City of Ashland

Water Treatment Plant and Reservoir Project

Membrane Filtration Equipment Pilot Testing Protocol

October 18, 2017

Version 5

Prepared for City of Ashland by:

Keller Associates, Inc.

TABLE OF CONTENTS

1 INTRODUCTION

The City of Ashland is in the process of preliminary design of a new water treatment plant (WTP) with full capacity in the range of 10 million gallons per day (MGD). The City is leaning favorably toward using a membrane filtration system in the new plant.

The City intends to pilot test three membrane filtration systems for approximately five months from late summer through early winter 2017. Performance during the pilot test and system cost will be evaluated to select the final membrane filtration system for installation in the new WTP (Project).

The City advertised a Request for Qualifications (RFQ) for statements of qualifications (SOQs) from qualified Membrane Filtration Equipment Manufacturers (MFEMs) with systems suitable for municipal water treatment to select up to three systems for pre-qualification for pilot testing and potential subsequent bidding to supply equipment for the Project. The RFQ document presents general requirements of the MFEMs for the pilot testing (Appendix A). The RFQ was advertised on May 5, 2017.

Three membrane filter manufacturers / systems have been selected to participate in pilot testing:

- Aqua-Aerobic, MultiBore C-Series ceramic membrane
- BASF/Inge, H_2O Innovation, dizzer Multibore UF membrane
- Pall Corporation, Asahi UNA-620A membrane

The following test plan outlines the testing protocol to be used for the Ashland WTP Membrane Pilot Study. The study will be conducted from August through December 2017 and will include a minimum of three 28-day design runs. The tests are designed to evaluate the performance of membrane systems for the treatment of source water from Reeder Reservoir and Talent Irrigation District (TID) and to refine the design parameters for the full-scale system.

2 PILOT PERFORMANCE TESTING PROGRAM

2.1 Pilot Performance Testing Program Objectives

Objectives of the pilot study are:

1. Provide operational staff experience with membrane microfiltration process
2. Evaluate compatibility of raw/pretreated water from Reeder Reservoir and Talent Irrigation District (TID) sources with membrane filtration process
    a. Summer (high temperature / high algae concentrations)
3. Demonstrate flux through membrane system without excessive fouling
4. Demonstrate acceptable physical integrity test(s) and ability to meet warranties for fiber breakage for each piloted membrane system
5. Evaluate the causes of any excessive membrane fouling that may occur during pilot testing
6. Demonstrate capability of membrane system to meet treated water quality requirements
7. Optimize and establish physical design parameters for the full-scale plant design that will allow determination of life-cycle costs, including:

    a. Flux (gallons per day per square foot of membrane material, GFD)
    b. Pre-treatment chemicals
    c. Backwash type, frequency, duration, and required flow rates for both air and water
    d. Water recovery rate (filtrate volume / feedwater volume)
    e. Cleaning chemicals and processes
8. Demonstrate membrane filter operating conditions established and recommended by the MFEM with minimum 28-day operation before chemical cleaning is required as determined through transmembrane pressure measurements
9. Characterize the quantity and composition of treatment residuals including backwash water that contains solids that will require handling

Membrane demonstration testing will be performed with aluminum chlorohydrate (ACH) pretreatment and no pre-clarification (direct filtration mode). The membrane systems will be evaluated based on hydraulic performance, module / fiber integrity, and permeate water quality. Criteria and the experimental approach are described below.

2.2 Performance Criteria

To be successfully complete the pilot study, the membrane system shall demonstrate the following:

1. Reduction of turbidity to a membrane effluent turbidity of less than 0.05 NTU in 95% of measurements.
2. Reduction of color to less than 5 cu.
3. Operation at a recovery of 95% or greater.
4. Require clean-in-place (CIP) no more frequently than once every 28 days. This shall be demonstrated in a continuous design run with consistent operating parameters. The following Design Run termination criteria shall be used,
    a. Terminal transmembrane pressure
    b. Successful operation for the 28 days at specified conditions
    c. Exceeding maintenance clean (chemical enhanced backwash) time (60 minutes/day) or frequency
    d. Exceeding acceptable downtime of 48 hours per run
    e. Exceeding membrane integrity criteria.
5. If more than one repair occurrence is required to maintain integrity of a membrane, the City reserves the right to exclude that supplier from bidding on the project.
6. Demonstrated ability of module to meet warranty provisions with respect to integrity and fiber breakage rates.
    a. Membrane integrity tests are to be run daily and reports submitted to the City.
7. Demonstrated membrane integrity testing procedure and fiber repair/plugging procedures during the pilot test consistent with requirements of the Long Term 2 Enhanced Surface Water Treatment Rule.

Historical data for the raw water qualities and finished water qualities are summarized in the Ashland WQ Summary and Review Technical Memorandum (Appendix B). Additional data and testing results will be provided to the MFEM as available.

2.3 Process Description

The major pilot study equipment is as follows:

- Pretreatment with aluminum chlorohydrate (ACH) and potentially acid
- Membrane pilot equipment and modules provided by suppliers, Aqua-Aerobic, BASF/Inge, and Pall.
- Common pilot system features such as pumps, hydraulic conveyance infrastructure, and weather protection

There will be two raw water sources for the pretreatment and membrane pilot system, Reeder Reservoir and TID water. The pilot system is installed within the existing WTP as shown in Figure 4 and 5 in the Ashland WTP Pilot Test Equipment drawings (Appendix C). During the pilot study, the existing WTP will operate under normal conditions. Temporary, submersible pumps will convey raw water from the tailrace (Reeder) or the Terrace Street Pump Station (TID) through a 4-inch PVC pipeline to the pretreatment equipment. The raw water line will be split to supply water to all three pilot units.

An initial target flow rate for the raw water feed for all three membrane pilot units is set at 100 gpm at 25-30 psi. Coagulant, aluminum chlorohydrate (ACH), will be added via chemical metering pump to the raw water feed line prior to splitting between the pilot units. Dosage of approx. 8 mg/L of 50% ACH solution will be injected in to the raw water line. Acid injection may occur at this point for optimal coagulation operation. Individual MFEM are permitted to supplement this pretreatment dosage within their pilot unit and must report any chemical addition.

Membrane influent flow is controlled and monitored at each of the three membrane filter pilot units. Membrane filtrate from each of the pilot units is conveyed to the head of the existing plant. Membrane backwash and other waste water from the membrane pilot units is conveyed to the backwash pond, which drains to the City sanitary sewer.

2.4 Pilot Performance Testing Program Schedule Overview

The overall pilot evaluation shall commence in August 2017. Specific activities and corresponding dates are summarized in **Table 1**. Each design run will be preceded by a brief optimization period for each membrane supplier for fine-tune operating conditions. For Design Runs, pilot units shall be operated 24-hours per day for a minimum duration of 28-days for each test condition before clean-in-place or maintenance is performed with downtime not exceeding 48 hours. Between each design run, time will be allotted for clean-in-place, maintenance, and optimization. This schedule will be updated and re-issued throughout the pilot test.

Table 1: Pilot Performance Testing Program Schedule Overview

Approximate Dates	Duration (Calendar Days)	Activity
8/7/17–8/13/17	7	Pilot Equipment Installation / Commissioning
8/18/17– 8/29/17	5	Pilot Optimization #1 by Manufacturers – TID supply, CIP and report proposed operating parameters
8/30/17 8 AM – 9/27/17 8 AM	28	Design Run #1: TID Source Water Evaluation w/ moderate flux rates, maintenance cleans not more frequent than every 24 hours (28 days continuous operation)
9/27/17 – 9/27/17	5	CIP #1 and maintenance
9/28/17 – 10/2/17	3	Pilot Optimization #2 by Manufacturers, CIP and report proposed operating parameters
10/6/17 8AM – 11/4/17 8 AM	28	Design Run #2: Reeder Reservoir Source Water Evaluation w/ moderate flux rates, maintenance cleans not more frequent than every 24 hours (28 days continuous operation)
11/4/17 – 11/6/17	2	CIP #2 and maintenance
11/7/17 – 11/13/17	5	Pilot Optimization #3 by Manufacturers, CIP and report proposed operating parameters
11/14/17 8 AM – 12/12/17 8 AM	28	Design Run #3: Reeder Reservoir Source Water Evaluation w/ aggressive flux rates, maintenance cleans not more frequent than every 24 hrs (28 days continuous operation, 4 days for CIP and maintenance)
12/13/17 – 12/14/17	2	CIP #3,
12/15/17 – 12/20/17	6	Pilot System shut-down and demobilization /removal
1/4/18		Manufacturer draft pilot test report due
1/16/18		Engineer’s comment on pilot test report
1/23/18		Manufacturer final pilot test report due

Data developed during design runs will be used to determine appropriate design criteria for tested membrane systems. The evaluations will focus on optimization of membrane flux / recovery, fouling, and characterization of permeate and backwash flow streams. Minimization of maintenance cleaning, waste flows, operational energy, and excess recirculation rates may be of interest to the suppliers in minimizing their projected life-cycle costs.

2.5 Pilot Performance Testing Program – Test Matrix

The proposed test conditions for Design Runs are presented in **Table 2**. For each test, the duration, coagulant type and dose, estimated temperature and turbidity ranges, and frequency of maintenance cleans and clean-in-place activities are indicated. Membrane integrity tests (MITs) will be required every day and MFEM must report daily results. MFEM should submit full MIT procedure to Keller and City.

Table 2: Pilot Test Plan Matrix

Test	Test Description	Source	No. Days	Coagulant Type/Dose	Estimated Temperature Range (°C)	Estimated Turbidity Range (NTU)	Frequency of Mini-Cleans	Clean-In-Place Frequency
Optimization (14 days)								
B	TID Optimization	TID*	7	10 mg/L ACH	TBD	TBD		
Design Runs 1 & 2: Moderate Flux Rates								
1	TID, Moderate Flux	TID*	28	10 mg/L ACH	TBD	TBD	>= 24 HRS	CIP at end of test
2	Reeder, Moderate Flux	Reeder	28	10 mg/L ACH	12-18	0-5	>= 24 HRS	CIP at end of test
Design Run 3: Aggressive Flux Rates								
3	Reeder, Aggressive Flux	Reeder	28	10 mg/L ACH	10-15	0-5	>= 24 HRS	CIP at end of test

*Any TID water quality data collected by the City will be sent to MFEMs as soon as received.

Maximum flux and transmembrane pressures will not exceed that established by California Department of Health Services (CDHS) for specific log-removal credits of organisms as documented in letters provided by the membrane suppliers.

All Design Runs must operate at a minimum of 95% feed water recovery. Greater recovery will reduce projected life-cycle costs. The recovery calculation shall account for all permeate water losses including production backwashes and maintenance cleans.

Once a design run has started, operating parameters shall not be changed until one of the termination criteria have been met. If it becomes clear that the terminal TMP will be exceeded prior to 28-days, the MFEM can petition the Engineer to adjust to reduced operating criteria (flux and / or recovery).

MFEMs shall report the specifics, both physical and chemical, of the maintenance cleans including, but not limited to, frequency, chemical used and their concentrations, flowrate, pressure, and duration of the clean.

2.6 Pilot Summary Report

At the conclusion of the pilot, a final report will be generated by each membrane manufacturer. This report shall include, but not be limited to, an introduction of the existing treatment and pilot study; description of operation; presentation and discussion of results; conclusions and recommendations drawn from the study; and associated test data, tables, and graphs.

2.7 Pilot Unit (Equipment, Chemical, and Analytical) Specifications

The MFEM shall supply a fully integrated water treatment pilot system. All equipment used to comprise the water treatment pilot system shall be less than 5-years old and be in good-working condition. The overall pilot unit will include all pumps, tanks, compressors, and other ancillary systems needed for full operation during the pilot testing. The pilot units shall be designed as self-contained systems that have their own feed water boost pump, air supply, and dryer for pneumatic valves, membrane filter enhanced backwash chemical systems, control valves for adjusting production rate and recovery, instrumentation and controls for controlling the system and collecting the data on the process variable that effect performance and sample points for monitoring and collecting different process streams for analysis. A PLC for automatic operation and alarm protections shall be provided.

The same membrane filter modules and process conditions must be used in the test unit as proposed for the full-scale system, including membrane fiber, membrane area, packing density, hydraulic configuration, and cycle times. The same membrane module shall be used throughout the pilot test (i.e.; replacement is not allowed).

The various membrane filtration products operate in different manners, with different backwash techniques for maintaining performance. A complete description of the operation of each membrane system must be provided by the manufacturer. These descriptions will become a part of the test data record. At a minimum, the documentation must include a flow schematic and description of the process, description of each unit process and mode of operation (service, backwash, flush, chemical washing, clean-in-place, etc.), instrumentation and controls, chemicals used and their respective dosages.

3 PILOT WORK PLAN

3.1 Data Requirements

Throughout the pilot study, data will be recorded by both operational staff and manufacturers. Data collection responsibilities and frequencies for operators and manufacturers are described in the following two sections. The minimum operating data requirements to achieve the ***Pilot Performance Testing Program*** **objectives** are indicated in **Tables 4, 5,** and **6**.

3.1.1 Data Requirements for Operations Staff

Tables 4 and **5** indicate the operational and water quality monitoring requirements for the duration of the pilot study.

Table 3: Minimum Operating Data Requirements

Parameter	Data Collection Frequency
Membrane Pilot Units	
Membrane Influent Flow Rate (gpm)	1 Time per Day
Membrane Effluent Temperature (^{O}C)	1 Time per Day
Membrane Inlet Pressure (psi)	1 Time per Day
Membrane Outlet Pressure (psi)	1 Time per Day
Membrane Influent Turbidity (NTU) and/or Particle Count	1 Time per Day
Membrane Effluent Turbidity (NTU) and/or Particle Count	1 Time per Day
Other Data Collection Requirements in Pilot System	
Raw Water Flow Rate to Pilot Units (gpm)	1 Time per Day
Coagulant Feed Pump Flow Rate (mL/min)	1 Time per Day
Coagulant Feed Pump Calibration Check	Weekly

*Excluding air used for pneumatic valves and integrity tests.

Keller will prepare log sheets with input from Ashland operators to accomplish the checks listed in **Table 4**.

Water quality requirements and test frequency needed to achieve the *Pilot Performance Testing Program* objectives are indicated in **Table 4**. Turbidity, pH, color, and temperature will be measured on-site. All other water quality parameters will be analyzed by a third-party laboratory, to be contracted by the City, or by the City using a spectrophotometer.

Table 4: Water Quality Parameter Monitoring Frequency

Parameter	Raw Feed Water	Existing Plant Filtrate (Reeder Only)	Each Membrane Pilot Unit		
			Filtrate	Backwash Waste	Comments
pH	Daily	Daily	Daily	Weekly	
TOC (mg/L)	Weekly	Weekly	Weekly	-	TOC/DOC/UV/Color should all be taken around the same time
DOC (mg/L)	Weekly		-	-	
UV_{254} (cm^{-1})	Weekly	Weekly	Weekly	-	
Color	Weekly	Weekly	Weekly	-	
Manganese (mg/L)	Weekly	Weekly	Weekly	Weekly	Lab tests
Iron (mg/L)	Weekly	Weekly	Weekly	Weekly	
Aluminum (mg/L)	-	-	Weekly	Weekly	
Total Suspended Solids (mg/L)	Weekly		-	Weekly	
Total Alkalinity (mg/L as CaCO3)	Weekly	Weekly	Weekly	-	
Total Hardness (mg/L as CaCO3)	Monthly		-	-	
Algae Counts	Weekly	Weekly	Weekly		
THM* (μg/L)	Monthly	Monthly	Monthly	-	
HAA5* (μg/L)	Monthly	Monthly	Monthly	-	
Geosmin	Monthly	Monthly	Monthly	-	Lab Tests
				-	
				-	
				-	
				-	

THM / HAA5 shall be tested on a water sample chlorinated (2.0 mg/L dose) in the laboratory one time during each design run of the pilot test (approximately monthly). Laboratory chlorination will also be required for the full-scale filtered sample. All chlorinated samples should be held at water temperature for period of 96-hours, covered and in the dark. Collect THM/HAA sample, and chlorine residual at the end of the 96-hour contact period.

3.1.2 Data Requirements for Manufacturers

Table 5 lists the minimum data collection requirements for membrane pilot units. The pilot systems must have sufficient instrumentation to collect and store this data. Data shall be submitted to Keller weekly and summarized in graphs. Raw data will be transmitted weekly to Keller and a conference call will be held weekly to discuss the data.

Table 5: Minimum Data Recording Requirements

Parameter	Maximum data logging interval
Online Data Collection	
Feed Pressure (psi)	15 minutes
Permeate Pressure (psi)	15 minutes
Feed Flow Rate (gpm)	15 minutes
Permeate Flow (gpm)	15 minutes
Permeate Flux Rate (gfd)	15 minutes
Backwash Water Flow (gpm)	15 minutes
Membrane Inlet Turbidity (ntu)	15 minutes
Membrane Outlet Turbidity (mntu)	15 minutes
Membrane Inlet Particle Count	15 minutes
Membrane Outlet Particle Count	15 minutes
Transmembrane Pressure (psi)	15 minutes
Temperature (°C)	15 minutes
Other Data Collection	
Backwash Frequency and Duration	When Performed
Maintenance clean Frequency and Duration	When Performed
CIP Frequency and Duration	When Performed

The membrane manufacturer will provide complete information on all of the following activities:

- Integrity test results
- Fiber repairs
- Permeability test results

3.2 Cleaning Process / Integrity / Permeability Test Requirements

Once design run condition termination criteria have been met, a chemical cleaning will be performed along with a clean water permeability test and an integrity test to ensure that 1) the following design run condition will be started with a clean membrane; 2) membrane is operating with all fibers intact. If compromised fibers are identified at anytime during the study period, it is the responsibility of the supplier to repair fibers prior to restarting the unit.

