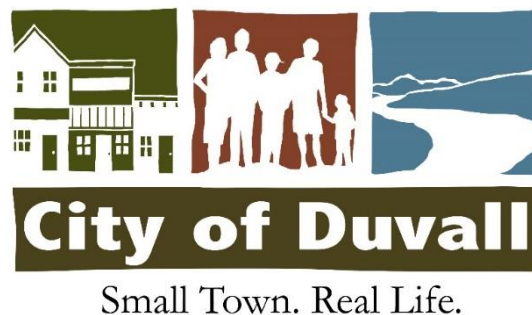


CITY OF DUVALL

Big Rock Road 2.2 MG Reservoir Improvements

REQUEST FOR QUALIFICATIONS



ISSUE DATE: Thursday, May 1st, 2025
SUBMITTALS DUE: Thursday, May 22nd, 2025, 12:00 PM PDT

1.1 REQUEST FOR QUALIFICATIONS

The City of Duvall is seeking interest and qualifications from experienced consultants to design Duvall's 2.2MG Reservoir Improvement project. Duvall is soliciting all consultants who have selected the following Engineering Services subcategories:

- Pump Station Design and Rehabilitation – Municipal Water System
- Reservoir Rehabilitation and Replacement - Municipal Water System
- Water System Planning and Design on the MRSC Consultant Roster

1.2 BACKGROUND / PROJECT DESCRIPTION

The City of Duvall, Washington, a community of approximately 8,500 residents, is situated in the northeast corner of King County, near the Cascade Mountain foothills to the east and the agricultural Snoqualmie River valley to the west. Incorporated in 1913, Duvall's history is rooted in the logging and farming industries, and the City actively works to maintain its charming heritage and small-town atmosphere, which attracts many seeking a "country living" experience. Governed by a Mayor and a seven-member City Council, Duvall purchases its water wholesale from Seattle Public Utilities (SPU) and distributes it to its customers through two intertie connections to the SPU Tolt pipeline.

A crucial element of Duvall's water infrastructure is the "450 Zone 2.2 MG Big Rock Road Reservoir," a 2.2-million-gallon, 138-foot diameter, 27-foot tall, welded steel reservoir constructed in 1996. Located off NE Big Rock Road and south of Roney Road, this reservoir provides water storage directly to the 450 Zone and indirectly to other zones within the system. The reservoir site is shared with the City's "615 Zone Booster Pump Station," which currently houses one 350-gpm vertical turbine pump with a 30 hp motor and two 1,000-gpm vertical turbine pumps with 60 hp motors. The station has pre-integrated space and piping for a fourth pump. The reservoir, with a base elevation of approximately 430 feet and an overflow elevation at 450.5 feet, provides approximately 111,000 gallons of storage per foot of height. It is equipped with a single 12-inch water main that serves as its common fill and drain (inlet/outlet) pipe, along with an external level gauge and an internal level sensor for accurate level measurements used for data logging and level control purposes. The reservoir can be filled from the 450 Zone with water from Tolt 2 Supply Station through a 12-inch transmission main in Big Rock Road or from the 615 Zone through a 6-inch altitude valve. This altitude valve, located onsite and adjacent to the 615 Zone Booster Pump Station building in a below-grade concrete vault, is programmed with a delayed opening and is also equipped with an intrusion alarm.

To ensure the long-term reliability and capacity of the reservoir and the associated pumping infrastructure to meet future demands, the City is undertaking the 2.2MG Reservoir Improvement project. This project will involve several key upgrades at both the reservoir and the pump station: installing a new fourth pump in the pre-existing space to increase capacity, and assessing the need to replace one or more of the three existing pumps, assessing seismic adequacy of reservoir and pump station, rehabilitating the reservoir's interior and exterior coatings (the interior was cleaned in 2016 and is



scheduled to be cleaned again in 2025) and implementing measures such as cathodic protection and sealing internal welds to mitigate corrosion, installing a new dedicated inlet with a mixing system (like TideFlex or an equivalent solution) to enhance water quality and assist in maintaining chlorine residuals, upgrading all electrical components and control hardware to accommodate new equipment, and upsizing the 12-inch overflow PVC pipe to improve resilience against potential supply control failures. The system also includes backpressure sustaining and pressure relief mechanisms to maintain minimum pressures and to relieve excess pressures in the 615 Zone.

The City has allocated a budget of \$2,000,000 in its 2025/2026 Biennium Budget for both the design and construction phases of this improvement. The City's ideal timeline is to bid the construction in the Summer of 2026, with construction commencing in the Fall of 2026 to coincide with reduced water demand after the summer peak. If the selected firm has construction management capabilities, the City may opt to extend this design contract through construction.

1.3 SOLICITATION & SELECTION SCHEDULE

Schedule of Events	Date	Notes
MRSC Solicitation	May 1, 2025	
Deadline for questions	Mon., May 19, 2025 by 12:00 PM PDT	Submit questions in .pdf form to City Project Manager <u>by e-mail only</u> . Questions will be answered as soon as possible.
City final response to questions	Mon., May 19, 2025 by EOD	Questions and responses will be posted on the project website listed below under Questions & Answers
Qualifications Due	Thurs., May 22, 2025, by 12:00 PM PDT	
Short listed Consultants notified	Fri., May 30, 2025	Additional review time may be needed. Please follow webpage schedule for updates.
Consultant interviews	Tues., June 10, 2025	<i>Up to the top 3 may be interviewed.</i>
City selects successful Consultant	Wed., June 11, 2025, EOD	
Contract Awarded by City Council	Tues., July 1, 2025	Will be extended to next available Council Meeting if additional negotiation time is needed.
Anticipated start	ASAP	



1.4 POINT OF CONTACT

Please direct any questions concerning this RFQ to the City’s Project Manager listed below. Only written questions will be considered. Submit questions in the form of a .pdf document attached to an e-mail. Questions received after the deadline identified in the Proposed Timeline may not be considered. Unauthorized contact regarding this RFQ with other City employees may result in disqualification of a submittal. Any oral communications will be considered unofficial and non-binding on the City.

City Contact:

Benjamin Sackett, Project Manager
City of Duvall
PO Box 1300 Duvall, WA 98019
Phone: (425) 667-9766
Email: benjamin.sackett@duvallwa.gov
CC: PM@duvallwa.gov and bids@duvallwa.gov

Questions will be answered in writing and posted on the project website’s Current Projects, Bid Opportunities section at: <https://www.duvallwa.gov/303/Current-Projects>. It is the responsibility of individual firms to check this website for any amendments or Q&As related to this RFQ.

1.5 EVALUATION PROCESS

Responses may be reviewed by staff alone, or by a committee consisting of staff from Public Works, other City Staff, and/or anyone appointed by the Mayor.

Responses are limited to 10 pages **excluding** the cover letter and resumes.

Evaluation of responses will be based on the following:

Evaluation Criteria	Maximum Score
Cover Letter	n/a
History and Experience of Providing Similar Services	30
Technical Expertise and Qualifications	50
Support Proximity and Availability to the City of Duvall	10
Unique and/or Ancillary Support Services	5
Presentation Clarity	5
Subtotal	100
Interviews (if needed)	100

Cover Letter (Not Scored)

The Cover Letter is not scored and does not count toward the submittal page limit. At a minimum, please include the bulleted information below:

- The name of the firm, as well as the signature, printed name and title, telephone number, and email address of the persons authorized to represent the firm in any correspondence, negotiations, and sign any contracts that may result.
- The address of the office that will be providing the service, project manager's name, telephone number, and email address.
- The Federal and State tax identification numbers, and the state of incorporation.
- Indicate whether the firm is a registered Minority, Woman, or Disadvantaged Business Enterprise (MWDBE). If so, please include relevant certification documentation. The City will award 5 bonus points to firms with current MWDBE registration at the time of the submission.

History and Experience Providing Similar Design Services (Weight: 30 Points)

Provide a description of similar previous design work (minimum 3 examples) demonstrating the firm's quality of design, ability to meet schedules, manage budgets, and effectively coordinate with clients. For each example, provide at least the following information:

- Project name (e.g., [Name of Previous Water Tank Upgrade Design Project])
- Name and location of client (e.g., [Name of City/Water District], [Location])
- Summary of the scope of design services provided (specifically highlight similar experience relevant to this pump station upgrade including pump sizing assessment and integration, reservoir inlet and mixing system design, electrical design for similar equipment, tank coating/repair design, etc.)
- Duration of design service to client (start and end dates)
- Budget (starting and ending costs)
- Client reference name and contact information (name, title, phone number, email address)
 - Note: The City may use the contact information provided to gain a reference.

Technical Expertise and Qualifications (Weight: 50 Points)

Describe the firm's expertise and qualifications in the following specific areas relevant to this project:

- **Pump Station Design and Upgrades:** Demonstrated experience in the design of pump station upgrades, including the addition of new pumps and assessment of existing pump capacity for future demand. Detail your firm's approach to hydraulic analysis and pump selection.

- **Reservoir Inlet and Mixing System Design:** Specific experience in the design of new reservoir inlets to improve water quality and the integration of mixing systems (preferably Tideflex or similar technologies). Describe your understanding of reservoir hydraulics and mixing principles.
- **Electrical Design for Water Infrastructure:** Proven expertise in the electrical design required for water infrastructure projects, including power distribution, control systems, and integration of new equipment (pumps, mixing systems).
- **Water Tank Coating and Repair Design:** Experience in developing design specifications for the repair of damaged exterior coatings, total recoating of tank roofs (mentioning experience with polyurethane coatings is beneficial if applicable), and sealing of interior weld joints for water storage tanks. Include knowledge of relevant industry standards and best practices.
- **Project Management for Water Infrastructure Design:** Describe your firm's approach to managing design projects for municipal water utilities, including schedule control, budget management, and communication with clients.

Provide a work chart of the firm's proposed team for this project, clearly outlining roles and responsibilities. Provide resumes for key team members, highlighting their relevant experience with similar projects to support information listed above. Resumes do not count toward the page limit but shall not be longer than 2 pages per person.

Proximity and Availability to the City of Duvall (Weight: 10 Points)

Describe the availability of the firm's personnel to the City of Duvall for project-related communication, meetings, and potential site visits during the design phase. Detail the proximity of the project manager and key design team members to Duvall, the anticipated response time for inquiries, and the methods of communication your firm utilizes to ensure effective collaboration.

Unique and/or Ancillary Support Services (Weight: 5 Points)

Describe any unique design-related services or specialized expertise that your firm offers or may offer through existing subconsultant/subcontractor relationships that could benefit this specific Water Tank and Pump Station Upgrade Design project. This might include specialized modeling software, advanced analysis capabilities, system knowledge, or specific expertise in permitting for similar projects in the region.

Presentation Clarity (Weight: 5 Points)

The submitted presentation must be organized in accordance with the list of scoring criteria categories. Submitted presentations will be evaluated on the following "clarity" factors: presentation format; ease of finding concise responses that correlate with the order of evaluation criteria in this RFQ; and the firm's attention to detail. Presentations should be prepared simply and economically. Special formats, colored displays,



promotional materials, etc., are not necessary. Emphasis should be on completeness, brevity, and clarity of content.

1.6 SUBMITTAL REQUIREMENTS / PROCESS

Interested firms shall submit an electronic copy of their response in PDF via email to Benjamin Sackett at benjamin.sackett@duvallwa.gov and CC bids@duvallwa.gov.

The email shall include “**2.2MG Reservoir Improvements – [Consultant Name]**” in the subject line. Responses must be received by the submittal deadline specified in section 1.3.

Submittals should not be excessively long or exceed 10 pages excluding the cover letter and resumes.

1.7 INTERVIEW

If warranted, the City will request interviews with, at most, the top three candidates. Interviews will consist of a series of questions with a maximum score of 100 points. The initial questions will be the same for all firms, but the City will be allowed to ask follow up questions related to the firm’s SOQ and/or previous interview answers. Interviews will be conducted over Microsoft Teams. The timing for the interviews is outlined in Section 1.3.

2.1 ANTICIPATED SCOPE OF SERVICES

The Scope of Services presented below is intended only to illustrate the services likely to be needed. The final work plan will be mutually agreed in terms of scope of work, fee proposal and availability of budgeted funds:

Project Management and Coordination

- Overall project management for the design phase of the reservoir and zone pump station upgrade.
- Coordination with City staff and other stakeholders throughout the design process.
- Development and management of a design schedule to meet the City's target bidding timeframe of Summer 2026.
- Regular progress reporting and communication of any potential schedule or budget impacts.

Pump Station Upgrade Design

- Detailed design for the addition of a fourth pump to the existing 615 zone pump station, ensuring seamless integration with the current system.
- Assessment of the existing pump configuration (one 30HP, two 60HP) in relation to projected future water demand. This assessment shall include a recommendation on whether an upgrade to one of the existing pumps is necessary to ensure long-term system capacity.
- Design of all necessary piping modifications, valve arrangements, and connections for the new and potentially upgraded pump(s).
- Integration of the new and upgraded pump(s) with the existing pump control system.
- Assessment of seismic adequacy based on modern seismic load criteria
-

Reservoir Inlet and Mixing System Design

- Design of a new dedicated inlet to the 2.2 MG water reservoir to enhance water quality through improved mixing. The design should consider optimal placement and hydraulic characteristics for effective water circulation.
- Selection and design of a Tideflex mixing system (or similar) suitable for the reservoir's size and operational requirements to further enhance water quality.
- Design of all the necessary piping and connections for the new inlet and Tideflex system.

Electrical Design

- Design of all necessary electrical upgrades to support the new fourth pump and any potential upgrades to existing pumps. This includes power supply, wiring, controls, and integration with the existing electrical infrastructure.
- Assessment of the existing electrical capacity at the site to ensure it can accommodate the new equipment.

Tank Coating and Repair Design

- Development of design details, specifications, and locations for the repair of damaged exterior coatings on the reservoir.
- Development of design details, specifications, and locations for cathodic protection.
- Development of design details, specifications, and locations for sealing the interior weld joints of the reservoir.
- Assessment of seismic adequacy based on modern seismic load criteria
-

Permitting / Agency Coordination

- City Permits: Commercial, Mechanical, Plumbing, Electrical
- DOH Coordination of project as required

Deliverables

- 30-60-90-100% Design Submittals
- Detailed design specifications for all new equipment, modifications, and repairs.
- Electrical design plans and schematics.
- Preliminary cost estimates for the construction phase of the project, aligning with the City's overall budget of \$2,000,000 for design and construction.
- Identification of any necessary permits and regulatory approvals.
- A phasing plan for potential construction activities.

Construction Management Services (Possible Contract Amendment)

If the selected project team has Construction Management capabilities, the City reserves the opportunity to amend this design contract to include CM services at the time this project goes to construction.

