BUREAU OF RECLAMATION

Willamette Basin Mercury TMDL Water Quality Implementation Plan

Tualatin Project, Oregon
Columbia-Pacific Northwest Region

U.S. Department of the Interior

February 2024

Mission Statements

The U.S. Department of the Interior protects and manages the Nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its trust responsibilities or special commitments to American Indians, Alaska Natives, Native Hawaiians, and affiliated Island Communities.

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

Willamette Basin Mercury TMDL Water Quality Implementation Plan

Tualatin Project, Oregon
Columbia-Pacific Northwest Region

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Cover Photo: Scoggins Dam and Henry Hagg Lake, Oregon (Reclamation photo)

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Contents

List of Tables

List of Figures

Appendix A – Hydromet SCO FB Day-to-Day Change, 2003-2023

Acronyms

Acronym or Abbreviation	Definition
BMP	Best management practice
DMA	Designated management agency
DO	Dissolved oxygen
EPA	U.S. Environmental Protection Agency
FY	Fiscal Year (October 1 to September 30 the following year)
HUC8	Hydrologic Unit Code 8
JWC	Joint Water Commission
MeHg	Methylmercury
ODEQ	Oregon Department of Environmental Quality
Reclamation	Bureau of Reclamation
TMDL	Total Daily Maximum Load
THg	Total mercury
TVID	Tualatin Valley Irrigation District
WQIP	Water Quality Implementation Plan
WQMP	Water Quality Management Plan

Executive Summary

The Willamette River basin and its numerous tributaries do not currently meet Oregon's Water Quality Standards for mercury. These standards protect designated beneficial uses such as human health, recreation, fish and aquatic life, wildlife, hunting, and fishing (fish consumption and rearing). When water quality standards are not met, the federal Clean Water Act requires a Total Maximum Daily Load (TMDL) to be established. A TMDL determines how much pollution can be added to the river without exceeding water quality standards.

On February 4, 2021, the U.S. Environmental Protection Agency (EPA) finalized the revised Willamette Basin Mercury Total Maximum Daily Load. The revised TMDL identifies sources of mercury and requirements needed to meet water quality standards. EPA's revised TMDL also relies on and incorporates portions of the November 2019 Willamette Basin Mercury TMDL prepared by the Oregon Department of Environmental Quality (ODEQ), including Section 13 of the November 2019 TMDL titled "Water Quality Management Plan." Section 13 describes goals and objectives of a plan to meet the TMDL load allocations via water quality implementation plans produced for ODEQ by designated management agencies (DMAs).

The Bureau of Reclamation (Reclamation) received a letter from ODEQ on February 17, 2022, designating Reclamation as a reservoir operator DMA. The letter identified August 17, 2023, as the deadline for Reclamation to submit to ODEQ a water quality implementation plan (WQIP) for ODEQ's review and approval. Reclamation has developed this Tualatin Project WQIP to describe proposed and ongoing water quality monitoring for Henry Hagg Lake, the reservoir formed by Scoggins Dam. Scoggins Dam is operated and maintained by the Tualatin Valley Irrigation District (TVID) under an existing operation and maintenance agreement. Data collected from this water quality monitoring will be used to establish baseline water quality conditions in Henry Hagg Lake that can be used to assess the potential for mercury methylation within the reservoir.

Baseline water quality monitoring at Henry Hagg Lake is proposed through the first 5 years of TMDL implementation. Henry Hagg Lake is a feature of the Tualatin Project (Project) and is operated to provide irrigation water, recreation, and flood and water quality control under existing environmental compliance commitments. Accordingly, operations are tightly regulated and any changes to operations will require extensive study; water contract review, and compliance with applicable laws including the National Environmental Policy Act, Endangered Species Act, and Section 106 of the National Historic Preservation Act. Such efforts likely would exceed the 5-year reporting cycle for this WQIP and are thus outside the scope and budget of this WQIP.

Background

Tualatin Project

The Project lies within the Tualatin watershed (HUC8 - 17090010) and is primarily in Washington County in the northwest part of the Willamette Basin, west of and adjacent to the city of Portland, Oregon. Congress authorized the Project to supply water for irrigation and municipal and industrial purposes (80 Stat. 822, Public Law 89-596). The Project serves irrigation water to some 17,000 acres of land and furnishes untreated water to several communities and an industrial corporation for municipal and industrial use. Fish and wildlife enhancement, recreation, and flood control are also important authorized Project functions. Principal features include Scoggins Dam, Henry Hagg Lake, Patton Valley Pumping Plant, Spring Hill Pumping Plant, booster pumping plants, and piped lateral distribution systems.

