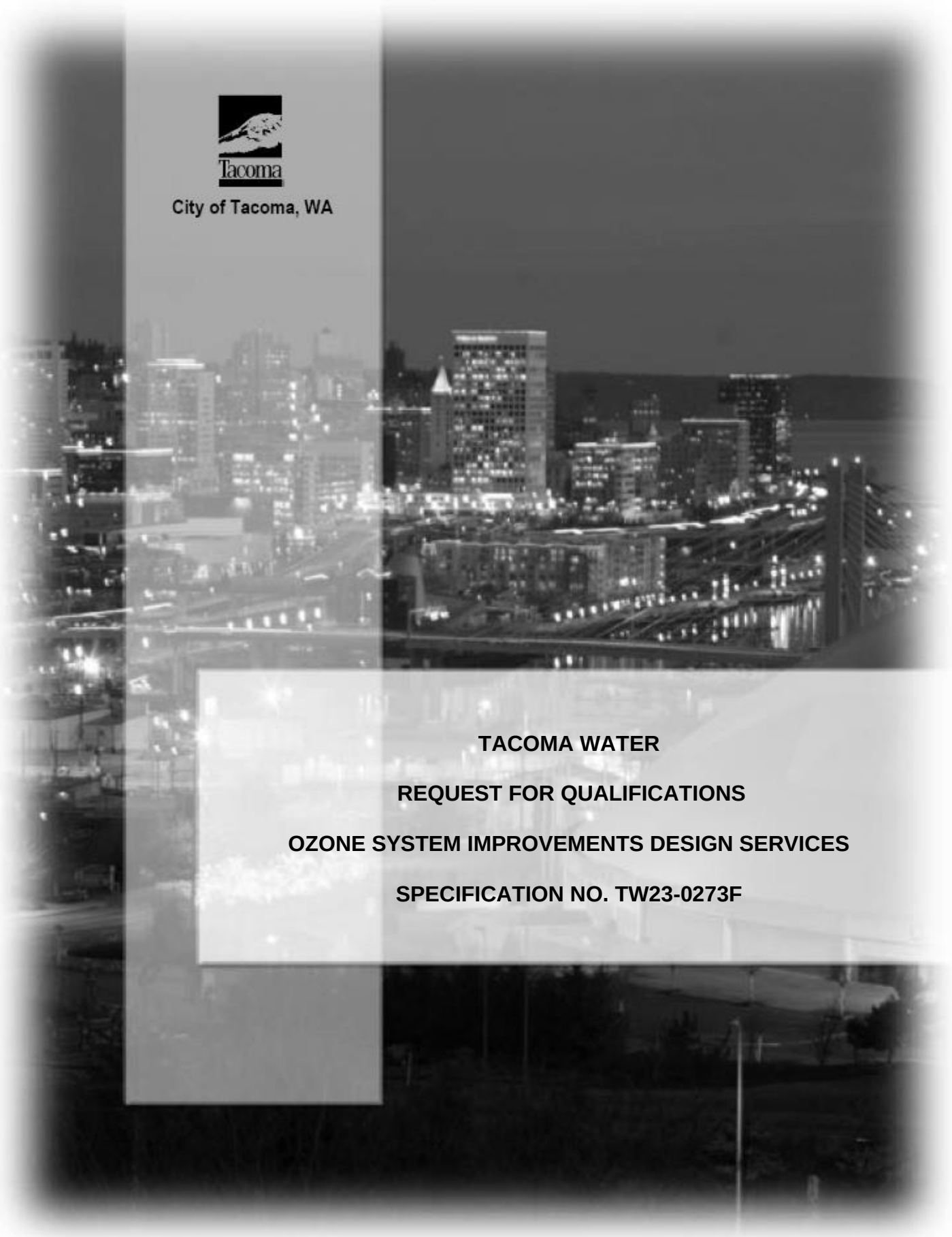

TACOMA WATER

REQUEST FOR QUALIFICATIONS

OZONE SYSTEM IMPROVEMENTS DESIGN SERVICES

SPECIFICATION NO. TW23-0273F

Template Revised: 5/11/2023

City of Tacoma
Tacoma Water

REQUEST FOR QUALIFICATIONS TW23-0273F
Ozone System Improvements Design Services

Submittal Deadline: 11:00 a.m., Pacific Time, Tuesday, April 2, 2024

Submittals must be received by the City's Procurement and Payables Division prior to 11:00 a.m. Pacific Time.

For electronic submittals, the City of Tacoma will designate the time of receipt recorded by our email, sendbid@cityoftacoma.org, as the official time of receipt. This clock will be used as the official time of receipt of all parts of electronic bid submittals. For in person submittals, the City of Tacoma will designate the time of receipt recorded by the timestamp located at the lobby security desk, as the official time of receipt. Late submittals will be returned unopened and rejected as non-responsive.

Submittal Delivery: Sealed submittals will be received as follows:

By Email:
sendbid@cityoftacoma.org
Maximum file size: 35 MB. Multiple emails may be sent for each submittal

Bid Opening: Submittals must be received by the City's Procurement and Payables Division prior to 11:00 a.m. Pacific Time. Sealed submittals in response to a RFB will be opened Tuesday's at 11:15 a.m. by a purchasing representative and read aloud during a public bid opening held at the Tacoma Public Utilities Administrative Building North, 3628 S. 35th Street, Tacoma, WA 98409, conference room M-1, located on the main floor. They will also be held virtually Tuesday's at 11:15 a.m. Attend via this link or call 1 (253) 215 8782. Submittals in response to an RFP, RFQ or RFI will be recorded as received. As soon as possible, after 1:00 PM, on the day of submittal deadline, preliminary results will be posted to www.TacomaPurchasing.org.

Solicitation Documents: An electronic copy of the complete solicitation documents may be viewed and obtained by accessing the City of Tacoma Purchasing website at www.TacomaPurchasing.org.

- Register for the Bid Holders List to receive notices of addenda, questions and answers and related updates.
- Click here to see a list of vendors registered for this solicitation.

Pre-Proposal Meeting: A pre-proposal meeting will not be held.

Project Scope: Provide final design for improvements to the Green River Filtration Facility ozone system, support Tacoma Water with equipment pre-purchase, and provide engineering services during construction and start-up.

Estimate: $800,000.00 (for budgetary purposes only)

Paid Sick Leave: The City of Tacoma requires all employers to provide paid sick leave in accordance with State of Washington law.

Americans with Disabilities Act (ADA Information: The City of Tacoma, in accordance with Section 504 of the Rehabilitation Act (Section 504) and the Americans with Disabilities Act (ADA), commits to nondiscrimination on the basis of disability, in all of its programs and activities. Specification materials can be made available in an alternate format by emailing the contact listed below in the *Additional Information* section.

Title VI Information:
"The City of Tacoma" in accordance with provisions of Title VI of the Civil Rights Act of 1964, (78 Stat. 252, 42 U.S.C. sections 2000d to 2000d-4) and the Regulations, hereby notifies all bidders that it will affirmatively ensure that in any contract entered into pursuant to this advertisement, disadvantaged business enterprises will be afforded full and fair opportunity to submit bids in response to this invitation and will not be discriminated against on the grounds of race, color, national origin in consideration of award.

Additional Information: Requests for information regarding the specifications may be obtained by contacting Brandon Snow, Senior Buyer by email to bsnow@cityoftacoma.org.

Protest Policy: City of Tacoma protest policy, located at www.tacomapurchasing.org, specifies procedures for protests submitted prior to and after submittal deadline.

Meeting sites are accessible to persons with disabilities. Reasonable accommodations for persons with disabilities can be arranged with 48 hours advance notice by calling 253-502-8468.

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SUBMITTAL CHECKLIST

This checklist identifies items to be included with your submittal. Any submittal received without these required items may be deemed non-responsive and not be considered for award.

Submittals must be received by the City of Tacoma Purchasing Division by the date and time specified in the Request for Qualifications page.

The following items make up your complete electronic submittal package (include all the items below):	
Signature Page (Appendix B)	
Statement of Qualifications, including Content to be Submitted (Section 9)	
After award, the following documents will be executed:	
City of Tacoma Contract (See sample in Appendix C)	
Certificate of Insurance and related endorsements (Appendix C)	

1. BACKGROUND

The City of Tacoma, Department of Public Utilities, Water Division (Tacoma Water) owns, operates, and maintains an ozone system that has been in service since 2007. The ozone system is located at the Green River Filtration Facility (GRFF) in Ravensdale, WA and includes a liquid oxygen system, two ozone generators and ancillary equipment, ozone injection equipment, ozone destruction equipment, and ozone monitoring equipment. The ozone system was supplied by Ozonia North America, now owned by Veolia.

The ozone system is nearing the end of its useful life and some components have been replaced in a piecemeal fashion while others have failed or are at risk of failing. Currently, only one ozone generator is in operation while the other generator is in need of replacement parts to restore it to working condition.

Tacoma Water intends to award a contract for engineering consultant support to design the improvements recommended during the ozone system condition assessment and evaluation performed in 2023. More detailed background on the project, including the Basis of Design Report, is provided in Appendix A.

To learn more about the City of Tacoma, visit www.cityoftacoma.org.

2. SUMMARY OF SCOPE OF SERVICES AND DELIVERABLES

It is the City's intent to select a consultant based on qualifications and abilities of the firm and key project individuals. The selected consultant will review the Basis of Design Report and provide expertise in designing the components identified for replacement. As part of the scope of work, the consultant will develop a detailed approach and schedule to deliver the recommended upgrades that consider Tacoma Water's immediate and future needs. The consultant will support Tacoma Water in preparing pre-purchase and bid documents to procure the components and a contractor to install the components and construct the improvements. Services during construction are also expected to be provided.

A more detailed discussion of the anticipated scope of work is provided in Appendix A.

These services are budgeted at approximately $800,000.00 and the anticipated project completion date is approximately December 2026; however, the scope, budget, and schedule will be negotiated with the selected consultant.

3. ANTICIPATED CONTRACT TERM

The anticipated duration of the contract is for approximately a two and a half-year period with the City's sole option to renew for additional periods as applicable.

4. CALENDAR OF EVENTS

The following schedule has been established for the submission and evaluation of the SOQs and selection of the Consultant. These are tentative dates only and the City reserves the right to adjust these dates at its sole discretion.

Contract may be issued after Public Utility Board and/or City Council approval.

The anticipated schedule of events concerning this Solicitation is as follows:

Publish and issue Solicitation:	**2/29/2024**
Pre-Submittal Questions:	**3/14/2024**
Response to Questions:	**3/19/2024**
Submittal Due Date:	**4/2/2024**
Submittal Evaluated, on or about:	**4/12/2024**
Interviews/presentations, if required, on or about:	**4/19/2024**
Award Recommendation, on or about:	**4/26/2024**
Public Utility Board/City Council Approval, on or about:	**6/12/2024**

5. INQUIRIES

5.1 Questions should be submitted to Brandon Snow via email to bsnow@cityoftacoma.org. Subject line to read:

TW23-0273F – Ozone System Improvements Engineering Services – *VENDOR NAME*

5.2 Questions are due by 3 pm on the date included in the Calendar of Events section.

5.3 Questions marked confidential will not be answered or included.

5.4 The City reserves the discretion to group similar questions to provide a single answer or not to respond when the requested information is confidential.

5.5 The answers are not typically considered an addendum.

5.6 The City will not be responsible for unsuccessful submittal of questions.

5.7 Written answers to questions will be posted alongside the specifications at www.tacomapurchasing.org

6. DISCLAIMER

The City is not liable for any costs incurred by the Respondent for the preparation of materials, or a submittal submitted in response to this Solicitation, for conducting any presentations to the City, or any other activities related to responding to this Solicitation or related to the contract negotiation process.

7. EVALUATION CRITERIA

A Selection Advisory Committee (SAC) consisting of City staff and other stakeholders, as appropriate, shall independently evaluate the SOQs. The relative weight of each scoring criteria is indicated in the table below.

Criteria	Max Points
Team Structure and Qualifications (Section 9.1)	**30**
Experience and Related Projects (Section 9.2)	**35**
Project Approach and Understanding (Section 9.3)	**30**
Equity in Contracting (Section 9.4)	**5**
Client References (Section 9.5)	**0**
Total	**100**

After the evaluation, the SAC may conduct interviews of the most qualified Respondents before final selection.

7.1 The SAC may use references to clarify information in the submittals and interviews, if conducted, which may affect the rating. The City reserves the right to contact references other than those included in the submittal.

7.2 Part 1 of the evaluation process shall consist of the evaluation of the written Statement of Qualifications (SOQ) package submitted by each Respondent and as a result, a short list of Respondents may be invited to interview with the SAC.

7.3 Part 2 of the evaluation process will evaluate the interviews, if conducted, to produce a final rating. The City reserves the right to select the Consultant team directly from the SOQs (Part 1 evaluation) without conducting an interview.

8. SOQ SUBMITTAL AND GENERAL GUIDELINES

The SOQ should be submitted in PDF format. Proposals should be formatted as 8 ½" x 11", except for specific exhibits where necessary. The City recommends that the Respondent's SOQ submittals be limited to no more than 8 double-sided pages or 16 pages total (not including City of Tacoma required forms and appendices).

9. CONTENT TO BE SUBMITTED

A full and complete response to each of the "CONTENT TO BE SUBMITTED" items is expected in a single location; do not cross reference to another section in your submittal.

Information that is confidential must be clearly marked and provide an index identifying the affected page number(s) and locations(s) of such identified materials. See Section 1 of the Standard Terms and Conditions – Solicitation 1.06 for Public Disclosure: Proprietary or Confidential Information.

Respondents are to provide complete and detailed responses to all items below. Submittals that are incomplete or conditioned in any way that contain alternatives or items not called for in this RFQ, or not in conformity with law, may be rejected as being non-responsive. The City will not accept any submittal containing a substantial deviation from the requirements outlined in this RFQ.

Submittals should present information in a straightforward and concise manner, while ensuring complete and detailed descriptions of the Respondent's/team's abilities to meet the requirement of this RFQ. Emphasis will be on completeness of content. The written submittals should be prepared in the sequential order as outlined below.

The City reserves the right to request clarification of any aspect of a firm's submittal or request additional information that might be required to properly evaluate the submittal. A firm's failure to respond to such a request may result in rejection of the firm's submittal. Firms are required to provide responses to any request clarification within two (2) business days.

Requests for clarification or additional information shall be made at the sole discretion of the City. The City's retention of this right shall no way diminish a Respondent's responsibility to submit a submittal that is current, clear, complete, and accurate.

9.1 Team Structure and Qualifications – 30 points

Please describe the consulting team structure, including names of lead team members with titles, technical qualifications, and general project responsibilities. Include the following:

- Provide a summary of the background and experience of the Project Manager relevant to this project.
- Describe the Project Manager's experience with projects of similar type and size. Provide at least one example.
- Identify key team members, including any staff expected to make key contributions to the project. For each team member, describe their technical qualifications and general project responsibilities.
- Provide an org chart for the team including all subconsultants. Clearly delineate responsibilities of subconsultants.
- Identify which office(s) the project will be delivered from and the locations of key team members.
- Provide a statement that clearly conveys the firm's commitment to actively perform the proposed work and the ability of all proposed project personnel to accept responsibility for completing the project in view of the firm's current and projected workload.
- Include individual resumes for all team members as ***Appendix A*** of Respondent's submittal (resumes will not count toward page count total).

9.2 Experience and Related Projects – 35 points

Please provide a summary of the experience of the firm relative to this project. For each example project identified, include the following:

- General description of the project

- Name and contact information of the client
- Project location
- Start and completion dates
- Any key similarities to Tacoma Water's Ozone System Improvements project
- Involvement of the individuals proposed for this project team and their role on the example project

Provide at least four examples of related projects, including at least one or more projects involving retrofit or replacement of existing ozone systems.

9.3 Project Approach and Understanding – 30 points

Summarize the project team's understanding of the project and primary issues that will need to be addressed to complete it. Describe the following:

- Respondent's suggested approach to accomplishing the proposed scope of work, including any proposed activities, methodologies, or tools that Respondent would like Tacoma Water to be aware of
- Respondent's understanding of key issues to be addressed in this project and potential approaches proposed to address them
- Respondent's recommendations for expediting procurement and maintaining successful coordination with the Ozone System Supplier through all stages of the project, including ongoing maintenance and repair
- Conceptual project schedule for completing the consultant services

9.4 Equity in Contracting – 5 points

Proposed teams with certified Washington State Office of Minority & Women's Business Enterprises will receive five points, these include the following categories:

☐ Disadvantaged Business Enterprise (DBE)

☐ Minority Business Enterprise (MBE)

☐ Minority/Women Business Enterprise (MWBE)

☐ Small Business Enterprise (SBE)

☐ Women Business Enterprise (WBE)

9.5 Client References – 0 points

References shall be used to verify the accuracy of the information provided by the Respondent, which may affect the rating of the Respondent. The City reserves the right to contact references other than those submitted by the Respondent.

Please provide a list of references in ***Appendix B*** of Respondent's submittal (references will not count toward the total page count).

Provide three recent references who may be contacted concerning your firm's performance with regard to the qualifications listed in the SOQ.

In listing the references, include the name of the client, contact person, contact person's position, contact person's role on the referenced project, telephone number, email address, and the specific work your firm did for the client.

10. INTERVIEWS / ORAL PRESENTATIONS

An invitation to interview may be extended to Respondents based on SAC review of the written submittals. The SAC reserves the right to adjust scoring based on additional information and/or clarifications provided during interviews. The SAC may determine additional scoring criteria for the interviews following evaluation of written submittals.

The City reserves all rights to begin contract negotiations without conducting interviews.

Respondents must be available to interview within five (5) business days' notice.

If interviews are conducted, the SAC will schedule the interviews using the email address for communications provided on the signature page. Additional interview information will be provided at the time of invitation. At this time, it is anticipated that the main objective of the interview will be for the SAC to meet the project manager and key personnel that will have direct involvement with the project and hear about their relevant experience and expertise. The City does not intend to meet with firm officials unless they are to be directly involved with the project.

Following interviews, submittals will be rescored using the same criteria as in the Evaluation Criteria Section.

11. RESPONSIVENESS

11.1 Respondents agree their submittal is valid until a contract(s) has been executed.

11.2 All submittals will be reviewed by the City to determine compliance with the requirements and instructions specified in this Solicitation. The Respondent is specifically notified that failure to comply with any part of this Solicitation may result in rejection of the submittal as non-responsive. The City reserves the right, in its sole discretion, to waive irregularities deemed immaterial.

11.3 The final selection, if any, will be that submittal which, after review of submissions and potential interviews, in the sole judgement of the City, best meets the requirements set forth in this Solicitation.

12. CONTRACT OBLIGATION

The selected Respondent(s) will be expected to execute a Contract with the City.

At a minimum, any contract will incorporate the contents of this specification, including all stated services or deliverables and other requirements and the City of Tacoma Standard Terms and Conditions, together with the contents of Respondent's submittal. The submittal contents of the successful Respondent will become contractual obligations.

13. FORM OF CONTRACT

In event the City's Services Contract or other City Contract template is attached to this RFQ as a sample form of Contract, the City expects to utilize the Terms and Conditions contained in the sample form of Contract. Post award negotiation may occur at the discretion of the City. Respondents should clearly state exceptions to City's Standard Terms and Conditions as well as to the Terms and Conditions contained in any attached sample form of Contract and to any other portions of this RFP, including the stated Insurance Requirements. Respondents may also propose to utilize their own form of Contract and, in such instances, Respondent must provide its form of Contract as part of its submittal. City, at its sole option, will decide whether to engage in negotiation on any or all proposed exceptions. City reserves sole discretion to determine the final form of Contract that will be used.

14. STANDARD TERMS AND CONDITIONS

City of Tacoma Standard Terms and Conditions apply.

15. INSURANCE REQUIREMENTS

Successful Respondent will provide proof of and maintain the insurance coverage in the amounts and in the manner specified in the City of Tacoma Insurance Requirements contained in Appendix C .

16. PARTNERSHIPS

The City will allow Respondents to partner in order to respond to this Solicitation. Respondents may team under a Prime Respondent's submittal in order to provide responses to all sections in a single submission; however, each Respondent's participation must be clearly delineated by section. The Prime Respondent will be considered the responding vendor and the responsible party at contract award. Any contract negotiations will be conducted only with the Prime Respondent. All contract payments will be made only to the Prime Respondent. Any agreements between the Prime Respondent and other companies will not be a part of the agreement between the City and the Prime Respondent. The City reserves the right to select more than one Prime Respondent.

17. COMMITMENT OF FIRM KEY PERSONNEL

The Respondent agrees that key personnel identified in its submittal or during contract negotiations as committed to this project will, in fact, be the key personnel to perform during the life of this contract. Should key personnel become unavailable for any reason, the selected Respondent shall provide suitable replacement personnel, subject to the approval of the City. Substantial organizational or personnel changes within the agency are expected to be communicated immediately. Failure to do so could result in cancellation of the Contract.

18. AWARD

Awardee shall be required to comply with 2 CFR Part 25 and obtain a unique entity identifier and/or be registered in the federal System for Award Management as appropriate.

After the Respondent(s) is selected by the SAC and prior to award, all other Respondents will be notified via email by the Purchasing Division.

Once a finalist (or finalists) has been selected by the SAC, contract negotiations with that finalist will begin, and if a contract is successfully negotiated, it will, if required, be submitted for final approval by the Public Utility Board and/or City Council.

19. SCOPE, BUDGET, AND SCHEDULE

The selected Respondent will meet with the City to review the project scope and timeline. Based on the meeting, the selected Respondent shall submit a draft scope, budget, and project schedule to the City within five (5) business days or as directed by the City's Project Manager. The scope and budget shall include an itemized list of tasks and include estimated hours for the proposed work. The budget shall be supported by a list of hourly rates for personnel to be utilized under this contract.

20. ENVIRONMENTALLY PREFERABLE PROCUREMENT

In accordance with the City's Sustainable Procurement Policy and Climate Action Plan, it is the policy of the City of Tacoma to encourage the use of products or services that help to minimize the environmental and human health impacts of City Operations. Respondents are encouraged to incorporate environmentally preferable products or services that have a lesser or reduced effect on human health and the environment when compared with competing products or services that serve the same purpose. This comparison may consider raw materials acquisition, products, manufacturing, packaging, distribution reuse, operation, maintenance or disposal of the product or service.

The City of Tacoma encourages the use of sustainability practices and desires any awarded contractor(s) to assist in efforts to address such factors when feasible for:

- Durability, reusability, or refillable;

- Pollutant releases, especially persistent bioaccumulative toxins (PBTs), low volatile organic compounds (VOCs), and air quality and stormwater impacts;
- Toxicity of products used;
- Greenhouse gas emissions, including transportation of products and services, and embodied carbon
- Recycled content;
- Energy and water resource efficiency

21. PROPRIETARY OR CONFIDENTIAL INFORMATION

The Washington State Public Disclosure Act (RCW 42.56 et seq.) requires public agencies in Washington make public records available for inspection and copying unless they fall within the specified exemptions contained in the Act, or are otherwise privileged. Documents submitted under this RFP shall be considered public records and, with limited exceptions, will be made available for inspection and copying by the public.

Information that is confidential or proprietary must be clearly marked. Further, an index must be provided indicating the affected page number(s) and location(s) of all such identified material. Information not included in said index will not be reviewed for confidentiality or as proprietary before release.

22. ADDENDUMS

In the event it becomes necessary to revise any part of this RFQ, an addendum will be posted alongside specifications at www.tacomapurchasing.org. Failure to acknowledge addendum(s) on the required Signature Page may result in a submittal being deemed non-responsive by the City.

APPENDIX A

BACKGROUND AND ANTICIPATED SCOPE OF WORK

Background and Anticipated Scope of Work

BACKGROUND

Ozone System Overview

Tacoma Water owns, operates, and maintains an ozone system at the Green River Filtration Facility (GRFF) in Ravensdale, WA. Ozone is generated onsite utilizing liquid oxygen that is vaporized to gaseous oxygen and is fed to two ozone generators. Ozone gas is injected into the raw water supply with a sidestream injection system to the primary plug-flow pipeline reactors (Reactor 1 and Reactor 5). Excess ozone gas is captured and destroyed through a destruct system. Before the water is introduced to the GRFF's coagulation and flocculation processes, it is monitored by various ozone monitoring equipment (dissolved ozone analyzers and offgas analyzers) and ozone may be quenched with sodium bisulfite. The ozone system was supplied by Ozonia North America (now owned by Veolia), and the facility has been in operation since 2007.

Ozone System Purpose and Capacity

The GRFF has a capacity of 150 million gallons per day (MGD). The ozone system was designed primarily to control taste and odor in the Green River and North Fork Wellfield water. Other benefits of this system include additional disinfection credit (when needed) and enhanced coagulation and pre-oxidation prior to filtration.

The two ozone generators each have a rated capacity of 1,050 pounds per day (ppd) at 12 percent and 1,400 ppd at 10 percent. Historically, the generators have been operated in a duty/standby arrangement, allowing complete redundancy at historical plant flows.

Recent and upcoming changes will affect the required capacity of the ozone system. Tacoma Water's largest industrial customer closed in late 2023, effectively dropping Tacoma Water's average daily demand by 16 MGD. Another upcoming change will be the construction of a downstream fish passage facility at Howard Hanson Dam, upstream of Tacoma Water's intake on the Green River. Fish passage will result in water quality changes that are expected to require increased ozone doses.

Ozone System Failures and Planning Efforts

The ozone system is nearing the end of its useful life, and some components of the system have been replaced in a piecemeal fashion while others have failed or are at risk of failing. Ozone Generator 1 has been out of service since 2022 due to power supply unit (PSU) failure. Despite multiple troubleshooting efforts, the generator remains out of service, increasing the risk to GRFF operations by no longer providing ozone system redundancy.

Since the failure of the PSU for Ozone Generator 1, condition assessments of the current ozone system have been performed and a basis of design report for ozone system improvements has been prepared. Based on this work, it has been determined that many components of the ozone system are obsolete and need replacement with newer equipment.

In particular, Tacoma Water intends to keep the existing ozone generator shells but completely replace the PSUs and control equipment. The Basis of Design Report (Jacobs Engineering Group Inc, 2023) is provided as Attachment 1.

The Basis of Design Report recommends a two-phase delivery approach in which one new PSU is procured and installed in advance of the remainder of the project. If Tacoma Water has not yet ordered the initial PSU by the time the project begins, the Consultant's initial task will be to support this procurement.

OBJECTIVES

Tacoma Water's objectives in completing this project include the following:

- Make across-the-board improvements to the ozone system to extend its useful life an additional 20 years or more.
- Ensure ozone system capacity is appropriate for expected future system demand and source water quality.
- Complete work in a timely manner with a stream-lined approach to best mitigate the lengthy equipment lead times expected and the ongoing risk of equipment failure.
- Complete work in a manner least disruptive to daily GRFF operations.

ANTICIPATED SCOPE OF WORK

A detailed scope of work and budget will be negotiated with the selected Consultant. The scope of work is expected to include, but is not limited to, the following tasks:

- Review the Basis of Design Report and work with Tacoma Water to consider each recommendation for replacement/upgrade. Reevaluate proposed ozone system capacity based on recent changes to Tacoma Water system demands.

- Support Tacoma Water in completion of Phase 1 work, to include pre-purchase of a new PSU for Generator 1 and ancillary equipment. Support procurement and contract negotiation with the Ozone System Supplier. Depending upon equipment lead times and project schedule, prepare bid documents to hire a separate contractor for Phase 1 installation and startup and support installation and startup of the PSU.

- Develop an approach to deliver the Phase 2 improvements considering Tacoma Water's immediate needs and future needs. Consider components for a pre-purchase package through the Ozone System Supplier and components to be included in the general construction bid.

- Work with Tacoma Water to review and approve Ozone System Supplier submittals.

- Complete final design for all identified project components for Phase 2, providing (1) a pre-purchase package for the Ozone System Supplier and (2) final plans and specifications for bidding. Prepare design deliverables for review at 30 percent, 60 percent, and 90 percent design.

- Provide cost estimates for the project at 30 percent, 60 percent, and 90 percent design.
- Facilitate design review workshops with Tacoma Water.
- Coordinate with S&B Inc. of Bellevue, Washington, Tacoma Water's instrumentation and control system integrator, throughout the project design and construction. At this time, it is assumed that S&B Inc. will be a sub-consultant to Consultant during design and a sub-contractor to the general contractor during construction.
- Support Tacoma Water in obtaining any required permits for the work.
- Support Tacoma Water in the bid processes, including answering any bidder questions on design.
- Provide engineering services during construction and startup for Phase 1 and Phase 2, including submittal review, responses to contractor inquiries, construction observation, start-up and performance testing support, and record drawing preparation.

Jacobs

Ozone System Evaluation and Basis of Design Report

Document no: DRAFT
Revision no: A

Tacoma Water
Green River Filtration Facility Ozone System Evaluation

July 11, 2023

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Acronyms and abbreviations

°F	Degree Fahrenheit
ACI	American Concrete Institute's
ASCE	American Society of Civil Engineers
AWWA	American Water Works Association
DOC	Dissolved Organic Carbon
FRA	Flavor Rating Assessment
g	Gravitational Acceleration
GOX	Gaseous Oxygen
gpm	gallons per minute
GRFF	Green River Filtration Facility
HMI	Human-Machine Interface
LCC	Life Cycle Cost
LOX	Liquid Oxygen
MCC	Motor Control Center
mg/L	milligrams per liter
mgd	million gallons per day
MOCP	Master Ozone Control Panel
O&M	Operations and Maintenance
OIT	Operator Interface Terminal
OSS	Ozone System Supplier
PLC	Programmable Logic Controller
ppd	pounds per day
psi	pounds per square inch
psig	pounds per square inch gauge
PSU	Power Supply Unit
SCADA	Supervisory Control and Data Acquisition
scfm	standard cubic feet per minute
TOC	Total Organic Carbon
UPS	Uninterruptible Power Supply

1 Introduction

Tacoma Water owns and operates the Green River Filtration Facility (GRFF), which treats water from the Green River and North Fork Wellfield. The GRFF has two modes of operation:

1. Direct filtration mode with a total capacity of 168 million gallons per day (mgd), typically operated during the summer.
2. Conventional treatment mode with sedimentation and filtration at a capacity of 90 mgd, typically operated during the winter.

Designed for taste and odor control, the ozone system was placed into operation in 2007 as part of an unfiltered multi-disinfection barrier treatment system. The filtration facility was placed online in 2015, downstream of the ozone facility. In addition to taste and odor control, the pre-ozonation system is also used for additional disinfection credit when needed and to enhance filtration performance. The Ozone System includes a liquid oxygen (LOX) system, ozone generation, ozone injection, ozone destruction and ozone monitoring equipment, which was supplied by Ozonia North America, now owned by Veolia. The ozone equipment is nearing the end of its useful life and various upgrades to the existing system are currently under consideration. The report summarizes the recommended ozone upgrades based on the various evaluations that have been completed.

1.1 Ozone System Overview

A schematic of the ozone system is shown in Figure 1.1. Raw water from the Green River and the North Fork Wellfield is blended before injection of ozone into two pipeline reactors called Reactor 1 and Reactor 5. Downstream of the ozone injection, the water flows to rapid mix and flocculation and then to sedimentation basins or directly to the filters depending on the GRFF operating mode.

The existing ozone system consists of two LOX tanks connected to two vaporizers which supply gaseous oxygen to the ozone generators. A nitrogen boost system blends nitrogen into the gaseous oxygen (GOX) header. The system includes two Ozonia (now owned by Veolia) generators, each with a rated capacity of 1,050 pounds per day (ppd) at 12 percent and 1,400 ppd at 10 percent. The generators feed ozone into two different pipeline reactors, each designed with approximately 11 minutes contact time at peak flow. Ozone is injected into the pipeline reactors using a sidestream injection system. Each reactor can be fed from two 6-inch or one 4-inch injector. Two duty pumps serve the two 6-inch injectors, and a set of duty/standby pumps serve the 4-inch injector. A closed loop cooling water system is used to cool the ozone generators and power supply units (PSUs). The open loop side of the cooling water system uses raw water. An ozone destruct system is used to destroy any ozone that is not transferred to the raw water in the reactors. Sodium bisulfite is used to quench any ozone in the water at the end of the contact pipeline before entering the downstream treatment processes.

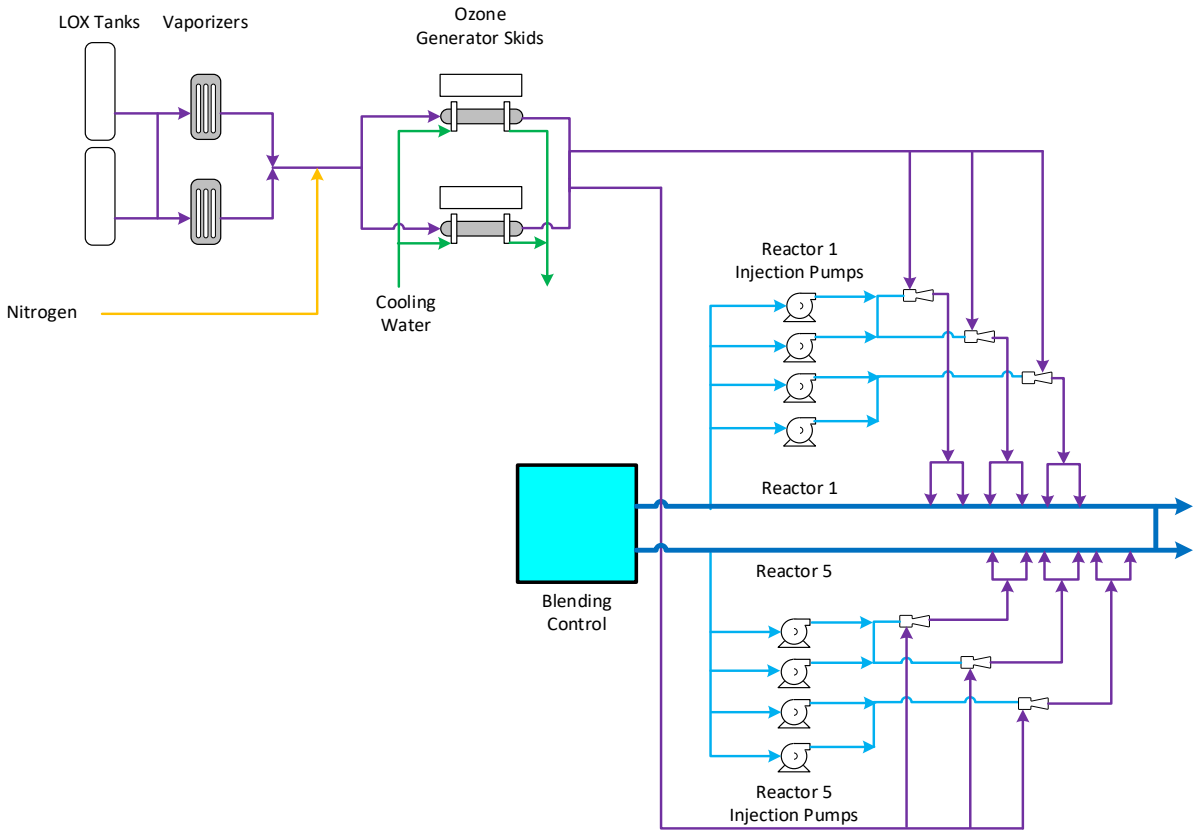


Figure 1.1. Ozone System Schematic

The existing ozone system targets taste and odor compounds and assists in pre-oxidation of organics upstream of the treatment process to improve filter performance. The ozone system is designed for a dose of 2.0 milligrams per liter (mg/L) at 72 mgd for Reactor 1 and 95 mgd for Reactor 5. The ozone dose is currently set by the operators, typically at 0.75 mg/L. The dose is adjusted, as needed, to maintain a detectable residual at Ozone Residual Monitoring Station 3. The historical daily average ozone dose range from 2018 to 2022 is 0.15 to 2.4 mg/L. The dose is also adjusted depending on the water quality of the Green River and North Fork Wellfield blend; a higher dose is required when taste and odor compounds and organics are present, and a lower dose is required when only North Fork Wellfield water is supplied. Disinfection credit for *Giardia* is also calculated continuously but is not typically reported.

1.2 Purpose

This Ozone System Evaluation and Basis of Design Report summarizes recommended upgrades to the identified ozone equipment to maintain reliable operations and continue to meet water quality targets at the GRFF. The report provides design criteria, standards, and codes used to develop the design basis, and defines the project scope for each design discipline. The plan also defines equipment to be replaced, replacement schedule, and contracting approach.

The purpose of this Basis of Design Report is to provide design definition for the upgrades to the ozone equipment and define the upgrade plan to achieve the goals summarized in the bullets below:

- Improve reliability of the ozone system
- Replace obsolete equipment to provide a 20 to 25-year service life

- Evaluate current and future operating criteria to ensure that the ozone equipment is sized properly to provide protection against taste and odor and algal toxins in the source water
- Define upgrades to the equipment and control system to ensure reliable operation
- Define the schedule and contracting approach for the ozone system upgrades

2 Ozone System Evaluations

The evaluations completed are summarized in the following sections:

- Section 2.1 includes field evaluations completed by Jacobs and other third parties, including Veolia, and supplemental evaluations on the deficiencies found in these field condition assessments.
- Section 2.2 includes tabletop evaluations looking at capacity of existing equipment and ability to meet treatment goals in current flow and water quality conditions.
- Section 2.3 includes evaluations looking at future capacity of ozone generators when considering future demands and changes in water quality.
- Section 2.4 includes an evaluation on optimizing ozone concentration and LOX usage for potential savings in operating costs.
- Section 2.5 summarizes the recommendations for the ozone generator sizing resulting from the various evaluations.

