Water Reclamation Facility Outfall 001 Effluent Mixing Zone Plan of Study

Prepared for

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CERTIFICATION

The technical material and data contained in this document were prepared under the supervision and direction of the undersigned, whose seal, as a professional engineer licensed to practice as such, is affixed below.

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ACRONYMS AND ABBREVIATIONS

AKART	all known, available, and reasonable methods of prevention, control, and treatment
BOD_5	5-day biochemical oxygen demand
$CBOD_5$	5-day carbonaceous biochemical oxygen demand
CFU	colony-forming units
City	City of Snoqualmie
DMR	discharge monitoring report
Ecology	Washington State Department of Ecology
EIM	Environmental Information Management
lbs/day	pounds per day
MEC	maximum expected concentration
mg/L	milligrams per liter
MGD	million gallons per day
mL	milliliter(s)
MMDF	maximum month design flow
NPDES	National Pollutant Discharge Elimination System
PARIS	Permitting and Reporting Information System
Permit	Waste Discharge Permit No. WA0022403
RM	river mile
RWC	reasonable worst case
TCP	Traditional Cultural Property
TMDL	total daily maximum load
TSS	total suspended solids
USGS	U.S. Geological Survey
UV	ultraviolet light
WQC	water quality criteria
WRF	water reclamation facility

1. INTRODUCTION

The City of Snoqualmie (City) owns and operates a water reclamation facility (WRF) that discharges treated municipal wastewater to the Snoqualmie River through Outfall 001, which is about 1,700 feet upriver of Snoqualmie Falls (river mile [RM] 40.4). Outfall 001 is permitted by the Washington State Department of Ecology (Ecology) under National Pollutant Discharge Elimination System (NPDES) Waste Discharge Permit No. WA0022403 (Permit) (Ecology 2021a). The current version of the Permit (version 6) was issued May 19, 2021, and is effective July 1, 2021, through June 30, 2026 (Ecology 2021a).

To establish effluent limits for the current Permit, Ecology used simple volumetric equations to estimate the amount of mixing of effluent from Outfall 001 with receiving water and the potential for violation of surface water quality standards at the edge of the mixing zone (Ecology 2021b). Permit Special Condition S9 requires the City to perform a mixing study that will more accurately determine mixing characteristics of the discharge by measuring or modeling those characteristics under conditions specified in the Permit to assess whether water quality is protected outside the mixing zones. The City must submit an Effluent Mixing Zone Plan of Study by July 31, 2023, and an Effluent Mixing Report by July 31, 2024.

This document presents the plan of study for completing the Effluent Mixing Zone Study for Outfall 001. This work plan follows *Guidance for Conducting Mixing Zone Analyses* (Appendix C of Ecology's Water Quality Program Permit Writer's Manual [Ecology 2018]) and the protocols identified in Special Condition S9.C of the Permit (Ecology 2021a). Note that the mixing study will not address Class A reclaimed water discharged from Outfall 002, which is subject to different Permit terms and conditions.

1.1 Facility Description

The City's WRF primarily serves residential customers and light commercial entities within city limits. The first wastewater treatment plant was a 6.7-acre facultative lagoon system that was constructed in 1967 and upgraded more than 20 years later to accommodate anticipated growth. The original facility was replaced by a new facility in 1997 to expand treatment capacity for a growing population and to reduce pollutant loadings to the Snoqualmie River. In addition to an advanced wastewater treatment system, the new facility included systems necessary to produce and distribute Class A reclaimed water for seasonal land application and irrigation (Outfall 002). The facility was further expanded in 2002, and several facility improvements were made in 2017 through 2019.

1.2 Current and Planned Process Wastewater Treatment System

For treated wastewater discharges to Outfall 001, the current WRF comprises a headworks facility (including screening and vortex grit removal), oxidation ditches, secondary clarifiers, an ultraviolet light (UV) disinfection system, and a solids handling facility. The solids handling facility comprises rotary drum thickening equipment, aerobic digesters, centrifuge dewatering equipment, and a truck bay to load Class B biosolids for off-site handling.