Scoggins Dam was completed in 1975 as a zoned embankment dam located on Scoggins Creek, a tributary of the Tualatin River. The dam's reservoir, Henry Hagg Lake, is the primary source of water for the Tualatin basin. It has 1,132 acres of surface water area and roughly 11 miles of shoreline at full pool (elevation 303.5; Reclamation 2023). The Project provides 14,000 acre-feet of water for municipal and industrial uses; 16,900 acre-feet for water quality control purposes and fish and wildlife habitat in the Tualatin River; and 30,000 acre-feet assigned for flood control. The reservoir typically reaches maximum storage volume by May 1 (Figure 1). Water is released from Scoggins dam to augment flows and improve water quality in the Tualatin River during the conservation release season (Figure 2).

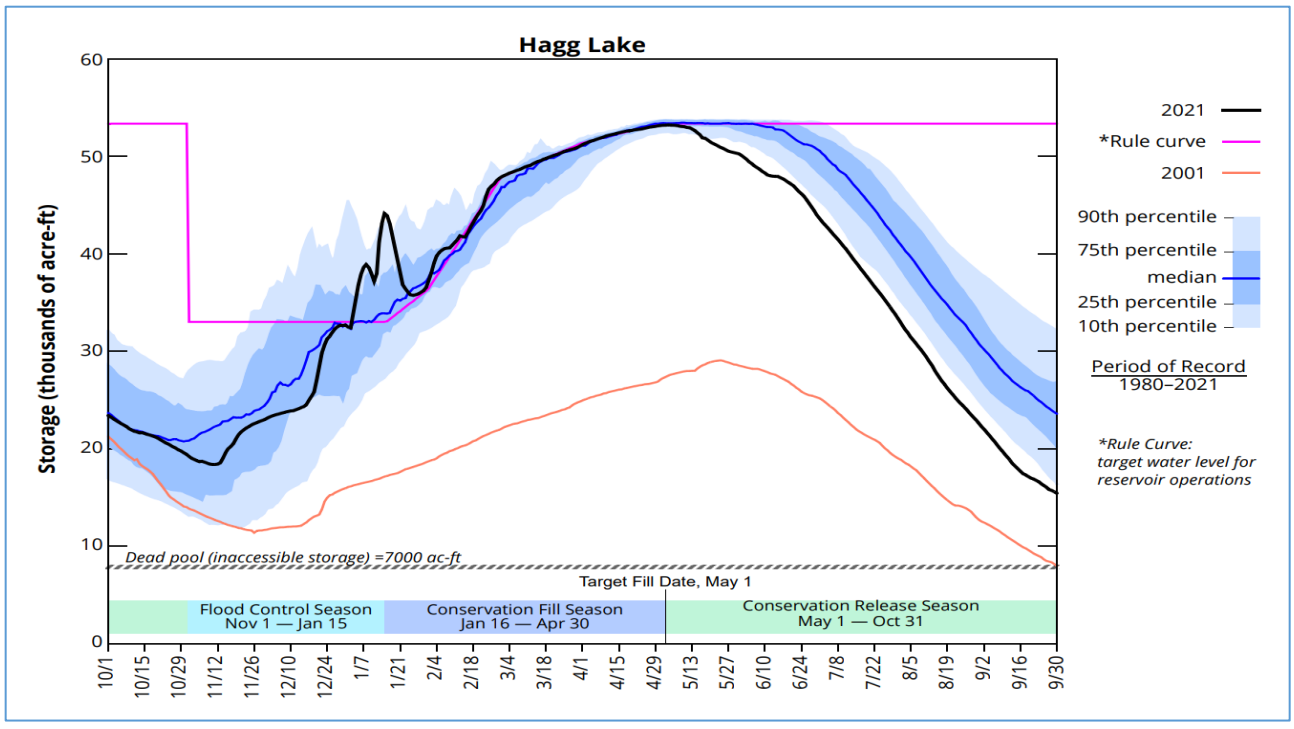

Figure 1. 2021 Hagg Lake fill curve (Clean Water Services 2023)

Scoggins Dam, Henry Hagg Lake, and related recreation facilities were initially operated and maintained by Reclamation. However, by agreement of August 16, 1983, between TVID and Reclamation, responsibility for the operation and maintenance of Scoggins Dam was transferred to the district effective September 15, 1983. Operation and maintenance of the recreation facilities at Henry Hagg Lake were transferred to Washington County effective November 15, 1973 (Reclamation 2023).

Reclamation remains the owner of the Project facilities and provides for maintenance of the Hydromet system (for flood control forecasting), fish mitigation, water quality monitoring, oversight of recreation management on Henry Hagg Lake by Washington County, pest management, environmental audits, water conservation measures, and activities related to resolving unauthorized use of water.

