2025

CITY OF STAYTON'S AQUIFER STORAGE AND RECOVERY: SEASONALLY VARYING FLOWS DETERMINATION

OREGON
WATER RESOURCES DEPARTMENT

TECHNICAL STUDY

STATE OF OREGON

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CITY OF STAYTON'S AQUIFER STORAGE AND RECOVERY: SEASONALLY VARYING FLOWS DETERMINATION TECHNICAL STUDY

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Contact: francisco.j.guerrero@water.oregon.gov

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Summary

The Seasonally Varying Flow (SVF) analysis for Stayton's Aquifer Storage and Recovery (ASR) project was initiated due to the project's potential diversion of water from a stream supporting sensitive, threatened, or endangered (STE) species, as required under **ORS 541.689(1)(b)**. In accordance with the **SVF Matrix to Select Methods for Development of Seasonally Varying Flow Prescriptions (OAR 690-093-0130)**, the SVF Matrix *score for ecological impact was significant*, indicating the need for thorough analysis, and the review confirmed that *sufficient information about streamflow functions* was available to proceed with the SVF determination.

Key findings from the **Oregon Water Resources Department (OWRD)** indicate that the proposed diversion rate of **2.32 cfs**, even under a potential 25% increase to **3.12 cfs**, does not affect the frequency with which the North Santiam River reaches the established ecological flow thresholds required by the SVF statute and associated rules. The project's diversion rate would not cause measurable changes to the flow regime and is, therefore, unlikely to adversely impact key factors such as aquatic species' lifecycles, habitat availability, sediment transport, floodplain connectivity, or water quality.

Based on these findings, OWRD recommends that the **Seasonally Varying Flow** prescription for the City of Stayton's ASR project should align with the previously identified **ecological flow thresholds**, including bypass flows of **1,200 cfs during January and February** and **1,500 cfs for the remaining months of operation**. No additional permit conditions are necessary, as the proposed diversion does not threaten the ecological integrity of the river system.

Further investigation into streamflow functions is not proposed, as it would not affect the outcome of the permit conditions for this project. **The Seasonally Varying Flows analyses presented here will be valid ONLY for this project**, given the small hydrological and ecological impact of City of Stayton's ASR project. Any future projects with larger withdrawals triggering SVF requirements will require a further analysis that commensurate with their impacts on the reference hydrograph for the North Santiam River.

Introduction

The Water Projects Grants and Loans program (WPGL) from the Oregon Water Resources Department (OWRD) is designed to support water projects that deliver economic, environmental, and social/cultural benefits. WGPL funds these projects through the Water Supply Development Account, created after the passing and implementation of Senate Bill 839 in 2013. OWRD is required in ORS 541.689 to develop a Seasonal Varying Flows (SVF) analysis and associated SVF prescription for select storage projects funded through the Water Supply Development Account. This requirement is aimed at preserving the watershed's biological, ecological, and physical functions downstream of the point of diversion.

The SVF requirement is described in statute (ORS 541.689) and rule (OAR-690-093-0130). An SVF is required if a funded project requires a water storage or aquifer recharge permit or limited license for the storage of water outside the official irrigation season and: 1) impounds surface water on a perennial stream, 2) diverts water from a stream that supports state or federally listed sensitive, threatened, or endangered (STE) fish species, or 3) diverts more than 500 acre-feet (AF) of surface water annually (Figure 1).

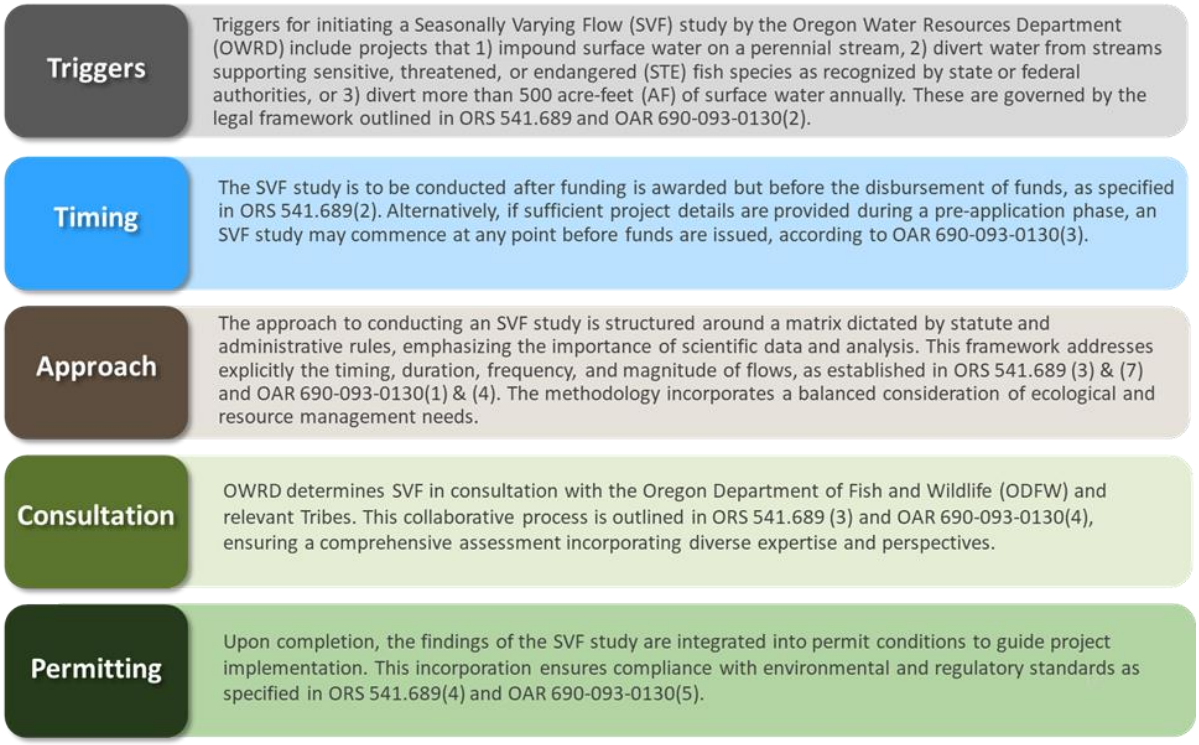

Figure 1. Development of Seasonally Varying Flows Prescriptions for water projects funded by OWRD Water Projects Grants and Loans Program (WPGL).

The statute (ORS 541.651(2)) defines Seasonally Varying Flows (SVFs) as "the duration, timing, frequency and volume of flows, identified for the purpose of determining conditions for a new or expanded storage project, that must remain in-stream **outside of the official irrigation season** in order to protect and maintain the biological, ecological and physical functions of the watershed downstream of the point

of diversion, with due regard given to the need for balancing the functions against the need to store water for multiple purposes." The SVF is used as the basis for developing a water right condition (the SVF prescription) on the storage water right or limited license associated with the funded project (ORS 541.689(4)(Figure 1). It is important to note that, for ASR projects these conditions would NOT apply to source water rights but to the storage water rights and/or limited licenses required to operate the storage portion of the project (Figure 2):