To meet the cleaning process objectives stated above, the following information needs to be determined with complete written description provided to Engineer:

- Chemical washing procedures including frequency, chemical dosing, flows, duration, and soak times
- Clean in place procedures including chemical dosing, temperature, flows, duration, and soak times
- Chemical washing and clean in place trigger criteria including maximum TMP and time
- Low pressure membrane integrity test procedure.
- Requirements for Potable Water Permeability Test:

  1. A Potable Water Permeability Test is required after all cleans in place (CIPs)
  2. The test will use potable water stored in the pilot unit feed tank. The potable water can be re-circulated as needed.
  3. The minimum number of flow rates to test is three. The three flow rates shall include: 1) the highest the pilot unit is expected to operate; 2) 2/3 of that value; and 3) 1/3 of that value. These flow rates shall remain consistent throughout the duration of the pilot test to facilitate comparisons of permeability throughout the pilot test duration.
  4. Each flow rate shall be operated for a duration not less than 2 minutes or until parameters stabilize, whichever is greater.
  5. Flow rate, temperature, actual flux, temperature corrected flux (20 C), and transmembrane pressure (TMP) at each flow rate shall be recorded and reported to Emily Flock at eflock@kellerassociates.com.

3.3 Sampling Points, Analyses, Frequency and Period

Operational data, laboratory data, and chemical analyses will occur during the membrane filtration testing process. Operational and water quality data will be collected at regular intervals during the period of membrane testing, as indicated in **Tables 5** and **6**. Key operating data from on-line instrumentation is presented in **Table 6**.

3.4 Standard Sampling Methods

To ensure the accuracy of all collected data, consistent sampling methods (e.g., location, timing, technique) will be maintained. In addition, consistent sample preservation, packaging, and shipping will be maintained for samples analyzed at off-site laboratories. Membrane operational parameters such as flow, pressure, and time since last backwash will be recorded when samples are taken.

Both on-line and bench-top analytical equipment will be used for on-site analyses. For parameters in which both on-line and bench-top instruments are used, such as turbidity or pH, comparisons between the two readings will be made to check data consistency. If the difference in the readings between on-line and bench top test equipment is greater than the sum of the manufacturer's specified +/- % accuracy for that equipment, both the on-line and bench-top instruments will be re-calibrated. If recalibration efforts do not reconcile the discrepancies in three days, the membrane manufacturer has one week to repair or replace the on-line instrument. Comparisons between on-line and bench-top readings will be made at least once per week.

All analyses will be performed according to *Standard Methods (*reference*)*. Analyses outside the WTP lab capability will be performed at State-certified, third party, or EPA-accredited laboratories.

3.5 Membrane Integrity Verification

Membrane integrity verification is required during the pilot testing on a dailly basis and after each recovery chemical cleaning to ensure that the membrane surface provides an uncompromised barrier to pathogens. Verification of membrane integrity will be a critical aspect of the pilot testing to both ensure the validity of removal performance data and demonstrate the reliability of the membrane process.

A direct integrity test and recovery clean procedure will be conducted prior to beginning each testing stage. The integrity monitoring methods employed during this study will include:

- Air pressure-hold (pressure or vacuum decay) direct integrity test (with or without accompanying sonic testing). The most recent draft version, or adopted version if finalized, of Standard Practice for Integrity Testing of Water Filtration Membrane Systems by the American Society for Testing and Materials (ASTM) must be used to determine the test pressure and calculate the detectable defect size. The membrane manufacturer will provide documentation of calculations or verification testing which validates the method to this level of sensitivity. Additionally, the method will be capable of detecting a single broken fiber within the pilot system.
- Continuous on-line filtrate turbidity monitoring with the turbidity reported for each five-minute period to a recorder.

A physical integrity test of each module will be conducted after each recovery clean procedure using the air-pressure hold test.

During the entire testing period only one unintentional fiber breakage event may occur. If a second fiber breakage event occurs, the City, after discussions of event with Keller and the membrane manufacturer, may elect to terminate testing of that system and eliminate it from further consideration. Damaged fibers shall be repaired by the membrane supplier before putting the membrane back into service.

A fiber break test may be performed to provide data on the sensitivity of the integrity monitoring methods. The membrane manufacturer will provide on-site support for fiber breakage and repair, and Keller will be present during this test.

4 LIFE CYCLE COST EVALUATION

Evaluation of proposals will be based on the calculation of life cycle cost, which will consider the following contributions:

- Equipment Cost
- Pumping and Process Energy
- Chemical Consumption
- Membrane Replacement
- Waste Disposal

The City reserves the right to modify the basis of calculation based upon the results of pilot testing to match the results of pilot testing.

4.1 Project Assumptions

Table 6 below presents a list of assumptions that are to be used in calculating life cycle costs. This is the best estimate at the time, but is subject to change. Final assumptions will be present in the procurement documents.

Table 6: Current Project Assumptions

Basis of Calculation	Value
Present Worth Factor (PW)	14.87 (3%, 20 years)
Interest Rate	3%
Period of Evaluation	20 years
Cost of Energy (EC)	$0.08 /kWhr
Hours Per Year (HPY)	8766
Days Per Year	365
BHP/kW Conversion	0.7457
Motor Efficiency (ME)	94%
VFD Efficiency (VE)	98%
Cleaning Waste Disposal	$0.00 /1000 gallons
Aluminum Chlorohydrate (ACH)	$0.33/lb (1)
Citric Acid (CA)	$0.92 /lb as Citric Acid (2)
Sodium Hypochlorite 12.5% (HYP)	$0.125 /lb as Chlorine (3)
Sodium Hydroxide 25% (SH)	$0.27 /lb as Caustic Soda (4)
Hydrochloric Acid 30% (HCA)	$0.37 /lb as Hydrochloric Acid (5)
Air Compressor Efficiency	$0.29 /hp/cfm

Note: Chemical costs are provided in dollars per pound with the noted % active ingredient. Chemical pricing was provided by Cascade Columbia on October 18, 2017.

(1) Pricing based on bulk delivery ~4,300 gallons
(2) Pricing based on 55 gal drum
(3) Pricing based on bulk delivery ~5,000 gallons
(4) Pricing based on 55 gal drum
(5) Pricing based on 55 gal drum

4.2 Present Worth Equations

Membrane System Present Worth is equal to the sum of the following:

- Total contract price
- Present Worth of Feed Water Pumps (PWFP)
- Present Worth of AS/RF or Backwash Pumps (PWBWP)
- Present Worth of Compressed Air (PWCA)
- Present Worth of Total CIP ($PWCIP_1$, $PWCIP_2$, etc)
    - Present Worth for Acid for CIP
    - Present Worth for Sodium Hydroxide for CIP
    - Present Worth for Detergent for CIP
    - Present Worth for Sodium Hypochlorite for CIP
- Present Worth of CIP Waste Disposal (PWCWD)
- Present Worth of Membrane Replacement (PWMP)

Cleaning Definitions

- Maintenance Clean: The periodic (initiated by time or volume throughput) application of a concentrated chemical solution at high concentration (i.e.; more than 10 mg/L of free chlorine or the addition of an acid which results in a pH of less than 4 or the addition of a base that results in a pH of greater than 10) to a membrane for a short duration of time (less than 60 minutes including rinse) for the intended purpose of maintaining membrane permeability or reducing membrane fouling.

- Clean In Place or Recovery Clean: The periodic application of a concentrated chemical solution at high concentration (i.e. more than 10 mg/L of free chlorine or the addition of an acid which results in a pH of less than 4 or the addition of a base that results in a pH of greater than 10, or the exposure of the membrane to a surfactant or enzymatic cleaning agent) for the intended purpose of removing membrane fouling materials to the greatest extent possible.

MEMBRANE FILTRATION EQUIPMENT MANUFACTURER (MFEM)

PRE-QUALIFICATION DOCUMENTS

FOR

CITY OF ASHLAND
WATER TREATMENT PLANT

Ashland, Oregon

Work under this contract is funded by the federal Safe Drinking Water Revolving Loan Fund through Business Oregon and a partnership of Local and/or Private Funds.

APRIL 2017

KELLER PROJECT NO. 217002

PREPARED BY:

Get there!
KELLER associates

Bryan Black, PE
1005 NW GALVESTON AVENUE, SUITE 220
BEND, OR 97703
(T) 503 490 2041
bryanblack@kellerassociates.com

PREPARED FOR:

CITY OF ASHLAND

Kevin Caldwell
20 EAST MAIN STREET
ASHLAND, OR 97520
(T) 541 552 2414
kevin.caldwell@ashland.or.us

NOTICE INVITING MEMBRANE FILTRATION EQUIPMENT MANUFACTURERS TO PRE-QUALIFY TO BID ASHLAND WTP MEMBRANE FILTRATION EQUIPMENT

RECEIPT OF QUALIFICATION INFORMATION. The Water Treatment Plant (WTP) Membrane Filtration Equipment Manufacturer (MFEM) digital Statements of Qualifications (SOQs) will be received by the City of Ashland's consultant at the following email address until **2:00 PM Pacific local time on May 23, 2017**. MFEM's are encouraged to follow up with a telephone call to confirm submittal receipt.

Bryan Black, Keller Associates
bryanblack@kellerassociates.com
(503) 490-2041

VENDORS: The pre-qualification procedure will select and pre-qualify MFEMs to perform pilot testing and potentially bid to supply membrane filtration equipment for the Ashland WTP (Project). Bids will only be accepted from those MFEMs that are pre-qualified by the City and successfully pass the pilot test. No other MFEMs will be eligible to bid on this Project.

DESCRIPTION OF WORK: The Work involves pilot testing and potentially furnishing membrane filtration system goods and services for a new water treatment plant.

OBTAINING PRE-QUALIFICATION DOCUMENTS: Pre-qualification Documents may be obtained by contacting Bryan Black at the email address or telephone number noted above.

PROJECT ADMINISTRATION: All communications relative to this work shall be directed to Bryan Black. Questions received less than 5 days prior to the date for opening the pre-qualification proposals may not be answered.

SOURCE OF FUNDING: Work under this contract is funded by the federal Safe Drinking Water Revolving Loan Fund through Business Oregon and a partnership of Local and/or Private Funds.

CITY'S RIGHTS RESERVED: The City reserves the right to reject any or all SOQs, to waive any formality in the Pre-qualification Information, and to terminate this process at any time for any reason.

City of Ashland

Dates Advertised: May 9, 5, and 12, 2017

MEMBRANE FILTRATION EQUIPMENT MANUFACTURER PRE-QUALIFICATION REQUIREMENTS

GENERAL: The City of Ashland, Oregon (City) is requesting statements of qualifications (SOQs) from qualified Membrane Filtration Equipment Manufacturers (MFEMs) with systems suitable for municipal water treatment. The membrane filtration system will be used in a new water treatment plant (WTP) with an ultimate capacity in the range of 10 million gallons per day (MGD).

The City's raw water supply is pressurized, and only membrane filters driven by positive pressure will be considered. The membrane filters must have excellent chemical and mechanical resistance with a demonstrated history of maintaining membrane integrity.

The City will select up to three MFEMs to participate in pilot testing. Only MFEMs / equipment that have been pre-qualified through this process and have successfully completed pilot testing will be allowed to bid or propose on the project to supply membrane filtration goods and services for the new WTP.

MINIMUM QUALIFICATIONS: Selection to participate in pilot-testing and the Request for Proposal or the Invitation to Bid process will be based on meeting the following required minimum criteria:

- Equipment approved as an alternative filtration technology by the State of California Department of Public Health on California Surface Water Treatment Rule, Alternative Filtration Technology Summary, CDPH DDWEM Technical Programs Branch – August 2011.
- Positive pressure-driven membrane system configuration. Vacuum-driven or submerged membrane systems will not be considered.
- Nominal pore size ≤ 0.2 micron that meets requirements of surface water treatment filtration as defined by US EPA in its Long Term 2 Surface Water Treatment Rule and latest edition of the Membrane Filtration Guidance Manual.
- Acceptable membrane materials: polyvinylidene difluoride (PVdF), polyether sulfone (PES), or ceramic.
- Ability to tolerate up to 60 pounds per square inch (psi) feedwater pressure.
- Commitment to provide a pilot-scale treatment unit for testing in Ashland, Oregon, from July 15 through November 15, 2017.
- Very high oxidant tolerance; tolerance over a wide pH range (pH 1 to pH 13); coagulant [aluminum sulfate (Alum), aluminum chlorohydrate (ACH), polyaluminum chloride (PACl)] tolerant.
- NSF 61 Certification.
- Total worldwide installed capacity of at least 200 MGD.

- At least two USA municipal drinking water treatment facilities under contract or operating with a total capacity equal to or more than 15 MGD.

QUALIFICATION EVALUATION: MFEMs / equipment meeting the minimum qualifications will be further evaluated to prepare a pre-qualified list of up to three. The City reserves the right to reject any submittal, including without limitation the right to reject any or all non-conforming or non-responsive submittals. The City also reserves the right to waive any and all informalities in selection of the MFEMs for participation in this process. Proceeding to the bidding or proposal phase requires the approval of the membrane system for use in filtering surface water by the State of Oregon Health Authority, Drinking Water Services. The City reserves the right to terminate this process at any time, for any reason. Preparation of SOQs and subsequent materials shall be at the sole expense of the proposer. Subsequent activities for pre-qualified MFEMs will include submission of electronic process and instrumentation diagrams, and specifications, in native file format; coordination in planning the pilot test; completing the pilot test; and others.

Should review of the submittals received indicate that there are more than three MFEMs that satisfy the minimum selection criteria, the City will select from the qualified MFEMs using the following selection criteria and weighting.

- Favorable references (30%).
- Fiber breakage, membrane integrity, and related history (50%).
- Number of service, engineering, and manufacturing support staff/locations (20%).

All eligible MFEMs that can meet these criteria shall submit digital SOQs by email or other electronic method to Bryan Black at bryanblack@kellerassociates.com, 503.490-2041, to be received by **May 23, 2017, by 2:00 PM Pacific local time**. It is recommended that the proposer call to confirm receipt. The submittal documentation shall include the attached Qualifications Statement, all documentation requested in this RFQ, and any additional information deemed relevant by the MFEM.

**MEMBRANE FILTRATION EQUIPMENT MANUFACTURER (MFEM)
QUALIFICATIONS STATEMENT**

SUBMITTED TO:

Bryan Black, PE
Keller Associates
1005 NW GALVESTON AVENUE, SUITE 220
BEND, OR 97703
(T) 503 490 2041
bryanblack@kellerassociates.com

SUBMITTED FOR:

MEMBRANE FILTRATION GOODS AND SERVICES, ASHLAND, OREGON

SUBMITTED BY:

Name of Organization: ____________________

Name of Representative Individual: ____________________

Title: ____________________

Business Address: ____________________

____

Telephone No.: ____________________

Email: ____________________

Fax No.: ____________________

GENERAL BUSINESS INFORMATION

Check if:

☐ Corporation ☐ Partnership ☐ Joint Venture ☐ Sole Proprietorship

---

If Corporation:

A. Date and Province/State of Incorporation:

____

B. List of Executive Officers:

NAME	TITLE

If Partnership:

A. Date and Province/State of Organization:

____

B. Names of Current General Partners:

____

____

C. Type of Partnership

☐ General ☐ Publicly Traded ☐ Limited

☐ Other (describe) ______________________________

If Joint Venture:

A. Date and State of Organization:

____

B. Name, Address, and Form of Organization of Joint Venture Partners (Indicate managing partner by an asterisk *):

____

____

____

____

If Sole Proprietorship:

A. Date and Province/State of Organization:

____

B. Name and Address of Owner or Owners:

____

____

____

____

FINANCIAL

1.0 Provide the following for your surety:

Surety Company: ________________________________

Agent: ______________________________________

Address:______________________________________

Telephone No.:__________________________________

2.0 What is your approximate total bonding capacity?

- ☐ $500,000 to $2,000,000
- ☐ $2,000,000 to $5,000,000
- ☐ $5,000,000 to $10,000,000
- ☐ $10,000,000 or more

3.0 Provide the following with respect to an accredited banking institution familiar with your organization.

Name of Bank:__________________________________

Address:______________________________________

Account Manager: ________________________________

Telephone No.:__________________________________

4.0 Attach a financial statement, prepared on an accrual basis, in a form that clearly indicates MFEM's assets, liabilities, and net worth.

Date of financial statement:____________________________

Name of firm preparing statement:________________________

SYSTEM DESCRIPTION

Provide basic information about the membrane system submitted for consideration as indicated below:

1.0 What is the name of the membrane system submitted for consideration (indicate MF or UF)?

____

2.0 *The City will only consider membrane filers designated as micro- or ultra-filters with a nominal pore size of ≤ 0.2 um.* Indicate the membrane module product name, membrane material, and nominal pore size.

____

____

Does the proposed membrane system meet requirements of surface water treatment filtration as defined by US EPA in its Long Term 2 Surface Water Treatment Rule and latest edition of the Membrane Filtration Guidance Manual?

☐ Yes

☐ No

3.0 *Due to the available driving head, the City is only considering membrane system configurations driven by positive pressure. Submerged or vacuum-driven system will not be considered.* Is the proposed membrane system enclosed and driven by positive pressure?

☐ Yes

☐ No

4.0 Indicate the maximum and minimum driving force utilized by the system.

Minimum driving force__________________psi

Maximum driving force__________________psi

5.0 *The City will only consider membrane system that can tolerate up to 60 psi feedwater pressure.* Indicate the maximum feedwater pressure that can be tolerated by the membrane system / module.