3.1 TERMS AND CONDITIONS

The City reserves the right to amend the terms of this Request for Qualifications (RFQ), to circulate various addenda, or to withdraw the RFQ at any time, regardless of how much time and effort Consultants have spent on their responses.

By submitting a Statement of Qualifications, the Consultant is indicating they have read and agree with the contract terms in the “CONTRACT FOR PROFESSIONAL SERVICES”, Attachment A.

The City reserves the right to reject any and all responses to this RFQ and to waive irregularities and informalities in the submittal and evaluation process. This solicitation for Consultant services does not oblige the City to pay any costs incurred by respondents in the preparation and submission of a response. This solicitation does not oblige the City to accept or contract for any expressed or implied services. Furthermore, the City reserves the right to award the contract to the next most qualified Consultant if the selected Consultant does not execute a contract within thirty (30) days after the award of the presentation. The City’s standard contract forms for Consultants will be the basis of terms and conditions.

Under Washington state law, the documents (including but not limited to written, printed, graphic, electronic, photographic or voice mail materials and/or transcriptions, recordings, or reproductions thereof) submitted in response to this RFQ (the “documents”) become a public record upon submission to the City of Duvall, subject to mandatory disclosure upon request by any person, unless the documents are exempted from public disclosure by a specific provision of law.

3.2 SYSTEM FOR AWARD MANAGEMENT (SAM) EXCLUDED PARTIES RECORDS

Per federal regulations, the City is required to ensure, to the best of its knowledge and belief, that none of the principals, affiliates, third party contractors and subcontractors are suspended, debarred, ineligible or voluntarily excluded from participation in federally assisted transactions or procurements. Federal regulations require the City to review records of excluded parties in the federal System for Award Management (SAM) before entering any third-party contracts exceeding \$25,000.00.

Prior to awarding a federally funded contract, the City will search the SAM system to ensure excluded parties do not participate in covered transactions.

To learn more about the federal SAM, go to <https://sam.gov/content/home>.



3.3 AMERICANS WITH DISABILITIES ACT (ADA) INFORMATION

The City, 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. This material can be made available in an alternate format by emailing Benjamin Ressler at benjamin.ressler@duvallwa.gov or by calling 425-939-8046.

3.4 TITLE VI STATEMENT

The City of Duvall in accordance with Title VI of the Civil Rights Act of 1964, 78 Stat. 252, 42 U.S.C. 2000d to 2000d-4 and Title 49, Code of Federal Regulations, Department of Transportation, subtitle A, Office of the Secretary, Part 21, nondiscrimination in federally assisted programs of the Department of Transportation issued pursuant to such Act, hereby notifies all bidders that it will affirmatively insure that in any contract entered into pursuant to this advertisement, disadvantaged business enterprises as defined at 49 CFR Part 26 will be afforded full opportunity to submit bids in response to this invitation and will not be discriminated against on the grounds of race, color, national origin or sex in consideration for award.



Attachment A

CONTRACT FOR PROFESSIONAL SERVICES

Contract # 20__ - __

This Agreement is entered into between the City of Duvall, Washington, hereinafter referred to as "the City," and _____, located at _____, hereinafter referred to as "the Consultant," in consideration of the mutual benefits, terms, and conditions hereinafter specified.

1. **Project Designation.** The City retains the Consultant to perform on-call consultant planning services under the terms of this contract.
2. **Scope of Services.** The Consultant agrees to perform the services identified on Exhibit "A" attached hereto, including providing all labor, materials, equipment, and supplies.
3. **Duration of Agreement; Time for Performance.** This Agreement shall be in full force and effect for a period commencing upon execution and ending _____, unless terminated sooner under the specified provisions. Work under this Agreement shall commence upon written notice by the City to the Consultant to proceed. The Consultant shall perform all services and provide all work product required according to this Agreement no later than _____ unless an extension of such time is granted in writing by the City.
4. **Payment.** The City shall pay the Consultant for completed work and services rendered under this Agreement as follows:
 - A. Payment for the work provided by the Consultant shall be made as provided on Exhibit "___" attached hereto, provided that the total amount of payment to the Consultant shall not exceed \$ _____) without express written modification of the Agreement signed by the City.
 - B. The Consultant may submit vouchers to the City once per month during the work progress for partial payment for that portion of the project completed to date. The City will check such vouchers, and upon approval thereof, payment shall be made to the Consultant in the amount approved.
 - C. Final payment of any balance due to the Consultant of the total contract price earned will be made promptly upon the City's ascertainment and verification after the completion of the work under this Agreement and its acceptance by the City.
 - D. Payment as provided in this section shall be full compensation for work performed, services rendered, and all materials, supplies, equipment, and incidentals necessary to complete the work.

E. The Consultant's records and accounts about this Agreement are to be kept available for inspection by representatives of the City and the state of Washington for seven (7) years after final payments. Copies shall be made available upon request.

5. **Ownership and Use of Documents.** All documents, drawings, specifications, and other materials produced by the Consultant in connection with the services rendered under this Agreement shall be the property of the City, whether the project for which they are made is executed or not. The Consultant shall be permitted to retain copies, including reproducible copies, of drawings and specifications for information, reference, and use in connection with the Consultant's endeavors. The Consultant shall not be responsible for any use of the said documents, drawings, specifications, or other materials by the City on any project other than the project specified in this Agreement.
6. **Compliance with Laws.** In performing the services contemplated by this Agreement, the Consultant shall faithfully observe and comply with all federal, state, and local laws, ordinances, and regulations applicable to the services rendered under this Agreement.
7. **Indemnification.** The Consultant shall defend, indemnify, and hold the City, its officers, officials, employees, and volunteers harmless from any and all claims, injuries, damages, losses, or suits, including attorney fees, arising out of or resulting from the Consultant's negligent acts, errors, or omissions in performing this Agreement.

Should a court of competent jurisdiction determine that this Agreement is subject to [RCW 4.24.115](#), then, in the event of liability for damages caused by or resulting from the concurrent negligence of the Consultant and the City, its officers, officials, employees, and volunteers, the Consultant's liability hereunder shall be only to the extent of the Consultant's negligence. It is further specifically and expressly understood that the indemnification provided herein constitutes the Consultant's waiver of immunity under Industrial Insurance, [Title 51 RCW](#), solely for the purposes of this indemnification. The parties have mutually negotiated this waiver. The provisions of this section shall survive the expiration or termination of this Agreement.

8. **Insurance.** The Consultant shall procure and maintain, for the duration of the Agreement, insurance against claims for injuries to persons or damage to property which may arise from or in connection with the performance of the work hereunder by the Consultant, its agents, representatives, or employees. Consultant's maintenance of insurance as required by the agreement shall not be construed to limit the liability of the Consultant to the coverage provided by such insurance or otherwise limit the City's recourse to any remedy available at law or in equity.

A. **Minimum Amounts and Scope of Insurance.** Consultant shall obtain insurance of the types and with the limits described below:

1. **Automobile Liability** insurance with a minimum combined single limit for bodily injury and property damage of \$1,000,000 per accident. Automobile Liability insurance shall cover all owned, non-owned, hired, and leased vehicles. Coverage shall be written on the Insurance Services Office (ISO) form CA 00 01 or a substitute form providing equivalent liability coverage. If necessary, the policy shall be endorsed to provide contractual liability coverage.



2. Commercial General Liability insurance with limits no less than \$1,000,000 for each occurrence, \$2,000,000 general aggregate. Commercial General Liability insurance shall be written on ISO occurrence form CG 00 01 and shall cover liability arising from premises, operations, independent contractors, personal injury, and advertising injury. The City shall be named as an additional insured under the Consultant's Commercial General Liability insurance policy concerning the work performed for the City.
 3. Workers' Compensation coverage as required by the Industrial Insurance laws of the State of Washington.
 4. Professional Liability with limits no less than \$1,000,000 per claim and \$1,000,000 policy aggregate limit. Professional Liability insurance shall be appropriate to the Consultant's profession.
- B. **Other Insurance Provision.** The Consultant's Automobile Liability and Commercial General Liability insurance policies are to contain or be endorsed to contain that they shall be primary insurance concerning the City. Any insurance, self-insurance, or insurance pool coverage maintained by the City shall be over the Consultant's insurance and shall not be contributed to or combined with it.
- C. **Acceptability of Insurers.** Insurance is to be placed with insurers with a current A.M. Best rating of not less than A:VII.
- D. **Verification of Coverage.** Consultant shall furnish the City with original certificates and a copy of the amendatory endorsements, including but not necessarily limited to the additional insured endorsement, evidencing the insurance requirements of the Consultant before commencement of the work. As required by this section, certificates of coverage and endorsements shall be delivered to the City within fifteen (15) days of execution of this Agreement.
- E. **Notice of Cancellation.** The Consultant shall provide the City with written notice of any policy cancellation within two business days of receiving such notice.
- F. **Failure to Maintain Insurance.** Failure on the part of the Consultant to maintain the insurance as required shall constitute a material breach of contract, upon which the City may, after giving five business days' notice to the Consultant to correct the breach, immediately terminate the contract or, at its discretion, procure or renew such insurance and pay any and all premiums in connection in addition to that, with any sums so expended to be repaid to the City on demand, or at the sole discretion of the City, offset against funds due the Consultant from the City.
9. **Independent Contractor.** The Consultant and the City agree that the Consultant is an independent contractor concerning the services provided under this Agreement. Nothing in this Agreement shall be considered to create a relationship between employer and employee between the parties hereto. Neither the Consultant nor any of the Consultant's employees shall be entitled to any benefits accorded City employees by the services provided under this Agreement. The City shall not be responsible for withholding or otherwise deducting federal income tax or social security or contributing to the state industrial insurance program, otherwise assuming the duties of an employer concerning the Consultant or any employee of the Consultant.

10. **Covenant Against Contingent Fees.** The Consultant warrants that he has not employed or retained any company or person, other than a bonafide employee working solely for the Consultant, to solicit or secure this contract and that he has not paid or agreed to pay any company or person, other than a bonafide employee working solely for the Consultant, any fee, commission, percentage, brokerage fee, gifts, or any other consideration contingent upon or resulting from the award or making of this contract. For breach or violation of this warrant, the City shall have the right to annul this contract without liability, or in its discretion to deduct from the contract price or consideration or otherwise recover the total amount of such fee, commission, percentage, brokerage fee, gift, or contingent fee.
11. **Discrimination Prohibited.** The Consultant, concerning the work performed by it under this Agreement, will not discriminate on the grounds of race, religion, creed, color, national origin, age, veteran status, sex, sexual orientation, gender identity, marital status, political affiliation or the presence of any disability in the selection and retention of employees or procurement of materials or supplies.
12. **Assignment.** During the term of this Agreement and following its expiration or termination for any reason, neither the Consultant nor the City may assign this Agreement or any rights, claims, or duty under it without the prior written consent of the other party. Furthermore, the Consultant shall not sublet or assign any of the services covered by this Agreement without the express written consent of the City.
13. **Non-Waiver.** A waiver by the City of any provision of this Agreement or any time limitation provided for in this Agreement shall not constitute a waiver of any other provision.
14. **Termination.**
 - A. The City reserves the right to terminate this Agreement at any time by giving the Consultant ten (10) days' written notice.
 - B. In the event of the death of a member, partner, or officer of the Consultant or any of its supervisory personnel assigned to the project, the surviving members of the Consultant at this moment agree to complete the work under the terms of this Agreement if requested to do so by the City. This section shall not be a bar to renegotiations of this Agreement between surviving members of the Consultant and the City if the City so chooses.
15. **Applicable Law; Venue; Attorney's Fees.** This Agreement shall be subject to, and the Consultant shall at all times comply with, all applicable federal, state, and local laws, regulations, and rules, including the provisions of the City of Duvall Municipal Code and ordinances of the City of Duvall. Suppose any suit, arbitration, or other proceeding is instituted to enforce any term of this Agreement. In that case, the parties specifically understand and agree that the venue shall be properly laid in King County, Washington. The prevailing party in any such action shall be entitled to its attorney's fees and costs of suit. Venue for any action arising from or related to this Agreement shall be exclusively in King County Superior Court.
16. **Severability and Survival.** Suppose any term, condition, or provision of this Agreement is declared void, unenforceable, or limited in its application or effect. In that case, such



event shall not affect any other provisions hereof, and all other provisions shall remain fully enforceable. The provisions of this Agreement, which by their sense and context are reasonably intended to survive the completion, expiration, or cancellation of this Agreement, shall survive termination of this Agreement.

- 17. **Business Licenses.** The consultant will adhere to all regulations related to business licensing in the State of Washington and, if applicable, shall conform to any relevant laws and regulations expressly outlined in the Duvall Municipal Code, particularly [§ 5.01](#) et seq.
- 18. **Notices.** Notices to the City of Duvall shall be sent to the following address:

City Clerk
City of Duvall
P.O. 1300
Duvall, WA 98019

Notices to Consultant shall be sent to the following address:

Company
Address Line 1
Address Line 2

- 19. **Entire Agreement; Modification.** This Agreement, together with attachments or appendices, represents the entire and integrated Agreement between the City and the Consultant and supersedes all prior negotiations, representations, or agreements, written or oral. No amendment or modification of this Agreement shall be of any force or effect unless it is in writing and signed by the parties.

DATED on this _____ day of the month of _____ of _____.

Amy Ockerlander, Mayor
City of Duvall

Authorized Consultant Signature

Attest/Authenticated:

Approved as to Form:

John Botero, City Clerk

Oskar E. Rey, City Attorney



TECHNICAL MEMORANDUM

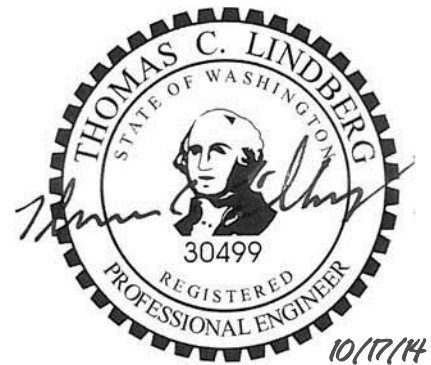
DATE: October 17, 2014

TO: Shaun Tozer, Project Manager
Boyd Benson, P.E., City Engineer
City of Duvall

FROM: Marshall Meyer, P.E.
Thomas C. Lindberg, P.E.
Murray, Smith & Associates, Inc.

PROJECT: Big Rock Road Reservoir and Crestview Estates Reservoir Improvements

RE: Reservoir Evaluations and Recommendations



Introduction and Purpose

This technical memorandum summarizes the engineering services provided by Murray, Smith & Associates (MSA) for the initial phase of the City of Duvall (City) Big Rock Road Reservoir and Crestview Estates Reservoir Improvements project. The purpose of the preliminary engineering services provided is to evaluate the condition of the two existing reservoirs and provide recommendations for improvements to the facilities. The conclusions and recommendations within this technical memorandum will be used as the basis for budgeting and scheduling improvements as well as subsequent preliminary and final design phases for the Big Rock Road Reservoir and Crestview Estates Reservoir Improvements project.