2.1 Ozone System Condition Assessment

The ozone equipment at the GRRF is approaching the end of its anticipated operating life and the power supply units (PSU) are considered by the manufacturer to be obsolete. Studies and evaluations were conducted in 2022 to assess the condition of the ozone equipment and evaluate performance, including:

- Ozone Water Systems, Inc completed an ozone system condition assessment in May 2022. The evaluation identified risks associated with the existing equipment and operations and maintenance (O&M) challenges due to the age of the equipment.
- Veolia completed a service visit to address issues on the PSUs on August 25, 2022. The service visit noted that the PSUs require replacement since spare parts are considered obsolete.
- Jacobs completed an ozone system evaluation on January 9, 2023 to confirm and identify additional risks to the aging equipment.

A summary of the findings from the various condition assessments and the recommendations to correct these deficiencies are presented in Table 2.1. These deficiencies found were used to identify the recommended scope of work for the ozone system in later sections.

Table 2.1. Ozone Equipment Condition Assessment Summary

System	Deficiencies	Recommendation
Liquid Oxygen (LOX) Tank, Vaporizers, and associated valves and instruments	• Economizer is not plumbed correctly and does not blow off automatically when pressure builds up in the LOX tanks. • LOX piping has freezing issues that threatens to ice up LOX valves. • Dew point monitor needs recalibration.	• Replace economizer pressure relief valve and change piping to feed upstream of vaporizer. • Replace LOX piping and valve insulation. • Replace dew point monitor. Calibrate and keep existing as spare.

System	Deficiencies	Recommendation
Nitrogen Boost System	• Dew point monitor needs recalibration. • High temperatures in the unconditioned generator room have triggered high temperature alarms on the nitrogen boost skid during the summer, which may be contributing to mechanical issues. • System has required a lot of maintenance and has experienced multiple scroll failures for the Atlas Copco scroll-type compressors.	• Recalibrate dew point monitor. • Consider replacement of scroll compressors with a high temperature tolerant scroll compressor. • Consider upgrading nitrogen boost system. See detailed alternatives evaluation in Section 2.1.2.
Ozone Generators and Power Supply Units	• High oxygen feed pressure was set at 24 psi on the PSU HMI and was too high according to Veolia. • Ozonia control system components are outdated and due for replacement. • Anchors appear small for the size of the equipment.	• The pressure regulators were set back to 20 psi in August 2022 which resolved this issue. • Full replacement of the Control Panels is recommended since many of the legacy components are no longer supported by the vendors. • Recommend inspection and review of the seismic bracing criteria for the ozone generators by a structural engineer during design.
Sidestream Injection System	• Each reactor has two six-inch injectors and one four-inch injector. The large injectors are each served by one duty pump and the small injector is served by two pumps (duty/standby). Anecdotally only the large injectors are used. • Operators indicated that the upper injector nozzles in the treated water pipeline have been blocked off. Only the bottom nozzles are used currently. • Injector skid corrosion was noted, particularly on the galvanized pipe supports.	• See detailed evaluations on injectors in Section 2.1.3. • See detailed evaluations on 4-inch injectors in Section 2.1.3. • Clean and re-paint or replace corroded galvanized pipe supports with stainless steel pipe supports.
Cooling Water System	• Generator cooling water system requires frequent cleaning of the basket strainers, especially when on Green River water. • Corrosion issues on the closed loop cooling system.	• Consider alternative such as automatic cleaning basket strainers. See detailed evaluation in Section 2.1.4. • The closed loop cooling water system should be drained, cleaned, and refilled. The closed loop system should be sampled periodically to monitor pH, conductivity, and color/ appearance of the water to confirm if corrosion is still an

System	Deficiencies	Recommendation
		issue. A corrosion inhibitor can also be added.
Ozone Off-Gas Destruct System	• Ozone monitors have not been serviced for quite some time.	• Perform testing on this equipment and identify elements that should be replaced.
Ozone Sample Stations	• Stations are equipped with dissolved ozone analyzers, however there is no instrument to indicate if flow to the sample analyzer is lost. The manual rotameters are not usable due to manganese buildup. • Y-strainers are not regularly cleaned and the differential pressure gauge at the y-strainer has been removed.	• Replace the rotameters with a small flowmeter. Due to the remote location of the sample stations, having a signal to supervisory control and data acquisition (SCADA) will be helpful when using the measured residuals for automatic ozone dosing control. • Provide regular schedule for strainer cleaning and provide low flow alarm to trigger maintenance
Ozone Safety Monitors	• INUSA ambient ozone monitors are considered obsolete.	• Replace INUSA ambient ozone monitors.
Pipeline Reactors	• Only one pipeline reactor (R5) is in operation.	• Pipeline reactors to be inspected and determined if cleaning and relining is needed. • Routine operation of both R1 and R5 is recommended to ensure extended life of reactors, operational flexibility, and capability to operate both reactors if future demands require it.

2.1.1 LOX Tank Economizer

The LOX tanks are designed with an economizer to reduce pressure in the tank and minimize loss of oxygen. The regulator as part of the economizer system allows gas from the top of the tank to vent to the oxygen piping to minimize loss of oxygen. One of the issues identified by Tacoma Water during the Jacobs site visit is that when pressure builds up in the LOX tanks it does not blowoff automatically. The current work-around to resolve this includes bringing the offline LOX tank online to help regulate pressure or performing a manual blowoff of oxygen from the tank.

US Cryogenics, Inc. reviewed the installation and determined that there is not sufficient pressure drop to operate the economizer. The economizer relief piping is sketched in Figure 2.1, which shows piping from each LOX tank manifolded together and then connecting downstream of each vaporizer via a tee connection at the two pressure relief valves, PSV-35211 and PSV-35212. The regulator on the economizer system is set to relieve at 75 psig. Figure 2.2 shows the operating pressure of the LOX tank for the year 2022. Operating pressures range between 67 and 123 psig with an average operating pressure of 88 psig. On average, the LOX tanks appear to be operating at pressures higher than the original design value of 75 psig. With the economizer pressure relief valve set at 75 psig, the valve may be constantly venting if pressure in the LOX tank is above 75 psig. The pressure in the gaseous oxygen piping where this relief piping is connected to is likely above the relief pressure of 75 psig given the operating pressures of

the LOX tank. The higher pressures in the gaseous oxygen piping compared to the economizer relief pressure will prevent flow of the oxygen gas from the tank into the pipe.

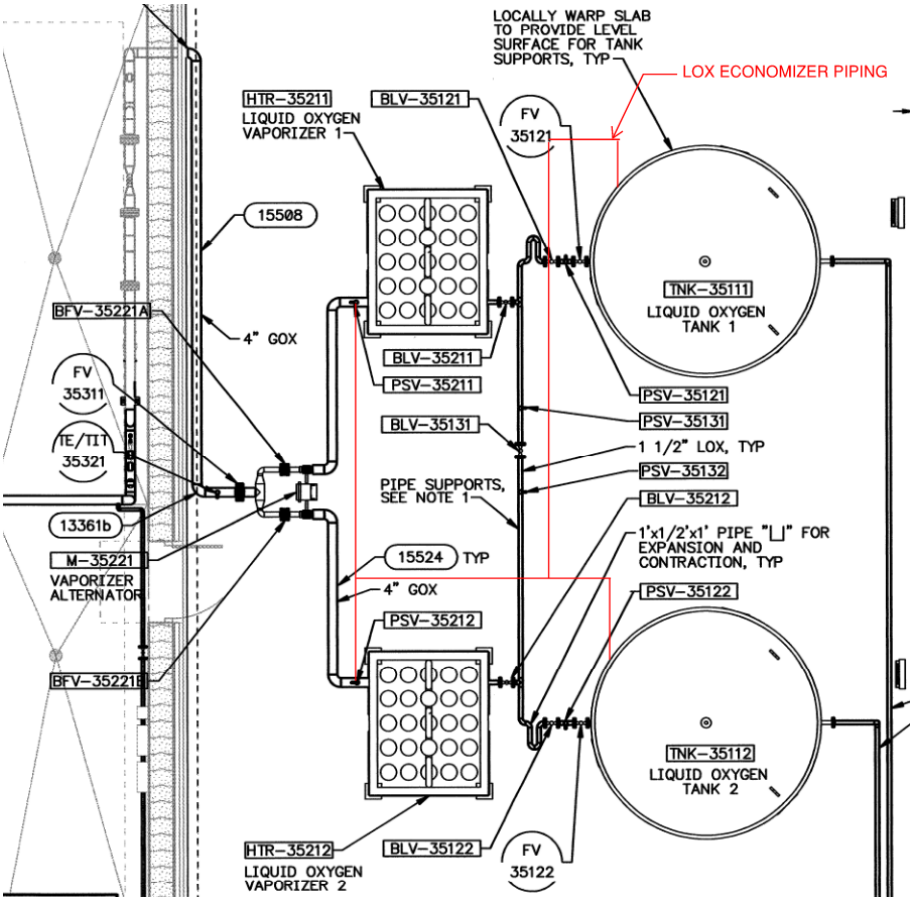


Figure 2.1. Existing Economizer Piping from LOX Tank to GOX Piping

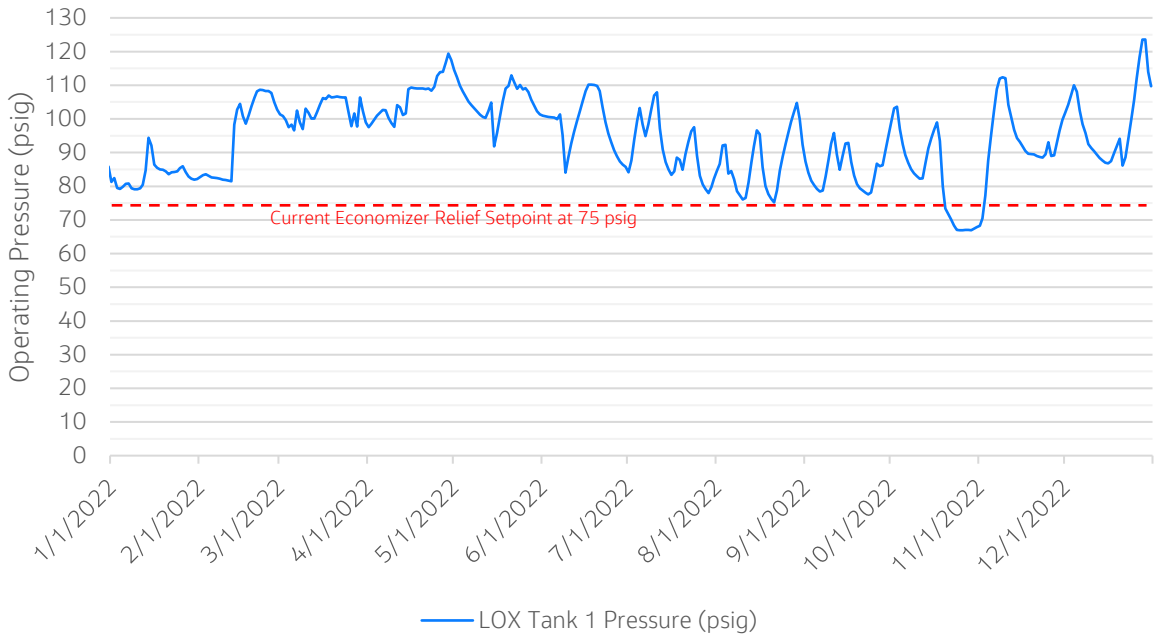


Figure 2.2. Operating Pressure of LOX Tanks in 2022

To resolve this economizer issue, the following is recommended:

1. Replace the economizer to adjust the pressure settings based on the current operating pressures of the LOX tanks.
2. Revise the economizer piping so that it connects upstream of the vaporizer. This ensures the any relieved gas from the economizer is warmed to within 20 degrees Fahrenheit of ambient. Note that if the gas is not warmed to above 35 degrees Fahrenheit, the ozone system may shutdown to prevent low temperatures from reaching the generator. Low gas temperature readings may also cause the vaporizer to prematurely switchover. A markup of the proposed piping is shown on Figure 2.3.

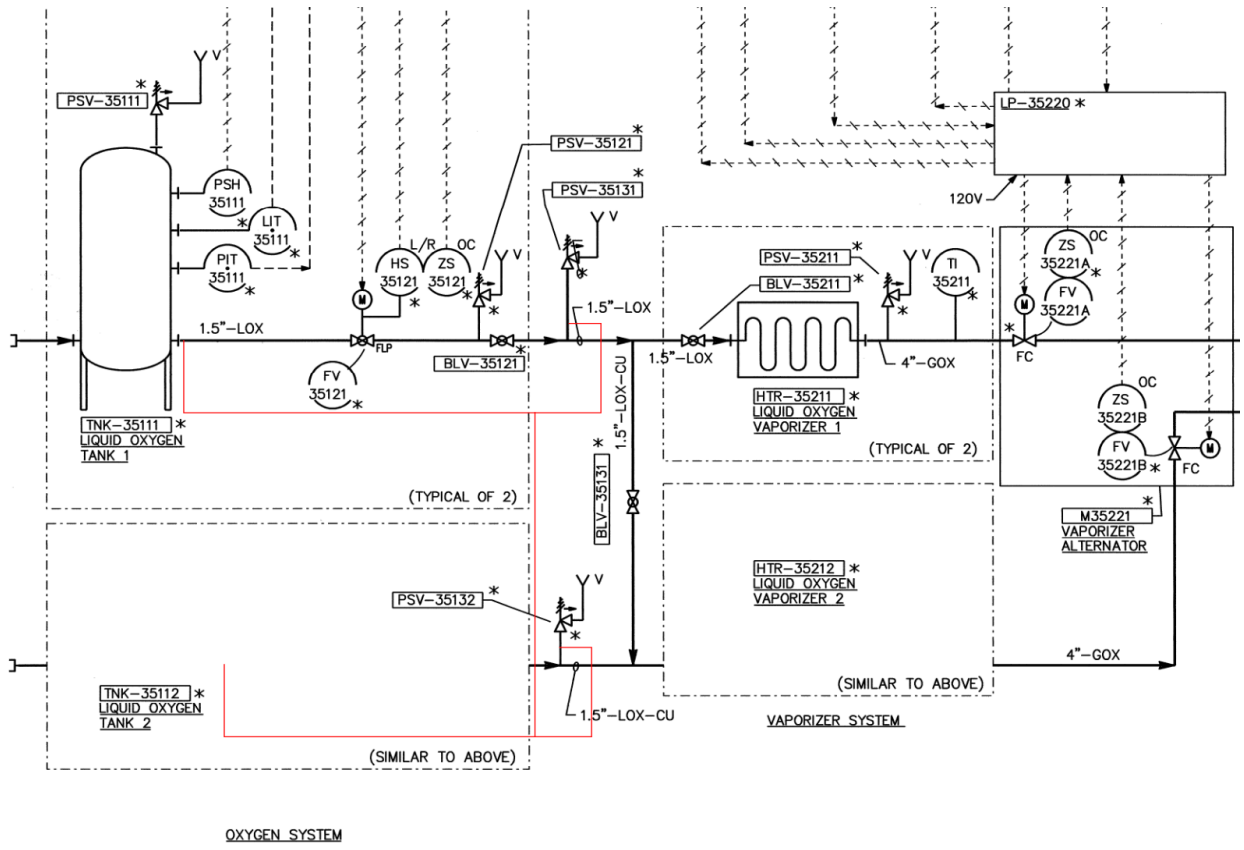


Figure 2.3. Proposed Economizer Relief Piping

2.1.2 Nitrogen Boost Alternatives

The current system uses an oil-free scroll compressor and receiver to deliver dry nitrogen gas at 2 to 5 percent of GOX flow. See Section 3.4.1 for a summary of the nitrogen boost design criteria. An alternative to the existing nitrogen boost system is a liquid nitrogen storage system with ambient vaporizers. A liquid nitrogen source significantly reduces the required mechanical maintenance and dew point concerns but has other drawbacks. Liquid nitrogen systems are more expensive, incurring higher capital and O&M costs compared to an air compressor skid system. The liquid nitrogen tank will need to be delivered and restocked by a cryogenic chemical supplier.

Jacobs recommends sizing the liquid nitrogen storage tank to supply 30 days of storage for average use. Preliminary evaluations indicate a 1,200-gallon storage tank would be appropriate for GRFF's current needs through the next 25 years. A liquid nitrogen system would require ambient vaporizers, a particulate filter, a dewpoint analyzer, and a gas flow controller. See Figure 2.4 for an example P&ID and Figure 2.5 for a possible site installation location.

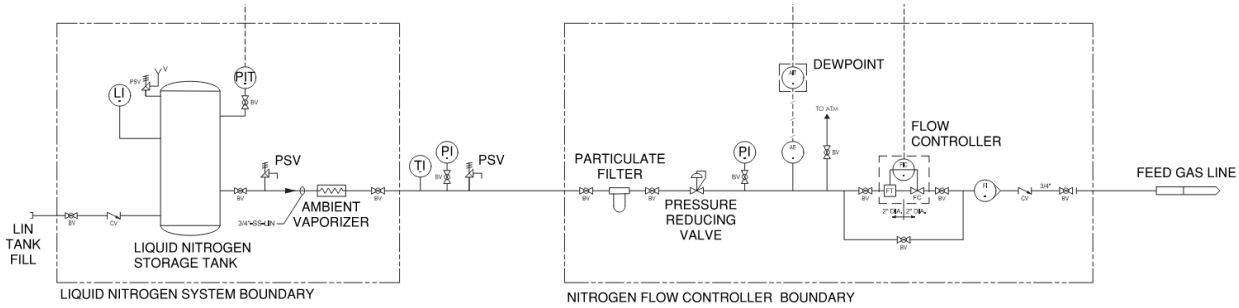


Figure 2.4. Liquid Nitrogen Example P&ID

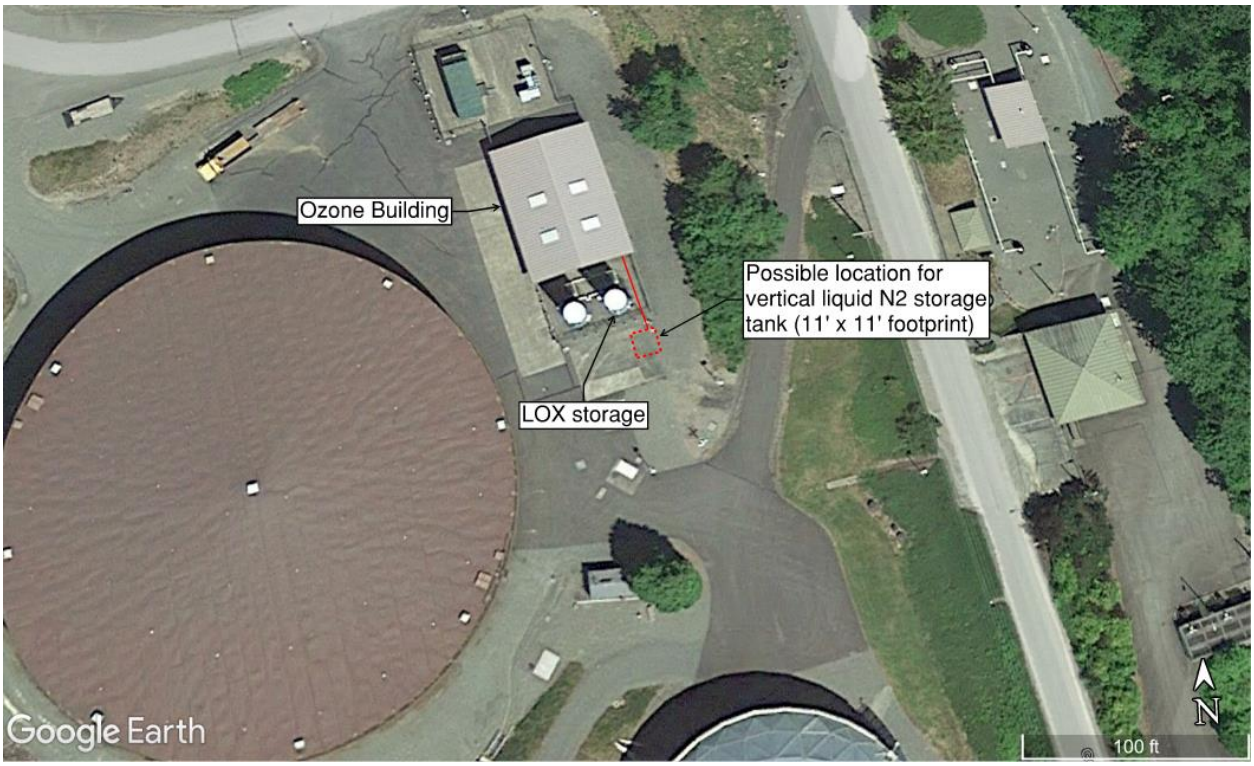


Figure 2.5. Plan view Ozone Building with possible Liquid Nitrogen storage tank footprint

A high-level Life Cycle Cost (LCC) was prepared to compare the two nitrogen boost systems. An inflation rate of 3.5% and a discount rate (nominal) of 3.0% were assumed in the 25-year LCC analysis. The LCC analysis also assumed an electricity rate of $0.06/kWh. The liquid nitrogen alternative includes a new cryogenic storage tank and vaporizer, which will incur higher initial capital costs but replaces the mechanical equipment and associated maintenance tasks. The nitrogen boost compressor alternative assumes replacement of the existing oil-free compressors in the near term.

The operating costs varied for the two alternatives, with the liquid nitrogen system being the more expensive option. The liquid nitrogen system operating costs are driven by the price of nitrogen. A chemical supplier provided Jacobs with an estimate of $0.06/lb liquid nitrogen in the spring of 2023 and this was used in the LCC analysis. The nitrogen boost percent recommended by Veolia makes it more cost

effective to install a dedicated storage tank on site and receive partial deliveries of bulk liquid nitrogen monthly. Micobulk dewars deliveries are another approach that has a lower capital cost but a higher delivery and chemical cost, even in a scenario where three are delivered concurrently.

The scroll compressor O&M cost is driven primarily by daily energy consumption and regular maintenance to the compressors and dryer towers. Information from Work Order Logs provided by Tacoma Water document that the scroll compressors or desiccant towers have been serviced every year for the past 6 years. It was assumed for the sake of the LCC that the replacement compressors would need similar maintenance service and full replacement every 15 years.

Table 2.2. Nitrogen Boost Alternative Life Cycle Cost

25 year Life Cycle Cost (LCC) Analysis	Compressor Skid	Liquid N_2
Operations (Electrical and Chemical)	$12,000	$176,000
Maintenance	$25,000	$2,000
Capital Cost[1]	$34,000	$146,000
25 year Net Present Value[2] w/ Inflation[3]	$911,000	$4,575,000

1. Initial capital investment and necessary replacement at end of lifetime (assumed 15 years for the compressor)
2. Assumed a nominal discount rate of 3.0% to calculate Net Present Value
3. Assumed an inflation rate of 3.5%

In summary, the compressor skid option has a lower LCC resulting from the lower equipment and operating cost. However, the costs must be balanced with the improved operations for the liquid nitrogen system. Nitrogen supply is continuous, and storage can be easily monitored in the liquid nitrogen system without fear of mechanical failure or dewpoint issues that are common with compressor skids. Due to the large cost difference, Jacobs recommends replacing the existing oil-free scroll compressors and continuing to use a compressed air nitrogen boost system.

2.1.3 Sidestream Injection System

Tacoma Water has two existing ozone contact pipelines (Reactor 1 and Reactor 5) that serve as plug flow reactors with dedicated sidestream injection systems. A schematic of the sidestream injection system that serves Reactor 5 is shown in Figure 2.6. Ozone gas is injected into the water by use of end-suction centrifugal pumps and venturi injectors. The sidestream injection pumps are fed with water from the reactor they serve. From the venturis, the ozonated water travels through approximately 100 feet of stainless steel pipe prior to reaching the injection nozzles to achieve optimal mixing and mass transfer of ozone in the pipeline. There are two pipeline injection nozzles per injector. The configuration of these injection nozzles on the pipeline is shown in Figure 2.7. There are a total of four 6-inch injection nozzles and two 4-inch injection nozzles for each reactor. Two different injector sizes, 4-inch and 6-inch, allow for operation across the full range of flows and doses while maintaining the minimum gas flow required for good transfer efficiency. If the total gas flow demand is less than 12 standard cubic feet per minute (scfm), the 4-inch injector are automatically put into service. If gas flows increase above 12 scfm, the 6-inch injector will be the lead injector and the 4-inch injector will be offline. A summary of the operating schemes for the injectors is presented in Table 2.3.

Table 2.3. Injection System Operating Scenarios

Scenario	Ozone Gas Flow Range (scfm)	Approximate Ozone Demand (ppd)	Injector(s) in Service
1	Less than 12 scfm	Less than 140 ppd at 10 percent ozone	4-inch injector
2	12 to 50[1] scfm	140 to 417 ppd at 10 percent ozone	One 6-inch injector
3	50[1] scfm to 100 scfm	417 to 1200 ppd at 10 percent ozone	Two 6-inch injectors

[1]This setpoint is operator adjustable

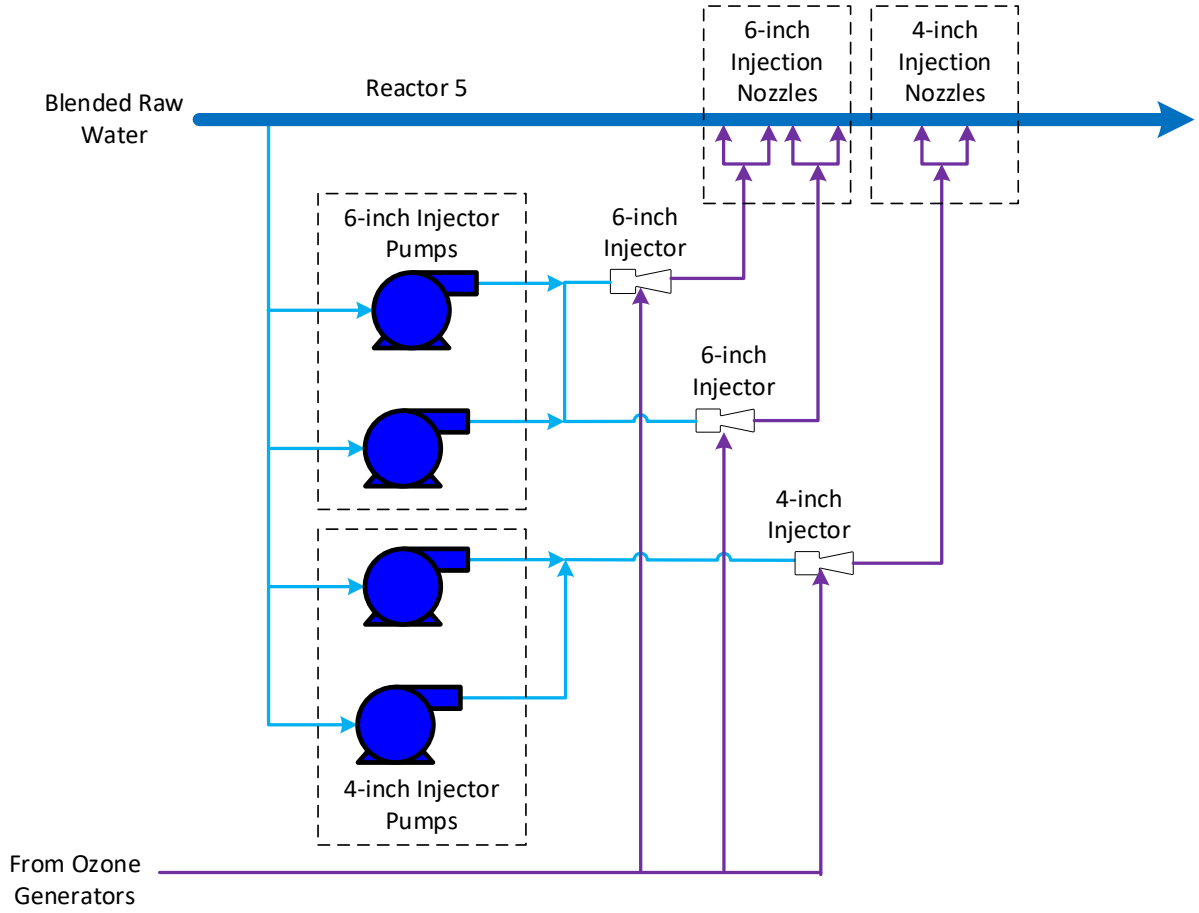


Figure 2.6. Reactor 5 Sidestream Injection System

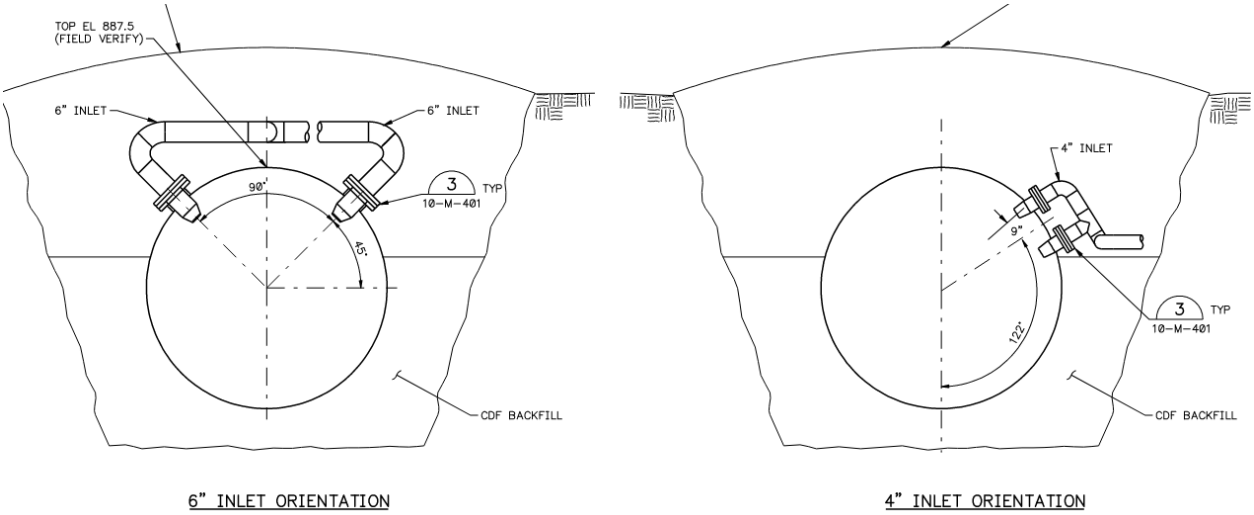


Figure 2.7. 4-Inch and 6-Inch Injection Nozzles Orientation

Tacoma Water indicated that typically only the 6-inch injectors are used. The upper 4-inch injector nozzle for each reactor was plugged in 2010 and only the bottom nozzle remains operational (Figure 2.8). Based on analysis of the historical data, there were instances in November 2018, 2019, and 2022 in which the 4-inch injector was operating in combination with one or two of the 6-inch injectors. During these periods of operation, the gas flow measured to the 4-inch injectors ranged between 8 and 12 scfm. These results indicate that the 4-inch injectors, even with increased backpressure from plugging the upper nozzles, can deliver up to 12 scfm of ozone. These dates in which the 4-inch injectors were in operation are shown in Figure 2.9.

Figure 2.8. 4-Inch Injector Nozzles

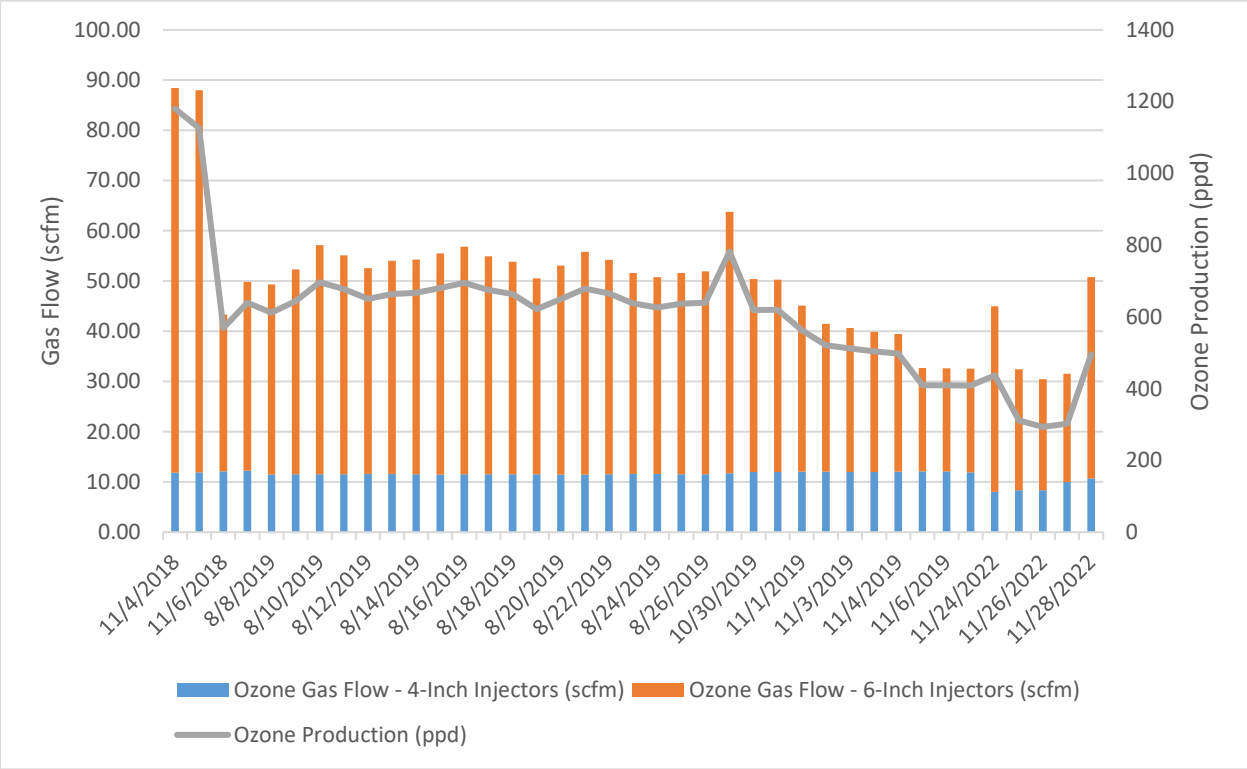


Figure 2.9. Operation of 4-Inch Injector and 6-Inch Injectors and Ozone Production

Figure 2.10 shows the range of ozone gas flows from 2018 to 2022 to be 12 to 90 standard cubic feet per minute (scfm) for the 6-inch injectors. These gas flow rates are within the design flow ranges of the injection system. The plant currently operates both 6-inch injectors when gas flow rates are above 35 scfm. The original design indicated that a single 6-inch injector would be capable of delivering 100 scfm (sufficient capacity for a Reactor 1 flow of 72 mgd and an ozone dose of 2.0 mg/L).

The 4-inch injectors allow for gas flow rates below 12 scfm. Since Tacoma Water primarily use the 6-inch injectors, the ozone gas flow rate is maintained at or above 12 scfm. This means that during low ozone demand periods, typically during the winter and spring, the ozone concentration is lowered, at times even below 5 percent, to meet the minimum gas flow requirement (Figure 2.11). Based on the 2018 to 2022 data, approximately 95 percent of the ozone production was above 171 ppd, which is the calculated ozone production with a gas flow of 12 scfm at 12 percent concentration. Therefore, 95 percent of the time the 6-inch injectors will allow the system to operate at 12 percent ozone. Due to this low frequency of operation below 171 ppd, adding a standby sidestream pump and injector to replace the 4" injectors and pumps should be considered. See Section 3.5 for details.

