ATTENTION: A 30-MINUTE COUNCIL DISCUSSION PERIOD WILL BE HELD IMMEDIATELY PRIOR TO THIS REGULAR MEETING. THE PUBLIC IS WELCOME TO ATTEND.

CITY OF OWOSSO
SPECIAL MEETING OF THE CITY COUNCIL
MONDAY, OCTOBER 30, 2023
7:30 P.M.

Meeting to be held at City Hall
301 West Main Street

AGENDA

PLEDGE OF ALLEGIANCE:
ROLL CALL:

ADDRESSING THE CITY COUNCIL

1. Your comments shall be made during times set aside for that purpose.
2. Stand or raise a hand to indicate that you wish to speak.
3. When recognized, give your name and address and direct your comments and/or questions to any City official in attendance.
4. Each person wishing to address the City Council and/or attending officials shall be afforded one opportunity of up to four (4) minutes duration during the first occasion for citizen comments and questions. Each person shall also be afforded one opportunity of up to three (3) minutes duration during the last occasion provided for citizen comments and questions and one opportunity of up to three (3) minutes duration during each public hearing. Comments made during public hearings shall be relevant to the subject for which the public hearings are held.
5. In addition to the opportunities described above, a citizen may respond to questions posed to him or her by the Mayor or members of the Council, provided members have been granted the floor to pose such questions.

CITIZEN COMMENTS AND QUESTIONS

SPECIAL PRESENTATIONS

1. City of Owosso Water Study. Receive a presentation from engineering firm Fishbeck regarding the recently completed City of Owosso Water Study.

NEXT MEETING

Monday, November 06, 2023

BOARDS AND COMMISSIONS OPENINGS

Building Board of Appeals – Alternate - term expires June 30, 2024
Building Board of Appeals – Alternate - term expires June 30, 2025
Downtown Development Authority – term expires June 30, 2024
Zoning Board of Appeals – Alternate – term expires June 30, 2024
Zoning Board of Appeals – Alternate – term expires June 30, 2025

ADJOURNMENT

The City of Owosso will provide necessary reasonable auxiliary aids and services, such as signers for the hearing impaired and audio recordings of printed materials being considered at the meeting, to individuals with disabilities at the meeting/hearing upon seventy-two (72) hours notice to the City of Owosso. Individuals with disabilities requiring auxiliary aids or services should contact the City of Owosso by writing, calling, or emailing the following: Owosso City Clerk's Office, 301 West Main Street, Owosso, MI 48867; Phone: (989) 725-0500; Email: city.clerk@ci.owosso.mi.us. The City of Owosso Website address is www.ci.owosso.mi.us.

PLEASE TAKE NOTICE THAT THE FOLLOWING MEETING
CAN ONLY BE VIEWED VIRTUALLY

The Owosso City Council will conduct an in-person meeting on October 30, 2023. Citizens may view and listen to the meeting using the following link and phone numbers.

OWOSSO CITY COUNCIL – SPECIAL MEETING
Monday, October 30, 2023
at 7:30 p.m.

The public joining the meeting via Zoom CANNOT participate in public comment.

- **Join Zoom Meeting:**
  https://us02web.zoom.us/j/86576548991?pwd=SGpSUGFIN3c5M3R1STlac2YwblE5UT09

- **Meeting ID:** **865 7654 8991**
  Password: **884189**

-

- **One tap mobile**

  +13052241968,,86576548991#,,,,*884189# US
  +13092053325,,86576548991#,,,,*884189# US

Dial by your location

+1 312 626 6799 US (Chicago)
+1 646 558 8656 US (New York)
+1 301 715 8592 US (Washington DC)
+1 346 248 7799 US (Houston)
+1 669 900 9128 US (San Jose)
+1 253 215 8782 US (Tacoma)

- **For video instructions visit:**
  - Signing up and Downloading Zoom https://youtu.be/qsy2Ph6kSf8
  - Joining a Zoom Meeting https://youtu.be/hIkCmbvAHQQ
  - Joining and Configuring Audio and Video https://youtu.be/-s76QHshQnY

- **Helpful notes for participants:** Helpful Hints

- **Meeting packets are published on the City of Owosso website** http://www.ci.owosso.mi.us

Any person who wishes to contact members of the City Council to provide input or ask questions on any business coming before the Council on October 30, 2023 may do so by calling or e-mailing the City Clerk's Office prior to the meeting at (989)725-0500 or city.clerk@ci.owosso.mi.us. Contact information for individual Council members can be found on the City website at: http://www.ci.owosso.mi.us/Government/City-Council

The City of Owosso will provide necessary reasonable auxiliary aids and services, such as signers for the hearing impaired and audio recordings of printed materials being considered at the meeting, to individuals with disabilities at the meeting/hearing upon seventy-two (72) hours notice to the City of Owosso. Individuals with disabilities requiring auxiliary aids or services should contact the City of Owosso by writing, calling, or emailing the following: Owosso City Clerk's Office, 301 West Main Street, Owosso, MI 48867; Phone: (989) 725-0500; Email: city.clerk@ci.owosso.mi.us. The City of Owosso Website address is www.ci.owosso.mi.us.

City of Owosso Water Study

City Council Presentation

October 30, 2023

fishbeck

Engineers | Architects | Scientists | Constructors

Agenda

- Introductions
- Existing System Overview
- Condition Assessment
- Plant Rehabilitation Recommendations
- Membrane Softening Evaluation
- Reliability Study

Owosso Water Treatment Plant

Meet the Team

Brian Van Zee

Project Manager

Mark Parsley

Senior Process Engineer

Colin McCorkle

Senior Process Engineer

Zach Gogulski

Process Engineer

fishbeck FACTS

Established in 1956

15 LOCATIONS

ALL IN ONE SERVICES

ARCHITECTURE/ ENGINEERING

INFRASTRUCTURE

ENVIRONMENTAL

CONSTRUCTION

575+ PROFESSIONALS

EMPLOYEE OWNED

280 SHAREHOLDERS

TOP 500 DESIGN FIRM IN THE NATION

Project Introduction

- Water Treatment Plant Performance Evaluation
  - Condition Assessment
  - Capital Improvements Plan
  - Membrane Softening Evaluation
- Reliability Study
  - Hydraulic Model Calibration
  - General Plan Update
  - Capital Improvements Plan

South Clarifier

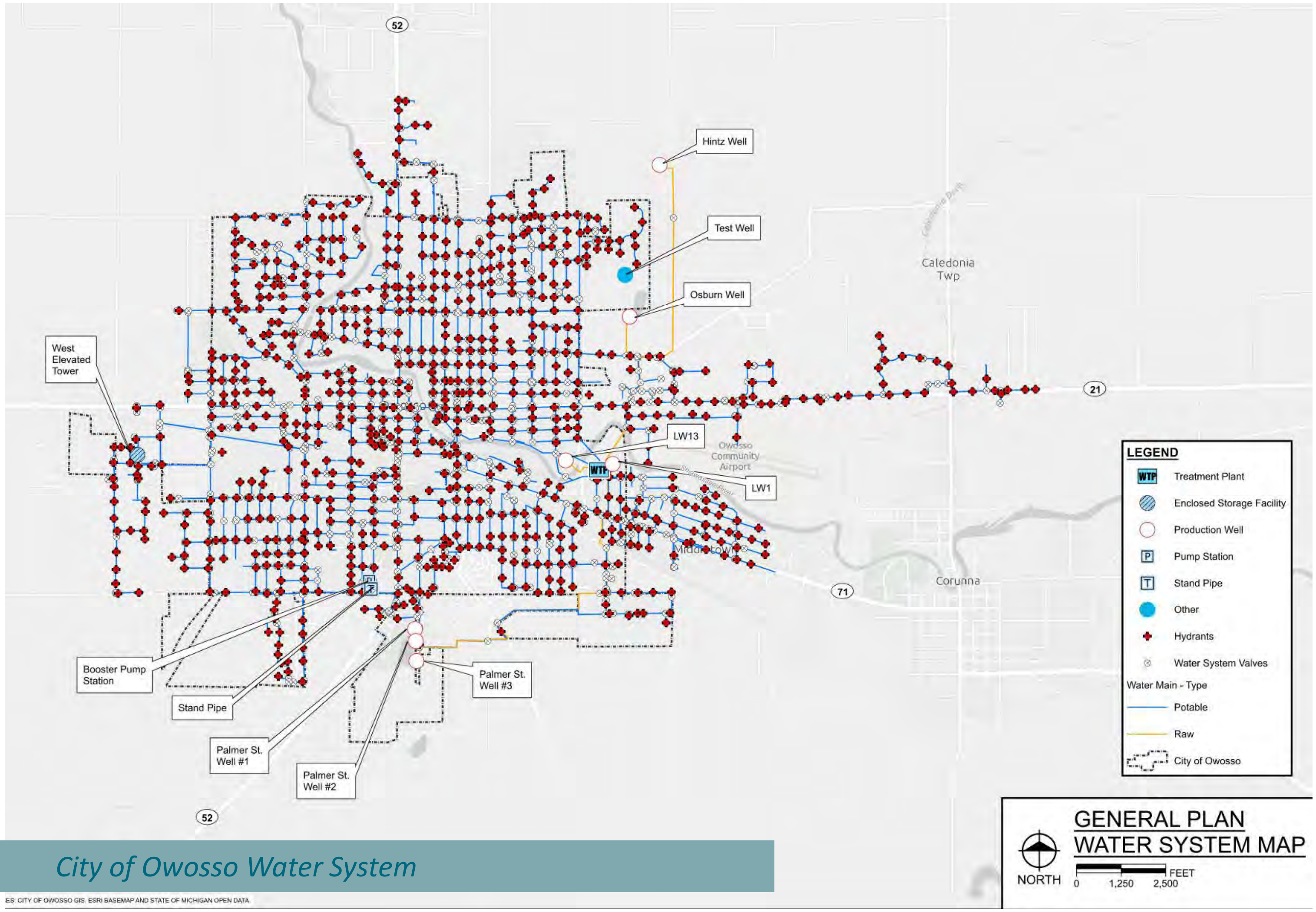
Local Well 1

Existing System – Raw Water

Five Existing Raw Water Supply Wells

- Local Well 1
- Local Well 13
- Hintz Well
- Osburn Well
- Palmer Street Well 2

4.7 Miles of Raw Water Main



City of Owosso Water System

Existing System – Raw Water Quality

Parameter	Minimum	Average	Maximum
Turbidity (NTU)	0.070	0.218	0.483
pH	6.73	7.13	7.41
Total Alkalinity (mg/L as $CaCO_3$)	286	365	397
Total Hardness (mg/L as $CaCO_3$)	458	500	594
Carbon Dioxide (mg/L as $CaCO_3$)	2.5	22.7	71.2
Iron (mg/L)	1.1	2.6	5.3

Existing System – Water Treatment Plant

- Originally Constructed in 1934
- Start-Up in 1941
- Last Major Upgrade in 2004
- Lime Softening Treatment Process
  - Aeration
  - Clarification
  - Recarbonation
  - Filtration
  - Disinfection

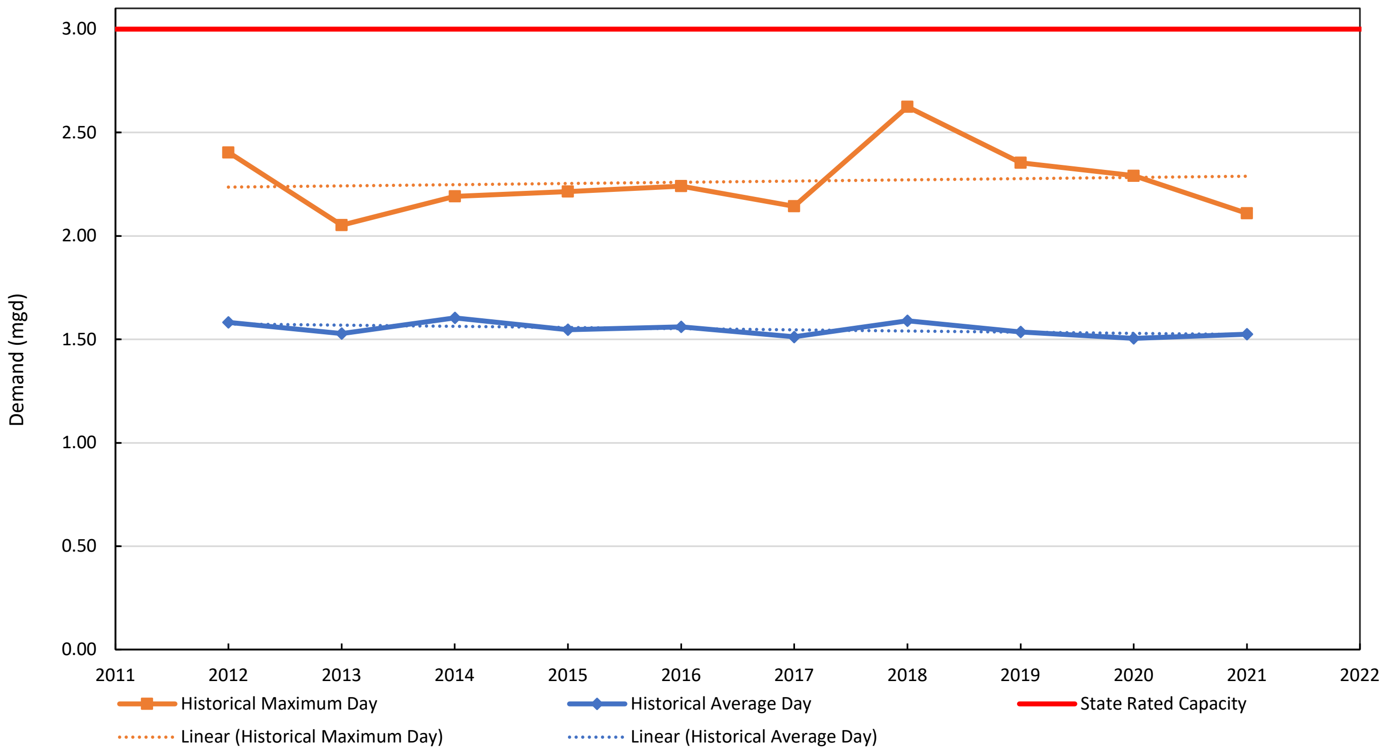
Pretreatment Building – Constructed in 2004

City of Owosso Standpipe

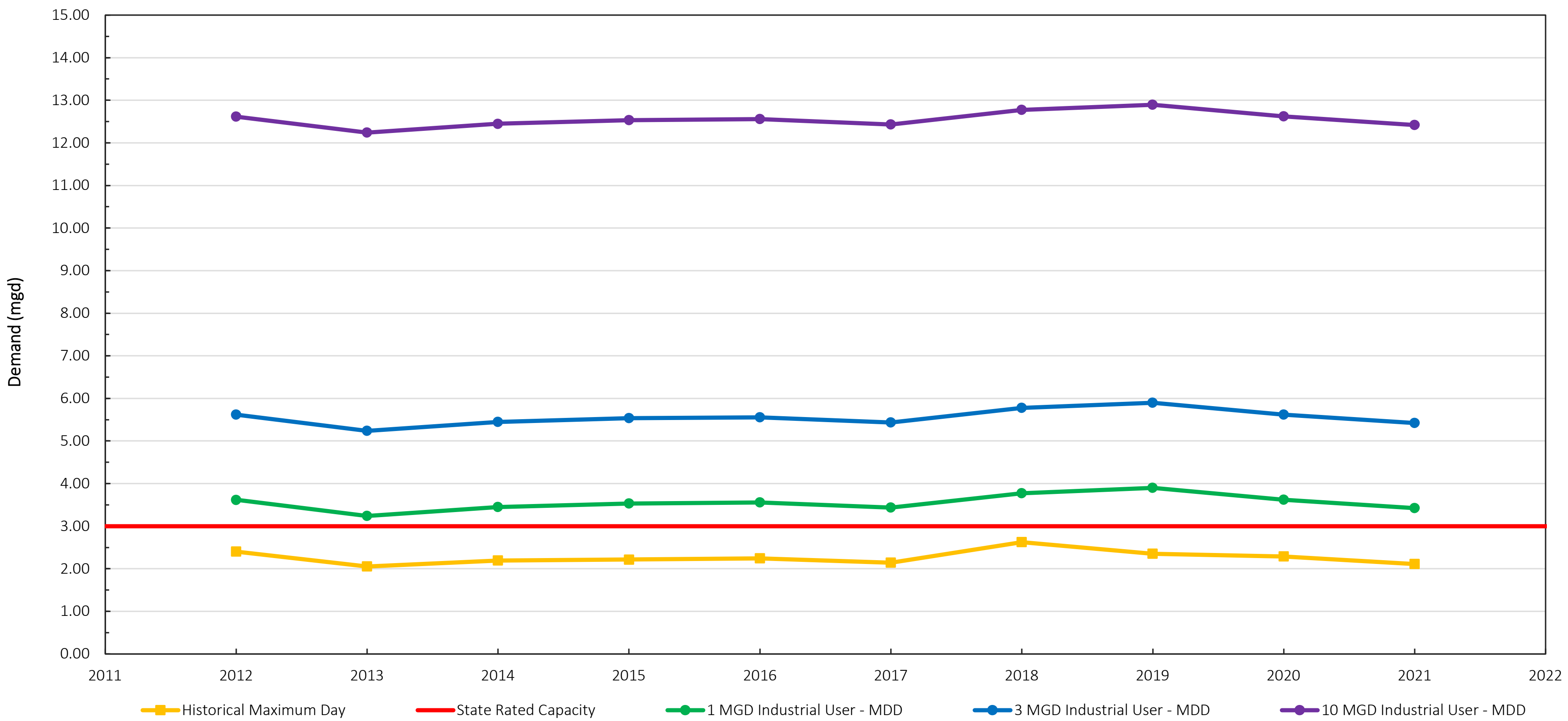
Existing System – Distribution System

- 109 miles of water main
  - Sizes range from 4” to 24”
  - Constructed of Ductile Iron, Cast Iron, and PVC
- 600,000-gallon Elevated Storage Tank
- 1,192,000-gallon Standpipe
- Serves City of Corunna, portions of Caledonia and Owosso Townships

Existing System – Historical Water Demands



Existing System – Potential Industrial Users



Projected Water Demands

Year	Projected Average Day Demand (mgd)	Projected Maximum Day Demand (mgd)	Projected Peak Hour Demand (mgd)
2022	1.55	2.51	3.76
2027	1.57	2.54	3.81
2042	1.63	2.64	3.96

- Consistent water use year on year
- Conservative growth rate of 0.25% annually

Questions?

fishbeck
Engineers | Architects | Scientists | Constructors

Condition Assessment - Overview

- Utilized WTP operational data from previous 10-years
- Architectural, structural, electrical, mechanical, and process professionals
- Wells, WTP, and Distribution System Sites

Onsite Condition Assessment

Local Well 1 Pump

Condition Assessment – Wells

- Local Well 1
  - Pump capacity decreased over 30% from 2020
  - Internal insulation showing signs of damage and age
- Local Well 13
  - Roof shingles are in poor condition
  - Significant corrosion on pump base

Local Well 1 Exterior

Local Well 1 Interior Insulation

Local Well 13 Exterior

Local Well 13 Pump

Condition Assessment – Wells (cont.)

- Hintz Well
  - Recently constructed
  - In good condition
- Osburn Well
  - Exterior concrete weathered, but stable
  - HVAC equipment in poor condition
  - Well is operating as expected

Hintz Well Pump Pitless Adapter

Hintz Well Exterior

Hintz Well Interior Piping

Osburn Well Exterior

Osburn Well Pump

Condition Assessment – Wells (cont.)

- Palmer Street Well 2
  - Corrosion on exterior metal panels
  - Degradation of concrete floor
  - HVAC in poor condition

Palmer Street Well 2 Pump and Piping

Palmer Street Well 2 Exterior

Palmer Street Well 2 Interior Floor

Condition Assessment – WTP Site

- Two buildings – original WTP and pretreatment building
- Storm water drainage issues
- Security fence only partially secures lagoon area
- Parking lot in OK condition

WTP Site Aerial Image

Condition Assessment – WTP Buildings

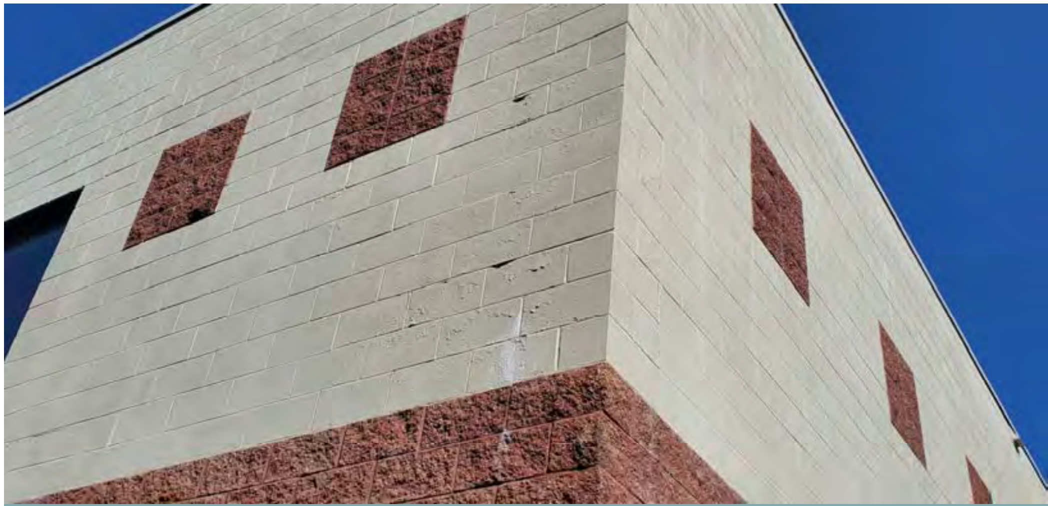

WTP Original Building Roof

- Roofs on both buildings are in poor condition
  - Significant buckling is present
- Coating on blocks of clarifier building are beginning to peel
- Spall on concrete entry stairs

Original WTP Roof

Clarifier Building Roof

Original WTP Entryway Stairs



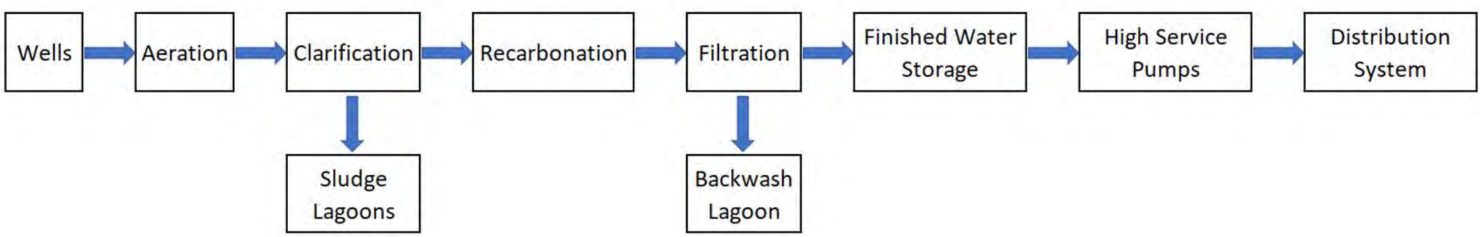
Clarifier Building Exterior Block

Condition Assessment – WTP Buildings (cont.)

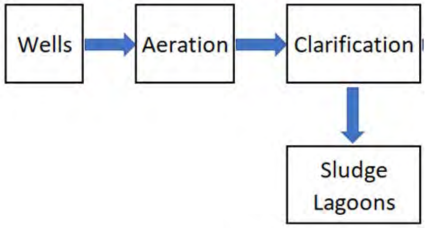
- Material and equipment handling challenges
  - Removal of elevator
  - Failure of overhead crane
  - Failure of loading bay leveler
  - Clarifier room overhead door

Existing overhead crane in high service pump room

Lime Softening Process Overview



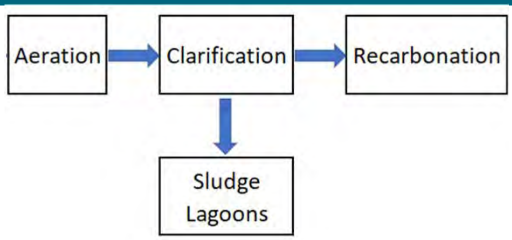
Lime Softening Treatment Flow Path



Condition Assessment – Aeration

- Single aluminum induced draft aerator installed in 2004
  - Removes CO_2 and oxides iron and manganese
- Interior is heavily corroded
  - Corrosion and sediment have built up inside
- Moderate corrosion on 20” effluent pipe and concrete pad

Aerator

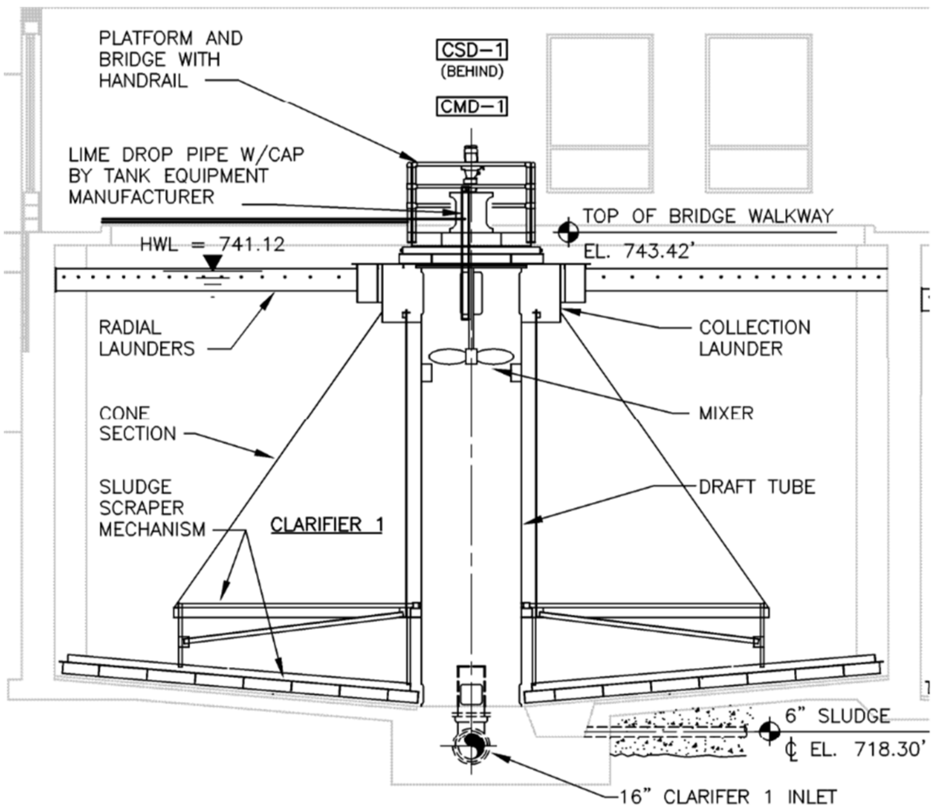


Condition Assessment – Clarifiers

- Two upflow solids contact clarifiers
  - Operated in series
  - Lime is dosed
  - Softening precipitates settle out
  - 3.0 MGD capacity each
- Mixing equipment, scraper drives
- Clarifiers are in good condition and operate as intended
- Interior paint peeling
- HVAC equipment in poor condition

North Clarifier

Condition Assessment – Clarifiers (cont.)



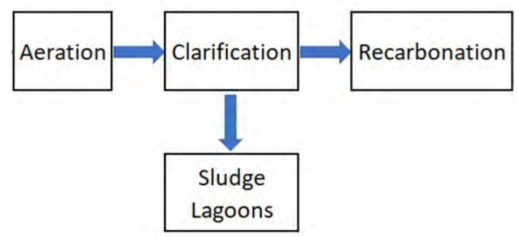
Clarifier Cross Section

Clarifier Scraper Drive (top), Clarifier Mixer (bottom)

Sludge Pump

Condition Assessment – Sludge Handling

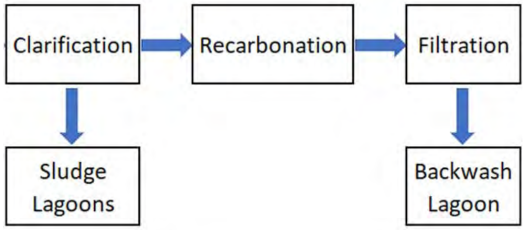
- Sludge pumps are in fair condition
- Pumped sludge dries in lagoons, 4 total
  - Approximately 35,650 cu. yards
  - Dry sludge is dredged and removed
- No current dredging/removal contract



Lime Sludge Lagoons

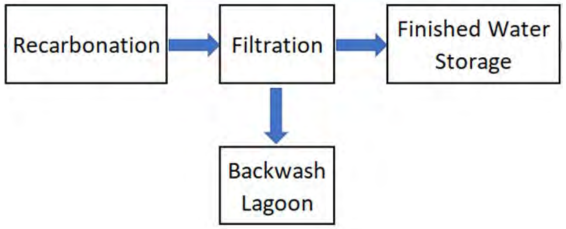
Lime Lagoon, north side of WTP site

Condition Assessment – Recarbonation



- CO_2 is injected
  - Lower pH, settle excess lime
- 30-ton capacity bulk storage
  - In good condition
- Automatic feed panels
  - Not currently operational
- Mixing tank
  - Requires annual draining, cleaning

Bulk CO_2 Storage Container



Condition Assessment - Filtration

- Four rapid gravity filters
  - Sand and anthracite media
  - Rated capacity of 5.44 MGD
- Media is in very poor condition
  - Expansion due to calcification
- Surface wash is not operational
- Underdrains expected to be in poor condition
- Filter effluent piping in poor condition, other piping fair
- HVAC requires upgrades
- Interior paint is peeling

Filter as viewed from walkway

Condition Assessment – Filtration (cont.)

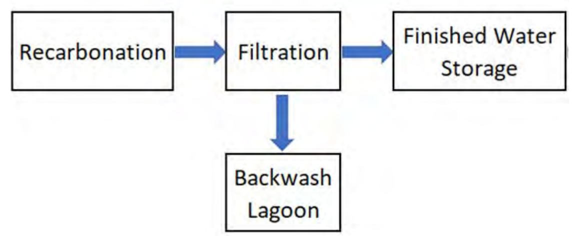
Filter Gallery Piping

Filter Effluent Piping to Underground Storage Tank

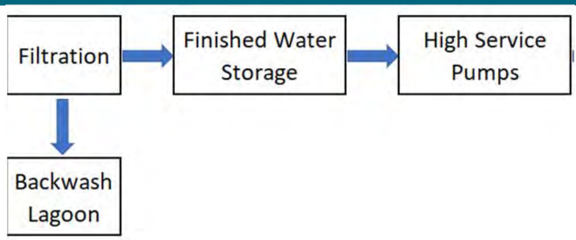
New Backwash Supply Pump

Condition Assessment – Backwash

- Backwash water is supplied from finished water to clean filters
- Backwash supply pumps replaced in 2021
  - Two total pumps, in good condition
- Backwash waste is sent to lagoons



Condition Assessment – Finished Water Storage



- Underground storage reservoir
  - Constructed in 1920
  - 1.75 MG capacity
  - Last rehabilitated in 1990
- 2002 inspections report leaking and sediment buildup
- Reservoir is in very poor condition, replacement is necessary

Grade level view of reservoir, west of WTP

Condition Assessment – High Service Pumping

- Four high service pumps
  - Firm capacity 9.51 MGD
  - HSP 1 is constant speed
  - HSP 2, 3, and 4 run on VFDs
- Pumps are in good to fair condition
- Unable to start when underground storage levels are low
- Located below flood elevation
- Pipe gallery piping ranges from good to fair condition

High Service Pumps 1, 2, and 3

Condition Assessment – High Service Pumps

High Service Pump Pipe Gallery

High Service Pump Pipe Gallery

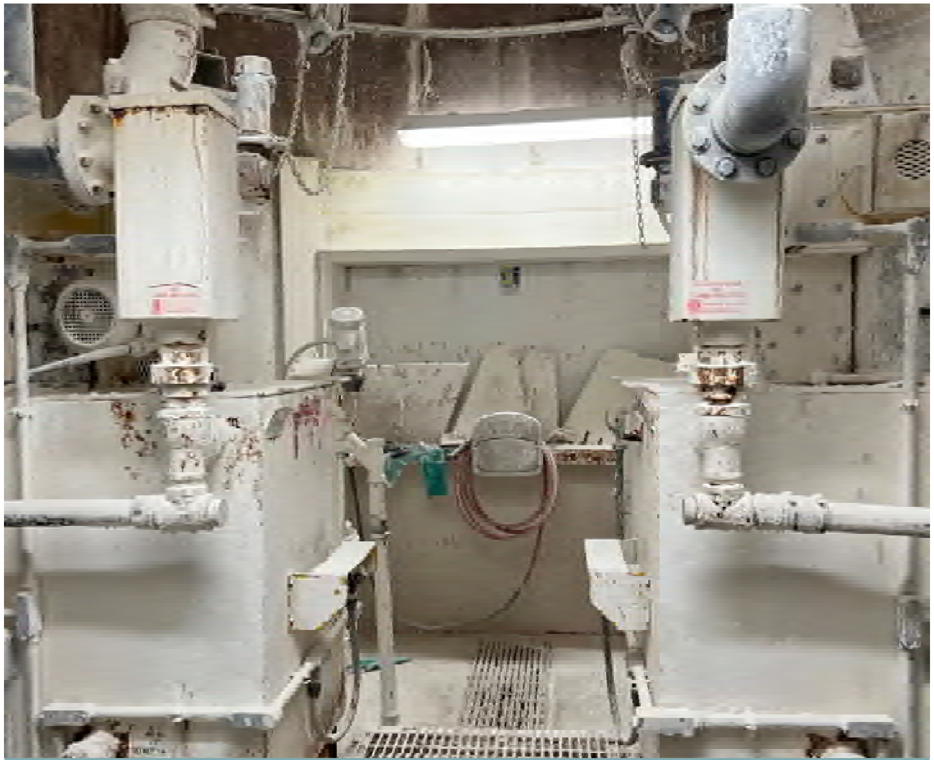
Lime storage Silo

Condition Assessment – Chemical Feed

- 4 chemicals used in treatment:
  - Lime (softening)
  - Sodium Hypochlorite (disinfection)
  - Fluoride (dental health)
  - LimeCure25 (reduce calcifying)
- Lime stored in silo onsite
  - 80-ton capacity
- Slakers convey lime slurry to clarifiers, requires large maintenance
- HVAC in lime silo in poor condition

Condition Assessment – Chemical Feed (cont.)

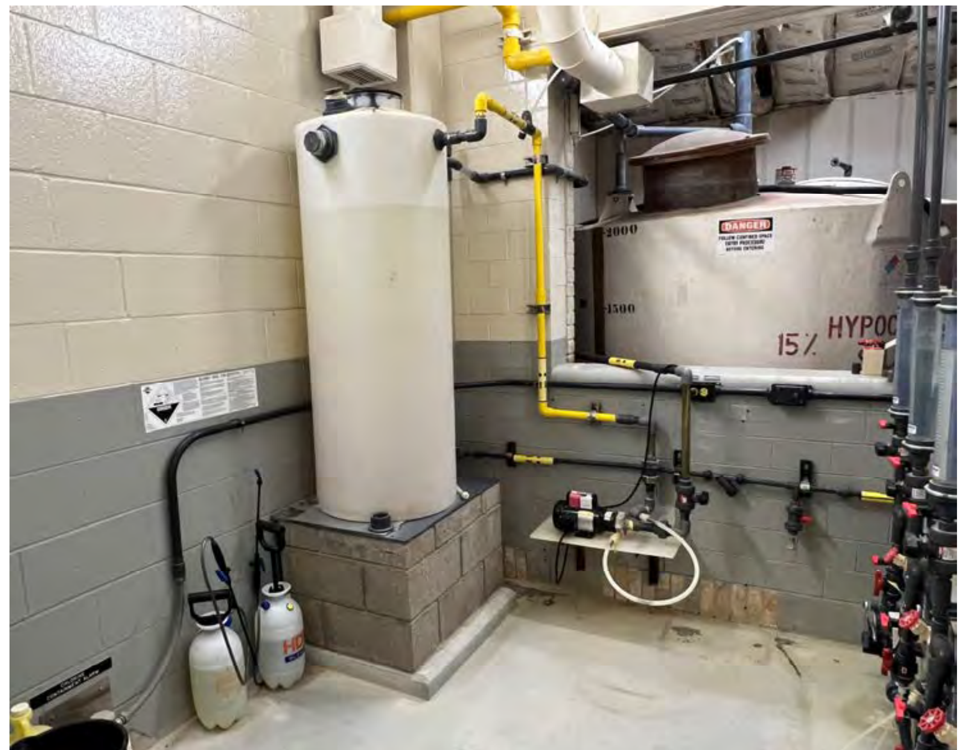
Lime Feeders



Continuous Lime Slurry Slakers

Condition Assessment – Chemical Feed (cont.)

- Sodium Hypochlorite
  - Aging bulk tank
  - Metering pumps and day tank in fair condition
- Sodium Fluoride
  - Installed in 2004, due for replacement
  - Should be located in separate space per regulatory standards
- LimeCure25
  - Requires secondary containment



Sodium Hypochlorite feed equipment

Condition Assessment – Chemical Feed (cont.)

Upflow saturator and fluoride feed equipment

LimeCure25 storage totes and feed equipment

Condition Assessment – Electrical Equipment

- Grounding deficiencies
- Aging switchboard
- Lack of surge protection
- Lack of arc flash warning labels
- VFD failure, additional electrical protection

WTP Electrical Room

Gute Hill Booster Station Building

Condition Assessment – Distribution System Sites

- Hydraulic deficiency at Gute Hill Booster Station
  - Piping/valving in good condition
  - Altitude valve OK condition
  - Electric unit heater aging
- Corrosion is present on piping/valving in elevated tank
- HVAC in good condition

Exterior of storage tank (left) and tank riser pipe (right)

Elevated Storage Tank

Condition Assessment – Distribution System Sites (cont.)

Gute Hill Booster Pump and Altitude Valve

Elevated Storage Tank Piping and Valving

Questions?

fishbeck
Engineers | Architects | Scientists | Constructors

Deficiency Correction Evaluation

- Lime Softening Plant Rehabilitation
  - Maintain current process
  - New equipment
  - Short- (5-year) and long-term (6-20-year) improvements
- Membrane Softening Plant
  - New process, demolish existing plant

Filter Improvements, including media replacement

Plant Rehabilitation – 5-Year Project Highlights

- Filter Improvements
  - Replace filter media
  - Replace underdrains
  - Install air scour piping and blowers
- Electrical Grounding Improvements
  - Replace existing switchboard
  - Upgrade transformers
  - Modify grounding electrode system
  - Add surge protection devices

Plant Rehabilitation – 5-Year Project Highlights

- Lime Residuals Mechanical Dewatering
  - Produces solid residuals cake
  - New building on WTP site
  - Screw press technology
- Building Materials and Equipment Handling Improvements
  - Overhead crane system
  - Truck bay leveler
  - Clarifier roll up door

Fairfield (OH) – Screw Press

Plant Rehabilitation Evaluation – 5-Year Project Summary

Project Name	Estimated Project Cost
Filter Improvements	$1,960,000
Electrical Grounding Improvements and Improvements to Meet Code Requirements	$1,550,000
Fluoride Feed Improvements	$350,000
Roofing Replacement	$470,000
Filter Effluent Piping Replacement	$330,000
Well Houses Building and Mechanical Equipment Improvements	$960,000
Aerator Improvements	$260,000

Filter effluent piping replacement

Plant Rehabilitation Evaluation – 5-Year Project Summary

Project Name	Estimated Project Cost
CO_2 Feed Panel Repair	$380,000
Lime Residuals Mechanical Dewatering	$11,520,000
WTP Site Improvements	$185,000
Gute Hill Booster Station Improvements	$834,000
Subbasement Sump Pump Improvements	$49,000
Building Material and Equipment Handling Improvements	$1,000,000
Filter Valve Improvements	$500,000
Total	$20,348,000

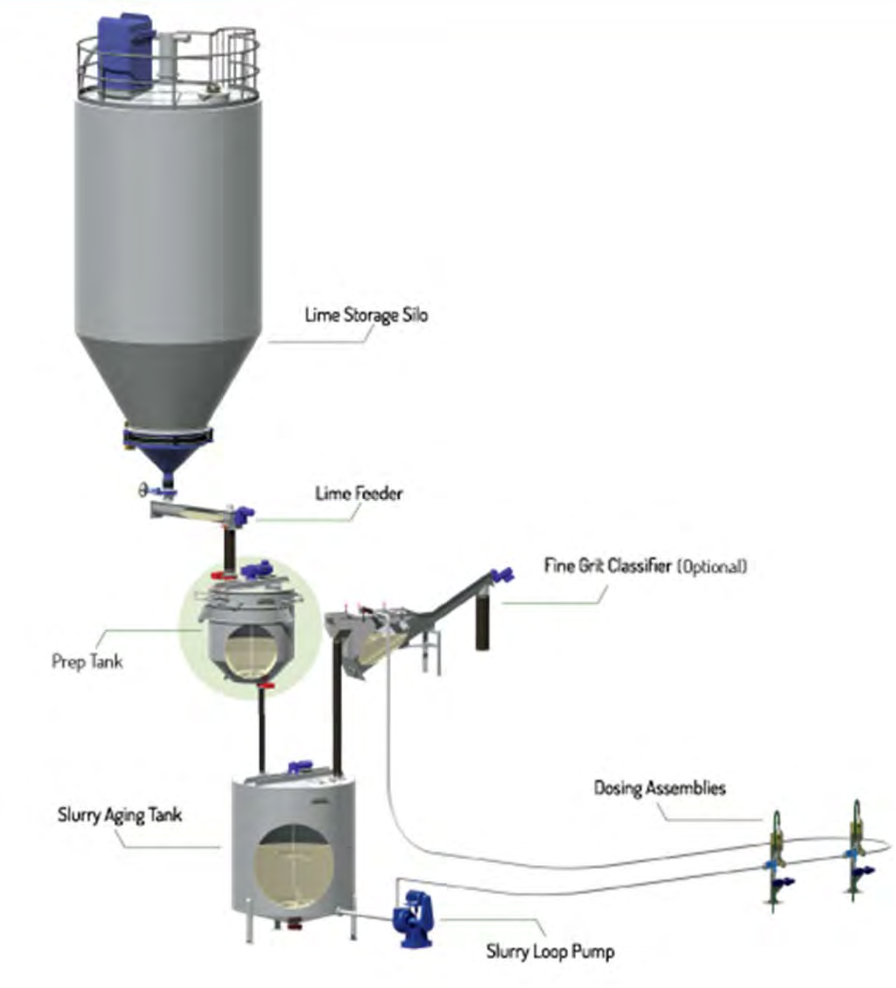
CO_2 Feed Panel

Plant Rehabilitation – 6-20-Year Project Highlight

Grand Ledge (MI), 0.75 MG storage tank

- New Reservoir and High Service/Transfer Pump Building
  - New building on WTP Site
  - Filtered water to transfer well
  - Two new 0.75 MG prestressed concrete ground storage tanks
  - New high service pump station

Plant Rehabilitation – 6-20-Year Project Highlight



Batch type slaker diagram

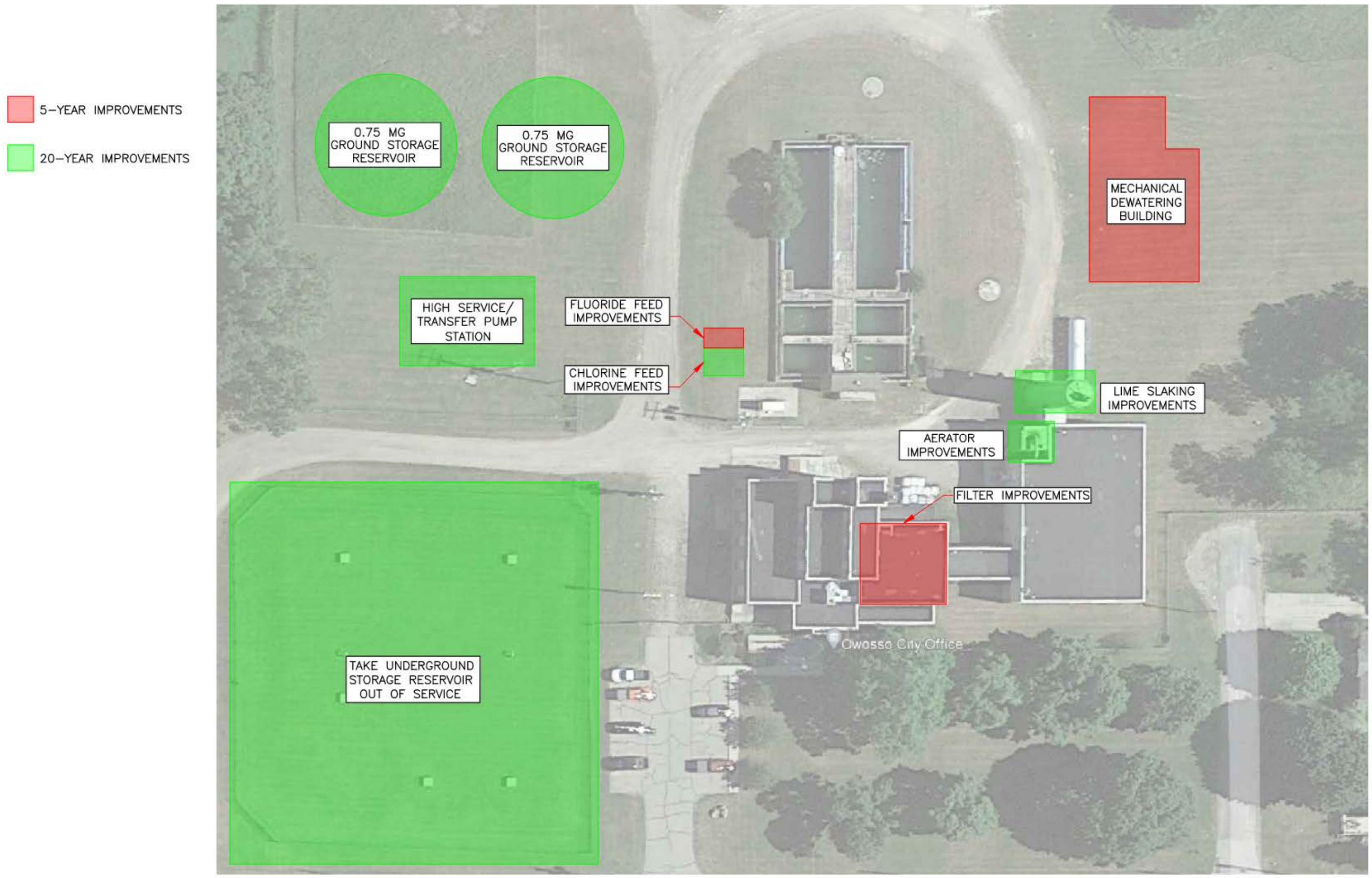
- Lime Slaking Improvements
  - Demolish existing slurry-type slakers and silo
  - New batch type slakers, mixing system, feed pumps, controls
  - New storage silo

Image Citation: RDP Technologies. (2023). *Hydrated-flow* [image]. RDPTech. https://rdptech.com/product/tekkem-lime-feed-systems/tekkem-slaker/

Plant Rehabilitation Evaluation – 6-20-Year Project Summary

Project Name	Estimated Project Cost
New Reservoir and High Service Transfer Pumping Building	$12,280,000
Building Improvements	$760,000
Chlorine Feed Improvements	$1,010,000
Lime Slaking Improvements	$5,180,000
SCADA/Controls Improvements Phase 1	$300,000
Juniper 2 Well Development	$750,000
Hintz 2 Well Development	$750,000
SCADA/Controls Improvements Phase 1	$1,000,000
Total	$22,030,000