Background

Evaluations and improvements to the existing Big Rock Road and Crestview Estates reservoirs are identified in the City's 2012 Comprehensive Water System Plan. The existing 450 Zone Big Rock Road Reservoir is a 2.2 MG welded steel reservoir that was constructed in 1996 and is approximately 137 feet in diameter with an overflow elevation of approximately 450.5 feet and maximum water height of approximately 20.5 feet. The existing 555 Zone Crestview Estates Reservoir is a 0.5 MG welded steel standpipe that was constructed in 1988 and is approximately 38 feet in diameter with an overflow elevation of approximately 556 feet and maximum water height of approximately 60 feet.

The objective of the preliminary engineering phase is to perform evaluations of the facilities for seismic code compliance, coating condition, cathodic protection needs and overflow capacity; evaluate the inlet and outlet configuration for the Big Rock Road reservoir; identify recommended improvements for each reservoir; and provide preliminary cost estimates of the recommended improvements that will assist the City in budgeting and scheduling of the improvements.

0.5 MG Crestview Estates Reservoir Evaluation

Information provided by the City was reviewed and evaluations were performed to assess the seismic and structural conditions, coating systems, and the overflow capacity of the existing 0.5 MG reservoir. Each evaluation and the recommended improvements are described in more detail in the following sections. Since site specific soil explorations were not completed as part of this evaluation, the seismic and structural evaluations were based on conservative estimates of soil conditions, which may result in more conservative recommendations.



Seismic and Structural Assessment

MSA's structural engineering subconsultant Peterson Structural Engineers (PSE) performed a site visit on November 15, 2013 and reviewed information provided by the City to complete a seismic and structural condition assessment of the existing 0.5 MG welded steel reservoir. Shell wall thicknesses were measured and computerized structural analyses were conducted in PSE's offices to determine to what extent the reservoir meets applicable structural and seismic requirements.

Based on the results of the condition assessment, PSE identified several deficiencies in the existing reservoir system. The deficiencies are mainly the result of new code developments in the past 26 years, which are more stringent now than in 1988 when the reservoir was constructed. The primary deficiency of the existing reservoir system is inadequate thickness in the steel wall (shell) over a significant portion of the reservoir. Steel reservoirs are typically constructed by joining rolled steel plates around the circumference of the reservoir. The group of steel plates around the reservoir circumference is often referred to as a "course" and is usually approximately 8 feet in height. Structural deficiencies identified include:

1. Inadequate shell thickness in the bottom six of nine courses of the wall shell;
2. Inadequate foundation anchorage;
3. Inadequate ringwall foundation; and
4. Inadequate freeboard height for seismic slosh events.

Options to address tank stability related to foundation and anchorage deficiencies exist. However, there are no economical ways to remedy the inadequate wall shell thicknesses of the existing reservoir. The only feasible way to operate the reservoir and comply with the current structural code requirements is to reduce the water height in the tank to 41 feet. Since the City typically operates the reservoir with a water level of approximately 50.5 feet, reducing the operating level to a maximum water height of 41 feet would result in a significant reduction in the available storage volume. If the operational water height is reduced to 41 feet or less, the freeboard height for seismic slosh is no longer a concern.

If the reservoir is operated with a water level no higher than 41 feet, the following improvements would still be necessary if upgrades are pursued to meet current codes:

1. Expand the existing ring wall footing to reduce allowable bearing pressure under a seismic event and gravity loading, and
2. Install additional anchorage between the shell and the concrete foundation, possibly using micropiles, for resistance to overturning during a seismic event.

In order for the existing foundation and anchorage to meet current code requirements, and therefore avoid all structural improvements, the water level in the reservoir would need to be reduced to a maximum operating height of 12 feet. This solution is not recommended since it greatly reduces the water storage volume in the reservoir.

The seismic and structural condition assessment performed by PSE is described in more detail in the report in Appendix A.

Coating Assessment and Cathodic Protection

MSA's corrosion protection subconsultant Northwest Corrosion Engineering (NCE) performed a field inspection on November 15, 2013 and reviewed information provided by the City to complete an internal and external corrosion and coatings evaluation of the existing 0.5 MG welded steel reservoir. During the visit, dry film thicknesses of the coatings were measured using a portable electromagnetic dry film thickness gauge. The evaluation indicated the interior coating of the reservoir appears to be in good condition based on NCE's limited assessment from the roof access hatch of the reservoir and subsequent review of the June 2013 diving inspection video provided by the City. Per the video inspection, there are isolated instances of coating damage and associated surface corrosion.

NCE identified that there are a few exterior coating defects visible on the lower shell course and on the reservoir roof. However, overall the exterior coating of the 0.5 MG reservoir is in very good condition and tested negative for the presence of lead. The deficiencies associated with corrosion and observations by NCE include:

1. Galvanic corrosion cells exist especially where carbon steel and stainless steel are in close contact;
2. Isolated crevice corrosion is occurring since there is no seal welding on the roof or support beam-to-roof connection; and
3. There is no dedicated corrosion control system (i.e., cathodic protection).

The coating and cathodic protection improvements recommended by NCE are listed below:

1. Clean the exterior coating and repair the areas of damaged coating (including the interior roof hatch surfaces, painter's rail, support columns and any other damaged locations);
2. Seal the interior non-welded joints, by welding or applying a caulking compound, to prevent further corrosion; and
3. Install a galvanic anode cathodic protection system for the interior of the reservoir to provide corrosion control for all interior submerged systems.

The coatings and corrosion assessment performed by NCE is described in more detail in the report in Appendix B.

Overflow Capacity Evaluation

The 0.5 MG reservoir overflow piping configuration consists of a 6-inch diameter pipe with a 2-foot diameter overflow weir inlet inside the tank. Outside of the tank, the 6-inch diameter overflow pipe discharges into a catch basin structure that is connected to the site drainage system.

Overflow Rate Determination

To evaluate the overflow capacity and requirements of the reservoir, the City's hydraulic model was used. The hydraulic model was used to simulate high pressure events from a failure of control valves in PRV stations for identifying the maximum potential overflow rate.

To simulate a high pressure event that would cause an overflow at the 0.5 MG reservoir site, the hydraulic model was updated to simulate the 0.5 MG reservoir operating at a level at its overflow elevation and the 8-inch diameter 615 Zone/555 Zone PRV station at NE 150th Street was modeled to simulate a "stuck open" control valve position. In doing so, the high pressure water entered the 555 Zone from the 615 Zone and resulted in an overflow flow rate of approximately 1,275 gpm.

Tank Overflow Capacity

To determine the approximate capacity of the existing overflow pipe within the 0.5 MG reservoir, a sharp crested weir equation was used assuming a funnel diameter of 2 feet. For calculation purposes, the height of water above the crest of the weir was varied until the flow over the weir matched or exceeded the anticipated flow rate into the reservoir. This resulted in an overflow capacity of approximately 1,540 gpm and a 2-inch height of water above the funnel.

Onsite Drainage Facilities Capacity

Manning's formula was used to determine the approximate overflow capacity of the existing onsite drain pipes receiving the reservoir overflow. A roughness coefficient of 0.013 and full

pipe flow were the parameters used for the calculations. The most restrictive flow for the 0.5 MG reservoir was in the 18-inch concrete pipe with a capacity of approximately 1,970 gpm.

The overflow capacity evaluation for the 0.5 MG reservoir is summarized in Table 1. The evaluation results show that during an overflow event due to a PRV station failure, the onsite drainage pipes receiving the reservoir overflow will be able to accommodate the anticipated flows. The evaluation contained provides a preliminary approximation of the capacity of the onsite drainage system and does not address the capacity of the downstream drainage system.

Table 1
0.5 MG Crestview Estates Reservoir
Overflow Capacity Evaluation Summary

Modeled Overflow Flow Rate	Storm Drain Pipe Capacity	Tank Overflow Capacity	Satisfies Overflow Capacity Requirements
1,275 gpm	1,970 gpm ⁽¹⁾	1,540 gpm ⁽²⁾	Yes

1. Manning’s roughness coefficient n=0.013 and full pipe flow.
2. Assuming height of water is 2 inches above 2-foot diameter funnel.
3. Evaluation approximates the capacities shown and is limited to onsite drainage system only.

Recommended Improvements and Planning Level Cost Estimate

Two alternatives for storage improvements at the Crestview Estates site were identified, based on the results of the evaluations and recommendations from the seismic, structural and coating evaluation services described above.

Alternative 1 involves rehabilitating the existing reservoir and reducing the operational water height. Rehabilitating the existing standpipe is estimated to have a project cost of approximately \$800,000, in 2014 dollars. Lowering the water level to the 41-foot maximum operating height in an effort to reduce the cost of improvements results in an approximately 30 percent reduction in the volume of the reservoir to approximately 0.34 MG of net usable storage, in addition to adversely affecting pressures in the 555 Zone.

Alternative 2 consists of demolishing the existing reservoir and replacing it with a new 0.5 MG standpipe. This alternative would maintain the current volume of the reservoir and pressures in the zone. Demolishing the existing standpipe and constructing a new 0.5 MG standpipe is estimated to have a project cost of approximately \$1,560,000, in 2014 dollars. Alternative 2 provides a better long-term solution in meeting storage needs with its longer service life and full 0.5 MG of storage capacity and is therefore the recommended alternative. Prior to implementation of this alternative, it is recommended that storage analyses be conducted to identify if a larger reservoir at this site is more beneficial to meet the City’s overall long-term storage needs of the system. At this size, cost efficiencies can be realized when increasing storage beyond 0.5 MG, based on a typical decreasing unit construction cost per gallon of the tank structure itself. For example, a planning level estimate of overall project costs for a 0.75 MG welded steel reservoir would be approximately \$2,000,000 in 2014 dollars.

These planning level estimated costs include construction costs, current sales tax, contingency and engineering, legal and administration costs. Detailed planning level cost estimates are included in Appendix C.

Preliminary Project Schedule

The following is the estimated duration for the completion of tasks required to implement the proposed improvements described above at the Crestview Estates Reservoir site.

Design and Permitting	6 to 8 months for Alternative 1 10 to 12 months for Alternative 2
Bidding and Award	2 to 3 months for both alternatives
Construction	5 to 7 months for Alternative 1 12 to 16 months for Alternative 2

Additional considerations should be given to potential water system operation modifications and the phasing of construction work to minimize impacts to water service during construction of improvements while storage is not available in the 555 Zone.

2.2 MG Big Rock Road Reservoir Evaluation

Information provided by the City was reviewed and evaluations were performed to assess the seismic and structural conditions, coating systems, overflow capacity, and inlet/outlet piping configuration of the existing 2.2 MG reservoir. Each evaluation and the recommended improvements are described in more detail in the following sections.



Seismic and Structural Assessment

MSA's structural engineering subconsultant Peterson Structural Engineers (PSE) performed a site visit on November 15, 2013 and reviewed information provided by the City to complete a seismic and structural condition assessment of the existing 2.2 MG welded steel reservoir. Shell wall thicknesses were measured and computerized structural analyses were conducted in PSE's offices to determine to what extent the reservoir meets applicable structural and seismic requirements.

Based on the results of the condition assessment, PSE identified the existing reservoir system satisfies all structural requirements based on the reservoir operating with a water level at the

overflow elevation. The freeboard height for seismic slosh events is sufficient, shell thicknesses are adequate based on code minimums, the tank shell is self-anchored when subjected to seismic loads and stable against sliding, allowable soil bearing pressure is not exceeded under seismic or gravity loading, and all roof framing members are adequate under gravity loading.

The seismic and structural condition assessment performed by PSE is described in more detail in the report in Appendix A.

Coating Assessment and Cathodic Protection

MSA's corrosion protection subconsultant Northwest Corrosion Engineering (NCE) performed a field inspection on November 15, 2013 and reviewed information provided by the City to complete an internal and external corrosion and coatings evaluation of the existing 2.2 MG welded steel reservoir. During the visit, dry film thicknesses of the coatings were measured using a portable electromagnetic dry film thickness gauge. The evaluation indicated the interior coating of the reservoir appears to be in generally good condition based on NCE's limited assessment from the roof access hatch of the reservoir and subsequent review of the June 2013 diving inspection video provided by the City. Per the video inspection, there are isolated instances of coating damage and associated surface corrosion.

NCE identified several coating deficiencies in the existing reservoir system during their evaluation. The most significant is the exterior topcoat of the reservoir roof, which is in poor condition with approximately 35 to 40 percent of the topcoat missing and the remainder loosely adhered to the intermediate coat. The exterior shell has numerous coating flaws generally located on the north to northeast side. Other deficiencies associated with corrosion and observations by NCE include:

1. Galvanic corrosion cells exist especially where carbon steel and stainless steel are in close contact;
2. Isolated crevice corrosion is occurring since there is no seal welding on the roof or support beam-to-roof connection; and
3. There is no dedicated corrosion control system (.i.e., cathodic protection).

Although the exterior coating has some deficiencies, it tested negative for the presence of lead which will make performing the repairs less burdensome.

The coating and cathodic protection improvements recommended by NCE are listed below:

1. Repair the areas of damaged coating, including the interior roof hatch surfaces, painter's rail, support columns and any other damaged locations;
2. Remove all non-adherent existing topcoat material, scarify the intermediate coating and apply a tie-coat and polyurethane topcoat.
3. Seal the interior non-welded joints, by welding or applying a caulking compound, to prevent further corrosion; and
4. Install a galvanic anode cathodic protection system for the interior of the reservoir to provide corrosion control for all interior submerged systems.

The coatings and corrosion assessment performed by NCE is described in more detail in the report in Appendix B.

Overflow Capacity Evaluation

The 2.2 MG reservoir overflow piping configuration consists of an 8-inch diameter pipe with a 3-foot diameter overflow weir inlet inside the tank. Outside of the tank, the 8-inch diameter overflow pipe discharges into an air gap catch basin structure that is connected to the site drainage system.

Overflow Rate Determination

To evaluate the overflow capacity and requirements of the reservoir, the City's hydraulic model was used. The hydraulic model was used to simulate high pressure events from a failure of control valves in PRV stations and supply stations for identifying the maximum potential overflow rate.

Two events were simulated in the hydraulic model to simulate an overflow of the 2.2 MG reservoir. The first event simulated a PRV station control valve "stuck open" position failure in the 555 Zone/450 Zone PRV station at NE 144th Place, which resulted in high pressure water entering the 450 Zone from the 555 Zone at an overflow flow rate of approximately 965 gpm. The second event simulated a control valve "stuck open" position failure in the Tolt 2 Supply Station, which resulted in high pressure water entering the 450 Zone at an overflow rate of approximately 2,145 gpm.