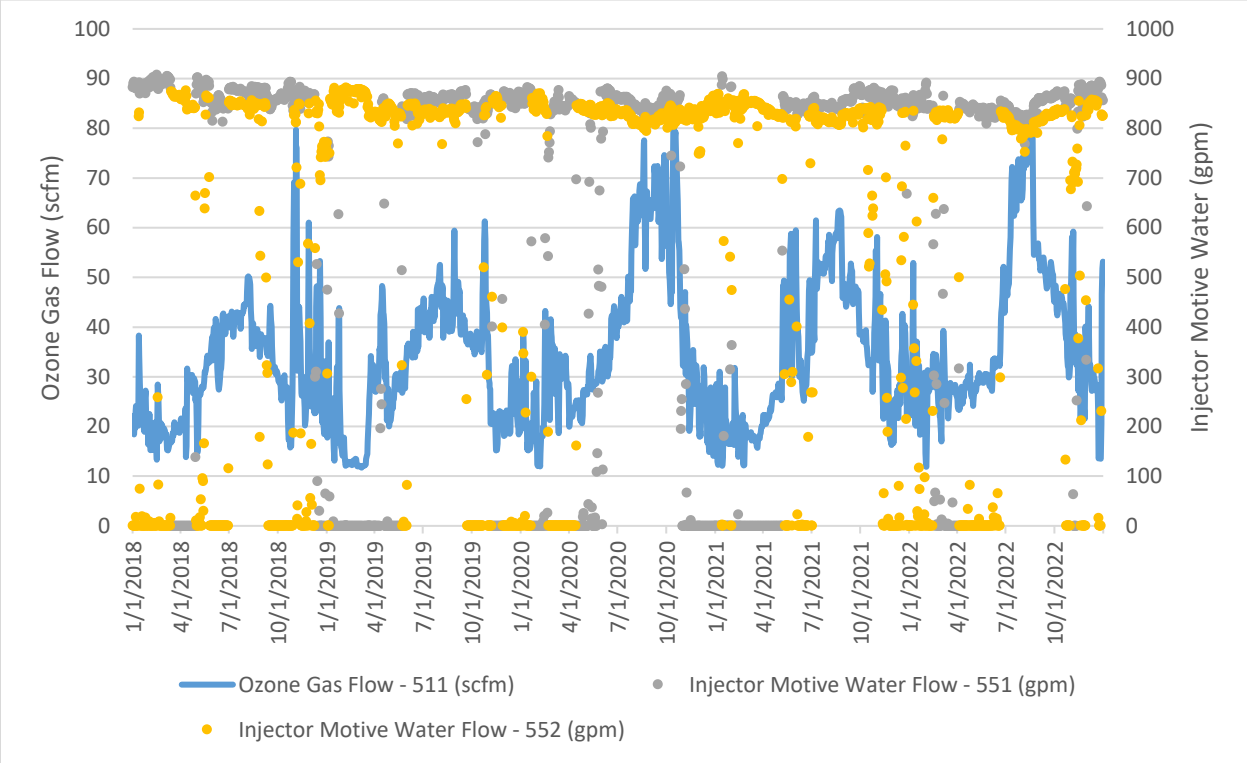


Figure 2.10. Ozone Gas Flow and Injector Motive Water Flow 2018 to 2022

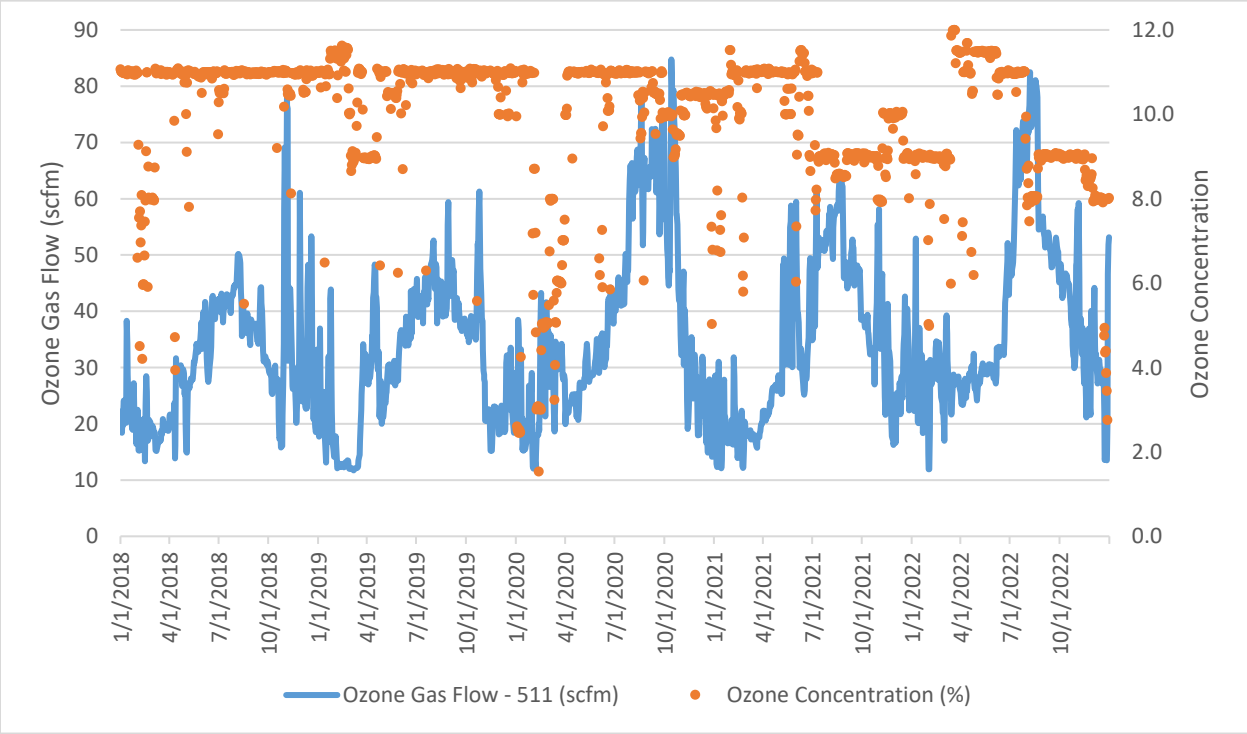


Figure 2.11. Ozone Gas Flow and Ozone Concentration 2018 to 2022

2.1.4 Cooling Water System

The existing generators use a closed loop cooling water system to remove heat formed during ozone generation. The closed loop system rejects heat through a heat exchanger connected to an open loop cooling water system supplied by GRFF raw water. A basket strainer is installed to minimize the risk of fouling the heat exchanger. Tacoma Water noted that the cooling water system requires frequently cleaning of the basket strainers. Raw water turbidity was limited to 5 NTU when this system was designed, but now raw water turbidity can be as high as 10 NTU (95th percentile turbidity). Alternatives to relieve this issue include be installing an automatic cleaning basket strainer designed for the higher raw water turbidity or utilizing different source water, such as well water or filtered water from the 10 million gallon storage tank on site. Well water cannot be relied upon for continuous operation due to water rights limitations and the ozone process is located very far away from the finished water. Therefore, an automatic strainer is recommended to replace the existing basket strainer. The automatic strainer has two motor drives and a motorized drain valve that will need to be wired to power and a local control panel. Figure 2.12 shows an example layout for the automatic strainers in the Ozone Injection building. Each automatic strainer will need a dedicated drain line. This drain line could connect to the existing 3" drain line. If this option is selected the hydraulic capacity of the existing 3" drain line should be evaluated to determine if a larger pipe or a second drain is needed.

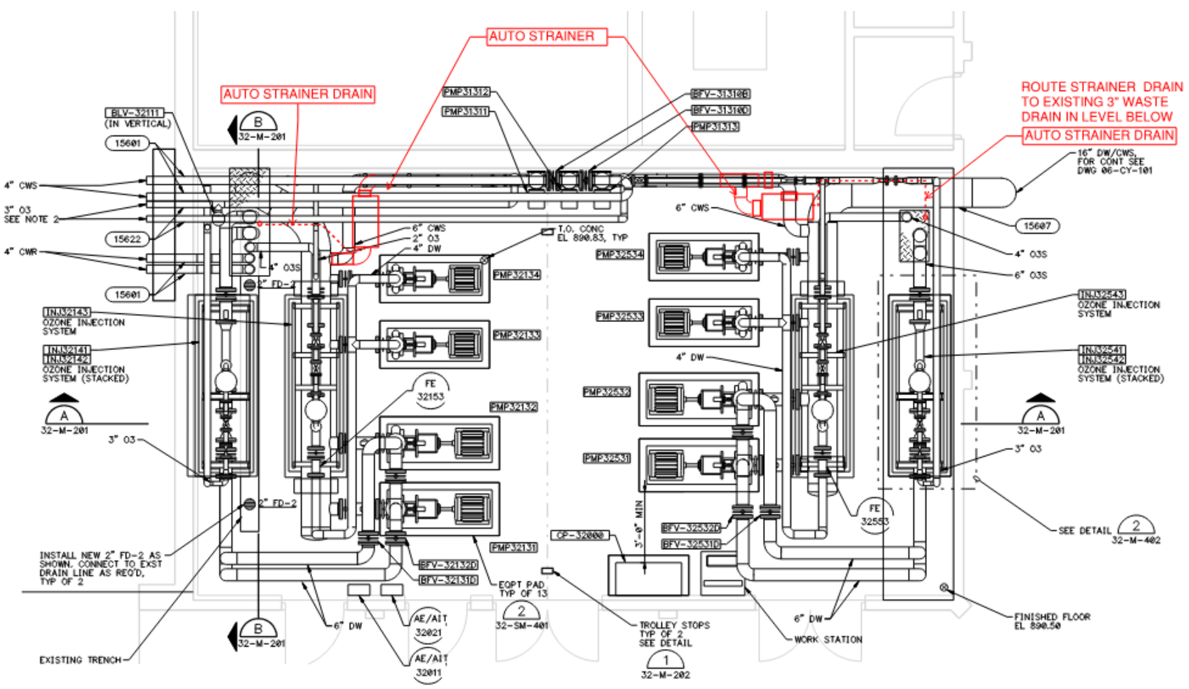


Figure 2.12. Automatic Strainer on 6" Cooling Water Supply

A service visit from the ozone generator supplier also identified that the water within the closed loop system on one of the generators had turned a rusty color. This is a sign or of corrosion in the closed loop cooling system and could lead to high temperatures and damage to the PSU. The closed loop cooling water system should be drained, cleaned, and refilled. The closed loop system should be sampled periodically to monitor pH, conductivity, and color/appearance of the water to confirm if corrosion is still an issue. A corrosion inhibitor should be added if the closed loop systems continue to corrode.

2.2 Ozone System Treatment and Capacity Evaluation

The following evaluations assesses the capacity of the ozone generators based on their ability to meet the following treatment goals:

- Taste and Odor Control
- Disinfection
- Support for Biologically Active Filtration

2.2.1 Raw Water Quality

This section summarizes the impact of raw water quality, including source water, pH, temperature, turbidity, total organic carbon (TOC) and flavor rating assessment (FRA) on current ozone operations.

2.2.1.1 Source Water

The primary source of the GRFF is the Green River. Groundwater from the North Fork Wellfield is used to supplement the Green River and is typically limited to use during the late fall and winter months. Figure 2.13 shows the flow data from the last five years of operation from 2018 to 2022. North Fork Wellfield is primarily used to supplement plant flows during the colder water months between November and March. Average monthly flows during the summer months have increased from 2018 to 2022. Table 2.4 shows the average winter and summer raw water flows between 2018 and 2022. During this period, winter flows ranged from 57 to 67 mgd and summer flows ranged from 73 to 107 mgd.

The ozone design was based on Reactor 1 operating between 24 and 72 mgd and Reactor 5 operating between 10 and 95 mgd. Reactor 5 is the only pipeline currently in service. Summer flows did go above 95 mgd during this period. Operating above the design flow decreases the contact time of the reactor and can impact ozone dose and its ability to remove taste and odor compounds and provide sufficient disinfection. However, the data showed that during these high summer flows, the contact time remained above 8 minutes and there was sufficient treatment for taste and odor.

During this period, ozone production did not exceed 1,400 pounds per day (ppd), which is the rated capacity of one generator at 10 percent ozone. Additional analysis related to ozone production will be discussed in later sections to determine whether the original ozone design continues to be sufficient to achieve treatment goals given the current flows and water quality.

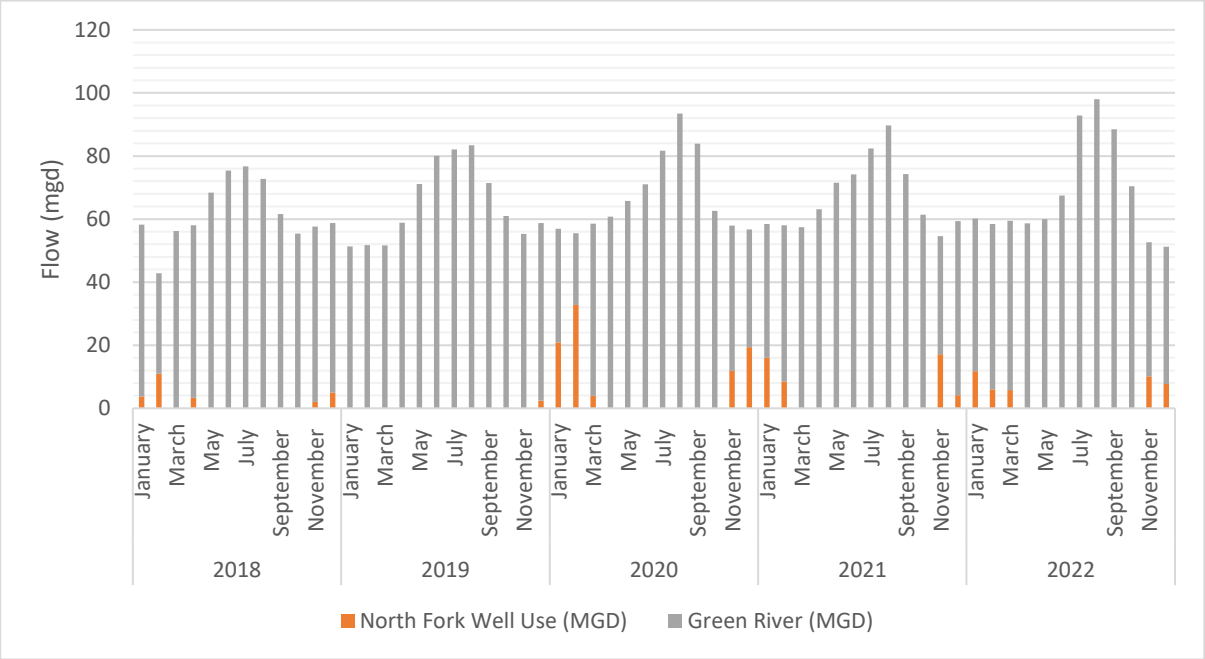


Figure 2.13. Monthly Average Green River Flows and North Fork Well Usage 2018 to 2022

Table 2.4. Winter and Summer Raw Water Flows

	Winter Flows (mgd)	Summer Flows (mgd)
Average	56.5	72.8
Minimum	34.5	27.5
Maximum	67.3	106.8

2.2.1.2 pH and Temperature

The effectiveness of ozone increases slightly with higher pH and temperature due to quicker decomposition into hydroxyl radicals and faster kinetics. Figure 2.14 shows the monthly average pH and temperature between 2018 and 2022. Monthly temperatures are relatively constant during this period. pH varies between 6.9 to 7.9 but does not have a seasonal pattern.

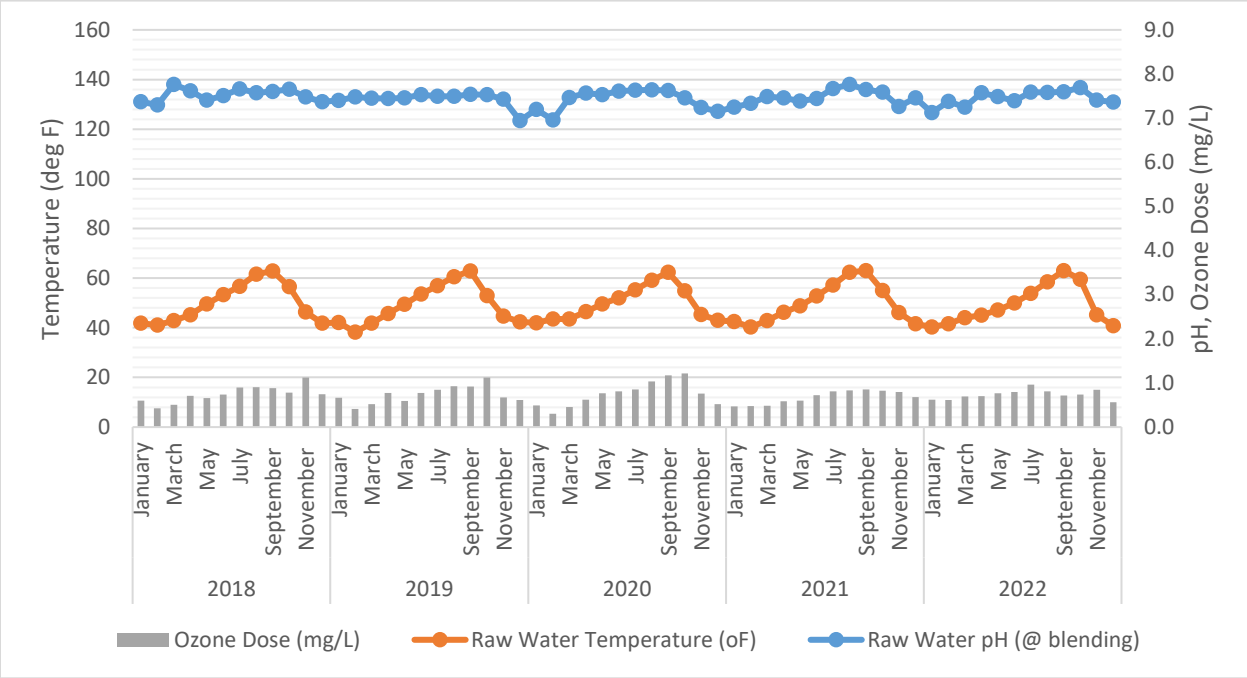


Figure 2.14. Monthly Average pH, Temperature and Ozone Dose 2018 to 2022

2.2.1.3 Turbidity

Figure 2.15 shows raw water flows and turbidity between 2018 and 2022. In general, higher turbidities are seen during the fall and winter months from September to February due to flood control releases from Howard Hanson Dam during this timeframe.

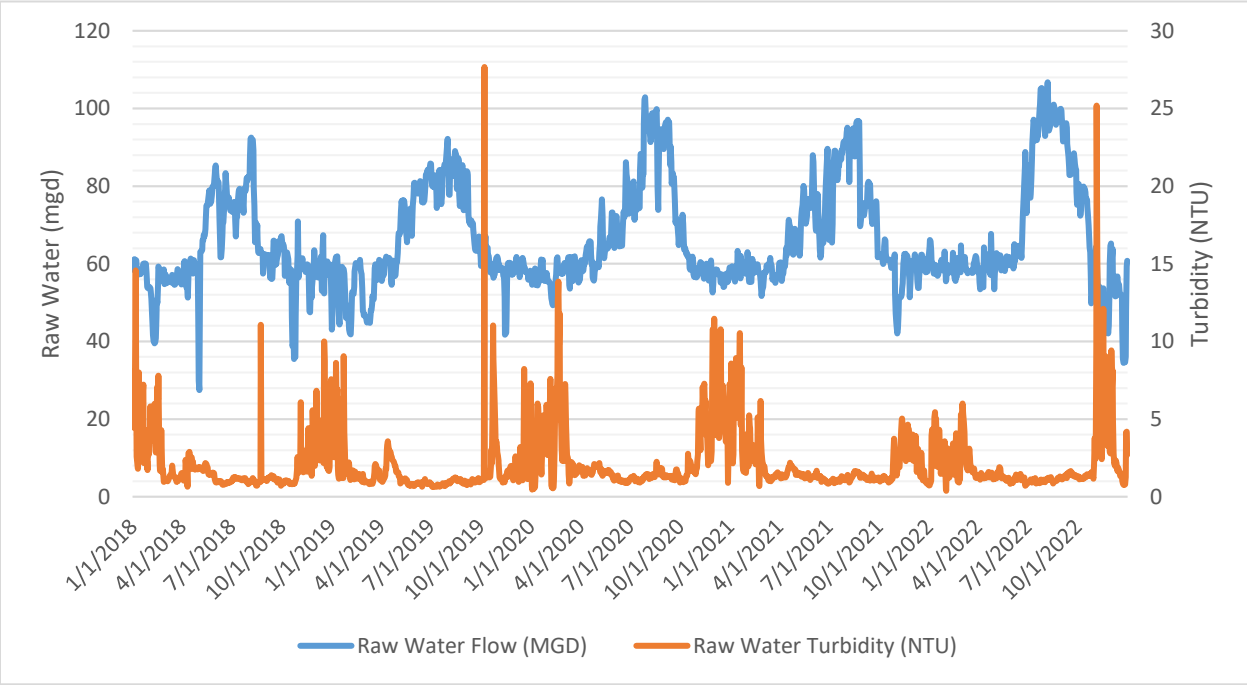


Figure 2.15. Daily Average Raw Water Flow and Turbidity 2018 to 2022

2.2.1.4 Total Organic Carbon

Figure 2.16 shows the monthly grab samples of Green River and North Fork wellfield TOC and the ratio of ozone to TOC. In general, the Green River source has higher TOC than the wellfield. On average, Green River TOC is around 1.0 mg/L and North Fork wells TOC is around 0.6 mg/L. TOC does not appear to have a seasonal trend. While the design of the ozone system is not based on removal of organics, raw water TOC impacts the ozone demand which therefore influences the ozone dose required for taste and odor control and disinfection. Water Research Foundation (WRF) *Biofiltration Guidance Manual for Drinking Water Facilities* (2020) states that ozone to dissolved organic carbon (DOC) ratios of 0.5:1 to 1:1 have shown improved biofiltration operation. DOC is not measured at the GRFF and therefore, this analysis conservatively assumes that DOC is equivalent to TOC. The data in Figure 2.16 show that during spikes in raw water TOC the ozone to DOC ratio falls below the recommended 0.5:1. These data points are included in Table 2.5, along with recommended minimum ozone dose and production to maintain at least a 0.5:1 ozone to DOC ratio. The minimum recommended ozone production to achieve at least a 0.5:1 ratio does not exceed the capacity of the ozone generator.

Table 2.5. O_3:DOC Below 0.5:1 Ratio

Date	Raw Water Flow (MGD)	Green River TOC (mgd)	North Fork Well TOC (mg/L)	Ozone Dose (mg/L)	Ozone Production (ppd)	O_3:DOC	Recommended Ozone Dose (mg/L)	Recommend Minimum Ozone Production (ppd)
3/6/2018	56.2	0.92	NA[1]	0.44	208	0.50	0.46	216
6/12/2018	61.6	1.80	NA	0.68	350	0.38	0.90	463
8/14/2018	69.4	2.80	NA	0.93	536	0.33	1.40	810
12/11/2018	59.3	1.30	0.81	0.60	293	0.46	0.65	321
6/11/2019	78.7	1.60	NA	0.71	473	0.44	0.80	525
2/18/2020	61.3	1.20	NA	0.36	182	0.25	0.60	307
12/15/2020	55.2	3.90	<0.5	0.63	293	0.16	1.95	897
4/6/2021	55.5	2.70	NA	0.57	265	0.21	1.35	625
7/5/2022	77.4	3.10	NA	0.91	585	0.29	1.55	1000

[1]NA = Nork Fork Wellfield not in service

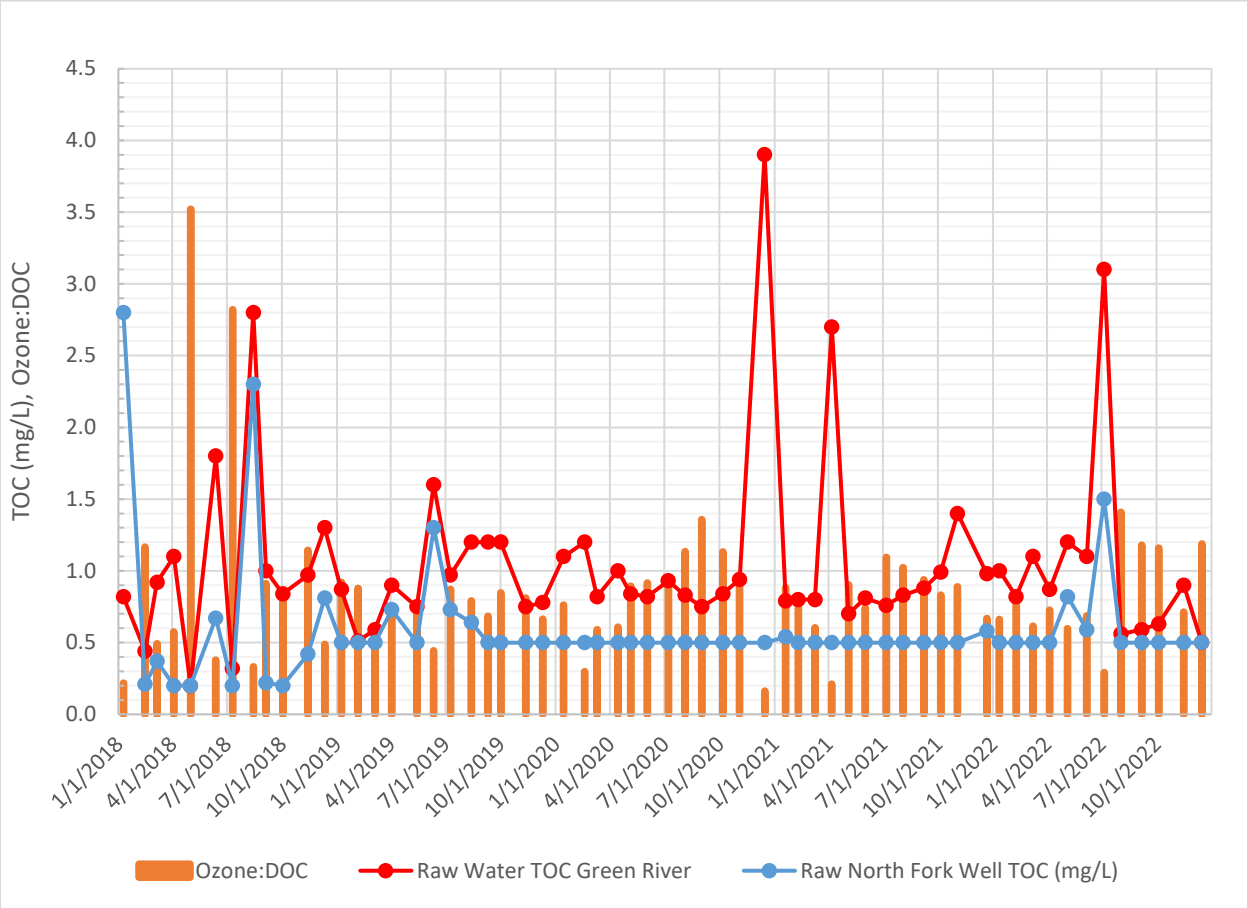


Figure 2.16. Average Green River and North Fork Well TOC 2018 to 2022

2.2.1.5 Taste and Odor

The ozone system was designed for taste and odor control. Flavor rating assessments are completed on Green River raw and treated water a few times a month. Flavor rating assessments are rated on a scale of 1 to 9 with 9 indicating very poor tasting water. Treated FRA below 2.0 indicates good taste and odor control at the plant. In general, treated water FRA is 1.0 suggesting good taste and odor control. However, Figure 2.17 shows that there are several samples in which the treated FRA was 2.0 and above. These generally occurred around times when the raw Green River FRA were high, typically occurring in the summer and fall. Figure 2.17 shows periods of higher raw water FRA coincided with increase of ozone dose. Peaks in the raw water FRA generally occur before peaks in the ozone dose because of the time delay between the river sample location and the ozone residual sample location in the reactor pipeline.

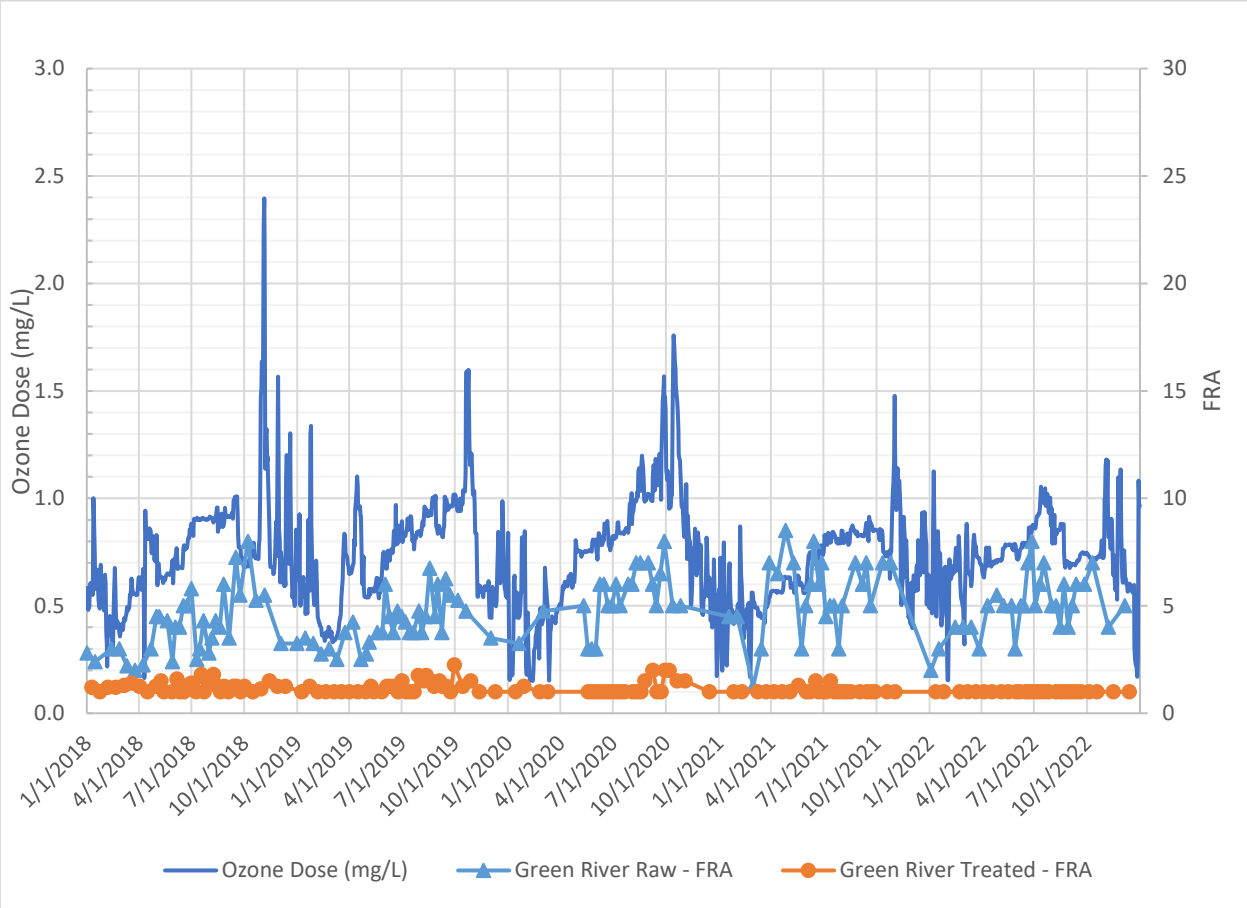


Figure 2.17. Ozone Dose and Green River Raw and Treated FRA 2018 to 2022

2.2.2 Ozone System Operations

This section summarizes the current ozone operations to treat taste and odor compounds, provide support for biological filtration, monitor disinfection, and quenching. The existing design of the ozone system is evaluated based on current operations and operational improvements to meet current treatment goals.

2.2.2.1 Control System Ozone Dose Modes

The ozone system can be operated in two modes: CT Mode or Dose Mode. The operator can manually select which method is to be used to control each reactor pipeline in the plant supervisory control and data acquisition (SCADA) system. The CT Mode operates the ozone system by providing the ozone dose to meet the log inactivation for *Giardia* and virus, which are setpoints entered by the operator. The Dose Mode operates the ozone system by providing a dose setpoint, which is entered by the operator. Under this method, the ozone production is flow-paced to maintain a constant dose. This is the most common operating mode.

2.2.2.2 Taste and Odor

A target of 1.0 mg/mg O_3:DOC is ideal for oxidizing the most common taste and odor compounds, such as *Geosmin* and MIB. Figure 2.18 shows the average raw and treated FRA and O_3:DOC. It is assumed that most of the raw water TOC is DOC, so the required ozone dose calculated from the O_3:DOC ratio is

conservative. Treated FRA are typically 1.0. There are several instances when average treated FRA values were above 1.5 in 2019 and 2020, highlighted below in the graph. These instances generally occurred during the fall and coincides with higher raw water organics and an O_3:DOC ratio less than 1.0. In general, adjusting the ozone dose higher during the fall when higher raw water FRA and TOC concentrations are expected can help maintain the treated FRA at 1.0 throughout the year.

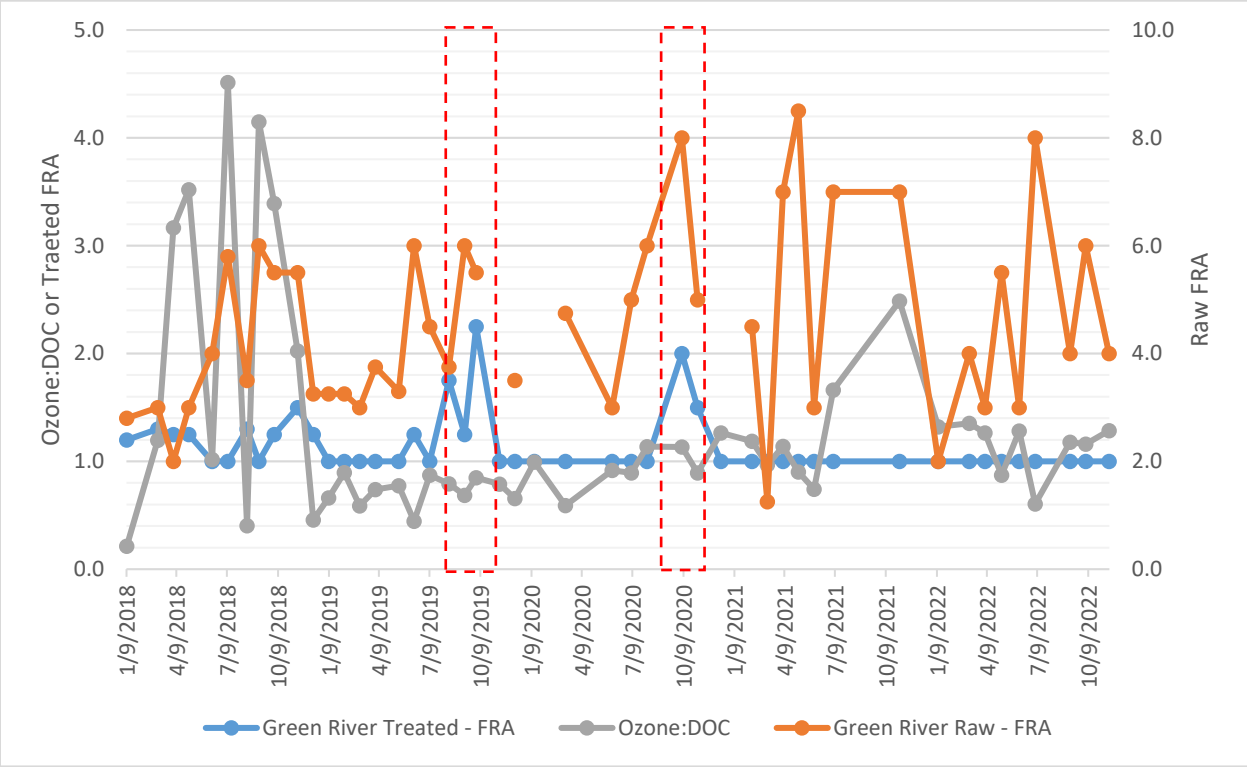
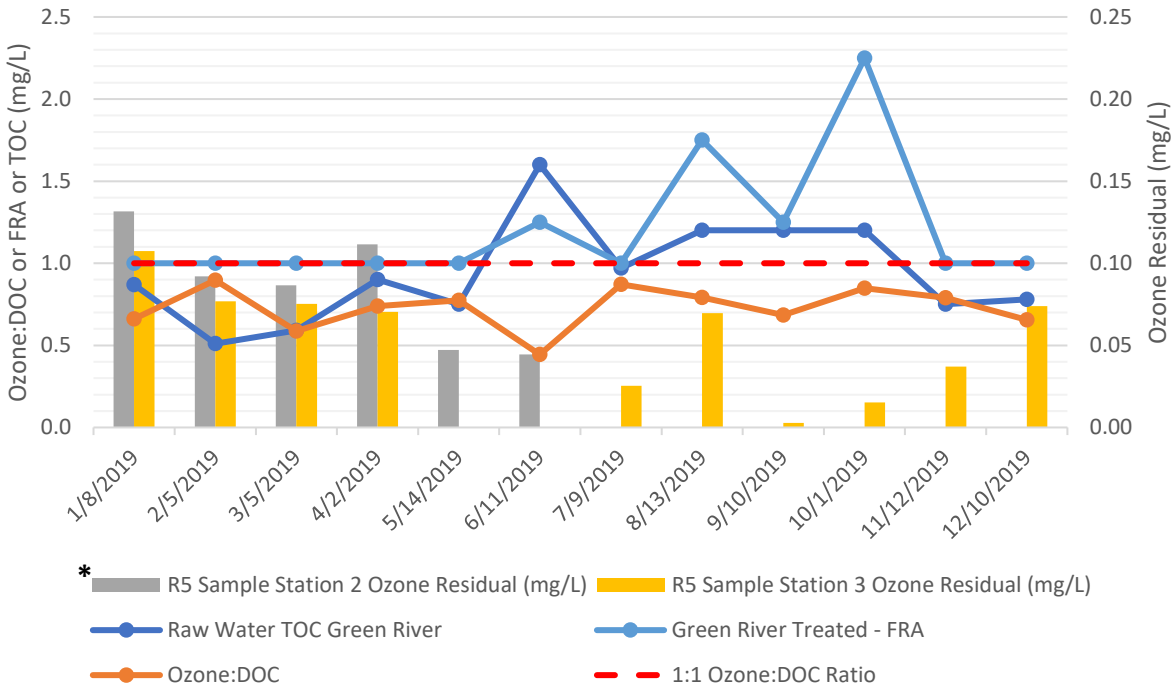


Figure 2.18. Average Raw and Treated FRA and O_3:DOC 2018 to 2022

While the O_3:DOC ratio is important for taste and odor control, it is also important to correlate this ratio to real-time operational monitoring, such as ozone residual, to be able to adjust the ozone dose in real-time and not be dependent on TOC or FRA sampling that only occurs monthly. A closer look at the year 2019 is shown in Figure 2.19. In this year, the FRA was 1.75 and 2.25 in August and October, respectively. During these higher-than-normal treated FRA samples, the O_3:DOC was lower than the ideal 1.0 for taste and odor compounds removal and raw water TOC was higher than previous months. During this period, ozone residual in Sample Stations 2 and 3 was either non-detectable or below 0.05 mg/L, which can be considered no presence of ozone. It is recommended that Tacoma Water maintain at least a 0.1 mg/L residual in Sample Station 3 and maintain an O_3:DOC ratio greater than 1.0, particularly in the summer and fall when raw water FRA and TOC are higher. A 0.1 mg/L ozone residual is recommended instead of 0.05 because it is a more reliable measurement that can be detected by the ozone analyzers.