Maximum feedwater pressure_____________________psi

6.0 How is the membrane system flow pattern configured?

☐ Inside-out

☐ Outside-in

7.0 What is the active membrane surface area per module based on feed side area?

Membrane area (square feet per module)____________

Membrane module diameter (feet)_________________

Membrane module length (feet)___________________

8.0 What is the maximum “clean water” membrane resistance?

____________ gfd/psi @20 deg. C*

*gallons per day per square foot of membrane area per psi of differential pressure at 20 degrees C

9.0 What is the minimum “clean water” membrane resistance?

____________ gfd/psi @20 deg. C*

*gallons per day per square foot of membrane area per psi of differential pressure at 20 degrees C

10.0 What is the average membrane life based on similar raw water quality to Ashland, as well as the proposed guaranteed membrane life?

Average membrane life (years)___________________

Proposed guaranteed membrane life (years)__________

QUALIFICATIONS

Membrane systems submitted shall meet the requirements described below.

1.0 *Regulatory Certification - Membrane system shall be approved by the State of California Department of Public Health on California Surface Water Treatment Rule, Alternative Filtration Technology Summary, CDPH DDWEM Technical Programs Branch – August 2011 for the removal of Giardia / Cryptosporidium of 99.99 percent (4-log) or higher.*

The MFEM certifies that the proposed membrane filtration system submitted for consideration is approved by the State of California for the removal of *Giardia / Cryptosporidium* at 99.99 percent (4-log) or higher.

☐ Yes

☐ No

2.0 The MFEM certifies that the proposed membrane filtration system submitted for consideration is approved by NSF 61 with certificate attached.

☐ Yes

☐ No

3.0 Membrane Material – *Membrane material shall be polyvinylidene di-fluoride (PVdF), polyether sulfone (PES), or ceramic – which have high oxidant tolerance according to the American Water Works Association Manual of Water Supply Practices M53 "Microfiltration and Ultrafiltration Membranes for Drinking Water"*.

The MFEM certifies that the membrane material is PVdF, PES, or ceramic.

☐ Yes

☐ No

4.0 Coagulant/Oxidant Tolerance – The project requires membrane filter materials with very high oxidant tolerance; tolerance over a wide pH range (pH 1 to pH 13); ability to use coagulants [aluminum sulfate (Alum), aluminum chlorohydrate (ACH), polyaluminum chloride (PACl)] in direct filtration mode. The following list of coagulants or oxidants are the only exceptions not approved for use with the membrane system specified above:

1)____

2)____

3) ____

4) ____

5) ____

6) ____

The MFEM certifies that the exposure to coagulants or oxidants used in the WTP will not be grounds for revoking or invalidating the membrane module replacement warranty except as noted above

☐ Yes

☐ No

5.0 Fiber Breakage / Membrane Integrity – The MFEM shall provide a history/background data report on fiber breakage / repair and membrane integrity for the proposed membrane system. The MFEM shall describe the expected frequency of membrane integrity loss along with methods to verify and restore membrane integrity.

Has this documentation been included?

☐ Yes

☐ No

6.0 System Capacity – (1) The MFEM shall have at least 200 MGD of total installed water treatment capacity using micro- or ultra-filtration membrane modules and systems of the same type proposed for this project. (2) The MFEM shall have previously completed, or be under contract to complete, at least two municipal drinking water treatment facilities within the USA with a combined capacity of at least 15 MGD. The referenced previous experience in (1) and (2) shall be for the specific membrane system proposed for this work.

6.1 The MFEM certifies that the following installations utilize micro- or ultra-filtration membrane modules and systems for the production of municipal drinking water, and that these facilities combined have a capacity of at least 200 MGD.

List the facilities used to satisfy the above criteria in the following table. Include a separate attached if needed.

FACILITY NAME/TYPE	OWNER NAME	CONTACT NAME	TELEPHONE NO.	EMAIL ADDRESS	DATES OF CONTINUOUS OPERATION	INSTALLED CAPACITY (MGD)
					TOTAL INSTALLED CAPACITY:	

(Attach separate sheet, if necessary, listing additional facilities.)

6.2 The MFEM certifies that it has previously completed or currently has a contract to provide equipment and services for at least two municipal drinking water treatment facilities in the USA with a combined capacity of at least 15 MGD.

☐ Yes

☐ No

List the facilities used to satisfy the above criteria. Attach additional pages as necessary.

(#1)
Location____

Capacity_______________MGD

Contact____

Telephone No.____

(#2)
Location____

Capacity_______________MGD

Contact____

Telephone No.____

7.0 Favorable References – Submittal documentation shall include a list of at least five reference projects in operation (including owner contact information, name, phone, and email).

Has this documentation been included?

☐ Yes

☐ No

8.0 Service Support – The MFEM shall provide a table listing the number of service, engineering, and MFEM support staff and locations in the USA, along with a brief summary describing the support.

Has this documentation been included?

☐ Yes

☐ No

9.0 Membrane Pilot Unit Availability – *The pilot unit will be fully assembled and skid-mounted. It will include on-line instruments: feed and filtrate pressure monitors (to calculate transmembrane pressures); and feed and filtrate turbidimeters, temperature, and flow to calculate flux and recovery. The pilot will include satellite communications for control and remote data collection. MFEM labor will include set-up, commissioning, and start-up; remote operation and data collection; monthly site visits with chemical cleaning; pilot decommissioning/shipping; and pilot report preparation. The pilot unit, including labor and reporting, will be made available for $5,000 per month for a minimum of 3 months.*

The MFEM certifies that a membrane pilot unit meeting the above description and ancillary equipment are reserved for use by Ashland between the dates of July 15 and November 15, 2017.

☐ Yes

☐ No

10.0 Membrane System Manufacturing Ability – The MFEM shall have the ability to manufacture 10 MGD capacity of micro- or ultra-filtration membrane units (racks, trains, etc.) and ancillary equipment within 6 months of the notice to commence fabrication of the equipment:

☐ Yes

☐ No

Indicate annual manufacturing capacity in number of units and capacity for the type and kind of membrane units proposed.

______________units ____________MGD

11.0 The MFEM has reviewed the attached document entitled “Contract Clauses for contracts with Professional Services Contractors for projects funded by Safe Drinking Water financing” and agrees to comply with its terms.

☐ Yes

☐ No

ACKNOWLEDGMENTS

The undersigned certifies under oath the truth and accuracy of all statements and of all answers to questions made herein.

Dated this ________ day of __________________, 2017.

Organization: ____________________________________
(Print or Type Name)

By: _______________________________

____

Title: ______________________________

(Seal, if corporation)

Sworn to before me this _______________ day of ____________, ________, in the County of

_____________________, State (Province) of _______________________.

____
(Notary Public)

My commission expires _____________________

(Seal)

++ END OF SECTION ++

Contract Clauses for contracts with
Professional Services Contractors
for projects funded by Safe Drinking Water financing

SAM Registration and DUNS number are required for all entities that enter into direct contracts with the recipients of Safe Drinking Water Revolving Loan funds

SAM Registration: http://ww.sam.gov/portal/public/SAM/ NOTE: The SAM registration expires annually and must be kept active until the SDWRLF project is closed	DUNS Number http://www.dnb.com/get-a-duns-number.html

Language to be included verbatim in contracts according to any accompanying instructions

1. **Source of Funds**

Work under this contract is funded by the federal Safe Drinking Water Revolving Loan Fund through Business Oregon and a partnership of Local and/or Private Funds.

Whistleblower (language to be included in all construction contracts and subcontracts)

"Contractor receiving SDWRLF funds shall under or through this contract to, post notice of the rights and remedies provided to whistleblowers under No Fear Act Pub. L. 107-174. 29 CFR § 1614.703 (d)."

3 **Non Discrimination**

"The contractor shall not discriminate on the basis of race, color, national origin or sex in the performance of this contract. The contractor shall carry out applicable requirements of 40 CFR part 33 in the award and administration of contracts awarded under EPA financial assistance agreements. Failure by the contractor to carry out these requirements is a material breach of this contract which may result in the termination of this contract or other legally available remedies."

4. **Termination for Cause and for Convenience & Breach of Contract** (language to be included in all construction contracts and subcontracts in excess of $10,000:)

"Contractor shall address termination for cause and for convenience, including the manner by which it will be effected and the basis for settlement. In addition, contractor shall address administrative, contractual, or legal remedies in instances where contractors violate or breach contract terms, and provide for such sanctions and penalties as appropriate."

5. **Intellectual Property** (language to be included in all contracts:)

"Contractor hereby grants to the U.S. E.P.A. a royalty-free, nonexclusive, and irrevocable license to reproduce, publish or otherwise use, and to authorize others to use, for federal government purposes, any intellectual property developed under this contract. Contractor shall secure from third parties the same license in the name of the U.S. E.P.A. regarding any intellectual property developed by third parties as subcontractors to perform this project, or developed under contract with the Contractor specifically to enable Contractor's obligations related to this project."

6. **Inspections; Information** (language to be included in all construction contracts and subcontracts:)

"Contractor shall permit, and cause its subcontractors to allow *[insert name of water system Owner]*, the State of Oregon, the federal government and any party designated by them to:

(1) Examine, visit and inspect, at any and all reasonable times, the property, if any, constituting the Project.

(2) Inspect and make copies of any accounts, books and records, including, without limitation, its records regarding receipts, disbursement, contracts, and any other matters relating to the Project, and to its financial standing, and shall supply such reports and information as reasonably requested.

(3) Interview any officer or employee of the Contractor, or its subcontractors, regarding the Project.

Contractor shall retain all records related to the Project for three years after final payments are made and any pending matters are closed."

7. **Environmental and Natural Resource Laws** (include the following language in all contracts and subcontracts in excess of $100,000:)

"Contractor shall comply with all applicable standards, orders, or requirements issued under section 306 of the Clean Air Act (42 U.S.C. 1857(h)), section 508 of the Clean Water Act (33 U.S.C. 1368), Executive Order 11738, and Environmental Protection Agency regulations (40 CFR part 15).

8. **Procurement of Recovered Materials** (include the following language in all contracts and subcontracts in excess of $10,000:)

"Contractor must comply with section 6002 of the Solid Waste Disposal Act, as amended by the Resource Conservation and Recovery Act, including procurement of recovered materials in a manner designated in guidelines of the Environmental Protection Agency (EPA) at 40 CFR part 247."

9. **Prohibition on the Use of Federal Funds for Lobbying** (Certification Regarding Lobbying form follows, for any contracts in excess of $100,000)

(form follows)

CERTIFICATION REGARDING LOBBYING

(Awards to Contractors and Subcontractors in excess of $100,000)

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

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

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

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

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

Signed ____

Title ____

Date ____

Technical Memorandum

Date:	Friday, April 21, 2017
Project:	Ashland Water Treatment Plant
To:	James Bledsoe, Bryan Black – Keller Associates
From:	Kelsey Harpham, Pierre Kwan
Subject:	Water Quality Data Summary and Review

Introduction

The City of Ashland, Oregon (City) has retained Keller/HDR to investigate the replacement of the City's existing Ashland Water Treatment Plant (WTP) with a new facility. This memorandum documents the City's available historical data for the raw water qualities and finished water qualities. The purpose of this memorandum is to identify potential water quality parameters that could affect the subsequent treatment process evaluation and selection for the new WTP.

Water Supply Description

The WTP is primarily supplied surface water from Ashland Creek that flows through and is stored in Reeder Reservoir prior to entering the WTP. The City also purchases water from the Talent Irrigation District (TID) to provide additional supply. The TID supply is used during periods when the Reeder Reservoir supply is low, which is typically during summer. When needed, TID water is pumped out of the Ashland Canal to the WTP, where it blends with the Reeder Reservoir supply prior to entering the WTP. See Figure 1 for the annual water supply by source to the City.

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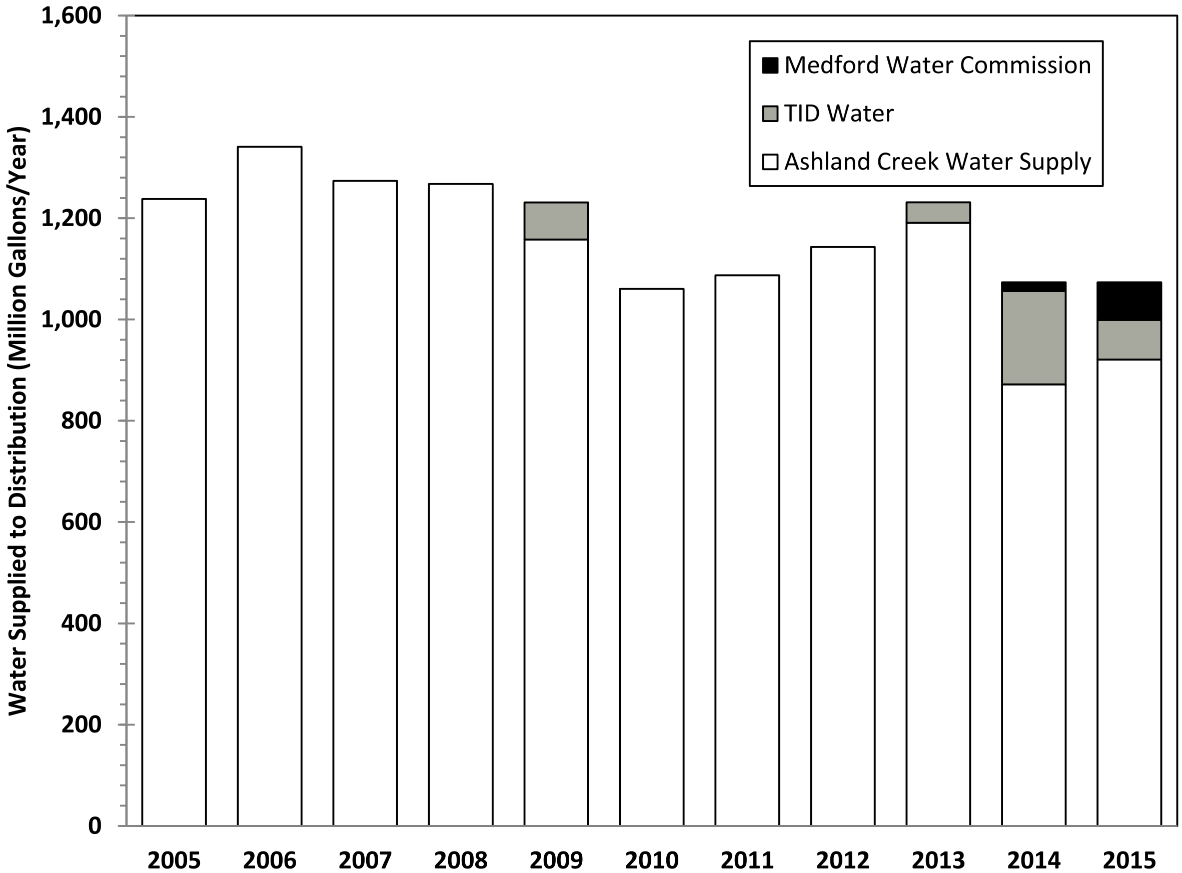

Figure 1. Annual Water Volume Supplied to City Distribution System

The years 2014 and 2015 were droughts and the City's water supply was supplemented with both TID water and MWC water. The MWC line was first operational in 2014 and thus it was not a source in previous years. Prior to 2014, the years of 2001, 2009 and 2013 were also considered drought years, and the City had to purchase TID water to supplement the Reeder Reservoir supply.

Reeder Reservoir water quality was evaluated in 2007 as described in a report entitled, "Reeder Reservoir (Ashland Oregon) Water Quality and Sediment Assessment". The report shows significant thermal stratification occurring during summer months. The thermocline appears to develop about 30-feet below the water surface. The stratification dramatically impacts water quality. Dissolved oxygen was completely depleted in the hypolimnion (lower reservoir). This is problematic because under these reducing conditions, contaminants dissolve from the sediments into the water. Contaminants that behave in this way typically include iron, manganese, and phosphorus. Currently, the reservoir outlet (WTP intake) is configured to accept reservoir water from about 30-feet deep below the full water surface.

For this memorandum, the raw water quality analysis generally focuses on samples collected from the plant, which is after the point where Ashland Creek/Reeder Reservoir and TID water are blended together. Since the TID water usage varies month-by-month and year-to-year, there was no way to distinguish the water quality results of Ashland Creek/Reeder Reservoir versus TID within this data. However, the water supply for most months is only from Reeder Reservoir, while the summer months may consist of a Reeder Reservoir / TID blend.

The City is also supplied potable water by the Medford Water Commission (MWC) and conveyed to the City through the Talent-Ashland Pipeline (TAP). The TAP discharges the MWC potable water directly into the City distribution system. This memorandum does not cover the MWC potable water since the existing WTP does not affect the MWC potable water quality. A study of any impacts of MWC potable water blending with current and future City potable water in the distribution system may be conducted in a subsequent phase of this project.

Ashland Creek/Reeder Reservoir Water Quality

The data presented in this section were provided by the City or found on the Oregon Health Authority's Public Drinking Water System webpage. The data evaluated include:

- Turbidity
- Total Organic Carbon (TOC)
- pH
- Alkalinity
- Hardness
- Iron and Manganese
- Temperature
- Pathogens (*Cryptosporidium* and *Giardia*)
- Cyanotoxins
- Inorganic compounds (IOCs)
- Volatile and synthetic organic compounds (VOCs and SOCs)
- Algae and cyanotoxins
- Taste-and-odor (T&O) compounds (2-methylisoborneol [MIB] and Geosmin)
- Color

Turbidity

Turbidity tracking and removal is a required parameter for surface water treatment, as waters with higher levels of turbidity have been positively correlated with having greater levels of pathogenic organisms that could induce water-borne illnesses if consumed. Additionally, higher turbidity levels results in increased headloss in filtration systems as filters clog from these materials being removed. Figure 2 shows the average monthly raw turbidity values recorded at the WTP from 2004 to 2016. Overall turbidity results are relatively very low for surface water supplies. Such results are expected as any variable turbidities in Ashland Creek are both attenuated when the water is discharged into Reeder Reservoir and settle out as the creek water spends several days to weeks in storage prior to withdrawal to the WTP. Most months' average turbidity levels are below 1 NTU, with some spikes occurring early in the year (January-February) and in the late summer (July-September).