ALLOCATION OF WATER FROM HAGG LAKE

Contracted To	Water Use	Available Volume	
		ac-ft	as percent
Tualatin Valley Irrigation District	Irrigation (up to 17,000 acres)	26,705	50%
Joint Water Commission *City of Beaverton* *City of Forest Grove* *City of Hillsboro*	Municipal and industrial	13,500 *4,000* *4,500* *5,000*	25%
Clean Water Services	Instream water quality	12,618	24%
Lake Oswego Corporation	Irrigation	500	1%
Total		***53,323**	**100%**

*The active storage in Hagg Lake was revised in 2011.

Figure 2. Allocation of water from Hagg Lake (Clean Water Services 2023)

Willamette Basin Mercury TMDL

The Willamette River is currently listed as water quality impaired due to elevated mercury levels. ODEQ first issued a Willamette Basin Mercury TMDL in 2006. EPA's revised 2021 Willamette Basin Mercury TMDL identifies sources of mercury and how much mercury needs to be reduced to meet water quality standards (EPA 2021). The 2021 TMDL relies on and incorporates certain portions of ODEQ's 2019 Final Revised Willamette Basin Mercury TMDL, including Section 13, which describes ODEQ's Water Quality Management Plan (WQMP; ODEQ 2019a). The WQMP identifies designated management agencies, or DMAs, with responsibility for implementing the TMDL.

A DMA is "a federal, state or local governmental agency that has legal authority of a sector or source contributing pollutants and is identified as such by the Department of Environmental Quality in a TMDL." TMDL implementation activities will be carried out under existing regulatory authorities, programs, and water quality restoration plans as well as by TMDL implementation plans that certain DMAs will develop in fulfillment of the requirements of this TMDL.

Along with other entities in the Willamette Basin, Reclamation has been named by ODEQ as a DMA, due to its legal authority over federally owned water storage and distribution systems within the Project

(80 Stat. 822, Public Law 89-596). Reclamation retains water quality responsibilities for Henry Hagg Lake, but reservoir operations are performed by TVID. As such, Reclamation is required to develop a TMDL implementation plan for review and approval by ODEQ.

As identified by EPA and ODEQ, atmospheric deposition, which is mercury in the air falling onto the land or into the water, is the primary and predominant source of mercury in the Willamette basin (EPA 2021). Most of the atmospheric mercury sources originate outside the Willamette basin, mainly from national and global sources rather than from local sources in Oregon. Once atmospheric mercury is deposited on the landscape, the major pathways to streams are erosion of sediment-bound mercury and surface runoff. The TMDL targets for reduction are 89 percent on average, but general nonpoint source pollution is targeted at 97 percent reduction (ODEQ 2019b; EPA 2021).

Table 1. Mercury TDML watershed targets

HUC8/Waterbody	Median Total Mercury (THg) Concentration (ng/l)	Required Percent Reduction	At source THg Load (g/day)	THg Loading Capacity (g/day)
17090010 (Tualatin)	1.32	89%	22.93	1.91

The TMDL identifies the Tualatin basin as having higher than median concentrations of THg as measured within the mainstem Tualatin River. However, data from Henry Hagg Lake was not included in this analysis (TetraTech 2019). There are no known mercury dischargers upstream of Henry Hagg Lake, and upstream watersheds do not contain legacy mining. Targets for water column THg to meet the percent reduction in surface waters (which are not reservoir-specific) are related to specific food-web sensitive fish species as identified in the WQMP (ODEQ 2019a**Error! Reference source not found.**). Surface water THg below the target level for the most sensitive species (Northern Pikeminnow) was determined to be conservative enough to meet TMDL required reductions.

Table 2. Fish species and target water column THg (ODEQ 2019a)

Fish Species	Surface Water Total Mercury Target Levels (ng/L) to Meet Fish Tissue Concentration	Required Reduction
Northern Pikeminnow	0.14	88%
Largemouth Bass	0.22	82%
Bluegill	0.32	73%
Smallmouth Bass	0.35	71%
Carp	0.37	69%
Largescale Sucker	0.42	65%
Rainbow Trout	0.58	52%
Cutthroat Trout	1.11	7%

Water Quality Implementation Plan

Water Quality Assessment

Henry Hagg Lake starts the year isothermal, cold, and well-oxygenated (USGS 2005). A thermocline develops in early summer, and by late August to October dissolved oxygen (DO) becomes depleted in the hypolimnion. Ammonia production and accumulation occurs in the hypolimnion concurrent with the depletion of dissolved oxygen. Anoxia in the hypolimnion typically lasts from August/September until the reservoir turns over in November, returning DO concentrations to high levels (USGS 2004). Algal blooms occur in the lake and appear to be limited in size by phosphorus availability, water temperature, and other factors.