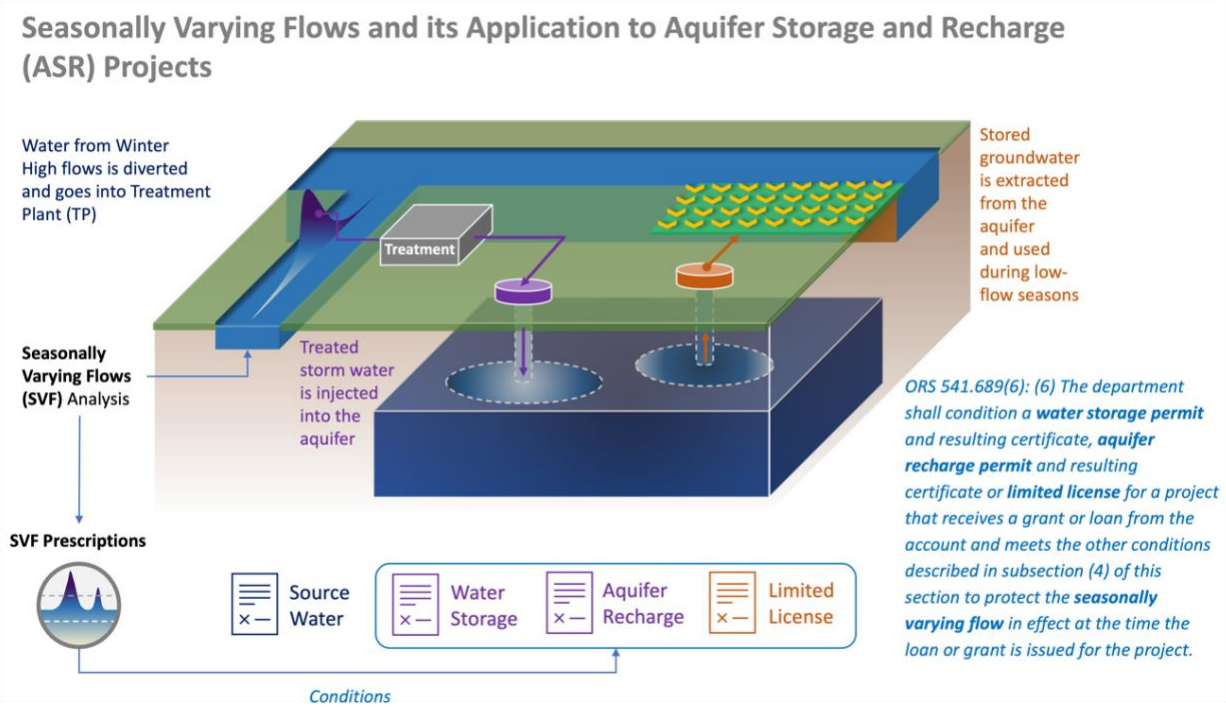

Figure 2. Conceptual model for the application of Seasonally Varying Flows to Aquifer Storage and Recharge (ASR) projects. According to ORS 541.689(6), SVF Prescriptions only condition water rights associated with the storage component of the project.

Seasonally Varying Flows seek to address the challenge of storing water during abundant periods (e.g., winter) while protecting instream flows essential for habitat creation, nutrient cycling, and aquatic life cycles. The variability in streamflow, encompassing the duration, timing, frequency, and volume, plays a crucial role in maintaining the ecological, biological, and physical functions of watersheds. These considerations are vital in balancing the need for water storage with the imperative to preserve watercourse dynamics that support diverse ecological systems.

The methods employed for the determination of SVFs are selected using the SVF Methods Matrix presented as an appendix for OAR 690-093-0130 (SB 839). The SVF Methods Matrix also establishes the maximum level of effort allowed to be expended (and therefore charged to the grant account) for the study.

City of Stayton's Aquifer Storage and Recovery (ASR): Project Overview

City of Stayton's Water Needs

The City of Stayton's water needs arise primarily from its reliance on the North Santiam River, which experiences reduced flow rates during the summer and is prone to water quality issues such as algal blooms and contaminant spills. The city's secondary water sources, two alluvial wells near the river, are compromised by biofouling and reduced yield, increasing the vulnerability of Stayton's water supply. The situation is further aggravated by the City's position within the Stayton Sublimity Groundwater Limited Area (GLA), where groundwater levels in the basalt aquifer have been consistently declining, restricting access to alternative groundwater sources.

The necessity for a reliable secondary municipal water source is highlighted by past incidents where the city was severed from its primary water supply due to contamination events, revealing the fragility of its current water supply infrastructure. This redundancy is critical not only for ensuring a continuous supply during emergency situations but also for accommodating the growing water demands of the city, especially during peak summer periods, and further economic development.

In response to these challenges, the city embarked on a comprehensive evaluation of potential secondary water sources, concluding that Aquifer Storage and Recovery (ASR) presents the most viable solution. Supported by studies conducted in 2019 and a feasibility study completed in 2022 with funding from the Oregon Water Resources Department (OWRD), ASR emerged as a practical approach to enhance the City's water supply resilience. This method not only promises to mitigate the impacts of drought and low streamflow conditions but also to provide a safeguard against water quality hazards inherent to the North Santiam River.

City of Stayton's ASR Project

The City of Stayton proposes to construct an Aquifer Storage and Recovery (ASR) well, complemented by necessary piping enhancements to integrate with the existing municipal water distribution system. This project aims to improve the city's water supply resilience by storing **480 acre-feet (AF) of water and recovering up to 420 AF**. This recovered volume is expected to supply the city with approximately 90 days of drinking water, every summer, to assist in managing peak water demands during summer periods and curtailments. The project also seeks to alleviate pressure on the North Santiam River by reducing withdrawals, particularly during critical low-flow seasons. However, the project does not include in-stream water rights to protect summer flows. At the time of the elaboration of this report, **the project it is still in its permitting phase**. The project would move into the next phases only until the SVF study is finalized.

Permitting Phase

The permitting phase ensures regulatory compliance and facilitates the project's start. This stage involves:

- Pre-application discussions with OWRD, Oregon Health Authority (OHA), and Oregon Department of Environmental Quality (DEQ) to delineate the ASR Limited License (LL) application process, focusing on project specifics and regulatory requirements.
- Submission of the ASR LL application, including a comprehensive hydrogeologic conceptual model and water quality data, to initiate a pilot testing regimen that adheres to established water quality and storage accounting standards.
- Preparation and submission of an application for an Underground Injection Control (UIC) Permit and the initiation of the OHA Plan Review process, reflecting the project's commitment to meeting environmental and public health protocols.
- Compliance with OWRD SVF requirements as described above.

Design and Construction Phase

This phase transitions the project from planning to tangible development, focusing on the Columbia River Basalt Group (CRBG) aquifer. Activities include:

- Detailed design and construction oversight, emphasizing the importance of a transparent public procurement process for selecting a qualified well construction contractor.
- Executing aquifer testing and water quality assessments to validate the ASR system's functionality and compliance with health standards.
- Development and construction of wellhead facilities, incorporating critical components like pumps, pipes, and control systems, concluded by comprehensive shakedown testing to ensure operational reliability.

Water System Upgrades

The project concludes with enhancements to Stayton's water distribution system, specifically:

- Design and construction of a new pipeline on Shaff Road, aimed at optimizing the ASR system's integration into the city's water network.
- Implementation of water system improvements, adhering to technical specifications and the city's engineering requirements, thereby ensuring the project meets all necessary regulatory standards for successful operation.
- Through these phases, the City of Stayton's ASR project represents a methodical approach to securing a sustainable and reliable water supply, highlighting the collaborative efforts between the city and state regulatory bodies to address future water demand challenges effectively.

City of Stayton's Aquifer Storage and Recovery (ASR): Project Infrastructure

The impact analysis on streamflow functions for Stayton's ASR project covers a reach of the North Santiam River starting upstream of the Upper Bennet Dam (44.8°N, 122.7°W) and ending downstream of the Stayton/Power Canal barrier at the North-South Channels confluence (44.8°N, 122.8°W) (Figure 3). This stretch experiences flow alterations due to diversions for Salem's Water Treatment Plant (WTP), the Santiam Water Control District (SWCD), Stayton's Water Treatment Plant (SWTP), as well as upstream regulation at Detroit and Big Cliff Dams. The reach's hydraulics are influenced by both natural formations, such as the river's bifurcation at Geren Island leading to North and South Channels, and human-made structures including the Upper Bennet Dam, Lower Bennet Dam, and the Stayton Canal headgates, along with a spill dam to manage excess flows (Figure 3). The Stayton Canal headgates, located between Stayton's diversion point and Stayton's WTP intake, significantly regulate canal flow, which can be halted during maintenance, as observed during a December 2023 site visit. The SWTP's intake capacity further limits water movement, complicating natural streamflow characterization within the canal.