The Permit includes facility loading requirements based on the WRF's design criteria:

- Maximum month design flow (MMDF): 2.15 million gallons per day (MGD).
- Influent loading for maximum month:
  - 5-Day biochemical oxygen demand (BOD_5): 5,220 pounds per day (lbs/day).
  - Total suspended solids (TSS): 5,220 lbs/day.
- Reclaimed Water Production MMDF: 1.56 MGD.

Production of reclaimed water generally occurs during the summer months (typically from sometime in May through sometime in September). During this period, discharges to Outfall 001 occur only if flows to the WRF exceed the limit for reclaimed water production or if any part of the reclaimed water system is offline for maintenance or repair.

The City recently updated its general sewer plan (RH2 Engineering 2022) for consistency with future population and employment growth projections, evaluated existing and projected future sewer flow and loadings, and determined whether the existing sewer system meets Ecology's minimum requirements and the City's policies and design criteria.

1.3 Snoqualmie River Characteristics

The Snoqualmie River originates on the west side of the Cascade Mountains in Washington. It flows about 45 miles from where its three tributary forks converge upriver from the city of Snoqualmie to where it meets the Skykomish River to form the Snohomish River near the city of Monroe. The river system drains about 700 square miles in King and Snohomish Counties. The lower basin below Snoqualmie Falls is primarily a mix of developed areas (residential, commercial, and industrial) and agricultural uses (dairies, berry fields, pastures, and row crops), while the upper basin above the falls is mostly privately and federally managed forestland with residential and commercial land uses along the Interstate 90 corridor and in the cities of North Bend and Snoqualmie (Stohr et al. 2011).

Above Snoqualmie Falls, where the City's Outfall 001 is located, the Snoqualmie River has the following designated uses (Ecology 2021b):

- Freshwater aquatic life use: core summer salmonid habitat.
- Recreational use: primary contact recreation.
- Water supply uses: domestic, agricultural, industrial, and stock watering.
- Miscellaneous freshwater uses: wildlife habitat, harvesting, commerce and navigation, boating, and aesthetics.

Development and loss of riparian vegetation within the Snoqualmie River basin has led to multiple water quality impairments of fecal coliform bacteria, nutrients, and temperature. As a result, total daily maximum loads (TMDLs) have been developed for these parameters. The studies supporting development of these TMDLs are listed below:

- Snoqualmie River Low Flow Water Quality Assessment, July-September 1989 (Joy et al. 1991).
- Snoqualmie River TMDL Study (Joy 1994).

- Quality Assurance Project Plan: Snoqualmie River TMDL Effectiveness Evaluation (Onwumere and Batts 2004).
- Snoqualmie River Basin Fecal Coliform Bacteria, Dissolved Oxygen, Ammonia-Nitrogen, and pH TMDL: Water Quality Effectiveness Monitoring Report (Sargeant and Svrjcek 2008).
- Snoqualmie River Basin TMDL – Water Quality Improvement Report and Implementation Plan (Stohr et al. 2011).

These studies include TMDL wasteload allocations for the City's Outfall 001 discharge:

- Ammonia-nitrogen: 68.7 pounds per day for the August through October critical season (Joy 1994).
- 5-day carbonaceous biochemical oxygen demand ($CBOD_5$): 206 lbs/day for the August through October critical season (Joy 1994).
- Fecal coliform bacteria: 2.5 x 10^{10} colony-forming units (CFU) per day (Joy 1994).
- Temperature: 24.7°C from June 1 through September 30 (Stohr et al. 2011).

As noted in the fact sheet (Ecology 2021b) for fecal coliform bacteria, Ecology has routinely enforced technology-based limits as the required controls necessary to comply with the TMDL rather than the wasteload allocation specified in the TMDL.