Currently, Reclamation collects grab samples for reservoir water quality analysis at Reclamation site TUL001 (Henry Hagg Lake 100 meters above Dam: 45.472, -123.204), once per year, typically between June and August. This annual sampling consists of surface grab and bottom grab samples and a vertical profile at the thalweg. Parameters include nutrients, cations, anions, organic carbon, metals, and chlorophyll-a. The Joint Water Commission (JWC) also collects water quality samples throughout the monitoring season for nutrients and DO. Figure 3 presents average minimum DO values per month as measured by Reclamation and JWC for the period from 2015 to 2023. Data for total organic carbon and sulfate are shown in Figure 4 and Figure 5, respectively.

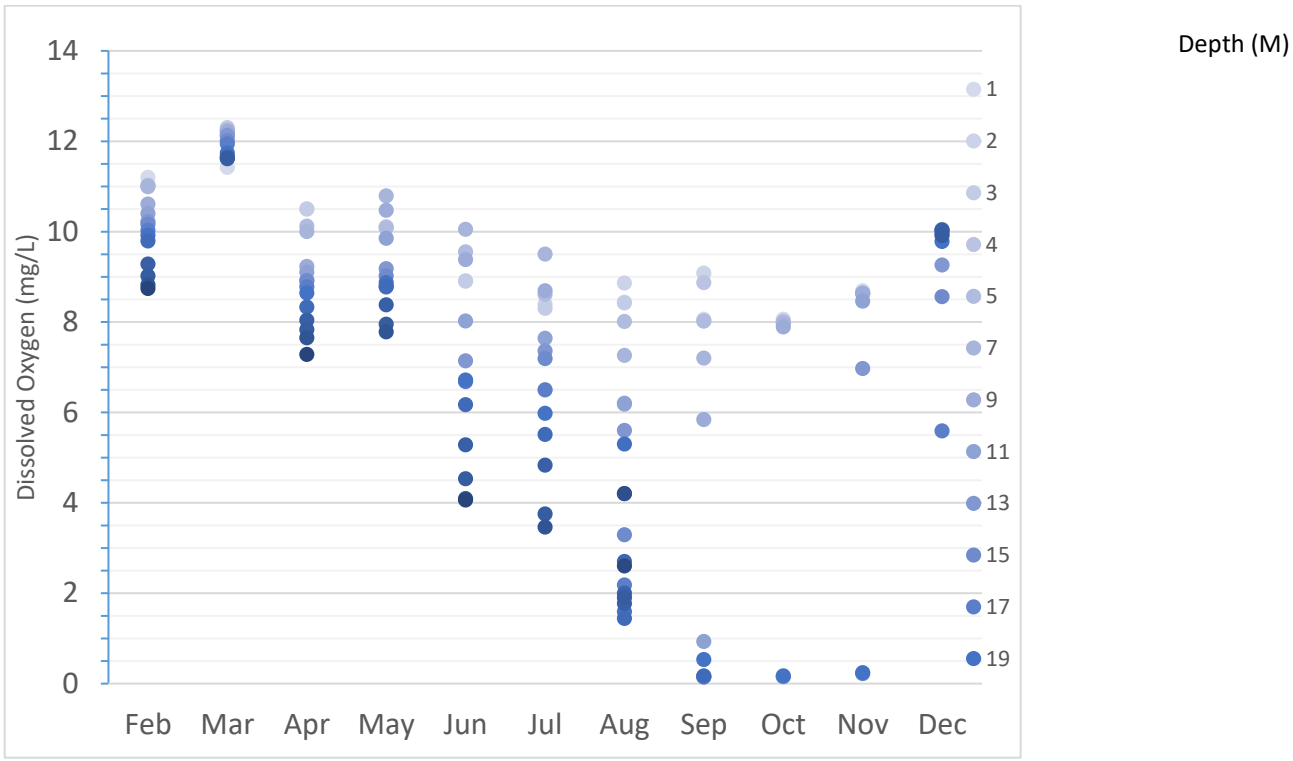

Figure 3. Average minimum DO per month at TUL001 by depth in meters (2015-2023), Reclamation/JWC