Tank Overflow Capacity

To determine the approximate capacity of the existing overflow pipe within the 2.2 MG reservoir, a sharp crested weir equation was used assuming a funnel diameter of 3 feet. For calculation purposes, the height of water above the crest of the weir was varied until the flow over the weir matched or exceeded the anticipated flow rate into the reservoir. This resulted in an overflow capacity of approximately 2,150 gpm and a 2.5 inch height of water above the funnel.

Onsite Drainage Facilities Capacity

Manning's formula was used to determine the approximate overflow capacities of the existing onsite drain pipes receiving the reservoir overflow. A roughness coefficient of 0.013 and full pipe flow were the parameters used for all calculations. The section of drain pipe analyzed with the most limiting capacity was an approximately 70 foot long section of 12-inch diameter PVC pipe at the 2.2 MG Big Rock Road Reservoir site, found to have a capacity of approximately 1,430 gpm. This pipe is located upstream of the catch basin at the base of the access driveway to the site. A portion of this section of storm pipe is shown in Figures 1 and 2 in Appendix D.

The overflow capacity evaluation for the 2.2 MG reservoir is summarized in Table 2. The results show that in the event of a PRV station failure, the surrounding onsite drainage pipes will be able to accommodate the overflow. However, the potential flows due to a Tolt 2 Supply Station control failure exceed the overflow capacity in a section of the 12-inch diameter PVC pipe by approximately 700 gpm. It is recommended that upsizing this section of the storm drainage system be taken into consideration during the design phase of the project.

Table 2
2.2 MG Big Rock Road Reservoir
Overflow Capacity Evaluation Summary

High Pressure Event	Modeled Overflow Flow Rate	Storm Drain Pipe Capacity	Tank Overflow Capacity	Satisfies Overflow Capacity Requirements
PRV Station Failure	965 gpm	1,430 gpm ⁽¹⁾	2,150 gpm ⁽²⁾	Yes
Supply Station Failure	2,145 gpm	1,430 gpm ⁽¹⁾	2,150 gpm ⁽²⁾	No

1. Manning’s roughness coefficient n=0.013 and full pipe flow.
2. Assuming height of water is 2.5 inches above 3-foot diameter funnel.
3. Evaluation approximates the capacities shown and is limited to onsite drainage system only.

Inlet and Outlet Piping Configuration

The existing 2.2 MG reservoir has a single 12-inch diameter pipe that penetrates the floor of the existing reservoir and serves as a combined inlet, outlet and drain piping system. Based on information provided by the City, MSA reviewed the existing common pipe configuration and evaluated alternatives for maintaining good water quality within the reservoir through improved mixing. The alternatives evaluated include creating a new dedicated inlet, adding a Tideflex mixing system to the existing inlet/outlet/drain pipe inside the reservoir, and a combination of the two. The alternatives are described in more detail below.

Alternative 1 – Dedicated Inlet

Alternative 1 provides for a separate inlet and piping system and includes constructing a dedicated inlet pipe on the west side of the reservoir, in the vicinity of the existing site piping. The proposed dedicated inlet would also include a horizontal header pipe along the floor of the reservoir with Tideflex inlet nozzle valves, running along the diameter of the reservoir. It is also recommended that flexible expansion joints similar to EBAA Iron Flex-Tend be installed outside the tank on the new dedicated inlet and existing outlet/drain pipes. The flexible expansion joints will help protect the system from stresses produced by ground motion caused by either seismic activity or gradual uneven settlement.

Alternative 2 – Inlet and Outlet Manifold

Alternative 2 includes construction a Tideflex mixing system manifold on the common inlet/outlet/drain pipe inside the reservoir. Tideflex Technologies assisted MSA with performing a preliminary reservoir mixing analysis and provided the general configuration of the Tideflex mixing system with guidance on the turnover/fluctuation necessary to ensure complete mixing. The general configuration of the mixing system includes a 12-inch diameter horizontal header pipe attached to the interior tank bottom with multiple Tideflex variable orifice inlet nozzles and Waterflex outlet check valves. The final quantity, size, locations and discharge angles of Tideflex inlet nozzles and outlet check valves would be determined by Tideflex during the final design phase of the project.

Alternatives Evaluation

Multiple items were taken into consideration when comparing the two inlet and outlet piping configuration alternatives, such as operation and maintenance, construction impact, water quality, usable storage, and construction costs. Table 3 below summarizes the two alternatives with respect to those considerations.

**Table 3
Inlet and Outlet Piping Configuration Summary**

Comparison Items	Alternative 1 Dedicated Inlet	Alternative 2 Inlet/Outlet Manifold
Flow Through Tank	All supply from Supply Station 1 must flow through tank prior to entering 450 Zone, achieving best turnover.	Short circuiting of supply from Supply Station 1 is possible, decreasing ability to turnover storage in tank.
Short-Term Construction Impact	More impact to existing utilities and more site disturbance.	Less impact to existing utilities and site.
Water Quality	Best opportunity to improve water quality	Water quality will be improved.
Usable Storage	No loss in usable storage, remains at 2.2 MG.	Loss in usable storage due to raised outlet elevation. Usable storage capacity is reduced to approximately 1.85 MG.
Estimated Construction Costs	Higher construction costs since more piping and site restoration is required.	Lower construction cost since less piping and site restoration is required.

The detailed planning level cost estimates for both alternatives are included in Appendix C. The preliminary layouts for the two proposed inlet and outlet piping configuration alternatives are schematically illustrated in Figure 1 for Alternative 1 and Figure 2 for Alternative 2 in Appendix D. Although Alternative 1 – Dedicated Inlet has a higher

construction cost, it is the recommended improvement since Alternative 2 – Inlet and Outlet Manifold will result in reduced storage capacity for the system, due to the outlet portion of the Tideflex manifold system being located above the floor of the reservoir. Alternative 1 also provides the best opportunity to maintain good water quality through the separated inlet and outlet systems and from the configuration that routes all water supply through the reservoir prior to entering the 450 Zone.

Recommended Improvements and Planning Level Cost Estimate

Alternative 1 with the dedicated inlet system is the recommended improvement for the 2.2 MG reservoir, as described above. Alternative 1 improvements are estimated to have an overall project cost of approximately \$650,000, in 2014 dollars. This planning level cost estimate includes construction costs, current sales tax, contingency and engineering, legal and administration costs. Alternative 2 improvements are estimated to have an overall project cost of approximately \$450,000, in 2014 dollars.

Preliminary Project Schedule

The following is the estimated duration for the completion of tasks required to implement the proposed improvements described above at the Big Rock Road Reservoir site for the two alternatives described above:

Design and Permitting	5 to 7 months
Bidding and Award	2 to 3 months
Construction	2 to 4 months

Additional considerations should be given to potential water system operation modifications and the phasing of construction work to minimize impacts to water service during construction of improvements while storage is not available in the 450 Zone.

Enclosures

- Appendix A - Seismic and Structural Evaluation Report
- Appendix B - Coatings and Corrosion Assessment Report
- Appendix C - Planning Level Cost Estimates
- Appendix D - Figure 1 & 2 – Big Rock Road 2.2 MG Inlet/Outlet Alternatives

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APPENDIX A

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Thomas C. Lindberg, P.E.
Murray, Smith & Associates, Inc.
2027 Colby Ave., Ste. 1110
Everett, WA 98201

5/28/14

File: Pse\13-229-03

Re: City of Duvall Reservoirs – Evaluation and Recommendations Report

Dear Tom:

The following report provides evaluation results and upgrade recommendations for two existing welded steel reservoirs. The first, constructed in 1988, is a 0.5MG standpipe, and the second, constructed in 1996, is a 2.2MG reservoir. Both are owned and operated by the City of Duvall, WA. Our firm conducted a site visit, collected data, and performed structural analysis. The analysis was based on information collected during the site visit and original construction documents provided by the City.

Site Visit Observations

Our site visit was performed on 11/15/13 and was attended by PSE, MSA, and City personnel. Exterior and interior tank conditions were observed and measurements taken where possible. For the purpose of the site visit, the water elevation had been lowered in each reservoir which allowed close observation of the interior condition of the tanks and roof support systems, but restricted observation of the interior base of the tanks. Original construction documents were also referenced. These consisted water transmission plans by Hammond, Collier & Wade-Livingstone Associates, Inc. for each reservoir and as built drawings by T. Baily, Inc. for the 2.2 MG reservoir. The water transmission plans included (2) sheets dated March 1987 for the 0.5MG reservoir and (17) sheets dated January 2000 detailing water system improvements for the 2.2MG reservoir. As built drawings for the 2.2MG reservoir consisted of (10) sheets dated November 1996.

Each of the reservoirs was founded on a flattened grade (Photographs 1 and 2). The 0.5MG reservoir was surrounded by a compacted gravel surface, while an asphalt road surrounds the 2.2MG reservoir. No geotechnical information was available. However, no evidence of creep, settlement, or other geotechnical issues was observed.

The 0.5MG standpipe reservoir is approximately 38' in diameter with a 60' overflow height and approximately 2' of freeboard at the perimeter increasing to approximately 4' of freeboard in the center of the reservoir. The reservoir is minimally anchored and rests on a concrete ringwall foundation. Existing anchorage consists of (8) 5"x24" flat steel straps. The top half of the straps are welded to the reservoir and the straps are embedded in the ringwall foundation (Photograph 3). The interior framing system consists of (1) central 12" standard pipe column and (16) radially arrayed C10x15.3 rafters and adjoining corner members which support 3/16" roof plates.

The 2.2MG reservoir is approximately 137' in diameter with a 20.5' overflow height and approximately 3.5' of freeboard. Freeboard increases towards the center of the reservoir. No anchorage exists and the reservoir rests on a concrete ringwall foundation. The interior framing system consists of (1) central pipe column and an outer ring of (8) pipe columns supporting wide flange beams. A system of radially arrayed steel channel rafters support 3/16" roof plates.

0.5MG Reservoir Observations

The exterior roof was observed by climbing the ladder on the side of the tank. The ladder and attached fall protection are in good condition and securely attached to the side of the reservoir. The hatch was located adjacent to the exterior ladder, and the vent was centered in the roof. Each was in excellent condition, with some minor corrosion observed on the hatch (Photographs 4 and 5). Roof plates and welds were in good condition structurally. No buckling was observed and only small portions of the coating sustained damaged from corrosion. Cellular transmission equipment was present over large areas of the roof, but did not pose any structural concerns (Photograph 6).

Exterior shell conditions were also observed. Plate welds and coatings were in good condition, with only minor damage visible (Photograph 7). The underlying concrete ringwall foundation extends approximately 12" beyond the exterior of the shell and is approximately 36" deep. A pothole was dug in order to observe the base of the foundation and the continuous drain pipe surrounding the perimeter of the foundation. Both the ringwall and drain pipe were in excellent condition (Photograph 8).

At the time of the site visit, the water level had been lowered enough to allow for a clear view of the interior of the roof and framing members. However, the water level was too high to conduct an accurate observation of the condition of the interior wall, wall coating, floor plates, and floor coating. Interior roof and shell plates were in good condition structurally. Minor corrosion was visible, particularly at plate joints and the upper portions of the shell, but this did not affect the structural integrity of the plates (Photographs 9 and 10). The central column and overflow pipe were also in good condition. Some corrosion was apparent on the upper portions of the interior ladder.

2.2MG Reservoir Observations

Similar observations were conducted on the 2.2MG reservoir. The exterior roof was observed by climbing the ladder on the side of the tank. The ladder and surrounding cage are in good condition and securely attached to the roof. Both the roof hatch and vent were in excellent condition (Photographs 11 and 12). Some minor buckling was observed in the roof plates, but was not extensive enough to significantly impact the structural integrity of the plates (Photograph 13).

Observations of the entire perimeter of the exterior shell were also conducted. Plates and welds appeared to be in excellent condition, though small areas of the coating have deteriorated in a few locations (Photograph 14). The ringwall foundation and all exterior appurtenances were in excellent condition (Photograph 15).

To observe the interior of the reservoir, the water level had been lowered somewhat. This allowed for observation of the underside of the roof and upper portions of the interior of the shell, but restricted the view of the portions of the reservoir beneath the water level. Roof plates were structurally sound, but some corrosion was observed along weld lines and where the rafters abut the roof plates as rafter were not welded to the roof (Photograph 16). The roof framing members and overflow pipe were in good condition (Photographs 17 and 18).

Reservoir Structural Analysis

Using the AWWA D100-11 and the 2012 Washington State Building Code (WSBC), the reservoirs were analyzed for code prescribed seismic and wind loads. Gravity analyses further considered bearing pressure and the structural integrity of the supporting elements of the roof. Analysis was conducted both at the overflow elevation and at the typical operating water elevation for each reservoir. A summary of results is provided below and detailed calculations for the analyses at overflow elevation follow.

0.5MG Reservoir Results

Preliminary analysis results at overflow water elevation were as follows:

- The operational freeboard of 2' is insufficient for calculated seismic slosh heights which require a freeboard of 3.8'.
- The global stability of the tank structure is inadequate when subjected to seismic loads, and the existing strap anchors are insufficient for the resulting loads. New anchors and chairs will likely be required.
- Under lateral loading, the shell is stable against sliding.
- Soil bearing pressure exceeds the assumed allowable pressure under both seismic and gravity loading.
- Based on the current code minimums, the shell thickness is inadequate at the bottom (6) courses. At an operational water height of 50.5' the reservoir shell plates in the bottom (3) of (9) courses are analytically overstressed for both static and seismic loads. If the maximum operating water height is voluntarily reduced to 41' the stresses in the wall shell are reduced to meet current code allowable stresses.
- Roof plates and framing members are adequate for the applied loads, though they exceed the maximum span and spacing requirements published in the code. We opine that while the span provision for the roof plates is exceeded, the roof has adequate strength to resist applied loads.

Performance improvements at typical water operating height of 50.5' were as follows:

- Slosh height is easily accommodated by freeboard of 11.5'.
- Shell remains subject to overturning, but anchor requirements reduce.
- Shell stress issues are reduced but still exceed allowable.
- Bearing pressure exceeds the assumed allowable, but to a lesser degree.

2.2MG Reservoir Results

Preliminary analysis results at overflow water elevation were as follows:

- The operational freeboard of 3.5' is sufficient to accommodate the 3.2' slosh height.
- The shell is self-anchored when subjected to seismic loads, therefore no anchorage is required.
- Under lateral loading, the shell is stable against sliding.
- Soil bearing pressure does not exceed the assumed allowable pressure under seismic or gravity loading.
- Shell thicknesses are adequate based on code minimums, and both hoop and longitudinal stresses are within acceptable stress limits.
- All roof framing members are adequate under the applied gravity loads when the rafters are considered laterally supported by the roof plates according to AWWA 3.6.1.1.