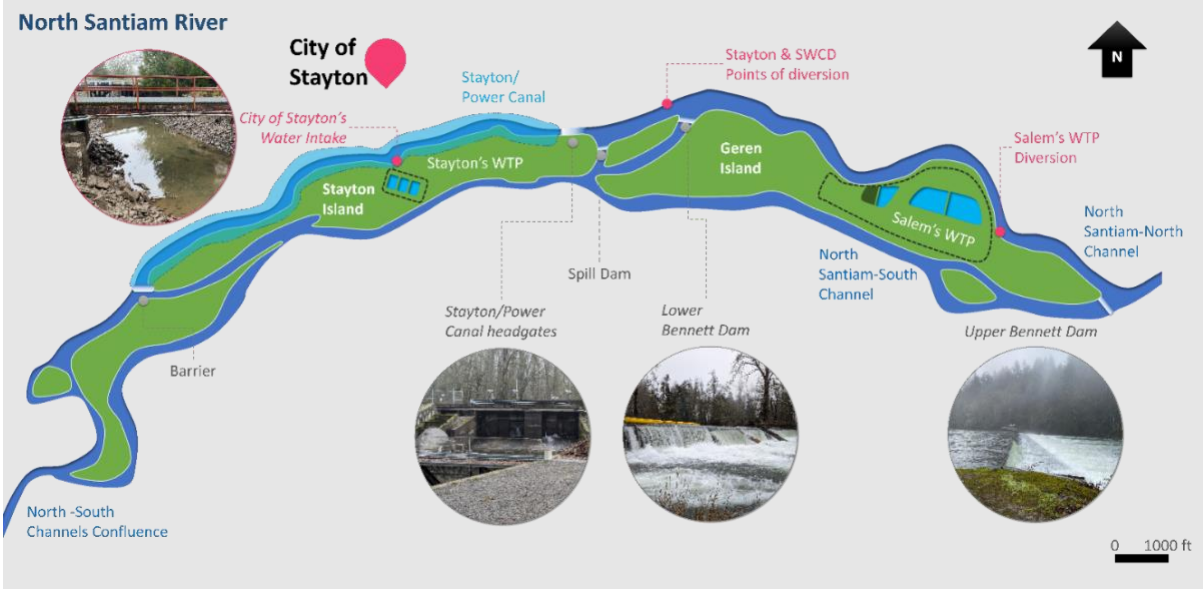

Figure 3. City of Stayton's ASR water source infrastructure in the context of the North Santiam River. Points of diversion and Water Treatment Plant uptake are highlighted in red. Main dams and Stayton Canal gates are shown in grey. Water flows east to west. Images were obtained during our field visit to the project's site in December 2023. During our visit the Stayton Canal was closed for maintenance and minimal flow (stagnant) was observed next to the WTP uptake.

Study Approach

The methods and effort required to develop flow prescriptions depend on the project's ecological impact and the availability of streamflow information, as outlined in the SVF Study Methods Matrix, or SVF Matrix herefore. These factors are assessed through two questions: 1) "What is the Ecological

Impact of the Proposed Project?" and 2) "What Information About Streamflow Functions is Available?". The SVF Matrix then determines the appropriate methods and the maximum allowable effort for the study; with projects with lower impacts and more data requiring simpler approaches than projects with higher impacts and less available data. The SVF matrix is qualitative and binary. The questions about Ecological impact only include “Minimal” or “Significant” as possible answers. The questions about information sufficiency only include “Sufficient” or “Insuficient” as possible answers. For a more detailed explanation about answering the SVF matrix questions, the reader can visit this link.

Determination of Study Methods: Seasonal Varying Flows Matrix (SB 839)

Ecological Impact and Information Criteria

Ecological Impact

The City of Stayton’s Aquifer Storage and Recovery (ASR) project, involving water diversion from the North Santiam River, operates within an ecological context that includes 13 identified sensitive, threatened, or endangered (STE) species. Therefore, the overall score for the impact of the project is **significant** as defined via the SVF Matrix (Figure 4, step 1).

A significant score indicates the scope of the study to support a Seasonally Varying Flow prescription may include a wide variety of methods. It this context, *significant* does NOT consider or substitute for an evaluation of the magnitude of the ecological impact of the project. Such magnitude must be estimated during the SVF study and ultimately reflected in the SVF prescription.

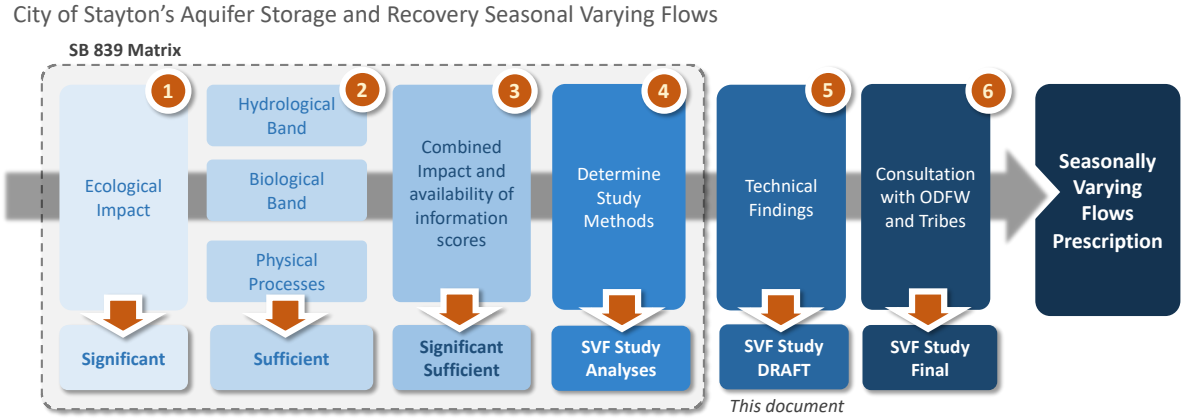

Figure 4. Workflow for developing a Seasonally Varying Flow Prescription for the City of Stayton’s Aquifer Storage and Recovery Project. The workflow includes the Matrix presented as an appendix for OAR 690-093-0130 (SB 839). This document corresponds to the SVF Study Draft, which will be revised in consultation with the Oregon Department of Fish and Wildlife (ODFW) and the Tribes present in the area where the project is proposed.

Information Criteria

OWRD determined there is **sufficient** information for the Hydrological, Biological, and Physical Processes Bands (Figure 4, step 2). This determination is based on long-term data and studies on the North Santiam River’s hydrological, biological, and physical processes. Two USGS stream gages provide a

historical record of streamflow, while research models and analyses have quantified potential climate-driven shifts in the current flow regime (i.e., that including current water use and other dam operations). Information inventoried for the analyses includes water availability, species lifecycle needs, habitat-streamflow relationships, sediment transport, stream complexity, floodplain connectivity, and sediment budgets. Specific sources of information reviewed for this analysis are included in the section *Biological Band and Hydraulic/Physical Processes Band Analysis* (see below).