Building Improvements – Clarifier Building Roof Replacement



Lime Softening Plant Site Plan with proposed improvements

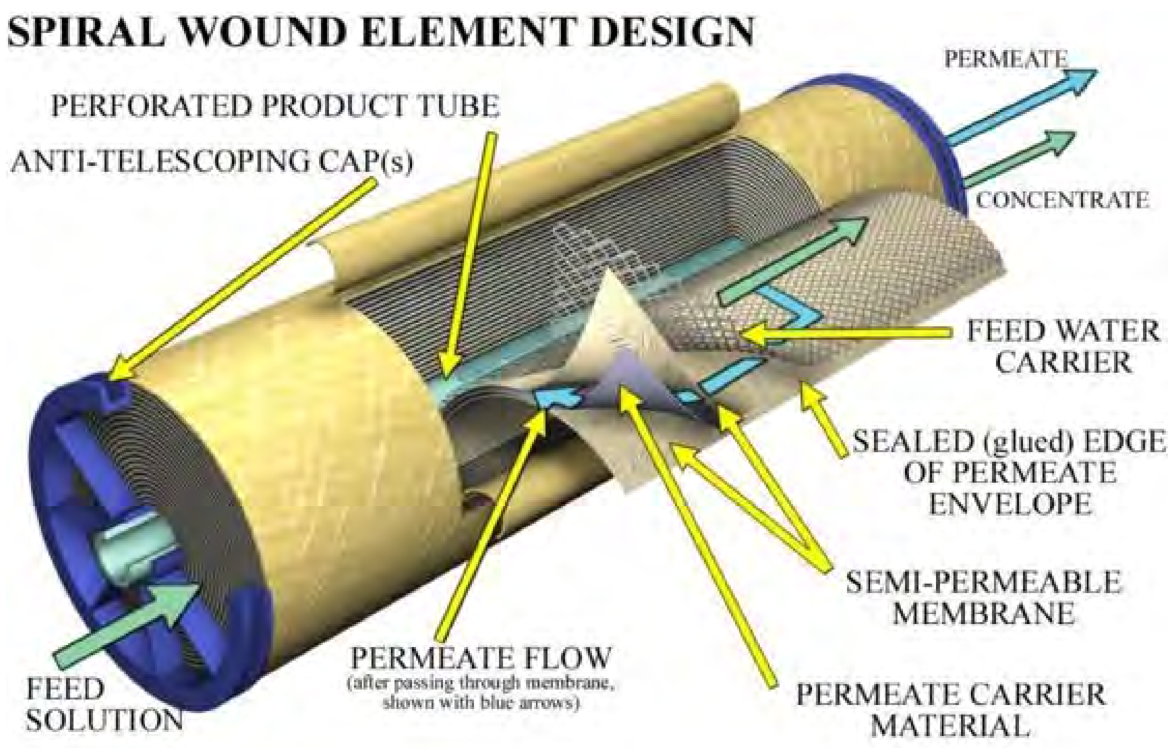
Total Estimated Project Costs: $42,378,000*

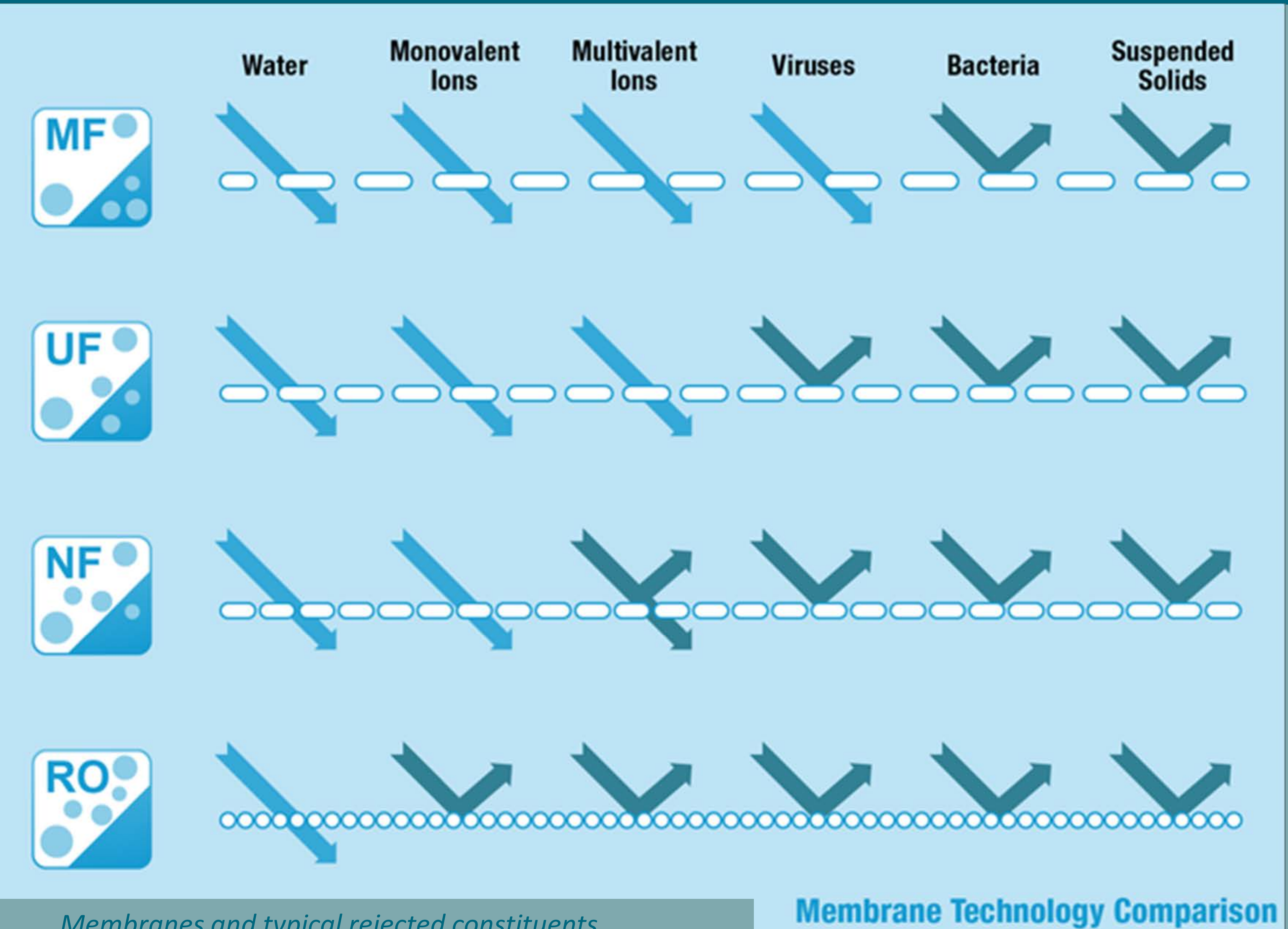
Questions?

fishbeck
Engineers | Architects | Scientists | Constructors

Membrane Softening – Introduction

- Membranes are semipermeable synthetic materials
- Depending on the type, they let certain constituents pass
  - Microfiltration
  - Ultrafiltration
  - Nanofiltration
  - Reverse Osmosis

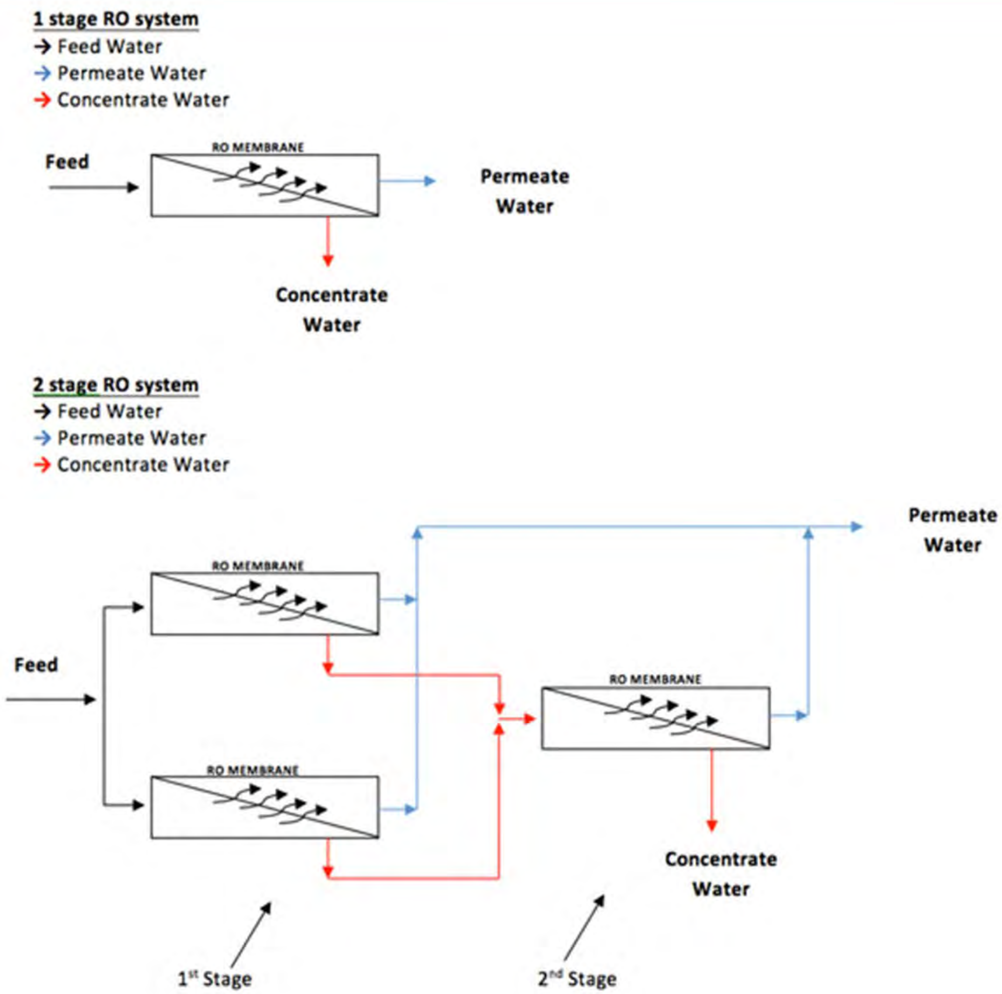




Membranes and typical rejected constituents

Membrane Types

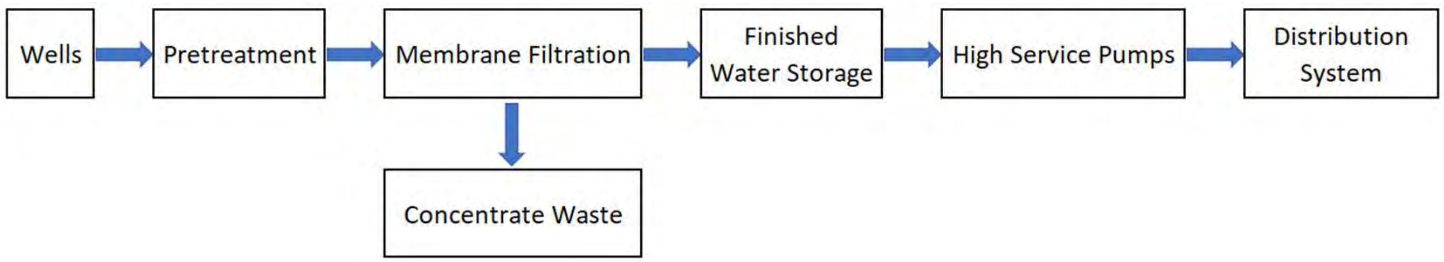
Membrane Softening – Introduction (cont.)



Single and Multistage membrane softening arrangements

- Often arranged in multiple stages
- Multiple stages reduce the volume of concentrate
- Concentrate is liquid waste stream
  - Requires disposal
- Increases the percentage of raw water recovery

Membrane Softening Process Overview



Membrane Softening Treatment Flow Path

Michigan State University WTP – Pressure Filters

Membrane Softening – Pretreatment

- Pretreatment Requirements
  - Required to prevent damage to membranes
  - pH adjustment and/or antiscalant
  - Turbidity <0.2 NTU
  - Filtration
- Pressure Filtration
  - Filters oxidized iron
  - Four initial filters, room to add additional in future
  - 6.5 MGD capacity

Membrane Softening – Pretreatment (cont.)

- Cartridge Filters
  - Provide an additional layer of filtration
  - Ensure softening membranes are protected and unfouled
- Intermediate Pumping
  - Ensures operating pressures are met for membrane filters

Harrison (OH) WTP – Cartridges and Filter Vessel

Membrane Softening – Filtration Skids

- Four skids initially
  - Arrays of pressure vessels
  - Each pressure vessel contains membrane elements
  - Firm capacity of 4.15 MGD
- Membrane Bypass
  - Mixes with filtered water
  - Maintains some hardness in the finished water
  - 0.85 MGD
- Firm Capacity of 5.0 MGD

Harrison (OH) WTP – Filter Skids

Membrane Softening – Finished Water Storage and High Service Pumping

- Similar to Lime Softening Rehab
- Two 0.75 MG prestressed concrete ground storage tanks
- High service pump station in separate building

Gratiot Area Water Authority (MI) – Pump Station

Membrane Softening – Project Cost Estimate

Description	Conceptual Construction Cost
Demolition	$560,000
Civil	$2,430,000
Building	$9,090,000
Process	$25,930,000
Mechanical	$2,250,000
Electrical	$9,000,000
Estimated Bare Construction Cost	**$49,260,000**
G.C. General (15%)	$7,390,000
Estimated Project Cost	**$56,560,000**
Design and Estimating Contingency (10%)	$5,670,000
Construction Contingency (10%)	$5,670,000
Expected Project Construction Cost	**$62,320,000**
Expected Project Construction Cost	**$67,990,000**

Conceptual Site Layout

Membrane Softening Plant Site Plan

Alternative Comparison – Current O&M

Lime Softening Plant

Description	Estimated Annual Cost
Labor Costs	$840,000
Chemical Usage	$250,500
Electrical Usage	$130,000
Lime Sludge Removal/Reuse	$350,000
Total Annual Operation and Maintenance Cost	$1,570,500

Membrane Softening Plant

Description	Estimated Annual Cost
Labor Costs	$590,000
Chemical Usage	$130,000
Electrical Usage	$320,000
Membrane Replacement Costs	$120,000
Total Annual Operation and Maintenance Cost	$1,160,000

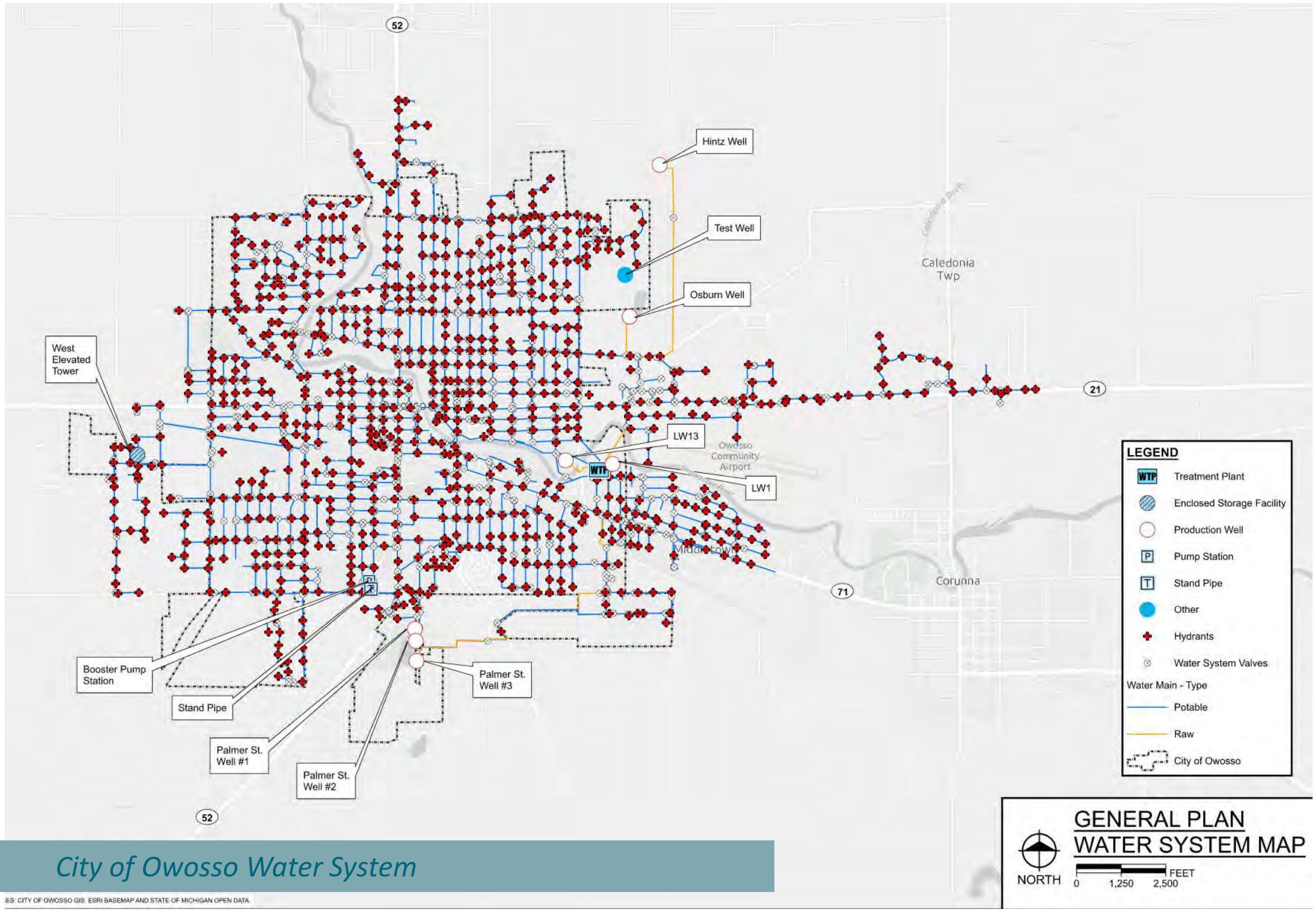
Questions?

fishbeck
Engineers | Architects | Scientists | Constructors

Reliability Study – Overview

- Historical Water Use
- Population and Water Demand Projections
- Water Supply/Water Storage Evaluation
- Water Distribution System Summary
- Hydraulic Model Development
- Water Distribution System Evaluation
- Recommended Improvements

General Plan



City of Owosso Water System

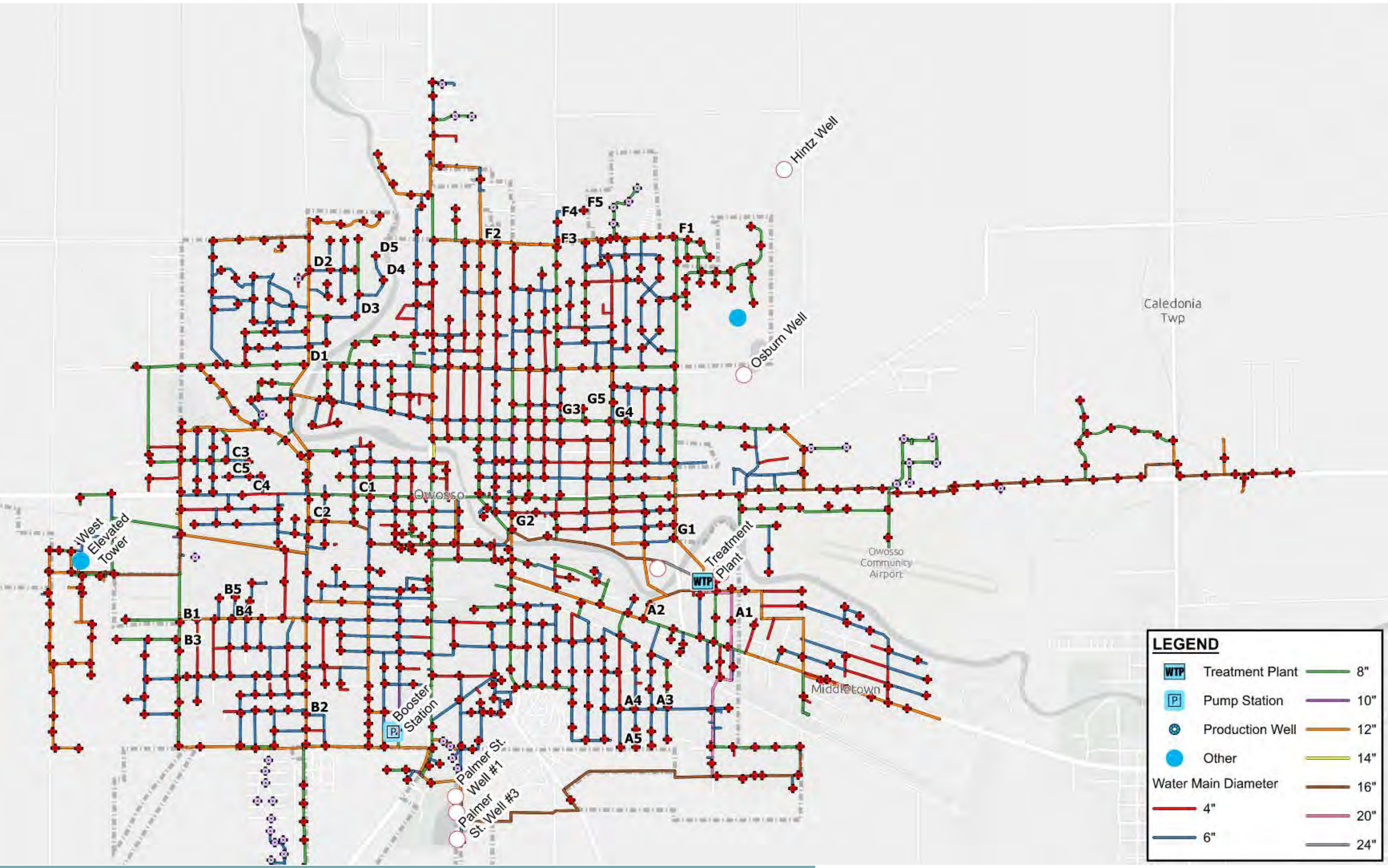
ES: CITY OF OWOSSO GIS, ESRI BASEMAP AND STATE OF MICHIGAN OPEN DATA.

Reliability Study – Hydraulic Model Calibration

- Hydrant Flow Testing
  - Seven tests
  - Five hydrants each test
  - Static and residual pressures
- Model Calibration
  - Adjust “roughness” of pipes
  - Account for closed valves and system conditions
  - Target ±3 psi

Typical Hydrant Flow Test

Hydrant Flow Tests

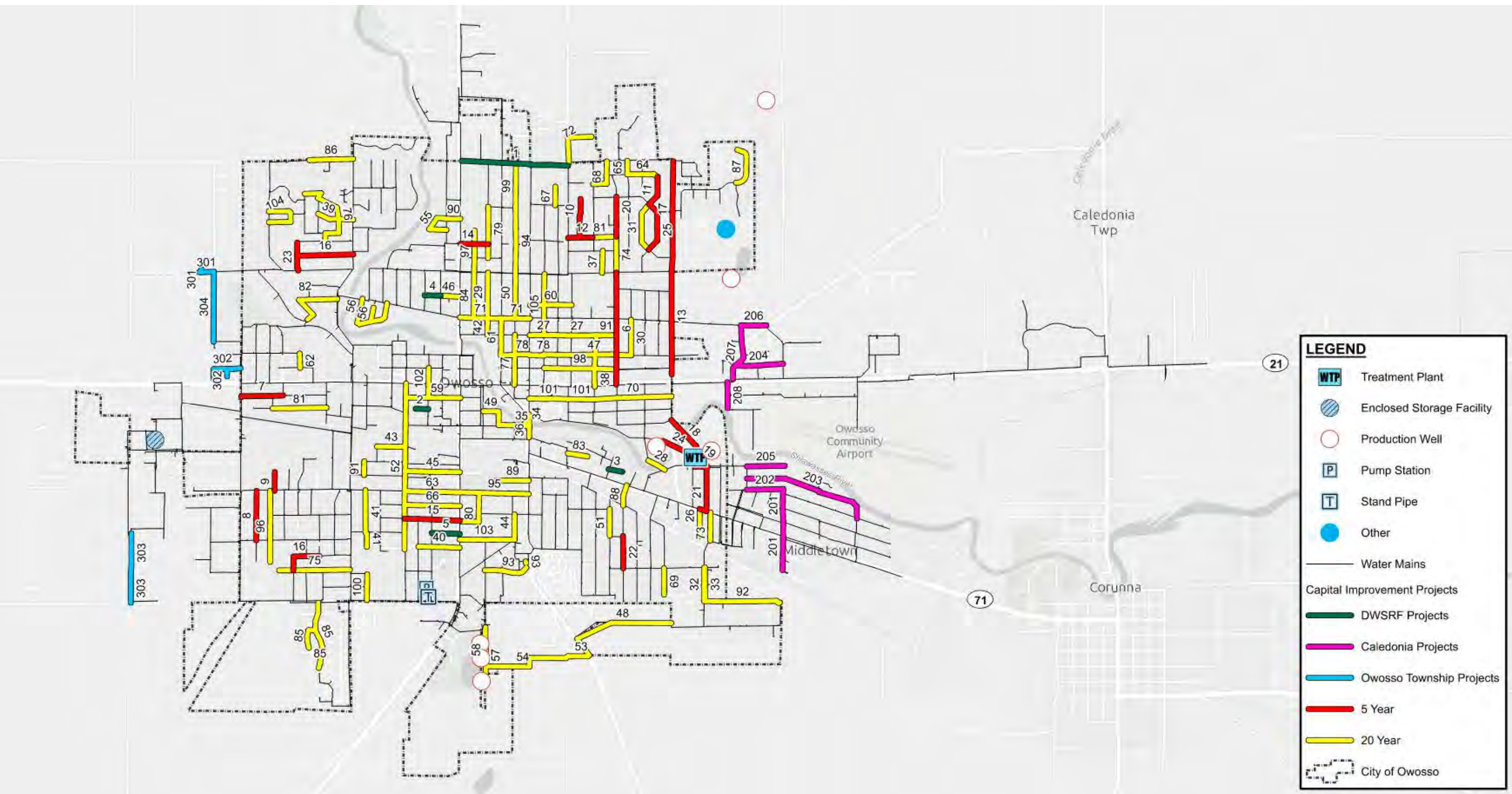


Overall Hydrant Flow Test Map

Reliability Study
Recommended Improvements

- 5-Year and 6-20-Year Improvements
- Prioritized based on water main age, impact to the system
  - Available fire flow, static pressures
- Raw Water Main, Caledonia and Owosso Township projects

Water System Capital Improvement Projects



Overall Capital Improvements Plan

Reliability Study – Project Cost Estimates

Description	Estimated Project Cost
5-Year Improvements	$11,866,000
6-20-Year Improvements	$32,855,000
Raw Water Main Improvements	$10,931,000
Total	$55,652,000
Caledonia Township Improvements	$4,050,000
Owosso Township Improvements	$1,885,000

Questions?

fishbeck

Engineers | Architects | Scientists | Constructors

Thank you!

fishbeck
Engineers | Architects | Scientists | Constructors

City of Owosso Water Treatment Plant Performance Evaluation

Project No. 221152
July 28, 2023

Engineers | Architects | Scientists | Constructors

fishbeck
Engineers | Architects | Scientists | Constructors

5913 Executive Drive, Suite 100
Lansing, Michigan 48911

517.882.0383 | fishbeck.com

Water Treatment Plant Performance Evaluation

Prepared For:
City of Owosso
Shiawassee County, Michigan

July 28, 2023
Project No. 221152

List of Tables

List of Figures

List of Appendices

List of Abbreviations/Acronyms

ADD	average day demand
AI	Aggressive Index
ATS	automatic transfer switch
BRE	business risk exposure
$CaCO_3$	calcium carbonate
CCPP	Calcium Carbonate Precipitation Potential
City	City of Owosso
CO_2	carbon dioxide
COF	consequence of failure
EGLE	Michigan Department of Environment, Great Lakes, and Energy
gpm	gallons per minute
HP	horsepower
HVAC	heating, ventilation, and air conditioning
IBC	intermediate bulk containers
KVA	Kilo-volt ampere
KW	Kilowatt
LSI	Langelier Saturation Index
MDD	maximum day demand
mgd	million gallons per day
mg/L	milligrams per liter
mm	millimeters
MOR	Monthly Operating Report
MTS	Maintenance Testing Specification
NEC	National Electric Code
NEMA	National Electric Manufacturer’s Association
NETA	InterNational Electric Testing Association
NFPA	National Fire Protection Association
NTU	nephelometric turbidity units
OSHA	Occupational Safety and Health Association
PHD	Peak Hour Demand
POF	probability of failure
psi	pounds per square inch
PVC	polyvinyl chloride
RI	Ryznar Index
SCADA	Supervisory Control and Data Acquisition
sf	square feet
VFD	variable frequency drive
WTP	water treatment plant

1.0 Executive Summary

The City of Owosso (City) retained Fishbeck in 2022 to complete a treatment performance evaluation for the City's water treatment plant (WTP). The purpose of this report is to summarize the results of the WTP inspection and evaluation, identify deficiencies based on current design standards and criteria, and to provide opinions of probable costs for recommendations for improvements.

The City owns and maintains a municipal water distribution system that supplies water to residents and businesses within the City and the City of Corunna, as well as portions of Caledonia and Owosso Townships. The WTP is a groundwater softening facility with a State of Michigan (State) rated treatment capacity of 3.0 million gallons per day (mgd). Raw water is currently supplied to the plant by four wells. The treatment process consists of aeration, lime softening, solids contact clarification, recarbonation, filtration, chlorination, and fluoridation. Water is conveyed to the distribution system from an underground finished water storage reservoir by high service pumps located in the plant. The City's WTP was originally constructed in 1941, and the last large-scale improvements to the plant were completed in 2004. The distribution system has an elevated storage tank, standpipe, and booster station.

Plant operational data from the last ten years was evaluated and compiled to analyze historical trends and to identify deficiencies in the treatment processes. Metrics including, but not limited to, plant influent and effluent flow, raw and finished water quality, chemical usage and dosing, and backwash and residuals volumes were compiled. Water demand projections were developed based on the plant pumping data and population projections to determine if existing processes could adequately meet future system demands. Table 1 summarizes the 20-year water demand projections including the average day demands (ADD), maximum day demands (MDD), and peak hour demands (PHD).

Table 1 – Water System Demand Projections

Year	ADD (mgd)	MDD (mgd)	PHD (mgd)
2022	1.55	2.51	3.76
2027	1.57	2.54	3.81
2042	1.63	2.64	3.96

In addition to historical data analysis, a physical inspection and condition assessment of the WTP and distribution system sites was performed by architectural, structural, electrical, mechanical, and process professionals to record observations and identify additional deficiencies.

Process deficiencies were mainly identified in processes that are original to the 1941 plant building. Many of these processes do not meet current standards and design criteria, including filtration, finished water storage, and high service pumping. Several other infrastructure deficiencies were identified as part of the WTP evaluation, including the plant's electrical grounding system and equipment, heating, ventilation, and air conditioning (HVAC) equipment, and the plant roof conditions.

Significant capital investment will be required to remedy the plant deficiencies. A list of prioritized projects has been prepared as part of an update to the City's Capital Improvement Plan. The projects on this list will remedy the identified system deficiencies and will allow the WTP to meet current design criteria and standards and improve the WTP's performance and reliability. Tables 2 and 3 present the total estimated project costs of these improvements, which are categorized as 5-Year and 6–20-Year projects, respectively. The combined total estimated cost for the 5-Year and 6–20-Year projects for the WTP improvements is $42,378,000.

Table 2 – Recommended 5-Year Capital Improvement Costs

Project Name	Estimated Project Cost
Filter Improvements	$1,960,000
Electrical Grounding Improvements and Improvements to Meet Code Requirements	$1,550,000
Fluoride Feed Improvements	$350,000
Roofing Replacement	$470,000
Filter Effluent Piping Replacement	$330,000
Well Houses Building and Mechanical Equipment Improvements.	$960,000
Aerator Improvements	$260,000
CO_2 Feed Panel Repair	$380,000
Lime Residuals Mechanical Dewatering	$11,520,000
WTP Site Improvements	$185,000
Gute Hill Booster Station Improvements	$834,000
Subbasement Sump Pump Improvements	$49,000
Building Material and Equipment Handling Improvements	$1,000,000
Filter Valve Improvements	$500,000
5-Year WTP Projects Total	$20,348,000
5-Year Distribution System Projects Total	$11,886,000

Table 3 – Recommended 6–20-Year Capital Improvement Costs

Project Name	Estimated Project Cost
New Reservoir and High Service/Transfer Pumping Building	$12,280,000
Building Improvements (Electrical, HVAC, Roofing)	$760,000
Chlorine Feed Improvements	$1,010,000
Lime Slaking Improvements	$5,180,000
SCADA/Controls Improvements Phase 1	$300,000
Juniper 2 Well Development	$750,000
Hintz 2 Well Development	$750,000
SCADA/Controls Improvements Phase 2	$1,000,000
6–20-Year WTP Projects Total	$22,030,000
6–20-Year Distribution System Projects Total	$32,855,000
6–20-Year Raw Water Main Projects Total	$10,931,000

2.0 Introduction

The City WTP is a groundwater softening facility that has a rated capacity of 3.0 mgd. The WTP process includes aeration, lime precipitative softening, recarbonation, and filtration. The source water is conveyed to the WTP through six supply wells located in various areas of the City. The WTP is owned and operated by the City, which has provided a municipal water supply since the early 1920s. The WTP has received a number of improvements and expansions since the original construction, including the construction of the original WTP in 1934.

The most recent upgrade and expansion was performed in 2002 which added the lime softening process to the WTP which included construction of the aerator, solids contact clarifiers, and recarbonation. However, replacement and upgrades to existing equipment and structures are necessary, especially for a facility in operation for more than 80 years, to continue to produce quality water. Over time, deterioration of assets affects performance, operator flexibility, and reliability, which limits the overall capacity of the facility. This report assesses the condition of the existing equipment to determine which components need to be replaced to meet current critical demands and water quality, identifies potential improvements that will enhance performance and reliability, and addresses future capacity increases. Based on the findings from the condition assessment summarized in Sections 4 and 5, alternatives were developed to replace deteriorated equipment and enhance performance and operation. Alternatives to expand the capacity of the WTP, including costs and other factors related to the overall condition and operation of the WTP, are developed in Section 5. Section 6 summarizes the overall costs and provides a suggested Capital Improvement Plan to implement the recommended improvements.

3.0 Water Demand Projections

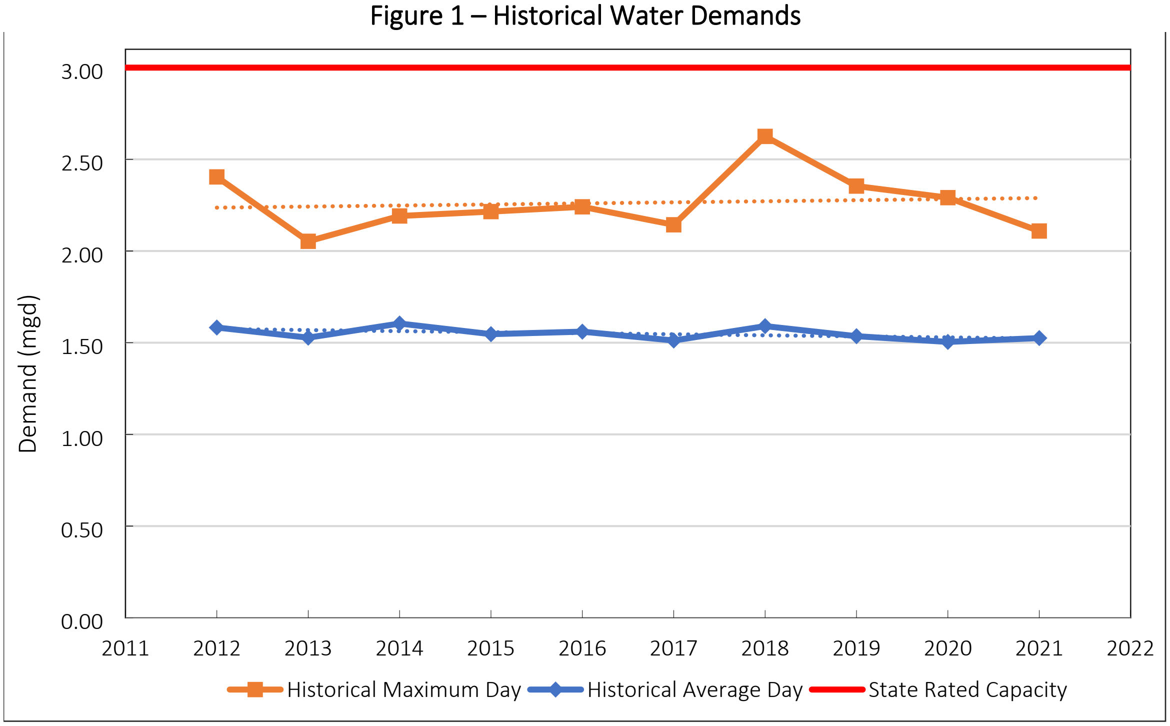
The following section includes a discussion regarding the water demand projections for the City. Fishbeck is currently finalizing the City's 2023 *Water System Reliability Study and General Plan Update* and this section is a summary of the findings related to water demands.

3.1 Historical Water Use

The City's WTP monthly operating reports (MORs) were utilized to analyze historical water use for the past 10 years. The ADD is the average daily volume of water pumped to the system in one year, while the MDD is the maximum amount of water pumped to the system in a single day, annually. The ADD and MDD were determined and calculated for years 2012 to 2021; the historical demands are shown in Figure 1 where they are compared to the state rated capacity of 3 mgd.

ADD has remained stable over the past decade, while the MDD has shown more variability which is typical of most water systems. The MDD has been getting close to the stated rated treatment capacity.

Figure 1 – Historical Water Demands



The PHD is not currently measured by the City; a typical peaking factor of 1.5 for a municipal system was used to estimate PHD for this study. Detailed calculations of the historical ADD, MDD, and peaking factor are described in the *Water System Reliability Study and General Plan Update* being finalized by Fishbeck in 2023

3.2 Water Demand Projections

Historical demands have remained consistent over the past decade even though the population has declined by 0.4% annually between 2010 and 2020. Therefore, applying per capita water use and population projections to water demand projections is not recommended, since historical demands do not closely correlate to population changes. To be conservative, a growth rate of 0.25% annually was applied to projected water demands.

To project future water demands, the starting point for the ADD was estimated by using the average ADD from 2012 to 2021 of 1.55. The MDD was calculated by multiplying the ADD by the 95th percentile peaking factor of 1.62. The peaking factor is the ratio of the MDD demands to the ADD. This value is used to show the variability in demands experienced by the water system. The PHD was calculated by multiplying the MDD by the peak hour factor of 1.5.

Table 4 indicates the projected water demands for the ADD, MDD, and PHD through 2042. For a detailed description of how the projected water demands and population projections for the City were estimated, see the *Water System Reliability Study and General Plan Update* being finalized by Fishbeck in 2023.

Table 4 – Projected Water Demands from 2022 to 2042

Year	Projected ADD (mgd)	Projected MDD (mgd)	Projected PHD (mgd)
2022	1.55	2.51	3.76
2027	1.57	2.54	3.81
2042	1.63	2.64	3.96

MDD:ADD Peaking Factor = 1.62
Peak Hour Factor= 1.5

4.0 Condition Assessment

Fishbeck staff, comprised of professionals specialized in the areas of process, structural, architectural, mechanical (HVAC and plumbing), electrical and instrumentation design, reviewed the treatment plant equipment and plant operations and performed site inspections of the plant and many of the raw water wells associated with the distribution system. The assessments were performed in August 2022. The assessments consisted of a visual inspection of key process equipment and discussions with City staff regarding the equipment.

4.1 Electrical Condition Assessment

4.1.1 Existing Conditions

The City WTP receives two medium-voltage (8,320Y/4,800-volt, 3-phase) primary electrical services from the local utility company (Consumers Energy). Primary circuits run to the site overhead, presumably via independent routes from separate utility substations. One service is referred to as the Stewart Circuit and the other is the Oakwood Circuit. There appear to be pole-mounted primary disconnect switches on each overhead service. The switch on the south service may be missing several parts that would allow it to be operated from grade. The switch on the north service appears to be intact. Consumers Energy meters each service via pole-mounted primary metering equipment (current transformers and potential transformers.

There are two banks of pole-mounted transformers that step power down to 480-volts, 3-phase. The City is on a primary rate schedule with Consumers Energy, so they own and are responsible for maintaining the transformer banks and primary switches. Each transformer bank is 500 Kilo-volt ampere (KVA) and consists of (3) 167 KVA transformers. The transformers appear to be connected in a delta configuration and are pole-mounted to keep them out of the 100-year floodplain.

480-volt, 3-phase, 3-wire power is routed from each transformer bank underground to a double-ended, 800-amp switchboard that includes a main-tie-main circuit breaker configuration. The main and tie circuit breakers are kirk-key interlocked to prevent paralleling. Each main and tie circuit breaker is 3-pole, 600-amps. The WTP typically operates with both main circuit breakers closed and the tie opened.

A 300 Kilowatt (KW) standby diesel generator with sub-base fuel storage tank is provided on the Oakwood circuit ahead of the double-ended switchboard. A 3-pole automatic transfer switch (ATS) is used to switch between utility and generator during power outages.

From the double-ended switchboard, circuits are routed to distribution panels MDP, MDP-R, and MDP-L. Panel MDP is normally on the Stewart Circuit and Panels MDP-R and MDP-L are normally on the Oakwood Circuit. Panels MDP-R and MDP-L are connected as a common panel via feed-through lugs. Panel MDP feeds High Service Pump Nos. 1 and 2 (150 horsepower [HP] each). Significant loads on Panels MDP-R and MDP-L include High Service Pump Nos. 3 and 4 (150 HP each), MCC-1, Washwater Pump Nos. 1 and 2 (40 HP each), Air Compressor Nos. 1 (15 HP), 2 (25 HP), and 3 (25 HP), sump pump, welder, autoclave, Panels DP4 (Well 1) and DP5 (Rapid Mix Room), several step--down transformers/panelboards, and HVAC equipment. Panels MDP, MDP-R, and MDP-L do not include main circuit breakers; they are protected by the 3-pole, 600-amp main circuit breakers in the double-ended switchboard.

MCC-1 includes a 3-pole, 400-amp main circuit breaker. It is fed via a 3-pole, 250-amp feeder circuit breaker in Panel MDP-L. Loads on MCC-1 include the lime silo, carbon dioxide (CO_2) storage tank control panel, (2) aerator blowers, (4) solids contact clarifier drives, (2) sludge pumps, HVAC equipment, and step-down transformer/panelboard.

4.1.2 Observations

According to the July 2022 electric bill for the WTP, the maximum historical demand at the WTP is 191 KW and the power factor is 0.95. The existing pole-mounted transformer banks are 500 KVA each and appear to be newer. Each bank should be capable of handling the historical maximum demand on a single service. That does not necessarily mean each transformer bank can handle the total connected load on a single service; that would require further investigation beyond the scope of this facility condition assessment.

4.1.2.1 <u>Grounding</u>

The configuration of the WTP grounding system is suspect. Following are several observations:

- A grounding connection on the pole with the north transformer bank appears to be broken (disconnected). The connection is supposed to bond the transformers to a driven grounding electrode (rod) at the base of the pole. The connection on the pole with the south transformer bank appears to be intact.
- Because each transformer bank is 3-wire and connected in a delta configuration, there are no neutral (grounded) connections between the transformers and plant power distribution system. There are no return paths for fault currents so overcurrent protective devices (i.e., fuses and circuit breakers) may not trip on faults and short circuits.
- It appears that individual equipment grounding conductors are not provided between the transformers and power distribution equipment. Instead, rigid steel conduits are used as the equipment grounding conductors. This means fault currents likely ‘bleed to ground’ as they try to return to their source (the pole-mounted transformers). Fuses and circuit breakers may not trip on faults and short circuits.

- The grounding of the generator could not be confirmed and there does not appear to be an equipment grounding conductor between the generator and ATS.
- There does not appear to be a grounding electrode connection to the WTP water service as required by the National Electrical Code (NEC).
- Equipment grounding conductors have not been provided in individual feeder and branch circuits as required by the NEC. Instead, cable trays are bonded to a main grounding bus next to the double-ended switchboard. It appears that the cable tray is used as a common equipment grounding conductor. Fuses and circuit breakers may not trip on faults and shorts. Fault currents that pass through the cable trays can impact other equipment whose feeder and branch circuits are routed via the cable tray.
- There appears to be one or more grounding electrodes (rods) outside the WTP building in the vicinity of the generator, near where the underground 480-volt conduits from the pole-mounted transformers enter the building. It is unclear if the rods are bonded to other items that are required to be bonded together (per the NEC) to form a grounding electrode system.
- The building grounding electrode system is supposed to include connections to the pole-mounted primary switch grounding electrodes, pole-mounted transformer grounding electrodes, building water service, effectively grounded building steel, and power distribution system grounding electrodes. The exact configuration of the grounding electrode system could not be verified.
- Equipment grounding conductor and grounding electrode conductor sizes may be smaller than what is required by the NEC.
- Dry-type, step-down transformers inside the WTP appear to be grounded (bonded) at their disconnects and transformers themselves. Per the NEC, they are supposed to be bonded at only one location.
- Improper grounding can have detrimental effects on electrical and electronic equipment.

4.1.2.2 Electrical Equipment

Plant staff are suspect of the reliability and operability of the main and tie breakers and kirk-key interlocks in the double-ended switchboard. This equipment is over 40 years old and has outlived its rated (useful) life.

Recently, two newer variable frequency drives (VFDs) that controlled Washwater Pump Nos. 1 and 2 failed. The VFDs were sent back to the manufacturer (Schneider Electric/Square D) for forensic analyses to determine the cause of the failures. An older high service pump motor also failed at approximately the same time. The VFDs were placed back in operation in March 2023, and the WTP now has a contract in place to install additional electrical protection for the VFDs.

There does not appear to be any surge protection on the double-ended switchboard or Panels MDP, MDP-R, or MDP-L.

Even after the Supervisory Control and Data Acquisition (SCADA) upgrade project, High Service Pump No. 1 will still be controlled via an older motor starter. A VFD could be provided for that pump to match the others. Consideration could also be given to including bypass contactors (i.e., across-the-line motor starters) on strategic motors controlled via VFDs. Bypass contactors can be used to start and stop pumps should a VFD fail.

There are no arc flash warning labels or electrical testing stickers on any of the existing power distribution equipment at the plant. Warning labels are required per Occupational Safety and Health Association (OSHA) regulations and National Fire Protection Association (NFPA) 70E – Standard for Electrical Safety in the Workplace, to identify incident energy levels and certain boundaries to warn qualified personnel that may work on electrical equipment while energized. A short circuit and protective device evaluation, coordination study, and arc flash risk assessment should be performed (possibly as a separate project) to meet OSHA regulations. At a minimum, the studies should be performed and equipment labeled as part of the next significant electrical project. NFPA – 70E also requires arc flash risk assessments to be updated at intervals not exceeding every 5 years.

Electrical equipment should be periodically inspected, cleaned, and tested in accordance with the InterNational Electrical Testing Association's Maintenance Testing Specification (NETA MTS). NETA MTS testing, including infrared thermographic scanning, should be performed every 3 to 5 years as part of following industry best practices for operating and maintaining electrical equipment. Infrared thermographic scanning equipment is available in-house for the WTP.

4.1.3 Recommendations

Following are options that could be implemented to potentially improve the overall reliability of the electrical power distribution.

4.1.3.1 Double-Ended Switchboard Replacement

A double-ended switchboard with two 3-pole, 600-amp main circuit breakers; 3-pole, 600-amp tie circuit breaker; and corresponding kirk-key interlocks to replace the existing switchboard is recommended. It is assumed the existing pole-mounted transformer banks would be reused along with the downstream distribution panels. The new switchboard should be service entrance rated, suitable for use on a 3-phase, 4-wire power distribution system, and include integral surge protection on each side.

4.1.3.2 Improvements to Meet Code Requirements and Industry Best Practices

4.1.3.2.1 Replace Pole-Mounted Gang-Operated Primary Switch on South Service

Replacing the pole-mounted, gang-operated primary switch on the south service is required to meet NEC requirements related to customer-owned service disconnects.

4.1.3.2.2 Upgrading Pole-Mounted Transformers and Building Services to 480-volt, 3-phase, 4-wire (Grounded Services)

Replacing both banks of pole-mounted transformers and the associated conduit and wiring between the transformers and building would provide grounded services to the WTP, ensuring that fuses and circuit breakers trip properly. The new services would include grounded (neutral) and equipment grounding conductors. It is assumed that the existing double-ended switchboard would be replaced separately.

4.1.3.2.3 Modify Grounding Electrode System

Modifying the grounding electrode system to include driven electrodes at the pole-mounted primary switches, pole-mounted transformers, and building along with connections to WTP water service and effectively grounded building steel is recommended.

4.1.3.2.4 Modify Feeder and Branch Circuits to Include Equipment Grounding Conductors

Modifying feeder and branch circuits (greater than 100-amps) to include appropriately sized equipment grounding conductors is recommended.

4.1.3.2.5 Add Surge Protective Devices

Adding surge protective devices to Panels MDP, MDP-R, and MDP-L is recommended.

4.1.3.2.6 Generate Warning Labels Per NFPA 70E

A short circuit and protective device evaluation, coordination study, and arc flash risk assessment should be performed, and arc flash warning labels generated to meet OSHA regulations and NFPA 70E requirements. Performing the required studies involves detailed field investigations, gathering data and specifications for the existing electrical equipment, generating a site-specific one-line diagram, developing a computer model of the power distribution system, and producing arc flash warning labels for each piece of equipment required to be labeled.

4.1.3.2.7 NETA Testing

It is recommended that electrical equipment be periodically inspected, cleaned, and tested in accordance with the NETA MTS. NETA testing, including infrared thermographic scanning, should be performed every 3 to 5 years.

4.1.3.3 Add High Service Pump VFD

4.1.3.3.1 Add VFD with Bypass Contactor to High Service Pump No. 1

Adding a 150 HP VFD with 3-pole, 250-amp circuit breaker disconnect and NEMA Size 5 full-voltage, non-reversing bypass contactor in a NEMA 12 enclosure for High Service Pump No. 1 is recommended if the new proposed high service pump station is not constructed. It is assumed that existing pump and motor would be reused. Addition of a third VFD on the high service pumps would allow for more operational flexibility at the WTP, which is useful as the City has noted interest in operating the plant unattended during third shift.