The reservoir satisfies all structural requirements at overflow elevation. Further analysis at a reduced water elevation was not deemed necessary.

Analytical Performance Summary

Analysis has shown the 2.2MG reservoir to perform well under static and seismic loading. The 0.5MG reservoir, however, is shown to be analytically overstressed under both loading conditions and will require some upgrades to satisfy current code requirements. Upgrades are recommended below which are intended to extend the life of the reservoirs and prevent potential future damage.

Reservoir Upgrade Recommendations

Upgrade to the existing reservoirs should take into consideration both the observed structural condition and the analytical performance of each reservoir. The primary analytical shortcomings of the 0.5MG reservoir are the tensile hoop stresses in the wall shell and the inadequate strength of the foundation anchors. Also included in the non-compliant findings are the soil bearing pressure, the tank global stability, and the freeboard requirements for seismic slosh.

Shell Coating

Corroded areas of each reservoir were observed and noted above. However, a more thorough corrosion investigation was performed by Northwest Corrosion Engineering who also produced an assessment report. The assessment report should be referenced for coating upgrade recommendations.

0.5MG Shell Stresses

While upgrade options to the 0.5MG reservoir exist to address foundation and anchorage issues exist, there is no economically viable way to upgrade the wall shell plates in the existing system. The only structurally viable way to reduce wall shell stresses for static and seismic loading is to reduce the operational water height. As previously mentioned, the current operational maximum water height of 60' is 19' higher than the 41' water height that would reduce shell stresses to an analytically acceptable level. If the system operation can

tolerate this reduced operating level then other structural upgrades become viable and the seismic slosh concern is removed. However, if operational water height reduction is not possible, we opine there is no economically viable way to upgrade the current structure to operate at or near the overflow elevation. The more economical approach is to replace it with a new reservoir structure that meets current code requirements.

If the reduced operational water height is implemented then the following additional 0.5MG reservoir upgrade recommendations exist:

0.5MG Foundation Expansion

To avoid exceeding allowable bearing pressure during a seismic event, we recommend expanding the current ringwall foundation. This could be accomplished by constructing an additional ringwall to be doweled into the existing ringwall. The additional foundation area will alleviate the bearing pressure being applied to the soil, as well as provide the means for anchoring the reservoir.

0.5MG Shell Anchorage

We further recommend the shell be anchored to the foundation, possibly using micropiles, in order to prevent overturning during a seismic event. Anchorage forces are significant at both overflow and normal operating water elevations. The previously recommended foundation expansion will also be needed to provide the concrete strength required to accommodate the anchors.

Additional Reduction in Operating Level

As a reduction in the water level reduced shell stresses to acceptable levels, continued reduction in the water level can help alleviate, although not eliminate, the need for foundation upgrades. The reservoir was evaluated using an operating water level of 29'. Further reduction in the operating height alters the reservoirs evaluation criteria and was not pursued. At the 29' water elevation the reservoir is still susceptible to overturning due to applied seismic forces and requires anchors for stability. However, for the existing strap anchors, this reduced operating height did reduce the applied tensile force in the anchors by 80%.

For the foundation the seismic overturning Factor of Safety (FS) increased from 0.16 to 0.70. This is still below, a minimum required FS=1.00 and as a result, expansion of the foundation is still required. It should be noted that the evaluation of the foundation uses the IBC minimum soil bearing values since a site-specific geotechnical report is not available. It is recommended that a geotechnical investigation be performed for two reasons 1) to determine if the upgrade suggestions can be further reduced and 2) to verify the suitability of the soil and identify if there are any unknown issues missing from the assumptions.

Based on the review, it is likely the water would need to be reduced to a 12' operating level in order to eliminate all of the upgrade options. The reason for such a drastic reduction in the water level is the reservoir itself, which is tall with a relatively narrow base. As the reservoir is comprised of approximately 50 tons of steel, once the water is reduced to a certain level, the reservoir's self-weight begins to play a larger factor in overturning. Due to

this the water must be reduced to a point where it plays virtually no part in overturning before the reservoir's foundation is acceptable for the assumed soil parameters.

0.5MG Freeboard

Freeboard is insufficient to accommodate the slosh wave height when the reservoir is operated at the overflow water elevation. However, freeboard is not an issue for water height up to 58' (554' elevation), which is well above the normal operating water height. Because of this, freeboard does not need to be directly addressed, but the City should be aware that a certain degree of risk of slosh related damage during a seismic event exists when the water elevation exceeds 554'.

Opinion of Probable Cost

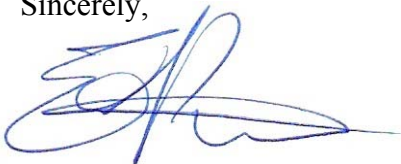
Our preliminary opinion of probable construction cost for the 0.5MG reservoir is in the range of \$250,000 to \$300,000 for the expansion of the existing ringwall footing, the installation of (14) micropiles around the circumference of the reservoir, and the installation of additional anchor points as required. At this time, actual upgrades have not been designed for this reservoir, and our opinion of probable cost is based on upgrade designs and costs for similar steel reservoirs. Please note the cost estimate does not include fees for the structural design of the proposed upgrades, nor for the geotechnical investigation of the site which would be required for installation of micropiles. The estimates also do not include costs for repairing/recoating of the interior or exterior steel surfaces. Finally, the provided estimate is solely an engineer's opinion of probable cost, and is subject to change due to geotechnical findings, changes in material/construction pricing, and the results of additional analysis/design.

Conclusions & Summary

Our visual observation and structural evaluation reveal both reservoirs to be in fairly good condition. The 2.2MG reservoir is also analytically in good condition requiring minimal maintenance level repairs. However, the 0.5MG reservoir has significant analytical vulnerabilities which should be addressed. Making adjustments to accommodate current seismic standards is necessary to prevent catastrophic damage from occurring during a seismic event. We feel that with the above recommendations and continued maintenance the reservoirs will be functional for many years.

Thank you, and please contact us if you have any questions.

Sincerely,



Erik Peterson



Submitted via e-mail: tom.lindberg@msa-ep.com



Photograph 1: 0.5MG Reservoir



Photograph 2: 2.2MG Reservoir



Photograph 3: 0.5MG Reservoir Existing Anchorage



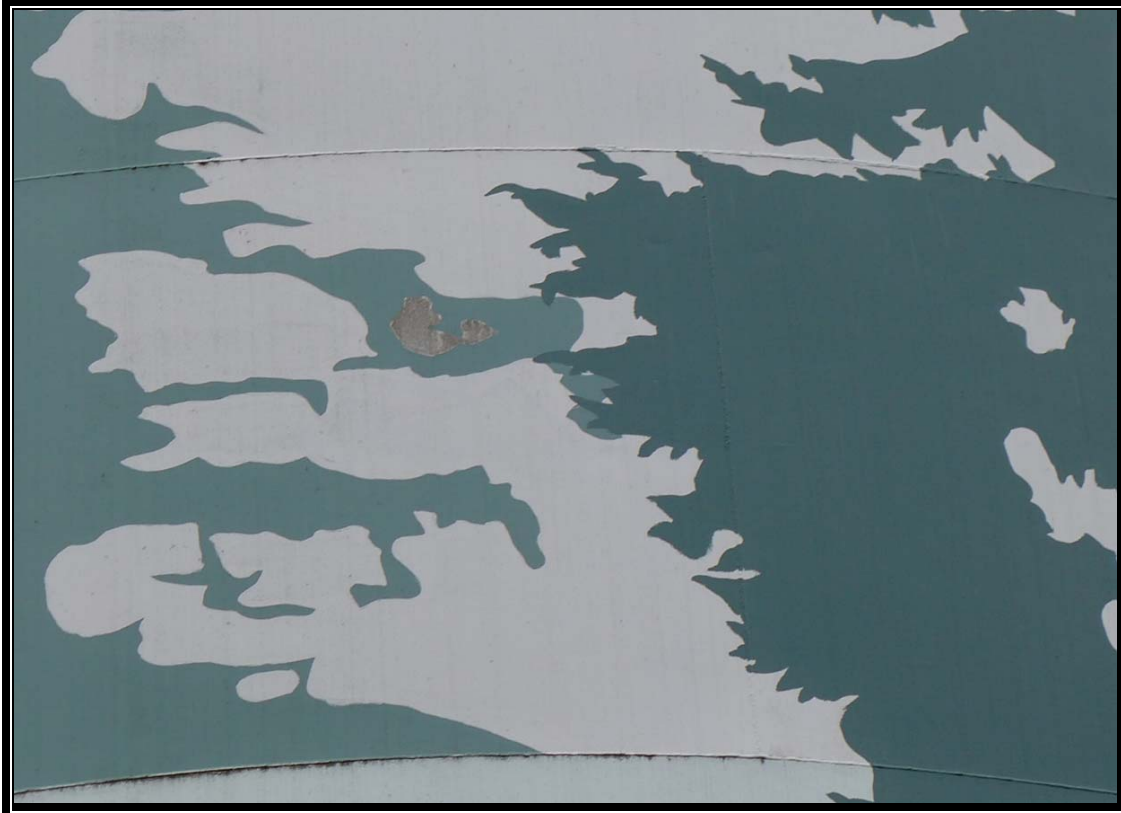
Photograph 4: 0.5MG Reservoir Vent



Photograph 5: 0.5MG Reservoir Hatch and Interior Ladder with Minor Corrosion



Photograph 6: 0.5MG Reservoir Cellular Transmission on Roof



Photograph 7: 0.5MG Reservoir Exterior Shell Coating



Photograph 8: 0.5MG Reservoir Ringwall Foundation and Drain



Photograph 9: 0.5MG Reservoir Roof Plates and Supporting Structure



Photograph 10: 0.5MG Reservoir Corrosion of Roof Framing Members



Photograph 11: 2.2MG Reservoir Roof Hatch



Photograph 12: 2.2MG Reservoir Vent



Photograph 13: 2.2MG Reservoir Buckled Roof Plates



Photograph 14: 2.2MG Reservoir Shell Plates



Photograph 15: 2.2MG Reservoir Ringwall Foundation



Photograph 16: 2.2MG Reservoir Roof Plates with Minor Corrosion



Photograph 17: 2.2MG Reservoir Interior Framing Members



Photograph 18: 2.2MG Reservoir Overflow Pipe

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APPENDIX B

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December 5, 2013



10995 Warfield Road, Sedro-Woolley, WA 98284
Phone: (360) 826-4570 Fax: (360) 826-6321

Mr. Tom Lindberg, P.E.
Murray, Smith & Associates
2707 Colby Avenue, Suite 1110
Everett, WA 98201

SUBJECT: City of Duvall 0.5 and 2.2 MG Reservoir Coatings and Corrosion Assessment

Mr. Lindberg,

Northwest Corrosion Engineering completed an internal and external corrosion and coatings evaluation for the City of Duvall's 0.5 and 2.2 million gallon steel water storage reservoirs. Specific tasks completed during this project include:

1. Review previous inspection reports and videos of diving inspection completed in June 2013.
2. Measure exterior coating dry film thickness and test coatings for general adhesion characteristics.
3. Measure steel thickness of individual shell courses and roof. Measure depth of any noted pitting.
4. Test for the presence of lead within the coating material.
5. Conduct a visual inspection of the interior surfaces from the roof access hatches.
6. Perform cathodic protection current requirement testing for each of the two reservoirs.
7. Prepare a report summarizing the results of the field inspection and condition assessment. The report includes an analysis of the quality of the interior and exterior coatings along with cost estimates and recommendations for recoating and corrosion control equipment.

BACKGROUND INFORMATION

0.5 MG Reservoir

Height 60-ft tall, 38-ft diameter, welded steel constructed in 1988. Interior equipment includes a coated carbon steel ladder, 6-inch diameter coated-steel overflow pipe, painter's rail, and a single central support column.

2.2 MG Reservoir

Height 24-ft tall, 137-ft diameter, welded steel constructed in 1996. Interior equipment includes a coated carbon steel ladder, 8-inch diameter coated-steel overflow pipe, painter's rail, eight outer support columns, and a single central support column.

COATING AND STEEL EVALUATION METHODS

A series of field tests were completed on the interior and exterior surfaces of the reservoirs during our site visit. A description of each test is provided below.

Dry Film Thickness

The thickness of the existing coating system was measured using a portable electromagnetic dry film thickness gauge (Type 2 gauge). This gauge measures the thickness of the coating between the gauge probe and the metallic substrate.

Steel Thickness

Steel wall thickness was measured using a Dakota Ultrasonic model MVX ultrasonic thickness tester calibrated for carbon steel. When sampling remaining thickness, this unit uses an echo-echo function that allows for measurement of the steel without removing the coating material.

Lead Testing

Field-testing for the presence of leachable lead was completed using Lead Check swabs. This type of testing is capable of detecting lead in paints at levels as low as 0.5% (5,000 ppm). The field lead check kits will detect high levels of leachable lead that exceed government regulations but will not provide a quantitative description of the actual leachable lead content.

Current Requirement

Current requirement testing was conducted on the interior submerged surfaces of the reservoirs. The purpose of this testing is to provide a general assessment of the quality of the interior coating and to provide information concerning the quantity of protective current necessary to provide corrosion control to the submerged surfaces. Current requirement testing is completed by inserting a temporary anode into the water and applying a known electrical current. Potential measurements are then recorded at multiple locations from the top of the water surface level to the bottom of the reservoir.

TEST RESULTS AND ANALYSIS

Exterior Coating Thickness

Dry film thickness (DFT) measurements were taken on the reservoir exterior walls and roofs. Results of the tests are summarized in Table 3.

Table 1: Exterior Coating Thickness

Location	Number of Readings	Average DFT, mils	Range, mils
0.5 MG Reservoir			
Walls	34	17.9	11.8 – 25.5
Roof	20	16.2	12.9 – 19.7

2.2 MG Reservoir			
Walls	35	13.0	9.1 – 17.5
Roof	10	7.6	4.7 – 10.8

The exterior coating thickness measurements are typical of high performance coatings applied to water reservoirs. Industry standards generally recommend a three-coat system consisting of a zinc primer, epoxy intermediate coat, and a polyurethane topcoat. The zinc primer acts as a corrosion protection barrier while the epoxy provides a durable tightly adherent coating. The polyurethane is used to provide a glossy finish and to enhance protection against ultraviolet radiation.