Consultation with Oregon Department of Fish and Wildlife and Affected Tribes

The consultation process for the Stayton Aquifer Storage and Recovery (ASR) project incorporated engagement with key stakeholders, including the Oregon Department of Fish and Wildlife (ODFW), and affected Indian Tribes, to ensure compliance with statutory and regulatory requirements and address potential ecological and cultural impacts.

Engagement with the Oregon Department of Fish and Wildlife (ODFW)

The consultation with ODFW involved a collaborative review process to ensure the Seasonally Varying Flow (SVF) analysis met ecological standards for sensitive, threatened, and endangered (STE) species:

- **Comments and Feedback**: ODFW reviewed the draft SVF report, providing detailed comments on the ecological metrics and requesting additional clarification, such as an appendix table for studies referenced in the "functional band" analysis.
- **Response to Feedback**: The project team incorporated ODFW's recommendations into the report, ensuring that all relevant ecological data and analyses were reflected.
- **Collaborative Meetings**: Regular meetings were held to align on timelines and finalize the SVF prescriptions, with ODFW confirming that the proposed diversion rates would not adversely affect the ecological flow thresholds or aquatic species.

Engagement and Coordination with Affected Indian Tribes

Efforts focused on engaging the Confederated Tribes of the Grand Ronde, the Confederated Tribes of Siletz Indians, and the Confederated Tribes of the Warm Springs.

Initial Outreach: OWRD identified the affected Tribes based on input from the Legislative Commission on Indian Services (LCIS) and previous determinations regarding the project's impact area. Draft consultation letters were prepared and tailored for each Tribe, acknowledging the cultural importance of the river and inviting their input on the project's ecological and hydrological considerations.

Follow-Up and Coordination: The project team finalized consultation letters after addressing feedback from ODFW to ensure the technical analysis was complete and ready for review by the Tribes.

Correspondence highlighted the goals of the SVF process, including maintaining ecological flow thresholds and protecting aquatic habitats critical to STE species.

Only the Confederated Tribes of the Grande Ronde engaged in further coordination for feedback on the project.

Feedback from Affected Indian Tribes: The Confederated Tribes of Grand Ronde (CTGR) provided feedback on the SVF analysis for the Stayton ASR project, expressing appreciation for the responsiveness

and thoroughness of the Water Resources Department (WRD) in addressing Tribal concerns. The CTGR emphasized its historical and ongoing connection to the North Santiam River, where it owns and manages land for fish and wildlife conservation.

The majority of CTGR's questions and requests were satisfactorily addressed through discussions with WRD, including a remote meeting on January 10 2025 and subsequent written communication. The primary remaining request from CTGR is for periodic updates on the ASR project's status, implementation, and any challenges encountered. This request is intended to keep the Tribe informed rather than to revisit project decisions. While CTGR hopes such updates can be established, the Tribe considers all comments on the SVF analysis to have been addressed by WRD and expresses appreciation for their efforts.

In separate written communication, the CTGR requested to be contacted immediately by phone if any archaeological and/or cultural resources are identified that may be impacted by the project. To ensure prompt communication, the project team, in collaboration with OWRD's Tribal Liaison, updated the LCIS Inadvertent Discovery Plan template to include relevant contact information for the City of Stayton ASR project.

Seasonally Varying Flows Analysis of Stayton's ASR Project

The Seasonal Varying Flow Matrix results reported here allows for a broad range of analyses to support the SVF prescription for the City of Stayton's ASR project. These could involve fieldwork, reviews of literature and expert opinions, the use of existing models or development of new ones, and expert workshops (Figure 4, Step 4). **OWRD believes these analyses are unnecessary for the SVF prescription, as the project's very low diversion rate does not significantly impact streamflow functions**. In the following sections we describe in detail the results of the **Hydrological Band Analysis** that support this conclusion.

Hydrological Band Analysis

The information available in the first band (Hydrological Band) was deemed sufficient. The analysis will consider the current hydrological conditions and water availability. The guiding principle here is that the **SVF determination for this project** must be consistent with all existing water rights within the impacted reach. We assume that all associated water uses are reflected on the streamgage data downstream from the City of Stayton's point of diversion. Thus, we will use the hydrograph obtained from data from USGS station at Green's Bridge as the **reference hydrograph** (Bach et al., 2013), as indicated in the final order (S-71584) extending the time for the City's water permit S-54227. Our analyses incorporate information from the Feasibility Study for the ASR project by GSI Water Solutions Inc. and Keller Associates as well as environmental flow recommendations in Bach et al., (2013).

Hydrological Regime in the North Santiam River Basin

The hydrology of the North Santiam River Basin (NSRB) is typical of mountainous river systems in Oregon, shaped by both natural processes and human activities. Major impacts include dam operations and water withdrawals. The flow regime changed significantly after the construction of the Detroit and Big Cliff dams by the U.S. Army Corps of Engineers in 1953 for water storage, flood control, and hydroelectric power. Additionally, surface and groundwater withdrawals by municipalities, such as the City of Stayton, further affect the flow. The City's water treatment facility receives surface water from the NSRB at a **point of diversion (POD)** along the north channel of Geren Island (Figure 3 and Figure 5).

During the wet season, from late fall to early spring, the NSRB receives most of its water from precipitation and snowpack. The snowpack serves as a natural reservoir, melting in spring and summer to maintain baseflows during the dry season. Streamflow rates peak during the wet season when precipitation and soil saturation are at their highest (Figure 6).

Analyzing hydrological data is essential to assess the potential impacts of the ASR project on the NSR's current flow regime. Two USGS gaging stations, upstream (14183000) and downstream (14184100) of the City's POD on the NSR, provide the relevant data. USGS gage 14183000 has records from 1905 to the present, while USGS gage 14184100 has data from 1964-1968 and 2005-2024 (Figure 6). The upstream gage is 9 miles from the POD, and the downstream gage is 13 miles away. **This analysis focuses on the 2005-2024 period.** Figure 6 shows the minimum, median, and maximum daily streamflows for both

gages, while Table 1 presents the median monthly stream flows for the project's injection period. Typically, streamflow increases as it moves downstream. However, median flows at the downstream gage are lower than at the upstream gage from November to January but higher from February to April (Table 1). This discrepancy is highly likely due to diversions between gaging stations. An analysis of water rights-based cumulative withdrawuals that could potentially occur between these two stations amounts to a difference of ~1500 cfs – if all water rights were used in full between Novermber and March (see corresponding section on "Cumulative Effects of Water Allocation").