In other instances where TOC concentrations were above 2.5 mg/L (on April 4, 2021 and July 5, 2022), shown in Figure 2.20 and Figure 2.21, treated FRA was 1.0. This is because either the O_3:DOC was above 1.0 or ozone residual in Sample Station 3 was detectable above 0.05 mg/L. The data show that maintaining a detectable residual at Sample Station 3 and a O_3:DOC ratio is more critical when TOC is above 1.0 mg/L. When TOC is lower than 1.0 mg/L, treated FRA is 1.0 without meeting these two criteria. Therefore, maintaining an ozone residual above 0.1 mg/L in Sample Station 3 will likely result in a treated FRA below 2.0 throughout the year. Adding an online ultraviolet transmittance (UVT) analyzer on the raw

water, which can be used as a surrogate for TOC, is recommended to monitor changes in the raw water organics to confirm ozone dosing for maintaining the O_3:DOC ratio. A short path length UVT analyzer (1 cm) is recommended for raw water analysis, see Section **Error! Reference source not found.** for details.



*Sample Station 2 was offline and serviced for maintenance July through December 2019.

Figure 2.19. 2019 Average O_3:DOC, Treated FRA and Ozone Residual.

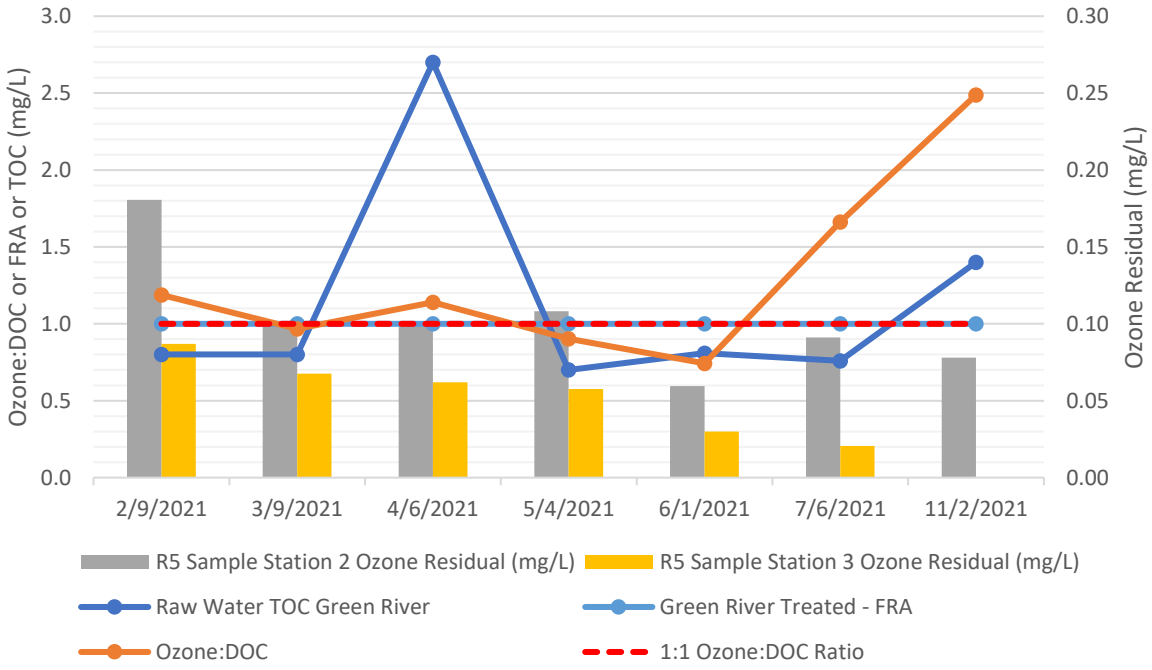


Figure 2.20. 2021 Average O_3:DOC, Treated FRA and Ozone Residual

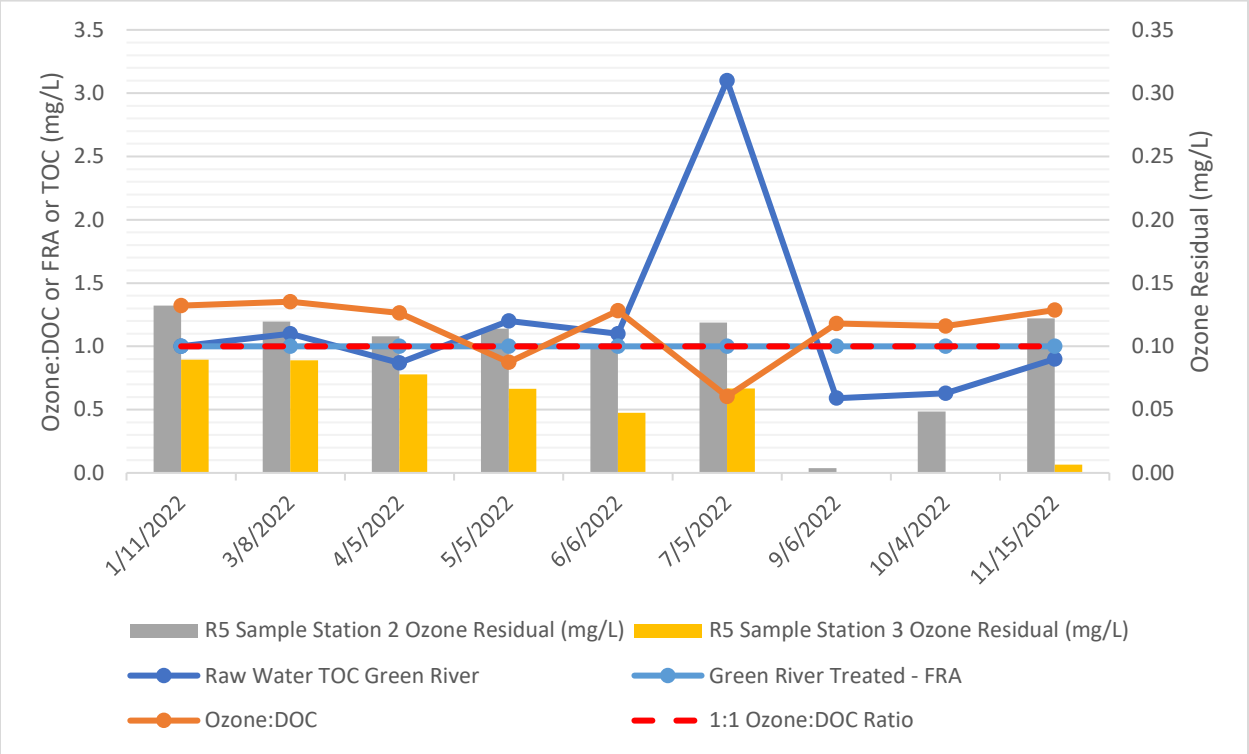


Figure 2.21. 2022 Average O_3:DOC, Treated FRA and Ozone Residual

Table 2.6 shows the data points when the O_3:DOC ratio was less than 1.0 and Treated FRA is at or above 1.0. The recommended ozone production to achieve at least a 1:1 ratio for improved taste and odor control does not exceed the capacity of the ozone generator. However, one of the instances results in a required ozone production of 1,385 ppd, which is about 99 percent of the 1,400 ppd capacity.

Table 2.6. O_3:DOC Below 1:1 Ratio and Treated FRA Above 1.0

Date	Raw Water Flow (MGD)	Blended TOC (mgd)	Ozone Dose (mg/L)	Ozone Production (ppd)	Treated FRA	O3:DOC	Recommended Ozone Dose (mg/L)	Recommend Ozone Production (ppd)
1/9/2018	58.7	0.82	0.60	293	1.20	0.73	0.82	402
3/6/2018	56.22	0.92	0.44	208	1.30	0.48	0.92	431
4/3/2018	56.25	1.10	0.63	298	1.25	0.58	1.10	516
8/14/2018	69.4	2.80	0.93	536	1.30	0.33	2.80	1,621
10/2/2018	65.37	0.84	0.68	371	1.25	0.81	0.84	458
11/13/2018	58.37	0.97	0.85	416	1.50	0.88	0.97	472
12/11/2018	59.3	1.16	0.60	293	1.25	0.51	1.16	575
6/11/2019	78.7	1.60	0.71	473	1.25	0.44	1.60	1,050
8/13/2019	84.0	1.20	0.95	664	1.75	0.79	1.20	841
9/10/2019	70.7	1.20	0.82	486	1.25	0.68	1.20	708
10/1/2019	61.8	1.20	1.02	523	2.25	0.85	1.20	618
11/3/2020	57.6	0.94	0.84	402	1.50	0.89	0.94	452

Research has also shown that pre-ozonation doses less than 0.5 mg/L will kill algae and oxidize extracellular toxins. The average design dose of 0.75 mg/L may not be sufficient to lyse and oxidize all intracellular toxins, however. Some toxins may be removed through downstream processes, such as flocculation/sedimentation and biological filtration.

2.2.2.3 Support for Biological Filtration

Pre-ozonation helps make nutrients assimilable and combined with biological filtration improves DOC removal. A target of 0.5 to 1.0 mg/mg O_3:DOC improves the operation of biological filtration (Brown et. al. 2020). Figure 2.22 shows that the majority of the time between 2018 and 2022, the O_3:DOC remain above 0.5, even when ozone residual at Sample Station 3 was below 0.05 mg/L. Therefore, the ozone dose should be based on taste and odor treatment. Maintaining Sample Station 3 above 0.1 mg/L for taste and odor treatment will assure that the target O_3:DOC to support biological filtration is reached.

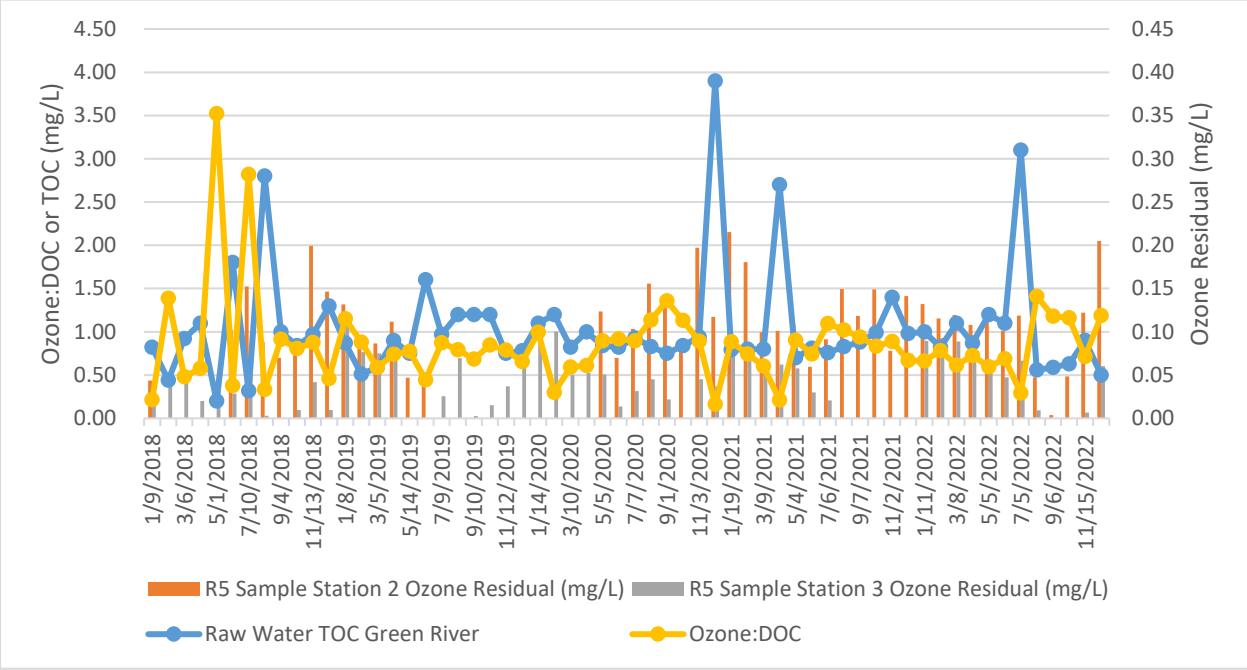


Figure 2.22. O_3:DOC and Ozone Residual at Sample Stations 2 and 3 2018 to 2019

2.2.2.4 Quenching

Quenching ozone is generally not needed at current low ozone doses since the ozone residual at Sample Station 4 is below the minimum quench residual setpoint of 0.1 mg/L. Figure 2.23 shows that between 2018 and 2022, only about 2 percent of the ozone residual data at Sample Station 4 is above 0.1 mg/L. The higher ozone residuals in Sample Station 4 from January to April is due to lower temperatures and slower ozone decay. Using the ozone dose strategy to maintain 0.1 mg/L at Sample Station 3 may help reduce the ozone residual in Sample Station 4 during the cold winter and spring months and potentially remove the need for quenching between January - April.

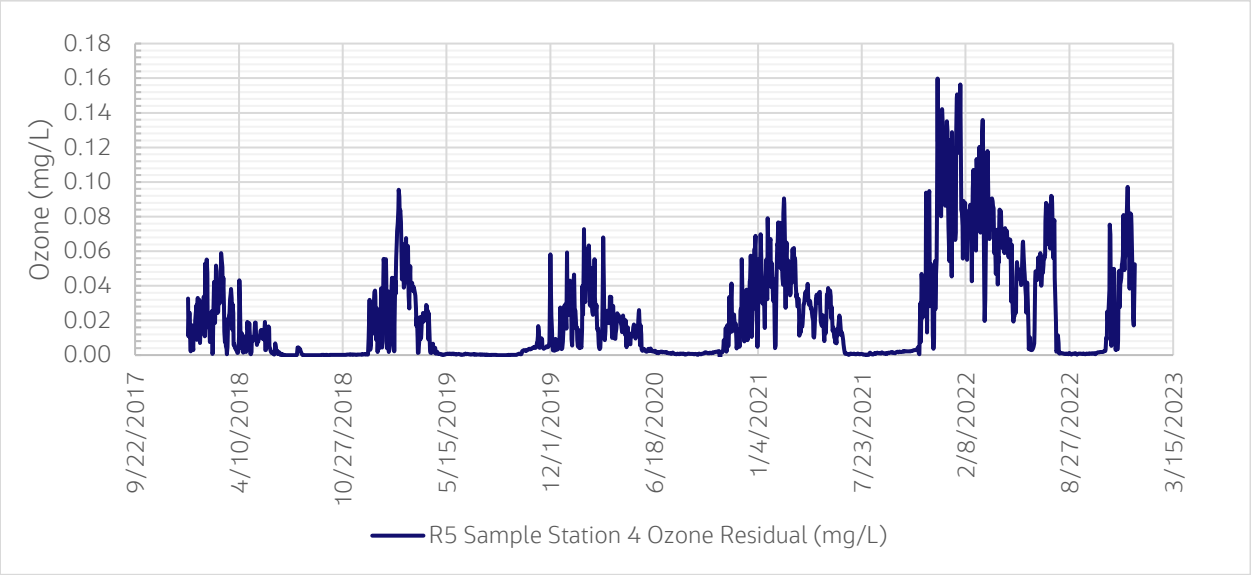


Figure 2.23. Ozone Residual in Sample Station 4 2018 to 2022

2.3 Future Flows and Water Quality Considerations

This section provides a summary of the projected finished water demands and anticipated changes to the source water quality. Historical production data has not met the projected flow increases giving the facility more time before upgrading major equipment capacity is required, details in section 2.3.1. Raw water quality is anticipated to worsen after completion of an approved fish passage project at the upper reservoir. Section 2.3.2 includes a summary of the water quality changes and their treatment implications.

2.3.1 Future Demands

The latest finished water demand projection was completed by Tacoma Water in 2011. See Figure 2.24 for historical and projected plant flow data and projections. The measured plant flowrate has been significantly lower than the projected values for 2015 and 2020. The projected value for 2020 shows an average daily demand of 90 mgd. Actual Green River usage data from 2020 indicates flows closer to 63 mgd. Based on this, future demands are assumed to be below the projections provided in 2011. The dashed line after 2022 in Figure 2.24 is a linear regression of the past 25 years projected into the next 40 years. This linear trend projection was used in all Life Cycle Analysis and future equipment design capacity considerations, with the peak and average flowrates summarized in Table 2.7. There is no indication that demand will suddenly increase, but rather follow the gradual trends observed in the past 25 years. Using the linear regression is a reasonable assumption for the next 5 to 10 years but a more detailed evaluation of the drivers of water use served by the GRFF and projected use is recommended to better predict future flows beyond that time horizon.

Based on the 2050 projected peak daily demand and recommended average operating ozone dose of 1.1 mg/L after considering a O_3:DOC ratio of 1.0 (mg/mg), the required ozone capacity is 1,320 ppd, which approaches but does not exceed the 1,400 ppd capacity with one generator online at 10 percent ozone. When considering a worst-case scenario with peak day and a 95th percentile ozone dose of 2.7 mg/L, the required ozone production is 3,000 ppd, which exceeds the 2,800 ppd capacity with both generators online at 10 percent ozone.

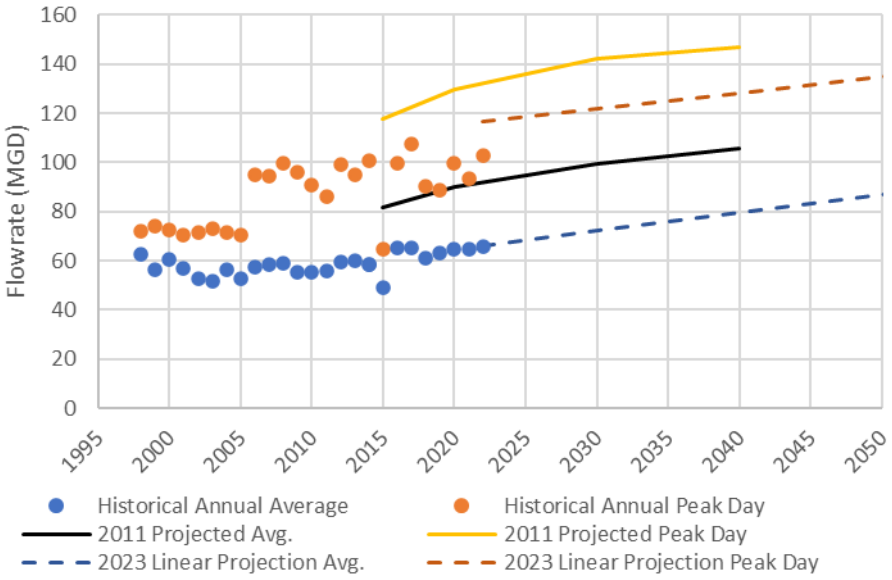


Figure 2.24. Historical and Projected Finished Water Flowrates for the GRFF

Table 2.7. Projected Annual Flows from linear Historical trends of GRFF Finished Water

	2030	2040	2050
Average Daily Demand (ADD) Annual Basis, mgd	72	79.5	87
Peak Daily Demand (PDD) Annual Basis, mgd	122	128	135

2.3.2 Future Water Quality Changes

The Howard Hanson Dam on the Green River will be retrofit with a new fish passage with construction starting in 2026 or 2027. The proposed fish passage project would change the reservoir release elevation and discharge more water from the top 15 – 20 feet of the reservoir. The dam is upstream of the Green River Filtration Facility intake and new release elevation are anticipated to impact the raw water quality. Water quality in the reservoir water column has been sampled for most of the years from 2022 to 2022 and the results between 2018 to 2022 and the results are described in this section. Spring and summer algal blooms have been recorded and are anticipated to increase taste and odor compounds and algal cells in the raw water. Other water quality changes include an increase in temperature and pH in the upper water column when the reservoir experiences thermal stratification. The water column can stratify because of differences in density between warm surface water and deeper colder water.

Monthly samples from Howard Hanson Dam were compared and averaged across 4 years, spanning 2018-2022 (see Appendix A). The averaged depth profile in the reservoir is visualized for each month in Figure 2.25. Algal blooms are quantified by cell counts and biomass through the water column. There is an increase in algal concentrations in the upper 20 ft of the water column (the proposed dam release point), when compared to the deepest part of the profile (the existing outlet). Similar seasonal profiles were observed in the weekly chlorophyll concentration in the water column, collected by an automatic sampler.

Data from the same automatic sampler also shows a consistently higher pH on the reservoir surface. Without pH adjustment, this natural increase in pH would have a secondary benefit and is expected to improve T&O removal during ozonation by favoring hydroxyl radical formation in the low alkalinity water. It should be noted that ozone decays faster at higher pH and higher ozone dosing may be needed in Spring/Summer months to overcome the faster decay kinetics due to higher pH, higher temperatures, and with more ozone demand (due to algae) in the water.

The implementation of the fish passage project is expected to increase the ozone dose required to maintain an O_3:DOC ratio of 1:1 (mg/mg) which is recommended to degrade >90% of common T&O compounds, such as Geosmin and MIB (Knappe, 2004). The TOC is approximately 0.5 mg/L higher in the upper water column (see Figure 2.26) and that increase will impact the initial ozone demand and decay rates. Because Howard Hanson Dam is used for flood control in the late Fall and Winter, the level of the pool is significantly lower and the fish passage project will not change operations during those months.

Continued water quality monitoring is recommended as the fish passage project moves forward. Based on the preliminary data analysis, Tacoma Water is recommended to increase their applied ozone dose when the project is implemented to maintain a target O_3:DOC ratio of 1:1. Note that it is not recommended to increase the ozone dose above 4 mg/L without first confirming the impacts on algal cell lysis (e.g., intracellular taste and odor compound release (Wert et al., 2014)) and chlorinated disinfection byproducts formation potential. Research by Hua and Reckhow has observed decreased formation of regulated trihalomethanes and increased formation of dihaloacetic acids after ozonation and subsequent chlorination for surface waters with low bromide and SUVA near 2 L/mg/m, similar to Green River raw water quality which has an average SUVA of 2.25 L/mg/m. Tacoma Water should perform bench testing or substantially increase the ozone dose while closely monitoring effluent water quality once the new release point from the dam is operational. The low bromide concentration in the raw water prevents formation of bromate, an ozone specific disinfection byproduct.

It is estimated that during spring and summer months when organics loading is high the required ozone dose to maintain the target O_3:DOC ratio of 1:1 will be as high as 3.0 mg/L. For the projected 2050 peak day this would result in an ozone production of 3,400 ppd.

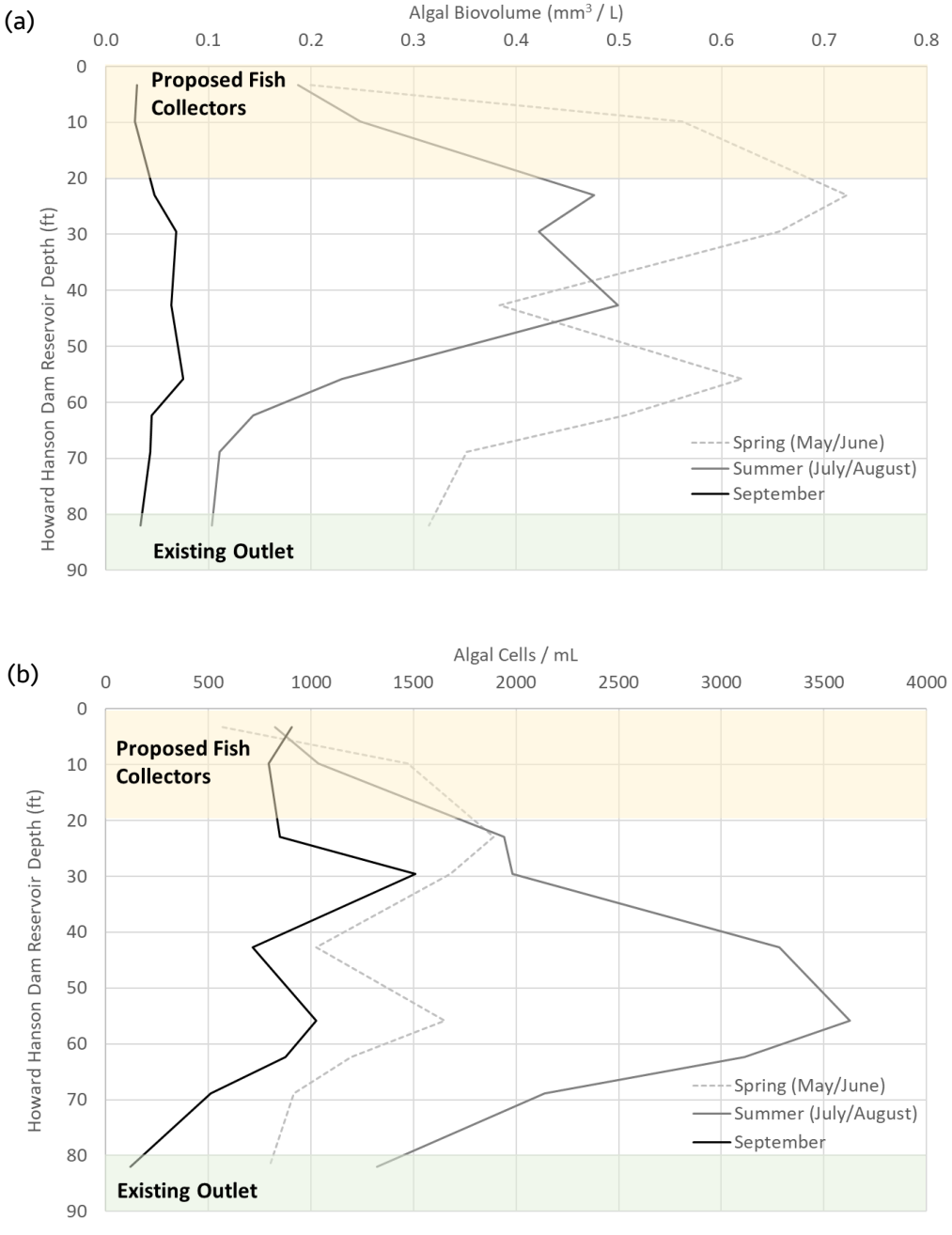


Figure 2.25. (a) Average Algal Biomass Profile and (b) Average Algal Count in Howard Hanson Dam Reservoir Water Column

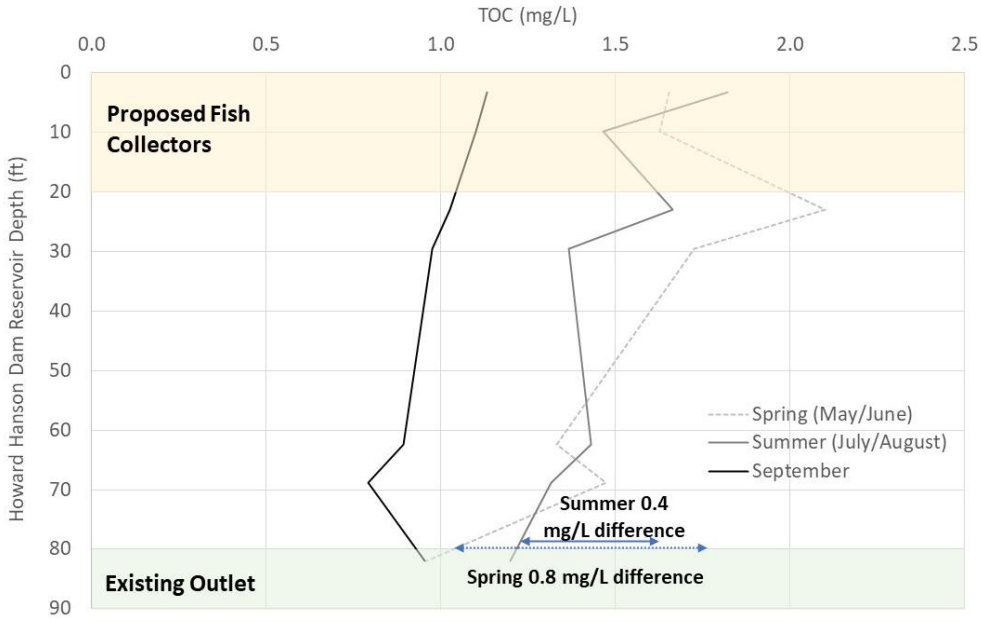


Figure 2.26. Average TOC in HHD Reservoir Water Column

2.4 Ozone System Optimization Evaluation

This section evaluates how the ozone system can be optimized for LOX usage following the recommendations on the sidestream injection system and PSU discussed in previous sections. Optimizing LOX usage can result in potential operating costs savings.

The control logic allows for an operator to set an ozone concentration setpoint. On average, the ozone system is operated at 10 percent ozone. Figure 2.27 shows the ozone production versus the applied power for generator 1 or generator 2. Figure 2.28 shows the ozone production and the ozone concentration. Between August 2021 and April 2022, generator 2 operated at the same applied power as previous years when the ozone production was the same, but the ozone concentration was lower, operating closer to 9 percent during this time period instead of 11 percent like in previous years. In fact, when generator 2 was brought online again in 2022, generator 2 continued to operate at 9 percent even though gas flow rates to the injectors were not close to the minimum of 12 scfm. Replacement of the PSU may improve performance of the ozone generators and ensure that they can run at higher ozone concentrations for potential LOX savings.

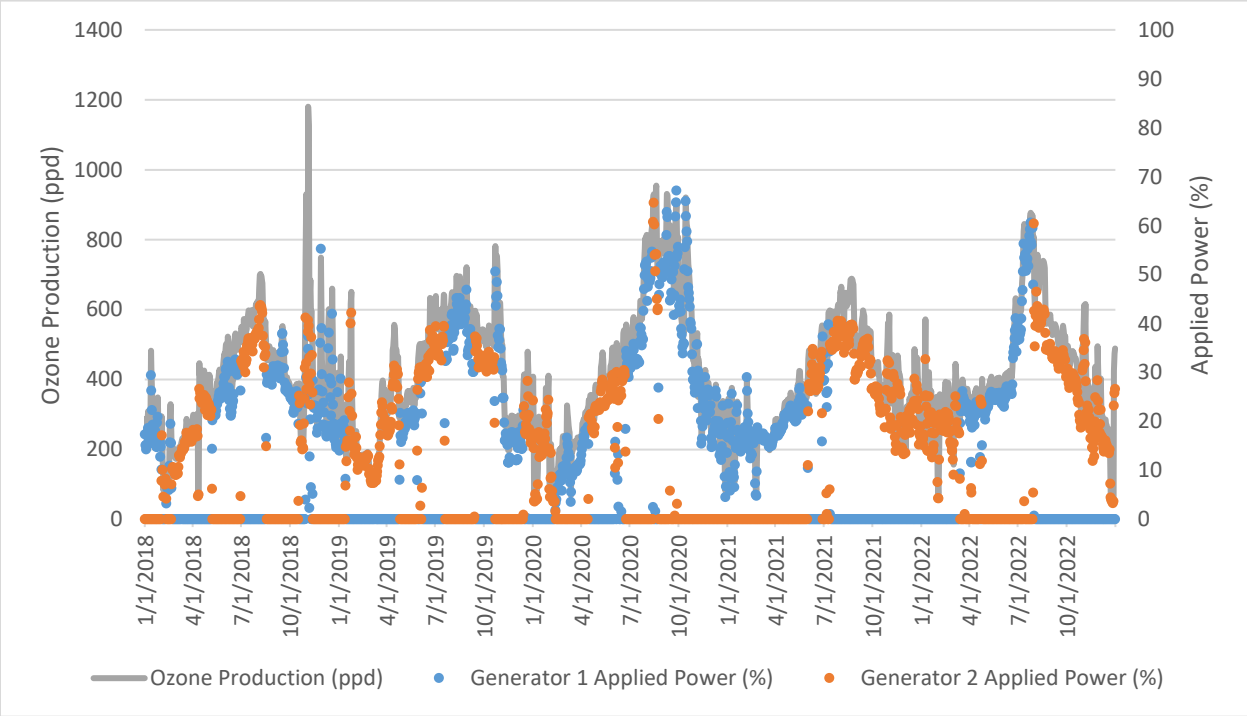


Figure 2.27. Ozone Production and Applied Power 2018 to 2022

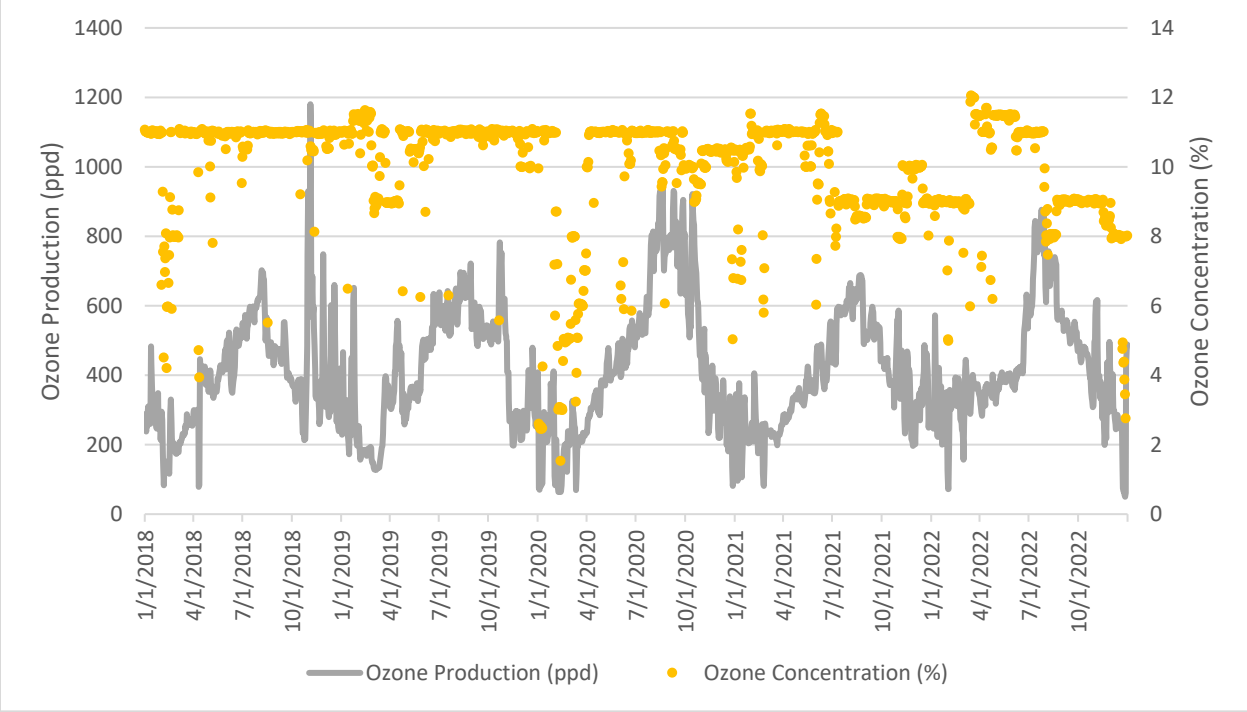


Figure 2.28. Ozone Production and Concentration 2018 to 2022

Figure 2.29 shows the potential annual cost savings for LOX if operating at higher ozone concentrations. Since the 6-inch injector is able to go as low as 12 scfm, the majority of the daily operating data from 2018 to 2022 can operate at 12 percent. However, actual operating data show that the ozone system is

not optimized which is likely due to the condition of the PSU. Operating consistently at 12 percent ozone would result in annual cost savings of approximately $18,000 based on the current ozone production rate. Note that operating the 4-inch injectors would result in additional savings during times of the year when the injection system runs below 12 scfm, but these savings are minor since approximately 95 percent of the operating points can be run at 12 percent ozone concentration without dropping the gas flow rate below 12 scfm. The 20-year life cycle savings assuming 3 percent discount rate and 3.5 percent inflation rate is $462,000 if the generators were consistently operated at 12 percent.