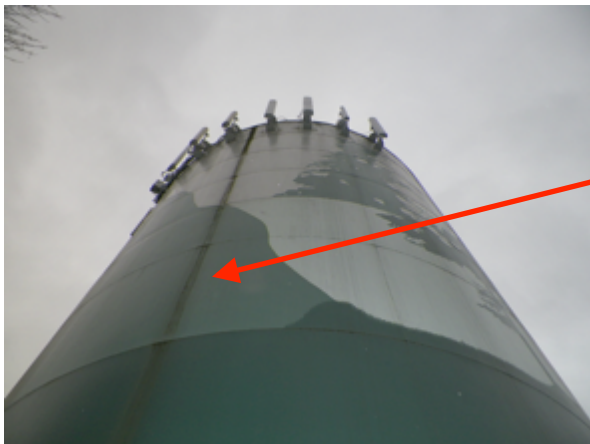
The exterior of the 0.5 MG reservoir appears to have been coated with four layers of paint. The additional fourth layer may have been added to support the mural design on the side of the reservoir. Knife scratch tests at existing coating defects show that the coating is tightly adhered and in very good condition. Given the quality of coating, it was determined that additional destructive testing was not warranted.

The coating on the exterior of the 2.2 MG reservoir is also in very good condition. The coating system appears to consist of three layers, although the top two layers are similar in color. Knife tests at coating defects show that the coating is very tightly adhered to the substrate.

Exterior Coating Inspection

The exterior sidewall coating on each reservoir exhibit good adhesion characteristics and are within acceptable ranges for total dry film thickness. There are a few nicks within the coating on the 0.5 MG reservoir that appear to be from rocks or other debris. This has resulted in the underlying steel being exposed to the environment and a small amount of general surface corrosion. However, the corrosion is limited and had not resulting in any measureable pitting.

The northern side of the reservoir roof has a low area that is supporting rain runoff concentrating at one location along the side of the reservoir. This allows for the accumulation of moss and other organic material growth along the side that will cause coating damage and premature failure.



Area of organic film build-up

0.5 MG - Exterior sidewall debris

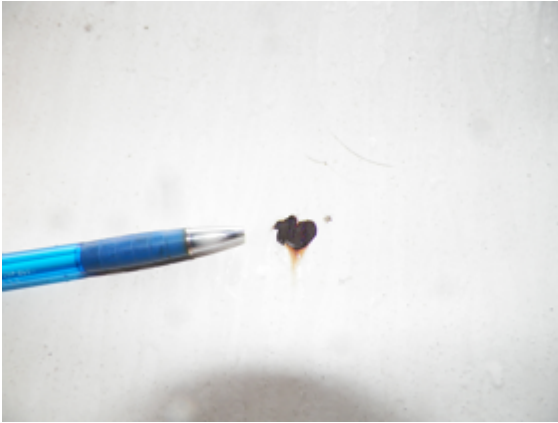
The coating on the 0.5 MG reservoir roof is dirty and there are approximately six quarter-sized defects where the coating has failed to bare metal. There was no steel pitting at these sites and so long as minor coating repairs are completed, further steel deterioration will not occur.



0.5 MG - Dirt on roof and small coating defect

The 2.2 MG reservoir has numerous (perhaps up to 100) rock chips on the lower northeast side of the structure. This location is adjacent to a tiered grassy area where mowers likely throw small rocks against the side of the reservoir. Steel is exposed at these locations, but there was no noted pitting.

The roof of the 2.2 MG reservoir is experience approximately 35 – 40% topcoat failure. The remainder of the topcoat is loosely adhered to the intermediate coat at all tested locations. There are approximately twelve instances of failure to steel on the roof with no associated pitting.



2.2 MG - Typical dime sized coating defect



2.2 MG – Coating failure at chine

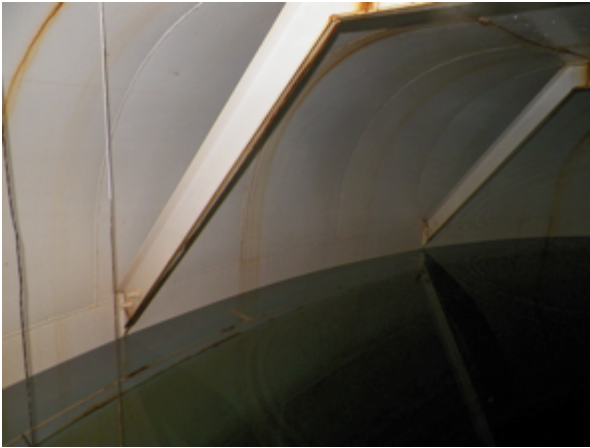


2.2 MG – Topcoat failure, comprising approximately 35 – 40% of roof

Interior Coating Inspection

The interior coating inspection was limited to that which could be viewed from the roof access hatch and by reviewing videos of the diving inspection completed in June 2013.

Both reservoirs were constructed without seal welding the interior roof lap joints or the internal beam supports in close contact with the roof. This has resulted in crevice corrosion at multiple locations within these overlap areas. The corrosion has resulted in rust staining, but it is unlikely that significant damage has occurred. The edges of the painter's rails and ladder supports have also experienced coating failure and subsequent general surface corrosion.



0.5 MG – Support beam and sidewall connection



0.5 MG – Overflow pipe



0.5 MG – Roof support beams



0.5 MG – Interior access ladder



2.2 MG - Missed coating on bottom of exterior landing



2.2 MG – Interior roof and beam overlaps with crevice corrosion



2.2 MG – Interior beam/roof areas



2.2 MG – Interior overview

Interior Dive Video Review

0.5 MG Reservoir

A review of the diving video provided for the 0.5 MG reservoir shows that most surfaces are in very good condition and that the coating is generally sound. There are isolated locations of spot corrosion at coating defects, but there was no associated pitting noted. Corrosion of the liquid level base was evident and is a result of galvanic activity between the carbon steel base and the stainless steel level guide cables. Additional corrosion activity was noted at the 1-inch water tap. If this uncoated fitting was originally galvanized, then corrosion of the zinc coating (galvanizing) would be accelerated because of its contact with the carbon steel reservoir.

2.2 MG Reservoir

Similar to the 0.5 MG reservoir, the interior of the 2.2 MG reservoir appears to be in generally good condition. Isolated instances of corrosion damage were noted at the liquid level base and the 1-inch tap. As previously discussed, this corrosion is likely due to galvanic activity between the different metals.

Instances of tuberculation were found at isolated areas on the reservoir wall and columns. Removing the corrosion deposit revealed that very little pitting had occurred at these sites.

Exterior Corrosion Assessment

The exterior surfaces of the reservoirs do not appear to have any significant corrosion damage. During our visual inspection, there were no observed instances of pitting or other noteworthy locations of corrosion. The few areas of exposed steel with general surface corrosion are cosmetic in nature and are not affecting the integrity of the reservoirs.

Field Lead Tests

Testing for presence of lead based paint was performed at two locations on the exterior surface of each reservoir using field lead check swabs. Both tests were negative for the presence of lead.

Ultrasonic Thickness Testing

The remaining steel wall thickness was measured using a Dakota Ultrasonic model MVX ultrasonic thickness tester calibrated for carbon steel. Thickness data was collected on each shell course and the roof. Results of the ultrasonic thickness tests are presented in Tables 2 and 3.

Table 2: 0.5 MG Steel Thickness Measurements

Location	Average Measured Thickness, inches	Design Thickness, inches
Floor Plate	N/A	0.250
Bottom Course	0.317	0.3125
2 nd Course	0.317	0.3125
3 rd Course	0.259	0.250
4 th Course	0.254	0.250
5 th Course	0.261	0.250
6 th Course	0.185	0.1875
7 th Course	0.188	0.1875
8 th Course	0.188	0.1875
9 th Course	01.79	0.1875

Knuckle	0.185	0.1875
Roof	0.186	0.1875

Table 3: 2.2 MG Steel Thickness Measurements

Location	Average Measured Thickness, inches	Design Thickness, inches
Floor Plate	N/A	0.250
Bottom Course	0.562	0.5625
2 nd Course	0.379	0.375
3 rd Course	0.312	0.3125
Roof	0.188	0.1875

Cathodic Protection Current Requirement Testing

Native state electrical potential readings were measured from the top of the water level to the bottom of the reservoirs. A temporary anode was then submerged in the water and connected to a battery. Using the reservoir as a cathode, current was discharged off of the anode and allowed to polarize the interior wetted surfaces. Using approximately 150 milliamps of current resulted in potentials that met criteria for effective corrosion control at all of the tested locations. Protection criterion is met when a minimum of 100 millivolts potential difference is measured between the native and off readings. Data associated with this testing is outlined in Tables 4 and 5.

Table 4: 0.5 MG Reservoir - Cathodic Protection Potential Measurements

Test Location	Native, mV	On, mV	Off, mV
Water Level	-390	-4500	-512
-20 feet	-356	-4500	-503
-40 feet	-302	-1150	-530

Table 5: 2.2 MG Reservoir - Cathodic Protection Potential Measurements

Test Location	Native, mV	On, mV	Off, mV
Water Level	-300	-4800	-419
-4 feet	-284	-4800	-445
-8 feet	-274	-3200	-462

Cathodic protection testing was completed to gain an understanding of the amount of current required to protect the structures based upon the existing condition of the interior reservoir coatings. Using this information, it will be possible to design a galvanic anode cathodic protection system that will provide protection to all the submerged surfaces within each reservoir.

CONCLUSIONS

The following conclusions are based upon results of the field testing and visual inspection of the reservoirs.

1. With the exception of the 2.2 MG reservoir roof, the exterior coating dry film thickness measurements recorded on both reservoirs are consistent with those of a high performance coating system.
2. The exterior coating of the 0.5 MG reservoir is in very good condition. A few coating defects are visible on the lower shell courses and on the reservoir roof.
3. The exterior shell of the 2.2 MG reservoir has numerous coating flaws, generally located on the north to northeastern side. These defects are likely the result of debris being discharged from mowers.
4. The topcoat on the 2.2 MG reservoir is in poor condition. Approximately 35 – 40% of the coating is missing and the remainder is loosely adhered.
5. Both reservoirs exterior coating tested negative for the presence of leachable lead.
6. The interior coating of both reservoirs appears to be in good condition. Isolated instances of coating damage and associated surface corrosion were noted during the diving inspection.
7. Galvanic corrosion cells exist within each reservoir, particularly where carbon steel and stainless steel are in close contact with each other.
8. Neither reservoir roof structure incorporated seal welding of the roof plates or support beam-to-roof connections. This is allowing crevice corrosion to occur at isolated locations.
9. Ultrasonic steel thickness testing of the reservoir wall sheets and roof structures are consistent with the as-built drawings. There was no pitting noted at any of the inspected surfaces.

10. The reservoirs do not have a dedicated corrosion control system. Based upon the results of our testing, a galvanic anode system would be capable of protecting any isolated instances of corrosion associated with the reservoirs interior submerged surfaces.

RECOMMENDATIONS

1. The exterior of the 0.5 MG reservoir should be cleaned of all foreign debris (organic material growth and dirt).
2. Repairs to the damaged coating areas associated with each reservoir should be completed. These include the isolated locations on the exterior of the reservoirs, the interior roof hatch surfaces, painter's rail, support columns, and any other damaged locations.
3. The 2.2 MG reservoir should have a new topcoat applied. This will involve removal of all non-adherent existing topcoat material, scarifying of underlying intermediate coating, and application of a tie-coat and polyurethane topcoat.
4. The interior non-welded joints should be sealed to prevent further corrosion damage. Sealing could be completed by welding or the application of a caulking compound (Sikaflex-1A).
5. A cathodic protection system for the submerged surfaces of the reservoirs should be designed and installed. This will provide for corrosion control at all locations of coating holidays and negate any effects of existing galvanic corrosion due to dissimilar metals.

BUDGETARY ESTIMATES

The following estimates are based upon our past experience with similar projects. The interior work will require that the reservoirs be drawn down and out of service for up to two weeks, depending upon the type of upgrade work being performed.

1. 0.5 MG reservoir exterior cleaning: \$5,000 – \$10,000. Cleaning will require the use of high lift equipment, pressure washing, and cleaning agents.
2. Repairs to the damaged coating areas: Reservoir exteriors (with the exception of the 2.2 MG roof) \$3,000 – \$8,000 per reservoir. The reservoir interiors will require the use of rolling scaffolding and cost on the order of \$25,000 - \$40,000 each for coating repairs.
3. The 2.2 MG reservoir exterior roof surfaces. The described work sequence (topcoat removed, scarifying, and two coat application) will be between \$25,000 and \$35,000.
4. Sealing of roof lap joints and support beams/roof.
 - a. 0.5 MG reservoir: \$15,000 - \$20,000
 - b. 2.2 MG reservoir: \$20,000 - \$30,000
5. Galvanic anode cathodic protection system:
 - a. 0.5 MG reservoir: \$12,000 - \$15,000
 - b. 2.2 MG reservoir: \$10,000 - \$15,000

We appreciate the opportunity to work with you on this project. If you have any questions or would like assistance with the implementation of the report recommendations, please do not hesitate to contact our office.

Sincerely,
Northwest Corrosion Engineering

A handwritten signature in blue ink that reads "Jeremy A. Hailey". The signature is written in a cursive style with a large initial 'J'.

Jeremy A. Hailey, P.E.

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City of Duvall
Crestview Estates Reservoir Improvements
Engineer's Opinion of Planning Level Project Costs
Alternative 1 - Rehabilitate Existing 0.5 MG Welded Steel Tank
June 2014

PROJECT COSTS					
No.	Construction Item Description	Qty	Unit	Unit Price	Item Total
1	Mobilization/Demobilization (8%)	1	LS	\$33,000	\$33,000
2	Construction Surveying and Staking	1	LS	\$5,000	\$5,000
3	Site Preparation and Erosion Control	1	LS	\$15,000	\$15,000
4	Micropiles	1	LS	\$200,000	\$200,000
5	Flex-Tend Expansion Joints	2	EA	\$14,000	\$28,000
6	Expand Tank Foundation	1	LS	\$50,000	\$50,000
7	Clean Reservoir	1	LS	\$10,000	\$10,000
8	Coating Repairs	1	LS	\$50,000	\$50,000
9	Cathodic Protection	1	LS	\$15,000	\$15,000
10	Seal Weld Interior Joints	1	LS	\$20,000	\$20,000
11	Finish Grading and Surface Restoration	1	LS	\$15,000	\$15,000
Subtotal					\$441,000
Sales Tax (8.6%)					\$37,926
Subtotal					\$478,926
Contingency (30%)					\$143,678
Engineering, Legal and Administrative Costs (35%)					\$167,624
Estimated Project Cost					\$800,000

The opinions or estimates of project costs herein were prepared on the basis of available project information, reflecting planning-level preliminary estimates for the year 2014. The project costs are expected to change in the future as new and more detailed information is collected as the project evolves from planning through construction. Factors beyond the control of MSA that may affect final project costs include, but are not limited to, project scope modifications, economic conditions, market conditions, competitive bidding, and variances in the cost of labor, materials and equipment.