4.2 Mechanical Condition Assessment

4.2.1 Existing Conditions

4.2.1.1 Well Houses

The well house HVAC equipment for Well House 1 and Well House 13 are both in fair condition. Both of these well houses have a permanent unit heater and screens located in the door for intake air. The Hintz Well House was rehabilitated in 2019, and the HVAC equipment has most of its serviceable life left. This well house contains an electrically actuated damper and louver, and permanent wall mounted unit heater.

The HVAC equipment at both the Osburn Well and Palmer Street Well 2 are in poor condition. At the Osburn Well, the permanent unit heater is no longer working, and a portable electric unit heater has been installed. Air intake louvers located in the door of this well house are heavily corroded and beyond their useful lives. At Palmer Street Well 2, the intake louver does not have any dampers installed. A wooden board is used to cover the louver inside the well house during cold weather. The unit heater and exhaust fans are both in poor conditions as well.

4.2.1.2 Water Treatment Plant

A number of aging and faulty pieces of HVAC equipment are located in the WTP. In July 2022, the City put out a request for bids for replacement of a number of these HVAC items. T.H. Eifert is currently under contract with the City to repair or replace the following items:

- Office roof top unit.
- Unit heaters in the docking area, hallway between the original and clarifier building, and clarifier room.
- Heating unit located in the clarifier pipe gallery.
- Tube heater in the high service pump room.
- Makeup air unit.
- Louver replacements in the clarifier room, filter room, and second floor.
- Inline exhaust fans located on the second floor.

In addition to the items already listed as a part of the July 2022 request for bids, the following mechanical equipment was noted as beyond its useful life or in poor condition by Fishbeck as part of the WTP evaluation:

- Louver L-4 located in the clarifier pipe gallery.
- Stormwater sump pump located in the subbasement is not operational.

- The three air compressors located in the compressor room are working but are likely beyond their useful service life.
- Unit heaters and wall fans located in the lime slaking room are covered in lime dust and are in average to poor condition.
- Sinks, plumbing, and drainage in the lab area are in poor condition.
- Locker room shower is not in use and has been converted into a mop storage area. Service sink in the locker room is in poor condition.

4.2.1.3 <u>Distribution System Sites</u>

The mechanical equipment at the booster station near the standpipe is in average to poor condition. The electrical unit heater is aging and likely beyond its useful life. The louver atop the door for intake air is functional and should be maintained.

The unit heater located inside the elevated storage tank is in overall good condition.

4.2.2 Recommendations

4.2.2.1 <u>Well Houses</u>

Regular maintenance should continue to be performed at Local Well 1 and the Hintz Well to maintain HVAC functionality. It is recommended that HVAC equipment at Local Well 1 be replaced in the next 5-10 years should new equipment not be installed as part of the recommended full well house renovation (See 4.3.2.1.1).

As there are no short-term plans to decommission Palmer Street Well 2, rehabilitation of the HVAC equipment is recommended should new equipment not be installed as part of the recommended full well house renovation (See 4.3.2.1.5). It is recommended that a new louver and electrically actuated damper be installed to replace the existing louver. In addition, the exhaust fan and unit heater should be replaced as these units are likely beyond their serviceable lives.

As the Osburn Well is planned to be decommissioned by the City, full rehabilitation of the HVAC equipment is not recommended. Local Well 13 is also planned for decommission due to water quality issues. It is recommended that the appropriate regular maintenance is undergone at these wells to keep the HVAC equipment functional until the planned decommission is completed.

4.2.2.2 <u>Water Treatment Plant</u>

It is recommended that the items set for repair/replacement as part of the July 2022 request for bids be repaired or replaced as planned, if not done so already. It is recommended that the additional items listed in Section 4.2.1.2 be replaced in kind to ensure reliability and functionality of the HVAC equipment in the WTP.

4.2.2.3 <u>Distribution System Sites</u>

It is recommended that the electric unit heater located at the booster pump station near the standpipe be replaced.

4.3 Architectural and Structural Condition Assessment

4.3.1 Existing Conditions

4.3.1.1 <u>Well Houses</u>

4.3.1.1.1 <u>Local Well 1</u>

Overall, no major structural deficiencies were observed at Local Well 1. The metal siding and roof appear to be in good condition. Internal insulation is in okay condition and is showing signs of damage and age. The exposed wooden roof opening is in fair condition. Improvements to the Local Well 1 building are desired by the City as part of an effort to help standardize well house design.

4.3.1.1.2 Local Well 13

Overall, no major structural deficiencies were observed at Local Well 13. The exterior wood siding is in fair condition, and the perimeter fascia is showing wear. The roof system is asphalt shingles that is in poor condition. Internal insulation in the well house is in fair condition.

4.3.1.1.3 Hintz Well

Overall, no major structural deficiencies were observed at the Hintz Well. The building was recently constructed and is in good condition overall.

4.3.1.1.4 Osburn Well

Overall, no major structural deficiencies were observed at the Osburn Well. The exterior precast concrete wall panels are extremely weathered but appear to be stable. The joints may not be fully weatherproof anymore, but no remediation is likely required. The metal roof shows no issues currently and appears in good condition. The well house door is significantly corroded.

4.3.1.1.5 Palmer Street Well 2

Overall, no major structural deficiencies were observed at Palmer Street Well 2. The exterior metal panels have minor damage and corrosion. Metal roof panels also exhibit minor corrosion. The metal door and jambs also have minor corrosion. The interior concrete floor of the well house has noticeable degradation from process pipe leakage. Improvements to the Palmer Street Well 2 building are desired by the City as part of an effort to help standardize well house design.

4.3.1.2 Water Treatment Plant

4.3.1.2.1 General WTP Site and Building Observations

The WTP is comprised of two separate buildings. The original WTP is multi-storied and last saw improvements in 1941. The clarifier building on the east portion of the WTP site houses the pretreatment processes and was constructed as part of the WTP improvements in 2004.

WTP staff have noted the growing challenge to transport equipment and materials into and around the plant due to failure or removal of key pieces of equipment. In the original WTP building, these equipment pieces include removal of the elevator, failure of the overhead crane system in the high service/electrical rooms, and failure of the loading bay leveler. In the clarifier building, an overhead door is present, however, the door sits above grade and there is no existing system to easily transfer materials from exterior ground level to inside the building.

On the WTP Site, the parking lot was observed to be in OK condition. WTP staff have noted site drainage issues during storm events. The backwash/lime sludge lagoons are only partially enclosed by a security fence. This was noted by EGLE in the 2018 Sanitary Survey. WTP staff have also noted that the existing equipment storage shed is too small and does not meet the current operational needs of staff onsite.

4.3.1.2.2 Roof

Roofing sections on both the original building and the clarifier expansion are in poor condition and significant buckling is present.

4.3.1.2.3 Exterior Walls

At the original WTP building, mortar joints are starting to wear out. In addition, concrete spall was observed in the entry stairs, and the railing support is compromised at the southwest corner of the lower step. The coating on the blocks of the clarifier building addition is beginning to peel. No major structural deficiencies were observed.

4.3.1.2.4 Interior Walls

In the original building, cracks were present on the second and third floors. Lintels over the doors and windows on the third floor were corroded. Significant paint peeling and corrosion of all lintels were present in the filter room. Three joints had deep spalls in the filter pipe gallery, approximately 15 cubic feet.

In the clarifier building addition, full height concrete masonry unit cracks were observed in the northeast and northwest corners of the clarifier room. Concrete spalling was also observed near the doorway to the clarifier room.

4.3.1.2.5 Interior Ceilings

Overall, no major structural deficiencies were observed. Spalling was observed throughout ceilings in the original building, including:

- High service pump room, approximately 15 cubic feet.
- High service pipe gallery, approximately 10 cubic feet.
- Filter pipe gallery, around pipe penetration, approximately 5 cubic feet.

In addition, leaking cracks were observed in the ceilings of the second floor (approximately 10 linear feet) and the compressor room (approximately 15 linear feet). Drop ceiling tiles in the lab/office area are in okay condition showing signs of wear and water damage.

4.3.1.2.6 Windows

Windows on the original building are extremely faded at the frames with multiple instances of internal condensation due to leaking seals.

4.3.1.3 Distribution System Sites

No major structural issues were observed at the booster pump station, standpipe, and elevated tank. Some efflorescence is visible on the wall surfaces of the booster pump station. Some minor corrosion is present on the door of the exterior door and jamb.

4.3.2 Recommendations

4.3.2.1 Well Houses

4.3.2.1.1 Local Well 1

Fishbeck is in agreement with the City that the well house building for Local Well 1 should be replaced with a new building to meet the City's standard well house design. Should a full replacement not occur, it is recommended that the existing roof be cleaned and coated to maintain waterproof integrity. The damaged internal insulation should be removed and replaced to maintain to the R-value of the envelope. Exposed wood should be coated to prevent rot.

4.3.2.1.2 Local Well 13

As Local Well 13 is planned for decommission by the City, it is recommended that regular maintenance is undergone to keep the well functional until decommission is complete. Should plans change and Local Well 13 no longer becomes slated for decommission, the roof should be replaced due to its poor condition. Additionally, the wood siding and perimeter fascia should be cleaned and coated to prevent rot.

4.3.2.1.3 Hintz Well

No recommendations are available for this as the well house was recently constructed and is in good condition.

4.3.2.1.4 Osburn Well

As the Osburn Well is planned for decommission by the City, it is recommended that regular maintenance is undergone to keep the well functional until decommission is complete. Should plans change and the Osburn Well no longer becomes slated for decommission, the metal door should be cleaned and coated to remove corrosion. Some of the precast concrete panels may need to be repaired in the future to ensure enclosure integrity.

4.3.2.1.5 Palmer Street Well 2

Fishbeck is in agreement with the City that the well house building for Palmer Street Well 2 should be replaced with a new building to meet the City's standard well house design. Should a full replacement not occur, the corrosion on the exterior panels and roof should be cleaned and coated to maintain aesthetics. Coating the roof will also reduce water intrusion. The metal door and jambs should also be cleaned and coated.

4.3.2.2 Water Treatment Plant

Several improvements are recommended to correct the equipment/materials handling issues at the plant. These recommendations include replacement of the existing overhead crane system in the original WTP building, replacement of the loading bay leveler and design and addition of a system at the clarifier building overhead door to allow transport of materials from the exterior. It is also recommended that the WTP parking lot be rehabilitated and that backfill is placed around the original WTP building to correct site drainage. In addition, the existing equipment storage shed should be replaced and the security fence around the lagoons should be repaired and expanded to surround the perimeter of the area.

All roof sections on both the original building and clarifier addition need to be replaced. Based on the amount of buckling, full depth replacement of the insulation will be required. The replacement roof should be designed to ensure the insulation does not buckle again.

Exterior coatings of the block on the clarifier building addition and masonry joints on the original building should be rehabilitated. The coatings in both the clarifier and filter room should be rehabilitated to prevent chips entering the process. The windows at the original building should be considered for replacement in the next 3 to 5 years due to their poor condition.

4.3.2.3 Distribution System Sites

The exterior door and jamb at the elevated storage tank should be cleaned and coated to remove minor corrosion.

5.0 Process Evaluation

This section describes the conditions of the existing process treatment components that were observed on the site investigations and review of historical operating data and documents. Included within this section are preliminary conclusions and recommendations. These recommendations are focused on replacement of deteriorated equipment as well as improvements related to water quality and process capacity issues. These recommendations, along with enhancements and expansion alternatives, are described to determine the feasibility of implementing the recommendations and whether they fit within the long-term expansion plan for the WTP. Therefore, these recommendations may not necessarily be included in future plant maintenance and upgrades.

5.1 Water Quality

Table 5 summarizes raw and finished water quality characteristics for the Owosso WTP. The information presented in Table 5 is based on monthly average data provided by WTP staff for January 2012 through December 2021 via their MORs. While the information presented in Table 5 is based on monthly average values, and therefore does not reflect short-term variations in concentrations, plant operators indicate that both raw and finished water quality parameters typically do not exhibit significant variations, and that overall water quality has not changed appreciably since the period for which data was provided.

Table 5 – Water Quality

	Raw Water			Primary Clarifier Effluent			Finished Water		
Parameter	Average	Min	Max	Average	Min	Max	Average	Min	Max
Turbidity (NTU)	0.218	0.070	0.483	-	-	-	0.126	0.043	0.242
pH	7.13	6.73	7.41	11.1	9.9	11.3	8.82	8.44	9.09
Total Alkalinity (mg/L as $CaCO_3$)	365	286	397	63	45	109	44	24	93
Total Hardness (mg/L as $CaCO_3$)	500	458	594	192	149	271	173	137	243
Calcium Hardness (mg/L as $CaCO_3$)	323	294	381	128	98	180	104	77	151
Magnesium Hardness (mg/L as $CaCO_3$)	177	158	213	65	39	117	69	46	117
Iron (mg/L)	2.6	1.1	5.3	-	-	-	-	-	-
CO_2 (mg/L as $CaCO_3$)	22.7	2.5	71.2	-	-	-	-	-	-
Chlorine Residual (mg/L)	-	-	-	-	-	-	0.56	0.37	0.66
LSI	-	-	-	-	-	-	0.43	0.15	0.72

($CaCO_3$) calcium carbonate
(LSI) Langelier Saturation Index
(mg/L) milligrams per liter
(NTU) nephelometric turbidity units

The source water exhibits high concentrations of hardness and alkalinity, and precipitative softening with lime addition is therefore practiced, to produce an aesthetically acceptable treated water supply. Removal of the calcium hardness can be accomplished at a pH of approximately 9. But to remove magnesium hardness in the process, a pH of about 11 is necessary. Recarbonation of the softened water is available to adjust the finished water pH from about 11 to 9 prior to filtration. Lime consumption, as discussed in the next section of this report, is slightly higher to the dosage calculations when using the average alkalinity and hardness values from the MORs.

Finished water iron has a secondary standard of 0.3 mg/L and a recommended level of less than 0.1 mg/L. This is a non-enforceable standard but provides for improved aesthetics of the finished water. While the source water contains significant concentrations of iron, the treatment process reduces iron concentrations. Iron concentrations should be periodically measured at the tap to determine if there is iron removal occurring and the extent. While there currently are no specific requirements for the turbidity of the finished water for plants treating groundwater sources not subject to direct surface water influence, the turbidity of the filtered water for the period evaluated routinely is below the current allowable level of 0.3 NTU, for a minimum of 90% of monthly samples, for plants treating surface water supplies.

A corrosion prevention additive is not currently applied to the finished water leaving the plant, and the ability to inhibit corrosive degradation of distribution system piping and appurtenances through deposition and maintenance of protective $CaCO_3$ coatings is monitored through the calculation of the Langelier Saturation Index

(LSI). Calculation of this index provides an indication of the finished water's ability to deposit (or dissolve) protective $CaCO_3$ coatings. Other indices that can be used are the $CaCO_3$ Precipitation Potential (CCCP), Ryznar Index (RI), and Aggressive Index (AI). The following is a summary of the indices and the ranges of desired values.

- LSI: Values > 0 indicates water will deposit $CaCO_3$
  - Calculated Value: 0.43, (see Table 4)
- CCPP: 4 – 10 mg/L desirable
  - Calculated Value: 5.6
- RI: 4 – 5 (heavy scale), 5 – 6 (light scale), 6 – 7 (little scale to some corrosion), > 7 (corrosive)
  - Calculated Value: 6.5
- AI: < 10 (heavy corrosion), 10 – 12 (moderate corrosion), > 12 (non-corrosive)
  - Calculated Value: 12.9

These indices suggest that the finished water is oversaturated with $CaCO_3$ and should be capable of maintaining protective $CaCO_3$ coatings within the distribution system. However, this analysis is theoretical in nature and the actual extent of these coatings and verification of their presence should be confirmed when opportunity arises during water main or water service replacements.

Other parameters that the City may consider monitoring is the total dissolved solids (raw and tap) and the raw water temperature. These parameters can be used to get more accurate calculations of the indices listed above and help to estimate sludge production from the process. CO_2 measurements downstream of the aerator would be helpful to monitor the aerator performance and ensure that the majority of the CO_2 is not entering the clarifiers.

5.2 Chemical Feed Rates

Table 6 summarizes daily lime, fluoride, and chlorine feed dosages according to the MORs for the timeline between January 2012 through December 2021. Feed dosages were determined based on the indicated total pounds of chemical fed per day and the corresponding daily total raw water flow treated. Information on raw water and treated water flows is also included in Table 6.

Table 6 – Chemical Feed Rates and Plant Flow

Parameter	Average	Minimum	Maximum
Lime Dose (mg/L)	328	258	444
Chlorine Dose (mg/L)	2.97	2.00	5.00
Fluoride Dose (mg/L)	0.28	0.11	0.55
Plant Raw Water Flow (mgd)	1.69	0.84	2.90
Treated Water Flow (mgd)	1.55	0.90	2.63

5.3 Raw Water Supply

Since 2012, the City has utilized six different raw water supply wells. Of these six, the City currently has a total of four active supply wells. Three wells, Local Well 1 (LW-1), Hintz 1, and Palmer Street 2 (PS-2) serve as the primary production wells for the WTP. The water produced by these wells has a lower level of hardness, which makes treatment less expensive. The other active well, Local Well 13 (LW-13), is currently used as an emergency backup; however, the City has plans to eventually decommission this well. Palmer Street 3 (PS-3) was decommissioned in 2019. The Osburn Well was placed back in service in April after receiving repairs and cleaning following a screen failure. Figure 3 illustrates the locations of the existing wells.

Although there is some attempt to balance pump and motor usage, the current operation primarily consists of the operators selecting a combination of wells to achieve a desired flow rate. Runtime on wells is recorded but not monitored, and no pattern or method is employed in the rotation of pumping units. This results in uneven usage of wells. More combinations should be utilized along with a more consistent rotation of wells to even out usage between the wells. Table 7 summarizes the operating hours for each production well.

Table 7 – Supply Wells Production Hours

Well	Average Annual Operating Hours	Percent of Total Operating Hours
LW-1	6,800	33%
Hintz 1	3,140	15%
PS-2	5,300	26%
LW-13	5,010	24%
Osburn	370	2%
Total	20,620	100%

Specific capacity, which is a well's pumping rate in gallons per minute divided by the drawdown in feet, is typically used to indicate the efficiency and capacity of a well. A greater specific capacity means that the well is more efficient and productive. The specific capacity is a major indicator of a well's remaining useful life by evaluating the percent reduction in specific capacity over time between cleanings, and how the well responds to cleanings. Lower specific capacities typically require larger pumps to overcome the additional head lift required to pump the desired flow rate. It does not mean the well needs to be replaced, as higher draw down on the wells are acceptable provided the water level remains above the top of the screen and pump impellers. The City currently hires Northern Pump and Well to do the well evaluation and performance testing. The most recent testing took place in 2022. The specific capacity of the wells is determined during this testing. Table 8 summarizes the information for the existing wells, including the permit capacity, actual current production capacities, and specific capacities. Table 8 refers to data collected in 2022. This information is useful to track historical performance and can help predict future rehabilitation or replacement of the wells.

Table 8 – Current Supply Wells

Well	Year Installed	Last Rehab	Permit Capacity (gpm)	Current Production Capacity (gpm)	Current Production Capacity (mgd)	Specific Capacity (gpm/ft)
LW-1	Pre 1960	2021	700	403	0.58	29.1
Hintz 1	1968	2019	730	482	0.69	54.9
PS-2	1963	2014	757	722	1.04	48.3
LW-13	1955	2016	750	482	0.69	132.5
Osburn	1968	2023	722	570	0.82	139.1
Total Capacity			3,659	2,659	3.83	
Firm Capacity			2,902	1,937	2.79	

Additional hydrogeologic investigations are required to determine the impact on overall well field capacity at wells with low specific capacities, but initial review of the historical draw downs and current groundwater levels shows that most of the wells have water levels significantly above the top of the screen. The total capacity of the five operational wells is 3.83 mgd. The firm capacity, or the capacity with the largest well out of service, is 2.79 mgd.

Overall, the pumping equipment in the wells was found to be in good to fair condition. A summary of the condition of the process equipment at each well is found below, including information on pumping equipment obtained from the 2022 well maintenance and inspection report performed by Northern Pump & Well.

- LW-1: Pump capacity decreased over 30% from 2020 tests. Recommended to remove the pump and tear it down for inspection.

- Hintz 1: Magnetic flowmeter needs to be connected to SCADA. No work on the well needed at this time.
- PS-2: Minor corrosion and paint failure on the process piping. Leaking process piping and condensation have degraded the concrete floor. The well is operating efficiently, and no work is needed at this time.
- LW-13: Significant corrosion on the base of the discharge head of the well pump. The specific capacity is down by 10% from previous testing and it is recommended that the well is cleaned and the pump is rebuilt.
- Osburn: Minor corrosion and paint failure on the process piping. Well is operating as expected.

5.3.1 Recommendations

Based on the water demand projections, the City's MDD in 2042 of 2.62 mgd will exceed the current firm well capacity. Michigan Department of Environment, Great Lakes, and Energy (EGLE) generally requires that communities begin planning for an expansion of their supply system when the MDD exceeds 80% of the firm supply capacity of the water system.

The City has been testing and is planning to develop two additional wells in 2023. One well will be constructed near Juniper Street, the other will be constructed near Palmer Street to replace the decommissioned PS-3. If the Osburn Well and LW-13 are decommissioned permanently, the two new wells at Juniper Street and Palmer Street will need to increase the firm capacity of the system to approximately 3.3 mgd to meet the 80% firm capacity target based on the projected 2042 MDD. Additional supply wells are recommended to be developed if the new wells at Juniper Street and Palmer Street are not able to raise the firm capacity of the supply system to the 3.3 mgd target.

5.4 Aeration

The aeration system is comprised of a single aluminum induced draft aerator that reduces CO_2 and hydrogen sulfide levels and oxidizes iron and manganese in the raw water. The aerator sits on a concrete platform on the north exterior of the clarifier building. The aerator is fed by a single 20-inch raw water line that enters the clarifier building on the lower level before running vertically through the concrete platform and to the top of the aerator. The aerator has 66 trays and was installed in 2004 with a design flow of 3.0 mgd and a total capacity of 6.0 mgd. The City noted that at flows above 3.0 mgd, there is a concern that water may leak out the side vents of the aerator due to clogging/fouling of the unit. The existing aerator should be hydraulically tested to ensure that it can meet the 6.0 mgd maximum capacity that it is rated for.

Using aeration in the treatment process reduces the CO_2 which in turn reduces the both the lime dosage and the sludge generated. These reductions have direct results on the chemical costs and the cost to dispose of lime sludge. The original design of the aerator is to provide 70% removal of CO_2 for a flow rate of 6 mgd for raw water CO_2 concentrations of up to 90 mg/L. The media is intermediate trays consisting of slat-style, 1-1/4-inch, schedule 20 polyvinyl chloride (PVC), supported by stainless steel grids. The two exhaust blowers have an air flow capacity of 10,800 standard cubic feet per minute. This results in an air-to-water ratio of 2.59 which is acceptable.

The average CO_2 levels in the wells are approximately 22.7 mg/L as $CaCO_3$. This amount of CO_2 will theoretically utilize approximately 38 mg/L of lime to remove. It will also produce approximately 51 mg/L of solids. Performance testing of the aerators is recommended to evaluate CO_2 removal rates.

Although increasing the removal efficiency of the existing aerator may be difficult, there are some potential options that can increase the removal efficiency. A cost-benefit analysis should be performed prior to any improvements made to the aerators as the potential chemical and sludge disposal savings may not outweigh the capital costs. One option for higher removal efficiency may be to install higher density media. Another option is raising the aerator height, as this gives it more detention time which results in higher oxygen transfer. These options can be evaluated with aerator manufacturers to determine if these improvements can increase CO_2 removal efficiency.

The interior of the aerator is heavily corroded and is in very poor condition. Corrosion and deposits of sediment have built up inside both the top inlet distributor and in the PVC slats. Additionally, it was noted during the inspection that moderate corrosion is occurring on the 20-inch effluent pipe as well as the aerator base, legs, and concrete pad that the aerator is mounted to.

5.4.1 Recommendations

An annual cleaning is planned for the aerator. Fishbeck concurs with the need for this. The aerator unit is recommended to be replaced in the 5-year planning period. It is recommended that the existing aerator be replaced with two units that can meet the required maximum capacity of 6.0 mgd when both are running. The aerator units would be smaller and easier to maintain and could also be taken down for maintenance while still providing aeration.

5.5 Clarification

Post-aeration, water flows to two upflow solids contact clarifiers, installed in 2004. These are US Filter Type C Contraflo clarifiers. Flow enters the basins through a common effluent line from the aerator. Flow can be split evenly between the clarifiers and the flow is measured using influent magnetic flow meters. For much of the year when the water demands are lower than 3.0 mgd, the clarifiers are operated in series with clarifier no. 1 being the primary and clarifier number 2 being the secondary. Clarifier no. 2 has a secondary inlet to achieve this purpose. While operating in series, an average of 7% of aerated water bypasses the primary clarifier and mixes with the secondary clarifier influent.

The primary function of the mixing equipment within the reaction zone of a solids contact clarifier is to (a) promote contact between the lime and the incoming raw water, and (b) promote agglomeration of softening precipitates into larger particles which will settle rapidly. When this is accomplished, both required lime dosages and the turbidity of the resulting settled water at that basin discharge are minimized. The clarifier is designed for an internal solids recirculation rate of 12,500 gpm which results in increased performance of generating settleable solids which decreases the required lime dosage. The internal slurry recirculation is designed to develop a “sludge blanket” within the basin. All the water exiting the center mixing/reaction zone is forced to flow through this “blanket” of softening precipitates. This creates a large settling zone that increases the removal efficiency and provides for less solids in the effluent. This also requires a high torque rating on the solids collection rakes to move through the settled sludge.

A comparison of theoretical vs. actual lime consumption was prepared using the monthly average raw and finished water quality and lime feed data summarized in Tables 4 and 5. A lime purity of 90% was assumed for these calculations. It is also assumed that the aerator removal efficiency for CO_2 is 50%. Results of this comparison are summarized in Table 9. The WTP doses slightly more lime (~10%) than what is theoretically necessary for the hardness being removed.

Table 9 – Theoretical vs. Actual Lime Dosages

Dosage Type	Average	Min	Max
Calculated Lime Dose (mg/L as $CaCO_3$)	299	201	402
Actual Lime Dose (mg/L as $CaCO_3$)	328	258	444

While it is recognized that comparison of actual lime feed requirements with theoretical (calculated) requirements is an inexact process (due to difficulties in accurately tracking lime feed rates), actual lime dosage exceeds theoretical requirements by an average of 10 percent over an extended evaluation period. Although there may be potential for reducing lime dosages through improvements in aeration, mixing, and solids recirculation capabilities for the softening basins, the actual lime doses compare favorably with theoretical calculations.

A lime additive, LimeCure 25, is injected to assist the operation of the clarifiers by preventing lime from calcifying. Typically, between 6% to 8% of the raw water bypasses the primary clarifier and mixes with the treated water from the primary clarifier in the draft tube of the final clarifier. Flocculation occurs inside the conical skirt. Water flows upwards out of the flocculation zone and is collected in radial effluent launders. The sludge is removed from each clarifier by sludge pumps through a 6-inch line.

The basins are square with filleted corners, 42-feet in length for a total surface area of 1,760 sq. feet. The basins have a usable depth of 21.3 feet, and an approximate volume of 286,000 gallons. This results in a clarification rate of 1.2 gpm/sf, satisfying the *Recommended Standards for Water Works* (Ten States Standards). The chemical mixing detention time is below 30 minutes which also meets Ten States Standards. Each basin has a rated capacity of 3.0 mgd. Ten States Standards recommends a detention time of two-hours for units treating groundwater. At the design flow of 3.0 mgd, the detention time for each unit is approximately 2.25 hours.

It is possible for the clarifiers to act in parallel for demands above 3.0 mgd; however, the clarifiers are not typically operated in this way. If demands rise above 3.0 mgd, the clarifiers are designed to be able to operate in parallel to provide a clarification capacity of up to 6.0 mgd. Both clarifiers can be bypassed to allow more maintenance and cleaning activities.

The design torque of the solids collection rakes in the clarifiers is 8,820 ft-lbs. Unit loading rates of 40 lbs/ft is typical for collection rakes operating in this application. The unit loading for the clarifiers at the Owosso WTP is over 200 lbs/ft and have sufficient capacity to operate without excessive torque loading.

The last inspection of the clarifiers occurred in 2017 by a clarifier manufacturer, Westech, who now owns the Contraflo line. The inspection report indicated that the clarifiers were in good physical condition and operated as designed.

5.5.1 Recommendations

It is recommended that regular annual maintenance continue, following manufacturer recommendations and current practices. A full basin inspection is recommended for each clarifier to observe any deterioration in the clarifier equipment, electronics, concrete basin condition, etc.

5.6 Recarbonation

CO_2 is injected into the effluent stream of the clarifiers to lower the pH and settle out excess lime and $CaCO_3$. A pressurized solution feed system is utilized. CO_2 gas is forced into solution under high pressure and maintained at high pressure until being released into the process stream as a carbonic acid solution through a chemical diffuser. Two CO_2 feed panels are located inside the clarifier room. These panels contain a pH meter/probe, an automatic gas control valve, and a controller which paces the flow of CO_2 automatically based on a pH setpoint. These feed panels are currently not operational. A bulk liquid CO_2 tank, installed in 2004, is located outside, north of the WTP. The bulk CO_2 tank has a 30-ton capacity and a maximum working pressure of 350 psig (pounds per square inch gage). Table 10 summarizes the daily CO_2 usage over the last ten-years.

Table 10 – Carbon Dioxide Usage and Dose

Dosage Type	Average	Minimum	Maximum
CO_2 Usage (lbs/d)	236	95	548
CO_2 Dose (mg/L)	16.9	5.8	42.8

A 20-inch line from the clarifier effluent feeds into the recarbonation tank. The tank is approximately 15-feet by 9-feet by 22-feet with a total volume of 24,000 gallons. A baffled wall is present in the tank which improves mixing. The tank has an overall detention time of 11.5 minutes at a flow of 3.0 mgd. Settled sludge in the recarbonation tank must be cleaned annually with a submersible pump. This requires a process shut down, entry into a confined space, and slow dewatering process.

The WTP staff have noted that when the clarifiers are run in parallel above demands of 3.0 mgd, they have no appreciable increase in the amount of water that can be treated. It is suspected that a hydraulic blockage is present downstream of the recarbonation tank. This blockage could be due to lime buildup in the piping and fittings or due to a broken or stuck valve. The City has had success in the past utilizing camera equipment to inspect the interior of the piping system and has previously contracted the cleaning of the inside of the piping system via high-pressure scouring equipment. This type of cleaning was performed in 2019 on the clarifier effluent line to the recarbonation tank. The City plans to perform similar inspections and cleaning on the recarbonation tank and downstream piping to determine and remediate the cause of the hydraulic deficiency. It is recommended that following the cleaning, a hydraulic performance test with flows ranging from 3.0 up to 6.0 mgd be conducted to ensure that the clarifiers are able to operate properly in parallel as designed.

5.6.1 Recommendations

The CO_2 feed panels should be repaired to restore automatic chemical dosing capabilities and to reduce the manual effort required to monitor clarifier effluent pH levels.

5.7 Filtration

Water is sent from the recarbonation tank to one of four sand/anthracite filters. The filters are each 18.5-feet long and 15-feet wide. Each of the four filters have Leopold filter block underdrains, with 13 inches of 1.1-millimeters (mm) effective size anthracite on top of 12-inches of 0.52 mm effective size sand over a support bed of 7-inches of gravel. All filters have surface wash capabilities; however, this is currently not functional due to excess media buildup. None of the filters have filter to waste capabilities.

The filters have an approved filtration rate of 3.5 gpm/ft^2. The total filter capacity is rated by the State as 5.44 mgd. Typically, the WTP operates with three filters online and one in standby. Filters are typically run at a filtration rate of 700 gpm each, which equates to a filtration rate of 2.52 gpm/ft^2

The filter media is well beyond its useful life, and has expanded significantly due to calcification, making filter operation difficult. The 2018 sanitary survey lists the depth of water above the media at only 28-inches, and this value has decreased since. Based on discussions with the City, filter underdrains are expected to be in poor condition based on observations.

Filter influent piping and valving was installed in 2004 and is in good condition. Other filter gallery piping including the backwash supply and backwash waste lines are in okay condition, with some corrosion present on piping and valves. Filter effluent piping to the underground storage reservoir was installed as part of the 1941 WTP improvements and is in very poor condition, with significant corrosion and pitting present. Individual filter flow metering is not present and is required per Ten States Standards.

The backwash supply pump and piping were replaced in 2021. Redundant backwash supply pumps are now present and are located in the compressor room and filter pipe gallery, respectively. The VFDs for the backwash supply pumps were repaired in 2023 following a failure.

5.7.1 Recommendations

The filter media in each of the four filters needs to be replaced as it is beyond its useful life. Filter media replacement would require removal of the existing sand and anthracite and installation of new media. It is possible to reuse the existing support gravel, but it is frequently disturbed during media removal which results in the need to screen and sort the gravel into appropriate layers and reinstall in its original placement. This replacement can be performed one filter at a time to minimize disruption in the WTP.

To optimize filter performance, the filter underdrains and surface wash system should be upgraded as part of the media replacement. One issue that can cause backwash uniformity issues is if the filter underdrains are causing increased head loss due to them being partially clogged. Replacing filter underdrains could provide more uniform backwashing across the filter bed.

If the underdrains are replaced, utilization of an air scour system during backwash would eliminate the need for a surface wash system, in addition to potentially reducing the required backwash flow rate. The existing surface wash mechanisms do not clean the media as effectively as newer air scour technology. Surface washers only churn up the top portion of the media bed, whereas air washing can scour the entire media bed. The air-wash system would be incorporated in the new plastic nozzle underdrain system. Two new positive displacement blowers (one duty, one standby) would be required for supplying the air scour to the filters.

The aging valves, controls, and piping in the filter gallery should be replaced. Individual filter flow metering for each filter is required to be added per Ten States Standards in order to ensure flow is equalized across the filter beds. Filter effluent piping on the lower level of the pipe gallery should be replaced in kind as the existing piping is beyond its useful life. As there is currently only a single filter effluent line that runs from the filter pipe gallery to the finished reservoir storage, it is recommended that the single filter effluent line be replaced by smaller parallel lines. This will provide added redundancy and operational flexibility in the future. Utilizing two parallel mains will also minimize process shut-down time during construction and will reduce the need for temporary piping. The first new main can be prepared adjacent to the existing line and can carry the filter effluent while the existing main is demolished and replaced with the second new line.

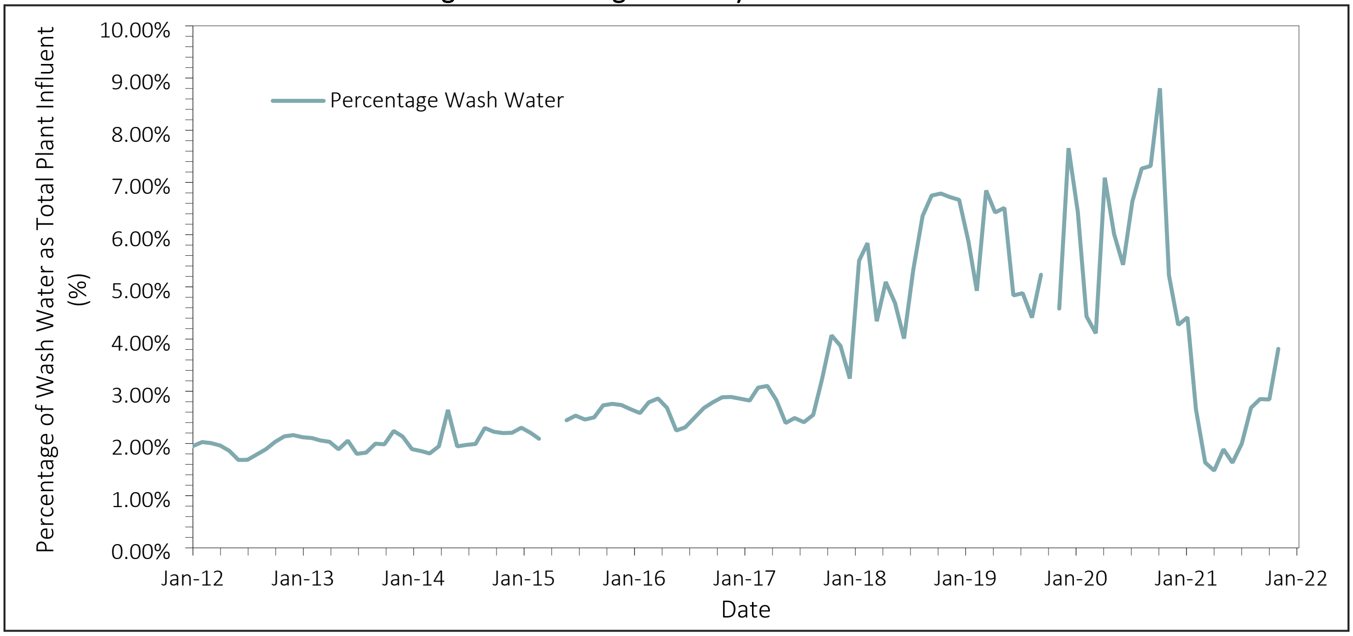
5.8 Backwash and Sludge Handling

There are two backwash pumps used to clean filter media. New backwash pumps were installed in the WTP in 2021. As described earlier, these pumps are not currently in operation due to issues the VFDs. Backwash supply water is currently obtained from the high service pump discharge in combination with a pressure reducing valve.

Historically, one filter was backwashed per day up to the installation of the new backwash pumps in 2021. MOR data from 2021 shows that filter backwash is occurring less frequently, and some days see multiple filters backwashed. Filter backwash waste is pumped to a backwash holding pond adjacent to the sludge lagoons. Water is removed from the holding pond via evaporation and infiltration into the ground.

The amount of backwash water used by the WTP had been significantly increasing up until the new backwash pumps were installed in 2021. Figure 2 summarizes the average amount of water used for backwash in the WTP as a percentage of the total WTP influent flow for each month from the last 10-years.

Figure 2 – Average Monthly Backwash Flow



Sludge from the two upflow clarifiers is pumped via two centrifugal sludge pumps to the lagoons. Sludge is pumped from the primary clarifier approximately hourly, while the secondary clarifier has sludge removed every four hours on a timer. The sludge pumps have a capacity of 330 gpm with a total dynamic head of 50 feet. Sludge lagoons are alternated on an annual basis as they become full. According to the 2018 *Sanitary Survey*, a full lagoon is idle for up to two years before the dry sludge is dredged. Table 11 below summarizes the current lagoon capacities. Typically, the City has the lagoons dredged when they are approximately 70% to 80% full.

Table 11 – Lagoon Capacities

Lagoon	Type	Estimated Size (acres)	Maximum Capacity (cu yd)
1	Sludge	1.38	6,650
2	Sludge	0.69	4,600
3	Sludge	0.73	7,800
4	Sludge	0.41	16,600
	Sludge Total	**3.21**	**35,650**
5	Filter Backwash	0.23	1,000

Up to 2017, sludge disposal for the City was handled through a private contract. This contract has expired, and the City has not determined a new disposal method to date. The City has commented that dredging and disposing of the lime sludge is becoming increasingly more expensive and there is difficulty in finding qualified contractors to perform the work. A mechanical dewatering system could greatly reduce the amount of sludge that requires disposal.

5.8.1 Recommendations

Implementation of an alternative lime sludge handling process could be implemented should the costs of dredging the existing lime sludge lagoons becomes prohibitive or if the City continues to have difficulties hiring a contractor to perform the work.

Many technologies exist for mechanical dewatering of sludge. Mechanical dewatering equipment further concentrates the sludge residuals using mechanical equipment to press water out of the residuals. Mechanical dewatering equipment receives residuals and produces a solid residuals cake which can be separately disposed.

Utilizing a mechanical dewatering technology would remove the need for the sludge lagoons, as the residuals cake would be collected in dumpsters and disposed of directly.

Screw press technology is one type of mechanical dewatering equipment that could be considered. A screw press consists of a hollow cylindrical screen/strainer that is mounted horizontally or at an angle. The influent solids stream is treated in a reaction tank upstream of the press and mixed with polymer that acts as a flocculant aid. A tapered screw conveyor then presses water from the solids through the perforations in the screen as the solids are conveyed along the length of the strainer. The strainer size is tapered, and more water is removed as the pressure increases towards the end of the strainer. Filtrate leaves the press through the screen and exits. Dewatered solids exit the press at the end of the strainer and are collected and disposed.

A belt filter press is another dewatering technology that could be considered. A belt filter press uses mechanical pressure between two tensioned belts to press water from the residuals. Starting at the gravity table, the residuals partially dewater by gravity through porous belts. The wedge section flattens and prepares the residuals for pressure. The pressure section is a series of serpentine belt filters that applies low pressure first, and then higher pressure to further squeeze the solids and force excess water out of the residuals. The residuals are then scraped off the belt and conveyed to a bin for disposal.

A final dewatering technology that could be considered is a plate and frame filter press. A plate and frame filter press consists of a set of recessed plates that are vertically arranged alongside each other to create chambers. The plates are supported on a frame with a stationary head on one side and a moving head on the other side powered by a hydraulic ram. Residuals are pumped through the center hole to fill the chambers and as pressure increases, water from the residuals drains through the filter cloth, and solids are retained in the chamber. Once the maximum pressure is reached, the feed pumps are shut down and the moving head presses against the plates to further squeeze the chambers and press out more water from the residuals through the filter cloth. After the hydraulic ram reaches full pressure, it is released, and the press operation is complete. Plates are then separated to allow the dewatered residuals to drop down to a conveyor or dumpster below. An automatic plate-shifting system separates each plate to reduce operational time as compared to manually separating each plate.

A new residuals handling building would be required. Space for a building is available northeast of the existing clarifier building on the WTP site. An access drive would be required to this building to transport the dewatered cake that is generated as part of the mechanical dewatering process. Even with implementation of a mechanical dewatering process, the existing sludge ponds would have to be totally emptied by dredging. This cost should still be accounted for in the evaluation of a mechanical dewatering system.

5.9 Finished Water Storage

Finished water storage at the WTP is comprised of an underground storage reservoir and two suction wells for the high service pumps. The south suction well has a capacity of 20,000 gallons and the west suction well has a capacity of 30,000 gallons. The underground reservoir was constructed in 1920 and has a capacity of 1,750,000 gallons. The total finished water storage capacity at the WTP is 1,800,000 gallons. There are no specific storage volume standards required for WTPs.

The underground reservoir was last rehabilitated in 1990, which included crack injection to repair fractures in the concrete, replacement of manholes and vents, and cleaning and chlorination. The reservoir was last inspected by Liquid Engineering Corporation in 2002. This inspection notes that the injection repairs appeared to be in good condition; however, there was evidence of leaking in both the roof and expansion joints in the floor and sediment buildup. Infiltration issues in the reservoir have continued into the present, as WTP staff note that pH levels drop during heavy rains and periods of elevated river levels. The 2021 *Sanitary Survey* recommended an aggressive approach to replacing the reservoir in the near future.

5.9.1 Recommendations

The existing underground storage reservoir is beyond its useful life, and significant rehabilitation is needed to bring the reservoir in line with current standards. Short-term rehabilitation of the underground reservoir is not possible as the storage tank cannot currently be bypassed. A long-term solution is recommended to be completed. It is recommended that the underground storage reservoir be taken out of service and that new ground storage be constructed on the WTP site. It is recommended that this improvement be incorporated with additional high-service pumping improvements, discussed in further detail in Section 5.10.1.

5.10 High Service Pumping

Water is conveyed from the underground storage tank to two suction wells. Four horizontal split case high service pumps convey water from the suction wells to the distribution system. HSPs 1 and 2 are supplied from the west suction well. HSP 3 takes water from both suction wells and HSP 4 is supplied from the south suction well. HSP 1 is currently a constant speed pump, while HSPs 2, 3, and 4 are controlled by VFDs. To meet the ADD, only one pump, HSP 3 or HSP 4, is required. HSPs 1 and 2 are operated once per month to verify reliable operation. The WTP plans to install new pneumatic controls to both HSPs 1 and 2 in the near future. Table 12 summarizes the high service pumps' capacities.

Table 12 – High Service Pump Capacities

Pump	Capacity (gpm)	Capacity (mgd)
HSP 1	2,200	3.17
HSP 2	2,200	3.17
HSP 3	2,200	3.17
HSP 4	2,200	3.17
Total Capacity	8,800	12.68
Firm Capacity	6,600	9.51

HSP 1 and HSP 2 are in overall good condition with some minor exterior corrosion present on the pump casing and suction elbows. HSP 3 is in fair condition with corrosion present on the pump casing. HSP 4 was out of service for repair during the visit and was not evaluated. All the pump air release valves show signs of corrosion. The piping in the high service pump pipe gallery is generally in good condition. The south suction well supply lines to HSP 1 and 2 have significant corrosion.

The high service pumps are not able to start when levels in the underground storage level are below 8-feet. This significantly reduces the operational flexibility of the WTP, reduces the amount of turnover that can be achieved in the underground reservoir, and reduces the overall storage volume for the system. In addition, the high service pumps are located below grade at the WTP. Ten States Standards requires that pumping stations be located a minimum of three feet above the 100-year flood elevation, or three feet above the highest recorded flood elevation, whichever is higher.

5.10.1 Recommendations

A new combined high service and transfer pumping station is recommended to be constructed on the WTP site in conjunction with the construction of new above ground storage reservoirs. Water from the filters will flow by gravity to a new clear well located beneath the pump station. Transfer pumps, sized to handle the maximum flow from the filters, will convey the water from the clear well to fill the proposed ground storage tanks as described in Section 5.9.1. The ground storage tanks will then supply the new high service pumps, which will convey water to the distribution system. Locating the high service pumps and finished water storage above grade not only updates the facilities to meet current design standards, but it also removes the existing hydraulic limitation of the existing storage and high service system, increasing the operational flexibility of the WTP and the overall storage capacity of the water system.

5.11 Chemical Feed

Four chemicals are added as part of the treatment process: quicklime, sodium hypochlorite, sodium fluoride, and LimeCure 25. Tables 13 and 14 summarize the chemical usage by weight and chemical usage by dose, respectively.

Table 13 – Chemical Usage

Chemical	Average	Minimum	Maximum
Lime Usage (lbs/day)	4,618	3,328	6,665
Sodium Hypochlorite Usage (lbs/day)	40	4	65
Sodium Fluoride Usage (lbs/day)	8	3	18
LimeCure 25 Usage (lbs/day)	69	47	99

Table 14 – Chemical Dosing

Chemical	Average	Minimum	Maximum	NSF Maximum Dose Limit
Lime Dose (mg/L)	328	258	444	500
Sodium Hypochlorite Dose (mg/L)	2.97	2.00	5.00	80
Fluoride Dose (mg/L)	0.28	0.11	0.55	0.7
LimeCure 25 Dose (mg/L)	4.86	3.41	6.22	20

5.11.1 Lime

Two continuous slurry type slakers were installed as part of the WTP improvements in 2004. Each slaker inlet feed includes a bin activator and volumetric rotary vane type feeder. Each slaker has grit removed via screw conveyors which deposit into buckets. Slaked lime is delivered to the process by gravity flow from the slakers to the softening reactors in 2-inch lines. Operators alternate usage of the two slakers, which can provide 1,000 pounds per hour of slaked lime.

The existing lime slaking system requires a large maintenance effort from WTP staff to run efficiently. The lime storage and slaking room on the inside of the silo have heavy buildup of lime dust on all equipment and appurtenances.

5.11.1.1 Recommendations

New batch type lime slakers and storage system should be installed to replace the existing continuous slurry type slakers. With the batch type lime slakers, lime is fed from the silo into a mixing tank with a screw feeder. Water is added and mixed with the lime in specified portions. Once the proper slurry dilution is achieved, the slurry is transferred by gravity to an aging tank. Pumps are used to transfer the slurry to the clarifier draft tube. Grit classifiers are used to remove and dispose of grit. Redundant mixing tanks and feed pumps could be installed. The batch type lime slakers are fully automatic and would significantly reduce operator labor in operating the lime injection process.

5.11.2 Sodium Hypochlorite

Sodium hypochlorite is used as the primary disinfectant at the WTP. Sodium hypochlorite is injected upstream of the recarbonation tank in the clarifier effluent line, downstream of the filters in the combined filter effluent line, and in the south suction well. Bulk sodium hypochlorite is stored in the chemical room in a 2,000-gallon bulk storage tank. A 100-gallon day tank and transfer pump are located adjacent to the bulk storage tank. Chlorine is fed via three chemical metering pumps. The 10-year average hypochlorite usage is 31 gallons per day as solution. At the average usage, the bulk storage tank has capacity for up to 65 days of storage.

A backup calcium hypochlorite tablet feed system is present. This system serves as an emergency backup to the sodium hypochlorite system. According to the 2018 *Sanitary Survey*, the stock of calcium hypochlorite tablets is restocked annually, and the system is operated regularly to ensure that the system is functional.

5.11.2.1 Recommendations

Due to increasing capital and delivery costs of bulk sodium hypochlorite, onsite generation of low-concentration sodium hypochlorite at the WTP facility may be a competitive alternative to bulk sodium hypochlorite. As the City's wastewater treatment plant is set to eliminate its need for bulk hypochlorite deliveries due to installation of UV disinfection equipment, bulk delivery costs of hypochlorite to the WTP are expected to increase as the City loses its discount for shared deliveries.