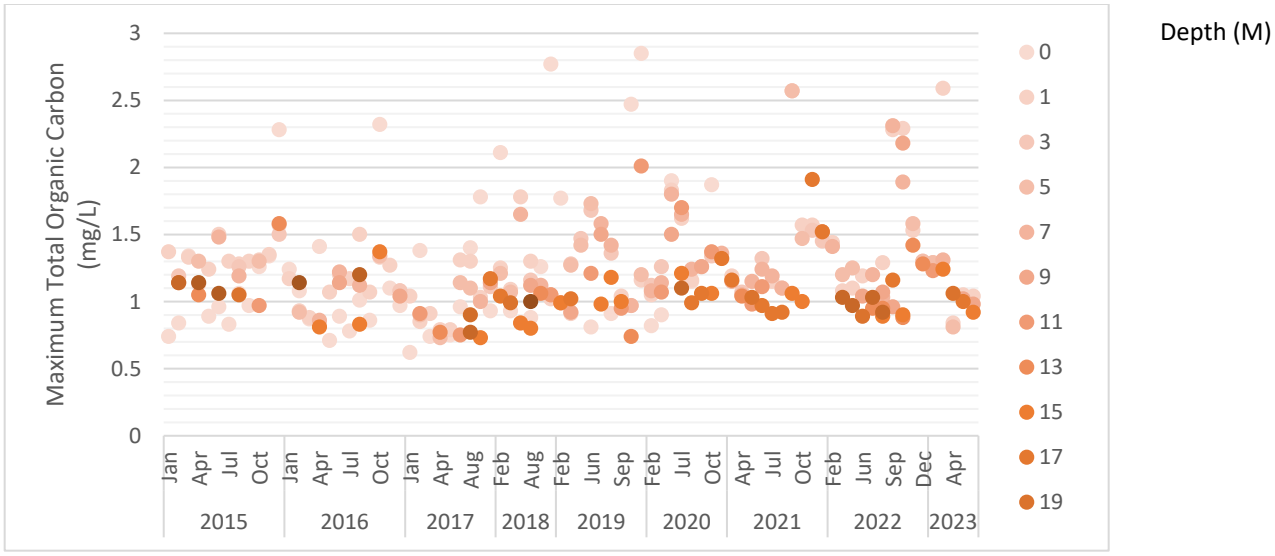

Figure 4. Average monthly total organic carbon by month and depth in meters (2015-2023), Reclamation/JWC

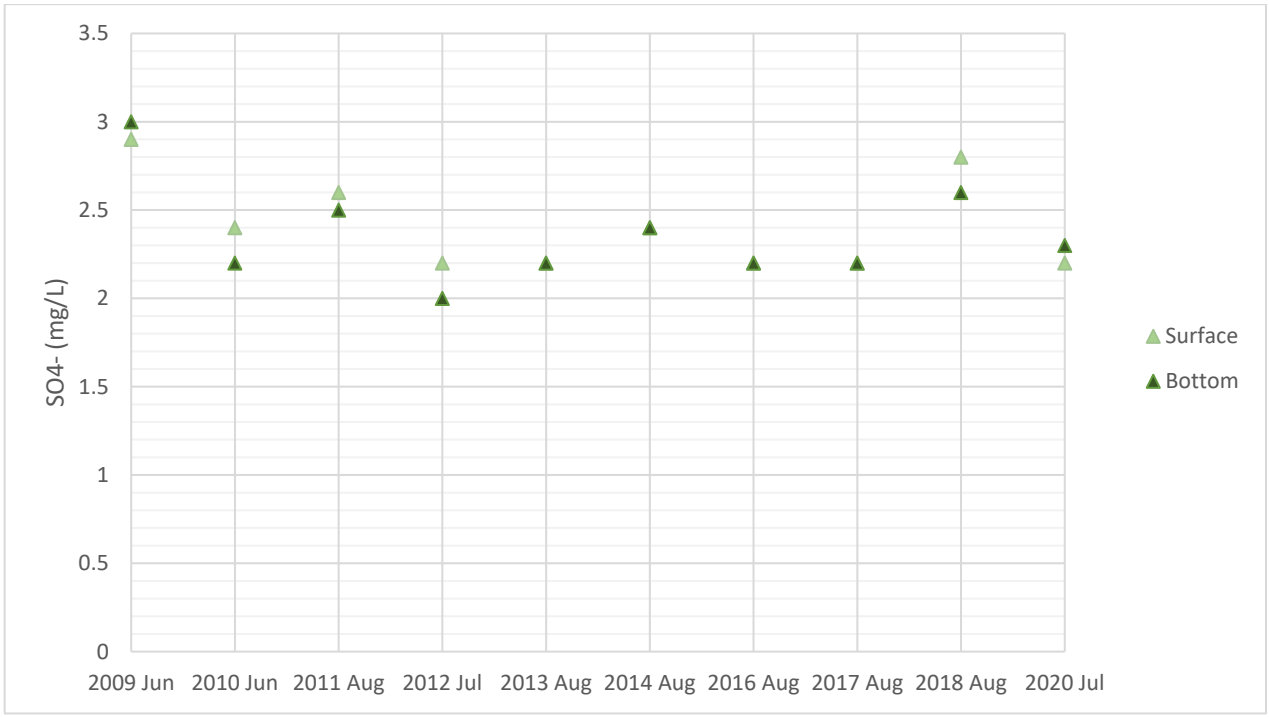

Figure 5. Sulfate concentration by year and depth location (2009-2020), Reclamation

