corrosive	Routine	Continuous	0.5 - 1.0	0.5 - 1.0	70	70	7-day and 96 hr NOEC 250 mg/l	7-day NOEC 250 mg/l	48 hr NOEC 250 mg/L; 48 hr LC50 119 mg/l active substance vs 275 mg/l product	96 hr LC50 > 100 mg/l
435INT1	8913 (CNDW)	WOC (SNS Pond)	2	28800	Summer	14400	NALCO 71D5 Plus: foam control	30-60% Straight Run Middle Distillate; 10-30% Hydrotreated Light Distillate (petroleum);10-30% Polypropylene Glycol; 1-5% Stearic Acid; 1-5% 1-Octanol; 1-5% Fatty Alkyl Polyglycol; 1-5% Aliphatic alcohol	Non-routine	As needed	2	2	70	70	96 hr NOEC 100 mg/L; 96 hr LC50 190 mg/l	7-day NOEC 0.19 - 1.5 mg/L; 48 hr LC50= 4.32 mg/l	48 hrs NOEC 16 mg/L	96 hr NOEC <78 mg/L
435INT1	8913 (CNDW)	WOC (SNS Pond)	2	28800	Winter	7200	NALCO 71D5 Plus: foam control	30-60% Straight Run Middle Distillate; 10-30% Hydrotreated Light Distillate (petroleum);10-30% Polypropylene Glycol; 1-5% Stearic Acid; 1-5% 1-Octanol; 1-5% Fatty Alkyl Polyglycol; 1-5% Aliphatic alcohol	Non-routine	As needed	2	2	70	70	96 hr NOEC 100 mg/L; 96 hr LC50 190 mg/l	7-day NOEC 0.19 - 1.5 mg/L; 48 hr LC50= 4.32 mg/l	48 hrs NOEC 16 mg/L	96 hr NOEC <78 mg/L
435INT1	SNS 8913 (TW)	WOC (SNS Pond)	2	36240	Summer & Winter	9000 gpm	Sulfuric acid: pH adjustment	93-98 % sulfuric acid: pH <1 at 25 C	Routine	Continuous	450, 8.0 pH	450, 8.0 pH	NA	70	NI	NI	NI	Gambusia affinis 96 hr LC50 42 mg/l
435INT1	SNS 8913 (TW)	WOC (SNS Pond)	2	36240	Summer	9000 gpm	NALCO 7346: biocide	54.2 % 1 Bromo-3-Chloro-5,5-Dimethyl-Hydantoin; 28.9% 1,3-Dichloro-5,5-Dimethylhydantoin; 15.9% 1,3-Dichloro-5-Ethyl-5-Methylhydantoin	Routine	Continuous	0.2-0.4	0.2-0.4	0.2	70	96 hr LC50 0.71 mg/l; 7-day NOEC 0.50 mg/l 7-day	7-day NOEC: 0.25 mg/l	48 hr LC50 and EC50: 1.1 mg/l; 48 hr NOEC: 0.63 mg/l 48 hrs	96 hr LC50 0.5 mg/l
435INT1	SNS 8913 (TW)	WOC (SNS Pond)	2	36240	Winter	9000 gpm	NALCO 7346: biocide	54.2 % 1 Bromo-3-Chloro-5,5-Dimethyl-Hydantoin; 28.9% 1,3-Dichloro-5,5-Dimethylhydantoin; 15.9% 1,3-Dichloro-5-Ethyl-5-Methylhydantoin	Routine	Continuous	0.2-0.4	0.2-0.4	0.1	70	96 hr LC50 0.71 mg/l; 7-day NOEC 0.50 mg/l 7-day	7-day NOEC: 0.25 mg/l	48 hr LC50 and EC50: 1.1 mg/l; 48 hr NOEC: 0.63 mg/l 48 hrs	96 hr LC50 0.5 mg/l
435INT1	SNS 8913 (TW)	WOC (SNS Pond)	2	36240	Summer	9000 gpm	NALCO Towerbrom 960: biocide	60-100% Sodium Dichloroisocyanurate; 5-10% Sodium Bromide; 1-5% Inorganic salt	Non-routine	As needed	1	1	0.2	70	96 hr LC50 0.7 mg/l (50% active ingredient)	48 hr LC50 1.02 mg/l	48 hrs LC50 2.5 mg/l (50% active ingredient)	NI
435INT1	SNS 8913 (TW)	WOC (SNS Pond)	2	36240	Winter	9000 gpm	NALCO Towerbrom 960: biocide	60-100% Sodium Dichloroisocyanurate; 5-10% Sodium Bromide; 1-5% Inorganic salt	Non-routine	As needed	1	1	0.1	70	96 hr LC50 0.7 mg/l (50% active ingredient)	48 hr LC50 1.02 mg/l	48 hrs LC50 2.5 mg/l (50% active ingredient)	NI
435INT1	SNS 8913 (TW)	WOC (SNS Pond)	2	36240	Summer	9000 gpm	NALCO 3DT231: corrosion and deposit inhibitor	1-5% Phosphoric acid; 1-5% Sulfuric Acid; 1-5 % Substituted aromatic amine. Evolves oxides of carbon.	Routine	Continuous	115	115	115	70	96 hr NOEC 1800 mg/l; LC50 2387 mg/L	48 hr LOEC 1800 mg/l; 48 hr LC50 2208 mg/l	NI	96 hr NOEC 500 mg/l; 96 hr LC50 758 mg/l
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435INT1	SNS 8913 (TW)	WOC (SNS Pond)	2	36240	Summer	9000 gpm	NALCO 71D5 Plus: foam control	30-60% Straight Run Middle Distillate; 10-30% Hydrotreated Light Distillate (petroleum);10-30% Polypropylene Glycol; 1-5% Stearic Acid; 1-5% 1-Octanol; 1-5% Fatty Alkyl Polyglycol; 1-5% Aliphatic alcohol	Non-routine	As needed	2	2	2	70	96 hr NOEC 100 mg/L; 96 hr LC50 190 mg/l	7-day NOEC 0.19 - 1.5 mg/L; 48 hr LC50= 4.32 mg/l	48 hrs NOEC 16 mg/L	96 hr NOEC <78 mg/L

WOC = White Oak Creek
MB = Melton Branch
FFK = Fifth Creek

NOEC = No Effect Concentration
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