Installation of an onsite sodium hypochlorite generation system would reduce reliance on bulk deliveries of sodium hypochlorite, providing operations savings. Typical generation systems utilize sodium chloride and softened water to make a salt brine. The brine is electrolyzed to form a low concentration sodium hypochlorite and hydrogen gas. This low-concentration sodium hypochlorite would be fed directly to the process.

The existing chemical storage room does not have sufficient space to install a new onsite hypochlorite generation system. A new chemical storage building located above the 100-year flood level will be required to house the chemical generation and feed equipment, including the bulk salt (sodium chloride) storage tank.

5.11.3 Fluoride

A sodium fluoride solution is injected into the filter effluent stream for dental health. The fluoride feed system was last updated as part of the 2004 WTP improvements. Fluoride is stored in 50-lb shipping bags in the chemical room. Powdered sodium fluoride is mixed with softened water in an upflow saturator, which is manually metered to the injection point by a peristaltic pump. No redundant metering pump is present. A flow switch located on the filter effluent line is interconnected with the metering pump, preventing chemical feed into the filter effluent if no flow is moving through. The City notes that replacement of the fluoride equipment is planned for in 2024 or 2025.

The 2018 *Sanitary Survey* completed by EGLE notes that average distribution levels of fluoride are at 0.46 mg/L, below the optimal levels of 0.6-0.8 mg/L. The 2021 average distribution levels of fluoride are 0.49 mg/L, which is also below the recommended level.

5.11.3.1 Recommendations

Fishbeck agrees that the existing fluoride feed system should be replaced in the 5-year planning period. It is recommended that the new fluoride system, including an online analyses/monitoring system, be constructed in a new space outside the existing chemical room to separate different chemicals, according to Ten States recommendations. As with the chlorine recommendations, installation of fluoride storage and feed equipment should be installed above the 100-year flood level in a new chemical storage building.

It is recommended that liquid hydrofluorosilicic acid be fed from 55-gallon drums on a scale. While powdered sodium fluoride may provide a small cost savings compared to hydrofluorosilicic acid, labor required to prepare the sodium fluoride solution and exposure to the fluoride chemicals is reduced. Redundant metering pumps and associated piping and appurtenances including anti-siphon backpressure valves, calibration columns, and pulsation dampers should be installed. In addition, an eyewash and shower should be added to the chemical room to be compliant with Ten Sates Standards. As part of startup, residual distribution system fluoride concentrations would be monitored to help ensure that levels are between the Michigan optimal levels of 0.6-0.8 mg/L.

5.11.4 LimeCure 25

LimeCure 25 is injected into the lime slurry and is used to reduce calcifying of lime. LimeCure 25 is stored in 250-gallon intermediate bulk containers (IBC) chemical storage totes located in the clarifier room. A skid mounted electric metering pump located on top of the totes doses the LimeCure 25 to the process.

5.11.4.1 Recommendations

Ten States Standards requires that liquid chemical storage containers be provided secondary containment such that the volume of the largest storage container would be contained. The IBC totes do not currently have chemical containment. A system for containing the IBC chemical storage totes, such as a chemical containment pallet, should be added in the clarifier room for secondary containment.

5.12 Gute Hill Booster Station

The Gute Hill Booster Station is connected to the standpipe located off Krouse Road between South Pearce Street and Walnut Street. The booster station has one pump that is manually controlled from the WTP by staff; however, this will soon be automated with ongoing control upgrades at the WTP. The flow capacity of the booster pump station is limited hydraulically by the level in the standpipe. The existing booster pump is rated for 1,000 gpm; however, the pumping capacity decreases significantly as levels in the standpipe drop.

Ductile iron and PVC pipe are used in the booster station; the piping and valving appear in good condition. The altitude valve and associated pilot piping and equipment are worn slightly and are in okay condition.

5.12.1 Recommendation

Several improvements are recommended to be added to the booster station to correct the existing hydraulic deficiency. These improvements include the reworking of the piping layout to improve hydraulic performance, installation of two new booster pumps and VFDs, instrumentation and SCADA improvements, emergency generator, and flow metering. These improvements will help to improve booster station performance and will allow a larger percentage of the standpipe volume to be utilized.

5.13 Treatment Capacity

An evaluation of the existing water treatment process capacity was completed. The design, rated, and firm capacities of individual processes are indicated in Table 15. The design capacities indicate the total capacities or the capacity of the process operating at maximum conditions. The rated capacities are indicated for the key treatment process in the WTP as designated by the State. Finally, the firm capacities are shown for the pumping processes; this is the capacity of the process with the largest unit out of service.

Table 15 – Water Treatment Process Capacities

Unit Process	Design Capacity (mgd)	Rated Capacity (mgd)	Firm Capacity (mgd)
Raw Water Supply	3.76	-	2.58
Aeration	6.0	6.0	-
Clarification	6.0	3.0	-
Filtration	5.4	5.4	-
High Service Pumping	12.7	-	9.5
Total Treatment Capacity	3.0	3.0	2.58

As discussed previously, the State has rated the WTP at 3.0 mgd based on the design flow of the clarifiers operating in series. It is assumed that the rated capacity of the clarifiers would be raised to the 6.0 mgd design capacity should the City demonstrate the ability to operate the WTP effectively with the clarifiers running in parallel and obtain EGLE approval. The treatment capacity of the WTP would therefore be set by the 5.4 mgd flow of the filtration process. This is sufficient to meet the projected 2042 demands of 2.62 mgd.

Assuming the WTP is rated for 5.4 mgd, the limiting factor of the treatment system would be the raw water supply of 2.58 mgd. As discussed in Section 5.3.1, the current well capacity of 2.58 mgd is not sufficient to meet the projected 2042 demands of 2.62 mgd.

6.0 Capital Improvements Plan

The following projects summarized in Table 16 are recommended to be completed in the next five years based on the findings of the WTP evaluation. The estimated total project cost is provided for each project.

Table 16 – Recommended 5-Year Improvements

Project Name	Description	Estimated Project Cost
Filter Improvements	Replace the media in the existing four gravity filters. Replace in kind with new support gravel, sand, and anthracite layers. Replace filter underdrain system in kind. Install new air scour piping as part of underdrain replacements, including two positive displacement blowers. Address any crack/repairs observed in filter, especially gullet wall. Repaint filter room.	$1,960,000
Electrical Grounding Improvements and Improvements to Meet Code Requirements	Replace double ended switchboard. Replace pole-mounted gang-operated primary switch on south service. Upgrade pole-mounted transformers and building services to 480-volt, 3-phase, 4-wire (grounded services). Modify grounding electrode system to be compliant with NEC requirements. Modify feeder and branch circuits to include equipment grounding conductors. Add surge protects devices to panels.	$1,550,000
Fluoride Feed Improvements	Demolish existing fluoride system in the chemical room. Install new fluoride equipment in new chemical storage building and online fluoride sample analyzer in the lab area.	$350,000
Roofing Replacement	Replace the roof on the original (west) WTP building.	$470,000
Filter Effluent Piping Replacement	Replace approximately 100 feet of 20-inch filter effluent pipe from filter pipe gallery to wall of existing high service pipe gallery.	$330,000
Well Houses Building and Mechanical Equipment Improvements.	Replace well buildings at Local Well 1 and Palmer Street 2 with new well house per the City's standard well house design. Replace faulty mechanical equipment at well houses in kind. Demolish well house, tie off raw water main, and cap well at Palmer Street 1.	$960,000
Aerator Improvements	Replace existing induced draft aerator.	$260,000
CO_2 Feed Panel Repair	Repair or replace existing CO_2 feed panels to restore automatic CO_2 dosing capabilities.	$380,000
Lime Residuals Mechanical Dewatering	Install mechanical dewatering equipment for lime sludge. Will require building addition to the northeast of existing clarifier building.	$11,520,000
WTP Site Improvements	Rehabilitate WTP parking lot. Backfill up around the original WTP building to correct site drainage. Replace existing WTP	$185,000

Project Name	Description	Estimated Project Cost
	equipment storage building onsite with new, larger building. Repair existing WTP fence.	
Gute Hill Booster Station Improvements	Replace existing pump and VFD, reworking piping layout to improve hydraulic performance. Install new instrumentation and SCADA upgrades. Install new emergency generator.	$834,000
Subbasement Sump Pump Improvements	Replace existing sump pump system. Includes redundant submersible pumps, controls, and discharge piping.	$49,000
Building Material and Equipment Handling Improvements	Improvements to overhead crane system, truck bay leveler, clarifier roll up door.	$1,000,000
Filter Valve Improvements	Replace filter influent, effluent, and backwash valves, including actuators. Install new flowmeters and controls.	$500,000
Distribution System Improvements	Replace and install new water main. See 2023 *Water System Reliability Study* for more information.	$11,886,000
	5-Year Projects Total	$32,234,000

The following projects summarized in Table 17 are recommended to be completed in the next six to twenty years based on the findings of the WTP evaluation. The estimated total project cost is provided for each project.

Table 17 – Recommended 6–20-Year Improvements

Project Name	Description	Estimated Project Cost
New Reservoir and High Service/Transfer Pumping Building	Abandon in place the existing underground storage reservoir. Construct a new high service pump station containing transfer pumps and high service pumps. Construct a new clearwell to be fed by gravity from the filters. Construct two new 0.75-million-gallon ground storage tanks.	$12,280,000
Building Improvements (Electrical, HVAC, Roofing)	Generate warning labels for electrical equipment per NFPA 70E. Replace the roof on the Clarifier (east) building of the WTP. Repaint/recoat clarifier room interior. Replace faulty mechanical equipment in kind.	$760,000
Chlorine Feed Improvements	Construct a new skid mounted onsite sodium hypochlorite generation system to provide disinfection supply, including bulk salt/brine storage tank. Install new chlorine room and bulk storage in new chemical storage building.	$1,010,000
Lime Slaking Improvements	Demolish existing slurry-type lime slaker assembly and storage silo. Construct two batch type lime slakers including silo system, mixing tanks, aging tank, grit classifiers, feed pumps and control system.	$5,180,000
Distribution System Improvements	Replace and install new water main. See 2023 *Water System Reliability Study* for more information.	$32,855,000
Raw Water Main Improvements	Replace and install new raw water main. See 2023 *Water System Reliability Study* for more information.	$10,931,000
SCADA/Controls Improvements Phase 1*	Upgrade SCADA/controls systems.	$300,000

Project Name	Description	Estimated Project Cost
Juniper 2 Well Development*	Develop new/additional well at the Juniper site.	$750,000
Hintz 2 Well Development*	Develop new/additional well at the Hintz site.	$750,000
SCADA/Controls Improvements Phase 2*	Upgrade SCADA/controls systems.	$1,000,000
	6–20-Year Projects Total	$65,816,000

**Planned Owner improvements, not evaluated as part of this study.*

7.0 Asset Criticality Analysis

Criticality analysis involves ranking the water system assets inventoried and consists of two parts: the probability of failure (POF) and the consequence of failure (COF). Generally, a numerical ranking value is assigned to each of these two parts and the two numerical values are multiplied together, with the resulting number representing the overall criticality, or business risk exposure (BRE), of the asset. The assets that have the greatest POF and the greatest COF are the assets most critical to the system.

The POF score is based on several parameters, with the condition of the asset, as assessed during the asset inventory component, being the most important. Assets that are in poor condition are generally assigned a higher POF. The COF relates to the impact the failure of a given asset would have on other equipment or processes, public health, the environment, property damage, and lost revenue. A higher score is given to assets when their failure would have a greater impact on the WTP's ability to provide drinking water to its customers.

Criticality analysis is a tool used to define the importance of a system or component to the overall water system. It provides a method to plan asset replacement/rehabilitation projects well into the future and consider the proper funding structure and water rates to cover the corresponding investment.

This section summarizes the criticality analysis of the WTP assets. Appendix 1 provides the BRE rankings and other associated data developed for each asset.

7.1 Probability of Failure Metrics

The following metrics were used to determine the POF for the vertical assets. Each metric was scored on a scale of 1 to 5 with 5 indicating the highest POF. The basis for determining the overall POF score is presented in Table 18.

1. Physical Condition

The worse the physical condition of a vertical asset, the more likely it is to fail. The physical condition score was determined based on the condition of the asset observed during the site visits and from City staff input.

2. Remaining Useful Life

The age of a vertical asset in relation to the typical useful life of that type of asset is important to the POF of the asset. The remaining useful life score was determined using the difference of the age of the asset and its typical useful life.

3. Operational Complexity

The more complex the operation of a vertical asset is, the more likely one of its components is to fail. This score was determined based on the complexity of operating a vertical asset.

4. Operational Frequency

This score was determined based on the frequency with which an asset normally operates within the water system.

Table 18 – Probability of Failure Evaluation Metrics

Evaluation Metric	Weighting Factor	5	4	3	2	1
		Very High	High	Moderate	Low	Very Low
Physical Condition	1	Very Poor	Poor	Fair	Good	Very Good
Remaining Useful Life	1	<20% of Useful Life Remaining	Age Between 21% and 40% of Useful Life	Age Between 41% and 60% of Useful Life	Age Between 61% and 80% of Useful Life	>81% of Useful Life Remaining
Operational Complexity	1	Very Complex	Complex	Moderate	Simple	Very Simple
Operational Frequency	1	Very Frequent	Frequent	Moderate	Irregular	Very Irregular

7.2 Consequence of Failure Metrics

The following metrics were used to determine the COF for the vertical assets. Each metric was scored on a scale of 1 to 5 with 5 indicating the highest COF. The rubric used in determining the overall COF score for each metric is provided in Table 19.

1. Water Supply

The importance of a vertical asset to maintaining a supply of water to the system has significant bearing on the COF of that asset. The water supply score is determined based on the effect the loss of an asset would have on the ability of the WTP to continue to supply water to its customers.

2. Water Quality

The importance of an asset to maintaining the quality of water in the system has significant bearing on the COF of that asset. The water quality score is determined based on the effect the loss of an asset would have on the quality of the water delivered to the system.

3. Financial Impact

If an asset fails, it must be replaced. Depending on the cost of replacing that asset, it can be paid for from the City's budget or force the City to find other means to finance the improvements.

4. Safety

To maintain a water system, City staff must perform periodic maintenance on and work around WTP assets. The safety of these workers and the public is important. The failure of certain assets can result in a workplace hazard for City staff or even be a public safety hazard due to water system pressure and water quality. The safety score is determined based on the threat to City staff and the public's health due to the failure of an asset.

Table 19 – Consequence of Failure Evaluation Metrics

Evaluation Metric	Weighting Factor	5	4	3	2	1
		Very High	High	Moderate	Low	Very Low
Water Supply	1	Mission critical; unable	Process shutdown	Potential process upset	Loss of redundancy	No impact on process

		to accomplish mission				
Water Quality	1	Mission critical; unable to accomplish mission	Process shutdown	Potential process upset	Loss of redundancy	No impact on process
Financial Impact	1	>$100,000	$50,001–$100,000	$20,001–$50,000	$5,001–$20,000	$0–$5,000
Safety	1	Loss of Life	Severe injury to employees or public; serious long-term health effects	Minor injury requiring treatment offsite or lost time; mild long-term health effects	Minor injury requiring no treatment with no lost time; no long-term health effects	No impact/ injury

7.3 Business Risk Exposure

The BRE is the overall score that quantifies the criticality using the POF and COF scores.

BRE = POF x COF

Since the POF and COF each have a score of 1 through 5, the BRE score is 1 through 25. Refer to Table 20 for the BRE Matrix.

Table 20 – Business Risk Exposure Matrix

25	20	15	10	5	5	Consequence of Failure
20	16	12	8	4	4	
15	12	9	6	3	3	
10	8	6	4	2	2	
5	4	3	2	1	1	
5	4	3	2	1		
Probability of Failure						

High	High Priority (15 – 25)
Medium	Medium Priority (5 – 14)
Low	Low Priority (1 – 4)

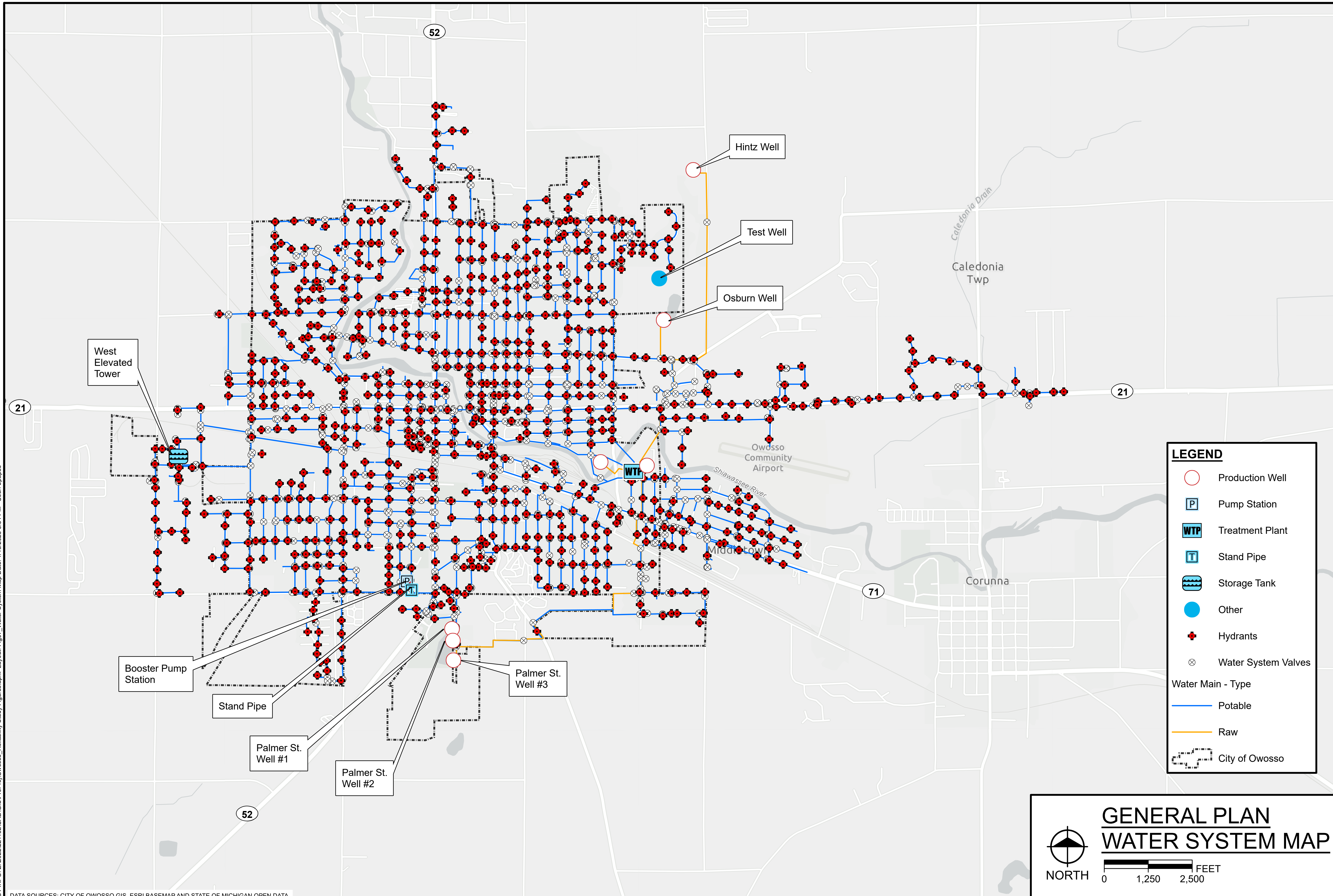
Assets with the highest BRE scores are those that should be rehabilitated or replaced first. EGLE guidelines for determining criticality state a BRE score of 15 and above is deemed high.

Assets with medium priority scores should be evaluated regularly to determine their priority. Assets with the lowest scores are those that do not currently require any rehabilitation or replacement but should be monitored at regular intervals to verify the scores do not change.

The inventory and criticality analysis for the WTP assets is included in Appendix 1.

Figures

Note – Figures 1 and 2 are contained within the narrative



GENERAL PLAN
WATER SYSTEM MAP

fishbeck
Engineers | Architects | Scientists | Constructors

Hard copy is intended to be 11"x17" when plotted. Scale(s) indicated and graphic quality may not be accurate for any other size.

City of Owosso
Shiawassee County, Michigan

Water Treatment Plant Performance Evaluation

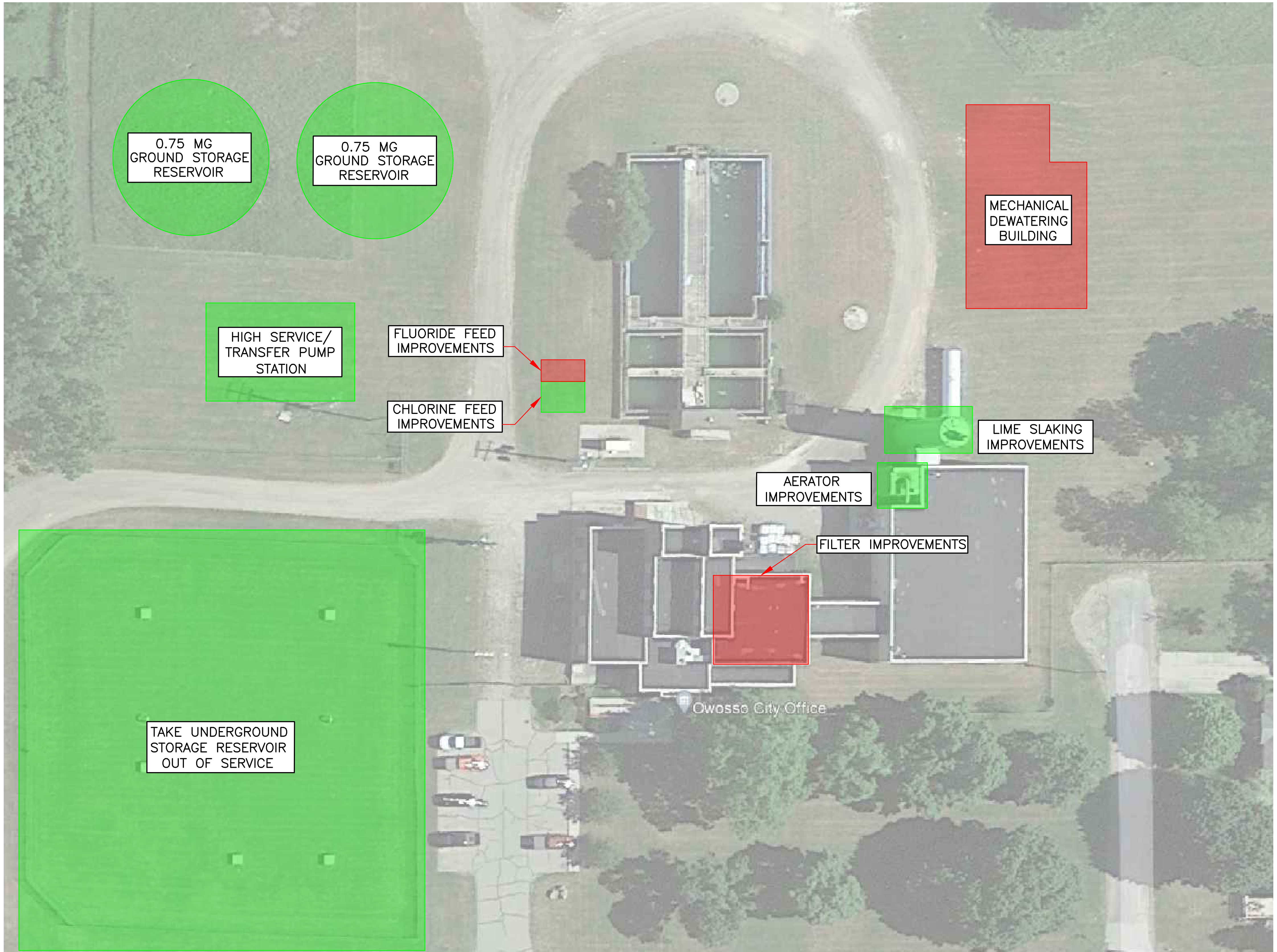
PROJECT NO.
221152

FIGURE NO.
3

PLOT INFO: Z:\2022\221152\CAD\GIS\Pro\Proj\Owosso_Reliability Study Figures.aprx Layout: Fig07_Water System Map Date: 1/19/2023 3:34 PM User: bpapes

5–YEAR IMPROVEMENTS

20–YEAR IMPROVEMENTS



NORTH

SITE PLAN WITH PROPOSED IMPROVEMENTS

NO SCALE

fishbeck

Engineers | Architects | Scientists | Constructors

Hard copy is intended to be 11"x17" when plotted. Scale(s) indicated and graphic quality may not be accurate for any other size.

City of Owosso

Shiawassee County, Michigan

Water Treatment Plant Performance Evaluation

PROJECT NO.

221152

FIGURE NO.

4

PLOT INFO: Z:\2022\221152\CAD_FIGURES\SITE PLAN.DWG LAYOUT: FIGURE 4 DATE: 7/25/2023 TIME: 4:27:22 PM USER: ZGOGULSKI

Appendix 1

City of Owosso
Water Plant Asset Criticality
WSSN 05120

Needs Replacement in Next 5 Years

Needs Replacement in Next 20 Years

Current Year 2023

No.	Asset Location	Asset Class	Asset Subclass	Description	Physical Conditon	Operational Complexity	Operational Frequency	Useful Life: Year Installed	Age (Years)	Theoretical Useful Life (Years)	Remaining Useful Life (Years)	% Useful Life Remaining (%)	Theoretical Year to be replaced (Year)	Probability of Failure: Physical Condition Score (1-5, 0.25)	Age Factor Score (1-5, 0.25)	Operations Complexity Score (1-5, 0.25)	Operational Frequency Score (1-5, 0.25)	Overall POF (1-5)	Consequence of Failure (COF): Water Supply (1-5, 0.25)	Water Quality (1-5, 0.25)	Financial Impact (1-5, 0.25)	Safety (1-5, 0.25)	Overall COF (1-5)	Business Risk Exposure (BRE) (1-25)
1	Local Well 1	Process Equipment	Pump	Local Well 1 Vertical Turbine Pump	Fair	Complex	Frequent	2021	2	20	18	90%	2041	3	2	4	4	3.3	4	3	3	3	3.3	10.56
2	Local Well 1	Process Equipment	Piping and Valving	Spool, Check Valves, Isolation Valves	Poor	Simple	Frequent	1960	63	40	0	0%	2023	4	5	2	4	3.8	4	3	2	3	3.0	11.25
3	Local Well 1	Process Equipment	Instrumentation	Pressure Transmitter, Level Transducer, Flow Meter, Door Switch	Fair	Simple	Frequent	1960	63	25	0	0%	2023	3	5	2	4	3.5	1	1	4	2	2.0	7.00
4	Local Well 1	Electrical Equipment	Control	Control Panel, Well Pump VFD	Very Good	Complex	Frequent	2022	1	25	24	96%	2047	1	1	4	4	2.5	3	1	4	3	2.8	6.88
5	Local Well 1	Electrical Equipment	Power	Transformer, Panelboard, Switchgear	Fair	Complex	Frequent	1960	63	30	0	0%	2023	3	5	4	4	4.0	3	1	5	3	3.0	12.00
6	Local Well 1	Mechanical Equipment	HVAC	Unit heater, exhaust fan, louvers	Fair	Moderate	Moderate	1960	63	25	0	0%	2023	3	5	3	3	3.5	3	1	3	3	2.5	8.75
7	Local Well 1	Building	Well House	Roof, Walls	Fair	Very simple	Irregular	1960	63	100	37	37%	2060	3	1	1	2	1.8	4	1	4	4	3.3	5.69
8	Local Well 13	Process Equipment	Pump	Local Well 13 Vertical Turbine Pump	Fair	Complex	Frequent	2016	7	20	13	65%	2036	3	3	4	4	3.5	4	3	3	3	3.3	11.38
9	Local Well 13	Process Equipment	Piping and Valving	Spool, Check Valves, Isolation Valves	Good	Simple	Frequent	1955	68	40	0	0%	2023	2	5	2	4	3.3	4	3	2	3	3.0	9.75
10	Local Well 13	Process Equipment	Instrumentation	Pressure Transmitter, Level Transducer, Flow Meter, Door Switch	Fair	Simple	Frequent	1955	68	25	0	0%	2023	3	5	2	4	3.5	1	1	4	2	2.0	7.00
11	Local Well 14	Electrical Equipment	Control	Control Panel, Well Pump VFD	Very Good	Complex	Frequent	2022	1	25	24	96%	2047	1	1	4	4	2.5	3	1	4	3	2.8	6.88
12	Local Well 13	Electrical Equipment	Power	Transformer, Panelboard, Switchgear	Fair	Complex	Frequent	1960	63	30	0	0%	2023	3	5	4	4	4.0	3	1	5	3	3.0	12.00
13	Local Well 13	Mechanical Equipment	HVAC	Unit heater, exhaust fan, louvers	Fair	Moderate	Moderate	1955	68	25	0	0%	2023	3	5	1	3	3.0	3	1	3	3	2.5	7.50
14	Local Well 13	Building	Well House	Roof, Walls	Poor	Very simple	Irregular	1955	68	100	32	32%	2055	4	1	1	2	2.0	4	1	4	4	3.3	6.50
15	Hintz Well	Process Equipment	Pump	Hintz Well Submersible Pump	Very Good	Complex	Frequent	2019	4	40	36	90%	2059	1	1	4	4	2.5	4	3	3	3	3.3	8.13
16	Hintz Well	Process Equipment	Piping and Valving	Spool, Check Valves, Isolation Valves	Very Good	Simple	Frequent	2019	4	40	36	90%	2059	1	1	2	4	2.0	4	3	2	3	3.0	6.00
17	Hintz Well	Process Equipment	Instrumentation	Pressure Transmitter, Level Transducer, Flow Meter, Door Switch	Very Good	Simple	Frequent	2019	4	25	21	84%	2044	1	1	2	4	2.0	1	1	4	2	2.0	4.00
18	Hintz Well	Electrical Equipment	Control	Control Panel, Well Pump VFD	Very Good	Complex	Frequent	2022	1	25	24	96%	2047	1	1	4	4	2.5	3	1	4	3	2.8	6.88
19	Hintz Well	Electrical Equipment	Power	Transformer, Panelboard, Switchgear	Very Good	Complex	Frequent	2019	4	30	26	87%	2049	1	1	4	4	2.5	3	1	5	3	3.0	7.50
20	Hintz Well	Mechanical Equipment	HVAC	Unit heater, exhaust fan, louvers	Very Good	Moderate	Moderate	2019	4	25	21	84%	2044	1	1	3	3	2.0	3	1	3	3	2.5	5.00
21	Hintz Well	Building	Well House	Roof, Walls	Very Good	Very simple	Irregular	2019	4	100	96	96%	2119	1	1	1	2	1.3	4	1	4	4	3.3	4.06
22	Osburn Well	Process Equipment	Pump	Osburn Well Vertical Turbine Pump	Fair	Complex	Frequent	2020	3	20	17	85%	2040	3	2	4	4	3.3	4	3	3	3	3.3	10.56
23	Osburn Well	Process Equipment	Piping and Valving	Spool, Check Valves, Isolation Valves	Fair	Simple	Frequent	1968	55	40	0	0%	2023	3	5	2	4	3.5	4	3	2	3	3.0	10.50
24	Osburn Well	Process Equipment	Instrumentation	Pressure Transmitter, Level Transducer, Flow Meter, Door Switch	Good	Simple	Frequent	1968	55	25	0	0%	2023	2	5	2	4	3.3	1	1	4	2	2.0	6.50
25	Osburn Well	Electrical Equipment	Control	Control Panel, Well Pump VFD	Very Good	Complex	Frequent	2022	1	25	24	96%	2047	1	1	4	4	2.5	3	1	4	3	2.8	6.88
26	Osburn Well	Electrical Equipment	Power	Transformer, Panelboard, Switchgear	Fair	Complex	Frequent	1968	55	30	0	0%	2023	3	5	4	4	4.0	3	1	5	3	3.0	12.00
27	Osburn Well	Mechanical Equipment	HVAC	Unit heater, exhaust fan, louvers	Poor	Moderate	Moderate	1968	55	25	0	0%	2023	4	5	3	3	3.8	3	1	3	3	2.5	9.38
28	Osburn Well	Building	Building	Roof, Walls	Poor	Very simple	Irregular	1968	55	100	45	45%	2068	4	1	1	2	2.0	4	1	4	4	3.3	6.50
29	Palmer Street Well 2	Process Equipment	Pump	Palmer Street Well 2 Vertical Turbine Pump	Fair	Complex	Frequent	2014	9	20	11	55%	2034	3	3	4	4	3.5	4	3	3	3	3.3	11.38
30	Palmer Street Well 2	Process Equipment	Piping and Valving	Spool, Check Valves, Isolation Valves	Poor	Simple	Frequent	1963	60	40	0	0%	2023	4	5	2	4	3.8	4	3	2	3	3.0	11.25
31	Palmer Street Well 2	Process Equipment	Instrumentation	Pressure Transmitter, Level Transducer, Flow Meter, Door Switch	Good	Simple	Frequent	1963	60	25	0	0%	2023	2	5	2	4	3.3	1	1	4	2	2.0	6.50
32	Palmer Street Well 3	Electrical Equipment	Control	Control Panel, Well Pump VFD	Very Good	Complex	Frequent	2022	1	25	24	96%	2047	1	1	4	4	2.5	3	1	4	3	2.8	6.88
33	Palmer Street Well 2	Electrical Equipment	Power	Transformer, Panelboard, Switchgear	Fair	Complex	Frequent	1963	60	30	0	0%	2023	3	5	4	4	4.0	3	1	5	3	3.0	12.00
34	Palmer Street Well 2	Mechanical Equipment	HVAC	Unit heater, exhaust fan, louvers	Poor	Moderate	Moderate	1963	60	25	0	0%	2023	4	5	3	3	3.8	3	1	3	3	2.5	9.38
35	Palmer Street Well 2	Building	Building	Roof, walls	Poor	Very simple	Irregular	1963	60	100	40	40%	2063	4	1	1	2	2.0	4	1	4	4	3.3	6.50
36	General WTP Site	Building	Original Building	Roof, exterior walls	Poor	Very simple	Irregular	1942	81	100	19	19%	2042	4	2	1	2	2.3	3	3	5	5	4.0	9.00
37	General WTP Site	Building	Clarifier Building	Roof, exterior walls	Fair	Very simple	Irregular	2004	19	100	81	81%	2104	3	1	1	2	1.8	3	3	5	5	4.0	7.00
38	General WTP Site	Electrical Equipment	Power	Generator	Very Good	Complex	Irregular	2020	3	50	47	94%	2070	1	1	4	2	2.0	3	3	5	3	3.5	7.00
39	Aerator	Process Equipment	Aerator	Aerator unit	Fair	Complex	Frequent	2004	19	25	6	24%	2029	3	4	4	4	3.8	3	3	5	3	3.5	13.13
40	Aerator	Process Equipment	Piping and Valving	Raw water inlet, isolation valves	Good	Simple	Frequent	2004	19	40	21	53%	2044	2	1	2	4	2.3	3	3	5	3	3.5	7.88
41	East Pipe Gallery	Process Equipment	Pump	Sludge Pump 1	Poor	Complex	Frequent	2004	19	25	6	24%	2029	4	4	4	4	4.0	3	3	2	3	2.8	11.00
42	East Pipe Gallery	Process Equipment	Pump	Sludge Pump 2	Poor	Complex	Frequent	2004	19	25	6	24%	2029	4	4	4	4	4.0	3	3	2	3	2.8	11.00
43	East Pipe Gallery	Process Equipment	Piping and Valving	Clarifer Influent, isolation valves	Good	Simple	Frequent	2004	19	40	21	53%	2044	2	1	2	4	2.3	4	2	5	3	3.5	7.88
44	East Pipe Gallery	Process Equipment	Piping and Valving	Aerator Bypass, isolation valves	Good	Simple	Frequent	2004	19	40	21	53%	2044	2	1	2	4	2.3	4	2	4	3	3.3	7.31
45	East Pipe Gallery	Process Equipment	Piping and Valving	Settled Water, isolation valves	Good	Simple	Frequent	2004	19	40	21	53%	2044	2	1	2	4	2.3	4	2	4	3	3.3	7.31
46	East Pipe Gallery	Process Equipment	Piping and Valving	Filter Influent, isolation valves	Good	Simple	Frequent	2004	19	40	21	53%	2044	2	1	2	4	2.3	4	2	5	3	3.5	7.88
47	East Pipe Gallery	Process Equipment	Piping and Valving	Backwash Waste	Good	Simple	Frequent	2004	19	40	21	53%	2044	2	1	2	4	2.3	4	2	5	3	3.5	7.88
48	East Pipe Gallery	Process Equipment	Piping and Valving	Sludge, isolation valves, check valve	Good	Simple	Frequent	2004	19	40	21	53%	2044	2	1	2	4	2.3	4	2	4	3	3.3	7.31
49	East Pipe Gallery	Process Equipment	Instrumentation	Mag-Meter	Good	Moderate	Frequent	2004	19	25	6	24%	2029	2	4	3	4	3.3	1	2	3	3	2.3	7.31
50	East Pipe Gallery	Mechanical Equipment	HVAC	Ductwork, Fan, Louver, Unit Heater	Good	Moderate	Frequent	2004	19	25	6	24%	2029	2	4	3	4	3.3	2	1	2	3	2.0	6.50
51	East Pipe Gallery	Mechanical Equipment	HVAC	Humidifier, Dehumidifier	Good	Moderate	Moderate	2004	19	25	6	24%	2029	2	4	3	3	3.0	2	1	2	3	2.0	6.00
52	East Pipe Gallery	Mechanical Equipment	Plumbing	Water Heater	Good	Moderate	Frequent	2004	19	25	6	24%	2029	2	4	3	4	3.3	1	1	2	3	1.8	5.69
53	Clarifier Room	Process Equipment	Clarifier	Clarifier 1	Good	Complex	Very frequent	2004	19	50	31	62%	2054	2	1	4	5	3.0	5	4	5	3	4.3	12.75
54	Clarifier Room	Process Equipment	Clarifier	Clarfier 2	Good	Complex	Very frequent	2004	19	50	31	62%	2054	2	1	4	5	3.0	5	4	5	3	4.3	12.75
55	Clarifier Room	Process Equipment	Chemical Feed Pump	LimeCure 25 metering pump	Good	Moderate	Moderate	2004	19	20	1	5%	2024	2	5	3	3	3.3	2	2	1	3	2.0	6.50
56	Clarifier Room	Electrical Equipment	Instrumentation	Clarifier Control Panels	Good	Complex	Moderate	2004	19	30	11	37%	2034	2	3	4	3	3.0	3	3	4	3	3.3	9.75
57	Clarifier Room	Electrical Equipment	Instrumentation	Recarbonation Control Panels	Very Poor	Complex	Moderate	2004	19	30	11	37%	2034	5	3	4	3	3.8	3	2	3	3	2.8	10.31
58	Clarifier Room	Mechanical Equipment	HVAC	Louver, unit heaters	Poor	Moderate	Frequent	2004	19	25	6	24%	2029	4	4	3	4	3.8	2	1	2	3	2.0	7.50
59	Clarifier Room	Mechanical Equipment	Plumbing	Emergency shower	Fair	Simple	Very irregular	2004	19	20	1	5%	2024	3	5	2	1	2.8	1	1	1	4	1.8	4.81
60	Filter Room	Process Equipment	Filters	Filter structure, backwash troughs	Fair	Moderate	Irregular	1988	35	50	15	30%	2038	3	3	3	2	2.8	3	5	5	3	4.0	11.00
61	Filter Room	Process Equipment	Filters	Filter media, underdrains	Very Poor	Moderate	Irregular	1988	35	20	0	0%	2023	5	5	3	2	3.8	3	5	5	3	4.0	15.00
62	Filter Room	Process Equipment	Filters	Surface wash	Good	Moderate	Frequent	2015	8	25	17	68%	2040	2	2	3	4	2.8	3	3	4	2	3.0	8.25
63	Filter Room	Electrical Equipment	Instrumentation	Filter control system	Very Poor	Moderate	Moderate	1988	35	30	0	0%	2023	5	5	3	3	4.0	3	2	4	3	3.0	12.00
64	Filter Room	Mechanical Equipment	HVAC	Louvers	Poor	Simple	Frequent	1988	35	25	0	0%	2023	4	5	2	4	3.8	1	1	2	2	1.5	5.63
65	Corridor b/t Clarifiers and Filters	Electrical Equipment	MCC	MCC	Fair	Moderate	Moderate	2004	19	30	11	37%	2034	3	3	3	3	3.0	5	3	4	3	3.8	11.25
66	Corridor b/t Clarifiers and Filters	Mechanical Equipment	HVAC	Unit heater	Poor	Moderate	Moderate	2004	19	25	6	24%	2029	4	4	3	3	3.5	1	1	1	3	1.5	5.25
67	Filter Pipe Gallery	Process Equipment	Pump	Backwash Waste Pump	Poor	Complex	Frequent	2004	19	40	21	53%	2044	4	1	4	4	3.3	3	3	2	3	2.8	8.94
68	Filter Pipe Gallery	Process Equipment	Pump	Wash Water Supply Pump 2	Very Good	Complex	Frequent	2021	2	40	38	95%	2061	1	1	4	4	2.5	3	5	3	3	3.5	8.75
69	Filter Pipe Gallery	Process Equipment	Piping and Valving	Filter Influent, isolation valves	Good	Moderate	Frequent	2004	19	40	21	53%	2044	2	1	3	4	2.5	4	2	5	3	3.5	8.75
70	Filter Pipe Gallery	Process Equipment	Piping and Valving	Filter Effluent, isolation valves	Very Poor	Moderate	Frequent	1940	83	40	0	0%	2023	5	5	3	4	4.3	4	2	5	3	3.5	14.88
71	Filter Pipe Gallery	Process Equipment	Piping and Valving	Washwater, isolation valves, check valves, PRV	Good	Complex	Frequent	2021	2	40	38	95%	2061	2	1	4	4	2.8	3	2	5	3	3.3	8.94
72	Filter Pipe Gallery	Process Equipment	Piping and Valving	Backwash Waste, isolation valves	Fair	Moderate	Frequent	1942	81	40	0	0%	2023	3	5	3	4	3.8	4	2	5	3	3.5	13.13