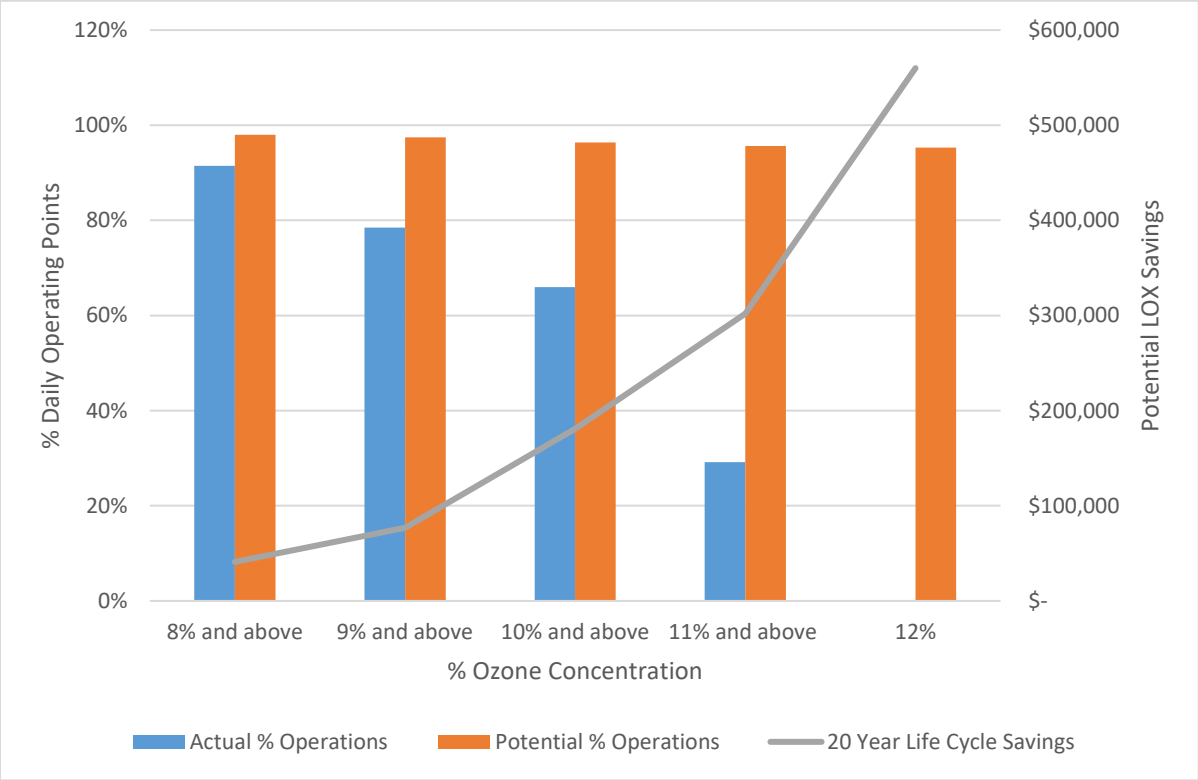


Figure 2.29. Potential 20 Year Life Cycle Cost Savings on LOX if Operating at Higher Ozone Concentrations

2.5 Recommended Ozone Capacity and Operational Improvements

The results of the evaluations in this Section are summarized in Table 2.8 and Table 2.9. The conclusion from these reviews indicate that the ozone generator capacity is sized appropriately to treat current plant flows and water quality. However, when considering future projected flows and water quality changes due to the new fish passage project, a larger capacity ozone generator is needed to meet treatment goals.

Table 2.9 and Figure 2.30 summarize future conditions beyond 2050 to meet the plant capacity of 150 MGD. Note ozone production capacity for the ozone generators with upgraded dielectrics is limited to an ozone dose of 3.0 mg/L with 150 MGD flows (see Figure 2.30). Future evaluations are recommended after completion of the Proposed Fish Collectors project to confirm the impacts to water quality and the required treatment dose for Tase and Odor compounds.

Table 2.8. Ozone Treatment Goals and Operational Improvements

Criteria	Discussion	Recommendation
Taste and Odor and Algae Control	A target of 1.0 mg/mg O_3:DOC is ideal for oxidizing the most common taste and odor compounds, such as Geosmin and MIB. Pre-ozonation at <0.5 mg/L will kill algae and oxidize extracellular toxins. The average design dose of 0.75 mg/L may not be sufficient to lyse and oxidize all intracellular toxins. Higher ozone doses can be added when the plant is not at peak production. Some toxins may be removed through downstream processes, such as flocculation/ sedimentation and biological filtration.	Target a minimum ozone residual of 0.1 mg/L at Sample Station 3 and maintain the target 1.0 mg/mg O_3:DOC, especially during the summer and fall seasons when raw water FRA and TOC increases. Measure raw water DOC during TOC sampling. Add online UVT analyzer on raw water to monitor raw water organics and ensure that the 1:1 ratio is being met. The current ozone design dose is sufficient for anticipated operating conditions. Monitor for changes in water quality, such as increases in algae and/or toxins.
Support for Biologically Active Filtration	Pre-ozonation helps make nutrients assimilable. A target of 0.5 to 1.0 mg/mg O_3:DOC improves the operation of biological filtration.	The current ozone dose is sufficient to support biological filtration.
Disinfection Credit	The GRFF calculates the log inactivation achieved with pre-ozonation but does not receive disinfection credit. A dose of 0.3 - 2.0 mg/L ozone would be required depending on temperature, pH, and flow. WAC 246-290-662 requires a minimum of 0.5-log inactivation of *Giardia* and 2.0-log inactivation of viruses after filtration. This is achieved by the GRFF with chlorination.	Continue to provide all CT with chlorination. Continue to calculate and document ozone CT provided for future contingency planning. No regulatory changes are anticipated to impact this approach. However, keep an eye on regulatory changes and other plants implementing ozone for disinfection credit as a future consideration.
Ozone Control Strategy Optimization	The current ozone control strategy is based on maintaining a detectable residual above 0.1 mg/L at Sample Station 3. However, operating data shows the plant is not consistently operating using this strategy.	A control strategy can be implemented to automate maintaining an ozone residual at Sample Stations 2 or 3. To ensure robustness of this control strategy, improvements on the ozone residual sample stations should be implemented as described in Section 3 of this report.
Ozone Quench	Quenching of ozone is generally not needed since the Sample Station 4 ozone residual typically is below the minimum quench residual setpoint of 0.1 mg/L. Between 2018 and 2022, only about 2 percent of the ozone residual data at Sample Station 4 was above 0.1 mg/L.	It is unlikely that quenching is needed using the proposed ozone dose control strategy to target a minimum of 0.1 mg/L residual at Sample Station 3.

Table 2.9. Ozone Capacity Evaluation Recommendations

Parameter	Units	Current Operation	Future
Description		Maintain 1:1 O3:DOC at current flows and water quality	Maintain 1:1 O3:DOC at future flows and water quality
Peak Flow	MGD	107	150
Peak Ozone Dose	mg/L	1.6	3.0
Recommended Capacity	ppd	1,400 (2,800 total)	1,850 (3,700 total)
Number of Generators in Service		1	2

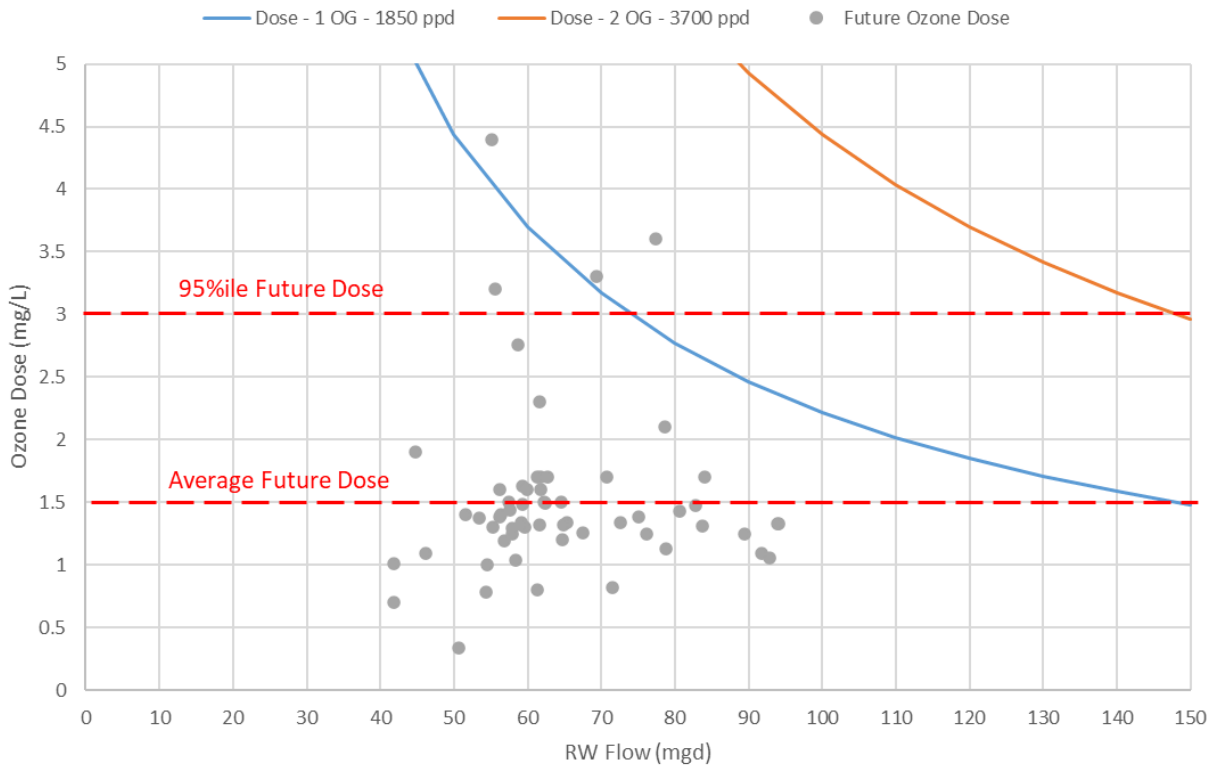


Figure 2.30. Future Ozone Dose for Maximum Ozone Generator Capacity

3 Process Mechanical

3.1 Process Mechanical Codes and Standards

The following codes and standards govern the process mechanical ozone system design.

- Federal Primary and Secondary Drinking Water Standards
- NSF International Standard 61
- American Water Works Association Ozone Systems for Water (ANSI/AWWA F120-18)

3.2 Ozone Generator and Power Supply Unit

The ozone system consists of two existing Ozonia (now owned by Veolia) generators, each with a rated capacity of 1,050 ppd at 12 percent and 1,400 ppd at 10 percent. Ozone Generator 1 is currently out of service due to issues with the PSU. While the generator shell and piping are in good condition, there were several issues that were identified on this subsystem from previous condition assessments and the Jacobs site visit, including:

- Ozonia control system components in the PSU are outdated and due for replacement.
- The system was operating at a high oxygen feed pressure of 24 psi compared to the design pressure of 20 psi. This higher setpoint was limiting the ozone generator capacity and increasing the power use. This issue appears to be resolved. Veolia noted that the pressure controller was set at 24 psi on the PSU HMI. After setting the pressure regulators back to 20 psi in August 2022, the generators have been operating at 20 psi.
- Equipment anchors appear small relative to the size of the equipment.

The results of the Ozone System Evaluation in Section 2 indicate that an increased capacity is warranted to prepare Tacoma Water for the water quality changes which will occur as a result of the Howard Hanson Dam fish passage project. Veolia provided an option to upgrade the existing generator capacity to 1,750 ppd (at 10 percent) by replacing the dielectrics as part of the proposal submitted for the PSU replacement in September 2022. The additional cost to replace the dielectrics in the ozone generators and increase the capacity is $234,000. This additional capacity would allow the plant to meet future flows and water quality without a full replacement of the ozone generators. A total capacity of 3,500 ppd would allow the plant to meet the 90th percentile ozone demand through 2050, with the potential to achieve the maximum projected ozone demand (3,700 ppd) by operating at a lower ozone gas concentration.

Figure 3.1. Ozone Generator

Figure 3.2. Ozone Generator and PSU

3.2.1 Design Criteria

The design criteria for the existing Ozone Generators are provided in Table 3.1. In general, the ozone system is operating within the original design criteria. The ozone capacity was evaluated against treatment requirements in Section 2.2. Future flow and water quality was considered and evaluated in Section 2.3. And optimization of ozone concentration and gas flow rate was discussed in Section 2.4.

Table 3.1. Ozone Generator Design Criteria

Parameter	Units	Original	Recommended
Number of generators		2	
Feed Gas		Gaseous Oxygen	
Capacity, per generator	ppd	1,400 at 10% 1,050 at 12%	1,750 at 10%
Gas flow rate at max capacity and 10% ozone, each	scfm	117	146
Max total gas flow at 10% ozone	scfm	234	292
Target ozone concentration	%	10%	12%
Operating pressure	psig	19.5	19.5
Cooling type		Closed loop with heat exchanger	

3.2.2 Recommended Scope of Work

The scope of work for this subsystem includes the following:

- Replacement of the PSU for each generator, including the PSU Control Panels since many of the legacy components are no longer supported by the vendors.
- Re-use the existing circuit breakers in the motor control center (MCC) to power new PSUs.
- Replace ozone generator dielectrics for higher ozone generator capacity.

Table 3.2 summarizes the equipment in this subsystem, the condition, and the replacement priority. See Section 3.10 for Valve and Instrumentation Scope of Work for all process areas.

Table 3.2. Ozone Generator Area Equipment Replacement

Tag Number	Description	Area	Condition	Replacement Priority
GEN-31141	Ozone Generator 1	Ozone Building	Generator shell and piping appear to be in good condition	1 (Only dielectrics)
GEN-31142	Ozone Generator 2	Ozone Building	Generator shell and piping appear to be in good condition	1 (Only dielectrics)
PSU-31151	Power Supply Unit 1	Ozone Building	Obsolete parts and need complete replacement; currently out of service	1
PSU-31152	Power Supply Unit 2	Ozone Building	Obsolete parts and need complete replacement	1

Replacement Priority Key

1 – Replace as soon as possible (Critical to continued operation of ozone system)

2 – Replace within the next 5 to 10 years (Good condition now, but nearing end of life and replacement should be considered)

3 – Replace as equipment fails (Spares or standby available)

3.3 Liquid Oxygen Tank and Vaporizers

The LOX tank and vaporizer equipment provide LOX storage and vaporizing capabilities to convert liquid oxygen into gaseous oxygen. The equipment consists of two storage tanks, two vaporizers, economizers, pressure regulators and associated sensors and piping, as shown in Figure 3.3.

The liquid oxygen piping insulation is showing signs of wear and ice buildup which can freeze the LOX Tank isolation valves. Replacing the LOX piping insulation should decrease the external ice buildup and allows the LOX tank ON/OFF isolation valves to operate normally. This could be done sequentially for each LOX tank to prevent service interruptions.

Figure 3.3. Existing LOX Tank and Vaporizers

3.3.1 Design Criteria

The design criteria for the Liquid Oxygen storage system are detailed in Table 3.3. No changes are recommended from the original design.

Table 3.3. Liquid Oxygen and Vaporizer Design Criteria

Parameter	Units	Design
LOX Storage Tank		
Type		Cylindrical, Double-Walled, Vertical
Number of Tanks		2
Nominal Capacity, Each	gal lb	15,000 143,000
Maximum Operating Pressure	psig	175
Days Storage (Average Use)	days	34
Days Storage (Maximum Use)	days	12
LOX Vaporizer System		
Type		Ambient Air
Number of Vaporizers		2 (Duty, Defrost)
Maximum Operating Pressure	psig	400
Design Temperature	°F	-320
Capacity, each	scfm	267

3.3.2 Recommended Scope of Work

The scope of work in the LOX and vaporizer area include:

- Upgrade the LOX tank economizer system by replacing existing economizers and installing new economizer relief piping to connect upstream of vaporizers.
- Replace insulation on LOX piping, particularly around the vaporizer alternator valves.
- Replace dew point analyzer and keep existing dew point analyzer as a spare.

Table 3.4 summarizes the equipment in this subsystem, the condition, and the replacement priority. See Section 3.10 for Valve and Instrumentation Scope of Work for all process areas.

Table 3.4. LOX Area Equipment Replacement

Tag Number	Description	Area	Condition	Replacement Priority
TNK-35111	LOX Tank 1	LOX	Tank and piping in good condition.	3
TNK-35112	LOX Tank 2	LOX	Tank and piping in good condition.	3
HTR-35211	LOX Vaporizer 1	LOX	Good	3
HTR-35212	LOX Vaporizer 2	LOX	Good	3

Replacement Priority Key

1 – Replace as soon as possible (Critical to continued operation of ozone system)

Tag Number	Description	Area	Condition	Replacement Priority
2 – Replace within the next 5 to 10 years (Good condition now, but nearing end of life and replacement should be considered)				
3 – Replace as equipment fails (Spares, standby or temporary facility available) or end of life greater than the next 20 years				

3.4 Nitrogen Boost System

The existing ozone system is designed for optimal performance using 2 to 5 percent nitrogen mix with the gaseous oxygen fed to the ozone generators. The nitrogen boost skid includes dual oil-free scroll compressors, desiccant towers, and a pressurized air receiving tank as shown in Figure 3.4.

Figure 3.4. Existing Nitrogen Boost Skid

The nitrogen boost scroll compressors require frequent maintenance and the compressors have failed five times in the past resulting in loss of nitrogen. The longest period without nitrogen supply was 67 days after a compressor failure in 2018. Loss of nitrogen limits the ozone production capabilities and decreases the energy efficiency of the generators.

Other maintenance issues have been reported and resolved in the past 6 years. The desiccant towers were rebuilt in 2019 and nitrogen dew point has been very low after the maintenance was completed. The nitrogen dew point sensor has been reporting the low end of the sensor's range and should be tested. Jacobs recommends exposing the dewpoint sensor to atmospheric conditions and subsequently reconnecting the sensor to the nitrogen gas line to observe that the dewpoint rises to ambient values and subsequently decreases and stabilizes at the actual nitrogen dew point.

The compressor high temperature sensor will periodically alarm during summer months as the Ozone Generator building, where the N_2 skid is installed, is not a conditioned space. Rising ambient temperatures in the Puget Sound Area, result in higher interior temperatures and higher raw water temperatures (used to cool Ozone generators and PSU). Indoor temperature are expected to be ~ 5 °F hotter than ambient temperatures with ventilation alone. Adding cooling to the building was evaluated and two options were considered: 1) add air conditioning to the Ozone generator building, and 2) add air cooler units to "spot-cool" equipment that is too warm. Option 1, add cooling to the entire room, is not considered a practical solution. Energy code requirements would necessitate adding heat recovery and building insulation to the whole ozone generator building. Option 1 would be the most expensive to install and operate. Option 2, adding spot-cooling units, would be a cheaper and easier option. The selected air cooling units would be positioned to direct cold air at equipment, such as the nitrogen-boost compressors and the ozone generator heat exchanger. Spot coolers have air delivered via flexible ducts and hence can be moved out of the way during maintenance. Figure 3.5 shows an example of the mobile air cooler units installation. Note further evaluation is required to confirm that spot coolers would not trigger the same energy code requirements described for Option 1.

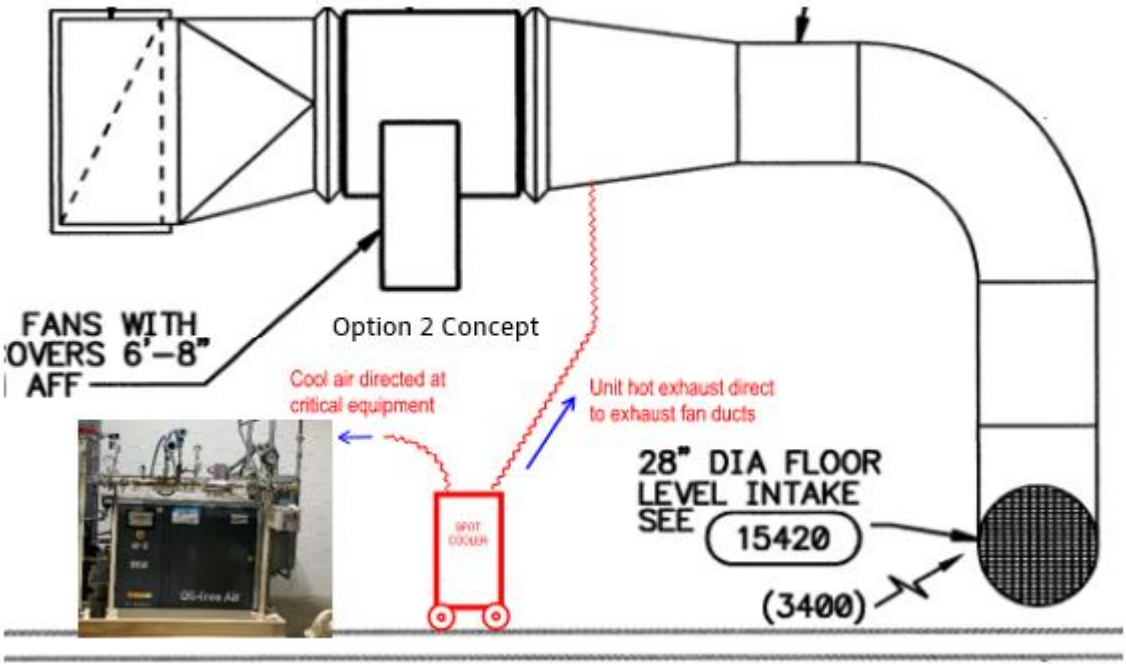


Figure 3.5. Spot Cooling Equipment (Option 2 Alternative)

3.4.1 Design Criteria

The design criteria for the existing Nitrogen Boost System are provided in Table 3.5.

Table 3.5. Nitrogen Boost System Design Criteria

Parameter	Units	Original
Number of Compressors		2
Compressor Type		Air Cooled Oil-Free Scroll-type Compressor
Air Receiver Volume	gal	200

Parameter	Units	Original
Air Receiver Pressure	psig	100
Design Feed Pressure	psig	25
Dryer Capacity at 100 psig	Scfm	28
Number of Desiccant Dryers		2
Capacity, Nitrogen Feed to Oxygen	%	0 - 5

3.4.2 Recommended Scope of Work

The scope of work for the nitrogen boost system includes the following:

- Replace Compressors on Nitrogen Boost Skid. Include Operating temperature up to 100 F in the specification to select a compressor that is appropriate for the unconditioned ozone building during summer months.
- Replace dew point analyzer and keep existing dew point analyzer as a spare.

See Section 3.10 for Valve and Instrumentation Scope of Work for all process areas.

Table 3.6. Nitrogen Boost System Equipment Replacement

Tag Number	Description	Area	Condition	Replacement Priority
CMP-31511	AIR COMPRESSOR 1	N2	Compressors have maintenance issues and should be replaced	1
CMP-31512	AIR COMPRESSOR 2	N2	Compressors have maintenance issues and should be replaced	1
TNK-31521	AIR RECEIVER TANK	N2	Good	3
M-31531	DESICCANT DRYER	N2	Was rebuilt in 2020, recommend replacing in 10 years	2

Replacement Priority Key

1 – Replace as soon as possible (Critical to continued operation of ozone system)

2 – Replace within the next 5 to 10 years (Good condition now, but nearing end of life and replacement should be considered)

3 – Replace as equipment fails (Spares, standby or temporary facility available) or end of life greater than the next 20 years

3.5 Ozone Sidestream Injection

Tacoma Water has two existing ozone contact pipelines (Reactor 1 and Reactor 5) that serve as plug flow reactors with dedicated sidestream injection systems. Each reactor is designed for 11-minute contact time at peak design flow. The sidestream injection pumps are fed with water from the pipeline to which they inject. Ozone gas is injected into the water by use of end-suction centrifugal pumps and venturi injectors. From the venturis, the ozonated water travels through approximately 100 feet of stainless steel pipe prior to discharging into the pipeline via injection nozzles for optimal mixing and mass transfer of ozone. There are two mixing nozzles per injector. Two different injector sizes, 4-inch and 6-inch, allow for operation

across the full range of flows and doses. More details related to this subsystem and its evaluation are provided in Section 2.1.3.

Figure 3.6. Existing Reactor 5 Sidestream Injection System

Some corrosion was observed on the pipe exterior of reactor 5 injectors and pipe supports. See Figure 3.7. The source of the water should be identified and fixed to prevent further corrosion on the piping, ozone liquid separator, and injector exteriors. Likely water sources are a leak in the building roof or an overhead pipe. Once the water source is controlled, the pipe exterior should be cleaned and refinished if needed.

Figure 3.7. Corrosion on Reactor 5 Ozone Injection Piping

3.5.1 Design Criteria

The design criteria for the existing Ozone Injection System are provided in Table 3.7 and Table 3.8. The existing 6-inch ozone injectors are capable of meeting the future maximum gas flow of 292 scfm since

each injector is capable of 100 scfm or more. It is recommended that a third 6-inch injector standby train be considered for full redundancy. The third 6-inch injector train would replace the existing 4-inch injector system and be located within the same footprint.

Table 3.7. 6-Inch Ozone Injection Design Criteria

Parameter	Units	Original	Recommended
Number of Pipelines Contactors		2 (Reactor 1 and Reactor 5)	
Number of Injectors per Pipeline		2 duty	2 duty, 1 standby
Total Number of Injectors		4 duty	4 duty, 2 standby
Total Design Gas Capacity, Each	scfm	100	100[1]
Injector Motive Water Inlet Pressure[1]	psig	25	
Injector Motive Water Outlet Pressure[1]	psig	8	
Injector Ozone Gas Inlet Pressure[1]	psig	5	
Design Injector Motive Water Flow, Each	gpm	815	
Number of Sidestream Injection Pumps		2 duty	2 duty, 1 standby
Sidestream Pump Control		Constant Speed	
Sidestream Pump Flow, Each	gpm	815	
Sidestream Pump Head	ft.	90	

[1]Pressures are approximate based on field investigations. Injectors should be tested at design motive water and gas flowrates to confirm capacity.

Table 3.8. 4-Inch Ozone Injection Design Criteria

Parameter	Units	Original	Recommended
Number of Injectors (Each Pipeline)		1	4-inch injectors to be removed
Number of Ozonated Pipelines		2 (Reactor 1 and Reactor 5)	
Total Design Gas Capacity, Each	scfm	12	
Injector Gas Inlet Pressure	psig	20	
Design Injector Motive Water Inlet Pressure	psig	5	
Design Injector Motive Water Flow, Each	gpm	263	
Number of Sidestream Injection Pumps		1 duty, 1 standby	
Sidestream Pump Control		Constant Speed	
Sidestream Pump Flow, Each	gpm	263	
Sidestream Pump Head	ft.	66	

3.5.2 Recommended Scope of Work

The scope of work for this subsystem includes the following:

- Install additional 6-inch injector system in the footprint of 4-inch injector to provide full redundancy when higher ozone generator capacity is installed and operating at the future flows and ozone doses.

Table 3.9 summarizes the equipment in this subsystem, the condition, and the replacement priority. See Section 3.10 for Valve and Instrumentation Scope of Work for all process areas.

Table 3.9. Sidestream Injection Equipment Replacement

Tag Number	Description	Area	Condition	Replacement Priority
PMP-32131	R1 6" INJECTOR PUMP 1	DW	Good condition but will be nearing end of life. Since these are duty/duty pumps, replacement is recommended.	2
PMP-32132	R1 6" INJECTOR PUMP 2	DW		
PMP-32133	R1 4" INJECTOR PUMP 3	DW	Remove and replace with additional 6" injector pump.	2
PMP-32134	R1 4" INJECTOR PUMP 4	DW		
INJ-32141	R1 OZONE GAS 6" INJECTOR 1	O3S	Good	3
INJ-32142	R1 OZONE GAS 6" INJECTOR 2	O3S	Good	3
INJ-32143	R1 OZONE GAS 4" INJECTOR 3	O3S	Remove and replace with 6" injector.	2
PMP-32531	R5 6" INJECTOR PUMP 1	DW	Good condition but will be nearing end of life. Since these are duty/duty pumps, replacement is recommended.	2
PMP-32532	R5 6" INJECTOR PUMP 2	DW		
PMP-32533	R5 4" INJECTOR PUMP 3	DW	Remove and replace with additional 6" injector pump.	3
PMP-32534	R5 4" INJECTOR PUMP 4	DW		
INJ-32541	R5 OZONE GAS 6" INJECTOR 1	O3S	Good	3
INJ-32542	R5 OZONE GAS 6" INJECTOR 2	O3S	Good	3
INJ-32543	R5 OZONE GAS 4" INJECTOR 3	O3S	Remove and replace with 6" injector.	3
INJ-32151A	R1 SIDESTREAM INJECTION NOZZLE 1 A	O3S	These injection nozzles are buried and the condition was not reviewed. Recommend capping 4" nozzles if abandoned.	3
INJ-32151B	R1 SIDESTREAM INJECTION NOZZLE 1 B	O3S		3
INJ-32152A	R1 SIDESTREAM INJECTION NOZZLE 2 A	O3S		3
INJ-32152B	R1 SIDESTREAM INJECTION NOZZLE 2 B	O3S		3
INJ-32153A	R1 SIDESTREAM INJECTION NOZZLE 3 A	O3S		3
INJ-32153B	R1 SIDESTREAM INJECTION NOZZLE 3 B	O3S		3
INJ-32551A	R5 SIDESTREAM INJECTION NOZZLE 1 A	O3S		3

Tag Number	Description	Area	Condition	Replacement Priority
INJ-32551B	R5 SIDESTREAM INJECTION NOZZLE 1 B	O3S		3
INJ-32552A	R5 SIDESTREAM INJECTION NOZZLE 2 A	O3S		3
INJ-32552B	R5 SIDESTREAM INJECTION NOZZLE 2 B	O3S		3
INJ-32553A	R5 SIDESTREAM INJECTION NOZZLE 3 A	O3S		3
INJ-32553B	R5 SIDESTREAM INJECTION NOZZLE 3 B	O3S		3

Replacement Priority Key

1 – Replace as soon as possible (Critical to continued operation of ozone system)

2 – Replace within the next 5 to 10 years (Good condition now, but nearing end of life and replacement should be considered)

3 – Replace as equipment fails (Spares, standby or temporary facility available) or end of life greater than the next 20 years

3.6 Cooling Water System

The ozone generators and PSUs are cooled with a closed loop water cooling system, see Figure 3.8. Heat is removed from the closed loop system via a heat exchanger that is connected to an open loop system and fed by raw water to the facility. The open loop cooling water system is supplied using a supply pump which feeds water through a strainer. The temperature, strainer differential pressure, and confirmation of flow (via a switch) are monitored with instrumentation. The closed loop cooling water is recirculated using a pump and the temperature and flowrate are monitored continuously.

New dielectrics proposed for the ozone generator will affect the anticipated heat rejection, but evaluations indicate that the existing cooling water system is sized adequately for the improved system.

Figure 3.8. Existing Cooling Water System

3.6.1 Design Criteria

The design criteria for the existing Ozone Generator Cooling Water are provided in **Table 3.10**.

Table 3.10. Ozone Generator Cooling Water System Design Criteria

Parameter	Units	Original	Recommended
Cooling Water System Type		Closed loop with heat exchanger	
Closed Loop Pumps		2 (1 duty for each generator)	
Closed loop cooling water temperature	°F	45-70	42-80
Closed loop cooling water flow	gpm[1]	205	275
Open Loop Pumps		2 duty, 1 standby	
Open loop cooling water temperature	°F	45-70	45-70
Open loop cooling water flow	gpm[1]	205	275

[1] gallons per minute

3.6.2 Recommended Scope of Work

The scope of work for this subsystem includes the following:

- The open loop cooling system has the potential to foul the heat exchanger. Jacobs recommends replacing the basket strainer to remove solids from the raw water open loop cooling water system with an automatic cleaning basket strainer located in the ozone injection building downstream of each supply pump. The each basket strainer (manual or automatic cleaning) should be designed for 275 gpm raw water with a turbidity of 10 NTU.
- The closed loop cooling water system should be drained, cleaned, and refilled with demineralized water or another clean source. The closed loop system should be sampled periodically to monitor pH, conductivity, and color/appearance of the water to confirm if corrosion is still an issue. A corrosion inhibitor may also be added if necessary.
- Clean heat exchanger with manufacturer's approved solutions. Jacobs recommends a caustic solution to be used on the open side of the heat exchanger to remove organics. Jacobs also recommends an acidic solution to be used on the closed side of the heat exchanger to remove inorganic scale build up and metallic oxides.
- If cooling capacity is insufficient for the new ozone dielectrics, then additional plates can be added ot the existing plate and frame heat exchangers.

See Section 3.10 for Valve and Instrumentation Scope of Work for all process areas.

Table 3.11. Ozone Cooling Water System Equipment Replacement

Tag Number	Description	Area	Condition	Replacement Priority
PMP-31311	HEAT REJECTION PUMP 1	CWS	Good condition but nearing end of typical life	2
PMP-31312	HEAT REJECTION PUMP 2	CWS	Good condition but nearing end of typical life	2
PMP-31313	HEAT REJECTION PUMP 3	CWS	Good condition but nearing end of typical life	2
M-31361	HEAT EXCHANGER 1	CWS/GCWS	Recommend cleaning with manufacturer approved solutions	3
M-31362	HEAT EXCHANGER 2	CWS/GCWS	Recommend cleaning with manufacturer approved solutions	3
PMP-31411	COOLANT WATER PUMP 1	GCWS	Good condition but nearing end of typical life	2
PMP-31412	COOLANT WATER PUMP 2	GCWS	Good condition but nearing end of typical life	2

Replacement Priority Key

1 – Replace as soon as possible (Critical to continued operation of ozone system)

2 – Replace within the next 5 to 10 years (Good condition now, but nearing end of life and replacement should be considered)

3 – Replace as equipment fails (Spares, standby or temporary facility available) or end of life greater than the next 20 years

3.7 Ozone Off-Gas Destruct System

Off-gas is collected from two high points in each reactor pipeline, one upstream and one downstream of the ozone injection point, and piped to the Ozone Destruct building. Two thermal catalyst ozone destruct units are utilized to maintain an ozone concentration below 0.1 ppm in the vented gas. See Figure 3.9 for one photo of the existing destruct skids. A fixed speed blower maintains vacuum pressure in the ozone reactor off-gas pipelines.

There have not been any major issues reported with the ozone destruct units as they currently operate. The vent off-gas flow is anticipated to increase as the ozone generator capacity increases in the next 5 years. The blower capacity is 306 acfm at 18" w.g. at 80 deg. F (310 scfm) and the original design was for 240 scfm, with the rest of the flowrate made up for by supplemental intake air. In a worst case scenario the destruct units should be able to maintain a vacuum during peak operations. With the conservative assumption that the peak ozone flow (292 scfm) is vented a single destruct unit has sufficient capacity. As ozone doses increase the air intake valve may need to be resized to decrease the dilution air flowrate and compensate for the higher vent gas flowrates as the plant approaches peak ozone capacity.

Jacobs recommends performing standard maintenance on these units, such as replacing the catalyst media. The ozone destruct catalyst media was replaced by Tacoma Water in 2016. The catalyst media should be replaced every 10 years or earlier if there is water-fouling or ozone gas breakthrough. Therefore, Tacoma Water should plan to replace the destruct catalyst media in the next three years.

Figure 3.9. Existing Ozone Destruct Unit

3.7.1 Design Criteria

The design criteria for the existing Ozone Destruct Unit System is provided in Table 3.12.

Table 3.12. Ozone Destruct Unit Design Criteria

Parameter	Units	Original	Recommended
Number of Units		1 Duty, 1 Standby	1 Duty, 1 Standby
Type		Catalyst packed bed	
Gas Flow Rate	scfm	240	315
Outlet Ozone Threshold	ppmv	0.1	

3.7.2 Recommended Scope of Work

The scope of work for this subsystem includes the following:

- Replace catalyst media
- Replace air intake solenoid valve (FV-33221 and FV-33222)

Table 3.13. Ozone Destruct System Equipment Replacement

Tag Number	Description	Area	Condition	Replacement Priority
PMP-33111	OFF-GAS OZONE ANALYZER 1 SAMPLE PUMP	OG	Pumps are operating well now, recommend adding conditioner to decrease humidity on outlet	2
PMP-33112	OFF-GAS OZONE ANALYZER 2 SAMPLE PUMP	OG	Pumps are operating well now, recommend adding conditioner to decrease humidity on outlet	2
FV-33221	AIR INTAKE SOLENOID VALVE 1	OG	Valves are functioning but oversized for future capacities	1
FV-33222	AIR INTAKE SOLENOID VALVE 2	OG	Valves are functioning but oversized for future capacities	1
HTR-33241	PREHEATER 1	OG	Near end of life and due to be replaced.	3
HTR-33242	PREHEATER 2	OG	Replaced in 2016	2
TNK-33251	CATALYTIC DESTRUCT 1	OG	Recommend replacing the catalyst media	2
TNK-33252	CATALYTIC DESTRUCT 2	OG	Recommend replacing the catalyst media	2
BLR-33271	OFF-GAS BLOWER 1	OG	Blowers are operating well now, replace at end of life	2
BLR-33272	OFF-GAS BLOWER 2	OG	Blowers are operating well now, replace at end of life	2
Replacement Priority Key				

Tag Number	Description	Area	Condition	Replacement Priority
1 – Replace as soon as possible (Critical to continued operation of ozone system)				
2 – Replace within the next 5 to 10 years (Good condition now, but nearing end of life and replacement should be considered)				
3 – Replace as equipment fails (Spares, standby or temporary facility available) or end of life greater than the next 20 years				

See Section 3.10 for Valve and Instrumentation Scope of Work for all process areas.