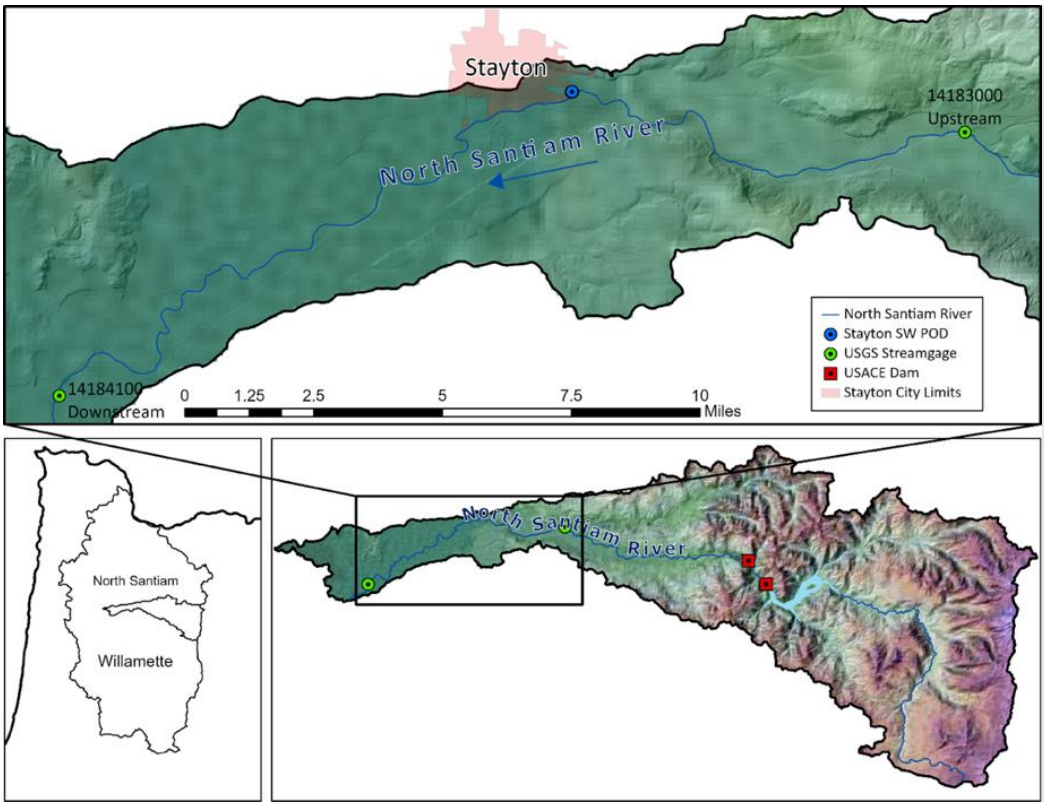

Figure 5. Composite map showing the location of USGS streamgages, USACE dams, Stayton surface water point of diversion (SW POD), Stayton city limits, and the North Santiam River Basin with respect to the Willamette River Basin.

Table 1. Median monthly streamflow (cfs) for USGS gaging stations upstream (14183000) and downstream (14184100) for November through April for the 2005-2024 POR.

Month	Upstream Median Flow (cfs)	Downstream Median Flow (cfs)
November	5,010	4,880
December	4,920	4,850
January	5,120	5,030
February	2,640	2,870
March	2,930	2,990
April	3,090	3,150

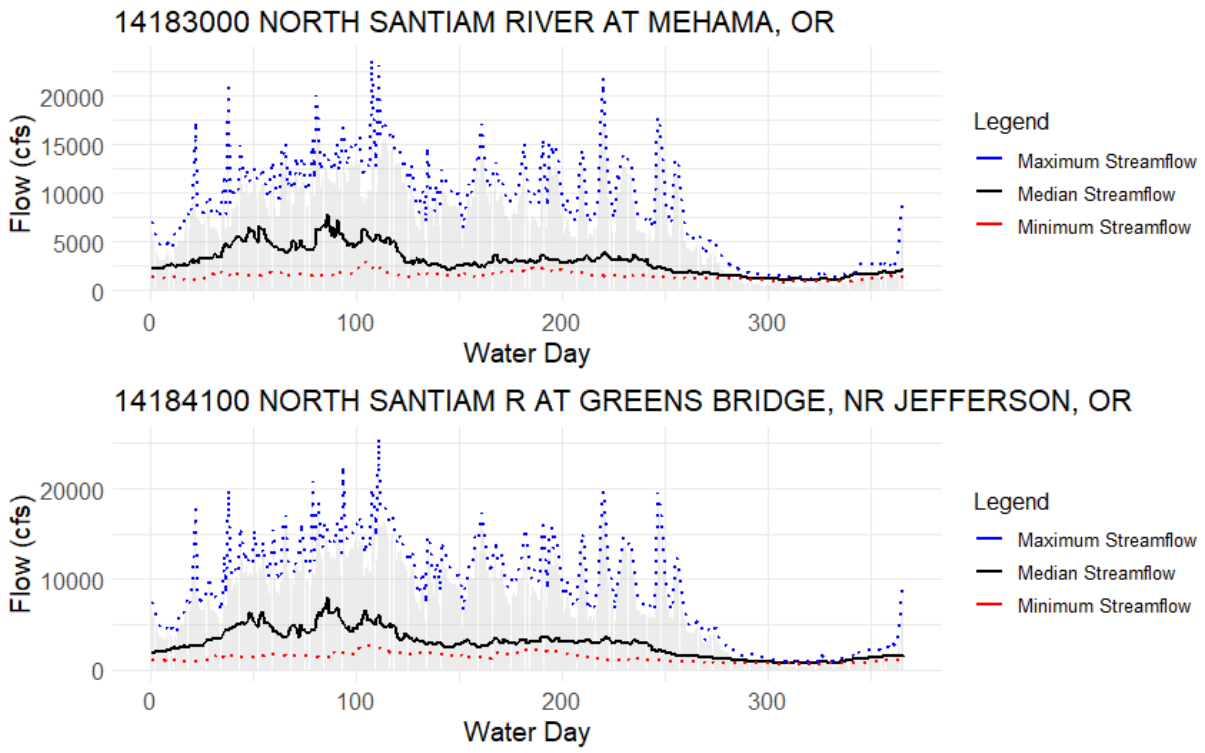

Figure 6. Minimum (red dashed line), maximum (blue dashed line) and median (solid black line) daily streamflow (POR 2005-2024) hydrographs for USGS gage 14183000 (above Stayton) and 14184100 (below Stayton).

Reference Hydrograph and Ecological Flows

To assess the potential impact of the City's ASR project on the NSR, the proposed injection rate (2.32 cfs) was compared to the **reference hydrograph** of the North Santiam River below the POD. The analysis focused on the impact on OWRD-defined Ecological Flows. These flows include, at minimum, bypass, optimum peak flows, and flushing flows. For complete definitions of these flows please refer to OWRD's "Storage-Specific Study Requirements (SSSR) for Feasibility Study Grants" and references therein. Succinctly, these SSSR-Ecological Flows can be described as:

- **By-pass Flows**: Maintain minimum habitat conditions downstream by ensuring a basic flow level (often around the average flow or lower) to support species populations. These flows are assessed similarly to baseflows and are essential for sustaining habitats for spawning, rearing, and passage.
- **Optimum Peak Flows**: Higher, less frequent flows that support key ecological functions. They include *ecological triggering flows*, which stimulate behaviors like migration and spawning, and *geomorphic maintenance flows*, which shape and sustain habitat. Determined through biological and geomorphic studies.
- **Flushing Flows**: A type of peak flow that mobilizes streambed materials to clean out fine sediments, enhancing spawning grounds and habitat for invertebrates.

These targets were included in the City's ASR Feasibility Study in compliance with the Storage Specific Study Requirements (OWRD, 2023). They serve as an initial point of comparison to determine if more refined biological, ecological, or physical function-based flow targets are needed for this project. Furthermore, the final order (S-71584) extending the time for the City's water permit S-54227 establishes:

"The undeveloped portion of water under Permit S-52447 per OAR 690-315-0010(6)(g) is 25.0 cfs. This 25.0 cfs is subject to these **fish persistence conditions** (as recommended by ODFW with flows are to be measured in the North Santiam River near Mehama, Oregon (USGS Gage Number 14183000, or its equivalent):"**October – December, 1500 cfs**; **January- March 15, 1200 cfs**; **March 16 – April, 1500 cfs**; **May 1 through September 30, Withdrawal Not Authorized**. The City of Stayton adopted the winter months values as corresponding bypass flows in the ASR Feasibility Study. In cases where conflicts arose between the values in Permit S-52447 and the USACE Willamette Fish Operations Plan for the North Santiam River, the City of Stayton adopted the higher flow value to provide greater protection to aquatic habitats (mostly for the period between May 1 through September 30, when water could be sourced from additional water rights without fish persistence conditions). These bypass flows are within the range of winter base flows (1000 – 1500 cfs) recommended for the North Santiam River (Bach et al., 2013). Both optimum peak flows and flushing flows were derived from an environmental flows workshop for the Santiam River Basin (Bach et al., 2013). This approach integrated multiple technical sources, including the Willamette Biological Opinion (NMFS, 2008).