City of Owosso
Water Plant Asset Criticality
WSSN 05120

Needs Replacement in Next 5 Years

Needs Replacement in Next 20 Years

Current Year 2022

No.	Asset Location	Asset Class	Asset Subclass	Description	Physical Conditon	Operational Complexity	Operational Frequency	Useful Life						Probability of Failure					Consequence of Failure (COF)					Business Risk Exposure (BRE)
								Year Installed	Age	Theoretical Useful Life	Remaining Useful Life	% Useful Life Remaining	Theoretical Year to be replaced	Physical Condition Score	Age Factor Score	Operations Complexity Score	Operational Frequency Score	Overall POF	Water Supply	Water Quality	Financial Impact	Safety	Overall COF	
									Years	Years	Years	%	Year	1-5	1-5	1-5	1-5	1-5	1-5	1-5	1-5	1-5	1-5	
														0.25	0.25	0.25	0.25		0.25	0.25	0.25	0.25		1-25
73	Filter Pipe Gallery	Process Equipment	Instrumentation	Mag-meter, pressure transmitter	Fair	Moderate	Frequent	2021	2	25	23	92%	2046	3	1	3	4	2.8	2	2	2	3	2.3	6.19
74	Filter Pipe Gallery	Mechanical Equipment	HVAC	Dehumidifier	Good	Moderate	Moderate	2004	19	25	6	24%	2029	2	4	3	3	3.0	2	1	1	3	1.8	5.25
75	Filter Pipe Gallery	Compressor Room	Plumbing	Storm water sump pump lag 2	Very Poor	Moderate	Irregular	2004	19	25	6	24%	2029	5	4	3	2	3.5	1	1	2	3	1.8	6.13
76	Compressor Room	Process Equipment	Pump	Wash Water Supply Pump 1	Very Good	Complex	Frequent	2021	2	40	38	95%	2061	1	1	4	4	2.5	3	5	3	3	3.5	8.75
77	Compressor Room	Process Equipment	Piping and Valving	Raw water, isolation valves	Fair	Simple	Frequent	1942	81	40	0	0%	2023	3	5	2	4	3.5	4	2	5	2	3.3	11.38
78	Compressor Room	Electrical Equipment	Control	Compressor control panel, disconnect, hour meter panel	Fair	Moderate	Moderate	1980	43	25	0	0%	2023	3	5	3	3	3.5	3	3	3	3	3.0	10.50
79	Compressor Room	Compressor Room	HVAC	Air Compressor 1	Poor	Complex	Moderate	1980	43	25	0	0%	2023	4	5	4	3	4.0	3	1	2	3	2.3	9.00
80	Compressor Room	Compressor Room	HVAC	Air Compressor 2	Poor	Complex	Moderate	1980	43	25	0	0%	2023	4	5	4	3	4.0	3	1	2	3	2.3	9.00
81	Compressor Room	Compressor Room	HVAC	Air Compressor 3	Poor	Complex	Moderate	1980	43	25	0	0%	2023	4	5	4	3	4.0	3	1	2	3	2.3	9.00
82	High Service Pipe Gallery	Process Equipment	Piping and Valving	High Service suction piping, isolation valves	Poor	Simple	Frequent	1942	81	40	0	0%	2023	4	5	2	4	3.8	4	2	5	3	3.5	13.13
83	High Service Pipe Gallery	Process Equipment	Piping and Valving	High Service discharge piping, isolation valves, check valves	Fair	Simple	Frequent	1942	81	40	0	0%	2023	3	5	2	4	3.5	4	2	5	3	3.5	12.25
84	High Service Pipe Gallery	Process Equipment	Instrumentation	Flow Switch	Fair	Moderate	Frequent	2004	19	20	1	5%	2024	3	5	3	4	3.8	1	4	2	3	2.5	9.38
85	Underground Reservoir	Building	Underground Storage	Underground storage reservoir	Very Poor	Simple	Very frequent	1930	93	100	7	7%	2030	5	4	2	5	4.0	5	5	5	3	4.5	18.00
86	High Service	Process Equipment	Pump	High Service Pump 1	Fair	Moderate	Moderate	2021	2	10	8	80%	2031	3	4	3	3	3.3	5	2	3	3	3.3	10.56
87	High Service	Process Equipment	Pump	High Service Pump 2	Fair	Moderate	Moderate	2017	6	10	4	40%	2027	3	5	3	3	3.5	5	2	3	3	3.3	11.38
88	High Service	Process Equipment	Pump	High Service Pump 3	Fair	Moderate	Moderate	2017	6	10	4	40%	2027	3	5	3	3	3.5	5	2	3	3	3.3	11.38
89	High Service	Process Equipment	Pump	High Service Pump 4	Fair	Moderate	Moderate	2022	1	10	9	90%	2032	3	4	3	3	3.3	5	2	3	3	3.3	10.56
90	High Service	Electrical Equipment	Control	High Service 1 Starter	Fair	Complex	Moderate	2004	19	30	11	37%	2034	3	3	4	3	3.3	5	1	3	3	3.0	9.75
91	High Service	Electrical Equipment	Control	High Service 2 VFD	Fair	Complex	Moderate	2022	1	20	19	95%	2042	3	2	4	3	3.0	5	1	3	3	3.0	9.00
92	High Service Balcony	Electrical Equipment	Control	High Service 3 VFD	Good	Complex	Moderate	2023	0	20	20	100%	2043	2	2	4	3	2.8	5	2	3	3	3.3	8.94
93	High Service Balcony	Electrical Equipment	Control	High Service 4 VFD	Good	Complex	Moderate	2020	3	20	17	85%	2040	2	2	4	3	2.8	5	2	3	3	3.3	8.94
94	High Service Balcony	Electrical Equipment	Control	Backwash pump 1 VFD	Very Good	Complex	Moderate	2021	2	20	18	90%	2041	1	2	4	3	2.5	3	3	3	3	3.0	7.50
95	High Service Balcony	Electrical Equipment	Control	Backwash pump 2 VFD	Very Good	Complex	Moderate	2021	2	20	18	90%	2041	1	2	4	3	2.5	3	3	3	3	3.0	7.50
96	Chemical Room	Process Equipment	Pump	Hypochlorite Metering Pumps	Fair	Moderate	Frequent	2004	19	20	1	5%	2024	3	5	3	4	3.8	1	5	2	3	2.8	10.31
97	Chemical Room	Process Equipment	Pump	Fluoride Metering Pumps	Fair	Moderate	Frequent	2004	19	20	1	5%	2024	3	5	3	4	3.8	1	5	2	3	2.8	10.31
98	Chemical Room	Process Equipment	Storage	Hypochlorite bulk storage tank	Poor	Simple	Moderate	1980	43	30	0	0%	2023	4	5	2	3	3.5	1	5	4	3	3.3	11.38
99	Chemical Room	Process Equipment	Storage	Hypochlorite day tank	Fair	Simple	Moderate	2004	19	30	11	37%	2034	3	3	2	3	2.8	1	5	3	3	3.0	8.25
100	Chemical Room	Process Equipment	Storage	Fluoride saturator	Fair	Simple	Moderate	2004	19	30	11	37%	2034	3	3	2	3	2.8	1	5	2	3	2.8	7.56
101	Chemical Room	Process Equipment	Piping and Equipment	Hypochlorite feed piping, accessories	Fair	Simple	Frequent	2004	19	20	1	5%	2024	3	5	2	4	3.5	1	5	2	3	2.8	9.63
102	Chemical Room	Process Equipment	Piping and Equipment	Fluoride feed piping, accessories	Fair	Simple	Frequent	2004	19	20	1	5%	2024	3	5	2	4	3.5	1	5	2	3	2.8	9.63
103	Chemical Room	Mechanical Equipment	Mechanical Equipment	Exhaust Fan, Louver, ductwork	Fair	Moderate	Moderate	2004	19	25	6	24%	2029	3	4	3	3	3.3	1	1	2	3	1.8	5.69
104	Chemical Room	Mechanical Equipment	HVAC	Makeup Aire, MAU-1	Very Poor	Moderate	Moderate	2004	19	25	6	24%	2029	5	4	3	3	3.8	1	1	3	3	2.0	7.50
105	Lab, Control Room & Office	Mechanical Equipment	HVAC	RTU-1	Poor	Moderate	Frequent	2004	19	25	6	24%	2029	4	4	3	4	3.8	1	1	1	3	1.5	5.63
106	Lab, Control Room & Office	Mechanical Equipment	Plumbing	Sink, drains,	Poor	Simple	Frequent	2004	19	25	6	24%	2029	4	4	2	4	3.5	1	1	1	3	1.5	5.25
107	Lab, Control Room & Office	Mechanical Equipment	Plumbing	Eyewash	Good	Simple	Very irregular	2004	19	20	1	5%	2024	2	5	2	1	2.5	1	1	1	4	1.8	4.38
108	Bathroom	Mechanical Equipment	HVAC	Exhaust fan	Fair	Moderate	Moderate	2004	19	25	6	24%	2029	3	4	3	3	3.3	1	1	1	3	1.5	4.88
109	Bathroom	Mechanical Equipment	Plumbing	Sink, drains, fixtures	Good	Simple	Moderate	2004	19	25	6	24%	2029	2	4	2	3	2.8	1	1	1	3	1.5	4.13
110	Locker Room	Mechanical Equipment	Plumbing	Shower, fixtures.	Good	Simple	Moderate	2004	19	25	6	24%	2029	2	4	2	3	2.8	1	1	1	3	1.5	4.13
111	Lab Hallway	Electrical Equipment	Control	CP-CHEM	Fair	Complex	Moderate	2004	19	30	11	37%	2034	3	3	4	3	3.3	1	5	4	3	3.3	10.56
112	Lab Hallway	Mechanical Equipment	HVAC	Unit heater, lab hood exhaust	Fair	Simple	Irregular	2004	19	25	6	24%	2029	3	4	2	2	2.8	1	1	2	3	1.8	4.81
113	Lab Hallway	Mechanical Equipment	Plumbing	Service sink	Good	Simple	Moderate	2004	19	25	6	24%	2029	2	4	2	3	2.8	1	1	1	3	1.5	4.13
114	Lab Hallway	Mechanical Equipment	Plumbing	Eyewash	Fair	Simple	Very irregular	2004	19	20	1	5%	2024	3	5	2	1	2.8	1	1	1	4	1.8	4.81
115	Electrical Room	Electrical Equipment	Power	ATS	Poor	Complex	Frequent	1980	43	30	0	0%	2023	4	5	4	4	4.3	3	3	5	3	3.5	14.88
116	Electrical Room	Electrical Equipment	Power	MDP, DPL, DPR, Transformers	Fair	Moderate	Frequent	1980	43	30	0	0%	2023	3	5	3	4	3.8	3	3	5	3	3.5	13.13
117	Electrical Room	Electrical Equipment	Power	Lighting contactor, transformers	Good	Moderate	Frequent	2004	19	30	11	37%	2034	2	3	3	4	3.0	3	3	4	4	3.5	10.50
118	Second Floor	Mechanical Equipment	HVAC	Louvers, exhaust fans, duct work	Fair	Moderate	Moderate	2004	19	25	6	24%	2029	3	4	3	3	3.3	1	1	2	3	1.8	5.69
119	Lime Silo	Process Equipment	Slaker	Slaker 1, feeder, grit screw, slurry piping	Poor	Moderate	Frequent	2004	19	25	6	24%	2029	4	4	3	4	3.8	3	4	5	3	3.8	14.06
120	Lime Silo	Process Equipment	Slaker	Slaker 2, feeder, grit screw, slurry piping	Poor	Moderate	Frequent	2004	19	25	6	24%	2029	4	4	3	4	3.8	3	4	5	3	3.8	14.06
121	Lime Silo	Electrical Equipment	Panels	LimeOIT, CP-Fill	Poor	Complex	Moderate	2004	19	30	11	37%	2034	4	3	4	3	3.5	3	3	4	3	3.3	11.38
122	Lime Silo	Mechanical Equipment	HVAC	Unit heaters, exhaust fan	Poor	Moderate	Moderate	2004	19	25	6	24%	2029	4	4	3	3	3.5	3	2	2	3	2.5	8.75
123	Lime Silo	Building	Building	Interior walls	Fair	Very simple	Irregular	2004	19	100	81	81%	2104	3	1	1	2	1.8	3	2	5	3	3.3	5.69
124	Carbon Dioxide Tank	Process Equipment	Storage	Liquid CO2 storage tank	Good	Complex	Frequent	2004	19	50	31	62%	2054	2	1	4	4	2.8	2	5	5	3	3.8	10.31
125	Carbon Dioxide Tank	Electrical Equipment	Control	Panel	Fair	Complex	Moderate	2004	19	30	11	37%	2034	3	3	4	3	3.3	2	3	3	3	2.8	8.94
126	Booster Station	Process Equipment	Pump	Booster Pump	Fair	Moderate	Frequent	2018	5	40	35	88%	2058	3	1	3	4	2.8	5	2	3	3	3.3	8.94
127	Booster Station	Process Equipment	Piping and Equipment	Discharge piping, isolation valves	Fair	Simple	Frequent	2018	5	40	35	88%	2058	3	1	2	4	2.5	5	2	2	3	3.0	7.50
128	Booster Station	Process Equipment	Piping and Equipment	Suction piping, isolation valves, altitude valve	Fair	Simple	Frequent	2018	5	40	35	88%	2058	3	1	2	4	2.5	5	2	2	3	3.0	7.50
129	Booster Station	Process Equipment	Storage	Standpipe	Fair	Simple	Very frequent	1970	53	100	47	47%	2070	3	1	2	5	2.8	5	2	5	5	4.3	11.69
130	Booster Station	Electrical Equipment	Power	480V DP, 120V DP, Transformer	Fair	Moderate	Moderate	1970	53	30	0	0%	2023	3	5	3	3	3.5	3	2	3	3	2.8	9.63
131	Booster Station	Electrical Equipment	Control	Pump controls, VFD, altitude valve control panel	Fair	Complex	Moderate	1970	53	30	0	0%	2023	3	5	4	3	3.8	3	2	3	3	2.8	10.31
132	Booster Station	Mechanical Equipment	HVAC	Unit heater	Poor	Moderate	Moderate	1970	53	25	0	0%	2023	4	5	3	3	3.8	2	1	1	3	1.8	6.56
133	Booster Station	Building	Building	Interior walls, roof	Fair	Very simple	Irregular	1970	53	100	47	47%	2070	3	1	1	2	1.8	3	2	5	5	3.8	6.56
134	Elevated Tank	Process Equipment	Piping and Equipment	Fill pipe, isolation valves, check valve	Poor	Simple	Frequent	1997	26	40	14	35%	2037	4	3	2	3	3.0	5	2	4	3	3.5	10.50
135	Elevated Tank	Process Equipment	Piping and Equipment	Control valve	Poor	Complex	Frequent	1997	26	30	4	13%	2027	4	2	4	3	3.3	3	2	3	3	2.8	8.94
136	Elevated Tank	Process Equipment	Instrumentation	Pressure transmitters, level transmitter	Fair	Moderate	Moderate	1997	26	25	0	0%	2023	3	5	3	3	3.5	3	2	2	3	2.5	8.75
137	Elevated Tank	Process Equipment	Storage	Spheroid Tank	Good	Moderate	Very frequent	1997	26	100	74	74%	2097	2	3	3	5	3.3	5	2	5	3	3.8	12.19
138	Elevated Tank	Electrical Equipment	Power	Power panel	Fair	Moderate	Moderate	1997	26	30	4	13%	2027	3	3	3	3	3.0	3	2	3	3	2.8	8.25
139	Elevated Tank	Electrical Equipment	Controls	Telemetry panel	Good	Moderate	Moderate	1997	26	30	4	13%	2027	2	3	3	3	2.8	3	2	2	3	2.5	6.88
140	Elevated Tank	Mechanical Equipment	HVAC	Unit heater, dehumidifer	Very Good	Moderate	Moderate	1997	26	25	0	0%	2023	1	1	3	3	2.0	3	2	2	3	2.5	5.00

fishbeck
Engineers | Architects | Scientists | Constructors

5913 Executive Drive, Suite 100
Lansing, Michigan 48911

517.882.0383 | fishbeck.com

Technical Memo 1

SUBJECT: Owosso Water Treatment Plant – Membrane Softening Evaluation

DATE: August 15, 2023 **PROJECT NO.:** 221152

Introduction

Large capital investment into the Owosso Water Treatment Plant (WTP) will be necessary to replace aging treatment equipment and to address the WTP capacity limitations and operational inflexibility. The existing lime softening process is difficult and labor intensive to operate and produces a large amount of sludge, which has grown increasingly costly to manage and dispose of. In addition, the WTP filtration equipment is in poor condition and needs rehabilitation. This memo will provide an overview of the membrane softening process and will summarize the design basis and estimated project costs for the construction of a new membrane softening treatment plant to replace the existing WTP.

Membrane Softening

Membrane softening can be accomplished using either nanofiltration or reverse osmosis membranes (NF/RO). Visually, the two types of membrane systems are nearly indistinguishable. With the evolution of low-pressure RO membranes, many groundwater softening applications have chosen RO as the more cost-effective method. Selection of the specific membrane type should be made during a detailed design phase and is not pertinent to this level of evaluation. This evaluation will generically refer to membrane softening, encompassing both types of membranes.

The membrane softening process is energy intensive, however it removes virtually all types of dissolved solids including hardness components. Softening membranes have the added benefit of effectively removing many of the currently regulated contaminants such as metals, organics, pesticides, and pathogens (including viruses), and have been shown to be effective in removing many of the emerging contaminants of concern (such as PFAS), as well as unregulated emerging contaminants. Some hardness in the water is desirable to provide a stable and non-corrosive water. To achieve this, the process normally includes bypassing a stream of filtered water that is blended with the permeate water to achieve the target hardness level. Pretreatment and filtration of the membrane feed water and bypass water will be required. In addition, adjustments to the blended softened water (such as pH, alkalinity and/or corrosion inhibitor) may be necessary to prevent unwanted corrosion in the distribution system.

Membrane softening produces a liquid waste stream (called concentrate or reject) which can be challenging to dispose of. As an example, the concentrate stream for a 5.0 MGD (million gallons per day) membrane softening treatment plant will be approximately 1.4 MGD (this will vary depending on the raw water characteristics). The most practiced (and frequently the most cost-effective) option for concentrate disposal across the country and in Michigan is discharge to a surface water (e.g., river or wastewater treatment plant). A cost-effective method of concentrate discharge will be critical to the viability of the membrane softening alternative. One potential option for concentrate discharge is the Shiawassee River, with which the existing WTP borders. Preliminary discussions with the Michigan Department of Environment, Great Lakes, and Energy should be undergone to determine if direct discharge of membrane concentrate to the Shiawassee River via a National Pollutant Discharge Elimination System permitted discharge is a viable approach.

The existing WTP footprint will not accommodate the addition of lime softening equipment. In addition, the options to retrofit components of the existing WTP are limited due to the aging equipment and lack of redundancy within the existing treatment process. A new standalone building will need to be constructed to house the new treatment equipment.

Basis of Design

The new membrane softening treatment plant would be located on the same site as the existing WTP. Demolition of the abandoned flocculation/sedimentation basin to the north of the existing WTP would create sufficient space for the footprint of the membrane softening plant. Figure 1 displays a preliminary site plan of the proposed membrane softening plant.

The membrane softening plant would be initially designed with a treatment capacity of 5.0 MGD, with accommodations to expand the plant to 10.0 MGD in the future to meet larger demands. While the new membrane softening treatment plant could be designed to meet the existing WTP design capacity of 6.0 MGD, the 5.0 MGD alternative would provide cost savings via smaller treatment equipment and would provide sufficient capacity to meet projected maximum day demands.

Pretreatment and filtration of the membrane feed water and bypass water will be required to prevent damage to the membranes. Raw water would be pumped from the supply wells to the new membrane treatment plant, where it would be treated with sodium hypochlorite to chemically oxidize iron in the raw groundwater. Oxidized iron would then be filtered by four horizontal pressure filters in an end-piped configuration with two independent filter cells each. The existing well pumps are likely not currently sized to meet the minimum operating pressures for horizontal pressure filters. New well pumps, motors, and electrical improvements may be needed for the existing wells to provide the required operating pressures. A potential alternative to upgrading the well pumps could be to add a raw water storage tank and low service pump station. While it is expected that the cost of an above ground storage tank and low service pump station will exceed the cost of upgrading the wells, additional benefits through raw water blending and lower operational pressure of the raw water mains could be seen. The hydraulics, capacity, and cost of the raw water storage tank and low service pump station would need to be evaluated and compared to the cost of upgrading the wells as part of a detailed preliminary design.

The four horizontal pressure filters would require a maximum treatment capacity of approximately 6.5 MGD. The extra capacity is necessary, as about 25% of the membrane feed water would be wasted as concentrate in the membrane treatment process. To reduce the building footprint, the filters could be located such that only the end-face of the filter would be inside the building, with the majority of the filter sitting outside. Backwash residuals from the filters would flow to the existing backwash lagoon onsite. The initial building would be designed to accommodate a future building expansion, which would house additional pressure filters to increase the pretreatment capacity to 13.0 MGD. This is the pretreatment capacity estimated to achieve a finished water capacity of 10.0 MGD in the membrane treatment process due to the inherent concentrate (or reject) flow of the process.

The final pretreatment step would see the filtered water pumped through cartridge filters. The cartridge filters provide an additional layer of filtration to ensure the softening membranes are protected and unfouled. An additional intermediate pumping step, upstream of the cartridge filters after the horizontal pressure filters, or downstream of the cartridge filters before the membrane skids, would be needed to ensure that the higher operating pressures are met for the membrane skids.

Following pretreatment, water would flow to the membrane softening skids. The skids contain arrays of pressure vessels, with each vessel containing membrane elements. The pressurized water is forced through the membrane, creating the separate softened permeate flow and concentrated reject flow. A total of 3 membrane softening skids would be needed to meet the initial design capacity of 5.0 MGD. Each skid would have a treated water capacity of 1.38 MGD, for a combined treatment capacity of 4.15 MGD. The remaining flow would be supplied by the membrane bypass line, which mixes with the membrane permeate such that a target finished water hardness value is met. The membrane bypass line would have a flow between approximately 15% to 20% of the finished plant effluent flow, depending on the water quality. In this case, the bypass flow would be approximately 17% of the finished water flow, or 0.85 MGD.

A fourth standby skid would be installed for redundancy and to maintain the firm capacity of the membrane softening plant at 5.0 MGD. With membrane softening, selection of the most appropriate treatment train size is important as the ability to turn down production for a given train limited. The proposed treatment capacity of 1.38 MGD for each skid would be sufficient following mixing of the membrane bypass stream, to meet the projected 2042 average day demand of 1.63 MGD with one train operating. As with the pressure filters, additional membrane skids would be installed along with a future building expansion to obtain a future treatment capacity of 10.0 MGD.

In addition to chemicals for disinfection, dental health, and corrosion control, other chemicals would be needed to clean the membranes and maintain finished water quality. Detailed raw water quality testing would be required to determine the exact chemicals and doses for the membrane softening treatment plant.

Following membrane filtration, the softened permeate would flow to two newly constructed prestressed concrete ground storage tanks. Each tank would have a capacity of 750,000 gallons. The existing below grade concrete storage tank utilized by the existing WTP would be taken out of service.

In conjunction with the new ground storage, a new high service pump station would be constructed in a separate building on the WTP site. This high service station would draw water from the new ground storage tanks and would be sized with an initial firm capacity of 7.0 MGD, with room to expand the capacity in the future to 10.0 MGD. Since the capacity of the high service pump station would exceed that of the treatment plant, operators could utilize the volume in the ground storage to pump to the distribution system to satisfy the peak demands that occur during the day.

Operation of the membrane softening plant would be less labor intensive than the existing lime softening plant. The membrane softening plant would be operated such that a setpoint pressure is maintained at the suction inlet of the high-pressure membrane feed pumps. Wells would automatically turn on and off as needed to maintain the suction pressure necessary to operate the membrane softening process. The membrane softening process would operate based on the levels in the two ground storage tanks. Skids would turn on at a low-level setpoint and would turn off at a high level setpoint.

In addition to their regular maintenance and inspection duties, operators would be required to monitor membrane rejection rates, initialize backwashes and chemical cleanings, adjust chemical feed rates to maintain membrane feed water and plant effluent water quality, and ensure storage levels are kept at appropriate levels. At a treatment rate of 5.0 MGD, operating the plant for 16 hours would produce 3.33 million gallons of water, which is sufficient to meet the 2042 projected maximum day demand of 2.64 MGD. In addition, subject to the approval of the State, the membrane softening plant would be able to operate and treat water semi-automatically overnight, with operators on call to respond to preset alarm or warning conditions. It should be noted that certain functions such as filter backwashes and chemical cleanings would still need to be initiated manually by an operator. Two operators on duty at any given time would ensure the wide range of monitoring, maintenance, operating, and inspection duties would be sufficiently fulfilled. Twenty-eight 8-hour shifts (4 operators per day, 7 days per week) would be the minimum amount needed to operate the plant. This minimum number of shifts could be filled by 4 full-time operators (40 hours/week) and 2 part-time operators (32 hours/week).

Estimated Project Costs

Table 1 summarizes the estimated project costs for the membrane softening plant, ground storage tanks, and high service pump station. The total estimated project cost of $67,990,000 for the membrane softening plant is significantly larger than the combined total estimated costs for the 5-Year and 6–20-Year lime softening treatment plant improvement projects of $39,084,000 developed as part of the *Water Treatment Plant Performance Evaluation* report (2023, Fishbeck). Attachment 1 details the estimated project costs for the improvements to the lime softening treatment plant.

Table 1 – Conceptual Cost Estimate for Membrane Softening Treatment Plant

Description	Conceptual Construction Cost
Demolition	$560,000
Civil	$2,430,000
Building	$9,090,000
Process	$25,930,000
Mechanical	$2,250,000
Electrical	$9,000,000
Estimated Bare Construction Cost	**$49,260,000**
G.C. General (15%)	$7,390,000
Estimated Project Cost	**$56,650,000**
Design and Estimating Contingency (10%)	$5,670,000
Construction Contingency (10%)	$5,670,000
Expected Project Construction Cost	**$62,320,000**
Expected Project Cost at Bid Day	**$67,990,000**

While the estimated capital costs of the upgrades to the existing plant are significantly less than the estimated project costs for the construction of the membrane softening plant, it is expected that the membrane softening plant will provide operational and maintenance savings compared to the existing lime softening plant. The existing lime softening plant incurs large costs to both purchase lime and dispose of lime sludge. It is expected that the membrane softening plant would see significant savings in chemical costs compared to the lime softening plant. Chemical costs for the membrane softening treatment plant were estimated based on the chemical costs similarly sized membrane softening treatment plants.

In contrast, operation of the membrane softening plant is much more energy intensive than the existing lime softening plant. In addition to the continuously operating high-pressure membrane feed pumps, well pumps would need to operate at higher flow and head conditions to accommodate the loss of the membrane waste stream. It is conservatively estimated that energy usage for the membrane softening plant could be double that of the existing lime softening plant for the same amount of treated water.

A final significant operation and maintenance cost that will be incurred by the membrane softening treatment plant is the replacement costs for the membrane elements. It is recommended that every membrane element be replaced every seven years. Should a membrane treatment plant be constructed, the City should budget funds annually for replacement of approximately one-seventh of the total number of membrane elements to ensure replacement membranes can be purchased and installed. It should be noted that membrane replacement does not need to occur all at once, it can be staggered such that a certain number of membranes are replaced annually.

Tables 2 and 3 summarize the estimated annual operating and maintenance costs for the two treatment plant options for the same volume of treated water. The total estimated annual operation and maintenance savings for the membrane softening treatment plant compared to the lime softening treatment plant is $410,500.

Table 2 – Estimated Existing Lime Softening Treatment Plant Annual Operation and Maintenance Costs

Description	Annual Cost
Labor Costs	$840,000
Chemical Usage	$250,500
Electrical Usage	$130,000
Lime Sludge Removal/Reuse	$350,000
Total Annual Operation and Maintenance Cost	$1,570,500

Table 2 – Estimated New Membrane Softening Treatment Plant Annual Operation and Maintenance Costs

Description	Annual Cost
Labor Costs	$590,000
Chemical Usage	$130,000
Electrical Usage	$320,000
Membrane Replacement Costs	$120,000
Total Annual Operation and Maintenance Cost	$1,160,000

Table 4 summarizes the estimated project and annual operation and maintenance costs for both treatment plant options. The payback period for the membrane softening treatment plant, or rather, the amount of time required to recover the additional capital investment of the membrane softening treatment plant through operation and maintenance savings, is estimated to be 70.4 years.

Table 4 – Payback Period Summary

Annual Savings with Membrane Softening	$410,500
Cost of Existing Lime Softening Plant Upgrades	$39,084,000
Cost of New Membrane Softening Plant	$67,990,000
Difference in Construction Cost	$28,906,000
Payback Period (years)	70.4

Non-cost related factors to consider when examining the two different plant options include the limited ability to expand the capacity of the existing plant within the existing footprint, and the increased viability of the membrane softening plant as a more effective treatment process to handle emerging contaminants such as PFAS compared to the existing lime softening treatment process.

Figures

DEMOLITION

NEW CONSTRUCTION

NORTH

SITE PLAN WITH PROPOSED MEMBRANE SOFTENING TREATMENT PLANT

NO SCALE

fishbeck

Engineers | Architects | Scientists | Constructors

Hard copy is intended to be 11"x17" when plotted. Scale(s) indicated and graphic quality may not be accurate for any other size.

City of Owosso

Shiawassee County, Michigan

Water Treatment Plant Performance Evaluation

PROJECT NO.

221152

FIGURE NO.

1

PLOT INFO: Z:\2022\221152\CAD_FIGURES\SITE PLAN.DWG LAYOUT: MEMBRANE SOFTENING LAYOUT DATE: 7/21/2023 TIME: 4:45:50 PM USER: ZGOGULSKI

Attachment

Recommended 5-Year Lime Softening Treatment Plant Capital Improvements Costs

City of Owosso Water Treatment Plant Performance Evaluation (Fishbeck, July 28, 2023)

Project Name	Estimated Project Cost
Filter Improvements	$1,960,000
Electrical Grounding Improvements and Improvements to Meet Code Requirements	$1,550,000
Fluoride Feed Improvements	$350,000
Roofing Replacement	$470,000
Filter Effluent Piping Replacement	$330,000
Aerator Improvements	$260,000
CO_2 Feed Panel Repair	$380,000
Lime Residuals Mechanical Dewatering	$11,520,000
WTP Site Improvements	$185,000
Subbasement Sump Pump Improvements	$49,000
Building Material and Equipment Handling Improvements	$1,000,000
Filter Valve Improvements	$500,000
5-Year WTP Projects Total	$18,554,000

Recommended 6–20-Year Lime Softening Treatment Plant Capital Improvements Costs

City of Owosso Water Treatment Plant Performance Evaluation (Fishbeck, July 28, 2023)

Project Name	Estimated Project Cost
New Reservoir and High Service/Transfer Pumping Building	$12,280,000
Building Improvements (Electrical, HVAC, Roofing)	$760,000
Chlorine Feed Improvements	$1,010,000
Lime Slaking Improvements	$5,180,000
SCADA/Controls Improvements Phase 1	$300,000
SCADA/Controls Improvements Phase 2	$1,000,000
6–20-Year WTP Projects Total	$20,530,000

City of Owosso
Water System Reliability Study and General Plan Update

WSSN No. 05120

Project No. 221152
August 7, 2023

fishbeck
Engineers | Architects | Scientists | Constructors

fishbeck
Engineers | Architects | Scientists | Constructors

1515 Arboretum Drive, SE
Grand Rapids, Michigan 49546

616.575.3824 | fishbeck.com

Water System Reliability Study and General Plan Update

WSSN No. 05120

Prepared For:

City of Owosso
Shiawassee County, Michigan

August 7, 2023
Project No. 221152

List of Figures

Figures Following Report

List of Tables

List of Appendices

List of Abbreviations/Acronyms

ADD	average daily demands
AWWA	American Water Works Association
City	City of Owosso, Michigan
CIP	Capital Improvements Plan
DSM	Distribution System Material
DWSRF	Drinking Water State Revolving Fund
EGLE	Michigan Department of Environment, Great Lakes, and Energy
ERP	Emergency Response Plan
gpm	gallons per minute
ISO	Insurance Services Office
LW-1	Local Well-1
LW-13	Local Well-13
MDD	maximum daily demands
MG	million gallons
mgd	million gallons per day
MOR	monthly operating report
PHD	peak hourly demand
ppb	parts per billion
PS-1	Palmer Street-1 (well)
PS-2	Palmer Street-2 (well)
PS-3	Palmer Street-3 (well)
PS-3A	Palmer Street-3A (well)
psi	pounds per square inch
PVC	polyvinyl chloride
REU	residential equivalent unit
SCADA	supervisory control and data acquisition

State	State of Michigan
VFD	variable frequency drives
WHPP	wellhead protection program
WTP	water treatment plant

1.0 Executive Summary

The City of Owosso (City) owns and maintains a municipal water distribution system that supplies water to residents and businesses within the City and the City of Corunna, as well as to portions of Caledonia and Owosso Townships. Raw water is supplied by five wells with a combined firm capacity of 2.79 million gallons per day (mgd). Firm capacity is determined with the largest process unit out of service. The City owns a water treatment plant (WTP) that is used to soften the groundwater with a State of Michigan (State) rated treatment capacity of 3.0 mgd. The treatment process consists of aeration, solids contact clarification, recarbonation, filtration, chlorination, and fluoridation. The water is then conveyed to the distribution system by the high service pump station with a firm capacity of 8 mgd. The distribution system has an elevated tank, standpipe, and booster station.

The Michigan Department of Environment, Great Lakes, and Energy (EGLE) requires that each public water supply complete a reliability study and update its general plan every five years. This report was completed to fulfill these requirements for the City. This document provides a complete update to the reliability study completed in 2017.

As part of the report, the City's water system was analyzed using a calibrated hydraulic model to assess fire flow and pressure metrics as indicated in the *Recommended Standards for Water Works* (Ten States Standards) and Insurance Services Office (ISO) requirements. These metrics give a general picture of the condition of the system. The water system hydraulic model was calibrated with data collected during six hydrant flow tests completed as part of the study.

Water use data was analyzed from the past 10 years to provide an update to the current and projected average daily demands (ADD), maximum daily demands (MDD), and peak hour demands (PHD). Although population in the City has declined, historical demands have remained consistent over the past decade. Therefore, applying per capita water use and population projections to water demand projections is not recommended since historical demands do not closely correlate to population changes. A conservative approach of assuming a 0.25% annual increase in water use was used to projected water demand within the water system. Projected water demands were updated for the years 2022 through 2042. Table 1 presents the water system demand projections for the current year, as well as the 5-year and 20-year planning intervals.

Table 1 – Water System Demand Projections

Year	ADD (mgd)	MDD (mgd)	PHD (mgd)
2022	1.55	2.51	3.74
2027	1.57	2.53	3.79
2042	1.63	2.62	3.93

The percentage of non-revenue water, or unbilled water, in the system was also evaluated. An average non-revenue water percentage of 16.2% was calculated for the City. A value of 10% non-revenue water is a typical goal for municipal water systems. Continuing regular calibration of the meters at the WTP and throughout the system, especially those serving large customers, will provide the City with the most accurate determination of water usage in the system.

The production capacity of the water supply facilities was evaluated. EGLE generally recommends that communities begin planning for an expansion of their supply system when their MDDs exceed 80% of the firm supply capacity of the water system. The firm well capacity is the limiting factor of the capacity for the overall water system. The projected 2042 MDD will be greater than the water system's current firm capacity. The City is considering WTP improvements and the construction of new wells in the near future.

The water storage available to the system in comparison to the recommended water storage volume based on projected water demands was evaluated. This evaluation was performed for the existing water system and fire protection requirements as well as for expected future development. The existing storage volume was determined to meet the required storage volume for the 20-year study period. However, the City is not able to use the full capacity of its underground reservoir and standpipe. The City has planned improvements to increase usable storage volumes.

Pressures throughout the system were predicted to remain above 35 pounds per square inch (psi) at all locations, the minimum pressure during non-emergency conditions as recommended by the Ten States Standards. A target available fire flow of 1,000 gallons per minute (gpm) was chosen, based on City input and previous studies completed for the City. Areas that did not meet this available fire flow goal were typically served by older dead-end mains. Approximately 17% of the distribution was installed over 75 years ago. It is recommended that the City plan for the replacement of this part of the distribution system within the next 20 years. Developing a sustainable, proactive water main replacement program is an important component of maintaining the water system's performance and avoiding costly reactive emergency repairs and replacement.

Several improvements to the water system have been proposed in the Capital Improvements Plan (CIP), which was developed using hydraulic modeling results and City input. Water main replacements were also recommended for Caledonia and Owosso Townships. Table 2 presents the total estimated costs of these improvements, which are categorized as 5- and 20-year water distribution projects and raw water main improvements for the City, and the total estimated cost for Caledonia and Owosso Townships. Section 11 of this report provides additional explanation of the need for these improvements. The improvements have been identified to increase reliability, improve hydraulic performance, or to replace aging undersized 4-inch cast iron water main.

Table 2 – CIP Improvement Costs

Improvement Category	Total Cost
5-Year Water Distribution Improvements	$11,886,000
20-Year Water Distribution Improvements	$32,855,000
Raw Water Main Improvements	$10,931,000
Caledonia Township Water System Improvements	$4,050,000
Owosso Township Water System Improvements	$1,885,000

2.0 Introduction

The City owns and maintains a municipal water distribution system that supplies water to residents and businesses within the City and the City of Corunna, as well as to portions of Caledonia and Owosso Townships. Groundwater is provided by four supply wells with a combined firm capacity of 2.79 mgd. Firm capacity is determined with the largest process unit out of service. The City's conventional WTP was originally constructed in 1934 with upgrades made in 1941, 1947, 1950, 1962, and 2002. The treatment processes consist of aeration, solids contact clarification, recarbonation, filtration, chlorination, and fluoridation. The aeration system, clarifiers, and recarbonation system have maximum treatment capacities of 3.0 mgd. The filters have a maximum treatment capacity of 4.0 mgd; however, under normal conditions three of the four filters are operated which reduces the treatment capacity to 3.0 mgd. The State has set the WTP's rated capacity to 3.0 mgd.

Finished water is stored at the WTP in a 1.75 million gallons (MG) underground reservoir. The water is then conveyed to the distribution system by the high service pump station with a firm capacity of 8 mgd. The distribution system has a 0.6 MG elevated tank, a 1.192 MG standpipe, and booster station.

The City retained Fishbeck to complete a reliability study and general plan for the City water system. A reliability study is required to comply with the Part 12 and Part 16 rules of the State Safe Drinking Water Act, P.A. 399. A reliability study is required every five years, focusing primarily on comparing firm water supply with present and projected future water demands. A general plan is also required every five years to evaluate the hydraulic performance of the distribution system and the development of the 5-year and 20-year CIP. This report fulfills the regulatory requirements for these two items.

The City has no major residential or industrial projects planned from 2022 through 2042. Although the City and the surrounding area's population has declined in the last ten years, the water demands are projected to increase slightly over the study period to reflect the current water usage trend.

3.0 Historical Water Use

3.1 Water Demands

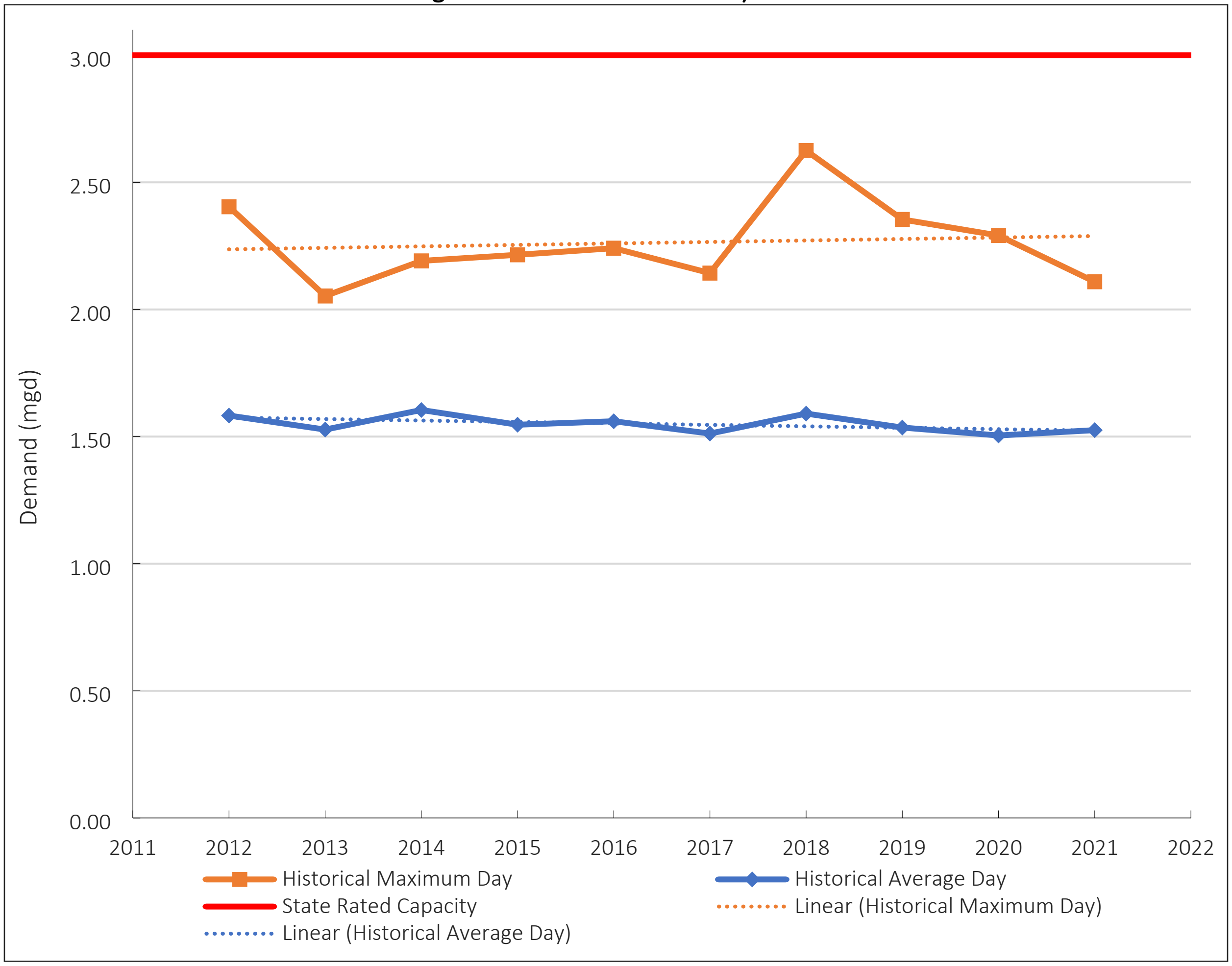
The City's WTP monthly operating reports (MORs) were utilized to analyze historical water use leaving the WTP for the years of 2012 to 2021. The ADD is the average daily volume of water pumped to the system in one year. The MDD is the maximum amount of water pumped to the system in a single day, annually. The ADD, and MDD were determined and calculated for years 2012 to 2021; the historical demands are shown in Table 3 and in Figure 1 where they are compared to the state rated capacity of 3.0 mgd.

Water demands for the City water system have remained relatively consistent the last 10 years. The total monthly pumpage for the water system is included in Appendix 1.

Table 3 – Historical Water Demands (2012-2021)

Year	ADD (mgd)	MDD (mgd)	MDD:ADD Peaking Factor
2012	1.58	2.40	1.52
2013	1.53	2.05	1.34
2014	1.60	2.19	1.37
2015	1.55	2.22	1.43
2016	1.56	2.24	1.44
2017	1.51	2.14	1.42
2018	1.59	2.63	1.65
2019	1.54	2.35	1.53
2020	1.50	2.29	1.52
2021	1.53	2.11	1.38
Average	1.55	2.26	1.46
Maximum	1.60	2.63	1.65
Standard Deviation	0.03	0.17	0.10
95^{th} Percentile	1.61	2.54	1.62

Figure 1 – Historical Water System Demand

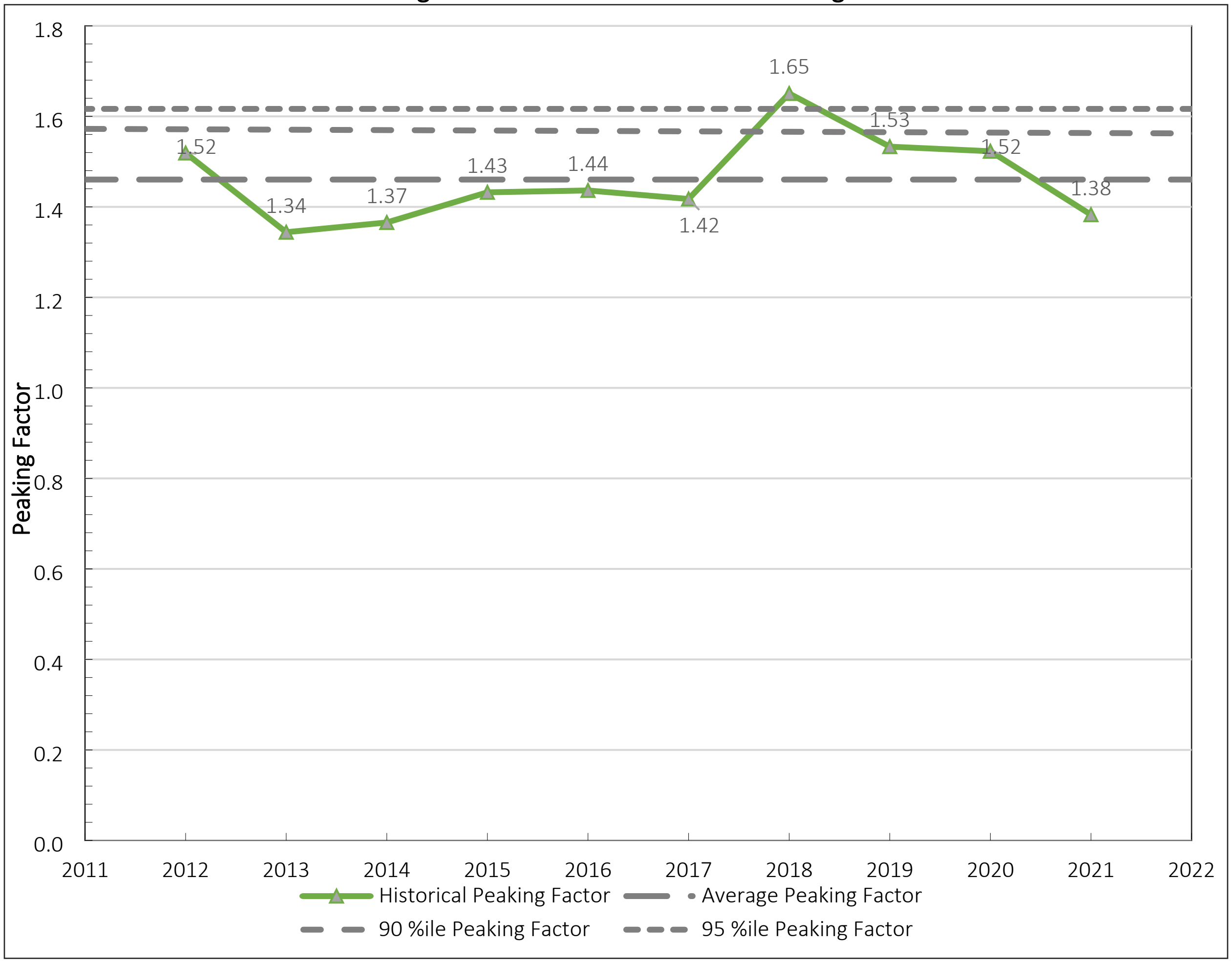


3.2 Peaking Factor

The MDD:ADD peaking factor is determined by the ratio of MDD demands to the ADD. Figure 2 shows the peaking factors observed over the last ten years. The peaking factor has remained relatively consistent over the last 10 years.

The MDD:ADD peaking factor is a useful tool in developing MDD projections. Statistical analysis of the historical peaking factors was performed to determine the peaking factor applied to the ADD to calculate the MDD projections. The starting point for peaking factor projections was set equal to the average of the data plus 1.65 standard deviations of the dataset. Statistically, assuming a normal distribution of the data, this value is predicted to be greater than 95% of the future peaking factors based on the observed data, assuming the data is normally distributed. In other words, there is a 95% chance in a single year that the peaking factor for that year will fall below this projected peaking factor. An MDD:ADD peaking factor starting point of 1.62 was used.

Figure 2 – Historical MDD:ADD Peaking Factor



The PHD are not currently measured and recorded by the City or the WTP. For purposes of this study, a typical PHD:MDD peaking factor of 1.5 was used to estimate PHD. The estimated peaking factor of 1.5 is typical for a municipal system.

3.3 Non-Revenue Water

Water distribution systems typically "lose" water due to unmetered usage, leaks, meter errors, firefighting, illegal water use, or other reasons. This lost water is referred to as non-revenue water. One metric that can help to indicate the health of a water system is the percentage of water supplied to the system that is not billed to the customer, also known as non-revenue water. In general, municipal water systems strive to reduce unaccounted water to less than 10% of total water use, but non-revenue water percentages of 10 to 15% is considered typical.

Historical WTP discharge and billing data were examined to estimate the percentage of water lost or otherwise non-revenue water. The City records the amount of finished water used for backwashing the filters each day and the recorded backwash volume was removed from the non-revenue calculations. The billing data was compiled, analyzed, and compared to the WTP discharge totals to determine the amount of non-revenue water and is summarized in Table 4. The City's non-revenue water as a percentage of the total water supplied averaged out to 16.2% from fiscal years (FY) 2017 to 2019.

The City was above the recommended 10% metric in each of the years analyzed. There are steps that can be taken to mitigate non-revenue water for the City. Replacement of water mains as recommended in the later sections of the study, especially the oldest water mains in the system, will replace the segments of water main at the highest risk for leakage and lost water. The City could use a meter tracking and replacement program for larger users. The City has installed new backwash pumps in 2021 which has reduced the frequency and volume of backwash water.

It should be noted that the non-revenue water volume was not adjusted to include the volume of water used for flushing the distribution systems or fire protection. Recording the volume of water used for these purposes, even estimates, will help the City better account for the final use of the water leaving the WTP. Though the volume of water used for flushing and fire protection will not generate revenue for the City's water system, it will better inform the City on accounting for its non-revenue water.

Table 4 – Non-Revenue Estimation

Fiscal Year	Water to the System (MG)	Metered Sales (MG)	Non-Revenue Volume (MG)	Backwash Filter Volume (MG)	Non-Revenue Water (%)
2017	553.4	463.6	72.2	17.5	13.1%
2018	580.5	420.9	125.6	33.9	21.6%
2019	560.2	448.7	78.5	33.0	14.0%
Average	564.7	444.4	92.1	28.1	16.2%
Maximum	580.5	463.6	125.6	33.9	21.6%
Minimum	553.4	420.9	72.2	17.5	13.1%

Continuing regular calibration of the primary meter at the WTP and throughout the system, especially those serving large customers, will give the City an accurate picture of what is occurring in the system and maintain the accuracy of the meters at the critical locations with the highest water usage. To account for issues with meter battery life, the City is considering installing residential meters with integral valves. The City is considering metering the filters individually at the WTP and a replacement effluent meter will be installed soon. The City should continue practices that have reduced non-revenue water and continue to monitor this metric to evaluate if any additional changes are needed.

3.4 Top Water Users

Table 5 presents the largest water users in the water system for 2021. The total volume of water used by the largest users equates to approximately 27.6% of the total volume of water leaving the WTP.

In the hydraulic model, these large user demands were applied to the nearest junction. The remaining demand for the water system was evenly distributed across the remaining junctions in the hydraulic model.

Table 5 – Summary of Largest Water Users

Rank	Customer	Service Location	Average Demand (gpm)	Percentage of FY22 Pumpage
1	SCA North America	123 North Chipman Street	20.15	8.97%
2	Memorial Hospital	826 West King Street	10.72	4.77%
3	Medical Care Facility	275 Caledonia Drive	3.56	1.59%
4	Georgia Pacific	465 South Delaney Road	3.01	1.34%
5	Woodard Station	317 South Elm Street	2.90	1.29%
6	Letavis Car Wash	1090 East M21	1.83	0.81%
7	Wakeland Oil Company	527 South Washington Street	1.51	0.67%
8	1720 East Main LLC	2170 West Main Street M21	1.45	0.64%
9	Machine Tool & Gear	401 South Chestnut Street	1.17	0.52%
10	Biomedical Applications of MI	500 Health Park Drive	1.17	0.52%
		Total	1,197	27.57%

4.0 Population and Projections

The historical population data was obtained from the US Census Bureau. There is no known data from any regional planning agency providing future population projections. The City of Owosso's population decreased by 0.4% annually between 2010 and 2020. Table 6 and Figure 3 indicate the historical and projected population served by the City's water system through 2042.

Several assumptions were made about the historical and future population projections for determining the total population served by the City's water system. The historical data documents show a decline in the City's population since 2010. A conservative approach, in relation to past population trends, of -0.25% annual change in population was used to project future population for the City. The same population decline of -0.25% was applied to the City of Corunna and Caledonia and Owosso Townships.

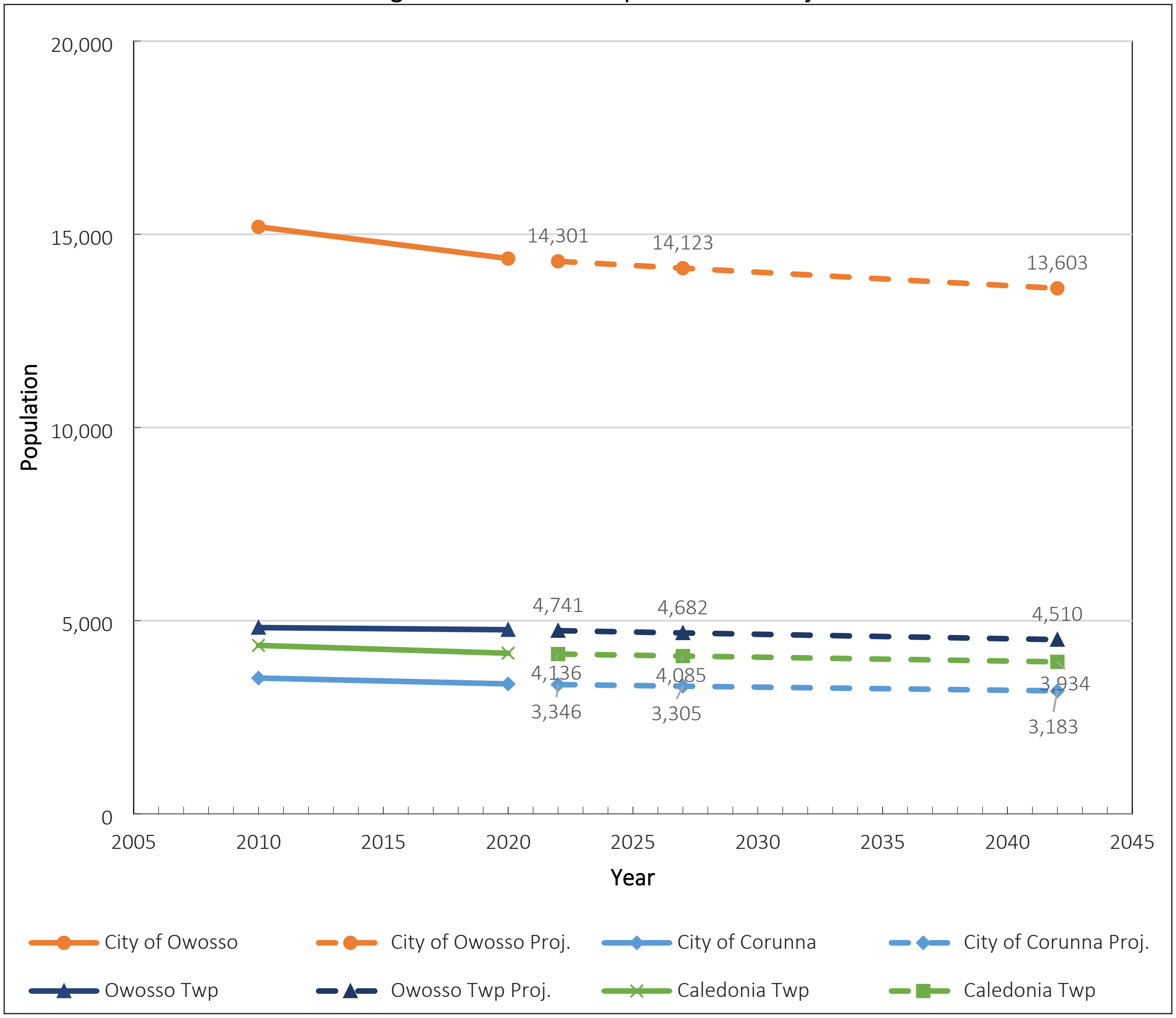
The total population served by the City's water system in 2020 was 26,658 people. The population served in 5 years is anticipated to decrease by 330 people and by 1,295 people in 20 years.