3.8 Pipeline Reactors

The Green River Filtration Facility has continually used the Reactor 5 pipeline during its operations. This reactor pipeline has not been taken offline for many years. Jacobs recommends switching to use the Reactor 1 pipeline to be able to take Reactor 5 offline and perform a pipeline inspection. A similar inspection on Reactor 1 is recommended. This inspection will focus on the condition of the cement mortar lining, as damage to the cement lining will enable the ozonated water to pit and corrode the welded steel pipeline. Proactive inspections and patches to the lining will extend the lifetime of both ozone reactors.

Higher ozone doses required during algal blooms will bring the initial ozone residual above 2 mg/L. The original pipeline cement mortar lining was designed for a maximum ozone residual of 2 mg/L. While the initial ozone residual should decay quickly, the pipe section adjacent to and immediately downstream of the ozone injection nozzles are vulnerable and should be inspected annually and repaired as needed.

3.8.1 Design Criteria

The design criteria for the existing Ozone Reactor Pipeline is provided in Table 3.14.

Table 3.14. Ozone Reactor Pipeline Design Criteria

Parameter	Units	Original
Reactor 1		
Pipeline Diameter	Inch	78
Minimum Design Flow	MGD	24
Maximum Design Flow	MGD	72
Reactor 5		
Pipeline Diameter	Inch	90
Minimum Design Flow	MGD	10
Maximum Design Flow	MGD	95

3.8.2 Recommended Scope of Work

The scope of work includes the following:

- Inspect Reactor Pipeline 1 for condition of pipeline and to confirm sidestream ozone injectors and other components are operational.
- Inspect Reactor Pipeline 5 for condition of pipeline and schedule maintenance as required to repair the pipe linings.

3.9 Sample Stations

There are four ozone sampling stations along each reactor. Sample analyzers have been installed in utility sheds close to the pipeline sample location. There are rotameters installed to allow manual flow confirmation and control. However, there is no confirmation of flow to the ozone analyzer on SCADA. Also the existing rotameters are discolored and difficult to adjust precisely. As the ozone residual is key to the proposed automated ozone dose RESIDUAL Control Mode, Jacobs recommends replacing the rotameters with a small digital flowmeter (e.g., Endress & Hauser Proline Promag H 300). The flow meter will allow for flow monitoring and an alarm if flow is not detected to the analyzer while the pipeline is operational. This upgrade is recommended to improve the reliability of ozone residual monitoring to implement automatic ozone dosing control.

Figure 3.10. Existing Rotameter in Ozone Sample Station (Reactor 5, Sample Station 2)

3.9.1 Recommended Scope of Work

The scope of work includes the following:

- Replace the dissolved ozone residual analyzers as detailed in Section 3.11**Error! Reference source not found.**.
- Replace the existing rotameter with a small digital flowmeter with flow signal and alarms to SCADA .

3.10 Ozone Quenching

The Ozone quenching system was not inspected as part of this evaluation. This system should be evaluated in further detail during the detailed design phase, including the condition of the chemical tanks, instrumentation, carrier water system, and a review of the control narrative.

It is recommended that the peristaltic chemical metering pumps be replaced with positive displacement pumps that can operate at a higher discharge pressure, similar to other metering pumps throughout the GRFF. Replacing the existing peristaltic sodium bisulfate pumps will allow use with carrier water at the utility water operating pressure and enable removal of the pressure reducing valves required for the peristaltic pump discharge pressure.

3.10.1 Recommended Scope of Work

The scope of work includes the following:

- Replace the sodium bisulfate peristaltic pumps with positive displacement pumps consistent with the site.
- Remove carrier water pressure reducing valves required for the peristaltic pumps.

3.11 Valves and Instrumentation

Much of the existing process piping and valves are in good shape and will be operational for years to come. However, this section will review the items that are good candidates for replacement to maintain the ozone process equipment.

3.11.1 Recommended Scope of Work

A summary table of the existing instruments with priority for replacement is provided in Table 3.15. Replacements are ranked from 1 to 3, with 1 being the highest priority and 3 being the lowest, with notes for recommendations. All manual gauges are considered priority 3 and are tabulated in Appendix B.

All electric actuators should be replaced at the same time as the control panels and electrical upgrades. Replacing the actuators with the PLC will ensure communication signals are compatible and the rewiring is done once for maximum efficiency. Most valves are operational and the valve body won't need to be replaced. The valve actuators to be replaced are listed in Table 3.16. Most of the valve actuators have medium priority since there are part of redundant systems.

As the raw water quality is anticipated to change with the new fish passage project, a UVT analyzer is recommended as a surrogate to monitor TOC continuously and is listed in Table 3.15. UVT is a cost-effective surrogate for TOC and will provide operators information about organics loading and algal blooms in the raw water supply. A short pathlength model of in-line UVT analyzer (1-mm or 2-mm path length) are commercially available and considered appropriate for high turbidity waters, such as the Green River Raw Water.

Ambient ozone analyzers in the Ozone generator room, ozone injection room, and ozone destruct building are manufactured by INUSA and are obsolete. These ozone safety monitors should be replaced and periodically tested to confirm proper operation and alarm to SCADA. Off-gas ozone analyzer (located on the gas line that feeds the ozone destruct units) are also manufactured by INUSA and should be replaced. A previous evaluation from Ozone Water Systems, Inc. identified that humidity in the off-gas is interfering

with the optical lens in the INUSA monitor. A desiccant should be used to condition the gas after the off-gas ozone analyzer sample pumps before reaching the high concentration ozone monitors.

Table 3.15. Instrument Evaluation Summary Table

Instrument Tag No.	Description	Priority* (1-3)	Age / Plan for Replacement
RAW WATER (RW)			
NEW	UVT ANALYZER	1	Add to monitor TOC in the raw water and select ozone dose
LIQUID OXYGEN (LOX)			
LIT-35111	LIQUID OXYGEN TANK 1 LEVEL	2	
PIT-35111	LIQUID OXYGEN TANK 1 PRESSURE	2	
PSH-35111	LIQUID OXYGEN TANK 1 PRESSURE SWITCH HIGH	2	
LIT-35112	LIQUID OXYGEN TANK 2 LEVEL	2	
PIT-35112	LIQUID OXYGEN TANK 2 PRESSURE	2	
PSH-35112	LIQUID OXYGEN TANK 2 PRESSURE SWITCH HIGH	2	
OZONE GENERATOR			
TIT-35321	GOX TRAIN TEMPERATURE	2	
PDIT-35421	GOX DIFFERNTIAL PRESSURE (PARTICULATE FILTER)	2	
PIT-35511	GOX PRESSURE	2	
AIT-35531	GOX DEWPOINT	1	
FIT-31121	OZONE GENERATOR 1 GOX FLOWRATE	1	
FIT-31122	OZONE GENERATOR 2 GOX FLOWRATE	1	
PIT-31131	OZONE GENERATOR 1 GOX PRESSURE	1	
TIT-31161	OZONE GENERATOR 1 OZONE TEMPERATURE	1	
AIT-31031	OZONE GENERATOR 1 OZONE CONCENTRATION	3	Installed BMT high conc. monitor 7 years ago, replace internal UV lamp
PIT-31132	OZONE GENERATOR 2 GOX PRESSURE	1	
TIT-31162	OZONE GENERATOR 2 OZONE TEMPERATURE	1	
AIT-31032	OZONE GENERATOR 2 OZONE CONCENTRATION	3	Installed BMT high conc. monitor 7 years ago, replace internal UV lamp
AIT-31061	OZONE INJECTOR FEED GAS OZONE CONCENTRATION	3	Installed BMT high conc. monitor 7 years ago, replace internal UV lamp
AIT-31011	AMBIENT OXYGEN ANALYZER	1	Replace obsolete INUSA analyzers with new analyzers
AIT-31021	AMBIENT OZONE ANALYZER	1	Replace obsolete INUSA analyzers with new analyzers
FIT-31251	GENERATOR 1 COOLING WATER SUPPLY FLOWRATE	2	

Instrument Tag No.	Description	Priority* (1-3)	Age / Plan for Replacement
TIT-31261	GENERATOR 1 COOLING WATER RETURN TEMPERATURE	2	
FIT-31271	POWER SUPPLY UNIT 1 COOLING WATER FLOWRATE	2	
FIT-31252	GENERATOR 2 COOLING WATER SUPPLY FLOWRATE	2	
TIT-31262	GENERATOR 2 COOLING WATER RETURN TEMPERATURE	2	
FIT-31272	POWER SUPPLY UNIT 2 COOLING WATER FLOWRATE	2	
TIT-31321	OPEN CWS 1 TEMPERATURE	2	
FSH-31341	OPEN CWS 1 FLOW SWITCH HIGH	2	
TIT-31421	CLOSED LOOP CWS 1 TEMPERATURE	2	
LSL-31481	EXPANSION TANK 1 LEVEL SWITCH LOW	2	
TIT-31322	OPEN CWS 2 TEMPERATURE	2	
FSH-31342	OPEN CWS 2 FLOW SWITCH HIGH	2	
TIT-31422	CLOSED LOOP CWS 2 TEMPERATURE	2	
LSL-31482	EXPANSION TANK 2 LEVEL SWITCH LOW	2	
TIT-31323	OPEN CWS 3 TEMPERATURE	2	
NITROGEN BOOST			
AIT-31561	NITROGEN BOOST DEW POINT	1	
TIT-31571	NITROGEN BOOST TEMPERATURE	2	
PIT-31541	NITROGEN BOOST PRESSURE	2	
FIT-31551	NITROGEN BOOST FLOWRATE	1	
INJECTION BLDG.			
FIT-32111	R1 OZONE GAS FLOWRATE 1	1	
FIT-32112	R1 OZONE GAS FLOWRATE 2	1	
FIT-32151	R1 SIDESTREAM INJECTOR 1 FLOWRATE	2	
FIT-32152	R1 SIDESTREAM INJECTOR 2 FLOWRATE	2	
FIT-32153	R1 SIDESTREAM INJECTOR 3 FLOWRATE	2	
FIT-32511	R5 OZONE GAS FLOWRATE 1	1	
FIT-32512	R5 OZONE GAS FLOWRATE 2	1	
FIT-32551	R5 SIDESTREAM INJECTOR 1 FLOWRATE	2	
FIT-32552	R5 SIDESTREAM INJECTOR 2 FLOWRATE	2	
FIT-32553	R5 SIDESTREAM INJECTOR 3 FLOWRATE	2	
AIT-32011	AMBIENT OXYGEN ANALYZER	1	Replace obsolete INUSA analyzers with new analyzers
AIT-32021	AMBIENT OZONE ANALYZER	1	Replace obsolete INUSA analyzers with new analyzers

Instrument Tag No.	Description	Priority* (1-3)	Age / Plan for Replacement
DESTRUCT BLDG.			
AIT-33111	OFF-GAS OZONE ANALYZER 1	1	Replace obsolete INUSA analyzers with new analyzers with desiccant conditioner
AIT-33112	OFF-GAS OZONE ANALYZER 2	1	Replace obsolete INUSA analyzers with new analyzers with desiccant conditioner
PIT-33131	OFF-GAS PRESSURE	2	
PDIT-33251	CATALYTIC DESTRUCT 1 DIFFERENTIAL PRESSURE	2	
PDIT-33252	CATALYTIC DESTRUCT 2 DIFFERENTIAL PRESSURE	2	
AIT-33311	VENT GAS OZONE ANALYZER	1	Replace obsolete INUSA analyzers with new analyzers
AIT-33411	AMBIENT OXYGEN ANALYZER	1	Replace obsolete INUSA analyzers with new analyzers
AIT-33421	AMBIENT OZONE ANALYZER	1	Replace obsolete INUSA analyzers with new analyzers
SAMPLE STATIONS AND SBS QUENCHING			
LIT-26111	SODIUM BISULFITE TANK 1 LEVEL	2	
LIT-26112	SODIUM BISULFITE TANK 2 LEVEL	2	
FIT-26241	SODIUM BISULFITE FLOW 1	1	
FIT-26242	SODIUM BISULFITE FLOW 2	1	
AIT-36121	SAMPLE STATION 1 R1 OZONE RESIDUAL	1	
NEW	SAMPLE STATION 1 R1 OZONE RESIDUAL FLOWMETER	1	Replace existing rotameters with small flowmeter
AIT-36521	SAMPLE STATION 1 R5 OZONE RESIDUAL	1	
NEW	SAMPLE STATION 1 R5 OZONE RESIDUAL FLOWMETER	1	Replace existing rotameters with small flowmeter
AIT-36122	SAMPLE STATION 2 R1 OZONE RESIDUAL	1	
NEW	SAMPLE STATION 2 R1 OZONE RESIDUAL FLOWMETER	1	Replace existing rotameters with small flowmeter
AIT-36522	SAMPLE STATION 2 R5 OZONE RESIDUAL	1	
NEW	SAMPLE STATION 2 R5 OZONE RESIDUAL FLOWMETER	1	Replace existing rotameters with small flowmeter
AIT-36123	SAMPLE STATION 3 R1 OZONE RESIDUAL	1	
NEW	SAMPLE STATION 3 R1 OZONE RESIDUAL FLOWMETER	1	Replace existing rotameters with small flowmeter
AIT-36523	SAMPLE STATION 3 R5 OZONE RESIDUAL	1	
NEW	SAMPLE STATION 3 R5 OZONE RESIDUAL FLOWMETER	1	Replace existing rotameters with small flowmeter
AIT-36124	SAMPLE STATION 4 R1 OZONE RESIDUAL	1	

Instrument Tag No.	Description	Priority* (1-3)	Age / Plan for Replacement
NEW	SAMPLE STATION 4 R1 OZONE RESIDUAL FLOWMETER	1	Replace existing rotameters with small flowmeter
AIT-36524	SAMPLE STATION 4 R5 OZONE RESIDUAL	1	
NEW	SAMPLE STATION 4 R5 OZONE RESIDUAL FLOWMETER	1	Replace existing rotameters with small flowmeter
FLASH MIX BUILDING			
NEW	AMBIENT OZONE ANALYZER	1	Add ambient ozone analyzer and alarm to the flash mix building to alert and protect operators if ozone is carrying through due to insufficient quenching.

* Replacement Priority Key

1 – Replace as soon as possible (Critical to continued operation of ozone system)

2 – Replace within the next 5 to 10 years (Good condition now, but nearing end of life and replacement should be considered)

3 – Replace as equipment fails (Spares, standby or temporary facility available) or end of life greater than the next 20 years

Table 3.16. Valve Evaluation Summary Table

Valve Tag No.	Description	Install location	Priority* (1-3)	Age / Plan for Replacement
FV-35121	LOX TANK 1 VALVE	LOX	2	
FV-35122	LOX TANK 2 VALVE	LOX	2	
FV-35221A	VAPORIZER 1 AUTOMATED VALVE	GOX	2	
FV-35221B	VAPORIZER 2 AUTOMATED VALVE	GOX	2	
FV-35311	GOX VALVE	GOX	1	
PCV-31111	OZONE GENERATOR 1 GOX FCV	GOX	2	Timed with increasing capacity of ozone generators
FV-31191	OZONE GENERATOR 1 OZONE VALVE	OZN	2	
PCV-31112	OZONE GENERATOR 2 GOX FCV	GOX	2	
FV-31192	OZONE GENERATOR 2 OZONE VALVE	OZN	2	
FV-31211	OZONE GENERATOR 1 COOLING WATER SUPPLY VALVE	GCWS	2	
FCV-31551	NITROGEN FLOW CONTROL VALVE	N2	1	
FV-31551	NITROGEN FLOW SOLENOID VALVE	N2	1	
FCV-32111	OZONE GAS R1 FCV 1	O3	2	
FCV-32112	OZONE GAS R1 FCV 2	O3	2	
FCV-32141A	R1 INJECTOR 1 SIDESTREAM FCV	DW	2	
FV-32141B	R1 INJECTOR 1 OZONE GAS VALVE	O3	2	
FCV-32142A	R1 INJECTOR 2 SIDESTREAM FCV	DW	2	

Valve Tag No.	Description	Install location	Priority* (1-3)	Age / Plan for Replacement
FV-32142B	R1 INJECTOR 2 OZONE GAS VALVE	O3	2	
FCV-32143A	R1 INJECTOR 3 SIDESTREAM FCV	DW	2	
FV-32143B	R1 INJECTOR 3 OZONE GAS VALVE	O3	2	
FCV-32511	OZONE GAS R5 FCV 1	O3	2	
FCV-32512	OZONE GAS R5 FCV 2	O3	2	
FCV-32541A	R5 INJECTOR 1 SIDESTREAM FCV	DW	2	
FV-32541B	R5 INJECTOR 1 OZONE GAS VALVE	O3	2	
FCV-32542A	R5 INJECTOR 2 SIDESTREAM FCV	DW	2	
FV-32542B	R5 INJECTOR 2 OZONE GAS VALVE	O3	2	
FCV-32543A	R5 INJECTOR 3 SIDESTREAM FCV	DW	2	
FV-32543B	R5 INJECTOR 3 OZONE GAS VALVE	O3	2	
FCV-33211	OZONE DESTRUCT 1 FCV	OG	2	
FV-33221	OZONE DESTRUCT 1 AIR INTAKE SOLENOID VALVE	OG	2	Resize for use with existing destruct blowers
FCV-33212	OZONE DESTRUCT 2 FCV	OG	2	
FV-33222	OZONE DESTRUCT 2 AIR INTAKE SOLENOID VALVE	OG	2	Resize for use with existing destruct blowers

* Replacement Priority Key

1 – Replace as soon as possible (Critical to continued operation of ozone system)

2 – Replace within the next 5 to 10 years (Good condition now, but nearing end of life and replacement should be considered)

3 – Replace as equipment fails (Spares, standby or temporary facility available) or end of life greater than the next 20 years

4 Instrumentation and Control

This section provides a description of the ozone control system components, condition assessment, recommended scope, and documentation of the control narratives for each process.

4.1 Ozone Control System

The master ozone control panel (MOCP) is the brain of the ozone system and provides automatic control of the various components. The MOCP calculates the required ozone production (in pounds per day) based on the raw water flow and ozone dose setpoint and automatically controls the gas flow, applied power, and injection system to generate and inject ozone.

The expected life of the existing MOCP is less than 10 years due to aging components and availability of replacements. According to the Veolia condition assessment, replacement of the existing PSUs may require upgrades to the MOCP to accommodate and adapt to the new PSU-PLC program and

communication protocols. Other system upgrades, such as instrumentation and analyzers will require integration with the MOCP as well. Therefore, replacement of the aging MOCP is recommended in the next 5-10 years to coordinate with instrumentation and electrical scope described in this report.

The ozone system includes various control panels and PLCs located throughout the system. Each of the PLCs communicate back to the MOCP which provides supervisory control for the system. The following is a summary of the existing control panels and communications panels:

- Control Panels:
  - CP-26000 Sodium Bisulfite Control Panel
  - CP-31000 Ozone Master Control Panel
  - CP-31001 and CP-31002 Ozone Generator Control Panels
  - CP-33001 & CP-33002 Ozone Destructor Panels
  - CP-32000 Ozone Injection Control Panel
  - CP-36001, CP-36002, CP-36003, CP-36004, and CP-36005 Dissolved Ozone Sampling Stations
- Communications Panels:
  - COMM-31000 Ozone Building Communications Panel
  - COMM-32000 Ozone Injection Communications Panel
  - COMM-33000 Ozone Destruct Communications Panel

The control system is generally in working order but many of the controls components are considered legacy and the support for many of the components is expiring in the near future or has already expired. Therefore, it is recommended that the controls components associated with the plant's existing Ozone Generation System be replaced or spares be purchased to enable the system to last another 5 to 10 years. The scope of the controls components discussed in this section includes instrumentation, control panels, PLC and Operator interface terminals (OITs) components, and legacy communications protocols. This section provides some information on existing components and describes some recommendations associated with the scope of work.

4.1.1 Control Panels

The ozone control system consists of many components including PLCs, OITs, Uninterruptible Power Supplies (UPSs), communications modules, and instrumentation. Consideration should be given to each of these categories when determining upgrades approach.

Each of the ozone control system panels at the plant have a variety of Siemens PLC components. According to the Siemens website, the various existing components fall into one of the following three categories:

- Active service – supported and available for purchase.
- Active but in phase-out status – supported and can be purchased for ten more years before being unavailable.
- Discontinued – unavailable for purchase new from manufacturer.

Not every component was reviewed but the list below summarizes the components that have been observed. Note that there have been long lead times associated with procuring new PLC components over the last few years. This may be a factor if components need to be procured and should be considered.

4.1.1.1 CP-31000 Ozone Master Control Panel

A summary of the component evaluation for this panel is provided in Table 4.1. Note that the discontinued items present significant risk to the control network functionality; therefore, high priority should be placed on having inventory on hand. If the plant does not have spare inventory then refurbished units may be available for purchase through third party vendors.

Table 4.1. CP-31000 MOCP Component Status Summary

Item	Status	Additional Notes
S7-412 PLCs and rack power supplies	Active Service	Redundant PLCs, power supplies
Remote I/O rack power supplies	Active Service	
Discrete and analog I/O modules	Phase-out	As of January 2023 they are in phase-out status which means they can be purchased as new for ten more years before being cancelled.
Ethernet modules	Discontinued, successor in phase-out status	Depending on the part number, they may be discontinued and no longer available for purchase. But there is a successor module available. However, as of 2023 the successor module is now in phase-out status.
ET 200M Remote I/O modules	Discontinued, successor in phase-out status	Discontinued but a successor module is available. As of 2023 it is in phase-out status.
Y-Link Coupler modules	Discontinued (with no successor module)	Allow the MOCP to communicate with the ozone generator PLCs and with the closed loop CW pump drives (labeled as PPM31xxx on drawings). No longer available for purchase and no successor modules listed on Siemens website.

4.1.1.2 CP-31001 & CP-31002 Ozone Generator Panels

A summary of the component evaluation for this panel is provided in Table 4.2. Note that the discontinued items present significant risk to the control network functionality; therefore, high priority should be placed on having inventory on hand. If plant does not have spare inventory then refurbished units may be available by third party vendors.

Table 4.2. CP-31001 & CP-31002 Ozone Generator Panel Status Summary

Item	Status	Additional Notes
S7-300 PLC rack power supplies	Active Service	
Discrete and analog I/O modules	Phase-out	As of January 2023 they are in phase-out status which means they can be purchased as new for ten more years before being cancelled.
S7-300 PLC	Discontinued, successor in phase-out status	A successor module is listed which is in phase out status as of 2023.

Item	Status	Additional Notes
Profibus DP communications modules	Discontinued, successor in phase-out status	These modules allow the PLCs to talk with the rest of the ozone system and are no longer active but do have a successor module which, as of 2023, is in phase out status.
Panel door OIT	Discontinued (with no successor module)	No successor available for purchase.

4.1.1.3 CP-33001 & CP-33002 Ozone Destructor Panels

The ozone destruct panels were not investigated in detail. However, the drawings show similar hardware as the ozone generator panels so it is assumed that the PLC and OIT components have the same part numbers and therefore the status is similar as shown under the ozone generator control panels above.

4.1.1.4 CP-32000 Ozone Injection Control Panel

A summary of the component evaluation for this panel is provided in Table 4.3. Note that the discontinued items present significant risk to the control network functionality; therefore, high priority should be placed on having inventory on hand. If plant does not have spare inventory then refurbished units may be available by third party vendors.

Table 4.3. CP-32000 Ozone Injection Panel Status Summary

Item	Status	Additional Notes
S7-300 PLC rack power supplies	Active Service	
Discrete and analog I/O modules	Phase-out	As of January 2023 they are in phase-out status which means they can be purchased as new for ten more years before being cancelled.
S7-300 PLC	Discontinued, successor in phase-out status	A successor module is listed which is in phase out status as of 2023.
ET 200M Remote I/O communication module	Discontinued, successor in phase-out status	These modules are no longer active but do have a successor module which, as of 2023, is in phase out status.
Panel door OIT	Discontinued (with no successor module)	No successor available for purchase.

4.1.1.5 CP-3600X Dissolved Ozone Sampling Stations

The dissolved ozone sampling station panels were not investigated in detail. These panels appear to have been provided by the general contractor and not Ozonia as part of the original installation. Further investigation is recommended, but for the sake of this scope it is assumed that new remote I/O panels will be required.

4.1.2 Control Network Communications

The OLM Profibus/fiber communications modules that allow the PLCs and remote I/O on Profibus DP to communicate over the fiber network around the plant are still in active service and available for purchase.

It is understood that as the plant intends upgraded control components to utilize Profinet communications protocol instead of the existing Profibus DP used at the plant. Depending on how the control system is upgraded there will likely be some period of time where upgraded PLCs equipped for Profinet need to communicate with existing PLCs on Profibus DP network. This can be accomplished using Profinet-to-Profibus Gateways which are readily available on the market.

4.1.3 Electrical Power and Wiring

- Replace existing control wiring with compatible network cabling in coordination with the control system upgrade for this facility.
- Install power and control wiring for process instrumentation replacements included as part of this work.

4.1.4 Uninterruptible Power Supplies

Many of the control panels around the plant have stand-alone UPSs. It is important that batteries be replaced on a regular maintenance schedule as recommended by manufacturer. If UPS health status signals are not monitored by SCADA, it is critical that the health status be manually checked on a regular basis – daily if possible and weekly at a minimum. Optimally, UPSs equipped for status monitoring by SCADA should be selected when upgrading and signals tied into SCADA system and alarms programmed into software.

Alternatives such as facility-wide UPS should be evaluated during design to determine if this approach could be implemented for the ozone system to serve PLCs and other critical instrumentation.

4.1.5 Spare Inventory

It is recommended that each type of PLC component should have at least ten percent spare inventory available. For components that are discontinued by successor modules, the successor modules should be procured. For discontinued modules, refurbished modules should be pursued.

Each PLC battery type should also be inventoried and replaced on regular maintenance schedule according to manufacturer recommendations.

UPS batteries should be inventoried for each type of stand-alone UPS used in control panels.

Instrumentation likewise should have adequate spares in inventory.

4.1.6 Ozone PLC and OIT Software Backups

The plant should have software program backups stored for each of the PLCs that comprise the ozone system. Likewise, the programs loaded on OITs should have backups stored.

Control descriptions for the subsystems where changes are proposed are further described herein. If replacement of the MOCP is pursued as part of this work, it is recommended that the automated control functions be reviewed in further detail during design in an effort to optimize controls and coordinate with the outcomes of the Ozone Optimization Evaluations in Section 2.

4.2 Recommended Scope of Work

The recommendation is to upgrade the entire ozone control system to modern platform PLCs and OITs. New components can be equipped with Profinet communication protocol but it is likely that

communication to other existing plant devices using the older Profibus DP protocol will be necessary. This can be achieved using gateways at the appropriate intersections.

If it is not possible to upgrade the entire ozone system concurrently then, speaking strictly from a hardware perspective, it may be possible to delay upgrading the MOCP and field panels since the modules (or their successors) are still in active service. However, Veolia would need to confirm whether the new PSU programming would be compatible with the existing MOCP programming. Also, the Y-Link Couplers do present risk and spares should be inventoried at the plant. Adequate spares should be inventoried as described above and UPS and PLC batteries replaced on regular maintenance schedule.

If replacement of the MOCP is pursued as part of this work, it is recommended that the automated control functions be reviewed in further detail during design in an effort to optimize controls and coordinate with the outcomes of the Ozone Optimization Evaluation.

4.3 Process Control Narrative

This section provides a summary of each of the process control narratives by unit process. It is recommended that the operation generally stay the same as the existing system with a few exceptions as described herein.

4.3.1 Ozone Generator Control Description

The existing ozone system can be operated in two modes: CT Mode or Dose Mode. The operator can manually select which method is to be used to control each reactor pipeline in the plant SCADA system. The CT method operates the ozone system by providing the ozone dose to meet the log inactivation for *Giardia* and virus, which are setpoints entered by the operator. The Dose Method operates the ozone system by providing a dose setpoint, which is entered by the operator. Under this method, the ozone production will be flow-paced to maintain this constant dose. This is the operating mode which is most used since taste and odor drive the treatment dose.

A third mode, Residual Mode, is recommended to automatically target an operator adjustable residual setpoint at the operator adjustable Sample Station (typically it would be 2 or 3). This mode will improve taste and odor control. This updated control strategy will need to be implemented in conjunction with improvements on the ozone residual sample stations including flowmeters that communicate with SCADA as well as regular maintenance on ozone residual monitors for improved reliability.

Regardless of the SCADA control mode, the ozone dose and raw water flow is transmitted to the MOCP resulting in a specific gas flow and applied power setting. The ozone generators are controlled in constant gas concentration or constant flow mode. A gas concentration setpoint is set by the operator and the gas flow will vary to maintain the gas concentration setpoint. If the gas flow demand drops below the gas flow low limit (12 scfm) when ozone demand is low, the ozone system will reduce the ozone concentration to maintain the gas flow above the low limit.

4.3.2 Cooling Water Control Description

The ozone generators are interlocked with the cooling water system and an open loop and closed loop cooling water pump must be available and online before power will be applied to the ozone generator. Temperature entering the ozone generator in the closed loop cooling water system is monitored and will alarm if the temperature is above the high temperature setpoint. The differential pressure across the open loop automatic strainer is also monitored and will alarm if above the HI pressure loss setpoint, indicating the strainer is clogging and there could be an issue with the automatic strainer. Flow is monitored on the

closed loop and open loop cooling water via a flow meter and flow switch, respectively, to ensure that the minimum flow requirements are met.

4.3.3 LOX Control Description

The LOX tanks provide liquid oxygen to the DUTY vaporizer when the ozone system is in service. When in service the LOX tank isolation valve is in the OPEN position. The level and pressure are monitored on each tank.

The vaporizers operate in a DUTY/DEFROST configuration. The vaporizers change status by actuating the downstream control valve when a preset timer expired or preset volume of gas or when the GOX temperature is low. The GOX pressure is reduced to 20 psig downstream of the vaporizers prior to entering the ozone generators via pressure reducing valves.

The temperature, pressure, dew point, and GOX filter differential pressure are monitored on the GOX to confirm the gas parameters prior to entering the ozone generators.

4.3.4 Nitrogen Boost Control Description

Nitrogen gas flow is varied to meet the operator entered nitrogen percent setpoint in the gas feed to the ozone generators. The nitrogen percent setpoint can vary between 0-5%, and the ozone generator power supply will be limited to 50 percent if nitrogen is not present. The measured ozone generator feed gas flowrate, measured by FE-31121, is used to calculate the demand nitrogen gas flowrate, measured by FE-31551 and controlled by modulating valve FCV-31551. Dewpoint is monitored in the nitrogen gas line and will alarm if the dewpoint is above the Hi dewpoint setpoint. Temperature and pressure across the desiccant dryer are also monitored and displayed on SCADA. Redundant compressors can be controlled from SCADA or automatically operate to maintain a pressure setpoint in the air receiving tank.

Note that if the liquid nitrogen alternative is selected, the desiccant dryers, differential pressure sensor, and air receiving tank would be eliminated. Temperature and pressure would be monitored after the ambient vaporizer.

4.3.5 Injector Control Description

The control logic allows for each injector to be selected as LEAD, LAG 1 and LAG 2. The operator enters a maximum allowable gas flow and a flow deadband flow for each injector, which when exceeded will bring a lag injector online. An injector is brought offline when the gas flow measured is the maximum gas flow minus the deadband setpoint. If the total gas flow demand is less than 12 scfm, the generator will automatically switch to fixed gas flow mode and will automatically modulate the ozone concentration.

4.3.6 Destruct Unit Control Description

Ozone concentration in the vent gas is monitored before and after the ozone destruct unit to confirm the destruct unit's performance. Inlet temperature and pressure across each catalyst bed is monitored, with high temperature and differential pressure alarms to SCADA. An ozone destruct unit must be available and online to permit power use in the generators to produce ozone.

A flow control valve on the ozone vent gas line inlet to each destruct unit modulates to maintain a vacuum pressure setpoint on the shared vent header. A constant speed blower is installed after the heated catalyst bed on each unit and air is drawn in (controlled by solenoid valve) from indoor ambient air to make up the remaining flow demand not supplied by the ozone off-gas for the blower.

5 Structural and Architectural

No new structures are anticipated as part of this work as the footprint of the existing facilities is sufficient to meet future demands. The structural work will consist of equipment pads and equipment bracing to the floors, walls, and ceiling, as required to meet code requirements and account for seismic and life or safety standards. The detailed design will include requirements for equipment bracing and equipment pads for floor-mounted equipment. Mechanical and electrical equipment will be installed within existing spaces in the ozone various ozone buildings.

No changes to the F-2 occupancy classification, life safety, personnel access requirements, and ingress or egress will be required since the ozone structure is not undergoing building additions or changes to occupancy or use. The scope of this work, codes and standards, and design criteria for the structural work are provided herein.

5.1 Scope of Work

The structural work expected as part of the ozone equipment upgrade includes the following:

- Identification of existing and new equipment that requires additional bracing to meet seismic and life safety considerations. Resulting equipment will be braced Bracing of equipment to the floors, walls, and ceiling, as applicable.
- Evaluating the demand-capacity ratio of the existing structural elements due to load changes.
- Installing concrete equipment pads for floor-mounted equipment and demolishing existing concrete pads, where required.
- Patching and resurfacing of finishes after demolition of equipment.

5.2 Codes and Standards

- International Building Code
- American Society of Civil Engineers' (ASCE's):
  - Minimum Design Loads for Buildings and Other Structures (ASCE 7-16)
  - Seismic Evaluation of Existing Buildings (ASCE 31-03)
  - Seismic Evaluation and Retrofit of Existing Buildings (ASCE 41-17)
- American Concrete Institute's Building Code Requirements for Structural Concrete (ACI 318-14)
- Washington State Fire Code

5.3 Loads

The loads resulting from the weight of fixed construction, equipment, and fixtures including permanent non-removable stationary construction are dead loads.

Live loads will consist of all gravity loads (not classified as dead loads) that must be considered in the design to satisfy the applicable codes and the specific project requirements.

5.3.1 Vibration Loads

The effect of vibration from the operation of the vibratory machinery to the structure will be considered in the design of all support structures. Resonance will be avoided. The following four basic guidelines for design of the support structures with vibratory equipment will be followed:

- Mount vibratory equipment that weighs more than 400 pounds on isolated concrete foundations, or use vibration isolators or damping devices, where appropriate.
- The natural frequency of the supporting structure will be less than 75 percent or greater than 125 percent of the operating frequency.
- Mass of the supporting foundation will be at least equal to five times the weight of the moving parts, or three times the gross equipment weight (whichever is greater).
- Equipment will be anchored. The use of expansion anchor bolts is not allowed for vibratory equipment.

5.4 Design Criteria

The design criteria used in the original design for the structural elements of the work are listed in Table 5.1.

Table 5.1. Structural Design Criteria

Parameter Value	Value
Concrete, f'c	4,000 psi @ 28 days with Type II cement
Reinforcing steel, fy	60,000 psi
Anchors, dowels, and fasteners	316L SST
Pipe supports	Galvanized steel
Seismic criteria: ▪ Site class ▪ Risk category ▪ Seismic design category ▪ Occupancy importance factor ▪ Spectral acceleration at a period of 0.2 seconds (Ss) ▪ Spectral acceleration at a period of 1.0 seconds (S1)	 D (stiff clay soil) II D 1.25 0.80 g 0.38 g
Notes: g = gravitational acceleration psi = pound(s) per square inch	

6 Other Codes and Standards

6.1 Electrical Codes and Standards

The facility will be designed in accordance with the applicable codes and standards listed herein.

Codes:

- National Electrical Code
- International Fire Code
- National Electrical Safety Code
- National Electrical Contractors Association installation guidelines

Standards:

- American National Standards Institute
- Canadian Standards Association
- National Electrical Manufacturers Association
- Institute of Electrical and Electronic Engineers
- International Society of Automation
- Insulated Cable Engineers Association
- Occupational Safety and Health Administration
- American Society for Testing and Materials
- UL and/or other Nationally Recognized Testing Laboratories
- Illuminating Engineering Society
- National Fire Protection Association

7 Delivery Approach and Schedule

To successfully deliver the upgrades defined in this basis of design report, there are several options which are worth consideration. The recommended approach is an equipment procurement package followed by a design and installation package to prioritize urgent items and reduce risk associated with long-lead equipment.

The following options are available to package and deliver the work summarized in this report:

- Compile the scope items into a single Ozone Equipment Upgrade package for delivery as a single design and construction package.
- Compile urgent scope items into an early procurement and construction package with additional scope identified for future implementation(s).

7.1 Phasing

The recommended approach for Tacoma Water is to pursue high-priority upgrades in the near term and implement other upgrades in the 1-5 year time horizon following that work, or as the equipment reaches the end of its design life and manufacturer support for control components expire. One example of the scope breakdown would be as follows:

- Phase 1: Veolia Pre-Purchase for Generator 1 Power Supply Unit (PSU).
- Phase 2: Veolia Pre-Purchase for remaining vendor scope, design, and installation contract to proceed with remaining ozone equipment upgrades as identified in this report.

Tacoma Water should determine if any of the other equipment should be prioritized for replacement during Phase 1. It is also possible to break Phase 2 into multiple work packages to delay replacement of low-priority items until the equipment fails.

7.2 Schedule

A two-phase delivery approach has been assumed for the development of the schedule in this section. The ozone equipment replacement project is assumed to be broken into the following steps for each phase. An example project schedule for each phase is presented in Figure 7.1 and Figure 7.2.