City of Duvall
Crestview Estates Reservoir Improvements
Engineer's Opinion of Planning Level Project Costs
Alternative 2 - Construct New 0.5 MG Welded Steel Tank
June 2014

PROJECT COSTS					
No.	Construction Item Description	Qty	Unit	Unit Price	Item Total
1	Mobilization/Demobilization (8%)	1	LS	\$71,000	\$71,000
2	Construction Surveying and Staking	1	LS	\$5,000	\$5,000
3	Site Preparation and Erosion Control	1	LS	\$15,000	\$15,000
4	Demo & Remove Existing Reservoir	1	LS	\$50,000	\$50,000
5	Site Piping and Valves	1	LS	\$65,000	\$65,000
	Yard piping	1	LS	\$50,000	\$50,000
	Isolation Valves	3	EA	\$5,000	\$15,000
6	Construct New Reservoir	1	LS	\$691,000	\$691,000
	New 0.5 MG Welded Steel Reservoir	1	LS	\$575,000	\$575,000
	Cathodic Protection	1	LS	\$15,000	\$15,000
	Tideflex Mixing System	1	LS	\$65,000	\$65,000
	Flex-Tend Expansion Joints	3	EA	\$12,000	\$36,000
7	Electrical and Control	1	LS	\$40,000	\$40,000
8	Finish Grading and Surface Restoration	1	LS	\$15,000	\$15,000
Subtotal					\$952,000
Sales Tax (8.6%)					\$81,872
Subtotal					\$1,033,872
Contingency (20%)					\$206,774
Engineering, Legal and Administrative Costs (30%)					\$310,162
Estimated Project Cost					\$1,560,000

The opinions or estimates of project costs herein were prepared on the basis of available project information, reflecting planning-level preliminary estimates for the year 2014. The project costs are expected to change in the future as new and more detailed information is collected as the project evolves from planning through construction. Factors beyond the control of MSA that may affect final project costs include, but are not limited to, project scope modifications, economic conditions, market conditions, competitive bidding, and variances in the cost of labor, materials and equipment.

City of Duvall
 Big Rock Road 2.2 MG Reservoir Improvements
 Engineer's Opinion of Planning Level Project Costs
 Alternative 1 - Dedicated Inlet
 June 2014

PROJECT COSTS					
No.	Construction Item Description	Qty	Unit	Unit Price	Item Total
1	Mobilization/Demobilization (8%)	1	LS	\$28,000	\$28,000
2	Construction Surveying and Staking	1	LS	\$5,000	\$5,000
3	Site Preparation and Erosion Control	1	LS	\$5,000	\$5,000
4	Existing Reservoir Structural/Seismic Improvements				
	2.2 MG Existing Reservoir Satisfies Structural Requirements - No Improvements	1	LS	\$0	\$0
5	Existing Reservoir Coating Improvements				
	Exterior Coating Improvements (including roof)	1	LS	\$43,000	\$43,000
	Interior Coating Improvements	1	LS	\$35,000	\$35,000
	Sealing Improvements (roof lap joints and support beams/roof)	1	LS	\$30,000	\$30,000
	Cathodic Protection	1	LS	\$15,000	\$15,000
6	Existing Reservoir Inlet and Outlet Improvements (dedicated inlet and yard piping)				
	Yard piping	1	LS	\$15,000	\$15,000
	Valves	1	LS	\$35,000	\$35,000
	Tideflex Mixing System	1	LS	\$65,000	\$65,000
	Wall Penetration	1	LS	\$10,000	\$10,000
	Flex-Tend Expansion Joints	2	LS	\$25,000	\$50,000
	Fittings and Appurtenances	1	LS	\$15,000	\$15,000
	Connections to Existing System	5	EA	\$2,000	\$10,000
7	Finish Grading and Surface Restoration	1	LS	\$8,000	\$8,000
Subtotal					\$369,000
Sales Tax (8.6%)					\$31,734
Subtotal					\$400,734
Contingency (30%)					\$120,220
Engineering, Legal and Administrative Costs (30%)					\$120,220
Estimated Project Cost					\$650,000

The opinions or estimates of project costs herein were prepared on the basis of available project information, reflecting planning-level preliminary estimates for the year 2014. The project costs are expected to change in the future as new and more detailed information is collected as the project evolves from planning through construction. Factors beyond the control of MSA that may affect final project costs include, but are not limited to, project scope modifications, economic conditions, market conditions, competitive bidding, and variances in the cost of labor, materials and equipment.

City of Duvall
 Big Rock Road 2.2 MG Reservoir Improvements
 Engineer's Opinion of Planning Level Project Costs
 Alternative 2 - Inlet/Outlet Manifold
 June 2014

PROJECT COSTS					
No.	Construction Item Description	Qty	Unit	Unit Price	Item Total
1	Mobilization/Demobilization (8%)	1	LS	\$18,000	\$18,000
2	Construction Surveying and Staking	1	LS	\$5,000	\$5,000
3	Site Preparation and Erosion Control	1	LS	\$5,000	\$5,000
4	Existing Reservoir Structural/Seismic Improvements				
	2.2 MG Existing Reservoir Satisfies Structural Requirements - No Improvements	1	LS	\$0	\$0
5	Existing Reservoir Coating Improvements				
	Exterior Coating Improvements (including roof)	1	LS	\$43,000	\$43,000
	Interior Coating Improvements	1	LS	\$35,000	\$35,000
	Sealing Improvements (roof lap joints and support beams/roof)	1	LS	\$30,000	\$30,000
	Cathodic Protection	1	LS	\$15,000	\$15,000
6	Existing Reservoir Inlet and Outlet Improvements (inlet/outlet manifold & yard piping)				
	Yard piping	1	LS	\$5,000	\$5,000
	Valves	1	LS	\$4,000	\$4,000
	Tideflex Mixing System	1	LS	\$65,000	\$65,000
	Fittings and Appurtenances	1	LS	\$4,000	\$4,000
	Connections to Existing System	2	EA	\$2,500	\$5,000
7	Finish Grading and Surface Restoration	1	LS	\$5,000	\$5,000
Subtotal					\$239,000
Sales Tax (8.6%)					\$20,554
Subtotal					\$259,554
Contingency (30%)					\$77,866
Engineering, Legal and Administrative Costs (40%)					\$103,822
Estimated Project Cost					\$450,000

The opinions or estimates of project costs herein were prepared on the basis of available project information, reflecting planning-level preliminary estimates for the year 2014. The project costs are expected to change in the future as new and more detailed information is collected as the project evolves from planning through construction. Factors beyond the control of MSA that may affect final project costs include, but are not limited to, project scope modifications, economic conditions, market conditions, competitive bidding, and variances in the cost of labor, materials and equipment.

APPENDIX D

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PRIMARY SUPPLY FROM TOLT 1

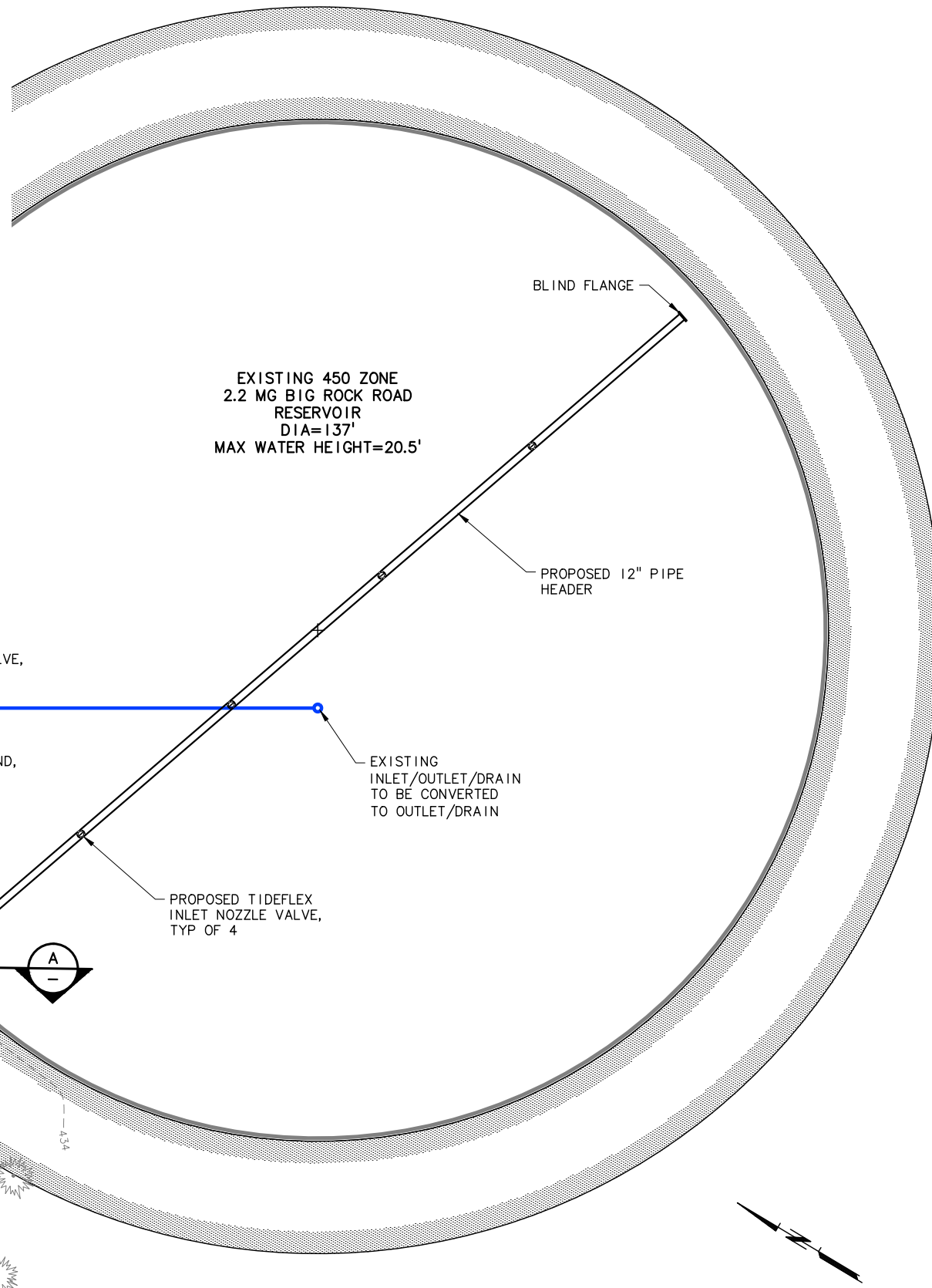
TANK IN SERVICE	
WATER VALVE ID	STATUS
(A)	OPEN
(B)	OPEN
(C)	CLOSED
(D)	OPEN
(E)	OPEN
(F)	OPEN
(G)	CLOSED
(H)	CLOSED
(I)	CLOSED
(J)	OPEN
(K)	CLOSED
(L)	OPEN
(M)	OPEN
(N)	CLOSED

TANK OUT OF SERVICE	
WATER VALVE ID	STATUS
(A)	OPEN
(B)	CLOSED
(C)	CLOSED
(D)	OPEN
(E)	OPEN
(F)	OPEN
(G)	CLOSED
(H)	CLOSED
(I)	CLOSED
(J)	CLOSED
(K)	OPEN
(L)	OPEN
(M)	OPEN
(N)	CLOSED

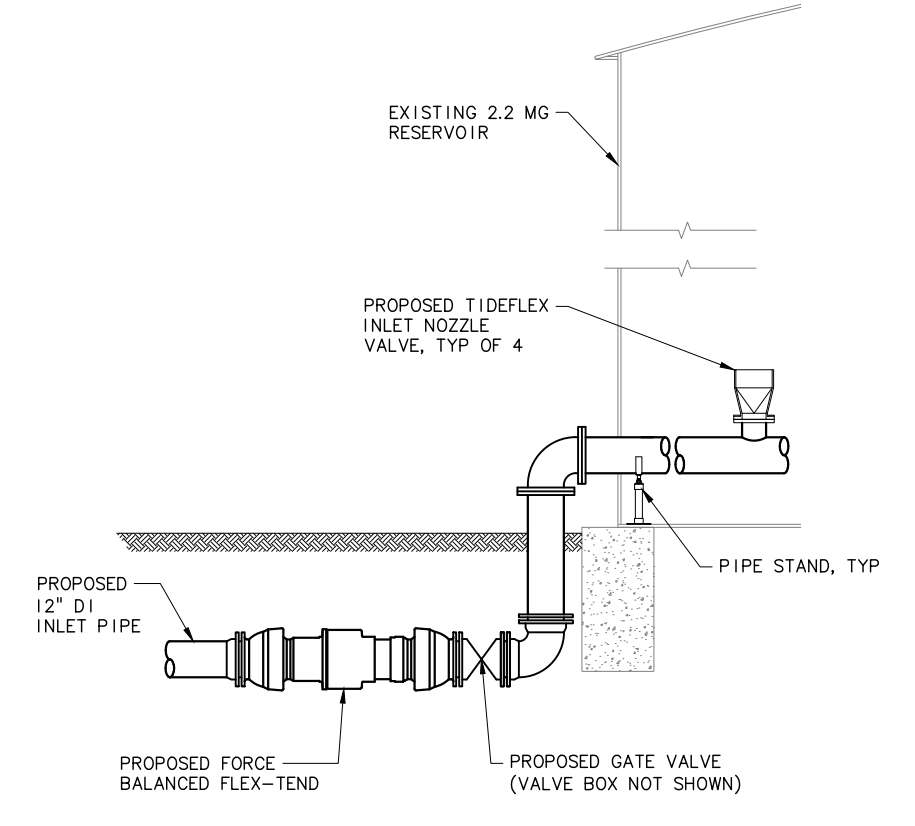
BACKUP SUPPLY FROM TOLT 2

TANK IN SERVICE	
WATER VALVE ID	STATUS
(A)	OPEN
(B)	OPEN
(C)	CLOSED
(D)	OPEN
(E)	OPEN
(F)	OPEN
(G)	CLOSED
(H)	CLOSED
(I)	CLOSED
(J)	OPEN
(K)	CLOSED
(L)	CLOSED
(M)	OPEN
(N)	CLOSED

TANK OUT OF SERVICE	
WATER VALVE ID	STATUS
(A)	OPEN
(B)	CLOSED
(C)	CLOSED
(D)	OPEN
(E)	OPEN
(F)	OPEN
(G)	CLOSED
(H)	CLOSED
(I)	CLOSED
(J)	CLOSED
(K)	CLOSED
(L)	CLOSED
(M)	OPEN
(N)	CLOSED