Snoqualmie Falls, the water flowing over the falls, and the surrounding area were listed on the National Register of Historic Places in 2009 as a Traditional Cultural Property (TCP). This designation recognizes the cultural and religious significance of the falls and surrounding land to the Snoqualmie Indian Tribe, which has historically occupied the Snoqualmie Valley and areas around Snoqualmie Falls (Ecology 2021b). The WRF and Outfall 001 (including its authorized mixing zone) are located upstream of the TCP boundary.

1.4 Permit Effluent Limits

The Permit authorizes acute and chronic mixing zones, with dilution factors for acute and chronic aquatic life and carcinogenic and noncarcinogenic human health criteria. Ecology determined the dilution factors associated with the authorized mixing zones based on simple mixing of the effluent with the percentage of the river flow at critical conditions. The authorized chronic mixing zone is 42.5 feet wide and extends 310.5 feet downstream and 100 feet upstream of the outfall; it is based on dilution factors ranging from 35.5 to 183.3 (Table 1). The authorized acute mixing zone is limited to 42.5 feet in any horizontal direction from the outfall and extends 31.0 feet downstream and 10 feet upstream of the outfall; it is based on a dilution factor of 2.4 (Table 1). Both zones also extend vertically from the discharge port to the top of the water surface.

Table 1. Dilution Factors Associated with Authorized Mixing Zones for Outfall 001

Criteria	Dilution Factor
Acute Aquatic Life Criteria	2.4
Chronic Aquatic Life Criteria	35.5
Human Health Criteria – Carcinogen	183.3
Human Health Criteria – Noncarcinogen	49.3

Source: Table 3 in Ecology (2021b)

Effluent limits in the current Permit are set so that pollutant concentrations at the edge of the chronic mixing zone meet chronic aquatic life criteria and human health criteria and pollutant concentrations at the edge of the acute mixing zone meet acute aquatic life criteria. The Permit established effluent limits (concentrations and/or loads) for $CBOD_5$, TSS, pH, fecal coliform bacteria, total ammonia-nitrogen, and temperature (Table 2).

Table 2. Effluent Limits for Outfall 001

Parameter	Average Monthly	Average Weekly
$CBOD_5$	25 mg/L 85% removal of influent $CBOD_5$	40 mg/L
$CBOD_5$ Mass *Effective November through July Only*	448 lbs/day	717 lbs/day
TSS	30 mg/L 538 lbs/day 85% removal of influent TSS	45 mg/L 807 lbs/day
Parameter	**Minimum**	**Maximum**
pH	6.3 standard units	9.0 standard units
Parameter	**Monthly Geometric Mean**	**Weekly Geometric Mean**
Fecal Coliform Bacteria	200/100 mL	400/100 mL
Parameter	**Average Monthly**	**Maximum Daily**
$CBOD_5$ Mass *Effective August through October Only*	51.6 lbs/day	206 lbs/day
Total Ammonia Mass (as NH3-N) *Effective August through October Only*	21.6 lbs/day	68.7 lbs/day
Temperature, Maximum 7-Day Running Average (7DADMax) *Effective June through September Only*	Not Applicable	24.7°C

Source: Table 2 in Ecology (2021a)

Notes: $CBOD_5$ = 5-day carbonaceous biochemical oxygen demand; mg/L = milligram(s) per liter; lbs/day = pounds per day; mL = milliliter(s).

Effluent limits for other conventional, nonconventional, or priority pollutants detected in the effluent were not specified because Ecology did not find any reasonable potential for those pollutants to violate water quality criteria at the mixing zone boundaries (Appendix D in Ecology 2021b).

2. DATA SOURCE SUMMARY

Parametrix compiled and reviewed available data to determine its suitability for use in dilution modeling and identify data gaps that will need to be addressed as part of the mixing zone study. Data sources reviewed to support plan of study development included the following:

- Permit WA0022403 (Ecology 2021a).
- Permit WA0022403 fact sheet (Ecology 2021b).
- U.S. Geological Survey (USGS) gage data and online calculations.
- TMDL documents (Joy et al. 1991; Joy 1994; Onwumere and Batts 2004; Sargeant and Svrjcek 2008; Stohr et al. 2011) and other publicly available reports.