- Phase 1 – High-Priority Veolia Pre-Purchase:
    - Procurement package development: 2 months
    - Installation Design: 3-5 months
    - Equipment submittals, fabrication, and delivery: 12-15 months
    - Contractor Installation: 2 months
    - Startup and Commissioning: 1.5 months

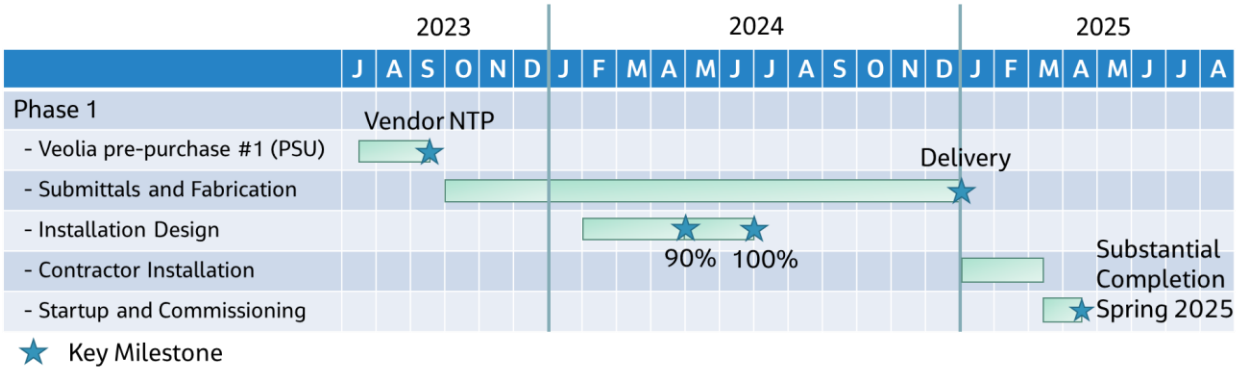


Figure 7.1. Phase 1 Example Project Schedule

- Phase 2 – Lower-Priority Design and Veolia Pre-Purchase:
    - Ozone upgrade detailed design: 8 months
    - Procurement package development (based on 60% design): 3 months
    - Equipment submittals, fabrication, and delivery: 12-15 months
    - Contractor installation: 5 months
    - Startup and commissioning: 2 months

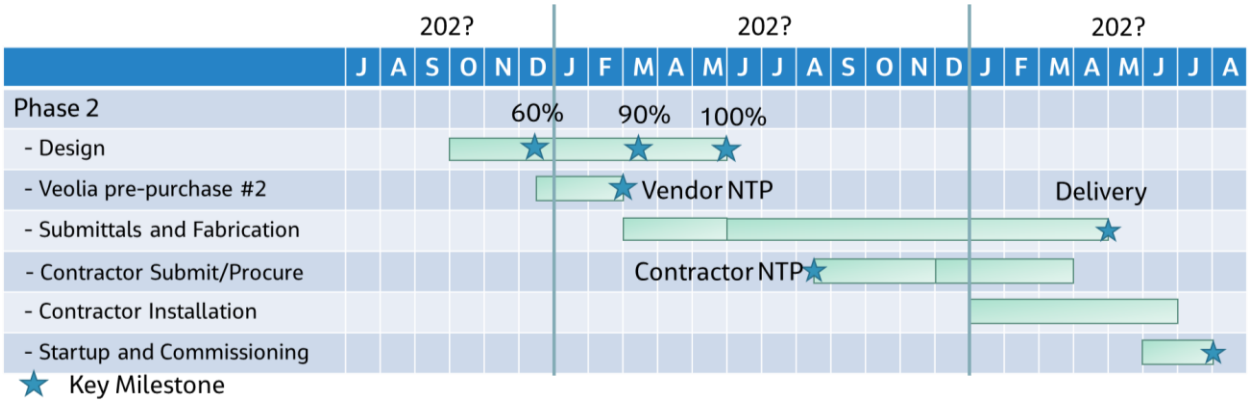


Figure 7.2. Phase 2 Example Project Schedule

8 Cost Estimate

The pricing included below is an estimate for budgetary planning purposes. A more detailed cost estimate should be completed during alternatives evaluation and preliminary design. The estimate is provided in Table 8.1.

The cost estimate assumes that all upgrades recommended within this report are executed, including replacement of the Ozone PSUs, Ozone Generator Dielectrics, instrumentation, and key process equipment as discussed in Section 3. It does not include the liquid nitrogen alternative or the HVAC upgrades discussed in section 2.1.2. Additional cost would need to be added if those options are pursued.

The budgetary pricing is presented in 2023 dollars and is considered to be Class IV with an accuracy of +50%/-25%.

Table 8.1. Ozone Equipment Upgrades Budgetary Cost Estimate

Item	Cost Estimate ($ 2023)	Cost Basis
Phase 1		
Ozone System Supplier	$350,000	Veolia quote for Generator #1 PSU from 2022 with escalated to 2023 dollars.[1]
Installing Contractor	$175,000	Assumes 50% of equipment cost.
Engineering	$75,000	Pre-purchase support, installation design, and services during construction.
Total	**$600,000**	
Phase 2		
Ozone System Supplier	$1,050,000	Veolia quote from 2022 for Generator #2 PSU, dielectrics, and with added control panel/misc scope, escalated to 2023 dollars.[1]
Installing Contractor	$2,400,000	Similar project bid in 2021, adjusted for differences in scope and escalated to 2023 dollars.[1]
Engineering	$650,00	Similar project budgeted in 2020. Includes pre-purchase support, pre-design, detailed design, and services during construction.
Total	**$4,100,000**	

[1] Escalation of 10% per year assumed.

9 References

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Hua, G., & Reckhow, D. A. (2013). Effect of pre-ozonation on the formation and speciation of DBPs. *Water research*, *47*(13), 4322-4330.

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Appendix A: Additional Water Quality Data

2018 - 2022 Monthly Summary Tables
Howard Hansen Dam Water Quality

May

Depth	Depth	Algae Biovolume	Algae Count	T&O	TOC	Chl-a	Phaeo-a	Total-P	Sol-Reactive Phosphorus	Fe	Mn	Turbidity	Temp	pH	UV254	%Transmittance	Total-N (as TKN)	Nitrite	Nitrate	Nitrate+Nitrite	Chlorine	$SUVA_{254}$
m	ft.	mm^3/L	cells/mL	FRA	mg/L	ug/L	ug/L	mg/L	mg/L	mg/L	mg/L	NTU	°C				mg/L	mg/L	mg/L	mg/L	mg/L	(L/mg/m)
1	3.3	0.341	903.083	0.000	2.150							0.800			0.032	96.400						1.465
3	9.8	1.014	2657.403	4.250	1.450							1.110			0.030	96.700						2.069
7	23.0	1.168	3220.967	4.917	1.700	4.333	12.000	0.007	#DIV/0!	0.020	0.015	1.270			0.030	96.450	0.291	#DIV/0!	#DIV/0!	#DIV/0!		1.735
9	29.5	1.040	2858.150	0.000	1.550					0.020	0.017				0.031	96.600						1.968
13	42.7	0.611	1735.345	0.000								1.130										
17	55.8	1.101	3019.547	0.000								5.790										
19	62.3	0.658	1790.363	0.000	1.200							0.981			0.029	96.650						2.417
21	68.9	0.590	1634.250	4.500	1.550					0.015	0.016				0.027	96.750						1.742
25	82.0	0.537	1479.383	3.917	0.940	3.600	4.650	0.018	0.002	0.015	0.018				0.028	96.900	0.230	#DIV/0!	0.028	0.028		2.926
HHD Outlet	HHD Outlet	0.684	1811.770	0.000		8.000	7.600	0.009	0.002	0.035	0.017	0.915	9.167	7.487			0.350	#DIV/0!	0.030	0.030		
Intake	Intake	0.921	2550.377	4.250	1.000	4.200	5.800	0.007	0.002	0.030	0.035	0.693	9.250	7.695			0.356	#DIV/0!	#DIV/0!	#DIV/0!		
Finished	Finished			1.250						0.015	0.028	0.093	8.933	8.423							1.270	

June

Depth	Depth	Algae Biovolume	Algae Count	T&O	TOC	Chl-a	Phaeo-a	Total-P	Sol-Reactive Phosphorus	Fe	Mn	Turbidity	Temp	pH	UV254	%Transmittance	Total-N (as TKN)	Nitrite	Nitrate	Nitrate+Nitrite	Chlorine	$SUVA_{254}$
m	ft.	mm^3/L	cells/mL	FRA	mg/L	ug/L	ug/L	mg/L	mg/L	mg/L	mg/L	NTU	°C				mg/L	mg/L	mg/L	mg/L	mg/L	(L/mg/m)
1	3.3	0.057	232.125	0.000	1.160										0.032	93.050						2.737
3	9.8	0.110	284.588	3.800	1.807					0.020	0.015				0.025	93.325						1.356
7	23.0	0.276	557.485	4.225	2.500	2.100	9.000	0.007	0.001	0.015	0.071				0.022	93.300	0.278	#DIV/0!	#DIV/0!	#DIV/0!		0.860
9	29.5	0.273	502.603	0.000	1.903					0.055	0.058				0.021	95.150						1.077
13	42.7	0.156	318.087	0.000								0.420										
17	55.8	0.138	284.283	0.000								0.190										
19	62.3	0.353	599.143	0.000	1.463										0.023	93.550						1.590
21	68.9	0.113	199.945	3.788	1.395					0.025	0.061				0.021	94.550						1.505
25	82.0	0.093	117.930	3.938	0.980	1.250	3.350	0.007	0.005	0.015	0.080				0.021	95.725	0.209	#DIV/0!	#DIV/0!	#DIV/0!		2.168
HHD Outlet	HHD Outlet	0.080	100.528	0.000		1.600	3.300	0.007	0.005	0.005	0.035	0.800	11.633	7.430			0.272	#DIV/0!	#DIV/0!	0.032		
Intake	Intake	0.076	76.590	3.788	0.940	3.950	3.800	0.007	0.005	0.035	0.084	0.610	12.000	7.510			0.338	#DIV/0!	#DIV/0!	0.030		
Finished	Finished			1.338						0.005	0.018	0.067	11.733	8.350							1.293	

July

Depth	Depth	Algae Biovolume	Algae Count	T&O	TOC	Chl-a	Phaeo-a	Total-P	Sol-Reactive Phosphorus	Fe	Mn	Turbidity	Temp	pH	UV254	%Transmittance	Total-N (as TKN)	Nitrite	Nitrate	Nitrate+Nitrite	Chlorine	$SUVA_{254}$
m	ft.	mm^3/L	cells/mL	FRA	mg/L	ug/L	ug/L	mg/L	mg/L	mg/L	mg/L	NTU	°C				mg/L	mg/L	mg/L	mg/L	mg/L	(L/mg/m)
1	3.3	0.332	686.560	0.000	2.420							0.472			0.032	92.900						1.309
3	9.8	0.346	633.630	3.763	1.928					0.023	0.012	0.439			0.033	92.733						1.695
7	23.0	0.887	1538.863	3.888	1.835	1.633	#DIV/0!	0.007	0.005	0.033	0.019	0.559			0.029	93.825	0.582	#DIV/0!	#DIV/0!	#DIV/0!		1.594
9	29.5	0.771	1286.908	0.000	1.290					0.020	0.018	0.525			0.028	92.750						2.171
13	42.7	0.699	1456.025	0.000								0.499										
17	55.8	0.372	1004.165	0.000								0.461										
19	62.3	0.208	399.190	0.000	1.570							0.335			0.025	92.875						1.561
21	68.9	0.184	313.395	3.700	1.343					0.023	0.019	0.371			0.025	94.650						1.881
25	82.0	0.169	256.815	4.450	1.360	1.077	#DIV/0!	0.007	0.005	0.020	0.020	0.470			0.023	94.775	0.270	#DIV/0!	#DIV/0!	#DIV/0!		1.710
HHD Outlet	HHD Outlet	0.149	184.967	0.000		2.950	0.820	0.010	0.005	0.053	0.023	2.603	13.850	7.603								
Intake	Intake	0.144	105.583	4.563	1.698	8.110	11.265	0.008	0.009	0.050	0.042	1.185	13.600	7.760			0.341	#DIV/0!	0.027	0.027		
Finished	Finished			1.325						0.007	0.027	0.240	13.150	8.380							1.195	

August

Depth	Depth	Algae Biovolume	Algae Count	T&O	TOC	Chl-a	Phaeo-a	Total-P	Sol-Reactive Phosphorus	Fe	Mn	Turbidity	Temp	pH	UV254	%Transmittance	Total-N (as TKN)	Nitrite	Nitrate	Nitrate+Nitrite	Chlorine	$SUVA_{254}$
m	ft.	mm^3/L	cells/mL	FRA	mg/L	ug/L	ug/L	mg/L	mg/L	mg/L	mg/L	NTU	°C				mg/L	mg/L	mg/L	mg/L	mg/L	(L/mg/m)
1	3.3	0.043	962.453	0.000	1.225							0.470			0.040	92.300						3.286
3	9.8	0.150	1438.380	4.438	1.005					0.023	0.018	0.550			0.033	91.675						3.284
7	23.0	0.065	2346.065	4.638	1.495	2.500	5.000	0.005	#DIV/0!	0.033	0.020	0.723			0.032	92.525	0.330	#DIV/0!	#DIV/0!	#DIV/0!		2.157
9	29.5	0.072	2675.823	0.000	1.445					0.023	0.020	0.617			0.034	92.750						2.353
13	42.7	0.299	5108.488	0.000								0.460										
17	55.8	0.089	6251.628	0.000								0.403										

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19	62.3	0.079	5826.290	0.000	1.293							0.493			0.030	92.850						2.282
21	68.9	0.038	3966.690	4.000	1.288					0.020	0.017	0.417			0.000							
25	82.0	0.038	2384.753	3.500	1.040	1.800	1.420	#DIV/0!	#DIV/0!	0.030	0.018	0.783			0.036	92.800	0.374	#DIV/0!	#DIV/0!	#DIV/0!		3.413
HHD Outlet	HHD Outlet	0.179	715.090	#DIV/0!		1.473	2.300	0.012	0.005	0.037	0.022	0.775	16.750	8.015			0.305	#DIV/0!	#DIV/0!	#DIV/0!		
Intake	Intake	0.149	557.625	4.888						0.070	0.046	0.680	15.900	7.895								
Finished	Finished			1.325						0.017	0.032	0.205	16.150	8.215							1.245	

September

Depth	Depth	Algae Biovolume	Algae Count	T&O	TOC	Chl-a	Phaeo-a	Total-P	Sol-Reactive Phosphorus	Fe	Mn	Turbidity	Temp	pH	UV254	%Transmittance	Total-N (as TKN)	Nitrite	Nitrate	Nitrate+Nitrite	Chlorine	$SUVA_{254}$
m	ft.	mm^3/L	cells/mL	FRA	mg/L	ug/L	ug/L	mg/L	mg/L	mg/L	mg/L	NTU	°C				mg/L	mg/L	mg/L	mg/L	mg/L	(L/mg/m)
1	3.3	0.031	905.835	0.000	1.133										0.036	93.000						3.147
3	9.8	0.029	793.830	4.500	1.100										0.034	93.000						3.061
7	23.0	0.048	849.200	6.167	1.027	1.500	4.800	0.006	#DIV/0!						0.036	92.950	0.272	#DIV/0!	#DIV/0!	#DIV/0!		3.474
9	29.5	0.069	1509.890	0.000	0.977										0.027	93.100						2.799
13	42.7	0.064	715.315	0.000																		
17	55.8	0.076	1024.105	0.000																		
19	62.3	0.045	876.840	0.000	0.893										0.024	94.750						2.649
21	68.9	0.043	512.005	6.000	0.793										0.025	94.800						3.151
25	82.0	0.034	118.290	5.125	0.953	0.815	5.600	0.031	0.018						0.037	90.800	0.375	#DIV/0!	0.037	0.037		3.916
HHD Outlet	HHD Outlet	0.065	1579.655	0.000		0.680	14.800	0.009	#DIV/0!								0.253	#DIV/0!	0.037	0.037		
Intake	Intake	0.102	269.915	5.417	0.857	0.730	2.300	0.009	0.173								0.289	#DIV/0!	0.043	0.043		
Finished	Finished			2.417																		

Spring (May/June)

Depth	Depth	Algae Biovolume	Algae Count	T&O	TOC	Chl-a	Phaeo-a	Total-P	Sol-Reactive Phosphorus	Fe	Mn	Turbidity	Temp	pH	UV254	%Transmittance	Total-N (as TKN)	Nitrite	Nitrate	Nitrate+Nitrite	Chlorine	$SUVA_{254}$
m	ft.	mm^3/L	cells/mL	FRA	mg/L	ug/L	ug/L	mg/L	mg/L	mg/L	mg/L	NTU	°C				mg/L	mg/L	mg/L	mg/L	mg/L	(L/mg/m)
1	3.3	0.199	567.604	0.000	1.655							0.800			0.032	94.725						2.101
3	9.8	0.562	1470.995	4.025	1.628					0.020	0.015	1.110			0.027	95.013						1.713
7	23.0	0.722	1889.226	4.571	2.100	3.217	10.500	0.007		0.018	0.043	1.270			0.026	94.875	0.284					1.298
9	29.5	0.656	1680.376	0.000	1.727					0.038	0.037				0.026	95.875						1.522
13	42.7	0.384	1026.716	0.000								0.775										
17	55.8	0.620	1651.915	0.000								2.990										
19	62.3	0.506	1194.753	0.000	1.331							0.981			0.026	95.100						2.003
21	68.9	0.351	917.098	4.144	1.473					0.020	0.038				0.024	95.650						1.624
25	82.0	0.315	798.657	3.927	0.960	2.425	4.000	0.012	0.004	0.015	0.049				0.024	96.313	0.220					2.547
HHD Outlet	HHD Outlet	0.382	956.149	0.000		4.800	5.450	0.008	0.004	0.020	0.026	0.858	10.400	7.458			0.311			0.031		
Intake	Intake	0.498	1313.483	4.019	0.970	4.075	4.800	0.007	0.004	0.033	0.059	0.652	10.625	7.603			0.347					
Finished	Finished			1.294						0.010	0.023	0.080	10.333	8.387							1.282	

Summer (July/August)

Depth	Depth	Algae Biovolume	Algae Count	T&O	TOC	Chl-a	Phaeo-a	Total-P	Sol-Reactive Phosphorus	Fe	Mn	Turbidity	Temp	pH	UV254	%Transmittance	Total-N (as TKN)	Nitrite	Nitrate	Nitrate+Nitrite	Chlorine	$SUVA_{254}$
m	ft.	mm^3/L	cells/mL	FRA	mg/L	ug/L	ug/L	mg/L	mg/L	mg/L	mg/L	NTU	°C				mg/L	mg/L	mg/L	mg/L	mg/L	(L/mg/m)
1	3.3	0.187	824.506	0.000	1.823							0.471			0.036	92.600						2.297
3	9.8	0.248	1036.005	4.100	1.466					0.023	0.015	0.495			0.033	92.204						2.489
7	23.0	0.476	1942.464	4.263	1.665	2.067		0.006		0.033	0.019	0.641			0.031	93.175	0.456					1.876
9	29.5	0.422	1981.365	0.000	1.368					0.022	0.019	0.571			0.031	92.750						2.262
13	42.7	0.499	3282.256	0.000								0.480										
17	55.8	0.230	3627.896	0.000								0.432										
19	62.3	0.143	3112.740	0.000	1.431							0.414			0.027	92.863						1.921
21	68.9	0.111	2140.043	3.850	1.315					0.022	0.018	0.394			0.013	94.650						1.881
25	82.0	0.104	1320.784	3.975	1.200	1.438				0.025	0.019	0.627			0.029	93.788	0.322					2.562
HHD Outlet	HHD Outlet	0.164	450.028			2.212	1.560	0.011	0.005	0.045	0.023	1.689	15.300	7.809			0.305					
Intake	Intake	0.146	331.604	4.725	1.698	8.110	11.265	0.008	0.009	0.060	0.044	0.933	14.750	7.828			0.341					
Finished	Finished			1.325						0.012	0.030	0.223	14.650	8.298							1.220	

Appendix B: Gauge Instrument Summary Table

Table 0.1. Gauge Instrument Summary Table

Instrument Tag	Description	Priority
TI-35211	VAPORIZER 1 OUTLET TEMPERATURE GAUGE	3
TI-35212	VAPORIZER 2 OUTLET TEMPERATURE GAUGE	3
PI-35411A	GOX HIGH PRESSURE GAUGE	3
PI-35411B	GOX PRESSURE REDUCING PRESSURE GAUGE	3
TI-31101	GENERATOR 1 GOX TEMPERATURE	3
PI-31171	GENERATOR 1 OZONE PRESSURE	3
TI-31221	GENERATOR 1 COOLING WATER SUPPLY TEMPERATURE	3
TI-31102	GENERATOR 2 GOX TEMPERATURE	3
PI-31172	GENERATOR 2 OZONE PRESSURE	3
TI-31222	GENERATOR 2 COOLING WATER SUPPLY TEMPERATURE	3
PI-31521	AIR RECEIVER TANK PRESSURE	3
PI-31551A	N2 PRESSURE GAUGE 1	3
PI-31551B	N2 PRESSURE GAUGE 2	3
PI-31311A	HEAT REJECTION PUMP 1 FEED PRESSURE	3
PI-31311B	HEAT REJECTION PUMP 1 DISCHARGE PRESSURE	3
DPSH-31301	RAW WATER STRAINER 1 DIFFERENTIAL PRESSURE	3
TI-31331A	OPEN LOOP HEAT EXCHANGER 1 TEMPERATURE 1	3
FI-31341	OPEN LOOP HEAT EXCHANGER 1 FLOW INDICATOR	3
PI-31351A	OPEN LOOP HEAT EXCHANGER 1 PRESSURE 1	3
TI-31331B	OPEN LOOP HEAT EXCHANGER 1 TEMPERATURE 2	3
PI-31351B	OPEN LOOP HEAT EXCHANGER 1 PRESSURE 2	3
PI-31481	EXPANSION TANK 1 PRESSURE	3
PI-31411	COOLANT WATER PUMP 1 DISCHARGE PRESSURE	3
T1-31431A	COOLANT WATER PUMP 1 DISCHARGE TEMPERATURE	3
FI-31441	CLOSED LOOP CWS 1 FLOWRATE	3
TI-31431B	COOLANT WATER PUMP 1 RETURN TEMPERATURE	3
PI-31451	COOLANT WATER PUMP 1 RETURN PRESSURE	3
PI-31312A	HEAT REJECTION PUMP 2 FEED PRESSURE	3
PI-31312B	HEAT REJECTION PUMP 2 DISCHARGE PRESSURE	3
DPSH-31302	RAW WATER STRAINER 2 DIFFERENTIAL PRESSURE	3
TI-31332A	OPEN LOOP HEAT EXCHANGER 2 TEMPERATURE 1	3
FI-31342	OPEN LOOP HEAT EXCHANGER 2 FLOW INDICATOR	3
PI-31352A	OPEN LOOP HEAT EXCHANGER 2 PRESSURE 1	3

Instrument Tag	Description	Priority
TI-31332B	OPEN LOOP HEAT EXCHANGER 2 TEMPERATURE 2	3
PI-31352B	OPEN LOOP HEAT EXCHANGER 2 PRESSURE 2	3
PI-31482	EXPANSION TANK 2 PRESSURE	3
PI-31412	COOLANT WATER PUMP 2 DISCHARGE PRESSURE	3
T1-31432A	COOLANT WATER PUMP 2 DISCHARGE TEMPERATURE	3
FI-31442	CLOSED LOOP CWS 2 FLOWRATE	3
TI-31432B	COOLANT WATER PUMP 2 RETURN TEMPERATURE	3
PI-31452	COOLANT WATER PUMP 2 RETURN PRESSURE	3
PI-31313A	HEAT REJECTION PUMP 3 FEED PRESSURE	3
PI-31313B	HEAT REJECTION PUMP 3 DISCHARGE PRESSURE	3
PI-32121	R1 OZONE GAS PRESSURE 1	3
PSL-32121	R1 OZONE GAS PRESSURE SWITCH LOW 1	3
PI-32122	R1 OZONE GAS PRESSURE 2	3
PSL-32122	R1 OZONE GAS PRESSURE SWITCH LOW 2	3
PI-32131A	R1 INJECTOR PUMP 1 FEED PRESSURE	3
PI-32131B	R1 INJECTOR PUMP 1 DISCHARGE PRESSURE	3
PI-32132A	R1 INJECTOR PUMP 2 FEED PRESSURE	3
PI-32132B	R1 INJECTOR PUMP 2 DISCHARGE PRESSURE	3
PI-32133A	R1 INJECTOR PUMP 3 FEED PRESSURE	3
PI-32133B	R1 INJECTOR PUMP 3 DISCHARGE PRESSURE	3
PI-32134A	R1 INJECTOR PUMP 4 FEED PRESSURE	3
PI-32134B	R1 INJECTOR PUMP 4 DISCHARGE PRESSURE	3
PI-32141A	R1 INJECTOR 1 WATER FEED PRESSURE	3
PI-32141B	R1 INJECTOR 1 OZONE GAS PRESSURE	3
PI-32141C	R1 INJECTOR 1 OZONATED WATER PRESSURE	3
LSH-32141	R1 OZONE LIQUID SEPERATOR 1 LEVEL SWITCH HIGH	3
PI-32142A	R1 INJECTOR 2 WATER FEED PRESSURE	3
PI-32142B	R1 INJECTOR 2 OZONE GAS PRESSURE	3
PI-32142C	R1 INJECTOR 2 OZONATED WATER PRESSURE	3
LSH-32142	R1 OZONE LIQUID SEPERATOR 2 LEVEL SWITCH HIGH	3
PI-32143A	R1 INJECTOR 3 WATER FEED PRESSURE	3
PI-32143B	R1 INJECTOR 3 OZONE GAS PRESSURE	3
PI-32143C	R1 INJECTOR 3 OZONATED WATER PRESSURE	3
LSH-32143	R1 OZONE LIQUID SEPERATOR 3 LEVEL SWITCH HIGH	3
PI-32521	R5 OZONE GAS PRESSURE 1	3

Instrument Tag	Description	Priority
PSL-32521	R5 OZONE GAS PRESSURE SWITCH LOW 1	3
PI-32522	R5 OZONE GAS PRESSURE 2	3
PSL-32522	R5 OZONE GAS PRESSURE SWITCH LOW 2	3
PI-32531A	R5 INJECTOR PUMP 1 FEED PRESSURE	3
PI-32531B	R5 INJECTOR PUMP 1 DISCHARGE PRESSURE	3
PI-32532A	R5 INJECTOR PUMP 2 FEED PRESSURE	3
PI-32532B	R5 INJECTOR PUMP 2 DISCHARGE PRESSURE	3
PI-32533A	R5 INJECTOR PUMP 3 FEED PRESSURE	3
PI-32533B	R5 INJECTOR PUMP 3 DISCHARGE PRESSURE	3
PI-32534A	R5 INJECTOR PUMP 4 FEED PRESSURE	3
PI-32534B	R5 INJECTOR PUMP 4 DISCHARGE PRESSURE	3
PI-32541A	R5 INJECTOR 1 WATER FEED PRESSURE	3
PI-32541B	R5 INJECTOR 1 OZONE GAS PRESSURE	3
PI-32541C	R5 INJECTOR 1 OZONATED WATER PRESSURE	3
LSH-32541	R5 OZONE LIQUID SEPERATOR 1 LEVEL SWITCH HIGH	3
PI-32542A	R5 INJECTOR 2 WATER FEED PRESSURE	3
PI-32542B	R5 INJECTOR 2 OZONE GAS PRESSURE	3
PI-32542C	R5 INJECTOR 2 OZONATED WATER PRESSURE	3
LSH-32542	R5 OZONE LIQUID SEPERATOR 2 LEVEL SWITCH HIGH	3
PI-32543A	R5 INJECTOR 3 WATER FEED PRESSURE	3
PI-32543B	R5 INJECTOR 3 OZONE GAS PRESSURE	3
PI-32543C	R5 INJECTOR 3 OZONATED WATER PRESSURE	3
LSH-32543	R5 OZONE LIQUID SEPERATOR 3 LEVEL SWITCH HIGH	3
PDI-33511	DEMISTER 1 DIFFERENTIAL PRESSURE	3
PDI-33512	DEMISTER 2 DIFFERENTIAL PRESSURE	3
TE-33231A	PREHEATER 1 FEED TEMPERATURE	3
TE-33231B	PREHEATER 1 OUTLET TEMPERATURE	3
TSH-33241	PREHEATER 1 TEMPERATURE SWITCH HIGH	3
TSH-33251	CATALYST DESTRUCT 1 OUTLET TEMPERATURE SWITCH HIGH	3
TI-33261	CATALYST DESTRUCT 1 OUTLET TEMPERATURE	3
TE-33232A	PREHEATER 2 FEED TEMPERATURE	3
TE-33232B	PREHEATER 2 OUTLET TEMPERATURE	3
TSH-33242	PREHEATER 2 TEMPERATURE SWITCH HIGH	3
TSH-33252	CATALYST DESTRUCT 2 OUTLET TEMPERATURE SWITCH HIGH	3
TI-33262	CATALYST DESTRUCT 2 OUTLET TEMPERATURE	3

Instrument Tag	Description	Priority
PI-26231	SODIUM BISULFITE PRESSURE 1	3
PI-26232	SODIUM BISULFITE PRESSURE 2	3
DPSH-36111	SAMPLE STATION 1 R1 STRAINER DIFFERENTIAL PRESSURE	3
DPSH-36511	SAMPLE STATION 1 R5 STRAINER DIFFERENTIAL PRESSURE	3
DPSH-36112	SAMPLE STATION 2 R1 STRAINER DIFFERENTIAL PRESSURE	3
DPSH-36512	SAMPLE STATION 2 R5 STRAINER DIFFERENTIAL PRESSURE	3
DPSH-36113	SAMPLE STATION 3 R1 STRAINER DIFFERENTIAL PRESSURE	3
DPSH-36513	SAMPLE STATION 3 R5 STRAINER DIFFERENTIAL PRESSURE	3
DPSH-36114	SAMPLE STATION 4 R1 STRAINER DIFFERENTIAL PRESSURE	3
DPSH-36514	SAMPLE STATION 4 R5 STRAINER DIFFERENTIAL PRESSURE	3
DPSH-36115	SAMPLE STATION 5 R1 STRAINER DIFFERENTIAL PRESSURE	3
DPSH-36515	SAMPLE STATION 5 R5 STRAINER DIFFERENTIAL PRESSURE	3
FI-36131A	SAMPLE STATION 1 R1 FLOW	3
FI-36531A	SAMPLE STATION 1 R5 FLOW	3
FI-36132A	SAMPLE STATION 2 R1 FLOW	3
FI-36532A	SAMPLE STATION 2 R5 FLOW	3
FI-36133A	SAMPLE STATION 3 R1 FLOW	3
FI-36533A	SAMPLE STATION 3 R5 FLOW	3
FI-36134A	SAMPLE STATION 4 R1 FLOW	3
FI-36534A	SAMPLE STATION 4 R5 FLOW	3
FI-36115A	SAMPLE STATION 5 R1 pH FLOW	3
FI-36115B	SAMPLE STATION 5 R1 Cl2 FLOW	3
FI-36315A	SAMPLE STATION 5 BACKUP pH FLOW	3
FI-36315B	SAMPLE STATION 5 BACKUP Cl2 FLOW	3
FI-36515A	SAMPLE STATION 5 R5 pH FLOW	3
FI-36515B	SAMPLE STATION 5 R5 Cl2 FLOW	3

APPENDIX B

SIGNATURE PAGE

SIGNATURE PAGE

CITY OF TACOMA
TACOMA WATER

All submittals must be in ink or typewritten, executed by a duly authorized officer or representative of the bidding/proposing entity, and received and time stamped as directed in the **Request for Qualifications page near the beginning of the specification**. If the bidder/proposer is a subsidiary or doing business on behalf of another entity, so state, and provide the firm name under which business is hereby transacted.

REQUEST FOR QUALFICATIONS SPECIFICATION NO. TW23-0273F
Ozone System Improvements Engineering Services

The undersigned bidder/proposer hereby agrees to execute the proposed contract and furnish all materials, labor, tools, equipment and all other facilities and services in accordance with these specifications.

The bidder/proposer agrees, by submitting a bid/proposal under these specifications, that in the event any litigation should arise concerning the submission of bids/proposals or the award of contract under this specification, Request for Bids, Request for Proposals or Request for Qualifications, the venue of such action or litigation shall be in the Superior Court of the State of Washington, in and for the County of Pierce.

Non-Collusion Declaration

The undersigned bidder/proposer hereby certifies under penalty of perjury that this bid/proposal is genuine and not a sham or collusive bid/proposal, or made in the interests or on behalf of any person or entity not herein named; and that said bidder/proposer has not directly or indirectly induced or solicited any contractor or supplier on the above work to put in a sham bid/proposal or any person or entity to refrain from submitting a bid/proposal; and that said bidder/proposer has not, in any manner, sought by collusion to secure to itself an advantage over any other contractor(s) or person(s).

_____
Bidder/Proposer's Registered Name

_____
Address

_____
City, State, Zip

_____
Authorized Signatory E-Mail Address

_____
E.I.No. / Federal Social Security Number Used on Quarterly Federal Tax Return, U.S. Treasury Dept. Form 941

_____
E-Mail Address for Communications

_____
Signature of Person Authorized to Enter into Contracts for Bidder/Proposer — Date

_____
Printed Name and Title

_____
(Area Code) Telephone Number / Fax Number

_____
State Business License Number
in WA, also known as UBI (Unified Business Identifier) Number

_____
State Contractor's License Number
(See Ch. 18.27, R.C.W.)

Addendum acknowledgement #1_____ #2_____ #3_____ #4_____ #5_____

THIS PAGE MUST BE SIGNED AND RETURNED WITH SUBMITTAL.

APPENDIX C

SAMPLE CONTRACT AND INSURANCE REQUIREMENTS

SERVICES CONTRACT

Click here for the Contract Questionnaire Popup Quick Reference

Start Questionnaire | Finalize Document

THIS CONTRACT, made and entered into effective as of [Month] [Day], [Year] ("EFFECTIVE DATE"), by and between the CITY OF TACOMA, a municipal corporation of the State of Washington (hereinafter referred to as the "CITY"), and **[INSERT legal name of Supplier exactly as it appears in Ariba including any dbas or trade names]**, (hereinafter may be referred to as "CONTRACTOR" or "SUPPLIER");

In consideration of the mutual promises and obligations hereinafter set forth, the Parties hereto agree as follows:

1. **Scope of Services**

   The CONTRACTOR agrees to diligently and completely perform the services or deliverables consisting of [INSERT A BRIEF DESCRIPTION OF THE WORK TO BE PERFORMED] as is described in [Exhibit A, B, ETC., if needed] attached hereto and incorporated herein.

2.

3. **Changes to Scope of Work**

   The CITY shall have the right to make changes within the general scope of services or deliverables upon execution in writing of a change order or amendment hereto. If the changes will result in additional work effort by CONTRACTOR, the CITY will agree to reasonably compensate the CONTRACTOR for such additional effort up to the maximum amount specified herein or as otherwise provided by City Code.

4.

5. **Term**

   All services shall be satisfactorily completed on or before [INSERT CONTRACT TERMINATION DATE] and this Contract shall expire on said date unless mutually extended by a written and executed Amendment to this Contract.

6.

7. **Delay**

Neither party shall be considered to be in default in the performance of this Contract to the extent such performance is prevented or delayed by any cause which is beyond the reasonable control of the affected party and, in such event, the time for performance shall be extended for a period equal to any time lost as a result thereof. In the event CONTRACTOR is unable to proceed due to a delay solely attributable to CITY, CONTRACTOR shall advise CITY of such delay in writing as soon as is practicable.

8. Compensation

The CITY shall compensate the CONTRACTOR for the services and deliverables performed under this Contract [on the basis of] [EXHIBIT XXXX and/or a DESCRIPTION OF COMPENSATION ARRANGEMENTS –MILESTONES, TIME AND MATERIALS, LUMP SUM ETC.]

9. Prevailing Wages

A. If federal, state, local, or any applicable law requires CONTRACTOR to pay prevailing wages in connection with this Contract, and CONTRACTOR is so notified by the CITY, then CONTRACTOR shall pay applicable prevailing wages and otherwise comply with the Washington State Prevailing Wage Act (RCW 39.12) in the performance of this Contract.

B. If applicable, a Schedule of Prevailing Wage Rates and/or the current prevailing wage determination made by the Secretary of Labor for the locality or localities where the Contract will be performed is made of part of the Contract by this reference. If prevailing wages apply to the Contract, CONTRACTOR and its subcontractors shall:

1. Be bound by and perform all transactions regarding the Contract relating to prevailing wages and the usual fringe benefits in compliance with the provisions of Chapter 39.12 RCW, as amended, the Washington State Prevailing Wage Act and/or the Davis-Bacon Act (40 U.S.C. 3141- 3144, and 3146-3148) and the requirements of 29 C.F.R. pt. 5 as may be applicable, including the federal requirement to pay wages not less than once a week.

2. Ensure that no worker, laborer or mechanic employed in the performance of any part of the Contract shall be paid less than the prevailing rate of wage specified on that Schedule and/or specified in a wage determination made by the Secretary of Labor (unless specifically preempted by federal law, the higher of the Washington state prevailing wage or federal Davis-Bacon rate of wage must be paid.