RESERVOIR SITE PLAN
SCALE: 1"=10'



RESERVOIR INLET SECTION
SCALE: NTS

H:\EVT_Projects\13\1502\CAD\SHEETS\13-1502-106-WA-C.dwg Figure 1 6/26/2014 4:27 PM JKM 18.2s (LMS Tech)

NO.	DATE	BY	REVISION

NOTICE
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

SSA DESIGNED
JKM DRAWN
MGM CHECKED
PRELIMINARY ONLY
DO NOT USE FOR CONSTRUCTION
JUNE 2014
MURRAY, SMITH & ASSOCIATES, INC.
Engineers/Planners

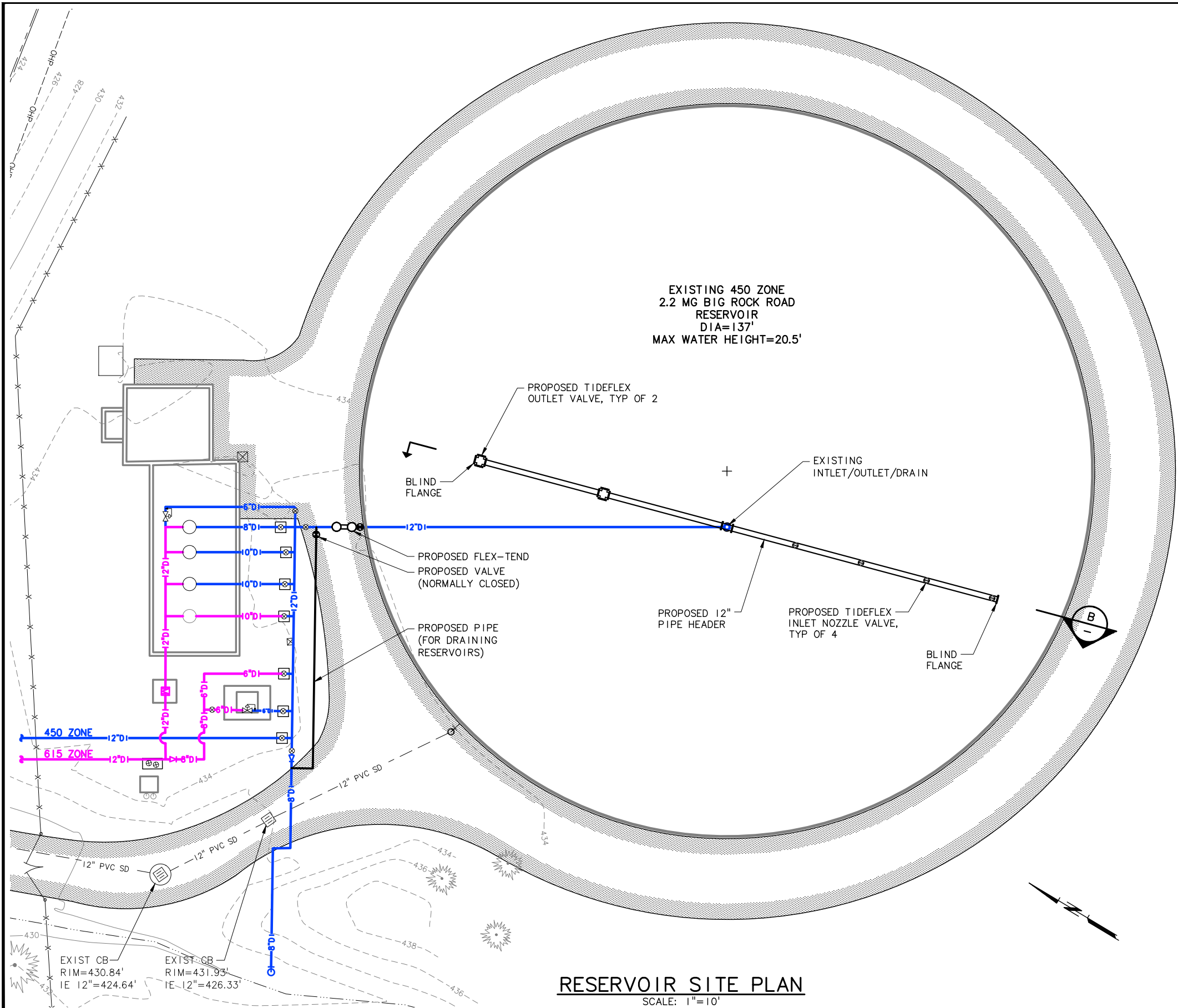
MSA Murray Smith & Associates, Inc.
Engineers/Planners
2707 Colby Avenue, Suite 1110 PHONE 425.252.9003
Everett, Washington 98201-3566 FAX 425.252.8853

CITY OF DUVALL
BIG ROCK ROAD RESERVOIR IMPROVEMENTS

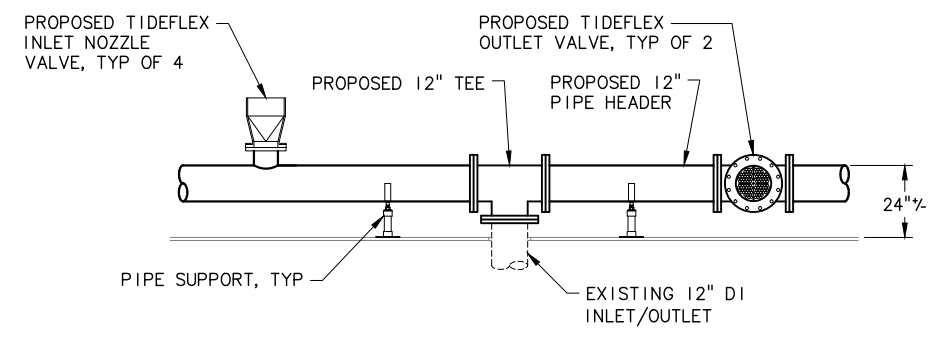
ALTERNATIVE 1
DEDICATED INLET
PROJECT NO.: 13-1502.106 SCALE: AS SHOWN DATE: JUNE 2014

SHEET
Figure 1

H:\EVT_Projects\13\1502\CAD\SHEETS\13-1502-106-WA-C.dwg Figure 2 6/26/2014 4:27 PM JKM 18.2s (LMS Tech)



RESERVOIR SITE PLAN
SCALE: 1"=10'



INLET/OUTLET MANIFOLD SECTION B
SCALE: NTS

NO.	DATE	BY	REVISION

NOTICE
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

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**CITY OF DUVALL
BIG ROCK ROAD RESERVOIR
IMPROVEMENTS**

**ALTERNATIVE 2
INLET/OUTLET MANIFOLD**
PROJECT NO.: 13-1502.106 SCALE: AS SHOWN DATE: JUNE 2014

SHEET
Figure 2

Attachment C

Table 9-2 (continued)
Capital Improvement Program Projects

ID Num	Project Location or Name	Project Limits	Existing Deficiency	Proposed Improvement	Proposed Improvement
FACILITIES					\$7,711,000
F1	Decommission 485 Zone	485 Zone	Insufficient looping and dead-end zone	This project will remove 555/485 PRV's on NE Big Rock Road and 275th Ave NE to convert 485 Zone to 555 Zone and reconfigure existing NE Big Rock Road/275th Ave NE pressure relief station to a 555/450 PRV.	\$220,000
F2	Crestview Estates 0.5 MG Reservoir Improvements	0.5 MG Reservoir	Based on the findings of the City's 2014 Reservoir Evaluations and Recommendations study, the Crestview Estates Reservoir will require extensive seismic and structural improvements as well as changes to its operations. It may be more beneficial for the City to rebuild the Crestview Reservoir.	This project assumes the replacement of the Crestview Estates Reservoir with a new 0.5 MG standpipe. Prior to implementation of this project, it is recommended that storage analyses be conducted to identify if a larger reservoir at this site is more beneficial to meet the City's overall long-term storage needs of the system.	\$2,733,000
F3	Big Rock Road 2.2 MG Reservoir Improvements	2.2 MG Reservoir	Based on the findings of the City's 2014 Reservoir Evaluations and Recommendations study, the Big Rock reservoir does not require any seismic improvements but will need to be recoated. Inlet / Outlet improvements will improve water turnover within the reservoir.	This task involves recoating the interior and exterior coating of the 2.2 MG reservoir and is anticipated to take place between 2021 and 2022. This project also contains inlet/outlet improvements. These improvements will improve water turnover within the reservoir, which would enable the City to operate it at higher levels and provide a larger volume of usable storage. Implementation of this improvement will increase the amount of available storage, which in turn enables the City to serve a larger number of new connections, since storage is the limiting facility in the City's water system, as shown in the capacity analysis in Chapter 8.	\$1,661,000
F4	Pump Station Improvements	615 Zone Booster Pump Station	The reservoir currently has a single inlet/outlet pipe for flow into and out of the reservoir, which prevents optimum turnover and water quality. The lack of turnover in the reservoir and potential for loss of chlorine residual, forces the reservoir to operate at a low level, which prevents full utilization of its available storage capacity. In addition, the reservoir may not have sufficient restraint to withstand seismic events.	As a result of revisions to DOH's definition of a pump station's "firm capacity," the City's 615 Zone Pump Station has of insufficient supply capacity to meet the demands. This project is anticipated to be completed by 2021. This project will increase the capacity of the pump station by adding a fourth pump in the available pump bay and replacing one or more of the other three pumps, as necessary; to optimize the operation of the pump station for meeting the future increased demand of the 615 Zone. The pump improvements will also require improvements to the electrical system and modifications to the telemetry and control system. The sizing of the pump and electrical improvements will be accomplished during the preliminary design phase of the project. The capacity of the pump station will need to be increased by as much as 1,200 gpm to meet the 615 Zone demands in the year 2040. However, since the need for the improvement depends on the timing and amount of development in the 615 Zone, it is prudent to evaluate the 615 Zone supply requirements every few years.	\$238,000
F5	Supply Station Improvements	Tolt 1		This project would increase the tap diameter and metering at the SPU source. The project will also provide improvements to adequately drain the existing vaults. The sump pump in the existing vault would be replaced, if necessary, to reduce the frequency of standing water in the bottom of the vaults. The SPU tap and meter will be upsized, if required.	\$291,000
F6	Supply Station Improvements	Tolt 2		This project would increase the tap diameter and metering at the SPU source. The project will also provide improvements to adequately drain the existing vaults. The sump pump in the existing vault would be replaced, if necessary, to reduce the frequency of standing water in the bottom of the vaults. The SPU tap and meter will be upsized, if required.	\$279,000
F7	Telemetry and Control Improvements	System Wide	The existing system is difficult to operate, requires too much manual intervention, and is not optimized. The existing telemetry system is not fully operational and is not currently set up to provide data collection and alarm notification at all facilities.	This project will provide a new SCADA system to enable a more simplified, automated control of the water system facilities with reduced operations costs. The SCADA system will monitor the Tolt1 and Tolt 2 supply stations, the 0.5 MG and 2.2 MG reservoirs, the 615 Zone Booster Pump Station, the PRV sites, and the chlorine monitoring sites. It will also entail a new telemetry system to allow communication between sites.	\$439,000
F8	Taylor's Landing Well Arsenic Treatment	Taylor's Landing Well	Arsenic in water supply, making it non-potable.	This project involves the installation of treatment equipment so that the City could use this well as potable water supply in the case of an emergency.	\$650,000
F9	Water Department Building	Admin Building for Water Department	Provide an updated facility for water department employees.	This project would include a building remodel, followed by the construction of an updated office space for water department staff. This office space may be a standalone building or part of a larger building housing other City staff.	\$1,200,000

Table 9-6
Planned Improvements Implementation Schedule

ID Num	Description	Water Main Priority	Estimated Project Cost (2020 x\$1,000)	20-Year Schedule of Improvements											
				Planned Year of Project and Estimated Cost in 2020 (x\$1,000)											
WATERMAIN REPLACEMENT				2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031-40
R1	12" Tolt 2 Supply Line from Tolt Supply Station to NE Big Rock Rd	High	\$1,800	\$270	\$810	\$720									
R2	8" Water Main in Bruett Rd from 3rd Ave NE to 3rd Pl NE	Low	\$193												\$193
R3	8" Water Main in 1st Ave from NE Stephens to NE Valley Street	Medium	\$329						\$329						
LOOPING															
L1	8" Water Main in 1st Ave from NE Virginia Street to NE Stephens	Low	\$111												\$111
L2	12" Water Main in Batten Rd NE from NE 140th Pl to Big Rock Rd	Low	\$2,072						\$518	\$1,036	\$518				
FACILITIES															
F1	Remove 555/485 PRV's on NE Big Rock Road and 275th Ave NE to convert 485 Zone to 555 Zone and reconfigure existing NE Big Rock Road/275th Ave NE pressure relief station to a 555/450 PRV.		\$220		\$220										
F2	Crestview Estates Reservoir Improvements and Recoating		\$2,733											\$547	\$2,186
F3	Big Rock Road Reservoir Re-coating and Inlet/ Outlet Improvements		\$1,661		\$415	\$831	\$415								
F4	615 Zone Pump Station Improvements		\$238		\$60	\$179									
F5	Tolt 1 Supply Station Improvements		\$291					\$291							
F6	Tolt 2 Supply Station Improvements		\$279					\$279							
F7	Telemetry and Control Improvements		\$439	\$39	\$400										
F8	Taylor's Landing Well Arsenic Treatment		\$650												\$650
F9	Water Department Building		\$1,200			\$200									\$1,000
CITYWIDE PROGRAM															
CW1	Conservation and Leak Detection		\$210	\$10	\$10	\$10	\$10	\$10	\$10	\$10	\$10	\$10	\$10	\$10	\$100
CW2	Water Reclamation		\$105	\$5	\$5	\$5	\$5	\$5	\$5	\$5	\$5	\$5	\$5	\$5	\$50
CW3	Cross Connection Control		\$105	\$5	\$5	\$5	\$5	\$5	\$5	\$5	\$5	\$5	\$5	\$5	\$50
CW4	Comprehensive Plan		\$674	\$175	\$50									\$225	\$225
CW5	Risk and Resiliency Plan		\$100	\$20				\$20						\$20	\$40
CW6	GIS Asset Management Program		\$210	\$10	\$10	\$10	\$10	\$10	\$10	\$10	\$10	\$10	\$10	\$10	\$100
CW7	Well Protection Program		\$105	\$5	\$5	\$5	\$5	\$5	\$5	\$5	\$5	\$5	\$5	\$5	\$50
Total Annual Cost (note - average cost per year is shown for years beyond 2030)			\$13,726	\$539	\$1,990	\$1,964	\$450	\$605	\$384	\$553	\$1,071	\$553	\$146	\$827	\$464