- Discharge monitoring report (DMR) data.
- Priority pollutant sampling data.
- Whole effluent toxicity test results.
- Ecology's Environmental Information Management (EIM) database.
- Ecology's Water Quality Permitting and Reporting Information System (PARIS).
- General sewer plan (RH2 Engineering).
- Outfall inspection results.
- Record drawings.

Results of this review are summarized separately below for the outfall, effluent, and receiving water.

2.1 Outfall Data

Data for Outfall 001 are available from multiple sources, including:

- The Permit (Ecology 2021a) and Permit fact sheet (Ecology 2021b).
- General sewer plan (RH2 Engineering).
- 1996 hydraulic profile (KCM).
- Results of the 2018 outfall inspection.
- Record drawings.

The available data from these sources include descriptions, dimensions, and diagrams/drawings. Together, they provide sufficient location, orientation, and dimension information for the outfall. A summary of the available data is provided below.

Outfall 001 is located in the Snoqualmie River about 1,700 feet upstream of Snoqualmie Falls and just upstream of the Railroad Avenue (State Route 202) Bridge. Geographic coordinates for the outfall are 47.53916 degrees north latitude and 121.83222 degrees west longitude (Ecology 2021b). It is a 1,500-foot-long (from the WRF), 36-inch-diameter concrete pipe with a submerged ductile iron single port diffuser (RH2 Engineering 2022). It is anchored to the river bottom using "H" pilings and chains. The most recent inspection of the outfall (2018) found the following:

- The pipe, joints, and anchor were serviceable and intact with no visible signs of damage.
- The outlet pipe was flowing free and unobstructed, with no signs of sediment accumulation.
- The "H" pilings, wire rope, and shackles were intact and working as designed.

According to the Permit fact sheet, the outfall pipe extends about 30 feet from the north river bank; the first 15 feet of pipe is buried, and the rest is uncovered. The river is 10.5 feet deep at the 7Q10 flow where the outfall pipe terminates. The 1996 hydraulic profile indicates that the river surface elevation is 398 feet at the 7Q10 flow. The 2018 inspection indicated that the pipe was visible and exposed at a submerged depth of 4.5 feet at a distance of 11 feet from the river bank, the end of the outfall was about 50 feet offshore, and the top of the outfall was 6 feet below the water surface (i.e., the bottom of the outfall was 9 feet below the water surface).

2.2 Effluent Data

As summarized in the Permit fact sheet (Ecology 2021b), Ecology characterized Outfall 001 effluent using data from the May 2014 through October 2018 DMRs, annual priority pollutant scans, and inspection monitoring results. For this mixing study, effluent flow will be characterized using the most recent 3 years of DMR data. Because the critical discharge conditions for protection of aquatic life occur during the dry season (June through September), the daily maximum and monthly average flows for dry season discharge will be calculated. Appendix D to the fact sheet contains Ecology's reasonable potential calculations for Outfall 001. No additional characterization of effluent quality is planned for this mixing study.

Because current discharge flows are less than 85% of the design flow, dilution associated with acute aquatic life standards will be modeled using maximum daily flow (dry season), dilution associated with chronic aquatic life standards will be modeled using maximum monthly flow (dry season), and dilution associated with human health standards will be modeled using average annual flow, as described in Appendix C of the Permit Writer's Manual (Ecology 2018). Per Appendix C in the Permit Writer's Manual (Ecology 2018), flow data from the previous 3 years will be used to characterize effluent flow. Mixing will also be analyzed using projected future effluent flow for 2040, which is the longest future projection in the sewer plan. For this analysis, effluent flows will be based on the design flow.