Higher levels of turbidity were detected in the late summer months of 2014 and 2015, which was also the time of higher levels of alkalinity and hardness. The data from 2014 and 2015 differs from other years as 2014 was considered a very severe drought year and 2015 was the worst drought ever experienced by the City. As a result, storage within Reeder Reservoir was quite low, which means less storage and settling, compared to other years.

The average monthly turbidity provides a good description of long-term turbidity trends but misses the potential short-term turbidity increases associated with storms. Figure 3 displays the maximum daily turbidity for each day of 2016. Whereas the January 2016 average monthly turbidity is 2.9 NTU, the daily data shows that the month consisted of half a month of 1 – 2 NTU and the storm-induced peak of 7.1 NTU on January 18, 2016. Turbidity remains very low (<1 NTU) throughout the drier summer months of May-October, and then spikes again with storm events in late October.

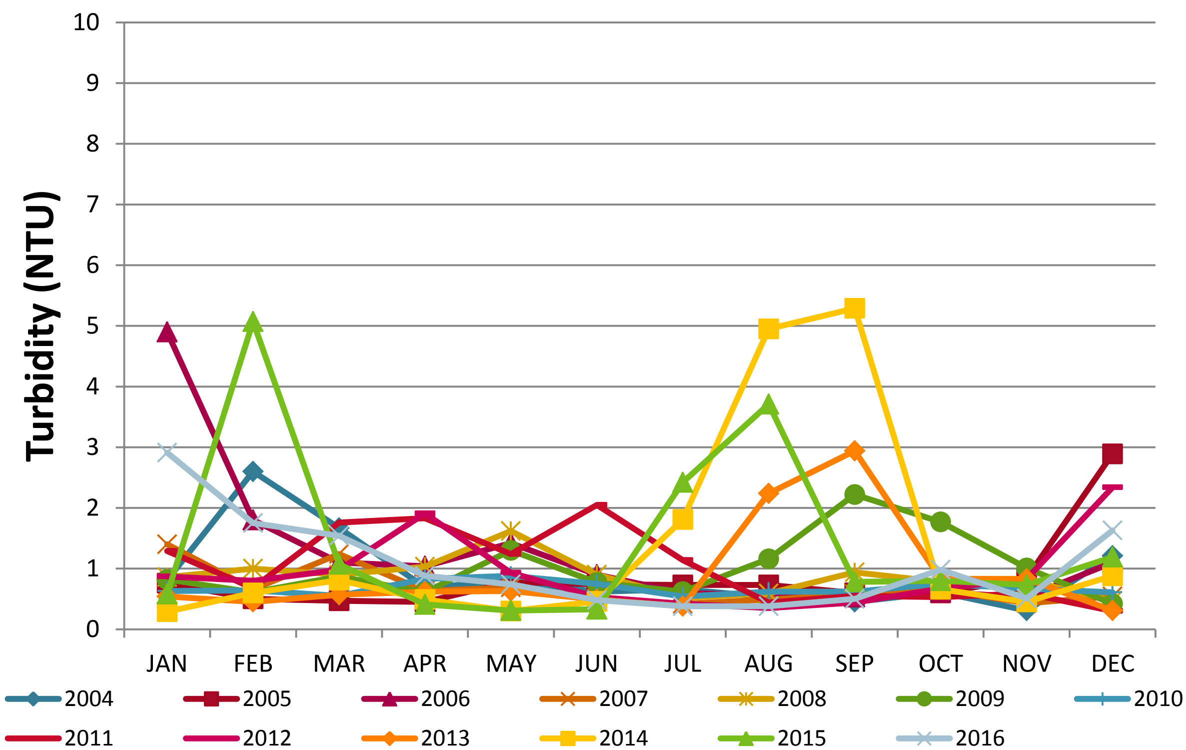

Figure 2: Average Monthly Turbidity Recorded at WTP Entry

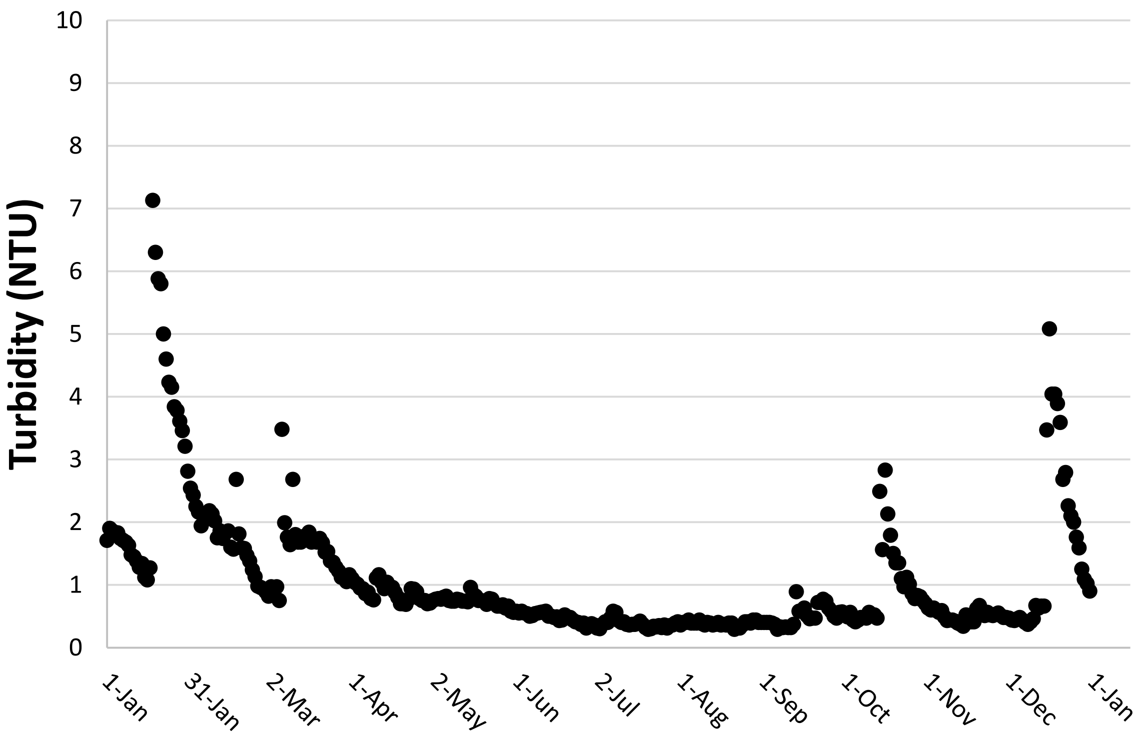

Figure 3: 2016 Maximum Daily Turbidity Recorded at WTP Entry

Total Organic Carbon (TOC)

TOC is a key precursor of the formation of disinfection byproducts (DBPs) that are regulated under the Federal Stage 2 Disinfection/Disinfection Byproducts Rule so removing TOC will reduce the DBP formation potential of the water. In addition, TOC removal also helps with minimizing the water's chlorine demand, improving chlorine maintenance in the distribution system, and reducing the potential for biofilm growth in the distribution system. For filtration systems, TOC is also a key parameter for having sand filters become biologically active and for organic fouling in membrane systems.

TOC samples are taken from raw water as it enters the WTP. Monthly values are reported from December 2010 to March 2017 and plotted in Figure 4. Three additional samples are also reported in 2004, and these values are within the range of the more recent data reported. Raw water TOC at the WTP ranges from 1.29 mg/L to 10.8 mg/L, with an average of 2.9 mg/L. TOC levels trend higher in winter months (November-March), and higher in summer months (July-September). April demonstrates the highest average level of TOC, however 2016 had some anomaly high values in January and February, while 2012 had the highest recorded TOC value of 10.8 mg/L in December. The City staff suspect that that this very high value is associated with a grab sample was collected at the same time as a large storm was stirring the water up in Reeder Reservoir.

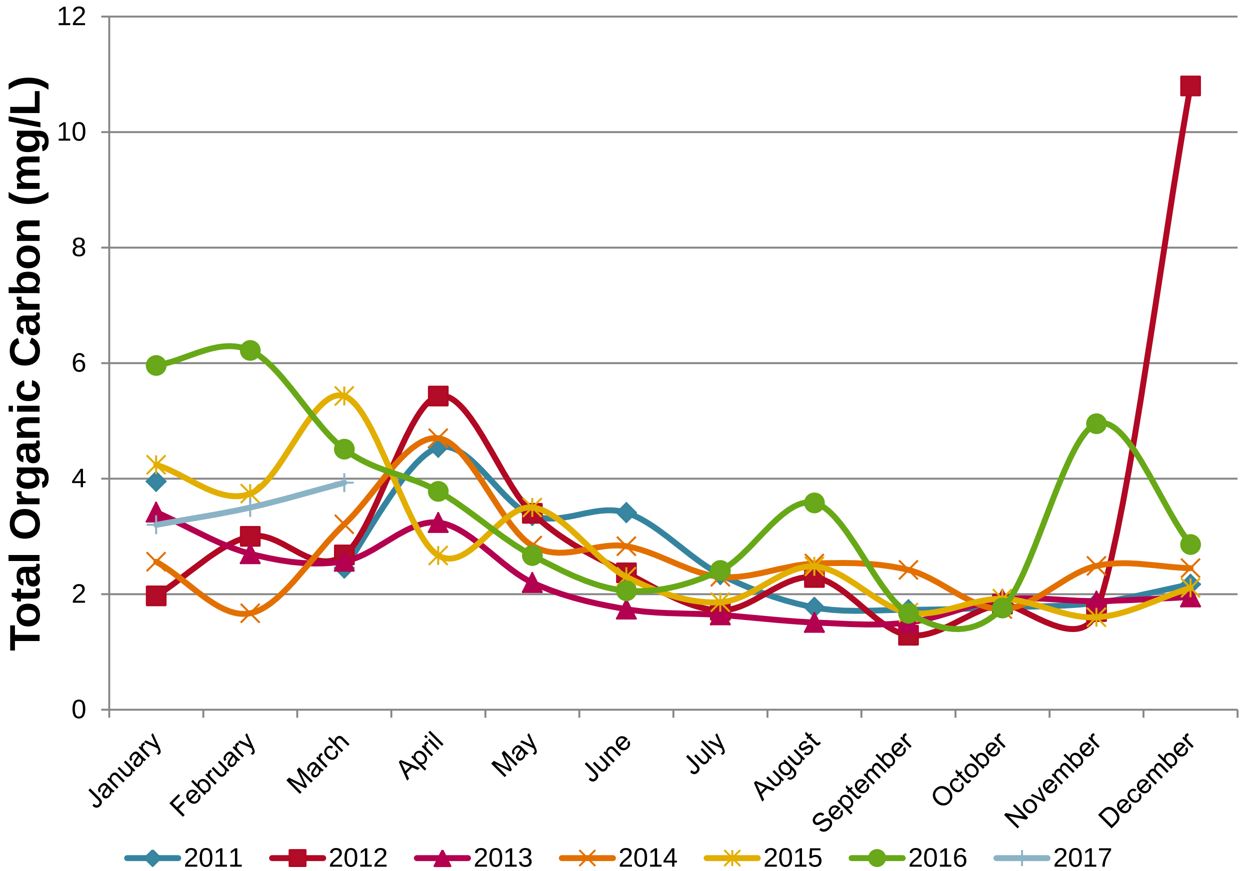

Figure 4: Monthly Grab Samples of Total Organic Carbon at WTP Entry

pH

pH is a water quality parameter that impacts coagulation and disinfection efficiency, as well as other chemical reactions. Finished water pH is important for the City to manage compliance with the Lead and Copper Rule. The monthly average pH of the Ashland raw water ranges from 6.8 to 7.9 as it enters the water treatment plant, with an overall average of approximately pH 7.3 – 7.5 for the entire year (see Figure 5). Such a range is fairly typical for Oregon surface waters and does not pose a challenge to a treatment process selection.

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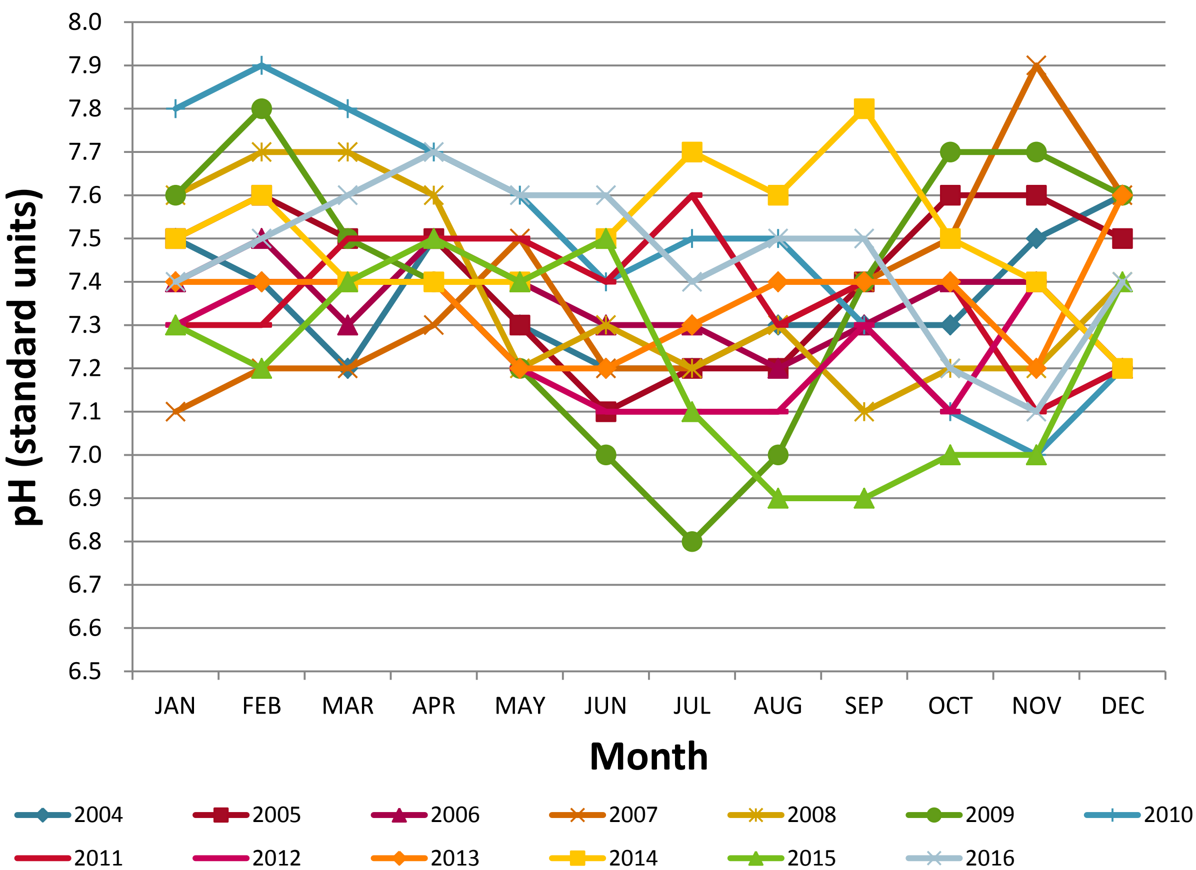

Figure 5. Monthly Average pH Recorded at WTP Entry

Alkalinity and Hardness

Alkalinity and hardness are water quality parameters that affect several key treatment and water quality processes. Alkalinity is a key factor for chemical coagulation and maintaining a stable pH in the distribution system while hardness is associated potential precipitation and scaling issues in distribution piping and customer plumbing, taste complaints, and the effectiveness of soap and detergent usage by businesses and individuals.

Alkalinity and hardness measurements were obtained monthly. From 2004 to 2016, monthly average alkalinity ranges from 22 mg/L to 61 mg/L as $CaCO_3$, and hardness ranges from 13 mg/L to 38 mg/L as $CaCO_3$. Figure 6 and Figure 7 show the average monthly values of alkalinity and hardness in the raw water entering the WTP.

The monthly average alkalinity and hardness values in 2014 and 2015 show results in the late summer months (June-September) that were consistently higher than other years recorded. As noted earlier in the pH section, this difference is likely related to the fact that 2014 and 2015 were drought years, and thus snowpack feeding the reservoir was extremely low. In years prior to 2014, snowmelt, which is free of most minerals, dilutes the alkalinity and hardness present in Ashland Creek, resulting in the observed decrease in Alkalinity and Hardness from May through August, when snowmelt runoff is most prevalent. Considerations for future reduced snowpack and drought-related water quality impacts need to be included in the treatment process selection.