As described in Table 3, current reservoir water quality could be indicative of mercury methylating conditions (anoxia in hypolimnion from August to November; Baldwin et al. 2022). The generally low concentrations of total organic carbon and sulfate in the reservoir are associated with lower methylation risk. In addition, current reservoir operations described in Table 3, including following the current rule curve which targets refill by May 1, represents a lower risk factor for mercury methylation. These mixed factors indicate a need for additional data collection to establish baseline conditions and inform management strategies.

Table 3. Mercury risk factors vs current operations

Mercury Risk Factor	Current Henry Hagg Lake Operations
Reservoirs can be sites where the rate of methylation of Hg is enhanced by conditions of low DO and elevated organic carbon and sulfate in bottom waters and sediment (ODEQ 2019a).	Reservoir anoxia occurs annually between August and November. Anoxia is restricted to approximately 5-10% of storage volume at depths 0-5 m from reservoir bottom. Anoxia occurs at elevations below 229.0 feet (dead pool). Total organic carbon levels are typically <2.0 mg/L year-round at hypolimnion depth (Figure 4), and sulfate levels do not appear to vary substantially with depth (Figure 5).
Water management was particularly important in influencing fish THg concentrations, which were up to 11-times higher in reservoirs with minimum water storage occurring in May, June, or July (Willacker et al. 2016). For northwestern forested mountain reservoirs, minimum water storage occurring in January was associated with the lowest fish THg levels.	Minimum water storage occurs in the period from November to January 15 for flood control per rule curve (Figure 1). The target date for maximum water storage is May 1.
Between-year changes in maximum water storage strongly influenced fish THg concentrations, but within-year fluctuations in water levels did not influence fish THg concentrations (Willacker et al. 2016).	The reservoir filled to >97.5% capacity in 42 out of 44 years since construction. Between-year changes in maximum water storage are rare. Within-year fluctuations between 97.5% to less than 20% reservoir capacity occurred 2 out of 44 years since construction (Reclamation 2023).

As summarized in Table 4, Reclamation proposes to follow the recommended assessment methods provided by ODEQ for reservoir operators and to continue assessing baseline water quality as required by the TMDL.

Table 4. Assessment methods (ODEQ 2019)

Assessment Method	Measure	Implementation Schedule	Methodology
Area of reservoir-adjacent wetlands	Satellite imagery, site survey	2024	Area of reservoir-adjacent wetlands may be determined by literature review of existing studies, wetland delineations, and/or satellite imagery. National Wetlands Inventory (usgs.gov)

Assessment Method	Measure	Implementation Schedule	Methodology
Water level fluctuations	Hydromet	Complete	Water level fluctuations are currently measured via Hydromet, which records reservoir elevations. Data from the period of August 2003 to August 2023 is provided in Appendix A.
Dissolved oxygen profile	Water quality studies	Begin in August 2024	Dissolved oxygen profiles (mg/L + percent saturation) are proposed to be collected at the established TUL001 site three times annually (August/September/October). Profiles will be provided to ODEQ and used to assess extent of anoxic conditions in reservoir.
Nutrient status	Water quality studies	Begin in August 2024	Nutrient status is scheduled to be collected at the established TUL001 site three times annually (August/September/October). Three water quality samples will be taken during each sampling event at the surface, thermocline, and bottom.
Water column THg and dissolved methylmercury (MeHg)	Water quality studies	THg to begin in August 2024 MeHg to begin in August 2025	Water column THg and dissolved MeHg will be collected three times annually at the established TUL001 site (August/September/October). THg monitoring will begin in 2024 and dissolved MeHg monitoring will begin in 2025.
Reservoir-specific mercury translator	Water quality studies	Develop mercury translator in 2028, to be completed by August 2028. See Mercury Methylation discussion in this document.	A reservoir-specific mercury translator, which relates water column THg to dissolved MeHg, like the translator in the TMDL model. Regression analysis of paired THg and dissolved MeHg results will be used to develop a mercury translator equation.

Management Strategies

Pollutant sources are summarized in Table 5; the following subsections describe associated management strategies.