For the North Santiam River, **optimum peak flows** are recommended to support ecological and geomorphic functions critical for habitat diversity, channel maintenance, and species sustainability. **Winter events below bankfull** should occur 2 to 5 times annually, with magnitudes ranging between 13,000 and 18,000 cubic feet per second (cfs) for 3 to 5 days each. These flows enhance side channel connectivity, initiate gravel movement, flush fine sediments, and provide spawning and rearing habitats for spring Chinook and resident trout, while also supporting riparian vegetation through bar formation and seed dispersal. **Winter events above bankfull** should occur once every 1 to 3 years, exceeding 18,000 cfs for 3 to 5 days. These larger flows are essential for channel maintenance, floodplain rejuvenation, and the mobilization of larger woody debris, as well as for opening side channels and redistributing sediments to protect the main channel from erosion. To prevent fish stranding, all peak flow events should have a gradual recession limb that mimics natural flow recession rates observed during pre-dam conditions. These flow recommendations should be timed to align with the life cycles of target species and monitored for ecological and geomorphic outcomes to ensure they meet long-term ecosystem objectives. The values and purposes of these ecological flows are summarized in Table 2. In this analysis, we focus on the **impacts of the additional withdrawal rate, 2.32 cfs, on Bypass Flows only**. At flows greater than 10,000 cfs, streamflow is measured in increments of 100 cfs, making a withdrawal of 2.32 cfs undetectable.

The reference hydrograph for the NSR below the POD, as well as the ecological flow targets and the bv City's proposed injection rate, are shown in Figure 7. Compared to the downstream median monthly flows during the injection period (**Error! Reference source not found.**), the injection rate (2.32 cfs) accounts for 0.08% to 0.04% of streamflow during this period. Streamflow measurements typically have

a minimum error of approximately 5%. Therefore, this decrease in streamflow would not measurably reduce downstream flows nor impact the identified ecological flow targets.

Table 2 Bypass, Optimum Peak and Flushing Flows Identified in the ASR Feasibility Study.

Ecological Flows (cfs)					
Time Period	Bypass Flow	Optimum Peak Flows	Purpose of Bypass and Optimum Flows	Flushing Flows Low	Flushing Flows High
January	1,200	13,000–18,000	Chinook Incubation; Side Channel Connectivity; Gravel Movement	13,000	18,000
February	1,200	13,000–18,000	Minimum Flow; Habitat Maintenance; Sediment Mobilization	13,000	18,000
March 1-15	1,200	13,000–18,000	Minimum Flow; Habitat Maintenance; Sediment Mobilization	13,000	18,000
March 16-30	1,500	13,000–18,000	Steelhead Spawning; Gravel Movement; Riparian Seed Dispersal	13,000	18,000
April	1,500	13,000–18,000 (1 Event)	Steelhead Spawning; Geomorphic Maintenance; Habitat Creation	13,000	18,000
May	1,500	3,000	Steelhead Spawning; Early Recession Limb	N/A	N/A
June	1,200	N/A	Steelhead Incubation	N/A	N/A
July 1-15	1,200	N/A	Steelhead Incubation	N/A	N/A
July 16-31	1,000	N/A	Rearing	N/A	N/A
August	1,000	N/A	Rearing	N/A	N/A
September	1,500	N/A	Chinook Spawning	N/A	N/A
October 1-15	1,500	N/A	Chinook Spawning	N/A	N/A
October 16-31	1,500	N/A	Chinook Spawning	N/A	N/A
November	1,500	13,000–18,000	Chinook Incubation; Sediment Mobilization; Habitat Creation	13,000	18,000
December	1,500	13,000–18,000	Chinook Incubation; Side Channel Connectivity; Gravel Movement	13,000	18,000

Water Availability (water rights)

The City possesses three year-round surface water rights (Table 3), allowing a withdrawal of 17.6 cfs without volume restrictions or fish persistence conditions. As per the City's 2018 Water Management and Conservation Plan, projected off-peak maximum day demands for water will increase from 3.75 to 7.96 cfs in 2017 to 5.35 to 8.83 cfs by 2037. The City of Stayton can use a combination of its water rights to meet municipal demands. Thus, these water rights are anticipated to adequately meet the projected demands and accommodate the ASR injection rate (2.32 cfs, approximately 1,040 gpm) without injuring downstream water rights holders. Downstream of the City's POD for surface water rights, there are three existing in-stream water rights. However, since the ASR injection rate will be covered by the City's existing water rights, there will be no adverse impact on these downstream water rights.

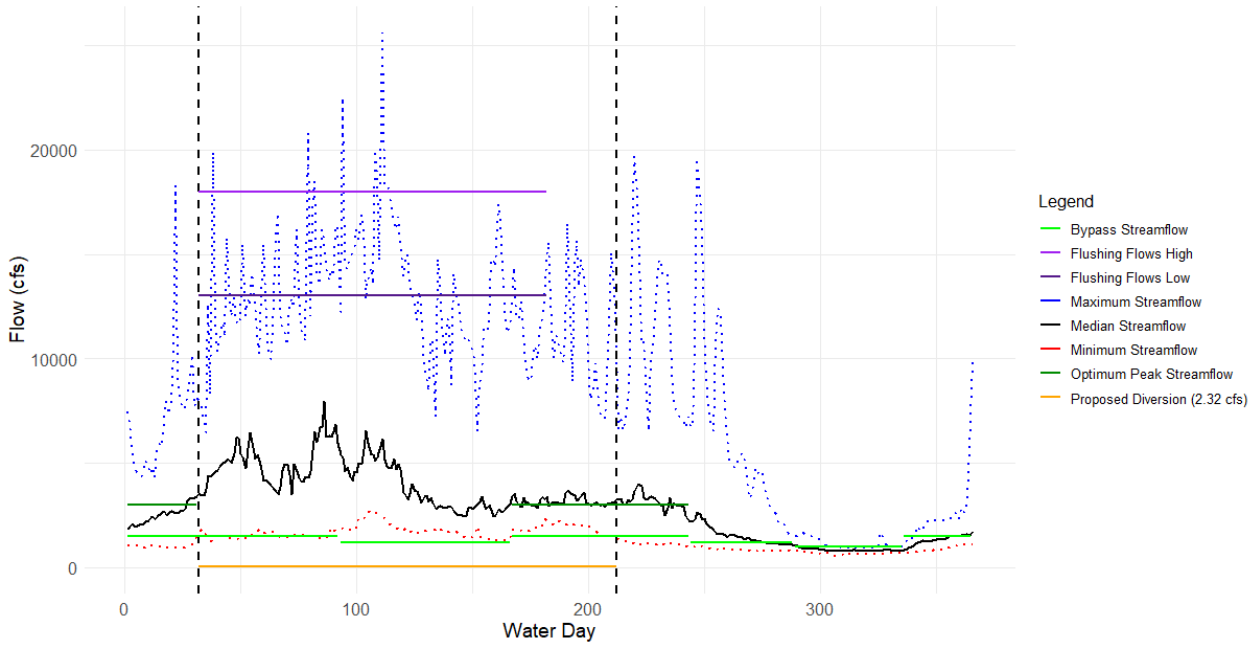

Figure 7. Reference hydrograph for the North Santiam River below the City's point of diversion at USGS gage 14184100 showing the minimum, median, and maximum flow for the period of record from 2005 – 2024. Storage-Specific Study-Ecological flows, the City's proposed injection rate (2.32 cfs), and diversion duration (November – April) are also shown.