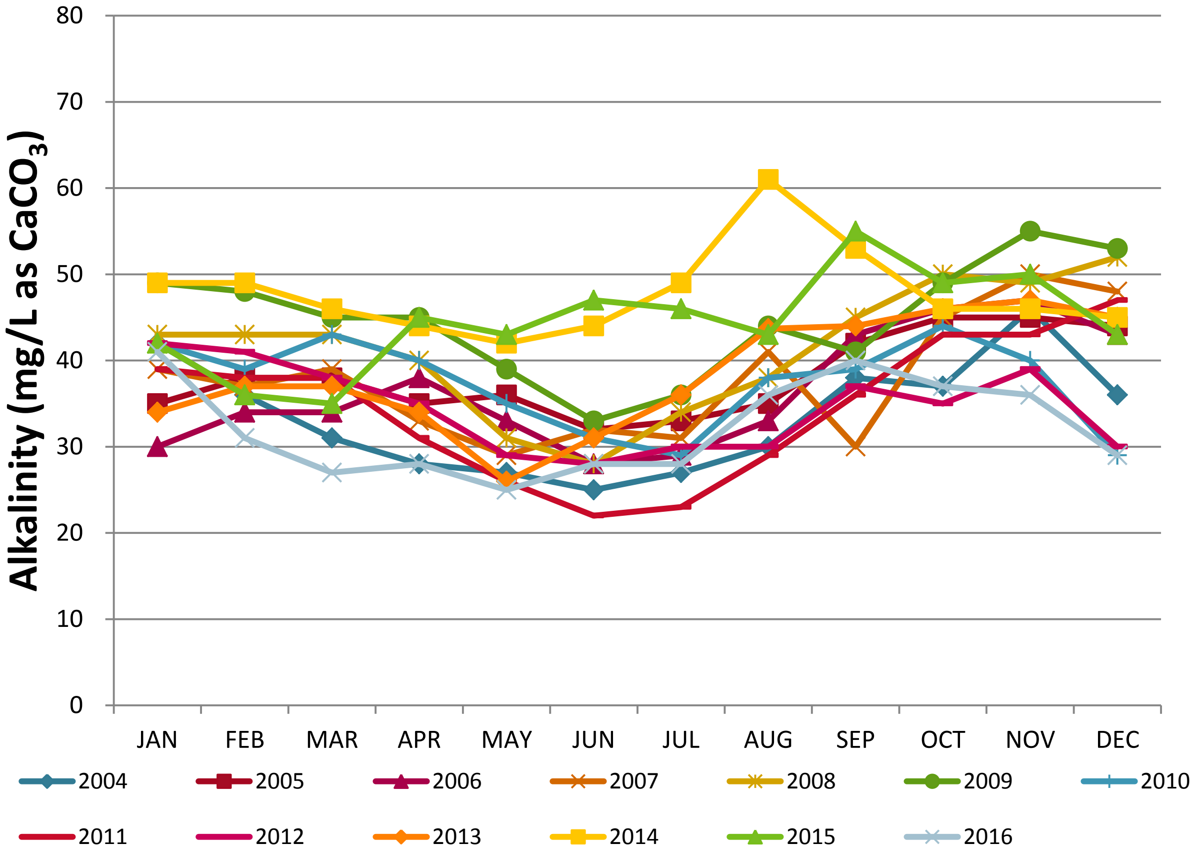

Figure 6: Monthly Average Alkalinity Recorded at WTP Entry

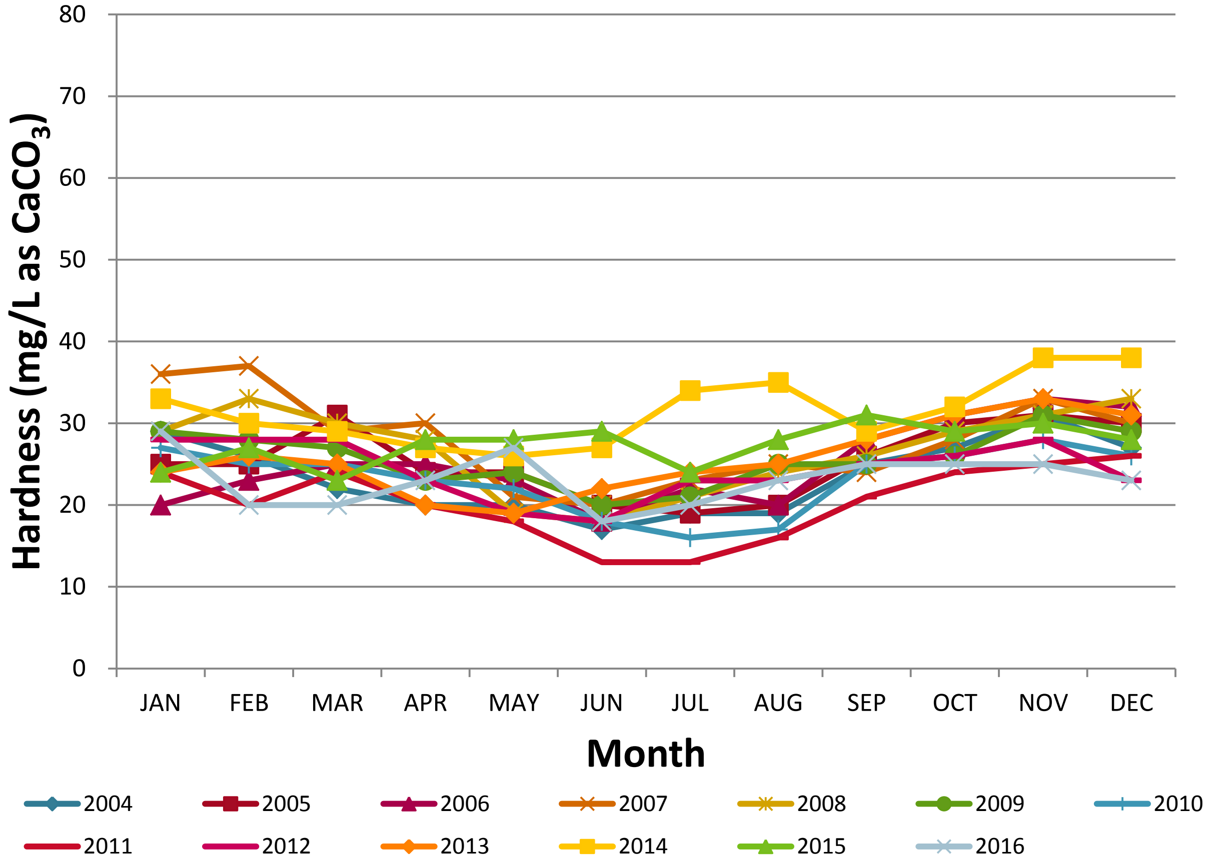

Figure 7: Monthly Average Hardness Recorded at WTP Entry

Iron and Manganese

Iron and manganese have not been found in notable quantities in raw water samples at the WTP. In 2012, testing demonstrated that both iron and manganese was not present in detectable levels. Previous testing from 1988, 1990 and 1999 did have positive samples for both elements, with the highest values reported in 1988 at 0.74 mg/L for iron and 0.07 mg/L for manganese.

Conversations with the WTP and water quality staff indicate that this historical data is not indicative of current water quality conditions. Iron and manganese are not issues with the raw water. A grab sample of the raw water found non-detectable concentrations of iron (<0.015 mg/L) and manganese (<0.005 mg/L).

Temperature

Water temperature is important as it has a direct impact on coagulation, filtration, and disinfection processes. Figure 8 shows the average temperature of raw water entering the WTP by month. Temperature ranges from 3 °C (37 °F) to 20 °C (68 °F), with clear warming and cooling periods associated with the changing seasons. The years of 2014 and 2015 had consistently higher water temperatures then other years, with a greater difference in temperature seen June through August.

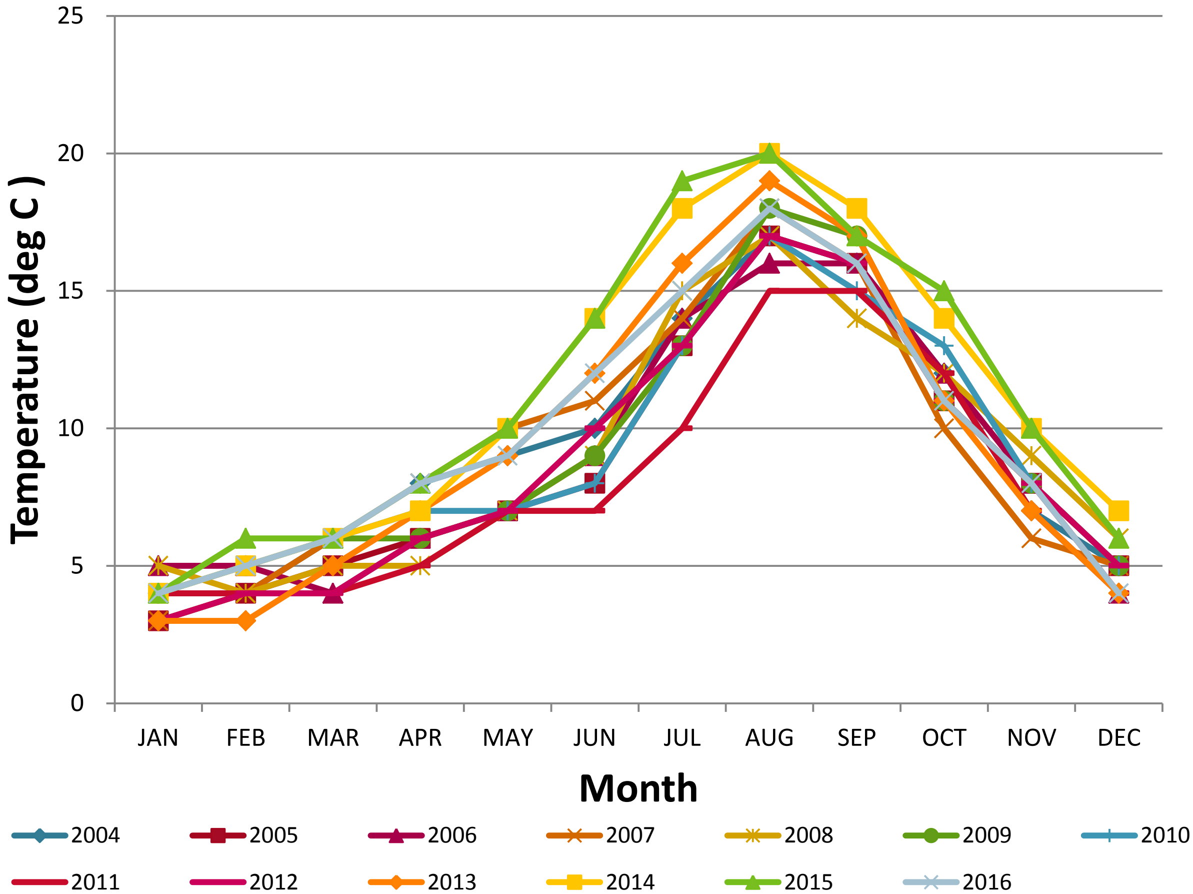

Figure 8: Monthly Average Temperature Recorded at the WTP Entry

Pathogens

The main purpose of surface water treatment is the removal of the pathogens that can potentially cause water-borne illnesses. The principal pathogens of concern are *Cryptosporidium*, *Giardia,* and viruses. The City has already completed Round 1 *Cryptosporidium* sampling and analysis per the requirements of the Long-Term 2 Enhanced Surface Water Treatment Rule (LT2ESWR). Based upon these results, the Oregon Drinking Water Program informed the City in September 2010 that the highest mean *Cryptosporidium* concentration was only 0.004 oocysts/L. This is a low value and places the City in Bin 1 (least additional treatment needed) of the LT2ESWTR treatment requirements.

The City has started Round 2 LT2ESWTR sampling in October 2016 and sampling and testing is ongoing. To date, one positive result for Cryptosporidium was detected on January 24, 2017, with a result of 0.093 oocysts/L. Discussions with the City indicate that the Round 2 sampling and analysis are anticipated to have similar results with Round 1 and the City should remain in LT2ESWTR Bin 1.

Similarly, the presence, and therefore pathogenic risk, of *Giardia* is also anticipated to be low. *Giardia* was detected only once in monthly testing taking place from April 2008 to March 2010. 21 out of 22 samples reported no oocysts detected.

Inorganic Compounds

A review of the posted water quality data on the OHA website from 1986 to 2017 found only nitrate as the only IOC at concentrations above each compounds' respective detection limits. However, nitrate concentrations were always below 1 mg/L, less than one-tenth of its 10 mg/L regulatory limit. In addition, communication with the City indicated that regulated IOCs have never been a raw water quality issue. A complete list of NPDWS regulated IOCs and their Maximum Contaminant Limits is located in Appendices A, B, and C.

In addition to the regulated IOCs, the City conducted sampling and analysis in 2013 for the Unregulated Contaminant Monitoring Rule 3 (UCMR3). The City detected chromium-6, chlorate, strontium, and vanadium in the raw water. Table 1 lists the detected concentrations for these analytes. There are no USEPA or OHA regulatory limits for these analytes at this time; there is no timeline for when, or if, these analytes will have limits established. However, the table does include limits other states or the AWWA have proposed. Each analyte is well below these limits.

Table 1: 2013 Analysis of UCMR3 Analytes

Analyte	Detected Range (mg/L)	Average (mg/L)	Examples Limits (mg/L)
Chromium-6	0.0 – 0.091	0.044	10 – California
Chlorate	79 – 190	123	700 – AWWA
Strontium	80 – 110	96	1,000 – 4,000 – AWWA
Vanadium	0.49 – 0.66	0.56	15 -50 - California

Volatile and Synthetic Organic Compounds (VOC and SOC)

The VOC and SOC analyses obtained from the OHA website from 1986 to 2017 did not find any VOCs or SOCs at concentrations above each compounds respective detection limits. In addition, communication with the City indicated that the watershed is completely forested, with none of the commercial or industrial activities that are the common sources for VOC or SOC pollution. Barring some unusual man-made contamination, VOCs or SOCs should not be an issue for the existing or future WTP.

Algae and Cyanotoxins

Algae are known sources of Taste-and-Odor (T&O) compounds and cyanotoxins. Reeder Reservoir sampling in 2007 reported blue-green algal species within the reservoir, including the potentially toxic *Anabaena flos-aquae,* reaching an extremely high cell count of 31,570,000 cells/mL at the reservoir surface. The 2007 study also noted that the Reeder Reservoir water quality and physical characteristics make it prone to algal blooms and the results from 2007 are likely typical algae conditions for most years. However, one grab sample of reservoir water in an area of dense algal growth had non-detectable concentrations of microcystin (<0.05 μg/L) and anatoxin-a (<0.15 μg/L).

Testing for cyanotoxins, based on species, has been preformed regularly since 2010. In October 2012, microcystin-LR was reported in initial and confirmation sampling at the Reeder Reservoir intake tower and WTP tailrace raw water. Repeated sampling of the WTP finished water at this time found no cyanotoxin, indicating that the existing WTP process was providing complete removal of microcystin. This is the only positive result ever in the raw water as no samples prior to or after this event has found any microcystin, anatoxin-a, cylindrospermospin, or saxitoxin in the raw water. However, the ongoing and high presence of *Anabaena* means that the potential cyanotoxin generation exists and should be considered in selecting treatment processes for the future WTP.

Taste-and-Odor Compounds (T&O)

The City conducted a study into T&O compounds in 2015 to identify raw water concentrations and the effectiveness of the existing WTP processes to remove the compounds prior to discharging to the distribution system. The study found that all of the T&O issues were caused by Geosmin; no MIB was ever detected in any sample.

Per conversations with the City, T&O issues only occur in the later part of summer prior to the beginning of fall, when Reeder Reservoir is warmest and has fully stratified. Thus, the City only conducted T&O sampling in the later half of 2015 (see Table 2). The results found that the raw and finished water were several times higher than the general public odor threshold concentration (OTC) of 5 – 10 ng/L, with a maximum value of 73.3 ng/L detected in Reeder Reservoir and 28.9 ng/L as the Power House Tailrace immediately prior to the WTP (an OTC is when 50 percent of a population reports detecting an odor). Conversations with City staff indicate that 2015 was a particularly severe T&O episode though some T&O complaints have been received by the City every late summer to early fall. The result is that T&O removal should be considered in selecting treatment processes for the future WTP.

Table 2: Detected Geosmin Concentrations

	Geosmin (ng/L [ppt]) at:		
Sampling Date	Reeder Reservoir, 2 meters below the surface	Raw Water at Power House Tailrace	Finished Water at WTP Lab
Sept. 28, 2015	73.3	28.9	16.1
Oct. 6, 2015	49.8	24.5	(lost sample)
Oct. 22, 2015	27.4	20.7	9.5
Nov. 2, 2015	23.2	18.0	14.7
Nov. 18, 2015	12.5	10.5	7.8
Note: General public odor threshold concentration is 5 – 10 ng/L (Source: WRF Report: A Decision Tool for Earthy/Musty Taste and Odor Control [Project #3032])			

Color

Color is an aesthetic parameter that is regulated with a secondary maximum contaminant level (SMCL) of 15 platinum-cobalt units (PCU). The raw water apparent color at the WTP from 2004 to 2010 ranges from a monthly average of 20 PCU to 35 PCU (see Figure 9). Apparent color values tend to be higher in spring (March-June) and generally highest in April. The high level of raw water color means the treatment process selection for the future WTP needs to consider color removal as a criteria.

Color is typically the result of iron, manganese, and/or organic matter in the water. As indicated earlier, the City staff have not found iron or manganese in the raw water. They suspect the color is all attributable to organic matter.

As with turbidity, the average monthly values tend to mask the full range of daily color episodes. Daily maximum values for 2016 are shown in Figure 10. In 2016, it shows that color constantly declined from approximately 45 PCU in January to October, and increased substantially in October and December, correlating to increased winter precipitation. Daily color values for 2016 corroborate this evidence, showing high spikes in color from storm events October through May, and lower values with no spikes during summer months. The color is suspected to have occurred as rainfall both washed debris into Reeder Reservoir and mixed the reservoir after a long summer stratification period.