Table 5. Pollutant sources

Pollutant	Source	Jurisdiction	Concern
Mercury	Atmospheric deposition directly to water	N/A	Atmospheric deposition originating from sources outside of the watershed cannot be controlled.
	Upstream runoff	Land managers	Runoff can transport organic material containing sorbed Hg from upstream areas into the reservoir.
	Shoreline erosion	Reservoir managers	Rapid reservoir level changes or improper resource management can transport atmospherically deposited Hg into the reservoir.
Methylmercury	Methylating conditions in wetlands	Reservoir managers	Wetland methylation is a complex process typically associated with wetland soil wetting and rewetting and the organic matter present.
	Methylating conditions in reservoir	Reservoir managers	Methylation is a complex process typically associated with organic matter and anoxic conditions at deeper depths in the reservoir.

Water Quality Monitoring

Until baseline conditions are established, implementing or exploring management strategies are outside of the scope of this WQIP. Existing reservoir operations at Henry Hagg Lake are already protective of reservoir methylating conditions. Reclamation will ensure that these protective operations continue. Reclamation is committed to the process of adaptive management as conditions in the reservoir are better characterized through water quality monitoring studies. Performance measures are provided in Table 6.

Upstream Sediment Control

Reclamation's jurisdiction only extends to the water quality in the reservoir itself and to surrounding park lands which are managed by Washington County. Reclamation will establish relationships with upstream DMAs to review progress on other DMAs' WQIPs and to provide partnerships where possible. Performance measures are provided in Table 6.

Erosion/Sediment Control

Reclamation will continue to implement erosion control best management practices (BMPs) as required by resource management plans, stormwater prevention plans, or construction permits for all

construction actions performed by either Reclamation or its contractors. Reclamation will continue to ensure that all lake shorelines and riparian areas are well established and maintained to reduce erosion and additional sedimentation releases to the reservoir. Performance measures are provided in Table 6.

Mercury Methylation

Currently, the risk of mercury methylation in Henry Hagg Lake remains unknown. Reservoir water quality and existing operations show both potential to enhance methylation risk (anoxia), and potential to reduce methylation risk (timing of fill, year-to-year fluctuations, low sulfate, and organic carbon concentrations). Water column sampling for THg will begin in August 2024 to better establish methylation risk and familiarize staff with the monitoring program. Dissolved MeHg sampling will begin in August 2025 to produce 3 years of data to inform the development of a mercury translator equation.

To produce the reservoir-specific mercury translator, water column THg results will be paired with dissolved MeHg results, and the relationship will be derived to produce the equation that best describes and fits with the observed data. This equation will be validated against data collected from ongoing monitoring, and will be proofed against the mercury translator equation used to develop the Hg TMDL.

Adaptative Management

Until Hg methylation risk in Henry Hagg Lake has been determined, management actions are outside of the scope of this WQIP. Data collection to develop a reservoir-specific Hg translator will begin in 2024, and the Hg translator equation will be developed in 2028 (completed by August 2028), within the first 5 years of the WQIP. Once the Hg translator has been developed and Hg methylation risk assessed, a 5-year WQIP revision will be initiated containing adaptive management planning, dependent on methylation risk derived from the Hg translator. This revision will explore updating the existing CE-QUAL-W2 model for Henry Hagg Lake to incorporate Hg modeling. Modeling would be used to simulate operational changes available within the constraints of the Project's authorized purposes, existing environmental compliance commitments (Reclamation 2009), and available budget.

Table 6. Performance measures

Reclamation Mercury TMDL Implementation Tracking Matrix							
Source	**Strategy**	**How**	**Fiscal Analysis**	**Measure**	**Timeline**	**Milestone**	**Status**
Shoreline Erosion	Monitor reservoir level fluctuations	Via Hydromet monitoring	N/A	Daily max water elevation change	April 2024 - August 2028	Annual report for the previous calendar year's monitoring (April 1)	--
Reservoir Chemistry	Maintain reservoir-adjacent wetlands	Existing surveys/delineations	N/A	Acreage of wetlands	April 2024 - August 2028		--
	Monitor	Dissolved oxygen profiles	$90,621 for August 2024 - August 2028	Percent of reservoir volume < 0.5 mg DO	August 2024 – August 2028		--
		DO, 1 m interval, pH, EC, temperature		Percent saturation			
		Nutrient status: nutrients, ions, organic carbon, 3 times annually		Nutrient concentrations, increase/decrease in sulfate or carbon	August 2024 – August 2028		--
		Water column Hg 3 times annually		THg concentrations	August 2024 – August 2028		--
		Water column dissolved MeHg 3 times annually		Dissolved MeHg concentrations	August 2025 - August 2028		--
	Continue existing protective reservoir operations	Refill is targeted for May 1; minimum storage occurs November – January.	N/A	Refill date, percent fill relative to previous year, date of minimum storage	N/A		--
	Assess opportunities to reduce sediment runoff	Coordination with upstream land managers	N/A	Upstream land managers WQIP progress	April 2024-August 2028, establish data sharing		--

Note: Additional performance measures will be considered based on the first 5 years of WQIP implementation to establish background reservoir conditions. Any reservoir operational changes will require extensive modeling and environmental compliance outside of the scope of the current WQIP and will be updated via a WQIP revision.