2.3 Receiving Water Data

Receiving water data are available from multiple sources, including:

- The Permit fact sheet.
- TMDL-related documents:
  - Snoqualmie River Low Flow Water Quality Assessment, July-September 1989 (Joy et al. 1991).
  - Snoqualmie River TMDL Study (Joy 1994).
  - Quality Assurance Project Plan: Snoqualmie River TMDL Effectiveness Evaluation (Onwumere and Batts 2004).
  - Snoqualmie River Basin Fecal Coliform Bacteria, Dissolved Oxygen, Ammonia-Nitrogen, and pH TMDL: Water Quality Effectiveness Monitoring Report (Sargeant and Svrjcek 2008).
  - Snoqualmie River Basin Temperature TMDL – Water Quality Improvement Report and Implementation Plan (Stohr et al. 2011).
- Ecology's EIM database.

For characterizing critical conditions, the 7Q10 flow[1] and river depth at 7Q10 flow were obtained from Joy et al. (1991), and the 30Q5[2] and harmonic mean flows are calculated based on the 7Q10 flow. Additionally, the Permit fact sheet states that the river width at 7Q10 flow and river slope were estimated using aerial photo interpretation and topographic map measurements.

[1] 7Q10 is the lowest 7-day average flow that occurs (on average) once every 10 years.

[2] 30Q5 is the lowest 30-day average flow that occurs (on average) once every 5 years.

River discharge data from USGS stations will be analyzed to confirm critical flow conditions listed in the fact sheet. Data are available from the following nearby stations:

- 12144500 (SNOQUALMIE RIVER NEAR SNOQUALMIE, WA), downstream of Snoqualmie Falls
- 12142000 (NF SNOQUALMIE RIVER NEAR SNOQUALMIE FALLS, WA)
- 12144000 (SF SNOQUALMIE RIVER AT NORTH BEND, WA)
- 12141300 (MIDDLE FORK SNOQUALMIE RIVER NEAR TANNER, WA)

3. DILUTION MODEL SELECTION

Parametrix anticipates using the CORMIX dilution modeling program to evaluate the discharge for effluent flow rates under critical conditions specified in the Permit and resulting from our review of data. The CORMIX model operates by mapping physical characteristics of the outfall, discharge, and receiving water to flow classifications within the model. Preliminary modeling using data from the Permit fact sheet resulted in plausible CORMIX flow classifications for the discharge, suggesting that CORMIX should be an appropriate dilution model to use for the mixing study.

Dilution may also be calculated using Ecology's RiverPlume6 spreadsheet model.

Although not planned at this time, a dye or tracer study may be considered if empirical validation or calibration of dilution modeling results is warranted.

4. MIXING STUDY OUTLINE AND APPROACH

The mixing study report will address the elements specified in Permit Special Condition S9.B, including the following:

- A statement confirming that all known, available, and reasonable methods of prevention, control, and treatment (AKART) have been applied.
- A description of outfall characteristics.
- A description of effluent discharge characteristics.
- A description of the ambient water characteristics, including critical flows, water quality, and currents.
- A discussion of how dilution modeling impacts the size and extents of the mixing zone.
- Identification and calculation of critical conditions used to determine dilution factors.
- Consideration of current on dilution factors.
- Summary of model results (dilution factors).

Additionally, any established information (e.g., outfall information) that is being used as part of this mixing study will be identified, restated, and/or referenced in the report. Based on the review of available information, sufficient data exist to complete the mixing study. No additional receiving water characterization or tracer, dye, or any other type of physical dilution study is planned at this time.

Parametrix will incorporate the mixing study findings into a report with the following or a similar outline:

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6. References

APPENDICES

- A Effluent Characterization
- B CORMIX Input
- C CORMIX Output

5. REFERENCES

Ecology (Washington State Department of Ecology). 2018. Water Quality Program Permit Writer's Manual. Publication No. 92-109. Manual revised July 2018. Appendices revised September 2018.

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