3. Immediately upon award of the Contract, contact the Department of Labor and Industries, Prevailing Wages section, Olympia, Washington and/or the federal Department of Labor, to obtain full information, forms and procedures relating to these matters. Per such procedures, a Statement of Intent to Pay Prevailing Wages and/or other or additional documentation required by applicable federal law, must be submitted by CONTRACTOR and its subcontractors to the CITY, in the manner requested by the CITY, prior to

any payment by the CITY hereunder, and an Affidavit of Wages Paid and/or other or additional documentation required by federal law must be received or verified by the CITY prior to final Contract payment.

10. Not to Exceed Amount

The total price to be paid by CITY for CONTRACTOR'S full and complete performance of the Scope of Work hereunder shall not exceed $ [INSERT TOTAL AMOUNT OF CONTRACT] plus applicable taxes without a written and executed Amendment to this Contract. Said price shall be the total compensation for CONTRACTOR'S performance hereunder including, but not limited to, all work, deliverables, materials, supplies, equipment, subcontractor's fees, and all reimbursable travel and miscellaneous or incidental expenses to be incurred by CONTRACTOR.
In the event the CONTRACTOR incurs cost in excess of the sum authorized for service under this Contract, the CONTRACTOR shall pay such excess from its own funds, and the CITY shall not be required to pay any part of such excess, and the CONTRACTOR shall have no claim against the CITY on account thereof.

11. Payment

CONTRACTOR shall submit [Pick one of the following monthly, weekly, annual, Contract milestone, other (describe in detail)] invoices for services completed and/or deliverables furnished during the invoice period. Upon CITY'S request, CONTRACTOR shall submit necessary and appropriate documentation, as determined by the CITY, for all invoiced services and deliverables. For transactions conducted in SAP Ariba, invoices shall be submitted directly through Ariba. For invoices paid by ACH or by check, unless stated otherwise, invoices shall be electronically submitted by email with corresponding PO number or other identifying number listed in the subject line to accountspayable@cityoftacoma.org.

Payment shall be made through the CITY'S ordinary payment process, and shall be considered timely if made within 30 days of receipt of a properly completed invoice. All payments shall be subject to adjustment for any amounts, upon audit or otherwise, determined to have been improperly invoiced. The CITY may withhold payment to the CONTRACTOR for any services or deliverables not performed as required hereunder until such time as the CONTRACTOR modifies such services or deliverables to the satisfaction of the CITY.

12. Payment Method

The City's preferred method of payment is by ePayables (Payment Plus), followed by credit card (aka procurement card), then Electronic Funds Transfer (EFT) by Automated Clearing House (ACH), then check or other cash equivalent. CONTRACTOR may be required to have the capability of accepting the City's ePayables or credit card methods of payment. The City, in its sole discretion, will determine the method of payment for this Contract.

13. Independent Contractor Status

The services and deliverables shall be furnished by the CONTRACTOR as an independent Contractor, and nothing herein contained shall be construed to create an employer and employee relationship. The CONTRACTOR shall provide at its sole expense all materials, office space, and other necessities to perform its duties under this Contract, unless stated otherwise in this Contract. No payroll or employment taxes of any kind shall be withheld or paid by the CITY with respect to payments to CONTRACTOR. The payroll or employment taxes that are the subject of this paragraph include, but are not limited to, FICA, FUTA, federal income tax, state personal income tax, state disability insurance tax and state unemployment insurance tax. By reason of CONTRACTOR's status as an independent Contractor hereunder, no workers' compensation insurance has been or will be obtained by the CITY on account of CONTRACTOR. CONTRACTOR may be required to provide the CITY proof of payment of these said taxes and benefits. If the CITY is assessed or deemed liable in any manner for those charges or taxes, the CONTRACTOR agrees to hold the CITY harmless from those costs, including attorney's fees.

14. Services Warranty

The CONTRACTOR warrants that all services performed pursuant to this Contract shall be generally suitable for the use to which CITY intends to use said services and deliverables as expressed in the Scope of Work. In the performance of services under this Contract, the CONTRACTOR and its employees further agree to exercise the degree of skill and care required by customarily accepted good practices and procedures followed by professionals or service providers rendering the same or similar type of service. All obligations and services of the CONTRACTOR hereunder shall be performed diligently and completely according to such professional standards.

15.

16. Contract Administration

[INSERT NAME TITLE AND DEPARTMENT OF CONTRACT ADMINISTRATOR] for the CITY shall have primary responsibility for contract administration and approval of services to be performed by the CONTRACTOR, and shall coordinate all communications between the CONTRACTOR and the CITY.

17. Specific Personnel

If before, during, or after the execution of this Contract, CONTRACTOR represents to the CITY that certain personnel would or will be responsible for performing services and deliverables under this Contract, then the CONTRACTOR is obligated to ensure that said personnel perform said Contract services to the maximum extent permitted by law. This Contract provision shall only be waived by written authorization by the CITY, and on a case-by-case basis.

18.

19.

The CONTRACTOR shall establish and maintain records in accordance with requirements prescribed by the CITY, with respect to all matters related to the performance of this Contract. Except as otherwise authorized by the CITY, the CONTRACTOR shall retain such records for a period of _____[INSERT THE TIME THE RECORDS SHOULD BE KEPT. MOST COMMON IS 6 YEARS] years after receipt of the final payment under this Contract or termination of this Contract.

20. Notices

Except for routine operational communications, which may be delivered personally or transmitted by electronic mail all notices required hereunder shall be in writing and shall be deemed to have been duly given if delivered personally or mailed first-class mail, postage prepaid, to the parties at the following addresses:

CITY: Name: Title: Address: Telephone No.: E-mail:	CONTRACTOR: Name: Title: Address: Telephone No.: E-mail:

21. Termination

A. Except as otherwise provided herein, the CITY may terminate this Contract at any time, for CITY's own reasons and without cause, by giving ten (10) business days written notice to CONTRACTOR. In the event of termination, all finished and unfinished work prepared by the CONTRACTOR pursuant to this Contract shall be provided to the CITY. CITY may terminate this Contract in the event of any material breach of any of the terms and conditions of this Contract if CONTRACTOR's breach continues in effect after written notice of breach and 30 days to cure such breach and fails to cure such breach.

B. In the event CITY terminates this Contract due to the CITY's own reasons and without cause due to the CONTRACTOR's actions or omissions, the CITY shall pay the CONTRACTOR the amount due for actual work and services necessarily performed under this Contract up to the effective date of termination, not to exceed the total compensation set forth herein.

C. In the event of material default or breach by CONTRACTOR of any of the terms or conditions of the Contract, CITY may, at its election, procure services and deliverables under this CONTRACT from other sources, and may deduct from the unpaid balance due CONTRACTOR, or collect against the bond or security (if any), or may invoice and recover from CONTRACTOR all costs paid in excess of the price(s) set forth in the Contract.

D. Termination of this Contract by CITY shall not constitute a waiver of any claims or remaining rights the CITY may have against CONTRACTOR relative to performance hereunder.

22. Suspension

The CITY may suspend this Contract, at its sole discretion, upon seven (7) business days' written notice to the CONTRACTOR. Such notice shall indicate the anticipated period of suspension. Any reimbursement for expenses incurred due to the suspension shall be limited to the CONTRACTOR'S reasonable expenses and shall be subject to verification. The CONTRACTOR shall resume performance of services under this Contract without delay when the suspension period ends. Suspension of this Contract by CITY shall not constitute a waiver of any claims or remaining rights the CITY may have against CONTRACTOR relative to performance hereunder.

23. Federal Funds

If federal funds will be used to fund, pay or reimburse all or a portion of the services or deliverables provided under the Contract, the terms and conditions set forth at Appendix A to this Contract are incorporated into and made part of this Contract and CONTRACTOR will comply with all applicable provisions of Appendix A and with all applicable federal laws, regulations, executive orders, policies, procedures, and directives in the performance of this Contract. If CONTRACTOR's receipt of federal funds under this Contract is as a sub-recipient, Appendix B, "Sub-recipient Information and Requirements" must be completed and incorporated into and made part of this Contract.

24. Taxes

Unless stated otherwise herein, CONTRACTOR is responsible for the payment of all charges and taxes applicable to the services performed under this Contract, and CONTRACTOR agrees to comply with all applicable laws regarding the reporting of income, maintenance of records, and all other requirements and obligations imposed pursuant to applicable law. If the CITY is assessed, made liable, or responsible in any manner for such charges or taxes, the CONTRACTOR holds CITY harmless from such costs, including attorney's fees.

If CONTRACTOR fails to pay any taxes, assessments, penalties, or fees imposed by any governmental body, including by Tacoma City ordinance, and including by a court of law, CITY will deduct and withhold or pay over to the appropriate governmental body those unpaid amounts upon demand by the governmental body. Any such payments shall be deducted from the CONTRACTOR's total compensation.

25. Licenses and Permits

The CONTRACTOR, at its expense, shall obtain and keep in force any and all necessary licenses and permits. The CONTRACTOR shall obtain a business license as required by Tacoma Municipal Code Subtitle 6B.20 and shall pay business and occupation taxes as required by Tacoma Municipal Code Subtitle 6A.30. If applicable, CONTRACTOR must have a Washington state business license.

26. Indemnification

CONTRACTOR shall indemnify, defend, and hold harmless the CITY, its officials, officers, agents, employees, and volunteers, from any and all claims, demands, damages, lawsuits, liabilities, losses, liens, expenses and costs arising out of the subject matter of this Contract; provided that this provision shall not apply to the extent that damage or injury results from the sole negligence of the CITY, or its officers, agents, or employees. This indemnification shall extend to and include attorneys' fees and the cost of establishing the right of indemnification hereunder in favor of the CITY. This indemnification shall survive the termination of this Contract.

It is expressly agreed that with respect to design professional services performed by CONTRACTOR herein, CONTRACTOR's duty of indemnification, including the duty and cost to defend, against liability for damages arising out of such services or out of bodily injury to persons or damage to property shall, as provided in RCW 4.24.115 apply only to the extent of CONTRACTOR's negligence.

27. Title 51 Waiver

CONTRACTOR specifically assumes potential liability for actions brought by the CONTRACTOR'S own employees against the CITY and, solely for the purpose of this indemnification and defense, the CONTRACTOR specifically waives any immunity under the state industrial insurance law, Title 51 RCW. THE CONTRACTOR RECOGNIZES THAT THIS WAIVER WAS THE SUBJECT OF MUTUAL NEGOTIATION.

28. Insurance

During the course and performance of the services herein specified, CONTRACTOR will maintain the insurance coverage in the amounts and in the manner specified in the City of Tacoma Insurance Requirements as is applicable to the services and deliverables provided under this Contract. The City of Tacoma Insurance Requirements documents are fully incorporated herein by reference.

Failure by CITY to identify a deficiency in the insurance documentation provided by CONTRACTOR or failure of CITY to demand verification of coverage or compliance by CONTRACTOR with these insurance requirements shall not be construed as a waiver of CONTRACTOR's obligation to maintain such insurance.

29. Nondiscrimination

The CONTRACTOR agrees to take all steps necessary to comply with all federal, state, and City laws and policies regarding non-discrimination and equal employment opportunities. The CONTRACTOR shall not discriminate in any employment action because of race, religion, creed, color, national origin or ancestry, sex, gender identity, sexual orientation, age, marital status, familial status, veteran or military status, the presence of any sensory, mental or physical disability or the use of a trained dog guide or service animal by a disabled person. In the event of non-compliance by the CONTRACTOR with any of the non-discrimination provisions of this Contract, the CITY shall be deemed to have cause to terminate this Contract, in whole or in part.

30. Conflict of Interest

No officer, employee, or agent of the CITY, nor any member of the immediate family of any such officer, employee, or agent as defined by City ordinance, shall have any personal financial interest, direct or indirect, in this Contract, either in fact or in appearance. The CONTRACTOR shall comply with all federal, state, and City conflict of interest laws, statutes, and regulations. The CONTRACTOR represents that the CONTRACTOR presently has no interest and shall not acquire any interest, direct or indirect, in the program to which this Contract pertains which would conflict in any manner or degree with the performance of the CONTRACTOR'S services and obligations hereunder. The CONTRACTOR further covenants that, in performance of this Contract, no person having any such interest shall be employed. The CONTRACTOR also agrees that its violation of the CITY'S Code of Ethics contained in Chapter 1.46 of the Tacoma Municipal Code shall constitute a breach of this Contract subjecting the Contract to termination.

31.

32. Public Disclosure

This Contract and documents provided to the CITY by CONTRACTOR hereunder are deemed public records subject to disclosure under the Washington State Public Records Act, Chapter 42.56 RCW (Public Records Act). Thus, the CITY may be required, upon request, to disclose this Contract and documents related to it unless an exemption under the Public Records Act or other laws applies. In the event CITY receives a request for such disclosure, determines in its legal judgment that no applicable exemption to disclosure applies, and CONTRACTOR has complied with the requirements herein to mark all content considered to be confidential or proprietary, CITY agrees to provide CONTRACTOR ten (10) days written notice of impending release. Should legal action thereafter be initiated by CONTRACTOR to enjoin or otherwise prevent such release, all expense of any such litigation shall be borne by CONTRACTOR, including any damages, attorneys fees or costs awarded by reason of having opposed disclosure. CITY shall not be liable for any release where notice was provided and CONTRACTOR took no action to oppose the release of information. Notice of any proposed release of information pursuant to Chapter 42.56 RCW, shall be provided to CONTRACTOR according to the "Notices" provision herein.

33. Confidential or Proprietary Records Must be Marked

If CONTRACTOR provides the CITY with records that CONTRACTOR considers confidential or proprietary, CONTRACTOR must mark all applicable pages of said record(s) as “Confidential” or “Proprietary.” If CONTRACTOR fails to so mark record(s), then (1) the CITY, upon request, may release said record(s) without the need to satisfy the notice requirements above; and (2) the CONTRACTOR expressly waives its right to allege any kind of civil action or claim against the CITY pertaining to the release of said record(s).

34.

35. Approval for Release of Information Related to Contract

If requested by CITY, CONTRACTOR shall not release any information or documentation concerning the work under this Contract or any part thereof for marketing, advertising, or other commercial activities or publication including, but not limited to, news releases or professional articles without CITY’s prior written approval. CONTRACTOR may submit at any time for review and approval a generic abstract describing the component parts of the completed Scope of Services (“Project Abstract”). After receiving written approval of the Project Abstract from the CITY, the CONTRACTOR may make minor insignificant changes to the Project Abstract and use all or parts of the Project Abstract in proposals.

This Section shall survive for six (6) years after the termination or expiration of this Contract.

36. Dispute Resolution

In the event of a dispute pertaining to this Contract, the parties agree to attempt to negotiate in good faith an acceptable resolution. If a resolution cannot be negotiated, then the parties agree to submit the dispute to voluntary non-binding mediation before pursuing other remedies. This provision does not limit the CITY’S right to terminate authorized by this Contract.

37. Miscellaneous Provisions

Governing Law and Venue

Washington law shall govern the interpretation of this Contract. Pierce County shall be the venue of any mediation, arbitration, or litigation arising out of this Contract.

Assignment

The CONTRACTOR shall not assign, subcontract, delegate, or transfer any obligation, interest or claim to or under this Contract or for any of the compensation due hereunder without the prior written consent of the CITY.

No Third Party Beneficiaries

This Contract shall be for the sole benefit of the parties hereto, and nothing contained herein shall create a contractual relationship with, or create a cause of action in favor of, a third party against either party hereto.

Waiver

A waiver or failure by either party to enforce any provision of this Contract shall not be construed as a continuing waiver of such provisions, nor shall the same constitute a waiver of any other provision of this Contract.

Severability and Survival

If any term, condition or provision of this Contract is declared void or unenforceable or limited in its application or effect, such event shall not affect any other provisions hereof and all other provisions shall remain fully enforceable. The provisions of this Contract, which by their sense and context are reasonably intended to survive the completion, expiration or cancellation of this Contract, shall survive termination of this Contract.

Entire Agreement

This Contract and the attached Exhibits and Appendices, as modified herein, contain the entire agreement between the parties as to the services to be rendered hereunder. All previous and contemporaneous agreements, representations or promises and conditions relating to the subject matter of this Contract are superseded hereby. The Parties hereto mutually acknowledge, understand and agree that the terms and conditions set forth herein shall control and prevail over any conflicting terms and conditions stated in any attachments hereto.

Modification

No modification or amendment of this Contract shall be effective unless set forth in a written and executed Amendment to this Contract.

IN WITNESS WHEREOF, the Parties hereto have accepted and executed this Contract, as of the Effective Date stated above, which shall be Effective Date for bonding purposes as applicable. The undersigned Contractor representative, by signature below, represents and warrants they are duly authorized to execute this legally binding Contract for and on behalf of Contractor and further represents and warrants that Contractor is not suspended, debarred, or otherwise disqualified under federal, state, or local law from participating in this Contract.

CITY OF TACOMA:	CONTRACTOR:
Signature:	Signature:
Name:	Name:
Title:	Title:

(City of Tacoma use only - blank lines are intentional)

Director of Finance: _____

Deputy/City Attorney (approved as to form): _____

Approved By: _____

Approved By: _____

Approved By: _____

Approved By: _____

Approved By: _____

Approved By: _____

Approved By: _____

Approved By: _____

APPENDIX A

FEDERAL FUNDING

1. COPELAND ANTI-KICKBACK ACT

For Contracts subject to Davis Bacon Act the following clauses will be incorporated into the Contract:

A. CONTRACTOR shall comply with 18 U.S.C. § 874, 40 U.S.C. § 3145, and the requirements of 29 C.F.R. pt. 3 as may be applicable, which are incorporated by reference into this Contract.

B. CONTRACTOR or subcontractor shall insert in any subcontracts the clause above and such other clauses federal agencies may by appropriate instructions require, and also a clause requiring the subcontractors to include these clauses in any lower tier subcontracts. The prime contractor shall be responsible for the compliance by any subcontractor or lower tier subcontractor with all of these Contract clauses.

C. Breach. A breach of the contract clauses above may be grounds for termination of the contract, and for debarment as a contractor and subcontractor as provided in 29 C.F.R. § 5.12.

2. EQUAL EMPLOYMENT OPPORTUNITY

During the performance of this Contract, CONTRACTOR will not discriminate against any employee or applicant for employment because of race, color, religion, sex, sexual orientation, gender identity, or national origin. If the CONTRACTOR does over $10,000 in business a year that is funded, paid or reimbursed with federal funds, CONTRACTOR will take specific and affirmative action to ensure that applicants are employed, and that employees are treated during employment without regard to their race, color, religion, sex, sexual orientation, gender identity, or national origin. Such action shall include, but not be limited to the following:

A. Employment, upgrading, demotion, or transfer; recruitment or recruitment advertising; layoff or termination; rates of pay or other forms of compensation; and selection for training, including apprenticeship. CONTRACTOR agrees to post in conspicuous places, available to employees and applicants for employment, notices to be provided setting forth the provisions of this nondiscrimination clause.

B. CONTRACTOR will, in all solicitations or advertisements for employees placed by or on behalf of the Contractor, state that all qualified applicants will receive consideration for employment without regard to race, color, religion, sex, sexual orientation, gender identity, or national origin.

C. CONTRACTOR will not discharge or in any other manner discriminate against any employee or applicant for employment because such employee or applicant has inquired about, discussed, or disclosed the compensation of the employee or applicant or another employee or applicant. This provision shall not apply to

instances in which an employee who has access to the compensation information of other employees or applicants as a part of such employee's essential job functions discloses the compensation of such other employees or applicants to individuals who do not otherwise have access to such information, unless such disclosure is in response to a formal complaint or charge, in furtherance of an investigation, proceeding, hearing, or action, including an investigation conducted by the employer, or is consistent with the Contractor's legal duty to furnish information.

D. CONTRACTOR will send to each labor union or representative of workers with which he has a collective bargaining agreement or other contract or understanding, a notice to be provided advising the said labor union or workers' representatives of the contractor's commitments under this section, and shall post copies of the notice in conspicuous places available to employees and applicants for employment.

E. CONTRACTOR will comply with all provisions of Executive Order 11246 of September 24, 1965, and of the rules, regulations, and relevant orders of the Secretary of Labor.

G. In the event of CONTRACTOR's noncompliance with the nondiscrimination clauses of this contract or with any of the said rules, regulations, or orders, this Contract may be canceled, terminated, or suspended in whole or in part and the CONTRACTOR may be declared ineligible for further federally funded contracts in accordance with procedures authorized in Executive Order 11246 of September 24, 1965, and such other sanctions may be imposed and remedies invoked as provided in Executive Order 11246 of September 24, 1965, or by rule, regulation, or order of the Secretary of Labor, or as otherwise provided by law.

H. CONTRACTOR will include the portion of the sentence immediately preceding paragraph (A) and the provisions of paragraphs (A) through (G) in every subcontract or purchase order unless exempted by rules, regulations, or orders of the Secretary of Labor issued pursuant to section 204 of Executive Order 11246 of September 24, 1965, so that such provisions will be binding upon each subcontractor or vendor. CONTRACTOR will take such action with respect to any subcontract or purchase order as the administering agency may direct as a means of enforcing such provisions, including sanctions for noncompliance:

Provided, however, that in the event CONTRACTOR becomes involved in, or is threatened with, litigation with a subcontractor or vendor as a result of such direction by the administering agency, the CONTRACTOR may request the United States to enter into such litigation to protect the interests of the United States.

3. CONTRACT WORK HOURS AND SAFETY STANDARDS ACT

A. Overtime requirements. Neither CONTRACTOR or subcontractor contracting for any part of the Contract work which may require or involve the employment of laborers or mechanics shall require or permit any such laborer or mechanic in any workweek in which he or she is employed on such work to work in excess of forty hours in such workweek unless such laborer or mechanic receives compensation at a rate not less than one and one-half times the basic rate of pay

for all hours worked in excess of forty hours in such workweek.

B. Violation; liability for unpaid wages; liquidated damages. In the event of any violation of the clause set forth in paragraph (3)(A) of this section the CONTRACTOR and any subcontractor responsible therefor shall be liable for the unpaid wages. In addition, such CONTRACTOR and subcontractor shall be liable to the United States (in the case of work done under contract for the District of Columbia or a territory, to such District or to such territory), for liquidated damages. Such liquidated damages shall be computed with respect to each individual laborer or mechanic, including watchmen and guards, employed in violation of the clause set forth in paragraph (3)(A) of this section, in the sum of $27 for each calendar day on which such individual was required or permitted to work in excess of the standard workweek of forty hours without payment of the overtime wages required by the clause set forth in paragraph (3)(A) of this section.

C. Withholding for unpaid wages and liquidated damages. The CITY shall upon its own action or upon written request of an authorized representative of the Department of Labor withhold or cause to be withheld, from any moneys payable on account of work performed by the CONTRACTOR or subcontractor under any such contract or any other Federal contract with the same prime contractor, or any other federally-assisted contract subject to the Contract Work Hours and Safety Standards Act, which is held by the same prime contractor, such sums as may be determined to be necessary to satisfy any liabilities of such CONTRACTOR or sub-contractor for unpaid wages and liquidated damages as provided in the clause set forth in paragraph (3)(B) of this section.

D. Subcontracts. The Contractor or subcontractor shall insert in any subcontracts the clauses set forth in paragraph (3)(A) through (D) of this section and also a clause requiring the subcontractors to include these clauses in any lower tier subcontracts. The prime CONTRACTOR shall be responsible for compliance by any subcontractor or lower tier subcontractor with the clauses set forth in paragraphs (3)(A) through (D) of this section.

4. CLEAN AIR ACT

A. CONTRACTOR agrees to comply with all applicable standards, orders or regulations issued pursuant to the Clean Air Act, as amended, 42 U.S.C. § 7401 et seq.

B. CONTRACTOR agrees to report each violation to the CITY and understands and agrees that the CITY will, in turn, report each violation as required to assure notification to the Federal Emergency Management Agency, and the appropriate Environmental Protection Agency Regional Office.

CONTRACTOR agrees to include these requirements in each subcontract exceeding $150,000 financed in whole or in part with federal funds.

5. FEDERAL WATER POLLUTION CONTROL ACT

A. CONTRACTOR agrees to comply with all applicable standards, orders, or

regulations issued pursuant to the Federal Water Pollution Control Act, as amended, 33 U.S.C. 1251 et seq.

B. CONTRACTOR agrees to report each violation to the CITY and understands and agrees that the CITY will, in turn, report each violation as required to assure notification to the appropriate federal agency.

C. CONTRACTOR agrees to include these requirements in each subcontract exceeding $150,000 financed in whole or in part with federal funding.

6. DEBARMENT AND SUSPENSION

A. This Contract is a Covered Transaction for purposes of 2 C.F.R. pt. 180 and 2 C.F.R. pt. 3000. As such, the CONTRACTOR is required to verify that none of the contractor's principals (defined at 2 C.F.R. § 180.995) or its affiliates (defined at 2 C.F.R. § 180.905) are excluded (defined at 2 C.F.R. § 180.940) or disqualified (defined at 2 C.F.R. § 180.935).

B. CONTRACTOR must comply with 2 C.F.R. pt. 180, subpart C and2 C.F.R. pt. 3000, subpart C, and must include a requirement to comply with these regulations in any lower tier Covered Transaction it enters into.

C. This certification is a material representation of fact relied upon by the CITY. If it is later determined that the CONTRACTOR did not comply with 2 C.F.R. pt. 180, subpart C and 2 C.F.R. pt. 3000, subpart C, in addition to remedies available to CITY, the Federal Government may pursue available remedies, including but not limited to suspension and/or debarment.

D. CONTRACTOR agrees to comply with the requirements of 2 C.F.R. pt. 180, subpart C and 2 C.F.R. pt. 3000, subpart C throughout the period of this Contract and to include a provision requiring such compliance in its lower tier covered transactions.

7. BYRD ANTI-LOBBYING AMENDMENT

A. Contractors who apply or bid for an award of $100,000 or more shall file the required certification with CITY. Each tier certifies to the tier above that it will not and has not used Federal appropriated funds to pay any person or organization for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, officer or employee of Congress, or an employee of a Member of Congress in connection with obtaining any Federal contract, grant, or any other award covered by 31 U.S.C. § 1352. Each tier shall also disclose any lobbying with non-Federal funds that takes place in connection with obtaining any Federal award. Such disclosures are forwarded from tier to tier up to the recipient who in turn will forward the certification(s) to the CITY.

B. If applicable, CONTRACTOR certification required by Appendix A to 44 CFR Part 18 contained at Appendix A-1 to this Contract is incorporated into this Contract.

8. PROCUREMENT OF RECOVERED MATERIALS

A. In the performance of this Contract, CONTRACTOR shall make maximum use of products containing recovered materials that are EPA-designated items unless the product cannot be acquired:

1. Competitively within a timeframe providing forcompliance with the contract performance schedule;

2. Meeting contract performance requirements; or

3. At a reasonable price.

B. Information about this requirement, along with the list of EPA- designated items, is available at EPA's Comprehensive Procurement Guidelines web site, https://www.epa.gov/smm/comprehensive- procurement-guideline-cpg-program.

C. CONTRACTOR also agrees to comply with all other applicable requirements of Section 6002 of the Solid Waste Disposal Act.

9. CONTRACTOR shall be required to comply with 2 CFR part 25, and obtain a unique entity identifier and/or be registered in the federal System for Award Management as appropriate.

APPENDIX A-1

APPENDIX A to 44 C.F.R. PART 18 – CERTIFICATION REGARDING LOBBYING
Certification for Contracts, Grants, Loans, and Cooperative Agreements

Supplier certifies, to the best of his or her knowledge and belief, that:

1. No Federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of an agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any Federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.

2. If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, “Disclosure Form to Report Lobbying,” in accordance with its instructions.

3. The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers (including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements) and that all subrecipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by section 1352, title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure.

Supplier, by Contract signature, certifies or affirms the truthfulness and accuracy of each statement of its certification and disclosure, if any. In addition, the Contractor understands and agrees that the provisions of 31 U.S.C. Chap.38, Administrative Remedies for
False Claims and Statements, apply to this certification and disclosure, if any.

APPENDIX B—Sub-recipient information and requirements

Pursuant to 2 CFR 200.332(a)(1) Federal Award Identification

<table>
<tr><td colspan="2">(i) Agency Name (must match the name associated with its unique entity identifier)</td><td>(ii) Unique Entity Identifier
(i.e., DUNS)</td><td>City of Tacoma Number for This Agreement</td></tr>
<tr><td>(iii) Federal Award Identification Number (FAIN)</td><td>(iv) Federal Award Date</td><td>(v) Federal Period of Performance Start and End Date</td><td>(vi) Federal Budget Period Start and End Date</td></tr>
<tr><td>(vii) Amount of Federal Funds Obligated to the agency by this action:
$</td><td colspan="2">(viii) Total Amount of Federal Funds <i>Obligated</i> to the agency</td><td>(ix) Total Amount of the Federal Award <i>Committed</i> to the agency
$</td></tr>
<tr><td colspan="4">(x) Federal Award Project Description:

CORONAVIRUS STATE AND LOCAL FISCAL RECOVERY FUNDS– City of Tacoma</td></tr>
<tr><td>(xi) Federal Awarding Agency:
DEPARTMENT OF THE TREASURY</td><td>Pass-Through Entity:
City of Tacoma</td><td colspan="2">Awarding Official Name and Contact Information:</td></tr>
<tr><td colspan="3">(xii) Assistance Listing Number and Name (the pass-through entity must identify the dollar amount made available under each Federal award and the Assistance Listing number at time of disbursement)</td><td>(xiii) Identification of Whether the Award is R&D</td></tr>
<tr><td>(xiv) Indirect Cost Rate for the Federal Award</td><td colspan="2">Award Payment Method (lump sum payment or reimbursement)
REIMBURSEMENT</td><td></td></tr>
</table>

CITY OF TACOMA
INSURANCE REQUIREMENTS FOR CONTRACTS

This Insurance Requirements shall serve as an attachment and/or exhibit form to the Contract. The Agency entering a Contract with City of Tacoma, whether designated as a Supplier, Contractor, Vendor, Proposer, Bidder, Respondent, Seller, Merchant, Service Provider, or otherwise referred to as "Contractor".

1. GENERAL REQUIREMENTS

The following General Requirements apply to Contractor and to Subcontractor(s) performing services and/or activities pursuant to the terms of this Contract. Contractor acknowledges and agrees to the following insurance requirements:

1.1. Contractor shall not begin work under the Contract until the required insurance has been obtained and approved by the City of Tacoma.

1.2. Contractor shall keep in force during the entire term of the Contract, at no expense to the City of Tacoma, the insurance coverage and limits of liability listed below and for Thirty (30) calendar days after completion of all work required by the Contract, unless otherwise provided herein.

1.3. Liability insurance policies, except for Professional Liability and Workers' Compensation, shall:

- 1.3.1. Name the City of Tacoma and its officers, elected officials, employees, and agents as **additional insured**
- 1.3.2. Be considered primary and non-contributory for all claims with any insurance or self-insurance or limits of liability maintained by the City of Tacoma
- 1.3.3. Contain a "Waiver of Subrogation" clause in favor of City of Tacoma
- 1.3.4. Include a "Separation of Insureds" clause that applies coverage separately to each insured and additional insured
- 1.3.5. Name the "City of Tacoma" on certificates of insurance and endorsements and not a specific person or department
- 1.3.6. Be for both ongoing and completed operations using Insurance Services Office (ISO) form CG 20 10 04 13 and CG 20 37 04 13 or the equivalent
- 1.3.7. Be satisfied by a single primary limit or by a combination of a primary policy and a separate excess umbrella

1.4. A notation of coverage enhancements on the Certificate of Insurance shall not satisfy these requirements below. Verification of coverage shall include:

- 1.4.1. An ACORD certificate or equivalent
- 1.4.2. Copies of requested endorsements

1.5. Contractor shall provide to City of Tacoma Procurement & Payable Division, prior to the execution of the Contract, Certificate(s) of Insurance and endorsements from the insurer certifying the coverage of all insurance required herein. Contract or Permit number and the City of Tacoma Department must be shown on the Certificate of Insurance.

1.6. A renewal Certificate of Insurance shall be provided electronically prior to coverage expiration via email sent annually to coi@cityoftacoma.org.

1.7. Contractor shall send a notice of cancellation or non-renewal of this required insurance within Thirty (30) calendar days to coi@cityoftacoma.org.

1.8. "Claims-Made" coverages, except for pollution coverage, shall be maintained for a minimum of three years following the expiration or earlier termination of the Contract. Pollution coverage shall be maintained for six years following the expiration of the Contract. The retroactive date shall be prior to or coincident with the effective date of the Contract.

1.9. Each insurance policy must be written by companies licensed or authorized (or issued as surplus line by Washington surplus line broker) in the State of Washington pursuant to RCW 48 with an (A-) VII or higher in the A.M. Best key rating guide.

1.10. Contractor shall not allow any insurance to be cancelled, voided, suspended, or reduced in coverage/limits, or lapse during any term of this Contract. Otherwise, it shall constitute a material breach of the Contract.

1.11. Contractor shall be responsible for the payment of all premiums, deductibles and self-insured retentions, and shall indemnify and hold the City of Tacoma harmless to the extent such a deductible or self-insured retained limit may apply to the City of Tacoma as an additional insured. Any deductible or self-insured retained limits in excess of Twenty Five Thousand Dollars ($25,000) must be disclosed and approved by City of Tacoma Risk Manager and shown on the Certificate of Insurance.

1.12. City of Tacoma reserves the right to review insurance requirements during any term of the Contract and to require that Contractor make reasonable adjustments when the scope of services changes.

1.13. All costs for insurance are included in the initial Contract and no additional payment will be made by City of Tacoma to Contractor.

1.14. Insurance coverages specified in this Contract are not intended and will not be interpreted to limit the responsibility or liability of Contractor or Subcontractor(s).

1.15. Failure by City of Tacoma to identify a deficiency in the insurance documentation or to verify coverage or compliance by Contractor with these insurance requirements shall not be construed as a waiver of Contractor's obligation to maintain such insurance.

1.16. If Contractor is a government agency or self-insured for any of the above insurance requirements, Contractor shall be liable for any self-insured retention or deductible portion of any claim for which insurance is required. A certification of self-insurance shall be attached and incorporated by reference and shall constitute compliance with this Section.

2. SUBCONTRACTORS

It is Contractor's responsibility to ensure that each subcontractor obtain and maintain adequate liability insurance coverage that applies to the service provided. Contractor shall provide evidence of such insurance upon City of Tacoma's request. Failure of any subcontractor to comply with insurance requirements does not limit Contractor's liability or responsibility.

3. REQUIRED INSURANCE AND LIMITS

The insurance policies shall provide the minimum coverages and limits set forth below. Providing coverage in these stated minimum limits shall not be construed to relieve Contractor from liability in excess of such limits.

3.1 Commercial General Liability Insurance

Contractor shall maintain Commercial General Liability Insurance policy with limits not less than One Million Dollars ($1,000,000) each occurrence and Two Million Dollars ($2,000,000) annual aggregate. This policy shall be written on ISO form CG 00 01 04 13 or its equivalent and shall include product liability especially when a Contract is solely for purchasing supplies. It includes Products and Completed Operations for three years following the completion of work related to performing construction services. It shall be endorsed to include: A per project aggregate policy limit (using ISO form CG 25 03 05 09 or equivalent endorsement)

3.2 Commercial (Business) Automobile Liability Insurance

Contractor shall maintain Commercial Automobile Liability policy with limits not less than One Million Dollars ($1,000,000) each accident for bodily injury and property damage and bodily injury and property damage coverage for owned (if any), non-owned, hired, or leased vehicles. Commercial Automobile Liability Insurance shall be written using ISO form CA 00 01 or equivalent. Contractor must also maintain MCS 90 and CA 99 48 endorsements or equivalent if "Pollutants" are to be transported unless in-transit Pollution coverage is covered under required Contractor's Pollution Liability Insurance.

3.3 Workers' Compensation

Contractor shall comply with Workers' Compensation coverage as required by the Industrial Insurance laws of the State of Washington, as well as any other similar coverage required for this work by applicable federal laws of other states. Contractor must comply with their domicile State Industrial Insurance laws if it is outside the State of Washington.

3.4 Employers' Liability Insurance

Contractor shall maintain Employers' Liability coverage with limits not less than One Million Dollars ($1,000,000) each employee, One Million Dollars ($1,000,000) each accident, and One Million Dollars ($1,000,000) policy limit.

3.5 Professional Liability Insurance or Errors and Omissions

For contracts with professional licensing, design, or engineering services. Contractor and/or its subcontractor shall maintain Professional Liability or Errors and Omissions with limits of One Million Dollars ($1,000,000) per claim and Two Million Dollars ($2,000,000) in the aggregate covering acts, errors and omissions arising out of the professional services under this Contract. Contractor shall maintain this coverage for Two Million Dollars ($2,000,000) if the policy limit includes the payment of claims or defense costs, from the policy limit. If the scope of such design-related professional services includes work related to pollution conditions, the Professional Liability policy shall include Pollution Liability coverage.

3.6 Excess or Umbrella Liability Insurance

Contractor shall provide Excess or Umbrella Liability Insurance with limits not less than Three Million Dollars ($3,000,000) per occurrence and in the aggregate. This coverage shall apply, at a minimum, in excess of primary underlying Commercial General Liability, Employer's Liability, Pollution Liability, Marine General Liability, Protection and Indemnity, and Automobile Liability if required herein.

3.7 Other Insurance

Other insurance may be deemed appropriate to cover risks and exposures related to the scope of work or changes to the scope of work required by City of Tacoma. The costs of such necessary and appropriate Insurance coverage shall be borne by Contractor.