Plan Review, Revision, and Reporting Requirements

Plan Review and Revision

Reclamation will review this WQIP every 5 years and submit a 5-year revision to ODEQ for evaluation and approval; or, in lieu of needing revisions, Reclamation will submit a survey of WQIP implementation to ODEQ. The first 5-year cycle of this WQIP will end in August 2028. The final ODEQ-approved WQIP and all final annual reports on the performance measures described in Table 6 will be hosted publicly on Reclamation's Columbia-Cascades Area Office website.

Reporting

Data collected under this implementation plan will be reviewed annually and submitted to ODEQ via email to the basin coordinator with the annual reports described in Table 6 by April 1 of each calendar year. The first annual report will be submitted by April 1, 2024, and will describe implementation for the preceding calendar year between January 1st and December 31st. Progress in implementing the monitoring program, Hg translator development, and ongoing performance of protective reservoir management actions discussed in this WQIP will be described in a 5-year report or survey, submitted to ODEQ by July 31st, 2028.

Table 7, Contacts

Reclamation	ODEQ
Cavan Gerrish Water Quality Coordinator Office: (208)-378-5347 cgerrish@usbr.gov	Brian Creutzburg Tualatin Basin Coordinator Office: (503) 229-6819 brian.creutzburg@deq.oregon.gov

Additional Requirements as Indicated in the WQMP

A fiscal analysis indicates that increasing the existing annual water quality monitoring program sampling from August 2024 through August 2028 will add an estimated cost of approximately $12,500 plus 5 percent per year in analytical and sampling costs. Methylmercury costs for August 2025 through August 2028 are estimated at approximately $5,000 plus 5 percent per year; technical writer and subject matter expert participation is estimated at approximately $7,500 for August 2023 to September 2024, and $5,250 plus 5 percent per year in labor costs from October 2024 to August 2028. Costs by fiscal year (FY) are presented in Table 8.

Table 8. Monitoring cost breakdown by Fiscal Year

Cost Period or Parameter	Water Quality Monitoring (nutrients and THg; begins August 2024)	MeHg Monitoring (begins August 2025)	Other Labor
FY 2023/FY 2024	$12,500	--	$7,500
FY 2025	$13,125	$5,000	$5,250
FY 2026	$13,781	$5,250	$5,513
FY 2027	$14,470	$5,513	$5,788
FY 2028	$15,194	$5,788	$6,078
Subtotal	$69,070	$21,551	$30,128
Total Laboratory Costs	$90,621		--
Annual Reporting/Section 508 Compliance	--		$30,128
Total Cost (FY 2023/2024-FY 2028)	$120,749		

The total WQIP costs are anticipated to be an additional $120,749 from August 2023 to August 2028 (5 years), including $90,621 in laboratory and sample collection costs and $30,128 in labor for plan and report writing. Analytical and laboratory costs are estimated based on Reclamation water lab FY 2024 costs, estimated costs for external Hg and MeHg laboratory analysis, current labor rates, and anticipating one monitoring event annually to be funded by existing reservoir monitoring programs.

The fiscal analysis includes costs for: water column THg sampling for August 2024 to August 2028; dissolved MeHg sampling for August 2025 to August 2028; water quality sampling for August 2024 to August 2028 for dissolved ammonia, dissolved nitrate + nitrite, dissolved ortho-phosphorus, total Kjeldahl nitrogen, total phosphorus, total organic carbon, total suspended sediment, dissolved chloride, dissolved fluoride, dissolved sulfate, dissolved calcium, dissolved magnesium, dissolved potassium, dissolved silica, and dissolved sodium. The fiscal analysis also includes field charges assessed per sampling trip for vehicle and equipment to produce dissolved oxygen, electrical conductivity, pH, and temperature profiles.

Water quality modeling and operational changes to the reservoir as part of an adaptive management strategy are beyond the scope of this WQIP and budget.

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APPENDIX A – Hydromet SCO FB Day-to-Day Change, 2003-2023