Cumulative Effects of Water Allocation

Water overallocation remains a critical issue in Oregon, where cumulative withdrawals can stress the river system during both high- and low-flow periods. Understanding the cumulative effects of water allocation is beneficial for ensuring sustainable water management while protecting ecological systems. In this analysis, OWRD analyzed the cumulative effects of water allocation from November to April as this is when the City of Stayton proposes to divert water, and it generally matches up with what is outside the irrigation season.

Water Allocation During the November–April Period

During the November to April period, the North Santiam River experiences seasonal variability in streamflow, with flows typically higher in the winter months due to precipitation but still vulnerable to periods of lower flow. The analysis of water rights (WRs) between USGS gages 14183000 (Mehama, OR) and 14184100 (near Jefferson, OR) indicates that the **cumulative water demand during this period is substantial**, especially when compared to downstream median flows and ecological bypass flow requirements. Table 4 summarizes key findings from the cumulative effects analysis, showing how cumulative demand represents a significant portion of the available water, especially during months with lower flows (i.e., February through April).

Table 3 City of Stayton's water rights with points of diversion (PODs) on the North Santiam River.

Water Rigth	Season of Use	Priority Date	Rate (cfs)	Volume (AF)	Notes
S-52447	Oct 1 - Apr 30	5/13/1991	25		Extended permit with fish persistence conditions. The City must request access to water through submittal of a Water Management and Conservation Plan before using water under this permit.
57094	Year-round	12/10/1963	7		No fish persistence conditions.
80346	May 1 - Sep 30	5/14/1909	2.78	779.5	Irrigation season only. No fish persistence conditions.
80347	May 1 - Sep 30	6/24/1911	0.82	230.6	Irrigation season only. No fish persistence conditions.
80348	Year-round	5/14/1909	0.39	78.5	Volume-limited No fish persistence conditions.
80349	Year-round	12/31/1907	0.6		No fish persistence conditions.
T-9192	Year-round	7/5/1923	10		Inchoate transfer extended through 2042. No fish persistence conditions.
Subtotal year-round surface water rights without restrictions			**17.6**		
Total non-irrigation season surface water rights			**42.99**		

While Table 4 shows the effects of cumulative withdrawals using average values, Figure 8 complements this analysis by illustrating the effects of cumulative potential withdrawals daily. This detailed view emphasizes how the impacts could be more immediate and less predictable at a daily scale (Figure 8).

Table 4 Total potential non-groundwater water rights (WRs) between USGS gages 14183000 and 14184100 (POR 2005-2024) as a percentage of the monthly median streamflow at USGS gage 14184100 (downstream of Stayton).

Month	WRs Total Max Rate (cfs)	Downstream Median Monthly Flow (cfs)	Percent of Med. Monthly Flow	Bypass Flow (cfs)	Percent of Bypass Stream Flow
NOV	1,556	4,590	34%	1,500	104%
DEC	1,556	4,460	35%	1,500	104%
JAN	1,556	4,785	33%	1,200	130%
FEB	1,556	2,750	57%	1,200	130%
MAR	1,592	2,890	55%	1,500	106%
APR	1,592	3,000	53%	1,500	106%

Analysis of Cumulative Effects

Comparison with median monthly flows

During the November–April period, cumulative demand (1,556 to 1,592 cfs) consistently represents a significant portion of the downstream median monthly flow. The highest percentage occurs in February, where cumulative demand reaches 57% of the median monthly flow (2,750 cfs). This suggests that,

particularly in late winter, a large proportion of available water is already allocated to existing water rights. The lowest percentage occurs in January, where demand constitutes 33% of the median flow (4,785 cfs). This indicates that, while demand remains high, there is comparatively more water available in the system during this month. Although the amount of potential diversion is significant due to multiple water rights, the contribution of City of Stayton's ASR project (2.32 cfs) is only 0.15% of this potential difference.

Bypass flows

The bypass flows fall within the range of flows needed to maintain habitat needs including upmigrating, outmigrating, a rearing of steelhead and juvenile Chinook and steelhead (Bach et al., 2013). These flows range from 1,200 to 1,500 cfs, depending on the month. The cumulative demand for water exceeds the bypass flow threshold in every month of the study period. Notably, in **January and February**, cumulative demand represents **130%** of the bypass flow (1,200 cfs), meaning that City of Stayton's withdrawals would be restricted once streamflows fall below this threshold, as ecological needs take precedence. In **November, December, March, and April**, cumulative demand exceeds the bypass flow by a smaller margin, ranging from **104% to 106%** of the bypass flow. To be clear, any cumulative demand surpassing 100% means that there would not be any flow remaining in the stream. Thus, in January and February there is a deficit of water equivalent to 30% of the bypass flow, while in the remaining months the deficits are between 4 and 6%. This reinforces the need of City of Stayton's to adhere to their permit conditions regarding stopping withdrawals if the NSR reaches bypass flow levels at any point during the project's operation. ASR limited licenses constraint both the storage amount and the injection rates of the project. Our assessment indicates that the projected injection rates will have a negligible impact on the reference hydrograph, precluding the need of additional conditions.

Daily variability of streamflows

While the monthly analysis provides a good overview of cumulative demand in comparison to median flow conditions, Figure 8 highlights daily fluctuations in streamflows and cumulative water withdrawals. Cumulative potential withdrawals could quickly stress the system during short periods of low flow, even if the monthly averages seem sustainable. For instance, the cumulative demand frequently exceeds 100% of minimum daily streamflows during late winter, particularly from January through February (Figure 8). The daily variability in streamflows also suggests that short-term events, such as a sudden drop in flow due to dry weather or other factors, could temporarily push the system into a critically overallocated state, even when monthly conditions appear stable.

Implications for water withdrawals

These values highlight the limited capacity for additional water withdrawals during the November–April period that do not impact ecological flows, especially in the late winter months when demand approaches or exceeds bypass flow requirements. Any further allocation would likely impact ecological flows, especially during low-flow conditions when the river is already nearing its ecological threshold. However, the proposed this project would not contribute to allocation during those periods. **Based on the projected injection rates of 2.32 cfs from November to March, the project will still adhere strictly to bypass flow constraints.**