Table 6 – Population Projections for the City's Water Service Area

Year	City of Owosso	City of Corunna	Owosso Twp	Caledonia Twp	Total
2010*	15,194	3,515	4,821	4,360	27,890
2020*	14,373	3,363	4,765	4,157	26,658
2022 Projection**	14,301	3,346	4,741	4,136	26,525
2027 Projection**	14,123	3,305	4,682	4,085	26,195
2042 Projection**	13,603	3,183	4,510	3,934	25,230

**US Census Bureau*
***Rate of decline -0.25% annually*

Figure 3 – Historical Population and Projections



5.0 Water Demand Projections

In order to project future water demands, the starting point for both the ADD and MDD projections was estimated. The starting point for the ADD was set as the average ADD from 2012 to 2021 of 1.55 mgd. The starting point for the MDD was set by multiplying the ADD of 1.55 mgd by the 95th percentile MDD:ADD peaking factor of 1.62. The starting point for the MDD using said peaking factor is 2.51 MGD. The projected peak hour demand was estimated by multiplying the projected MDD by 1.5.

The City's population has been decreasing from 2010 to 2020, yet the water use has remained consistent. Therefore, applying per capita water use and population projections to water demand projections was not used since historical demands do not closely correlate to population changes. To be conservative, a growth rate of 0.25% annually was applied to projected water demands.

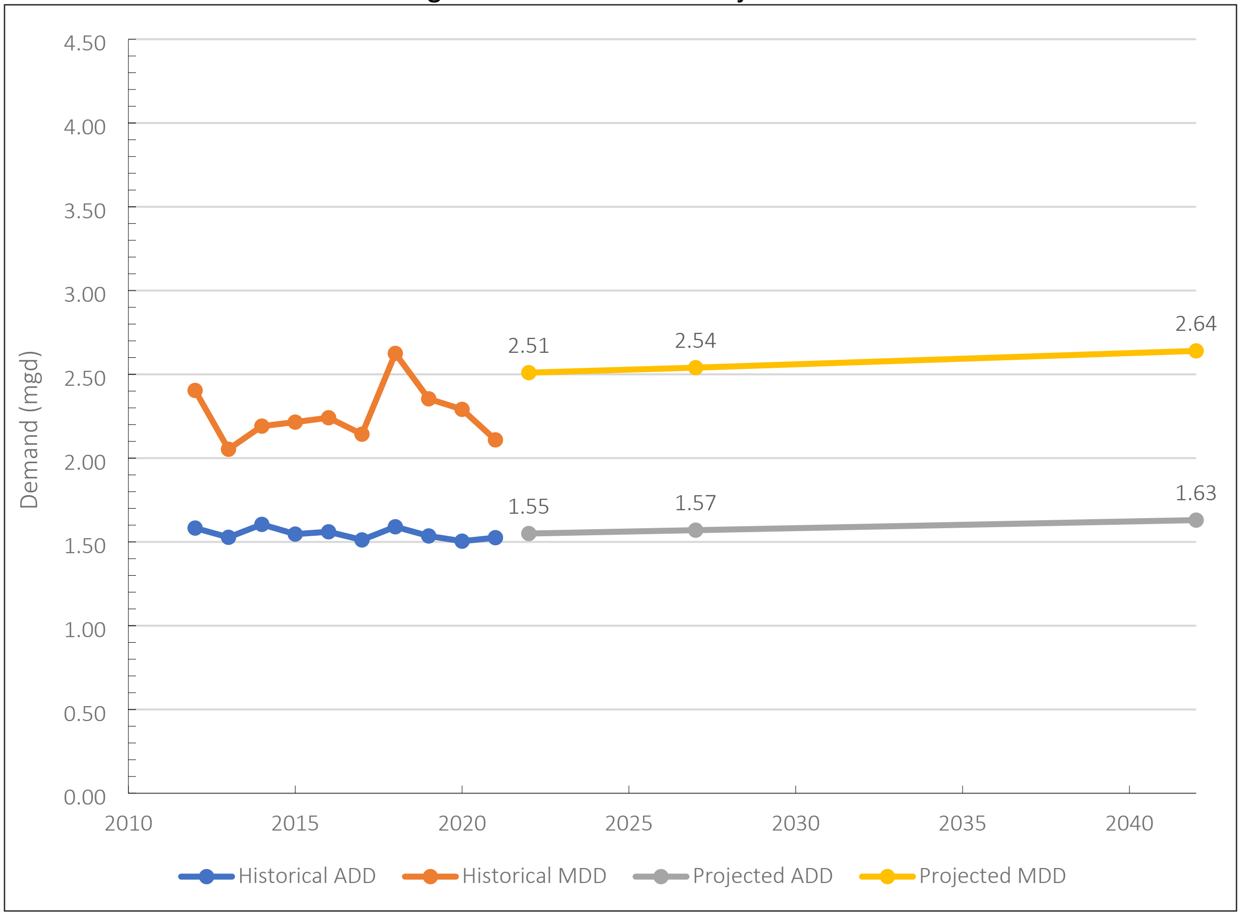
Table 7 and Figure 4 indicate the historical datasets and projected water demands for the ADD, MDD, and PHD through 2042.

Table 7 – Projected Water Demands Through 2042

Year	Projected ADD (mgd)	Projected MDD (mgd)	Projected PHD (mgd)
2022	1.55	2.51	3.76
2027	1.57	2.54	3.81
2042	1.63	2.64	3.96

MDD:ADD Peaking Factor = 1.62
PHD:MDD Peak Hour Factor = 1.5

Figure 4 – Historical and Projected Demands



6.0 Water Supply

6.1 Raw Water Supply

The City has five functional groundwater supply wells. Two wells, Palmer Street-1 (PS-1) and Palmer Street-3 (PS-3) are no longer operational. Of the five functional wells, three wells, Local Well-1 (LW-1), Hintz 1, and Palmer Street-2 (PS-2), are the primarily production wells for the WTP. The other wells, Local Well-13 (LW-13) and Osburn, are currently serving as an emergency backup due to higher levels of hardness which is more expensive to treat. The City has plans to decommission LW-13. To maintain sufficient raw water for the system, the City has been testing and planning to develop an additional well at Juniper Street to eventually replace LW-13 and to develop a new well (Palmer Street-3A) at Palmer Steet to replace PS-3. Table 8 outlines the current and firm capacities of the City's current supply wells.

Table 8 – Current and Future Supply Wells

Well	Year Installed	Last Rehab	Permit Capacity (gpm)	Current Capacity (gpm)	Current Capacity (mgd)	Long Term Plan
LW-1	Pre 1960	2021	700	403	0.58	Primary Production Well
Hintz 1	1968	2019	730	482	0.69	Primary Production Well
PS-2	1963	2014	757	722	1.04	Primary Production Well
LW-13	1955	2016	750	482	0.69	Emergency Backup until Decommissioned
Osburn	1968	2023	722	570	0.82	Emergency Backup
PS-1	1963	1975	-	-	-	Out of Service
PS-3	1964	2012	-	-	-	Out of Service
PS-3A	2023	-	-	-	-	In Development
Juniper 1	2023	-	-	-	-	In Development
Total Capacity			3,659	2,659	3.83	
Firm Capacity			2,902	1,937	2.79	

6.2 Water Treatment

The City's WTP is used to soften the raw water. The WTP consists of aeration, solids contact clarification, recarbonation, filtration, chlorination, and fluoridation. The aeration, clarification, and recarbonation systems have a maximum treatment capacity of 3.0 mgd. There are four filters with a maximum treatment capacity of 4.0 mgd; however, the WTP normally operates with only three filters running for a total treatment capacity of 3.0 mgd. The limiting treatment capacity is the source water with a firm capacity of 2.79 mgd.

6.2.1 Treatment Process

Raw water from the groundwater wells is transported to the WTP through a 20-inch transmission main prior to aeration. Aeration is accomplished through an induced draft aerator to strip carbon dioxide from the raw water and oxidize iron. The aerated water is treated with lime prior to the clarifiers to aid in softening the raw water.

Coagulation and flocculation take place in the two upflow clarifiers. The clarifiers operate in series. The next process is recarbonation; A recarbonation tank with baffles is provided to maximize contact time to lower pH.

The final treatment process is filtration. Chlorine is added prior to the filters. Each filter is a single, dual media filter which can be operated independently. Normal operation involves three of the four filters running. The media profile consists of anthracite (top layer), sand (middle layer), and gravel (bottom layer). After the filters, fluoride and additional chlorine are added to the effluent before the water is gravity fed to the WTP's underground reservoir. The high service pumps convey the water from the suction wells to the distribution system.

6.2.2 High-Service Pumping

The City has four active high service pumps. Pumps 1 and 2 take suction from the West Suction Well and are both constant speed pumps. Pumps 1 and 2 are operated once monthly to verify reliable operation. Pump 3 takes suction from the West and South Suctions Wells, while Pump 4 takes suction from the South Suction Well. The West Suction Well is 30,000 gallons; the South Suction Well is 20,000 gallons. Pumps 3 and 4 are controlled by variable frequency drives (VFD). The capacity of the high service pumps is listed in Table 9.

Table 9 – High Service Pumps Capacity

Pump	Capacity (gpm)	Capacity (mgd)
HS Pump 1	2,200	3.17
HS Pump 2	2,200	3.17
HS Pump 3	2,200	3.17
HS Pump 4	2,200	3.17
Total Capacity	8,800	12.68
Firm Capacity	6,600	8.00

The firm capacity of the high service pumps is limited by the combined discharge line which does not allow three pumps to operate at their full capacity.

6.3 Standby/Auxiliary Power

The WTP has a 350-kW diesel generator that is available to provide primary backup power. The generator is capable of running LW-1 and the entire WTP. The generator is located behind the WTP.

6.4 Source Water Protection

The City completed a Wellhead Protection Program (WHPP) in 2022 to protect against contamination of water. The WHPP includes the five operational groundwater wells and sites for a new Palmer Street well. The WHPP will require an update with the addition of the Juniper well.

6.5 Water Shortage Response

The City completed an Emergency Response Plan (ERP) in May 2021. This plan outlines critical contacts that may be needed in an emergency for public notification, contractors, or suppliers for equipment. Contact information is also included for critical water customers. A copy of the City's ERP is included in Appendix 2.

7.0 Water Storage

The City water system was evaluated to determine if it has adequate storage capacity. This analysis was based on emergency storage, fire protection and operational equalization volume. The existing system has an elevated tank and a standpipe located in the distribution system. An underground storage reservoir is located at the WTP.

7.1 Storage Capacity

The elevated tank, standpipe, and underground storage reservoir information is presented in Table 10. The elevated tank located on Delaney Road was constructed in 1997 and has a capacity of 600,000 gallons. The standpipe located on Gute Hill was constructed in 1950 and has a total capacity of 1,192,000 gallons. The usable capacity of the standpipe is 25 feet which corresponds to 556,000 gallons. When the standpipe has 40 feet of water the normal low-level alarm goes off and the remainder of the storage (636,000 gallons) is unable to be utilized due to suction pressure issues with the booster station pump.

An underground reservoir was constructed in 1920 and unfortunately, the size of the reservoir is not accurately known. The size indicated on the 1920 drawings is 1.75 MG, while the size on the 1934 drawings is 1.5 MG. The reservoir volume is assumed to be 1,750,000 MG based on calculations done using the 1920 drawing sections and the 1934 reservoir area which matches the volume listed on the 2018 Sanitary Survey.

Table 10 – Available Water Storage Summary

	Elevated Tank	Standpipe	WTP Reservoir
Tank Location	Delaney Road	Gute Hill	WTP
Tank Type	Elevated	Standpipe	Reservoir
Ownership	City	City	City
Installation Year	1996	1953	1930
Capacity (gal)	600,000	1,192,000	1,750,000
Usable Capacity (gal)	600,000	556,000	500,000
Range of Operation (ft)	7.5	20	1.5
Upper Level (ft)	34.5	65	11
Lower Level (ft)	27	40	9.5

7.2 Storage Condition Assessment

Several improvements were recently completed on the elevated tank. These improvements include replacing mud valves, replacing vents, installing a tank mixer, installing an overflow flap gate, removing cathodic protecting system, and installing gaskets on the roof and access tube hatches.

The standpipe received a number of improvements recently. These improvements include installing roof ladders, replacing vents with vacuum relief vents, installing an overflow flap gate and a tank mixer, welding cathodic lift hole plates to the roof, installing conduit routing lugs to exterior, removing existing cathodic protection system, installing a mixing system, controls, and appurtenances, installing roof, accessways, gaskets, and screens, and ancillary mechanical, installation of a gravel driveway, and electrical and site improvements. The City still has several additional improvements planned for the standpipe. These include installing isolation valves on the distribution system to allow for tank draining without shutting off customers, repairing and replacing altitude valves, updating the signage, updating SCADA (supervisory control and data acquisition), and implementation of inspection and maintenance standard operating procedure.

The reservoir was last inspected by Liquid Engineering Corporation in 2002. At the time of the inspection, the reservoir was in overall good condition with a few spots of hairline fractures with minor effloresce visible. Some possible leaks were detected at the expansion joints. The current condition of the reservoir, indicated by operational data, is poor. The reservoir's age is over 90 years, and the isolation valves and piping are in very poor condition. The recommended 3-to-5-year cleaning and inspections cannot be performed in the reservoir's current state. Isolation valves and pipe replacements would be required to isolate the reservoir and suction wells for inspection. The City plans to replace the existing reservoir.

7.3 Storage Volume Assessment

The City provides water service to residential, commercial, and industrial customers. In addition to the main function of the water system of providing potable water for consumption and domestic use, providing adequate fire protection and emergency storage for the service area is important as well. It is understood that the pressures in the remainder of the system will decrease slightly as the fire flows occur and the storage volume is drawn down, but this analysis focuses on evaluating the volume available for emergency conditions and fire protection. The ISO provides fire protection recommendations for various building types; the American Water Works Association (AWWA) also developed resources for determining requirements. Table 11 highlights the typical fire flow requirements by building classification.

Table 11 – ISO Recommended Target Fire Flows

Classification	Recommended Fire Flow (@20 psi) (gpm)	Duration (hours)
Residential	1,500	2
Commercial	2,500	2
Institutional (school, hospital)	3,000-3,500	3
Industrial	3,500	4

One method to calculate the required storage volume for the City, accounts for emergency, fire protection, and equalization storage. The two largest values are combined to determine the recommended storage volume. Equalization storage was calculated by multiplying the MDD by 25%. Fire flow was calculated based on a 3,500 gpm over a 4-hour duration. This is recommended to protect large industrial locations in the City. An emergency storage volume equal to 50% of the ADD was used to determine the emergency storage requirements over an average 12-hour emergency. The emergency and fire flow storage were greater than the equalization requirement, so they were used for the recommended storage volume calculation.

A summary of the values used for the calculation and the calculated results are presented in Table 12. The full calculations are included in Appendix 3. Based on the recommended storage analysis and available storage volume, the City's current water storage is equal to the recommended storage volume.

Table 12 – Recommended Storage Volume

Storage Requirement Metric	Volume (gallons)
Emergency (50% of ADD)	815,000
Fire Flow (3,500 gpm for 4 hours)	840,000
Equalization (25% of MDD)	655,000
Existing Usable Storage	1,656,000
Recommended Storage (based on calculation)	1,655,000
Additional Storage Needed	0

Although the City meets the recommended storage volume, the standpipe and the underground reservoirs' storage volume cannot be fully utilized in their current conditions. The booster station pump is limited hydraulically by the level in the standpipe. The existing booster pump capacity is rated for 1,000 gpm; however, the pumping capacity decreases significantly as levels in the standpipe drop. To address these hydraulic issues, the City has plans for a number of upgrades at the booster station in 2025. The improvements include replacement of the existing pumps, reworking the piping layout to improve hydraulic performance, installation of flow meters and level sensors, replacement of the pump VFD, and improvements to the SCADA system. The upgrades for the booster station are included in Appendix 4 and the estimated cost is $834,000.

The underground storage reservoir is in poor condition and only a portion of it can be used because of issues with high service pump startup when the reservoir is below 9 feet. The City plans to take the reservoir out of service and construct two new 0.75 MG underground reservoirs. For more detail on reservoir improvements, see the *Water Treatment Plant Performance Evaluation* completed by Fishbeck in 2023. Once these improvements are completed, the City will have well above the recommended storage volume for the study period.

8.0 Water Distribution System

The distribution system includes over 109 miles of water mains, primarily cast iron, ductile iron, and polyvinyl chloride (PVC).

8.1 System Connections

The current number of service connections in the water system by meter size is shown in Table 13.

Table 13 – Service Connections

Service Size	Number of Connections
5/8"	6,039
3/4"	53
1"	112
1 1/2"	91
2"	55
3"	28
4"	6
6"	2
Total Services	6,386

Table 14 summarizes the estimated residential equivalent units (REU) for the City system. Each REU represents the water use for a single-family dwelling. For other types of customers, the REUs are estimated based on that customer's water use in comparison to a single-family unit.

Table 14 – System REUs

Service Size	Number of Connections	REU Meter Equivalent	REUs per Service Size
5/8"	6,039	1.0	6,039
3/4"	53	1.1	58
1"	112	1.4	157
1 1/2"	91	1.8	164
2"	55	2.9	160
3"	28	11.0	308
4"	6	14.0	84
6"	2	21.0	42
		Total Estimated REUs	7,012

8.2 Water Mains

The City's water distribution system map is illustrated in Figures 7 to 10 following the report. The City's Geographic information system and data indicate there are more than 109 miles of water main in its water distribution system. The water distribution is connected to water mains in the City of Corunna, as well as to portions of Caledonia and Owosso Townships. Figure 7 shows the general plan map of the City's water system, including mains, hydrants, valves, storage tanks, and pumps. The water mains in the City of Corunna are not included. The water main sizes in the water system range from 4 to 24 inches. The lengths of water main are listed by diameter in Table 15 and are shown in Figure 8.

Table 15 – Main Lengths by Water Main Diameter

Diameter (inches)	Water Main Length (feet)	Percent of Water Main by Length
Unknown	3,903	0.68%
4-inch	67,711	11.75%
6-inch	233,668	40.56%
8-inch	126,084	21.89%
10-inch	3,111	0.54%
12-inch	99,788	17.32%
14-inch	365	0.06%
16-inch	35,542	6.17%
20-inch	4,996	0.88%
24-inch	878	0.15%
Total	576,045	100.00%

The City's water main lengths are indicated by water main material in Table 16. The water main materials in the City's system are shown in Figure 9. A little more than 45% of the water system is cast iron, 29% is ductile iron, and 11% is PVC. Approximately 14% of the distribution system pipe material is unknown.

Table 16 – Main Lengths by Water Main Material

Pipe Material	Water Main Length (feet)	Percent of Water Main by Length
Unknown	83,450	14.49%
Ductile Iron	169,722	29.46%
PVC	62,828	10.91%
Cast iron	260,046	45.14%
Total	576,045	100.00%

The approximate years of installation for mains throughout the City System are listed by their corresponding length in Table 17 and shown in Figure 10. One third of the water system was installed in the 1950s and 17% of the water main has an unknown installation date, but these water mains were assumed to have been installed more than 75 years ago.

Table 17 – Main Lengths by Water Main Age

Approximate Year of Installation	Water Main Length (feet)	Percent of Water Main by Length
*75+ years old	99,303	17.24%
1920-1929	1,130	0.20%
1950-1959	193,100	33.52%
1960-1969	75,517	13.10%
1970-1979	23,359	4.06%
1980-1989	12,861	2.23%
1990-1999	32,193	5.59%
2000-2009	56,762	9.85%
2010-2019	56,901	9.88%
2020-current	24,921	4.33%
Total	576,045	100.00%

**Unknown installation date*

8.3 Gute Hill Booster Station

The Gute Hill Booster Station is connected to the standpipe located off Krouse Road between South Pearce Street and Walnut Street. The booster station has one pump that is manually controlled from the WTP but is scheduled to be automated with control upgrades at the WTP. The pump is controlled by a VFD. The design capacity of the pump is 1,000 gpm; however, the booster station capacity is limited hydraulically by the level in the standpipe. As the water level in the standpipe drops, the pumping capacity significantly decreases.

9.0 Hydraulic Model

The water distribution system evaluation included calibrating the hydraulic model with hydrant flow testing data obtained in the field. The calibrated hydraulic model was used to predict system performance. The system's reliability in meeting projected water demands and fire flows at adequate pressures was assessed. Recommendations were provided for system improvements based on the hydraulic modeling analysis.

9.1 Hydrant Flow Testing

Hydrant flow test locations were identified in the hydraulic model by determining where the system could be significantly stressed to evaluate performance of the system in the field. In choosing the hydrant flow test locations, the age, diameter, location, and material of the distribution mains in the system were considered. In total, six flow tests were completed with five hydrants used in each test. For each test, one hydrant was flowed, while residual pressures were observed at the hydrants not flowing. A list of the hydrant flow test locations used for the calibrations is included in Appendix 5.

9.2 Hydraulic Model Development

System operational data was recorded during the flow tests, including tank levels and pump operation. This data was used to adjust settings for pumps and tanks in the hydraulic model during calibration. During the flow tests, the elevated tank was offline for maintenance. To account for this in the model, the elevated tank was made inactive for calibration. The Hazen Williams pipe friction C-factors, or pipe condition factors, were then adjusted over several iterations, to bring the hydraulic model output towards the results observed in the field. The model static and residual pressure outputs were brought to within 3 psi of the field data for most flow tests. For Flow Test A and Flow Test C, there was one pressure logger that was not within 3 psi of the observed data. However, the calibration was considered to be successful. The model calibration data is included in Appendix 6. Due to errors with pressure loggers and data loss, some of the tests have a limited number of missing data points.

The calibration process grouped pipes in the model by material and age. It was assumed that mains with similar age and material would have similar C-factors. C-factors were then adjusted as required to calibrate the model. Table 18 summarizes the percentage of pipes for various ranges of C-factors after model calibration. A fairly large percentage of pipes have very low C-factors which typically correspond to older, corroded pipes in poor condition. These results were generally in keeping with similarly aged water systems in the State.

Table 18 – Distribution of Friction Factors

Hazen-Williams C-Factor	Percent of Water Main by Length
< 60	39.51%
60-69	13.38%
70-79	3.60%
80-89	11.69%
90-99	3.37%
100-109	8.66%
110-119	3.50%
> 120	16.29%
Total	100.00%

10.0 Water Distribution System Evaluation

A detailed evaluation of the City's water distribution system was conducted as a part of the Water Reliability Study Update. The hydraulic model was used to evaluate the capability of the City's system to meet current and future system demands. Results from the hydraulic modeling were used to form the basis of recommendations for distribution system improvements.

10.1 2022 Demand with Current System Model Runs

10.1.1 Pressure Analysis

The calibrated model was run with the 2022 peak hour demand condition of 3.74 mgd to evaluate the system wide pressures of the current distribution system when considerably stressed. In this scenario, it is assumed that the water leaving the WTP was at 75 psi and the initial level in the West Tank was set at 30 feet. The initial level in standpipe was 60 feet and the Gute Hill Booster Station was running. Figure 11 illustrates the resulting pressure contours for the 2022 peak hour model run.

Pressures ranged from 40.2 to 75.3 psi throughout the system. Pressures below 35 psi are considered deficient, so the pressures predicted by the model exceeded the Ten States Standards recommendations. Areas with lower pressures were at higher elevation than surrounding pipes. It should be noted that without the booster station running, pressures around the standpipe borderline 35 psi. The standpipe is used to maintain adequate pressures throughout the system and is a vital component of the water system.

Additionally, the hydraulic model is evaluated at worst-case scenario conditions with the maximum expected system demands and elevated storage tanks at the low-end of their operating range, the results shown in Figure 11 indicate the worst pressures expected.

10.1.2 Available Fire Flow Analysis

Using the model, available fire flow analyses were also conducted. The model calculates available fire flow by calculating the maximum flow rate that can be withdrawn from the system at any given node while maintaining a pressure of 20 psi at all other nodes in the model. For this study, an available fire flow goal of 1,000 gpm was chosen as the criteria to be evaluated for the model runs. Fire flows less than 1,000 gpm are considered deficient based on ISO recommendations for residential fire protection.

A fire flow analysis was completed for the system using the 2022 MDD of 2.51 mgd. In this scenario, it is assumed that the water leaving the WTP was at 75 psi and the initial level in the West Tank was set at 30 feet. The initial level in the standpipe was 60 feet and the Gute Hill Booster Station was running. Figure 12 illustrates the resulting available fire flow contours. The deficient fire flow locations were typically dead-end mains that were served by 4-inch water mains. Another deficient fire flow location was the area east of the WTP and north of Corunna Avenue to the Shiawassee River.

10.2 2027 Demand with Current System Model Runs

10.2.1 Pressure Analysis

The calibrated model was run with the 2027 peak hour demand condition of 3.79 mgd to evaluate the system wide pressures of the current distribution system when considerably stressed. In this scenario it is assumed that the water leaving the WTP was at 75 psi and the initial level in the West Tank was set at 30 feet. The initial level in the standpipe was 60 feet and the Gute Hill Booster Station was running. Figure 13 illustrates the resulting pressure contours for the 2027 peak hour model run.

Pressures ranged from 40.1 to 75.2 psi throughout the system. Pressures below 35 psi are considered deficient, so the pressures predicted by the model exceeded Ten States Standards recommendations. Areas with lower pressures were at higher elevation than surrounding pipes.

10.2.2 Available Fire Flow Analysis

A fire flow analysis was completed for the system using the 2027 MDD of 2.53 mgd. In this scenario it is assumed that the water leaving the WTP was at 75 psi and the initial level in the West Tank was set at 30 feet. The initial level in the standpipe was 60 feet and the Gute Hill Booster Station was running. Figure 14 illustrates the resulting available fire flow contours. The deficient fire flow locations were typically dead-end mains that were served by 4-inch water main. Another deficient fire flow location was the area east of the WTP and north of Corunna Avenue to the Shiawassee River.

10.3 2042 Demand with Current System Model Runs

10.3.1 Pressure Analysis

The calibrated model was run with the 2042 peak hour demand condition of 3.93 mgd to evaluate the system wide pressures of the current distribution system when considerably stressed. In this scenario it is assumed that the water leaving the WTP was at 75 psi and the initial level in the West Tank was set at 30 feet. The initial level in the standpipe was 60 feet and the Gute Hill Booster Station was running. Figure 15 illustrates the resulting pressure contours for the 2042 peak hour model run.

Pressures ranged from 39.8 to 75 psi throughout the system. Pressures below 35 psi are considered deficient, so the pressures predicted by the model exceeded Ten States Standards recommendations. Areas with lower pressures were at higher elevation than surrounding pipes.

10.3.2 Available Fire Flow Analysis

A fire flow analysis was completed for the system using the 2042 MDD of 2.62 mgd. In this scenario it is assumed that the water leaving the WTP was at 75 psi and the initial level in the West Tank was set at 30 feet. The initial level in the standpipe was 60 feet and the Gute Hill Booster Station was running. Figure 16 illustrates the resulting available fire flow contours. The deficient fire flow locations were typically dead-end mains that were served by 4-inch water main. Another deficient fire flow location was the area east of the WTP and north of Corunna Avenue to the Shiawassee River.

11.0 Recommended Improvements

The deficient areas in the distribution system were analyzed to determine the combination of proposed improvements that would satisfy fire flow with projected demands. The improvements were added to the hydraulic model to evaluate their effectiveness in solving the deficiencies. The improvements were grouped into 5 and 20-year improvements with the 5-year projects predicted to have a greater impact on the hydraulic performance of the system.

Small-diameter pipes, 4-inches or less in diameter, are often a source of the deficient fire flows, particularly when not interconnected with larger, adequately sized pipe. A concern in the City's water system is the installation of fire hydrants on 4-inch or smaller pipes. The Ten States Standards sets the minimum-diameter pipe that a fire hydrant can be connected to, at 6 inches, since smaller diameter water mains often do not provide enough capacity to maintain recommended fire flows. In these situations, the hydrants should be relocated to a larger main if possible, or the 4-inch-diameter mains should be replaced with 6-inch-diameter or larger pipe. The City should consider replacing all small-diameter pipe and provide interconnections where possible to reduce the number of dead-end pipes in the system.

Other criteria used to assess water main health and reliability was the City's water main break history. The City has been experiencing an average of 27 water main breaks each year with a maximum of 44 breaks in a year. The CIP also addressed replacing water mains that have experienced breaks within the last 10 years.

Along with addressing deficient fire flow areas, the water main's expected service life was also considered when recommending improvements. The expected service life of each water main was estimated based on standards established in the AWWA report, *Buried No Longer*. The report estimated service life of water mains by investigating utilities' experiences, extensive research, and professionals' experiences. The expected service life for cast iron main was estimated at 100 years and the ductile iron main was estimated at 80 years. The percentage of water mains in the City system that have already or will exceed their design life in the planning period are provided in Table 19.

Table 19 – Expected Useful Service Life of Water Main

		% of Mains Beyond Expected Useful Life		
Material	Expected Useful Life	Existing System	System in 5 Years	System in 20 Years
Cast iron	100 Years	0.0%	0.0%	0.0%
Ductile Iron	80 Years	0.2%	0.2%	4.4%
	Total	0.2%	0.2%	4.4%

To maintain a reliable and sustainable water system, water main should be replaced on a regular basis. The goal is to replace water main in the system before it reaches the end of its expected useful life. It is estimated that 0.2% of the City's water system is currently beyond its expected useful life; 4.4% of the system will be beyond its expected useful life within 20 years. It should be noted that 17% of the system has an unknown installation date which the City assumes is prior to 1947. The pipe material commonly used in the 1940s for water main was cast iron which means that by 2047 a little less than one fifth of the system will have exceeded the useful service life. The current CIP targets approximately 1% of the system being replaced each year to account for the unknown installation years and to establish a sustainable water main replacement schedule into the future.

11.1 Lead Service Line Replacement

The 2018 Revision to the Lead and Copper Rule require municipalities to replace a minimum of 5% of lead service lines annually, meaning 100% of the system will be replaced in 20 years. Additionally, the revision requires that a Distribution System Material Inventory (DSMI) be submitted to EGLE by January 1, 2025, with a comprehensive updated inventory due every five years. The revision also lowers the lead action level from 15 parts per billion (ppb) to 12 ppb starting January 1, 2025.

The City has been testing for lead and copper since 1992 and every three years thereafter. The 90th percentile lead results exceeded the lead action level in 2020, at 22 ppb. Prior to 2020, the lead results have remained below the lead action level. The 90th percentile copper results have been 0 ppb since 2014. The results of the lead and copper sampling have been relayed to the consumers in the Consumer Confidence Report.

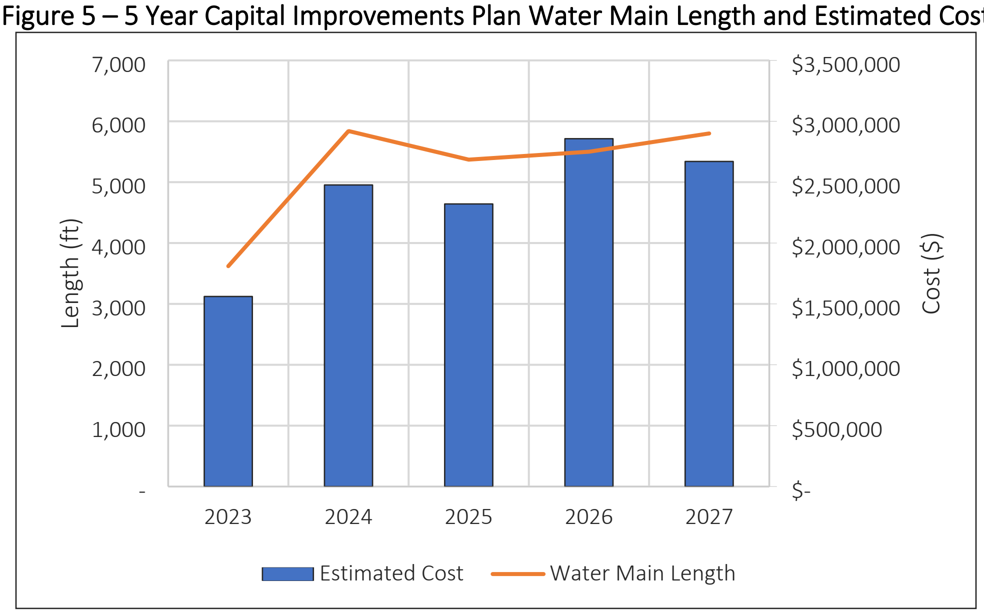
The City plans to replace 220 non-compliant water service lines per year to meet the 5% requirement. In 2022, the City received a $3 million grant for replacements through the Water Infrastructure Fund Transfer Act (WIFTA) which will fund approximately 600 total replacements from 2022 through 2024. Additionally, the City received a $460,000 Drinking Water Asset Management (DWAM) grant to investigate water service lines for the DSMI submittal.

11.2 5-Year Distribution Improvements

The following are the recommended 5-year water distribution system improvements and their corresponding construction cost estimates. These improvements were chosen as 0- to 5-year improvements based on water main age and hydraulic impact on the system. These improvements were considered a higher priority than the projects identified for the 6- to 20-year improvement period.

In 2022, the City applied to obtain a Drinking Water State Revolving Fund (DWSRF) loan from EGLE and the State of Michigan for five water main replacements. The DWSRF program provides funding for approved project planning documents with low interest loans, principal forgiveness, and grant opportunities. Federal infrastructure funding is typically allocated through the DWSRF program in Michigan. The City's project planning document was approved by EGLE, and funding was provided to the City for the next project year (Fiscal Year 2023). The location of each DWSRF and 5-year improvement is illustrated in Figure 17 and a summary of the project cost and water main length for each year is in Figure 5. A full description of each improvement is included in Appendix 7.

Figure 5 – 5 Year Capital Improvements Plan Water Main Length and Estimated Cost



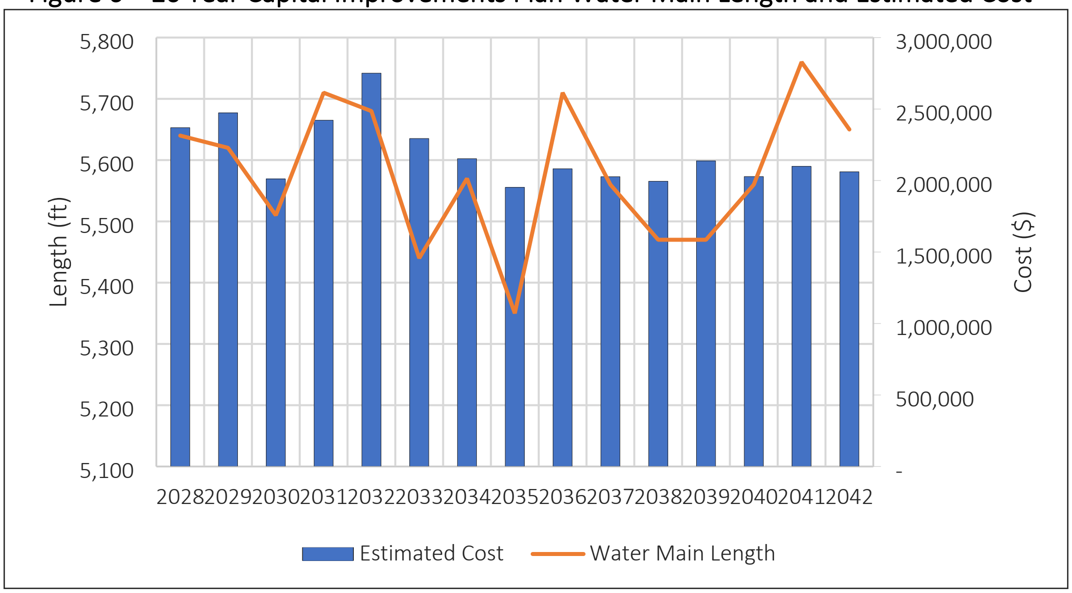
After the completion of these CIP projects, fire flows will be improved throughout the City and pressure will increase slightly as well. Figure 19 shows the pressure contours with the improvements completed, and Figure 20 indicates the fire flow contours available in the distribution system after the improvements. Pressures range from 40.3 to 75.7 psi after the 5-year CIP completion and the average available fire flow increases to approximately 3,550 gpm.

11.3 20-Year Distribution Improvements

The 6- to 20-year period of the CIP was developed with the goal of improving hydraulic deficiencies and replacing undersized 4-inch water mains. It was also developed considering a sustainable water main replacement schedule for the water system. Portions of the existing water system were installed approximately 75 years ago. A typical estimate of the useful life of a water main is about 70 to 100 years. By replacing 1% of the water system each year, it will allow each main to be replaced approximately every 100 years as it reaches the end of its service life. This also allows costs of distribution improvements to be more consistent from year to year for budgetary planning purposes.

The following are the recommended 6- to 20-year water main improvements along with their corresponding construction cost estimates. The projects were phased over the years to approximately balance the annual project costs. The location of each improvement is illustrated in Figure 17, and Appendix 7 includes a summary of the water main length and estimated costs of each improvement. A full description of the improvements is included in Appendix 7.

Figure 6 – 20 Year Capital Improvements Plan Water Main Length and Estimated Cost



The 5-year CIP replaces approximately 0.90% of the system per year while the recommended 20-year CIP increases this replacement rate and replaces 0.97% of the system per year over years 6 through 20.

After the completion of these CIP projects, fire flows will remain high, and pressures will remain adequate as well. Figure 21 shows the pressure contours with the improvements completed, and Figure 22 shows the fire flow contours available in the distribution system after the improvements. Pressures range from 40.0 to 75.4 psi after the 20-year CIP completion and the average available fire flow remains the same at approximately 3,550 gpm.

11.4 Raw Water Main Improvements

There are approximately 4.7 miles of raw water ranging from 16 to 10 inches. The installation year for the water mains is unknown and likely over 75 years ago. Many of the raw water mains run parallel with potable water mains and the replacements should be coordinated when possible. The raw water main improvements are shown on Figure 18. The improvements replace the water main from Hintz Well and PS-1, PS-2, and PS-3.

11.5 River Crossing Improvements

The Shiawassee River runs through Owosso essentially cutting the water system in half which requires the distribution system to cross the river a total of eight times. Three of the river crossings were installed in the early 2000s; however, five of the crossings were installed in 1959 and 1960 and were not buried under the river but laid on the riverbed. It is recommended that the City bury the water main below the riverbed. The constructability of each river crossing was preliminary investigated, and proposed locations are indicated in Figures 23 and 24. The river crossing replacements are included in the 5- and 20-year improvements and indicated by the project number with a double asterisk.

11.6 Caledonia and Owosso Township Distribution Improvements

Caledonia and Owosso Townships are served by the City's water system; however, each Township is responsible for maintaining their own distribution system. The water mains in the Townships were included in the model and water main replacements were recommended based on hydraulic performance and water main age. An additional criterion for Caledonia Township was deficient fire flow. Caledonia owns a significant number of water mains east of the WTP and north of Corunna Avenue to the Shiawassee River which was identified during the fire flow analysis. Tables 20 and 21 include a summary of the recommended water main replacements for Caledonia and Owosso Townships. Additionally, Caledonia Township has several potable water mains that run parallel with raw water mains from the Hintz and Osburn wells. The raw and potable water main replacements were coordinated and indicated by an asterisk.

Table 20 – Caledonia Township Distribution Improvements

Project No.	Description/Location	Diameter (in)	Completion Year	Length of Main (ft)	Estimated Cost
201	Replace 12-inch main on Aiken Street from Melinda Street south to dead end	12	2025	2000	$996,000
202	Replace 12-inch main on Melinda Street from Byerly Street to Aiken Street	12	2026	870	$433,000
203	Replace 4-inch main on Grove from Aiken Street to Division Street	8	2027	2080	$758,000
204	Replace 6-inch main on Exchange Street from Rawleigh Avenue to Hintz Road	8	2029	1,130	$412,000
205	Replace 4-inch main on Allendale Avenue from Byerly Street to dead end	8	2030	890	$325,000
206*	Replace 8-inch main on Copas Road from Hintz Road to Fairview Avenue	8	2037	530	$194,000
207*	Replace 6-inch main on Fairview Avenue from Copas Road to M-21	8	2038	1250	$456,000
208*	Replace 8-inch main on Rawleigh south and along Grover Street from M-21 to dead end	8	2039	1,305	$476,000
			Total	10,055	$4,050,000

Table 21 – Owosso Township Distribution Improvements

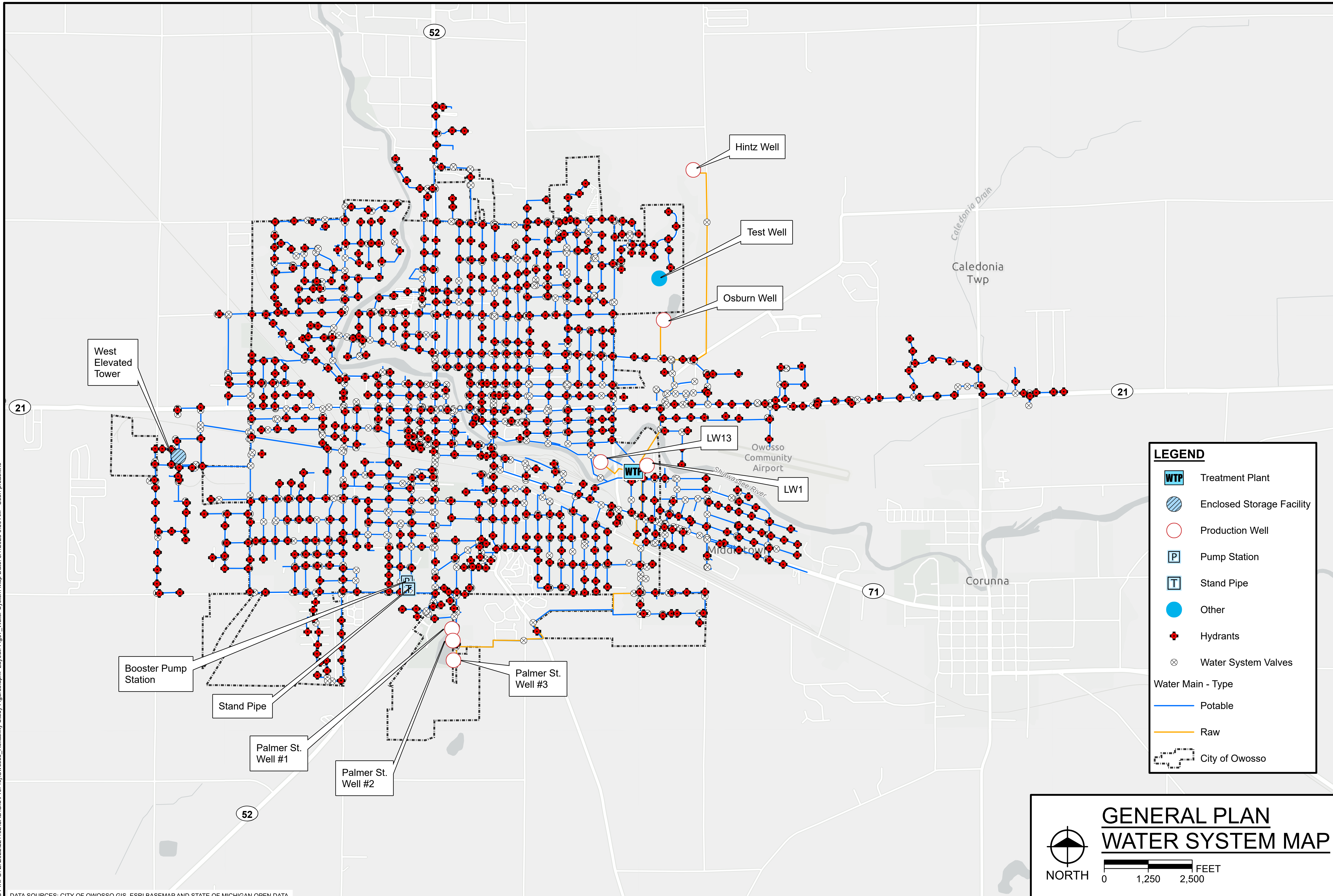
Project No.	Description/Location	Diameter (in)	Completion Year	Length of Main (ft)	Estimated Cost
301	Replace 8-inch main on King Street from Cleveland Avenue west to dead end	8	2024	300	$110,000
302	Replace 4-inch main on Keifer Street from Chipman Street to Cleveland Avenue; 4-inch main on Cleveland off Keifer	8	2027	1,010	$368,000
303	Replace 12-inch main on Delaney Road from Sequoia Trail south to dead end	12	2031	1,625	$809,000
304	Replace 8-inch main on Cleveland Avenue from King Street to Marion Street	8	2034	1,640	$598,000
			Total	4,575	$1,885,000

11.7 Cost Estimation

While the water main replacement could be completed alone, other parts of the City's infrastructure continue to require periodic repair and replacement. Such pieces of infrastructure include roadway, curb and gutter, sanitary sewer, and storm sewers. The CIP tables and cost estimates do not include costs for these additional utilities in addition to the water main. These costs only include the cost of the water main, installation, and surface restoration above the water main. Projects should be coordinated with other utility and road projects wherever feasible to maximize the benefit of the investment and required restoration. The cost differences across each size of water main result from the additional restoration cost dependent upon the road classification (residential, commercial, collector street, etc.) and the location of the water main (field, right-of-way, roadway, etc.). City budgetary constraints will dictate the actual priorities and timing of construction for projects.

The construction cost estimates presented in this report reflect March 2023 costs. These opinions of cost were prepared to determine approximate project costs. There are several factors that could cause the actual project costs to deviate from these estimates. These include the competitive bidding climate at the time the construction bids are received, inflation, and additions to or changes in the scope of the project that may occur during the design process. As the cost estimates are reflective of current 2023 costs, the City will need to update estimated costs prior to proceeding with any future work and make necessary adjustments to determine the bidding climate in the year the work is proposed to be completed. Inflationary adjustments were not made to the projected costs, so the City should anticipate costs to rise above the estimates provided in this study, especially for some of the 20-year CIP projects. The planning, engineering, and construction required to implement the recommended improvements could take from several months to many years. It is therefore recommended that the City begin planning and budgeting efforts as soon as practical.

Figures



GENERAL PLAN WATER SYSTEM MAP

fishbeck
Engineers | Architects | Scientists | Constructors

Hard copy is intended to be 11"x17" when plotted. Scale(s) indicated and graphic quality may not be accurate for any other size.