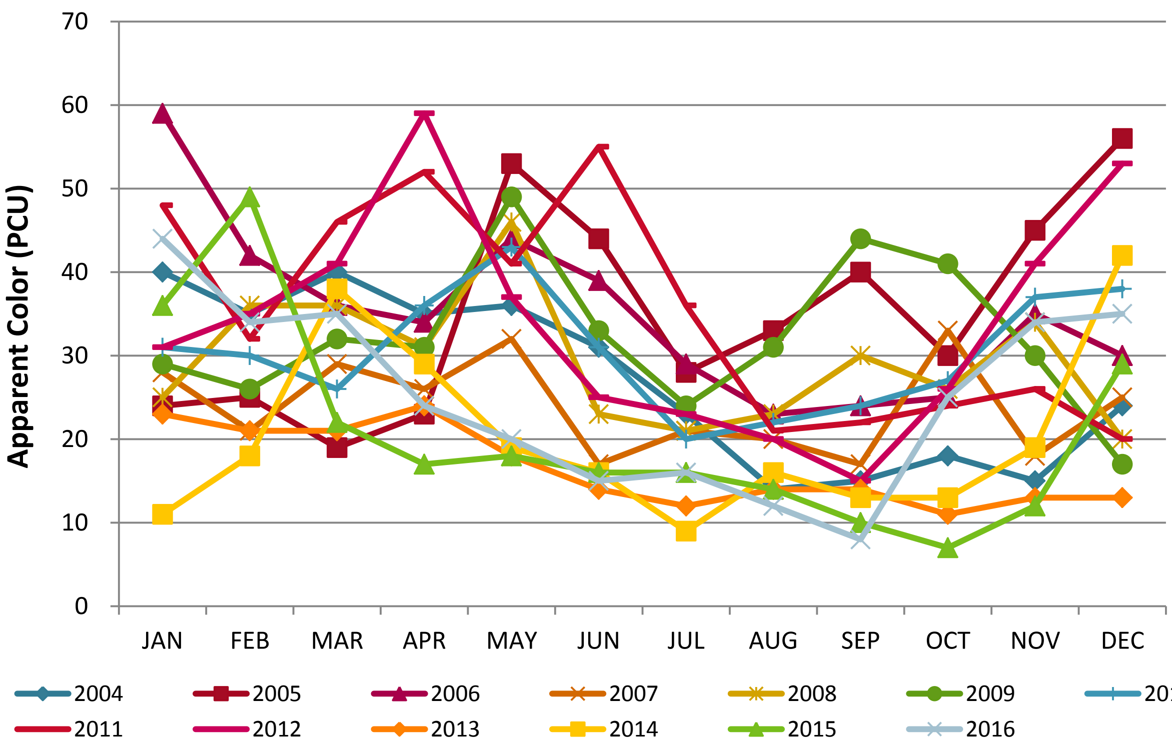

Figure 9: Monthly Average Apparent Color Recorded at the WTP Entry

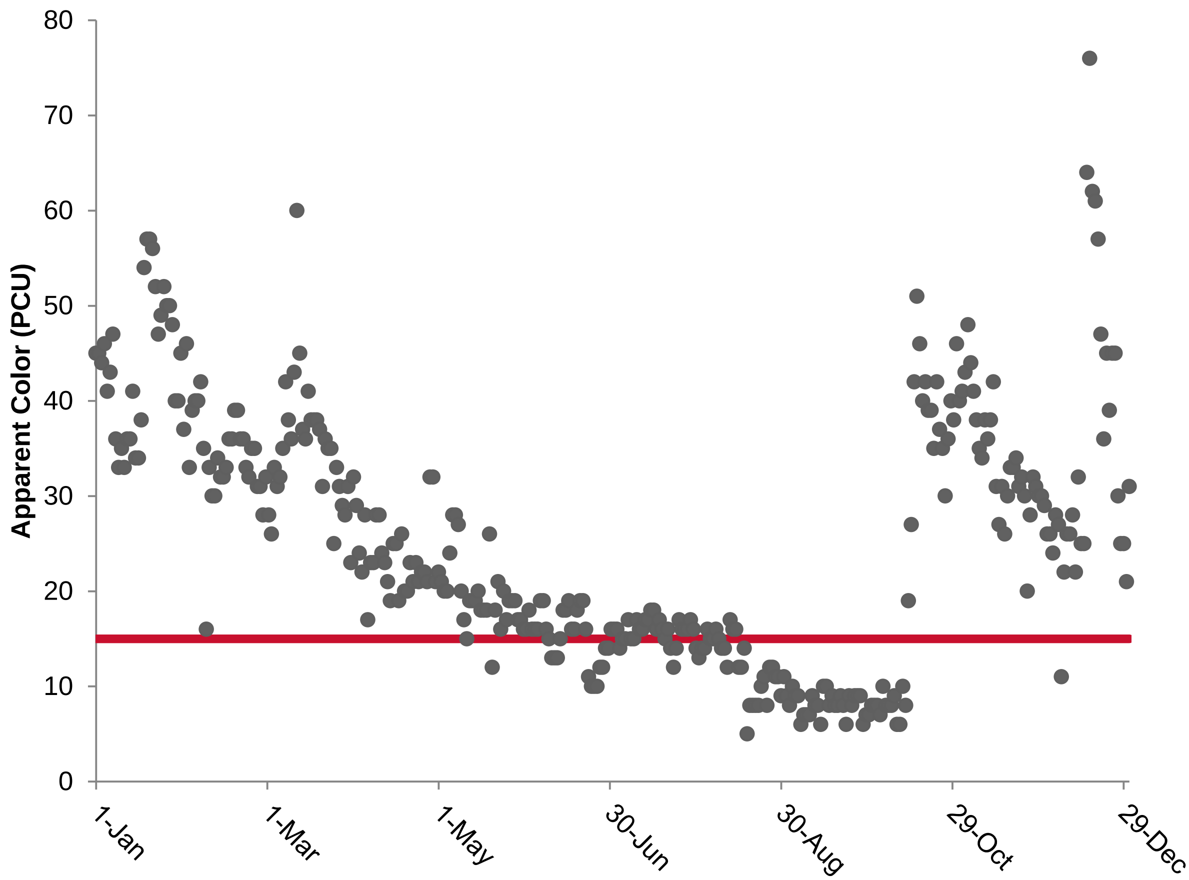

Figure 10: Maximum Daily Color Recorded at the WTP Entry, 2016

Talent Irrigation District Water Quality

Comprehensive water quality data for the TID water is limited to a grab sample collected on August 20, 2009. This sample was taken at the WTP intake and consists of TID water blended with Ashland Creek water, and thus the presented results are not representative of TID alone. A summary of the grab sample analytical results and how the results compare to the lengthy historical records for Reeder Reservoir is shown in Table 3. Those parameters which are the same as or in the mid-range of Reeder Reservoir suggest that the TID water quality is similar to that of Reeder Reservoir, as the addition of TID water to the intake does not significantly impact the overall quality of raw water.

Table 3. Summary of Blended Talent Irrigation Data Grab Sample Results and Comparison

Water Quality Parameter	2009 Grab Sample Results	Comparison to Reeder Reservoir Results
Turbidity	3.2 NTU	Mid-range of Reeder Res.
Total Organic Carbon (TOC)	2.9 mg/L	Mid-range of Reeder Res.
pH	Sample exceeded hold time for accurate measurement	-
Alkalinity	37 mg/L as $CaCO_3$	Mid-range of Reeder Res.
Hardness	Not reported but calculated to be 33 mg/L as $CaCO_3$	High end of Reeder Res.
Temperature	Not analyzed	-
Pathogens	Zero for *Cryptosporidium* and *Giardia*	Same as Reeder Res.
IOCs	Non-detect for nitrate, sulfate, fluoride. No data for all other regulated IOCs or for UCMR3 analytes.	Mid-range of Reeder Res.
VOCs and SOCs	Non-detect for all compounds.	Same as Reeder Res.
Algae and cyanotoxins	99 counts/mL	Low end of Reeder Res., though sample could have been obtained prior to peak algae growth.
T&O Compounds	Non-detect for both MIB and Geosmin. 1 TON for odor.	Better than Reeder Res., though sample could have been obtained prior to T&O issues forming.
Color	20 PCU	Mid-range of Reeder Res.
Other		
Ammonia	Non-detect	No data for Reeder Res.
Dissolved organic carbon	2.7 mg/L	No data for Reeder Res.
Dissolved UV-254 absorb.	0.050/cm	No data for Reeder Res.
Specific conductance	78 umhos/cm	No data for Reeder Res.

In addition to the single grab sample, the City's 2013 and 2014 annual consumer confidence reports (CCRs) lists TOC concentrations when TID water was purchased and blended with the Ashland Creek water prior to entering the WTP. This information is summarized below in Table 4 and compared against similarly reported values for Ashland Creek/Reeder Reservoir. The CCRs prior to and after 2013 and 2014 did not include a breakdown of TID TOC information. The CCRs did not list any other TID water quality data.

Table 4. Reported Talent Irrigation District and Ashland Creek Total Organic Carbon

Consumer Confidence Report	Reported Total Organic Carbon Data (mg/L) for:	
	Blend of Talent Irrigation District and Ashland Creek Water	**Ashland Creek/ Reeder Reservoir**
2013	Average: 1.5 No range reported	Average: 2.2 Range: 1.5 – 3.4
2014	Average: 2.42 Range: 2.30 – 2.53	Average: 2.66 Range: 1.67 – 4.70

In general, the 2009 grab sample and the limited 2013-2014 TOC data would appear to indicate that the TID water is possibly comparable to the City's main water supply. However, further water quality sampling is recommended as the TID water quality dataset is quite limited and more data should be gathered analyzed prior to drawing any more conclusions. A separate memorandum has been prepared to further discuss the additional sampling requirements.

Finished Water Quality

Water quality testing of the potable water at the WTP is conducted for temperature, hardness, pH, and alkalinity. There are no meaningful differences in the potable water temperature and hardness from the WTP as compared to the raw water reported in the prior section. This can be attributed to the fact that the existing WTP does not hold the water for long periods of time exposed to direct sunlight and does not perform hardness adjustments.

The existing WTP uses soda ash to replace the alkalinity consumed by the alum coagulation process and to allow that process to operate better. In general, the finished water alkalinity does not meaningfully differ from the raw water alkalinity as soda ash is controlled to replace, but not further boost, the alkalinity through the WTP.

Alum coagulation also depresses the water pH while consuming alkalinity, while soda ash addition also boosts pH in a small way. As a result, the potable water pH is slightly lower than the raw water. The WTP processes also helps smooth out the variances in the raw water pH, making the potable water pH have less variability than the water entering the WTP. The monthly average WTP pH is shown in Figure 11.

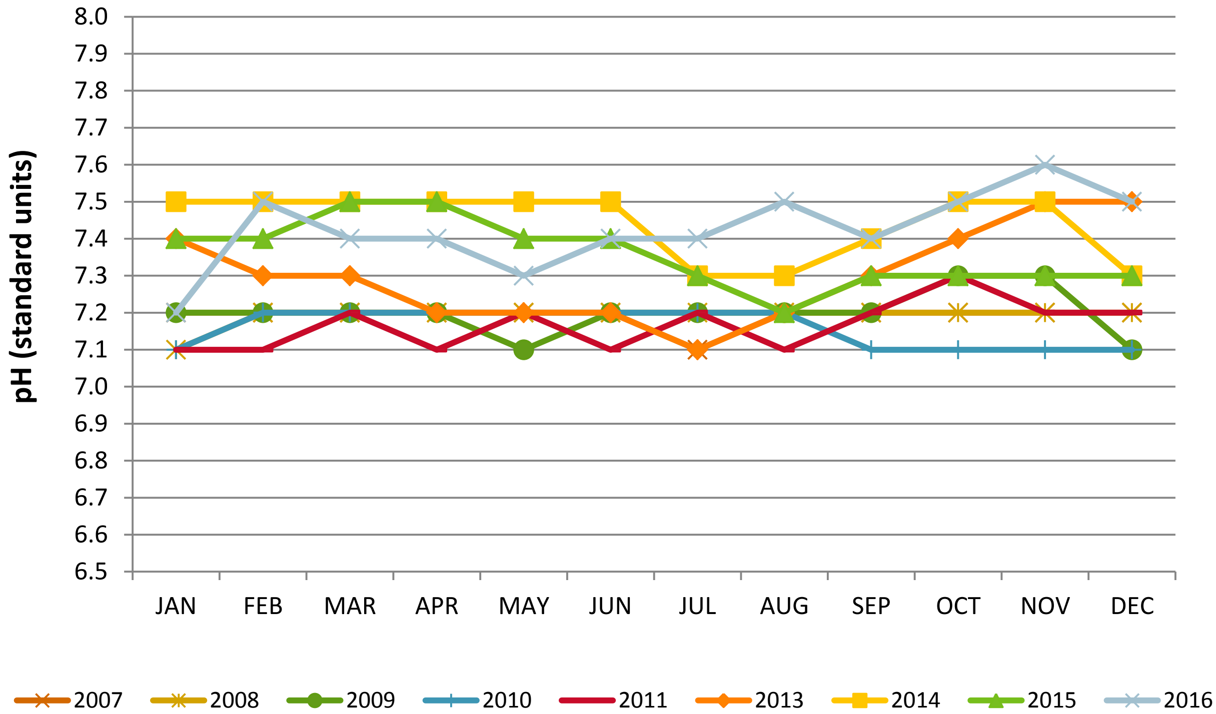

Figure 11. Average Monthly Potable Water pH Entering the Distribution System

Turbidity data shows that the WTP has been very successful in removing turbidity. The vast majority of time, the existing WTP produced potable water with turbidities less than 0.1 NTU. From January 2009 to February 2017, the plant had only four episodes in which the potable water turbidity exceeded 0.3 NTU, and only one instance (January 8, 2015) where the maximum daily turbidity exceeded 1.0 NTU. These four observed spikes were directly linked to disturbances in the WTP clearwell that caused settled debris deposits to get mixed into the water. OHA investigated the events, accepted the City's explanation, and did not cite the City for any water quality violations.

The WTP has also been successful in removing color, with the monthly average potable water color being zero, with occasionally 1 PCU recorded. While the color removal has been successful, the City has had color complaints in the distribution system. The City staff has stated that these complaints are from manganese, which is added as potassium permanganate in the existing WTP's pre-treatment system. Reducing the use of potassium permanganate in the future WTP will reduce the color complaints.

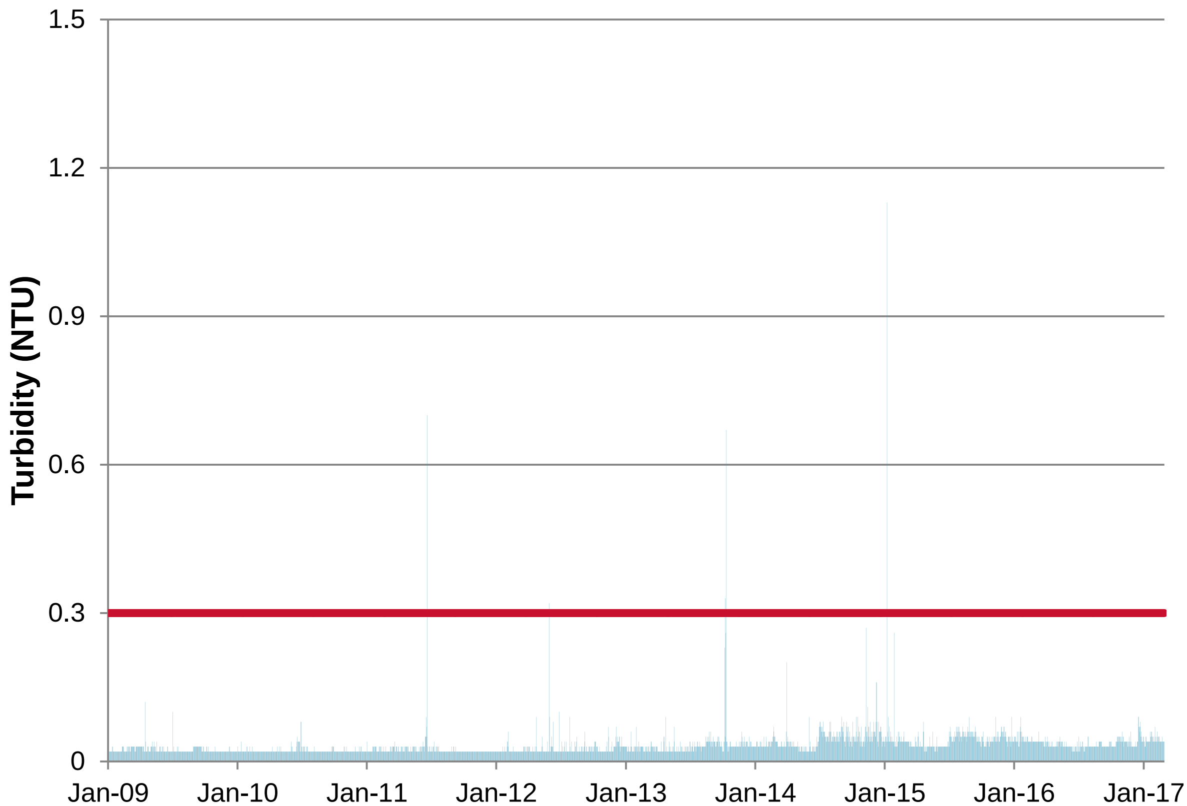

Figure 12: Daily Maximum Turbidity in Potable Water Entering Distribution System

Disinfection Byproducts

Disinfection byproducts (DBPs) are potentially carcinogenic compounds formed as organic materials in the water react with the disinfectants, chlorine and chloramine. There are two regulated categories of DBPs: four trihalomethanes grouped together as Total Trihalomethanes (TTHM) and five haloacetics acids grouped as Haloacetic Acids (HAA5). TTHM and HAA5 testing is done quarterly in the distribution system. In the previous ten years, the City has had only three HAA5 sampling rounds with any results above 0.060 mg/L. These were recorded in February and May of 2010, and February 2012. The City maintained full compliance despite these high detected concentrations as compliance is determined by annual running averages, not individual results. In this same time period, no TTHM results have been above 0.08 mg/L MCL.