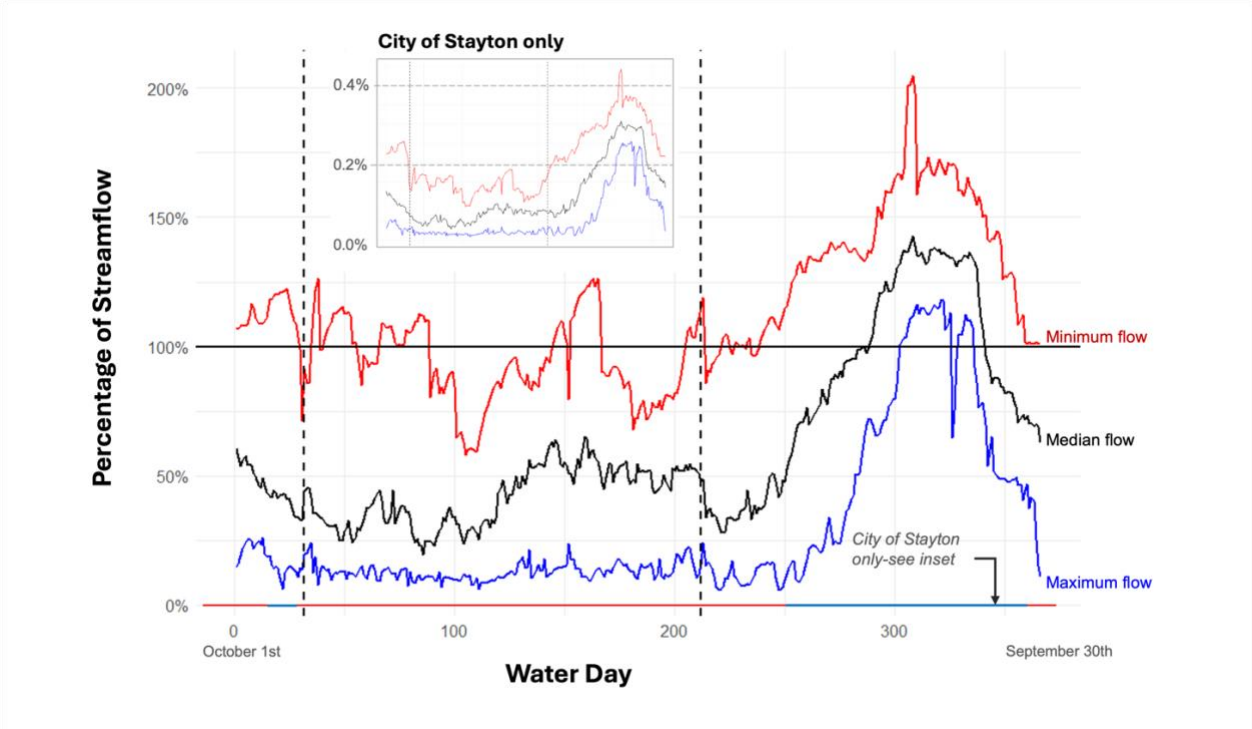

Figure 8. Percent of minimum, median, and maximum streamflow accounted for by total potential water rights demands (non-groundwater) between USGS gages 14183000 and 14184100 (POR 2005 – 2024). Inset showing percentages corresponding to the implementation of City of Stayton's ASR project only.

Ecological and Systemic Impacts

The cumulative effect of water allocation, particularly during periods when streamflow approaches the median minimum low flow, presents a risk for **Ecological Stress on Aquatic Species.** These results indicate that if all paper water rights were diverted the river will drop below the bypass flows periodically outside the irrigation season. Any reduction in streamflow below the bypass level would directly impact habitat availability for fish and other aquatic species, particularly those requiring specific flow conditions for migration and spawning.

Biological Band and Hydraulic/Physical Processes Band Analysis

The analysis of the Hydrological Band concluded that a diversion of 2.32 cfs would not measurably impact the NSR's flow regime. As hydrological functions sustain both biological and physical functions, no further analysis of potential impacts on these aspects is necessary. However, the following sections summarize the key information available for the Biological and Hydraulic/Physical Processes bands.

Biological Band

The Biological Band of the SVF Matrix assesses the sufficiency of information about all species present at or below the point of diversion and their lifecycle needs. For the NSR, the 2008 Biological Opinion (NMFS, 2008) is the most comprehensive source, identifying species listed as threatened or endangered under the Endangered Species Act (ESA) and their lifecycle needs. Additionally, the National Marine Fisheries Service (NMFS) conducts 5-year reviews of ESA-listed species, with the most recent review completed in 2015 (NWFSC, 2015).

While this report was being prepared, the Biological Opinion for the Willamette River Basin, including the North Santiam River, was updated by the National Marine Fisheries Service (NMFS) in 2024. The updated BiOp provides refinements to flow management strategies, emphasizing adaptive management, temperature regulation, and fish passage improvements. However, these refinements largely maintain the 2008 BiOp flow targets as a baseline and are not expected to significantly alter the ecological flow thresholds relevant to the City of Stayton's ASR project. The small-scale diversion rate of 2.32 cfs (or a potential 25% increase to 3.12 cfs) falls well within the ecological parameters established under the 2008 BiOp and confirmed through this analysis. Consequently, the new BiOp does not introduce changes that would affect the conclusions of this report or the sufficiency of the proposed Seasonally Varying Flow prescription for this project..

Hydraulic/Physical Processes Band

The Hydraulic/Physical Processes Band of the SVF Matrix evaluates the availability of information addressing the physical processes of a flow regime. For the NSR, a USGS and USACE environmental streamflow assessment provides data on the relationship between habitat features and streamflow (Risley et al., 2012). Multiple stream gages within the NSRB, equipped with turbidity sensors (USGS gages 14181500 and 14182500), can estimate the relationship between streamflow and sediment transport using established regression models (Bragg and Uhrich, 2010). Additionally, a temperature model for the NSR simulates streamflows with temperatures (Stonewall and Buccola, 2015), supported by temperature sensors at various stream gages (USGS gages 14181500, 14182500, 14183000, and 14184100) providing data on water quality, particularly related to temperature.

Seasonally Varying Flow Prescription for City of Stayton's ASR in the North Santiam River

The determination of Seasonally Varying Flow (SVF) for the City of Stayton's Aquifer Storage and Recovery (ASR) project was conducted through a detailed assessment of the hydrological, ecological, and regulatory frameworks governing water use in the North Santiam River (NSR). The objective was to balance the need for water storage during periods of abundance while safeguarding the ecological integrity of the river, particularly during critical low-flow periods. The assessment incorporated findings from the SVF Matrix, which evaluates the sufficiency of ecological and hydrological data to ensure the project's compatibility with ecological flow requirements.

Key Findings

Ecological Impact

The proposed ASR diversion rate of 2.32 cfs (with evaluations considering up to 3.12 cfs) was determined to have no measurable impact on the river's ecological flow thresholds, including bypass, optimum peak, and flushing flows. These thresholds were established to preserve habitat conditions for species listed under the Endangered Species Act (ESA), including those identified in the 2008 Biological Opinion (NMFS). The diversion rate is sufficiently small, ensuring that aquatic species' lifecycles, habitat availability, sediment transport, floodplain connectivity, and water quality remain unaffected.

Hydrological Analysis

Historical streamflow data from USGS gages 14183000 and 14184100 and hydrological assessments concluded that the proposed diversion rate is a minimal fraction of the overall flow regime. The hydrological band analysis indicated that the diversion of 2.32 cfs would not measurably impact the NSR's flow regime, ensuring that the ASR project will have negligible hydrological effects.

The river's reference hydrograph, as analyzed through a combination of flow data and environmental assessments, demonstrates that sufficient water is available to accommodate the ASR injection rate without disrupting flow patterns during the November–April operating period.

Water Availability

Stayton's existing water rights are sufficient to support the ASR diversion rate, as evaluated through cumulative demand assessments. These rights do not infringe upon the rights of downstream users.

The cumulative demand analysis showed that the ASR project, operating within the bounds of Stayton's existing water rights, can be sustainably implemented without negatively affecting downstream water rights holders or ecological flow conditions.

Prescription

The Seasonally Varying Flows (SVF) for the City of Stayton's ASR project are aligned with the already identified ecological flow thresholds, including the bypass flow requirements of 1,200 cfs during January and February and 1,500 cfs during November, December, March, and April. These thresholds are crucial for ensuring the ecological health of the river, particularly during the low-flow periods when aquatic species are most vulnerable. The project must adhere to these bypass flow requirements, ensuring that withdrawals cease when streamflows drop below these levels.

Permitting Conditions

No modifications to the intake rate are necessary to maintain compliance with ecological flow thresholds. Given that the proposed diversion rate does not measurably affect the NSR's flow regime, no additional permitting conditions are required beyond the enforcement of existing bypass flow constraints. This ensures that the project remains a sustainable solution for water management within the basin without compromising ecological or hydrological integrity.

Final Remarks

The Seasonally Varying Flows analyses presented here will be valid ONLY for this project, given the small hydrological and ecological impact of City of Stayton's ASR project. Any future projects with larger withdrawals triggering SVF requirements will require a further analysis that commensurate with their impacts on the reference hydrograph for the North Santiam River.

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