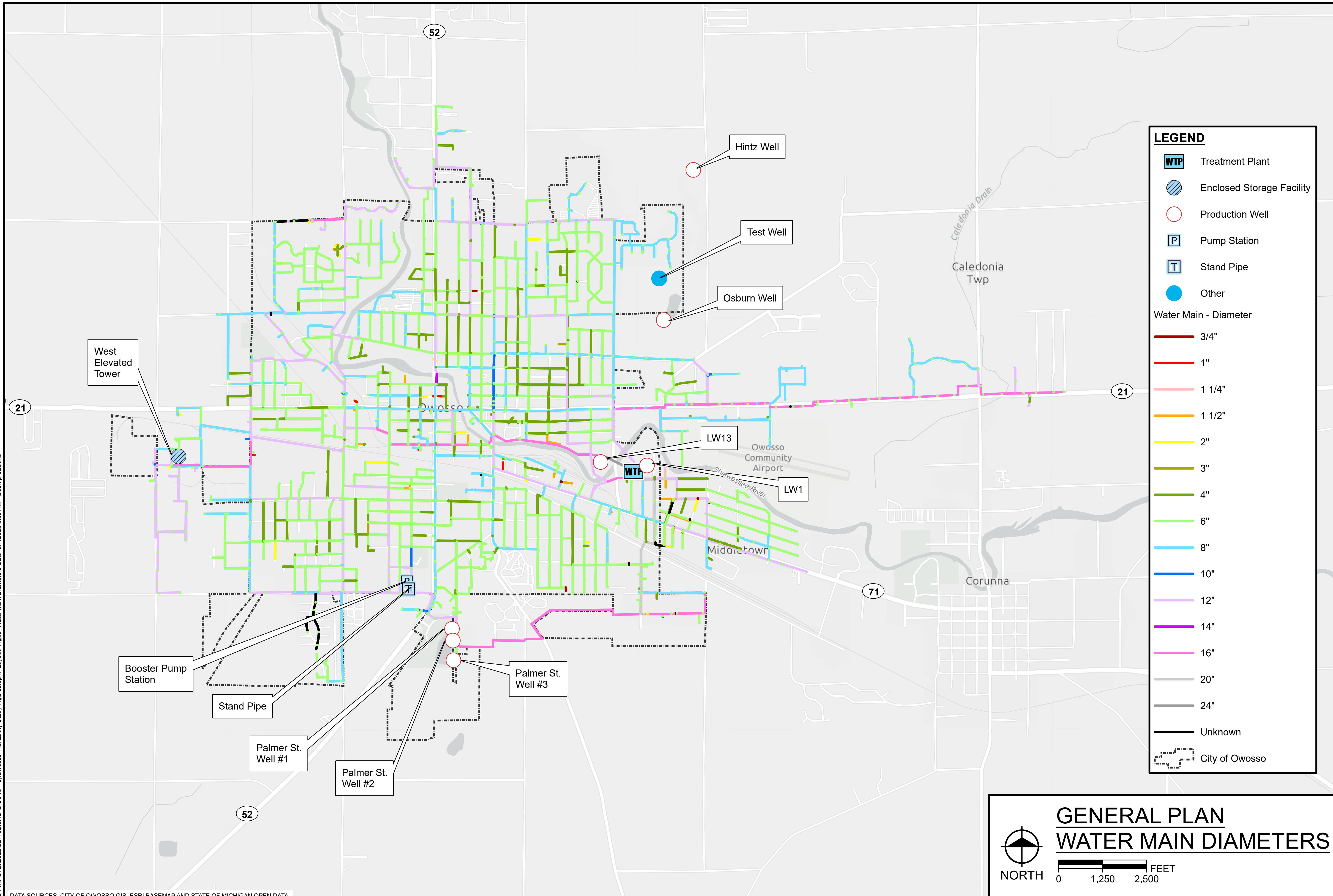
City of Owosso
Shiawassee County, Michigan

Water System Reliability Study and General Plan Update

PROJECT NO.
221152

FIGURE NO.
7

PLOT INFO: Z:\2022\221152\CAD\GIS\ProProj\Owosso_Reliability Study Figures.aprx Layout: Fig07_Water System Map Date: 3/7/2023 9:50 AM User: prbaskins



DATA SOURCES: CITY OF OWOSSO GIS. ESRI BASEMAP AND STATE OF MICHIGAN OPEN DATA.

GENERAL PLAN WATER MAIN DIAMETERS

NORTH

0 1,250 2,500 FEET

fishbeck

Engineers | Architects | Scientists | Constructors

Hard copy is intended to be 11"x17" when plotted. Scale(s) indicated and graphic quality may not be accurate for any other size.

City of Owosso

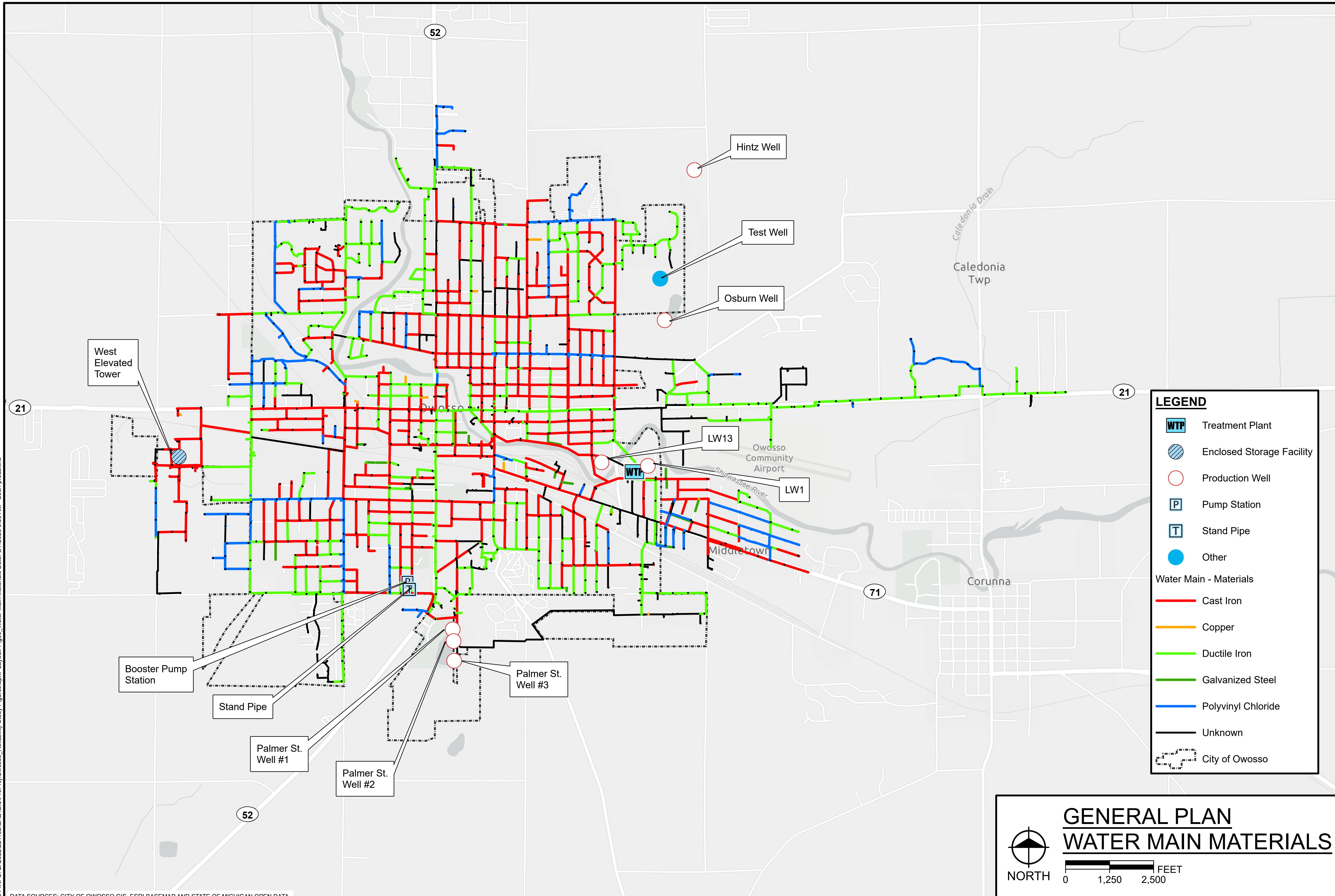
Shiawassee County, Michigan

Water System Reliability Study and General Plan Update

PROJECT NO. 221152

FIGURE NO. 8

PLOT INFO: Z:\2022\221152\CAD\GIS\ProProj\Owosso_Reliability Study Figures.aprx Layout: Fig08_Water Main Diameters Date: 3/7/2023 9:50 AM User: prbaskins



DATA SOURCES: CITY OF OWOSSO GIS. ESRI BASEMAP AND STATE OF MICHIGAN OPEN DATA.

GENERAL PLAN WATER MAIN MATERIALS

fishbeck
Engineers | Architects | Scientists | Constructors

Hard copy is intended to be 11"x17" when plotted. Scale(s) indicated and graphic quality may not be accurate for any other size.

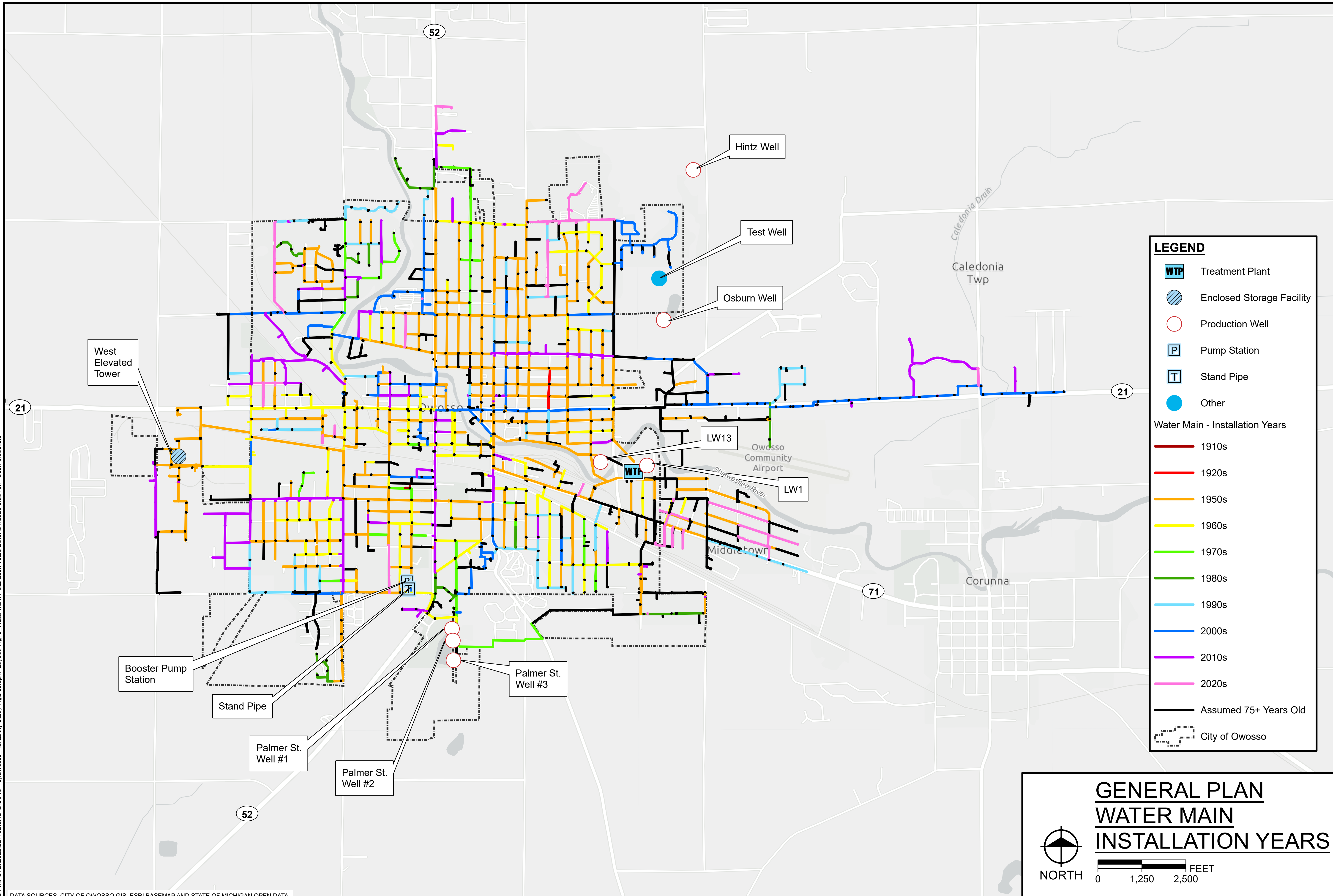
City of Owosso
Shiawassee County, Michigan

Water System Reliability Study and General Plan Update

PROJECT NO. 221152

FIGURE NO. 9

PLOT INFO: Z:\2022\221152\CAD\GIS\Pro\Owosso_Reliability Study Figures.aprx Layout: Fig09_Water Main Materials Date: 3/7/2023 9:50 AM User: prbaskins



DATA SOURCES: CITY OF OWOSSO GIS. ESRI BASEMAP AND STATE OF MICHIGAN OPEN DATA.

GENERAL PLAN WATER MAIN INSTALLATION YEARS

fishbeck
Engineers | Architects | Scientists | Constructors

Hard copy is intended to be 11"x17" when plotted. Scale(s) indicated and graphic quality may not be accurate for any other size.

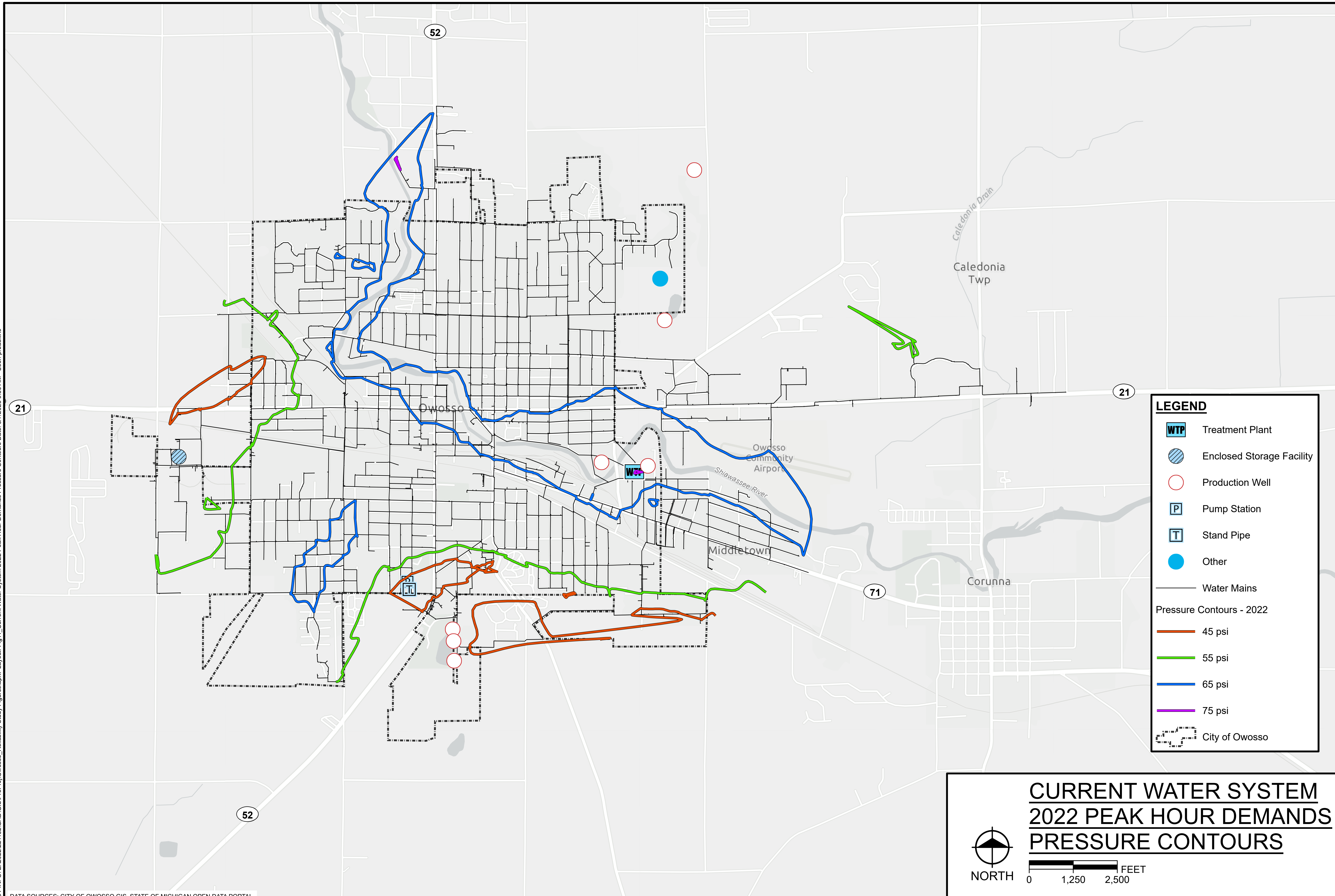
City of Owosso
Shiawassee County, Michigan

Water System Reliability Study and General Plan Update

PROJECT NO.
221152

FIGURE NO.
10

PLOT INFO: Z:\2022\221152\CAD\GIS\ProProj\Owosso_Reliability Study Figures.aprx Layout: Fig10_Water Main Installation Years Date: 3/7/2023 9:50 AM User: prbaskins



CURRENT WATER SYSTEM 2022 PEAK HOUR DEMANDS PRESSURE CONTOURS

fishbeck
Engineers | Architects | Scientists | Constructors

Hard copy is intended to be 11"x17" when plotted. Scale(s) indicated and graphic quality may not be accurate for any other size.

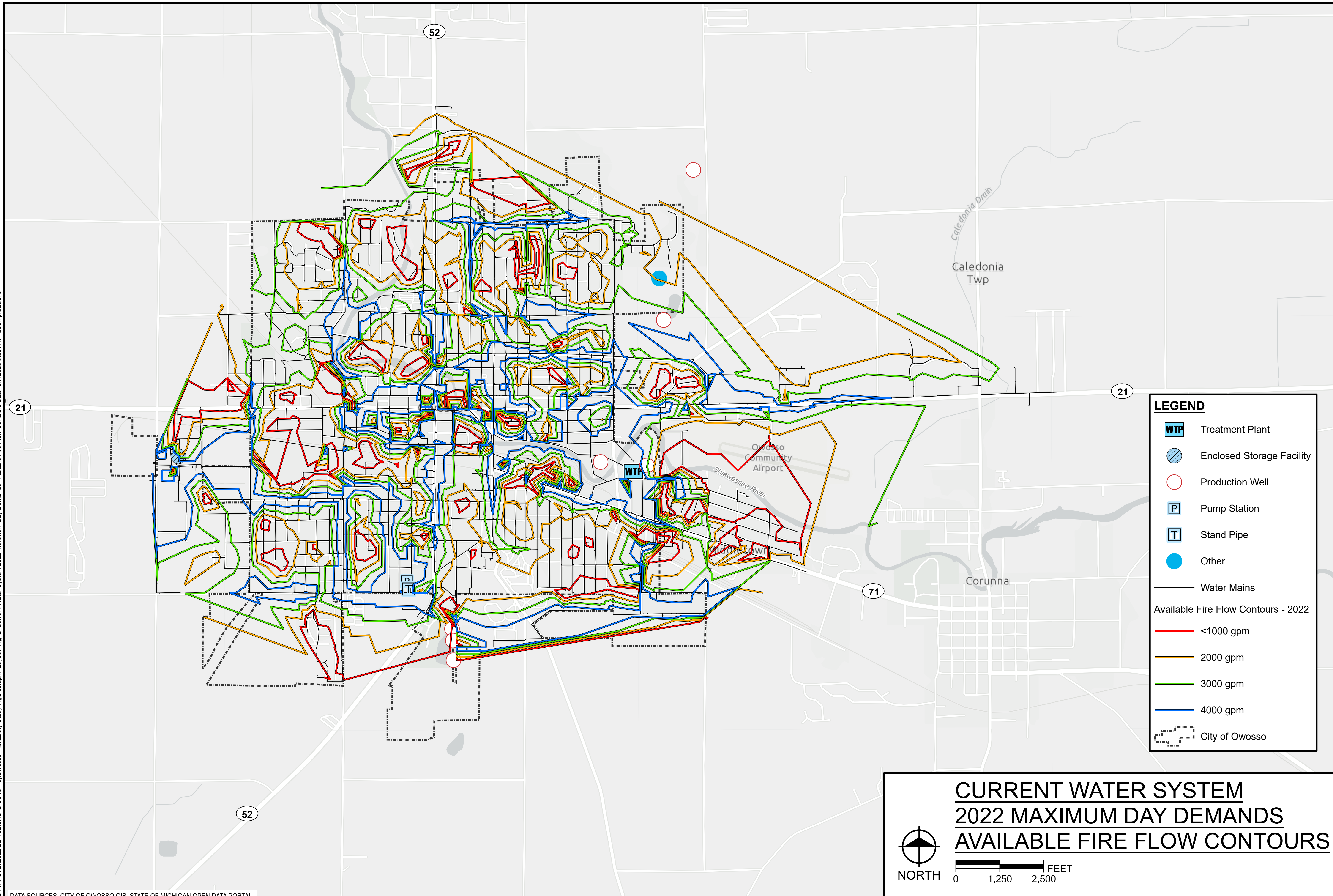
City of Owosso
Shiawassee County, Michigan

Water System Reliability Study and General Plan Update

PROJECT NO.
221152

FIGURE NO.
11

PLOT INFO: Z:\2022\221152\CAD\GIS\ProProj\Owosso_Reliability Study Figures.aprx Layout: Fig11_Current Water System 2022 Peak Hour Demands Pressure Contours Date: 3/7/2023 9:50 AM User: prhaskins



CURRENT WATER SYSTEM 2022 MAXIMUM DAY DEMANDS AVAILABLE FIRE FLOW CONTOURS

fishbeck

Engineers | Architects | Scientists | Constructors

Hard copy is intended to be 11"x17" when plotted. Scale(s) indicated and graphic quality may not be accurate for any other size.

City of Owosso

Shiawassee County, Michigan

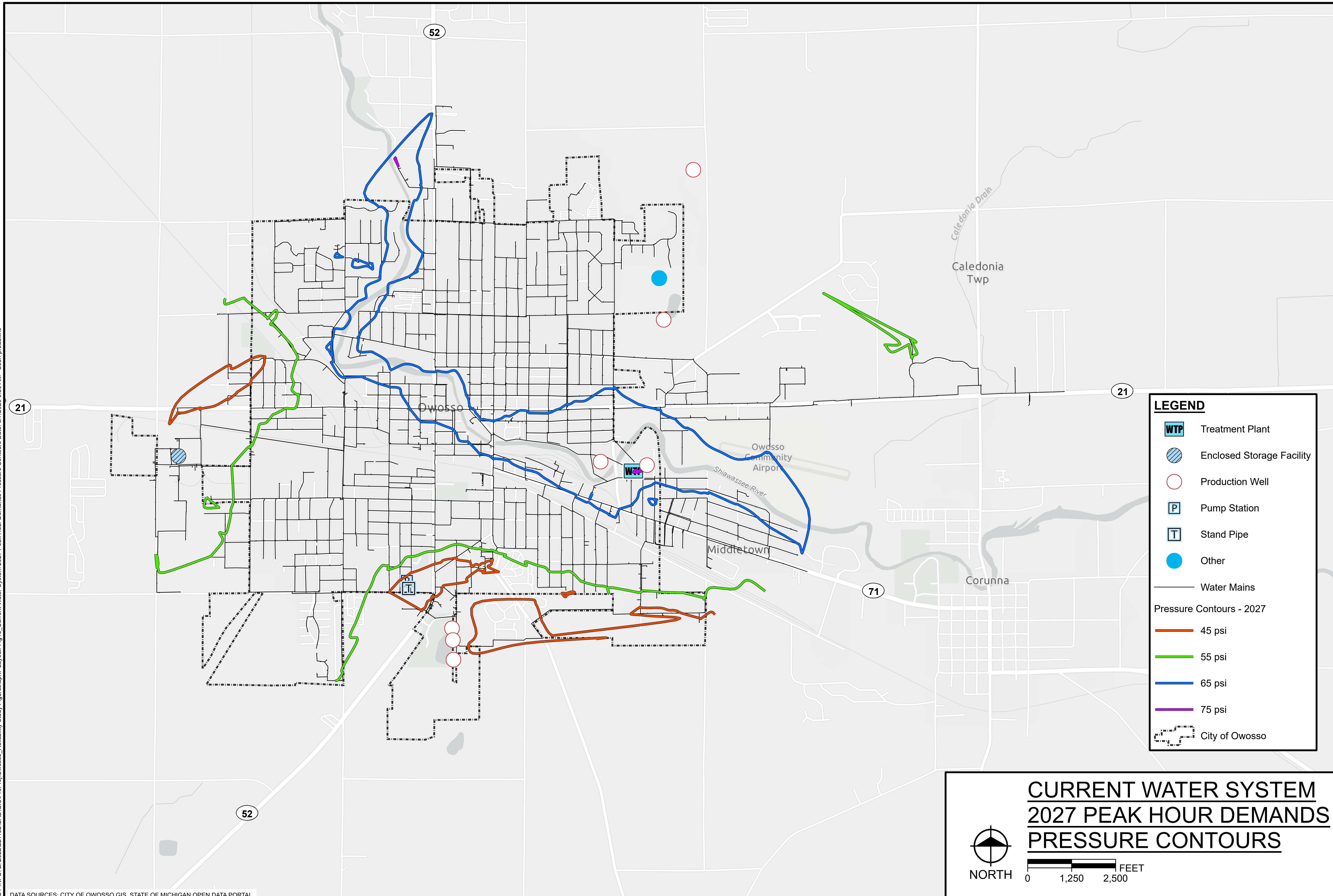
Water System Reliability Study and General Plan Update

PROJECT NO.
221152

FIGURE NO.
12

PLOT INFO: Z:\2022\221152\CAD\GIS\ProProj\Owosso_Reliability Study Figures.aprx Layout: Fig12_Current Water System 2022 Maximum Day Demands Available Fire Flow Contours Date: 3/7/2023 9:50 AM User: prbaskins

CURRENT WATER SYSTEM 2027 PEAK HOUR DEMANDS PRESSURE CONTOURS



DATA SOURCES: CITY OF OWOSSO GIS. STATE OF MICHIGAN OPEN DATA PORTAL.

fishbeck
Engineers | Architects | Scientists | Constructors

Hard copy is intended to be 11"x17" when plotted. Scale(s) indicated and graphic quality may not be accurate for any other size.

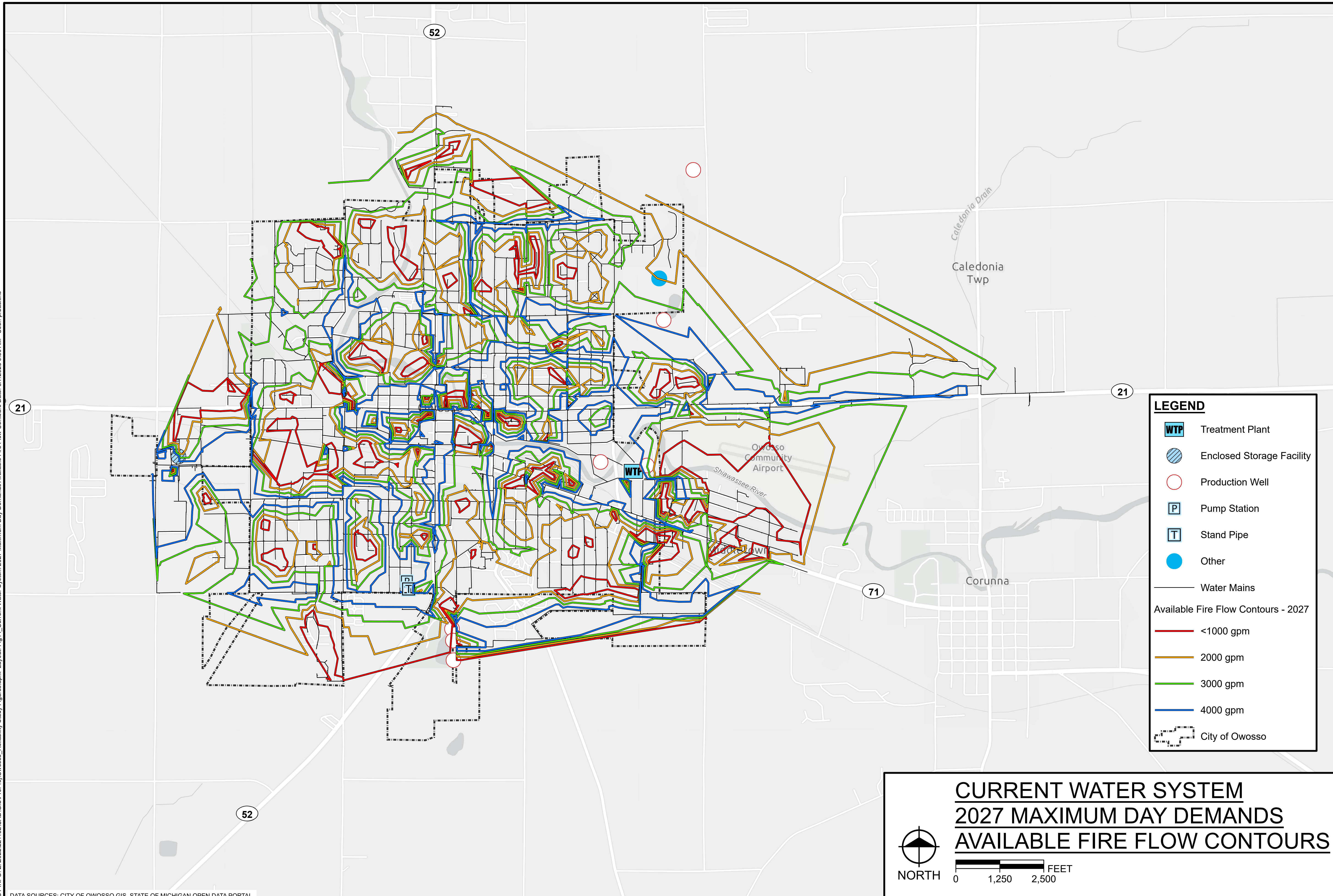
City of Owosso
Shiawassee County, Michigan

Water System Reliability Study and General Plan Update

PROJECT NO.
221152

FIGURE NO.
13

PLOT INFO: Z:\2022\221152\CAD\GIS\ProProj\Owosso_Reliability Study Figures.aprx Layout: Fig13_Current Water System 2027 Peak Hour Demands Pressure Contours Date: 3/7/2023 9:50 AM User: prbaskins



CURRENT WATER SYSTEM 2027 MAXIMUM DAY DEMANDS AVAILABLE FIRE FLOW CONTOURS

DATA SOURCES: CITY OF OWOSSO GIS. STATE OF MICHIGAN OPEN DATA PORTAL.

PLOT INFO: Z:\2022\221152\CAD\GIS\ProProj\Owosso_Reliability Study Figures.aprx Layout: Fig14_Current Water System 2027 Maximum Day Demands Available Fire Flow Contours Date: 3/7/2023 9:50 AM User: prbaskins

fishbeck

Engineers | Architects | Scientists | Constructors

Hard copy is intended to be 11"x17" when plotted. Scale(s) indicated and graphic quality may not be accurate for any other size.

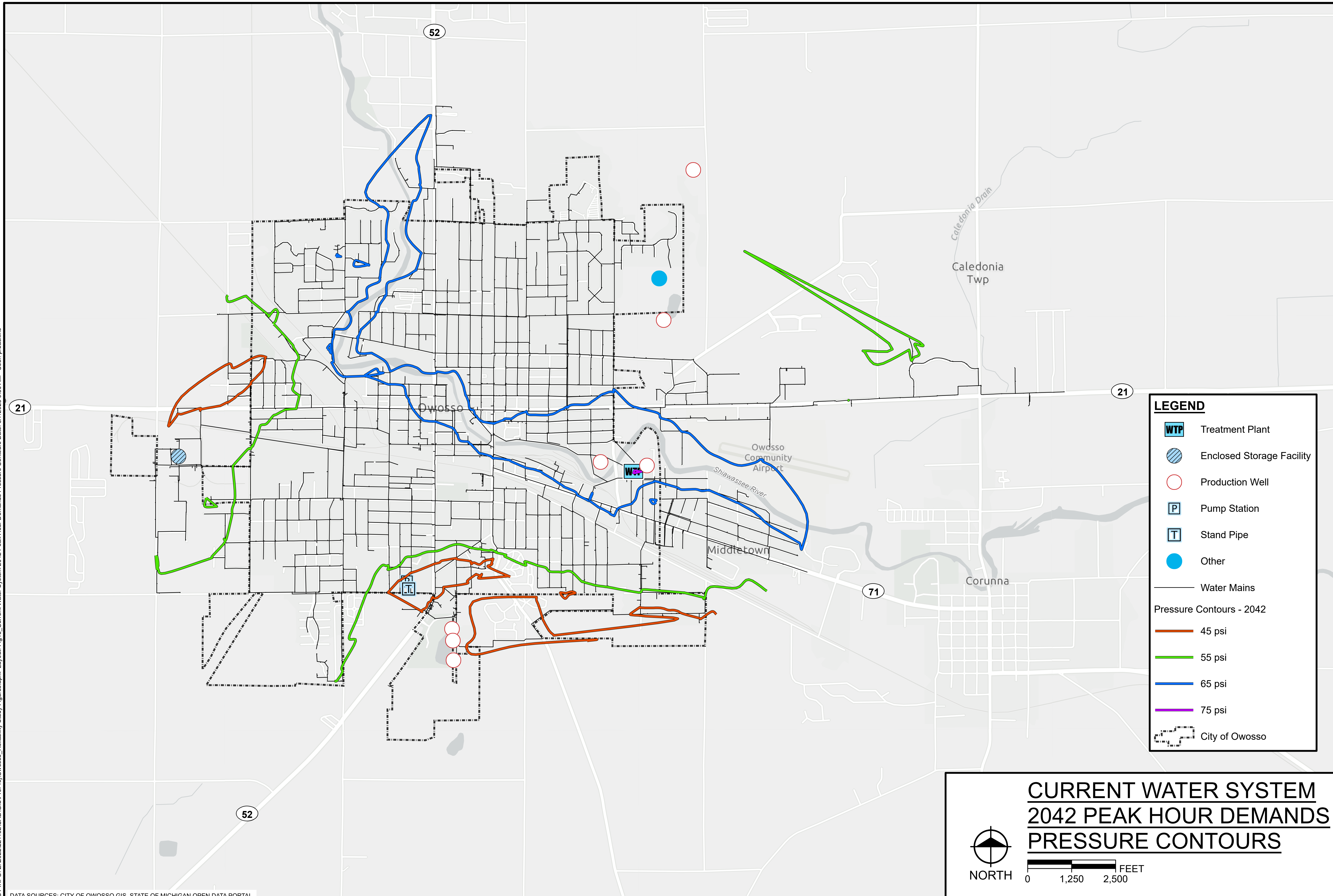
City of Owosso

Shiawassee County, Michigan

Water System Reliability Study and General Plan Update

PROJECT NO.
221152

FIGURE NO.
14



CURRENT WATER SYSTEM 2042 PEAK HOUR DEMANDS PRESSURE CONTOURS

fishbeck
Engineers | Architects | Scientists | Constructors

Hard copy is intended to be 11"x17" when plotted. Scale(s) indicated and graphic quality may not be accurate for any other size.

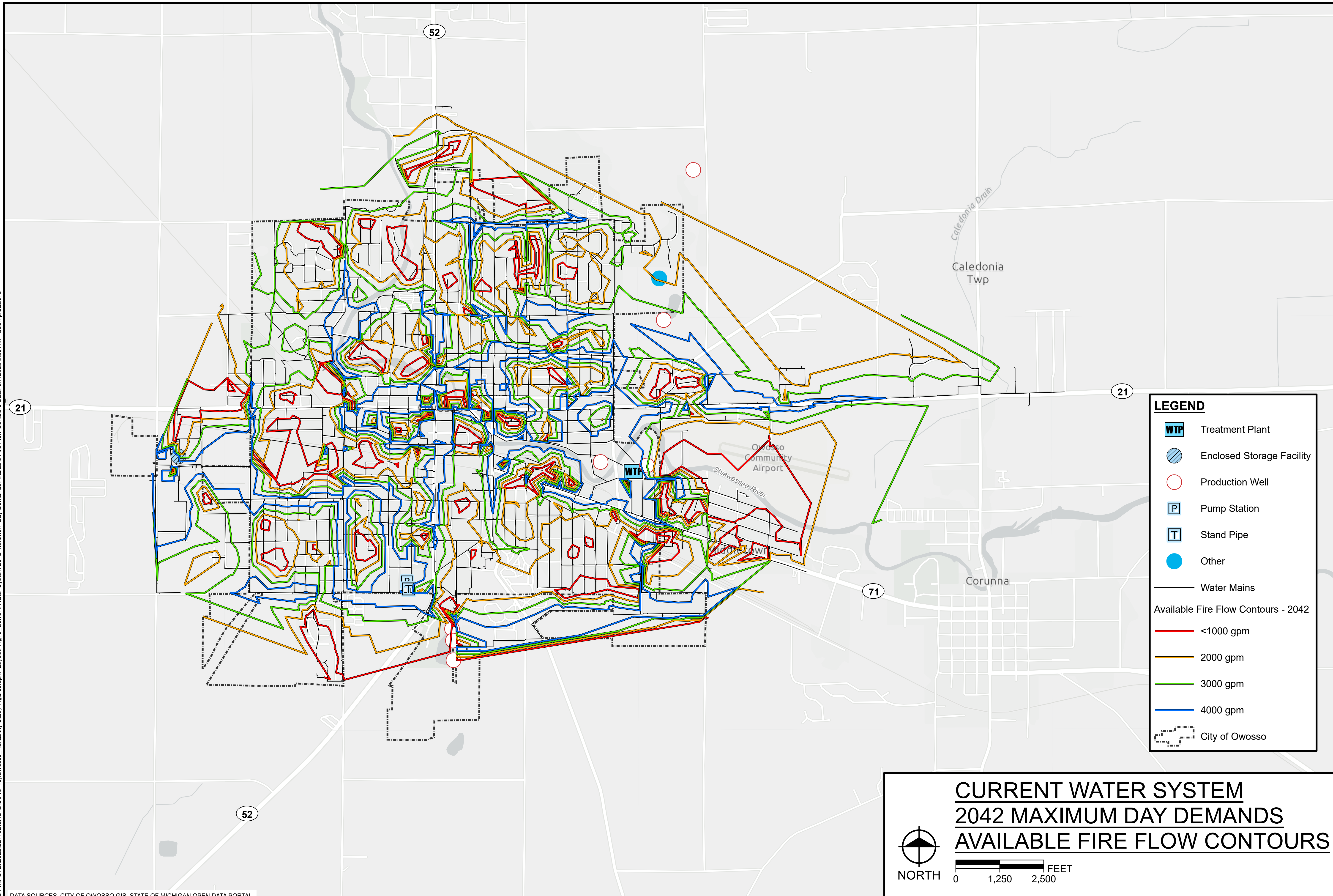
City of Owosso
Shiawassee County, Michigan

Water System Reliability Study and General Plan Update

PROJECT NO.
221152

FIGURE NO.
15

PLOT INFO: Z:\2022\221152\CAD\GIS\ProProj\Owosso_Reliability Study Figures.aprx Layout: Fig15_Current Water System 2042 Peak Hour Demands Pressure Contours Date: 3/7/2023 9:50 AM User: prbaskins



CURRENT WATER SYSTEM 2042 MAXIMUM DAY DEMANDS AVAILABLE FIRE FLOW CONTOURS

DATA SOURCES: CITY OF OWOSSO GIS. STATE OF MICHIGAN OPEN DATA PORTAL.

PLOT INFO: Z:\2022\221152\CAD\GIS\ProProj\Owosso_Reliability Study Figures.aprx Layout: Fig16_Current Water System 2042 Maximum Day Demands Available Fire Flow Contours Date: 3/7/2023 9:50 AM User: prbaskins

fishbeck
Engineers | Architects | Scientists | Constructors

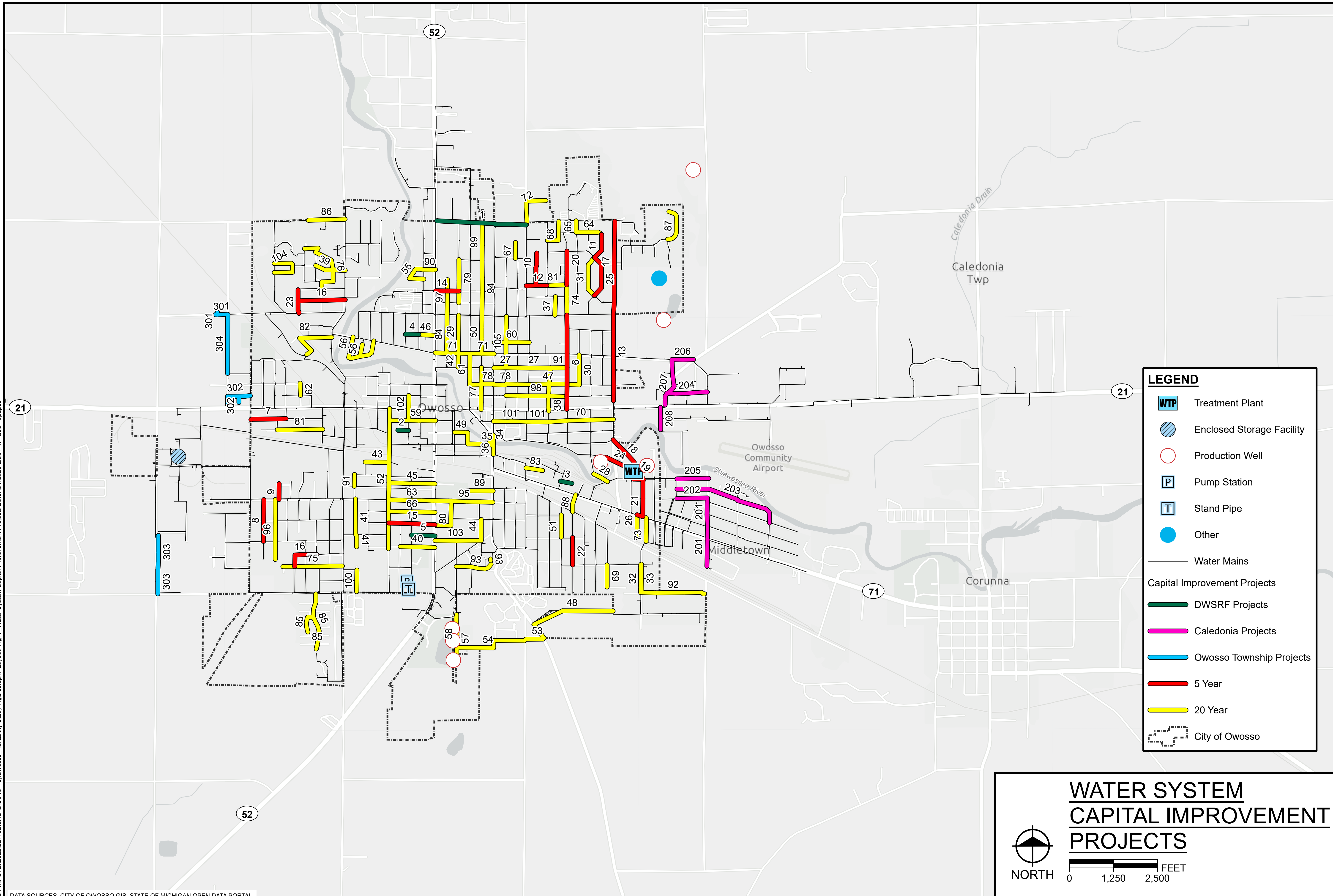
Hard copy is intended to be 11"x17" when plotted. Scale(s) indicated and graphic quality may not be accurate for any other size.

City of Owosso
Shiawassee County, Michigan

Water System Reliability Study and General Plan Update

PROJECT NO.
221152

FIGURE NO.
16



WATER SYSTEM CAPITAL IMPROVEMENT PROJECTS

fishbeck
Engineers | Architects | Scientists | Constructors

Hard copy is intended to be 11"x17" when plotted. Scale(s) indicated and graphic quality may not be accurate for any other size.

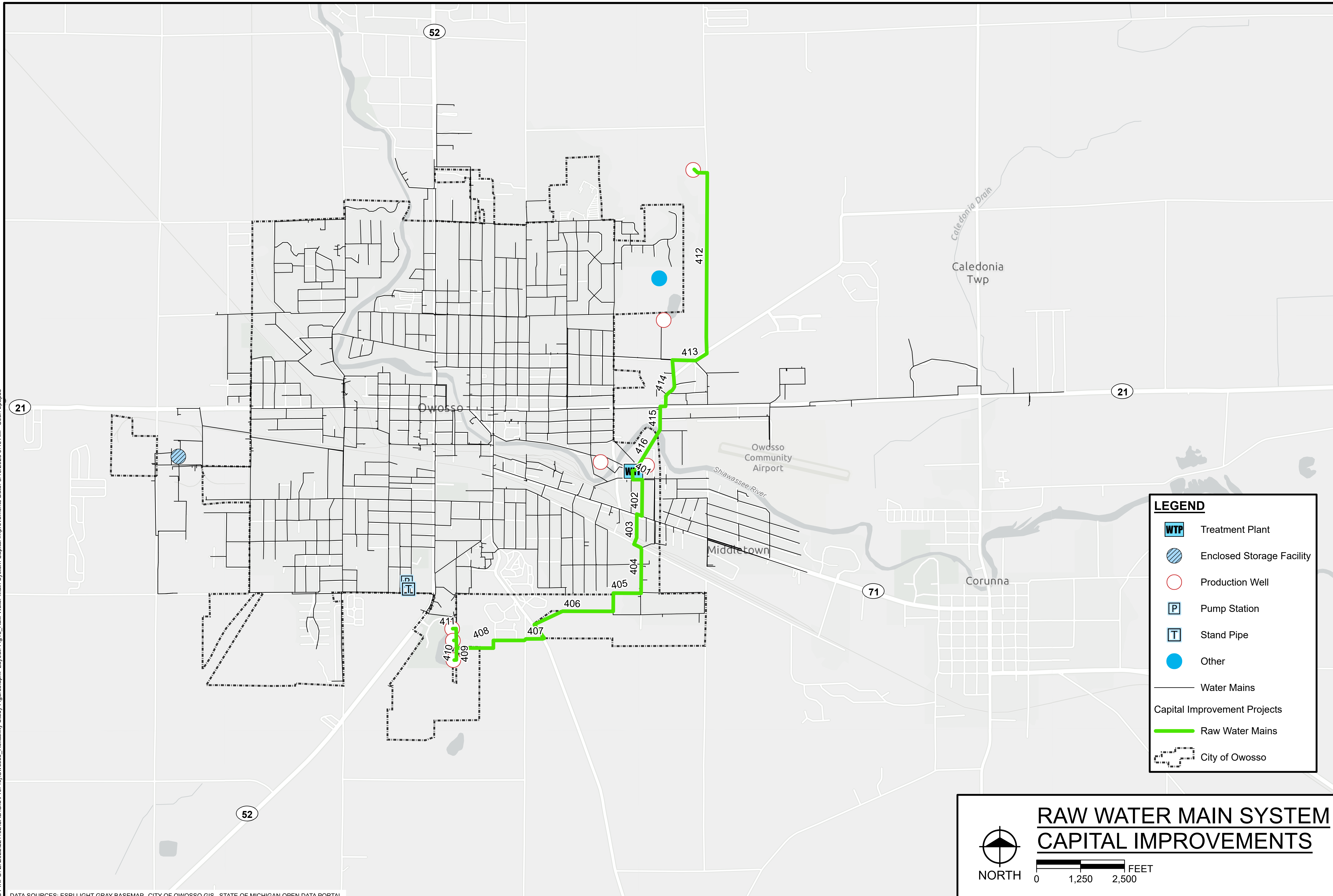
City of Owosso
Shiawassee County, Michigan

Water System Reliability Study and General Plan Update

PROJECT NO.
221152

FIGURE NO.
17

PLOT INFO: Z:\2022\221152\CAD\GIS\ProProj\Owosso_Reliability Study Figures.aprx Layout: Fig17_Water System Capital Improvement Projects Date: 3/7/2023 2:39 PM User: bpapes



RAW WATER MAIN SYSTEM CAPITAL IMPROVEMENTS

NORTH

FEET 0 1,250 2,500

fishbeck Engineers | Architects | Scientists | Constructors

Hard copy is intended to be 11"x17" when plotted. Scale(s) indicated and graphic quality may not be accurate for any other size.

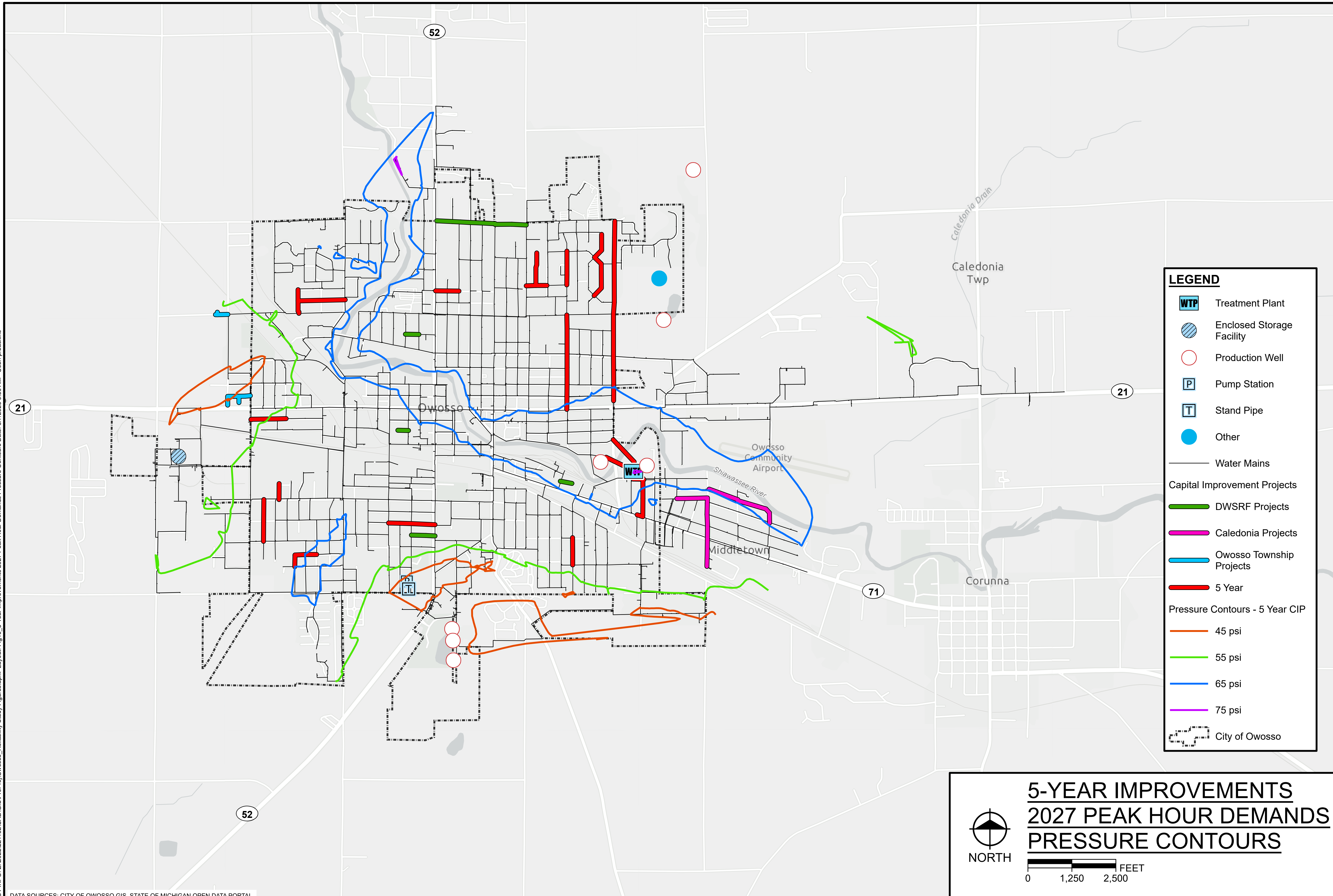
City of Owosso
Shiawassee County, Michigan

Water System Reliability Study and General Plan Update

PROJECT NO.
221152

FIGURE NO.
18

PLOT INFO: Z:\2022\221152\CAD\GIS\ProProj\Owosso_Reliability Study Figures.aprx Layout: Fig18_Raw Water Main System Capital Improvements Date: 3/13/2023 9:43 AM User: bpapes



5-YEAR IMPROVEMENTS 2027 PEAK HOUR DEMANDS PRESSURE CONTOURS

fishbeck
Engineers | Architects | Scientists | Constructors

Hard copy is intended to be 11"x17" when plotted. Scale(s) indicated and graphic quality may not be accurate for any other size.