The high HAA5 results were determined to be the result of past WTP practice of prechlorination. The WTP abandoned this practice in 2013 and the highest HAA5 result since then has only been 0.041 mg/L, nearly one-third below the regulatory limit.

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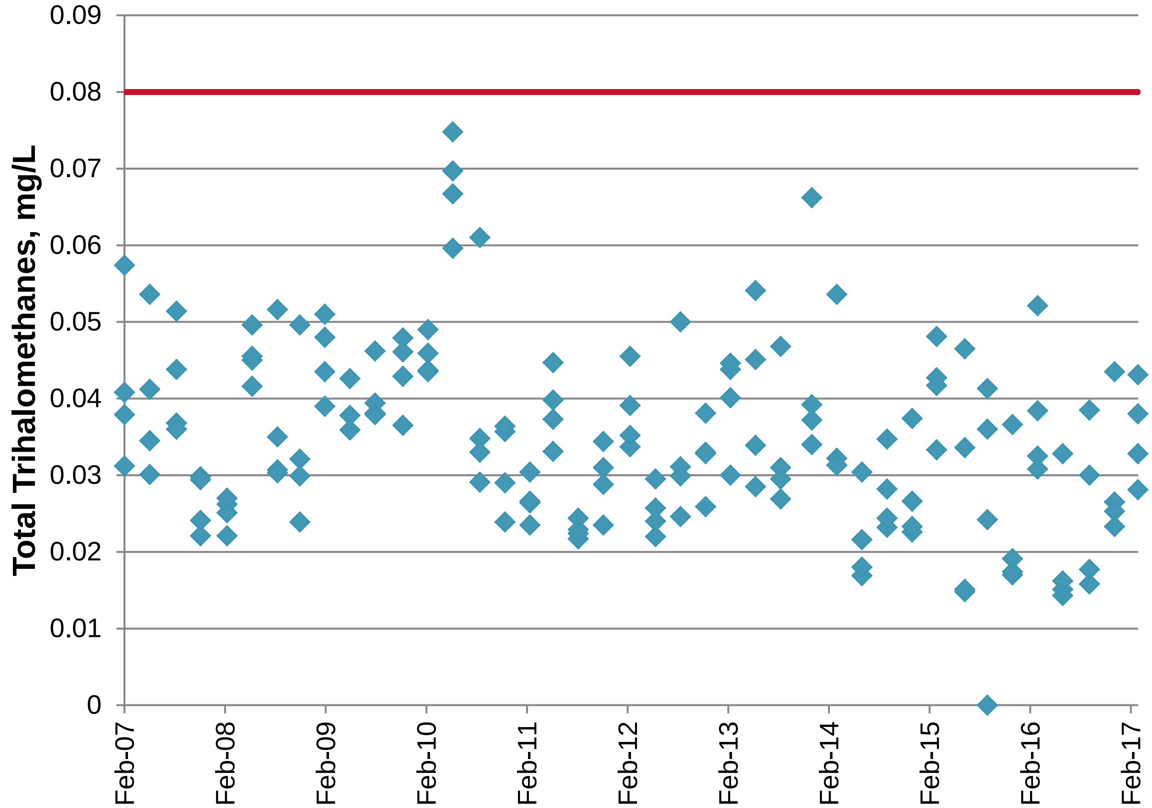

Figure 13: Total Trihalomethanes

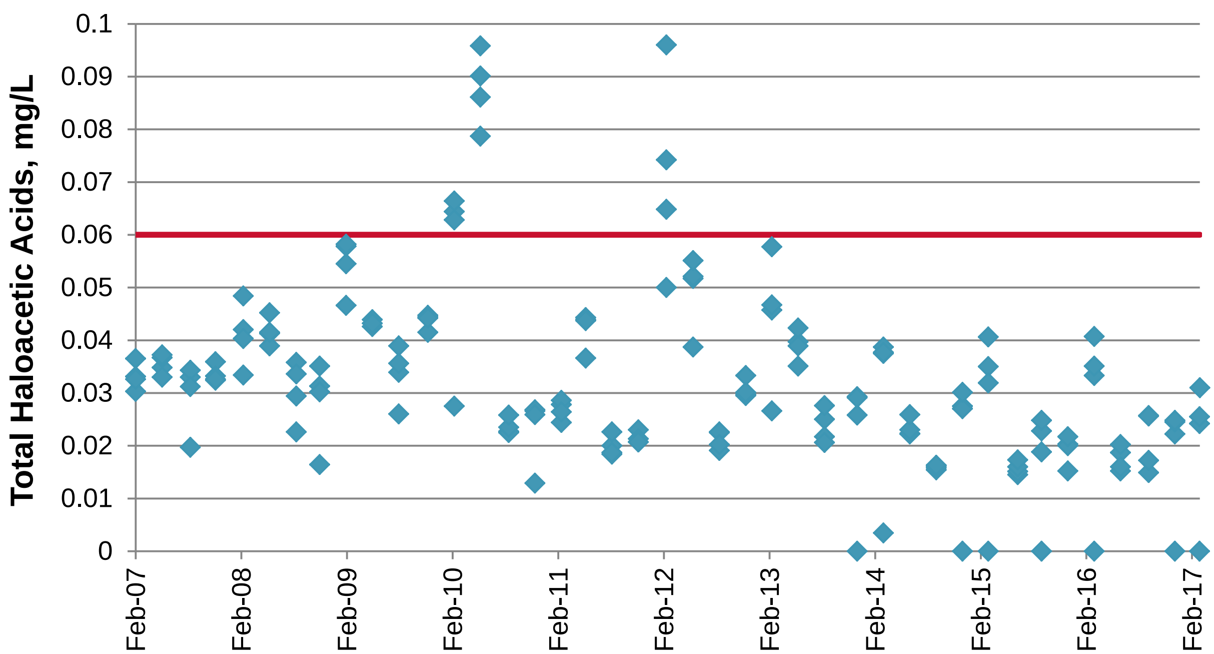

Figure 14: Total Haloacetic Acids

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Summary

The Ashland Creek/Reeder Reservoir raw water and existing WTP performance can be summarized as follows:

- Generally low turbidities are found in the surface water supply due to the presence of Reeder Reservoir acting as a large sedimentation basin. Occasional heavy storms can increase raw water turbidities but even then, maximum values are low. Despite these regular storm-driven increases, the existing WTP has been very successful in removing turbidity. The future WTP needs to at least match current turbidity removal performance.
- The raw water contains organic carbon that can be precursor to biological activity in media filters, organic fouling in membranes, and cause distribution system water quality issues. The TOC is higher and most variable at the start of the year and declines from there.
- The raw water pH is variable but in the range that does not unduly affect a treatment process selection.
- Alkalinity and hardness values are comparable to other raw water sources in Oregon and exhibit seasonal depression in the summer. Careful attention should be made to prevent consuming too much alkalinity if metal salt coagulation is used or providing a method to supplement alkalinity. The existing WTP uses soda ash to counteract this issue.
- Ashland's climate exhibits all four seasons so the monthly average raw water temperature can fall to 3 deg C during winter and go as high as 20 deg C during summer. Water temperature needs to be considered in the evaluation of any treatment process. The existing WTP performance is not heavily influenced by water temperature, though the future WTP might be affected depending on the treatment process selected.
- The City is blessed with having a water supply that has little to no *Cryptosporidium* or *Giardia*, which means it is not necessarily forced to having multiple and/or advanced filtration and disinfection processes for pathogen destruction.
- The existing and future WTPs do not need to consider IOC, VOC, or SOC removal in the treatment process, though the use of potassium permanganate needs to be carefully considered to minimize distribution system color issues.
- Reeder Reservoir can contain quite high populations of algae, especially algae that can produce cyanotoxins. This issue must be considered during the future WTP treatment process selection.
- The algae are also the source for the seasonal T&O issues that the City currently experiences and which the existing WTP has had only partial success in treating. The future WTP needs to also consider T&O control measures.

- Finally, water from Reeder Reservoir contains considerable amounts of color that needs to be removed. The current WTP processes have very good success in removing color, a level of performance the future WTP should match.

Compared to the extensive raw water quality available from Ashland Creek/Reeder Reservoir, specific TID water quality is limited to one grab sample and some intermittent TOC sampling. The limited data suggests TID water is similar to Reeder Reservoir but further water quality sampling is recommended before more conclusions can be made.

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Appendix A:

Inorganic Contaminants Regulated by the EPA

Contaminant	MCLG (mg/L)	MCL or TT (mg/L)
Antimony	0.006	0.006
Arsenic	0	0.010 as of 01/23/06
Asbestos (fiber > 10 micrometers)	7 million fibers per liter (MFL)	7 MFL
Barium	2	2
Beryllium	0.004	0.004
Cadmium	0.005	0.005
Chromium (total)	0.1	0.1
Copper	1.3	TT; Action Level=1.3
Cyanide (as free cyanide)	0.2	0.2
Fluoride	4	4
Lead	zero	TT; Action Level=0.015
Mercury (inorganic)	0.002	0.002
Nitrate (measured as Nitrogen)	10	10
Nitrite (measured as Nitrogen)	1	1
Selenium	0.05	0.05
Thallium	0.0005	0.002

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Appendix B:

Volatile Organic Contaminants Regulated by the EPA

Contaminant	MCLG (mg/L)	MCL or TT (mg/L)
Acrylamide	zero	TT
Benzene	zero	0.005
Carbon Tetrachloride	zero	0.005
Chlorobenzene	0.1	0.1
o-Dichlorobenzene	0.6	0.6
p-Dichlorobenzene	0.075	0.075
1,2-Dichloroethane	zero	0.005
1,1-Dichloroethylene	0.007	0.007
cis-1,2-Dichloroethylene	0.07	0.07
trans-1,2-Dichloroethylene	0.1	0.1
Dichloromethane	zero	0.005
1,2-Dichloropropane	zero	0.005
Epichlorohydrin	zero	TT
Ethylbenzene	0.7	0.7
Styrene	0.1	0.1
Tetrachloroethylene	zero	0.005
Toluene	1	1
1,2,4-Trichlorobenzene	0.07	0.07
1,1,1-Trichloroethane	0.2	0.2
1,1,2-Trichloroethane	0.003	0.005
Trichloroethylene	zero	0.005
Vinyl Chloride	zero	0.002
Xylenes (Total)	10	10

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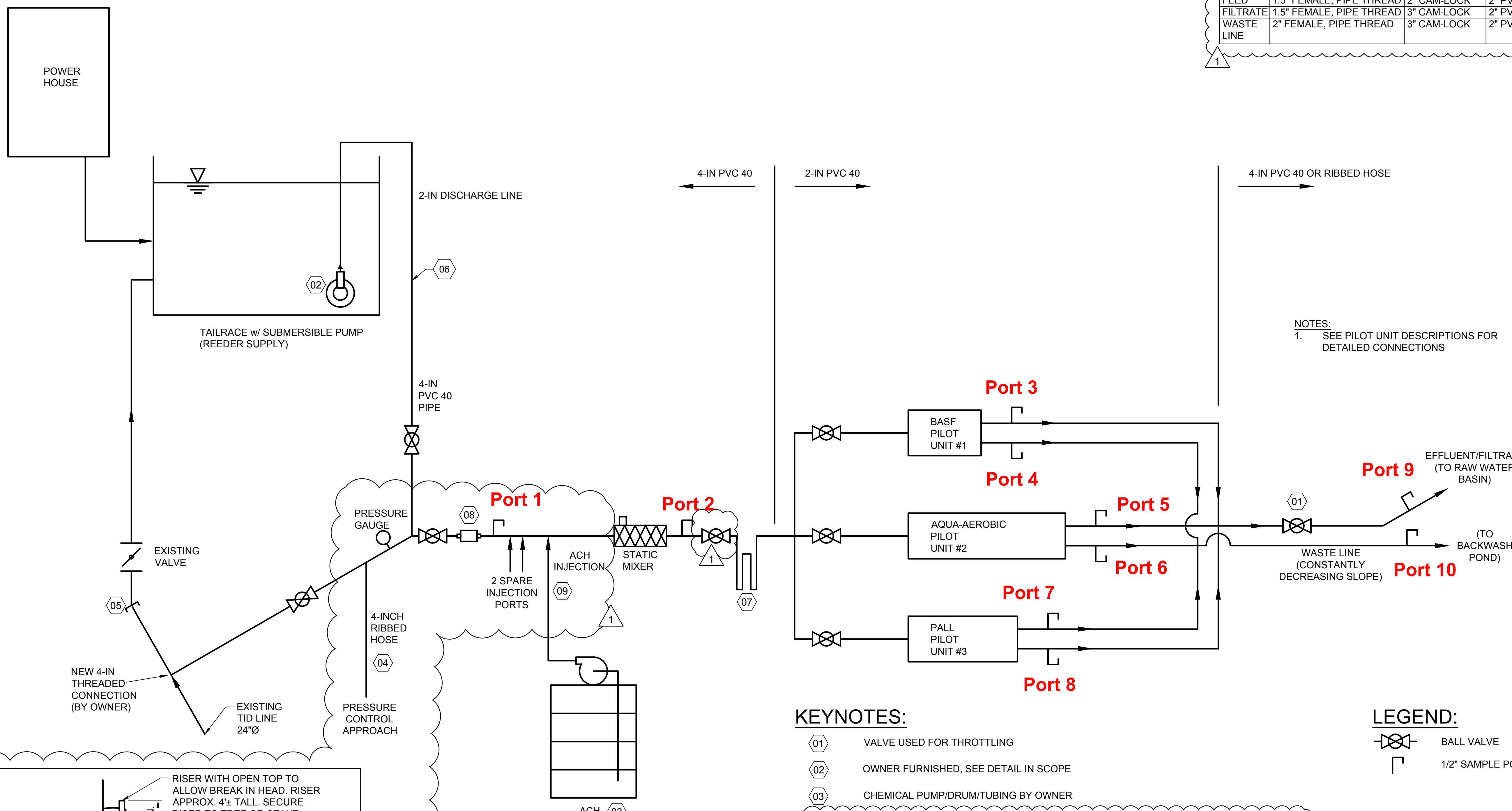
Appendix C:

Synthetic Organic Contaminants Regulated by the EPA

Contaminant	MCLG (mg/L)	MCL or TT (mg/L)
Alachlor	zero	0.002
Atrazine	0.003	0.003
Benzo(a)pyrene	zero	0.0002
Carbofuran	0.04	0.04
Chlordane	zero	0.002
2,4-D	0.07	0.07
Dalapon	0.2	0.2
1,2-dibromo-3-chloropropane	zero	0.0002
Di(2-ethylhexyl)-adipate	0.4	0.4
Di(2-ethylhexyl)-phthalate	zero	0.006
Dinoseb	0.007	0.007
Dioxin (2,3,7,8-TCDD)	zero	0.00000003
Diquat	0.02	0.02
Endothall	0.1	0.1
Endrin	0.002	0.002
Ethylene Dibromide (EDB)	zero	0.00005
Glyphosate	0.7	0.7
Heptachlor	zero	0.0004
Heptachlor epoxide	zero	0.0002
Hexachlorobenzene	zero	0.001
Hexachlorocyclopentadiene	0.05	0.05
Lindane	0.0002	0.0002
Methoxychlor	0.04	0.04
Oxymal (Vydate)	0.2	0.2
Pentachlorophenol	zero	0.001
Picloram	0.5	0.5
Polychlorinated byphenyls (PCBs)	zero	0.0005
Simazine	0.004	0.004
Toxaphene	zero	0.003
2,4,5-TP (Silvex)	0.05	0.05

PILOT UNIT CONNECTIONS

	BASF/H2O INNOVATIONS	AQUA-AEROBIC	PALL
FEED	1.5" FEMALE, PIPE THREAD	2" CAM-LOCK	2" PVC NPT
FILTRATE	1.5" FEMALE, PIPE THREAD	3" CAM-LOCK	2" PVC NPT
WASTE LINE	2" FEMALE, PIPE THREAD	3" CAM-LOCK	2" PVC NPT



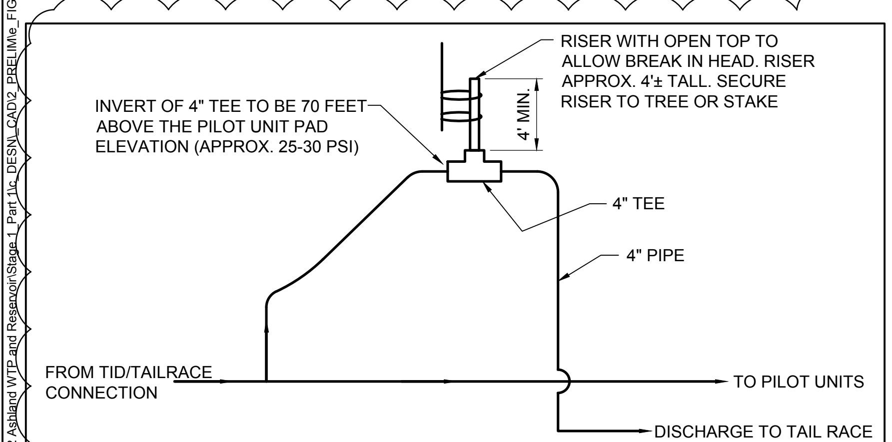
NOTES:
1. SEE PILOT UNIT DESCRIPTIONS FOR DETAILED CONNECTIONS

KEYNOTES:

- 01 VALVE USED FOR THROTTLING
- 02 OWNER FURNISHED, SEE DETAIL IN SCOPE
- 03 CHEMICAL PUMP/DRUM/TUBING BY OWNER
- 04 4-INCH RIBBED HOSE OR RIGID PIPE APPROX. 400 FEET. PULL 4-INCH HOSE UP TO AN ELEVATION 70FT. HIGHER THAN FEED ELEVATION. AT TOP, INSERT 4" TEE WITH RISER OPEN TO ALLOW BREAK IN HEAD AT MINIMUM 4 FEET TALL. SECURE RISER TO TREE OR STAKE. SEE PRESSURE CONTROL APPROACH DETAIL. ROUTE IN FIELD AS DIRECTED BY OWNER.
- 05 TEMPORARY CAP ON TID LINE (OWNER INSTALLED)
- 06 CONNECT TO SUBMERSIBLE PUMP DISCHARGE LINE AS REQUIRED
- 07 NEED 160 FEET OF 4" PIPE FOR DETENTION DOWNSTREAM OF STATIC MIXER. PLACE AT CONVENIENCE OF CONTRACTOR; DISCUSS WITH OWNER.
- 08 FLOWMETER WILL BE CUT INTO PVC ONCE PALL VERIFIES DIMENSIONS AND CONNECTION STYLE
- 09 (3) INJECTION PORTS WITH 4" SADDLEBACK INJECTOR ADAPTER TO 1/2" INJECTION QUILL (PVC 1/2" MNPT X 1/2" MNPT) TO 1/2" BALL VALVE (PVC 1/2" FNPT X 1/2" FNPT) TO 1/2" MALE CONNECTOR WITH PLASTIC GRIPPER (PP 1/2" JACO X 1/2" MNPT)

LEGEND:

- BALL VALVE
- 1/2" SAMPLE PORT WITH VALVE



PRESSURE CONTROL APPROACH DETAIL

NO.	REVISIONS	DATE
1	ADDENDUM 1	08/01/17

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WATER TREATMENT PLANT

CITY OF ASHLAND

PILOT TEST SCHEMATIC

PROJECT NO. 217002

FIGURE NO. 2

J:\217002 Ashland WTP and Reservoir\Stage 1_Part 1\c_DESN_CAD\2_PRELIM\e_FIG\FIGURE 2 rev1.dwg DATE: 08/01/2017 TIME: 03:11:37 PM

-- KEYNOTES:

01 PRESSURE RELIEF VALVE ACCESS HATCH

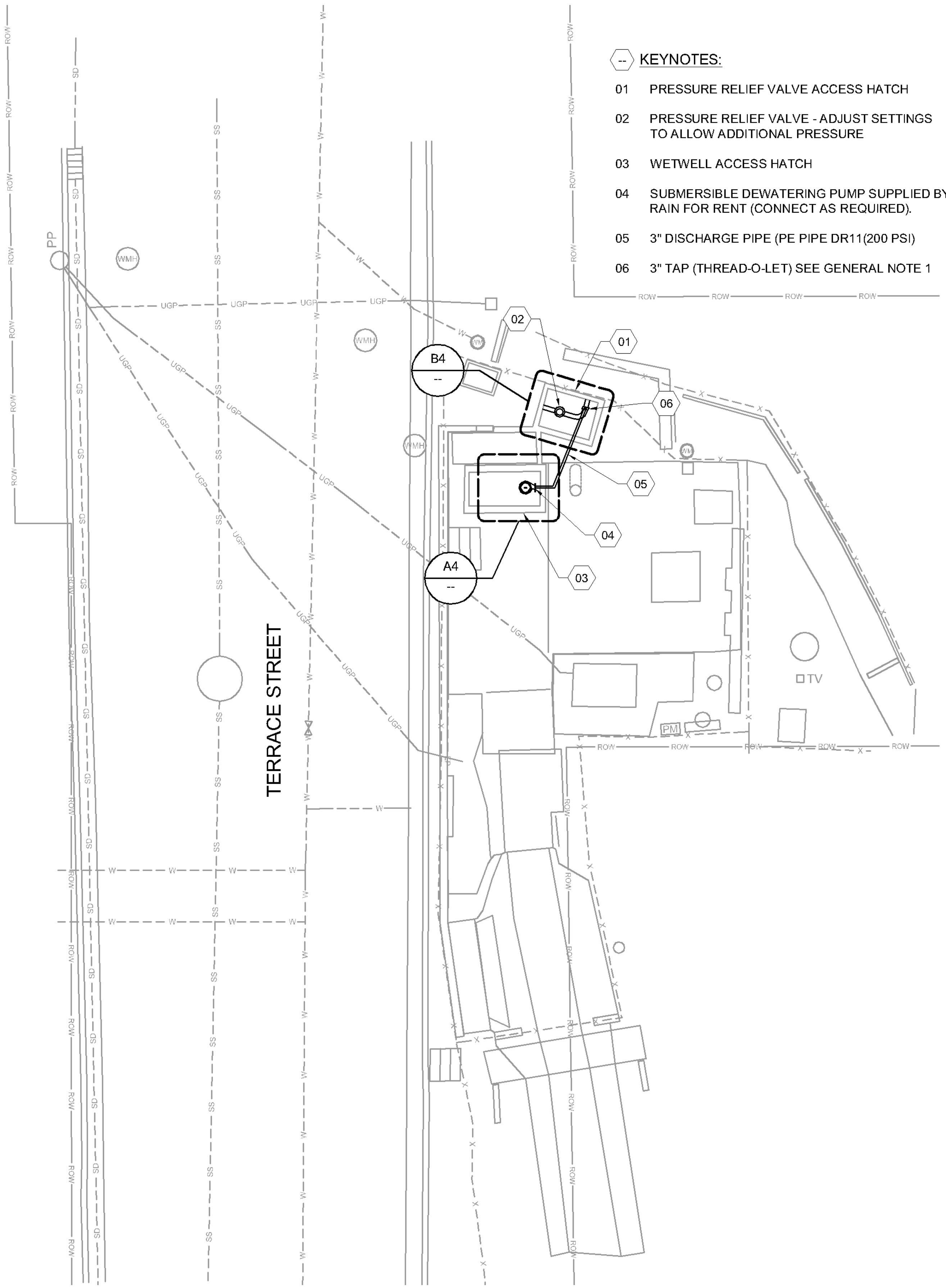
02 PRESSURE RELIEF VALVE - ADJUST SETTINGS TO ALLOW ADDITIONAL PRESSURE

03 WETWELL ACCESS HATCH

04 SUBMERSIBLE DEWATERING PUMP SUPPLIED BY RAIN FOR RENT (CONNECT AS REQUIRED).

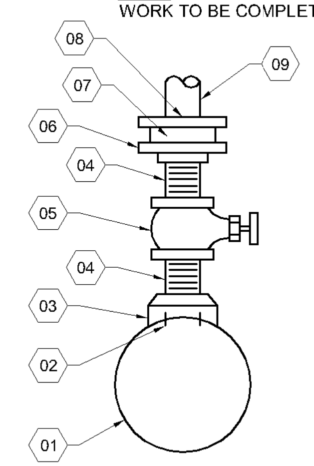
05 3" DISCHARGE PIPE (PE PIPE DR11(200 PSI)

06 3" TAP (THREAD-O-LET) SEE GENERAL NOTE 1



A1 SITE PLAN
N.T.S.

NOTE:
WORK TO BE COMPLETED BY CITY



-- KEYNOTES:

01 EXISTING STEEL PIPE

02 3" HOLE CUT IN PIPE

03 3" THREAD-O-LET - WELDED

04 3" STEEL NIPPLE

05 3" CLASS 300 DUCTILE IRON GLOBE VALVE (THxTH)

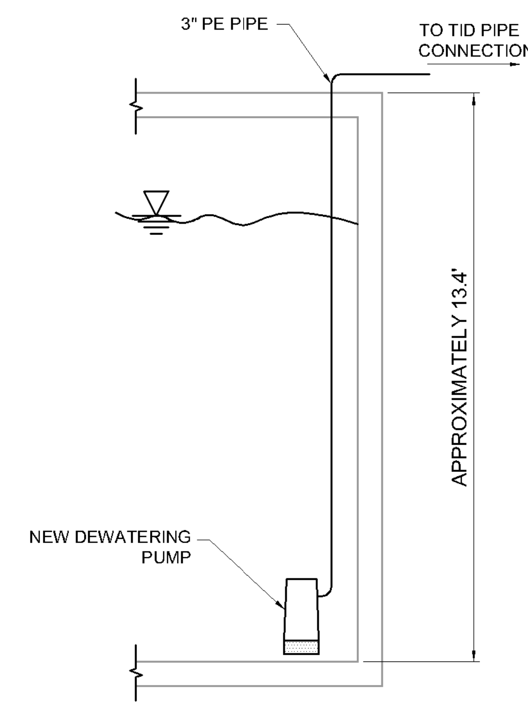
06 3"x 7 1/2" THREADED FLANGE (NPT)

07 PE FLANGE WELDED TO PE PIPE

08 3"x 7 7/8" IRON BACK UP RING

09 3" PE PIPE

B4 3" PIPE CONNECTION
N.T.S.



A4 EXISTING WETWELL
N.T.S.

GENERAL SHEET NOTES

1. ALTERNATIVELY CONTRACTOR MAY CHOOSE TO EXCAVATE AND EXPOSE THE TID PIPELINE ADJACENT TO THE PRV VAULT TO MAKE THE 3" CONNECTION.

KELLER associates

WATER TREATMENT PLANT

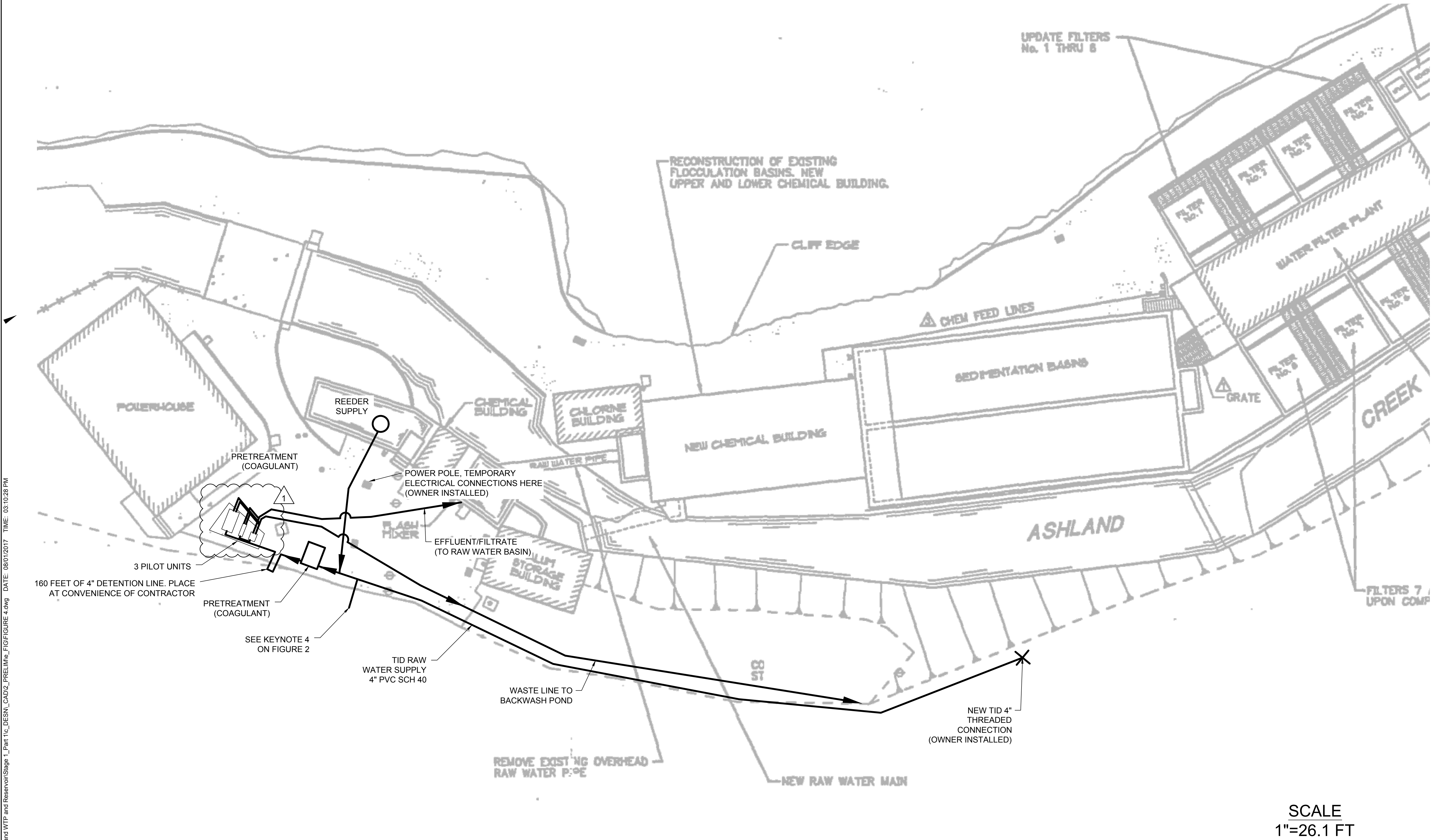
CITY OF ASHLAND

SITE PLAN

PROJECT NO. 217002

FIGURE NO. 3

J:\217002 Ashland WTP and Reservoir\Stage 1_Part 1\c_DESN_CAD\2_PRELIM\e_FIG\FIGURE 3.dwg DATE: 07/14/2017 TIME: 07:36:33 AM



SCALE
1"=26.1 FT

NO.	REVISIONS	DATE
1	ADDENDUM 1	08/01/17

J:\217002 Ashland WTP and Reservoir\Stage 1_Part 1\c_DESN_CAD\2_PRELIM\e_FIG\FIGURE 4.dwg DATE: 08/01/2017 TIME: 03:10:28 PM

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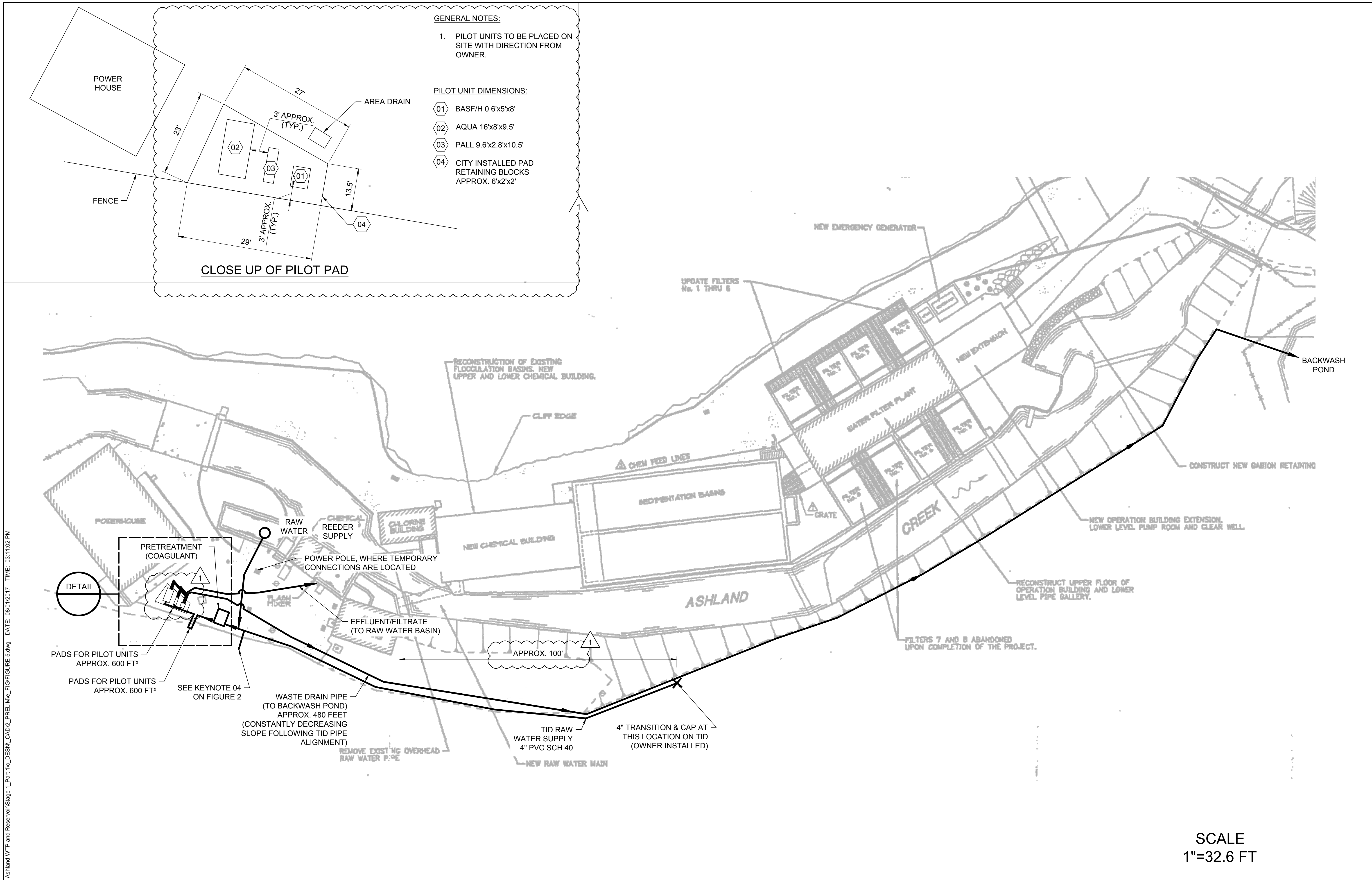
WATER TREATMENT PLANT

CITY OF ASHLAND

PILOT TEST LAYOUT 2

PROJECT NO.
217002

FIGURE NO.
4



NO.	REVISIONS	DATE
1	ADDENDUM 1	08/01/17

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FIGURE NO. 5