City of Owosso
Shiawassee County, Michigan

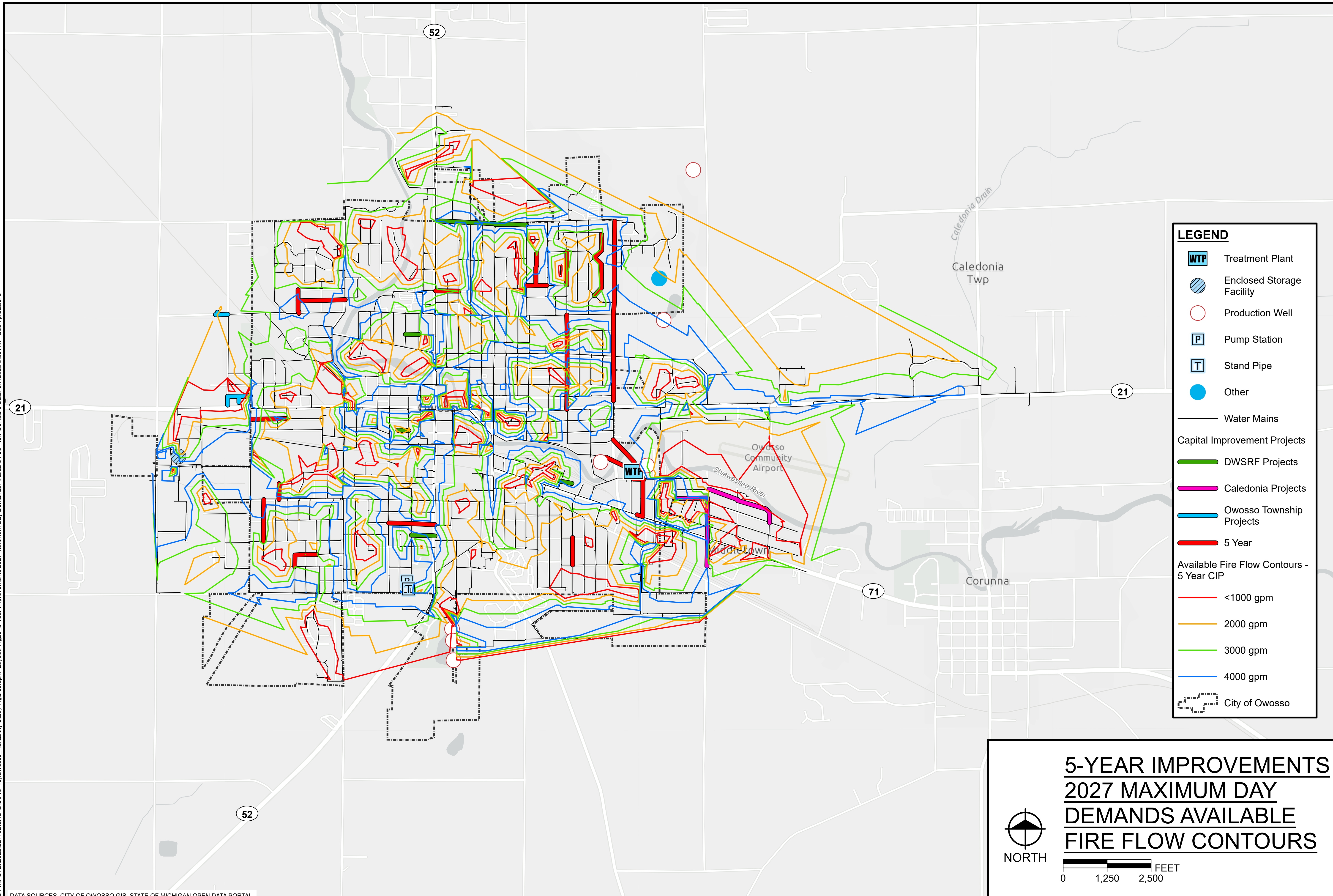
Water System Reliability Study and General Plan Update

PROJECT NO.
221152

FIGURE NO.
19

DATA SOURCES: CITY OF OWOSSO GIS. STATE OF MICHIGAN OPEN DATA PORTAL.

PLOT INFO: Z:\2022\221152\CAD\GIS\ProProj\Owosso_Reliability Study Figures.aprx Layout: Fig19_5-Year Improvements 2027 Peak Hour Demands Pressure Contours Date: 3/7/2023 9:50 AM User: prhaskins



5-YEAR IMPROVEMENTS 2027 MAXIMUM DAY DEMANDS AVAILABLE FIRE FLOW CONTOURS

fishbeck
Engineers | Architects | Scientists | Constructors

Hard copy is intended to be 11"x17" when plotted. Scale(s) indicated and graphic quality may not be accurate for any other size.

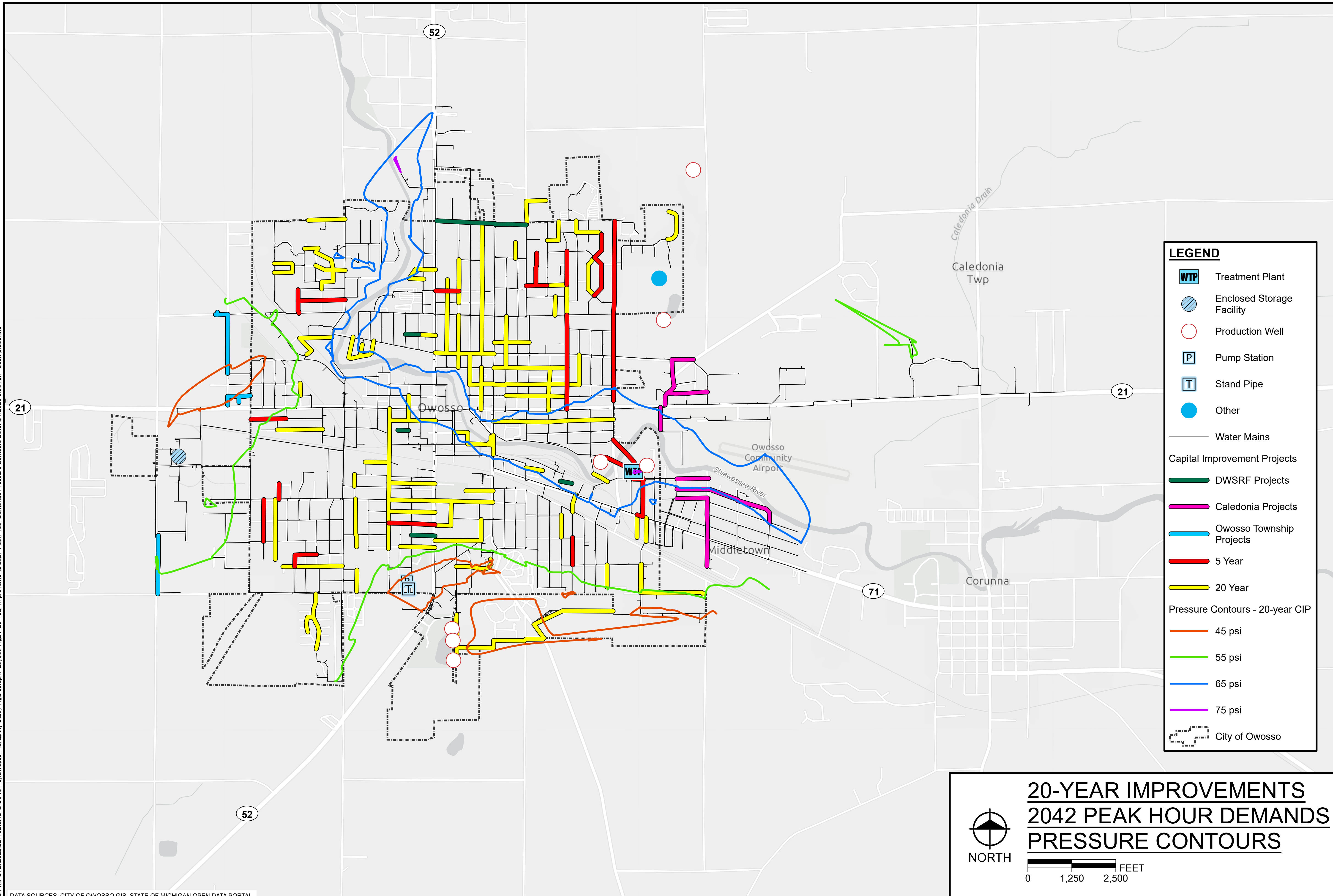
City of Owosso
Shiawassee County, Michigan

Water System Reliability Study and General Plan Update

PROJECT NO.
221152

FIGURE NO.
20

PLOT INFO: Z:\2022\221152\CAD\GIS\ProProj\Owosso_Reliability Study Figures.aprx Layout: Fig20_5-Year Improvements 2027 Maximum Day Demands Available Fire Flow Contours Date: 3/7/2023 9:50 AM User: prbaskins



20-YEAR IMPROVEMENTS
2042 PEAK HOUR DEMANDS
PRESSURE CONTOURS

DATA SOURCES: CITY OF OWOSSO GIS. STATE OF MICHIGAN OPEN DATA PORTAL.

fishbeck
Engineers | Architects | Scientists | Constructors

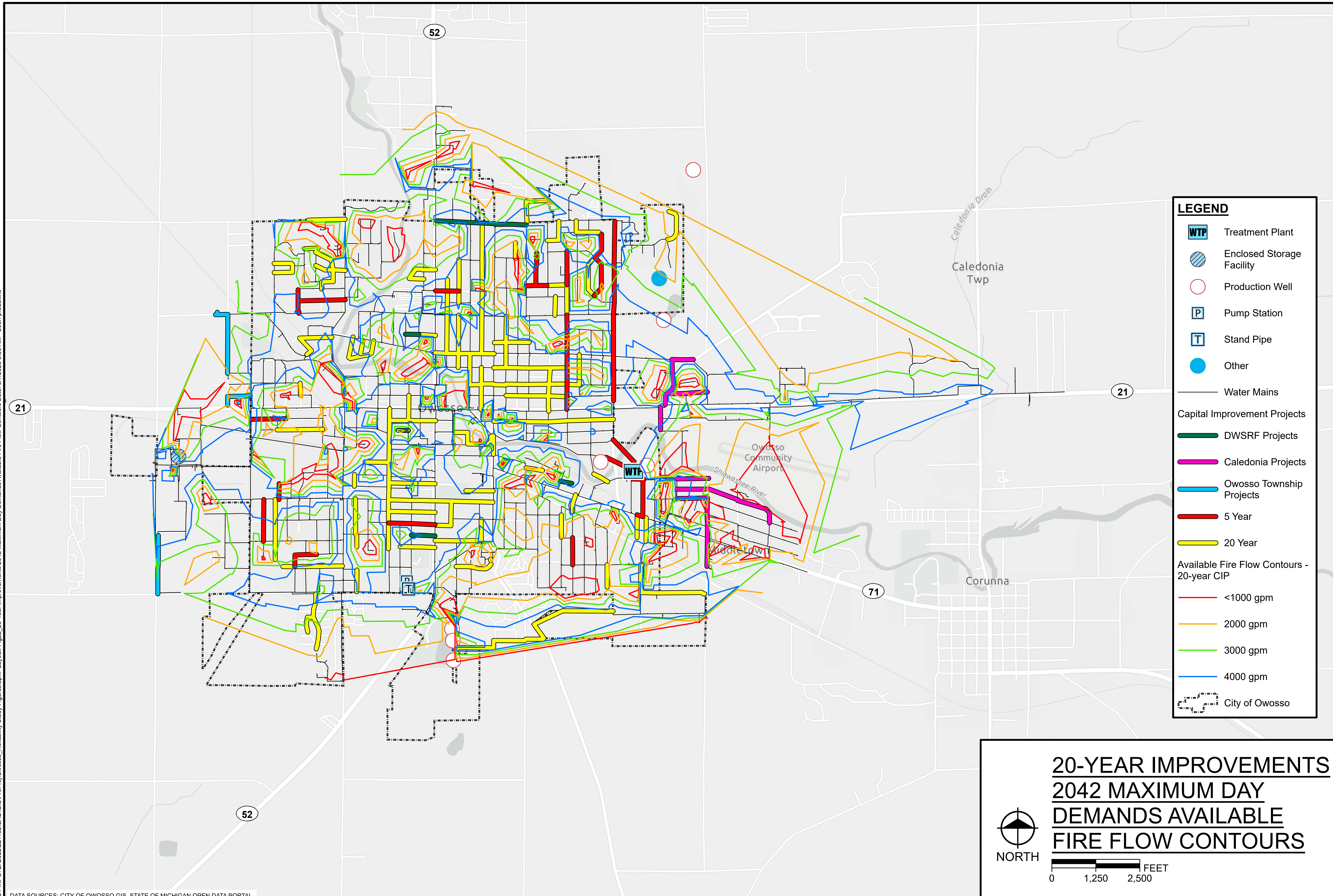
Hard copy is intended to be 11"x17" when plotted. Scale(s) indicated and graphic quality may not be accurate for any other size.

City of Owosso
Shiawassee County, Michigan
Water System Reliability Study and General Plan Update

PROJECT NO.
221152

FIGURE NO.
21

PLOT INFO: Z:\2022\221152\CAD\GIS\ProProj\Owosso_Reliability Study Figures.aprx Layout: Fig21_20-Year Improvements 2027 Peak Hour Demands Pressure Contours Date: 3/7/2023 9:50 AM User: prbaskins



20-YEAR IMPROVEMENTS 2042 MAXIMUM DAY DEMANDS AVAILABLE FIRE FLOW CONTOURS

DATA SOURCES: CITY OF OWOSSO GIS. STATE OF MICHIGAN OPEN DATA PORTAL.

PLOT INFO: Z:\2022\221152\CAD\GIS\Pro\Owosso_Reliability Study Figures.aprx Layout: Fig22_20-Year Improvements 2042 Maximum Day Demands Available Fire Flow Contours Date: 3/7/2023 9:50 AM User: prbaskins

fishbeck
Engineers | Architects | Scientists | Constructors

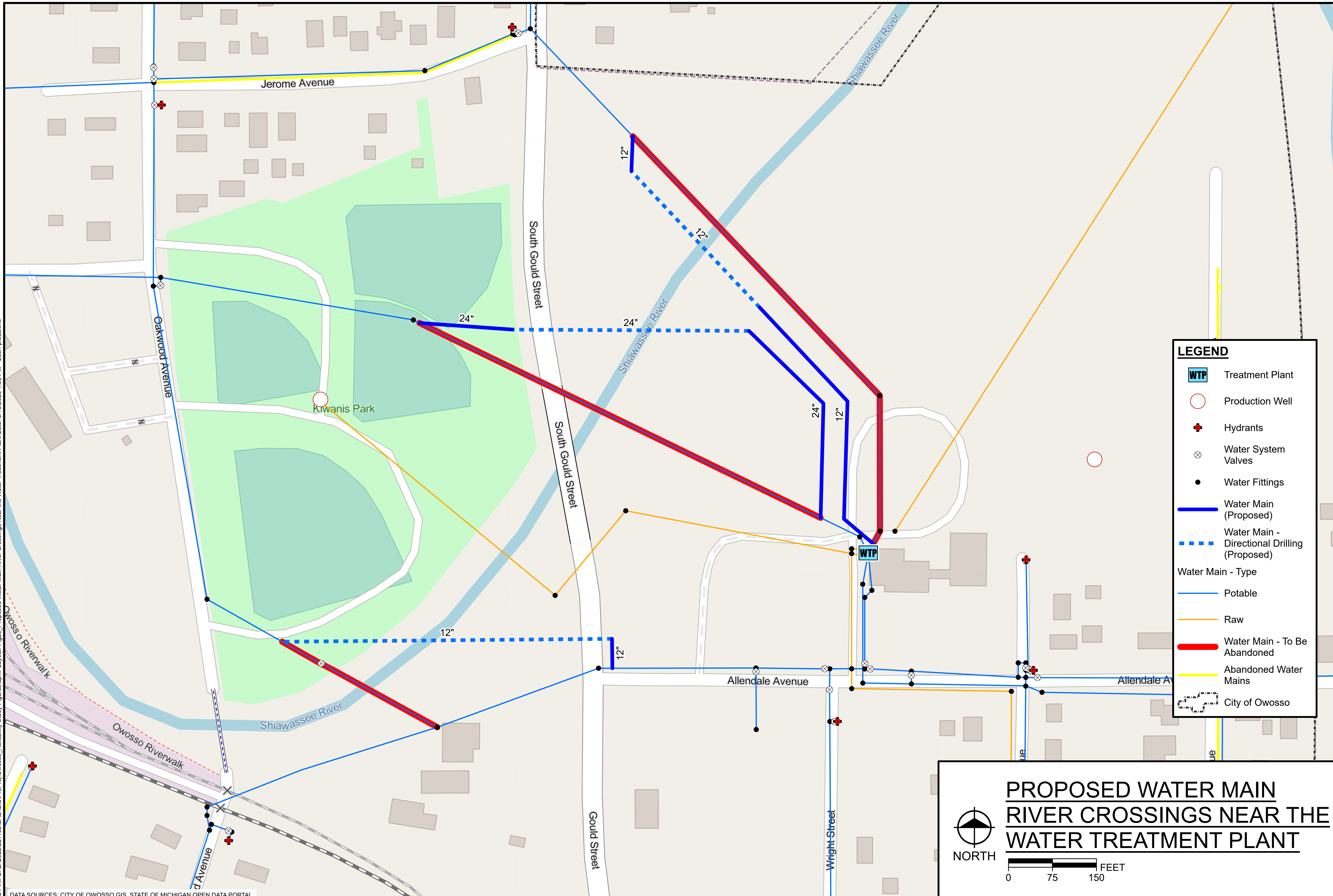
Hard copy is intended to be 11"x17" when plotted. Scale(s) indicated and graphic quality may not be accurate for any other size.

City of Owosso
Shiawassee County, Michigan

Water System Reliability Study and General Plan Update

PROJECT NO.
221152

FIGURE NO.
22



PROPOSED WATER MAIN RIVER CROSSINGS NEAR THE WATER TREATMENT PLANT

fishbeck
Engineers | Architects | Scientists | Constructors

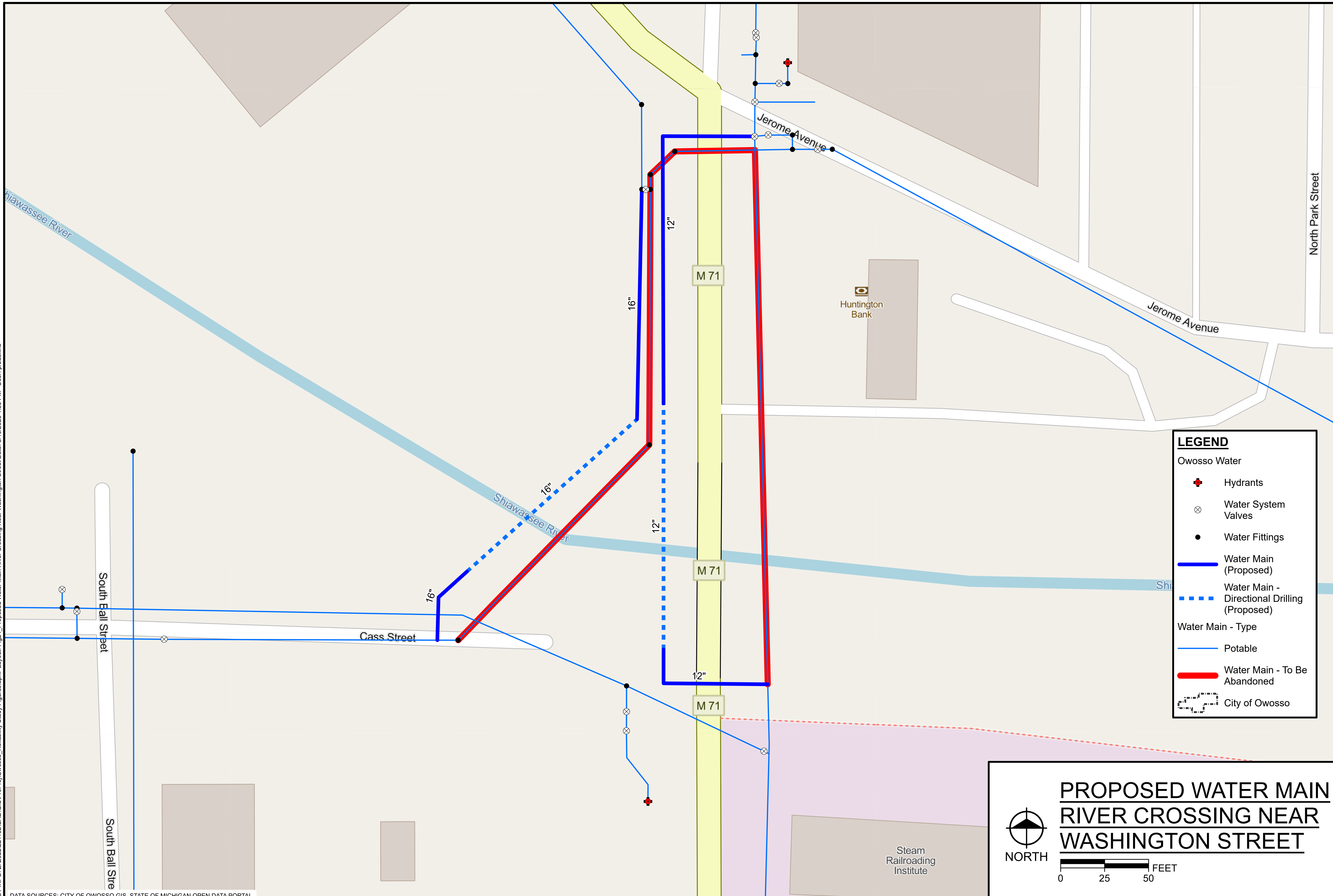
Hard copy is intended to be 11"x17" when plotted. Scale(s) indicated and graphic quality may not be accurate for any other size.

City of Owosso
Shiawassee County, Michigan
Water System Reliability Study and General Plan Update

PROJECT NO.
221152

FIGURE NO.
23

DATA SOURCES: CITY OF OWOSSO GIS. STATE OF MICHIGAN OPEN DATA PORTAL.



PROPOSED WATER MAIN RIVER CROSSING NEAR WASHINGTON STREET

NORTH

FEET 0 25 50

fishbeck

Engineers | Architects | Scientists | Constructors

Hard copy is intended to be 11"x17" when plotted. Scale(s) indicated and graphic quality may not be accurate for any other size.

City of Owosso

Shiawassee County, Michigan

Water System Reliability Study and General Plan Update

PROJECT NO.
221152

FIGURE NO.
24

PLOT INFO: Z:\2022\221152\CAD\GIS\ProProj\Owosso_Reliability Study Figures.aprx Layout: Fig24_Proposed Water Main River Crossing Near Washington Street Date: 3/10/2023 1:35 PM User: prbaskins

Appendix 1

Appendix 1: City of Owosso Monthly Pumpage
City of Owosso, Michigan
Owosso Water System Reliability Study
Project 221152

	Month	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Total Pumpage (million gallons)	January	49.85	50.67	55.18	48.60	48.29	47.74	52.66	48.08	47.18	49.95
	February	46.01	45.43	54.02	50.00	46.00	44.01	47.58	45.75	46.17	46.35
	March	50.29	49.65	59.86	57.94	47.56	45.67	52.62	47.66	52.31	54.53
	April	48.10	47.73	54.97	47.60	45.84	43.64	49.15	42.67	49.05	51.65
	May	54.71	55.12	52.78	51.69	51.27	49.58	54.29	47.88	55.83	57.37
	June	62.37	51.36	54.29	53.12	61.23	57.31	57.02	53.94	58.52	61.45
	July	67.46	57.81	55.39	54.87	63.03	58.29	66.92	64.03	59.87	66.21
	August	58.96	56.96	54.48	55.34	58.13	58.67	60.00	60.09	62.65	62.95
	September	52.38	51.45	49.82	52.39	51.02	55.76	52.68	53.13	51.57	54.93
	October	50.21	49.95	49.23	50.04	50.64	50.05	50.53	50.76	49.63	51.10
	November	46.84	45.49	46.00	44.94	45.48	44.04	48.31	46.57	40.41	45.46
	December	48.33	47.26	47.13	46.79	46.74	47.34	49.60	46.15	48.96	52.34
Average Annual Demand (mgd)		1.72	1.65	1.73	1.68	1.69	1.64	1.76	1.68	1.64	1.71
Maximum Day Demand (mgd)		2.62	2.24	2.45	2.53	2.56	2.43	2.78	2.90	2.62	2.42

Appendix 2

RICK SNYDER
GOVERNOR

STATE OF MICHIGAN
DEPARTMENT OF ENVIRONMENTAL QUALITY
LANSING DISTRICT OFFICE

DEQ

DAN WYANT
DIRECTOR

December 16, 2015

Mr. Don Crawford, City Manager
City of Owosso
301 West Main Street
Owosso, Michigan 48867

Dear Mr. Crawford:

SUBJECT: Community Water Supply – City of Owosso – WSSN: 05120

This letter is to acknowledge receipt of the Emergency Response Plan (ERP) for the city of Owosso community water supply. The Department of Environmental Quality, Community Water Supply Program, thanks you for updating the ERP.

The content of the ERP was reviewed for contact information, communication with customers, plans and agreements, and emergency procedures for operating the water system. Many of these items were satisfactorily covered in the ERP. The ERP has been examined and approved.

If you should have any questions in regards to this correspondence, please contact me at the telephone number below; via e-mail at swendsenk@michigan.gov; or Department of Environmental Quality, P.O. Box 30242, Lansing, Michigan 48909.

Sincerely,

Kurt Swendsen

Kurt Swendsen,
Office of Drinking Water
and Municipal Assistance
Lansing District Office
517-525-1487

cc: Mr. Glenn Chinaware, City of Owosso
Mr. David Haut, City of Owosso
Mr. Larry Johnson, Shiawassee County Health Department

EMERGENCY RESPONSE PLAN

For the City of Owosso Water Supply System
Public Water Supply # 5120

CITY OF OWOSSO
301 W. MAIN STREET
OWOSSO, MICHIGAN 48867

Updated May 2021

REVISIONS: (All copies of this plan must be revised as the names, addresses, and telephone numbers of personnel, suppliers, contractors, and governmental agencies are changed, as well as changes in the water supply system, but at least annually and a copy of the reviewed plan submitted to the State DEQ.)

TABLE OF CONTENTS

In case of an emergency, get needed assistance. Make the required notifications; contact the Michigan Department of Environment, Great Lakes, and Energy (EGLE) as soon as possible if directed. Keep in mind the following considerations: Loss of pressure, inadequate quantities of water available and possible contamination.

Water Plant Phone Numbers Updated 06/28/2023

NON - EMERGENCY POLICE DIAL 743-9111 OR 743-3411

DIAL 911 FOR EMERGENCIES								
DO NOT GIVE ANY PERSONNEL PHONE NUMBERS TO OUTSIDE CALLERS WITHOUT PERMISSION								
Ryan E. Suchanek Utility Director		Direct Dial:	555	Cell:	989-666-1919		FAX: 725-0524	
		Office:	725-0555					
Water Filtration Plant		**989-725-0560**		**WTP Cell:**	**989-666-8212**		**FAX: 725-0526 (HR)**	
David H. Haut	Superintendent	Personal Cell:	914-224-4301	**Work Cell:**	**989-666-8210**	Home:	845-226-1155	
Chase Peiffer	Lead Operator	Personal Cell:	989-627-7708	**Work Cell:**	**989-445-0305**	Home:	989-723-5112	
Adam Riley	Operator/Mech.	Personal Cell:	989-666-2827			Home:		
Kirk Machala	Plant Operator	Personal Cell:	989-723-4581			Home:		
Ryan Farley	Plant Operator	Personal Cell:	989-494-8540			Home:		
Steve Lockwood	Plant Operator	Personal Cell:	989-721-7995			Home:		
Noah Aurand	Plant Operator	Personal Cell:	989-413-4259			Home:		
Adam B.	Plant Operator	Personal Cell:	989-413-0178			Home:		
CORUNNA DPW								
Tim Crawford:	Superintendent			**Work Cell:**	517-625-4996		989-666-3391	
Leigh	Plant Operator			**Work Cell:**	989-743-5564	**Personal Cell:**	989-413-6132	
Corunna DPW Barn:		**Office/Work**	989-743-5040				517-730-0006	
Corunna Booster Pump		**Office/Work**	989-743-4138					
Corunna City Hall:		**Office/Work**	989-743-3650					
Waste Water Treatment Plant Office		**725-0562**		**Cell:**	**989-666-8213**		**FAX: 723-1170**	
Tim Guysky:		Personal Cell:	517-214-4202			Home	723-8935	
SEWER MAINT - LIFT STATION ALARMS		If you can't reach anyone call Tim Guysky.		JEFF LUFT	989-666-8211	Home	725-2768	
DEPARTMENT OF PUBLIC WORKS			**989-725-0556**	**Cell:**	**989-666-8214**			
DO NOT GIVE DPW PERSONNEL PHONE NUMBERS TO OUTSIDE CALLERS WITHOUT PERMISSION								
Central Dispatch		**989-743-9111**	**EXT 581**		**Answering Service:**		**989-723-9128**	
Thomas Wheeler	Superintendent	**989-721-6065**	**989-725-0556**		**Standby Cell:**		**989-494-2006**	
Humphreys, Dan	Mechanic	517-763-9085	989-725-2772		**Meter truck**		**989-666-0052**	
Oberlin, Paul	Forman	989-413-9503						
OTHER PLANT INFORMATION								
Address			**Consumers Account #**	**Substation**	**Circuit**	**Facility**		
Plant:	1111 Allendale Ave.		100000036614	Owosso	Oakwood	W.T.P. Main		
	1111 Allendale Ave.		100025833060	Owosso	Stewart	W.T.P. Pumps #1 and #2		
Standpipe:	1418 Walnut St.		100000367555	Owosso	Business	Standpipe Booster		
Wells:	1510 Palmer Ave.		100047729072	Owosso	Stewart	Palmer Street Well 2		
	1590 Palmer Ave.		100047729072	Owosso	Stewart	Palmer Street Well 3		
	1586 Palmer Ave.		Future	Owosso	Stewart	Future Palmer Ave Well 3a		
	1260 Hintz Rd.		100000088797	N Corunna	Copas	Hintz Well		
	1233 E. Oliver St.		100000088557	N Corunna	Copas	Osbum Well		
	1040 Juniper St		Future			Future Juniper I Well		
	527 S. Oakwood St.		100000111979	Owosso	Oakwood	L.W. #13		
Elevated Tank:	1890 Dowling Dr.		100024267963	Owosso	West Main	West Elevated Tank		
CONSUMER'S ENERGY - "PRIORITY" EMERGENCY NUMBER 1-800-805-0490 or Brian - Maintenance 729-3222								
Direct Dial Numbers								
HR		552	WWTP		562	Fire Captains		593
Payroll		574	City Hall Desk		599	Kevin Lenkart		585
Account Payable		572	DPW		556			
Shiawassee County Environmental Health			**989-743-2390**					

1. Miscellaneous (List other telephone numbers that may be needed during emergencies.)

Young's Environmental Cleanup, Inc. 1-800-496-8647

a. Michigan Department of Environmental Quality:

District Engineer/Sanitarian:

DEQ: Kurt Swendsen District Engineer 1-517-525-1487

Environmental Quality Analyst:

DEQ: (517) 284-6644

Emergency Number:

DEQ Pollution Emergencies only: 1-800-292-4706
DEQ Environmental Assistance Center: 1-800-662-9278

b. Appropriate Municipal Officials:

City of Owosso
City Manager: Nathan Henne
Direct Line 569
Office (989) 725-0568

Utilities Director: Glenn M. Chinavare
Direct Line 555
Office 989-725-0555
Cell 989-666-8206

City of Corunna
402 North Shiawassee St
Corunna, MI 48817
Phone: (989) 743-3650

Owosso Township Hall
2998 W M 21, Owosso, MI 48867
(989) 723-2187

Caledonia Charter Township Hall
135 North State Road, Owosso, MI 48867
Supervisor Joe DeCaire
Phone: 989-743-5300 ext. 222

c. Local Health Department:

Shiawassee County Health Department
Environmental Health Division
Surbeck Building
201 N. Shiawassee St., 3rd Floor
Corunna, Michigan 48817

Office: (989) 743-2390
Fax: (989) 743-2413

d. Department of Agriculture:

Shiawassee Conservation District
1900 S. Morrice Rd.
Owosso, MI 48867
(989) 723-8263 ext. 3

MDARD Emergency Contact Information

EMERGENCY CONTACT INFORMATION FOR THE MICHIGAN DEPARTMENT OF AGRICULTURE & RURAL DEVELOPMENT

During regular business hours, Monday through Friday, 9 am to 5 pm ET , please call the Michigan Department of Agriculture & Rural Development's Customer Service Center at **1-800-292-3939**.

Agriculture Pollution/Spills Hot Line: 1-800-405-0101

This 24-hour hot line should be used for reporting accidental agricultural pesticide, fertilizer and manure spills. (Chemical spills not agriculture-related should be referred to the Michigan Department of Environmental Quality's Pollution Emergency Alerting System (PEAS) number, 1-800-292-4706.)

AFTER HOURS EMERGENCIES - If you have a human health emergency, please call 911. For animal emergencies, contact your veterinarian or local animal control office.

MDARD's after-hours number is 517-373-0440. This number should be used by agriculture producers and food and feed manufacturers and retailers who have experienced damage or loss. Veterinarians should also use this number for foreign animal diseases or unusual events.

Water Response Contacts Region 5 – Midwest – Michigan:
When utility and local resources have been exhausted during a response, you may wish to request resources from your mutual aid partners in your state's Water and Wastewater Agency Response Network (WARN), your state emergency management agency, your state drinking water or wastewater agency, or federal response support from USACE, FEMA, or EPA.
WARN
Co-Chair: Tim Faas (tim.faas@canton-mi.org)
734-394-5160
Co-Chair: Tim Neumann (tneumann@mrwa.net)
989-539-4111
State Police, Emergency Management and Homeland Security Division
517-336-6198
Department of Environmental Quality, Drinking Water Programs
800-292-4706 – **24-hour emergency**
Department of Environmental Quality, On Site Wastewater
800-292-4706 – **24-hour emergency**

e. Police:

911 FOR EMERGENCIES
NON - EMERGENCY OWOSSO POLICE DIAL **743-9111** OR **743-3411**

Director of Public Safety
Kevin Lenkart
202 South Water Street
Owosso, MI 48867
Phone: (989) 725-0580
Fax: (989) 725-0528

State Police
Capt. Gene Kapp
810-732-1111

Shiawassee County Sheriff Department
George R. Braidwood
989-743-3411

f. Fire Department:

Dial 911 for Emergencies
Director of Public Safety - Kevin Lenkart
City of Owosso Fire Department
202 S WATER ST
Owosso, MI 48867
Phone: (989) 725-0591
Fax: (989) 725-0528

g. Newspapers:

The Argus-Press Company
201 E. Exchange St.
Owosso, MI 48867
Ph: (989) 725-5136

h. Radio/TV Stations:

Z92.5 The Castle

z925.com

103 N Washington St, Owosso

(989) 725-1925

Krol Cuminications

224 W Exchange St, Owosso

(989) 725-1039

Channel 3 Broadcasting

106 W Mason St, Owosso

(989) 472-4899

Woap The Big 1080

www.woapradio.com

2301 N M 52, Owosso

(989) 472-4104

i. Nearby Laboratories:

Drinking Water Laboratory
Michigan Department of Environmental Quality
3350 North M.L. King Blvd., P.O. Box 30270
Lansing, MI 48909
(517) 335-8184

j. Other:

EPA's Safe Drinking Water Hotline at 1-800-426-4791

EPA Region 5
Email: r5hotline@epa.gov
Water Program
Dean Maraldo, Water Division, Security Program Manager (dean.maraldo@epa.gov)
Phone: 312-353-2098
Alicia Brown (brown.alicia@epa.gov)
Phone: 312-886-4443
Jodie Opie (opie.jodie@epa.gov)
Phone: 312-353-1938

Mailing Address

EPA Region 5 (IL, IN, MI, MN, OH, WI)
Environmental Protection Agency
77 West Jackson Boulevard
Chicago, IL 60604-3507

Phone: (312) 353-2000
Fax: (312) 353-4135
Toll free within Region 5: (800) 621-8431

2. Contractors List telephone numbers of reputable contractors which may be needed during emergencies.

a. Excavators:

Sumbera Excavating
6490 W McBride Rd, Owosso, MI
989-723-1985

b. Well Drillers:

Dale E. Stewart
Northern Pump & Well
Operations Manager

(517) 322-0219 Work
(877) 477-1757 Work
dstewart@northernpwco.com
6837 W. Grand River Ave.
Lansing, MI 48906

c. Welders:

SLH Metals Inc.
229 Sleeseman Dr, Corunna, MI 48817
(989) 743-3467

d. Electricians:

Halligan Electric Inc.
705 Kelso St
Flint, MI 48506
810-238-8581

Ludington Electric
453 E. King St. Owosso Mi 48867
Contact: Carl Ludington
Office 989-729-9473

e. Plumbers:

Lamphere's Plumbing Heating & Cooling
919 W Main St, Owosso, MI 48867-2516
(989)723-7488

3. Suppliers (List telephone numbers of suppliers which may be needed during emergencies)

a. Chemical Suppliers:

Sodium Hypochlorite –

JCI Jones Chemical Inc.
18000 Payne Avenue,
Riverview, Michigan 48192
Phone: 734.283.0677
Fax: 734.283.0979
To place an order: 1.800.635.5489 – Cust. # 21689305

Other Sodium Hypochlorite suppliers:

K.A. Steel Chemicals
15185 Main St.
P.O. BOX 729
Lemont, Illinois 60439

800-677-8335 or 888-257-3900
Local phone number: 630-257-3900
Alexander Chemical Company
Darlene Devereaux Michigan Rep.
orders@alexanderchemical.com
800 348 8827 (orders and general inquiries)

PVS Nolwood Chemicals
10900 Harper Avenue
Detroit, MI 48213
Phone: (313) 921-1200
Fax: (313) 921-1378

Rowell Chemical Corporation
15 Salt Creek Lane - Suite 205
Hinsdale, IL 60521
Phone: (630) 920-8833
Fax: (630) 920-8994
E-Mail: info@rowellchemical.com

WEBB CHEMICAL SERVICE CORPORATION
2708 Jarman Street
Muskegon Heights, MI 49444
Phone: 231-733-2181
Fax: 231-739-5454
Email: info@webbchemical.com

Quicklime

Graymont Western Lime Inc. - Port Inland Plant
Our Customer # 201019
181 W. County Rd. 432
Gulliver, MI 49840
Plant phone 1 906 283-2900
Sales phone 1 800 433-0036

Felicia Reid
Carmeusena Lime

(412) 995-1053 Work
Felicia.reid@carmeusena.com

carmeusena.com

Lime Hauler:

Cordes, Inc
charlie@cordestrucking.com
10100 Sedroc Industrial Drive SW
Byron Center, MI 49315
Phone- 616.877.9935
Fax - 616.877.9976

b. Pump Suppliers:

IONIA BRANCH OFFICE
Peerless-Midwest
505 Apple Tree Drive
Ionia, MI 48846
Phone: 616.527.0050 | Fax: 616.527.5508
Email: info@peerlessmidwest.com

c. Water Main Repair Materials Supplier:

Etna Supply
529 32nd Street
Grand Rapids, MI 49548
Phone: 1-855-839-8011
After Hours Emergency Phone for All Locations: (616) 245-4373

CRITICAL CUSTOMERS

1. List critical customers or users for whom the provision of a continuous supply of safe water is most urgent. Include name, telephone number and address.

Memorial Health Care
826 W. King St
989-723-5211 or 800-206-8706

Fresenius Medical Services (FMS) Dialysis - Owosso
918 Corunna Ave
(989) 725-3144
Johnathan Gifford - Area Technical Manager
810-931-6388 & (989) 725-1041

Fresenius Medical Services (FMS) Dialysis - Owosso
500 Health Park Drive
Bradley Reedy - Area Technical Operations Manager
517-224-6624

Fresenius Medical Services (FMS) Dialysis - Owosso
826 W King St
Johnathan Gifford - Area Technical Manager
810-931-6388

Chuck Days/JoAnn Cranson
Water Treatment Consultant for Corunna Machine Tool and Gear
Chiller operations (advise when softening event or bypass happens)
517-974-4970/517-627-8444
jcranson@enercorp.com
800-292-5908

A list of schools and childcare facilities are attached to this document and should also be considered in emergency situations for a continuous supply of water.

2. Describe method to provide critical customers with a continuous supply of water.

Refer to the following reference booklet produced by the CDC and AWWA:

http://www.cdc.gov/healthywater/pdf/emergency/emergency-water-supply-planning-guide.pdf

Bulk Water Suppliers:

New Lothrop - GROMBIR TRANSPORT INC., 810-638-5172
Flint - Michigan Water Transport, 888-733-3959
Flint - Ken Brown Trucking 810-230-6725
Fowlerville - Aqua Haul 517-546-1991
Fowlerville - Maleitzke Trucking H20 To Go 517-223-9625
Lowell - The Waterboy, 269-998-7708

Bulk water will be distributed in the vacant parking lot at the following address:

201 S Washington St.
Owosso, MI 48867

The crossroads are at N. Park St. and Jerome Avenue as shown in the map below.

COMMUNICATIONS

- Describe methods of communication available during power outages.

  The emergency phone at the WTP is a hardline phone. It is located in the WTP office. The number is 989-723-0317.

  There is also a cell phone that shift operators are instructed to keep with them at all times. That number is 989-666-8212.

  The WTP general number is 989-725-0560, which should remain operational in most power outages.

- Describe methods to provide customers or users with current information and recommended precautions to protect public health.

Notifications are provided on an annual basis with the Consumer Confidence Report in regards to the water quality each year. Any emergency events are communicated using the city website, door-to-door notifications, and other news agency media outlets as needed. Printed and posted notifications are used also.

EMERGENCIES - POWER OUTAGE

- ☐ Follow the SOP Power Interruption Procedures to switch to an alternate power source in the event the Automatic Transfer Switch fails to start the Emergency Generator and the second Consumers Power Utility source is not available.
- ☐ Contact the power company. Get an estimate when power will be restored.
- ☐ If the time estimate for power restoration is such that depressurization may occur, then do the following:
    1. Contact critical water users.
    2. Contact emergency personnel and agencies. Notify them of the situation.
    3. Notify the public in the affected area using a water advisory.
    4. If depressurization is expected to occur, follow the depressurization policy.

EMERGENCIES - MAIN WATER BREAK

- ☐ Evaluate the break - Can be repaired under pressure? If not and depressurization will (or has) occurred, do the following:

    1. Contact critical water users as necessary.
    2. Contact emergency personnel and agencies. Notify them of the situation.
    3. Notify the public in the affected area using the water advisory.
    4. Follow the depressurization policy.

    NOTE: It is preferable to repair a water break under pressure if at all possible to reduce the likelihood of contamination.

- ☐ Contact the work personnel, city officials, and contractors needed to proceed with repairing the break.
- ☐ If any valves must be closed to isolate the area of the break, keep the isolated area as small as possible.
- ☐ Make an inventory of the parts necessary to repair the break. Obtain the parts as necessary.

EMERGENCIES - SUSPECTED TAMPERING AT SYSTEM FACILITIES

Tampering with may range from the simple defacement of property to the introduction of biological or chemical agents into the water supply. Refer to the attached “A Utility Guide for Security Decision Making” document for appropriate response actions. These actions can be divided into several general categories:

Action	Description
Vandalism	Actions that cause physical damage to property and structures, such as cutting fences to gain access to secure areas, breaking windows, and damaging or removing locks from doors or wells.
Malicious Action	Actions that, intentional or not, introduce or threaten to introduce foreign substances into a portion of the treatment or distribution system or cause damage to a portion of the public water systems infrastructure. These acts range from pranks that “go too far” (adding food coloring to a storage tank) to actions intended to cause a disruption to the public water supply or the introduction of toxic substances into the distribution system.
Terrorism	Intentional actions introduce or threaten to introduce foreign substances into a portion of the treatment or distribution system or cause damage to a portion of the public water systems infrastructure. These acts are meant to cause harm to individuals and cause unease or panic in the general public.

PROCEDURE

- Immediately take the following actions:
    1. Treat the area as a crime scene. Minimize disturbance of the area in order to preserve physical evidence, which can include fingerprints, tire tracks, tool marks, dropped materials, or tools. Document the observed conditions, with photographs and video if possible, taking care to note anything that is out of the ordinary.
    2. Contact the law enforcement agency. Work with local law enforcement personnel to determine if the tampering was the result of vandalism, a malicious action, terrorism, or had some other cause.
    3. Isolate the affected portion of the system.
    4. Immediately contact the DEQ and any other emergency personnel or agencies that are appropriate for the situation.
- Complete the following activities as soon as possible:
    1. If there is evidence of contamination, perform a physical check on the system and its structural integrity (check storage tanks for foreign objects, look for open hydrants, etc.).
    2. Contact the laboratories to determine if they are capable of analyzing for and identifying unknown substances.
    3. If it is determined that the tampering resulted in the probable introduction of chemical or biological contaminants into the storage tank, proper precautions must be taken during sampling to prevent exposure to the contaminant and/or daughter products.
    4. With the consent of law enforcement, begin to repair/secure all points of entry and other physical damage to structures.

EMERGENCIES - DISTRIBUTION SYSTEM STORAGE FAILURE

- Isolate or remove the storage unit from the system.
- After the storage unit has been removed from service either:
    1. Pump the source continuously with pressure relief.
    2. Bring in an NSF-approved temporary storage tank with approval of DEQ.
    3. Activate an existing emergency connection to another public water system or install a new emergency connection to another public water system with DEQ approval.
    4. Haul water using approved haulers if necessary.
- After repairs have been made, bring the storage unit online in accordance with AWWA C652.

EMERGENCIES - RECOMMENDED PROCEDURE WATER SYSTEM DEPRESSURIZATION

- In the event of depressurization due to water main breaks or other physical disruptions in the integrity of a water system, the system should be considered *E. coli* or fecal positive (unsafe) and the system must be sampled for total coliform bacteria.
    1. Contact critical water users and notify them of the situation and the necessity to boil their water.
    2. Immediately contact the DEQ and any other emergency personnel or agencies that are appropriate for the situation.
    3. Issue a water use/boil advisory for the affected area. Provide notice by radio, television, handbill, or continuous posting within 72 hours.
- Contact the work personnel, city officials, and contractors needed to proceed with repairing the break.
- Institute any water conservation measures deemed necessary.
- If depressurization is the result of a break, isolate the area. Keep the isolated area as small as possible. Refer to a map of valve and water main locations. Make an inventory of the parts necessary to repair the break. Obtain the parts as necessary using the Supplier and Parts list if needed.
- Take the necessary measures to restore pressure as soon as possible. Repairs must be made in accordance with AWWA C651-92 Section 10.
- Disinfect the system according to recommended procedures for line breaks or physical disruption of the integrity of the system.
- Sample for bacterial contamination. Obtain at least one set of samples that are total coliform negative before the boil advisory is lifted by DEQ. Mark the sample SPECIAL PURPOSE. Even if the first set is negative, it is suggested that a second set of samples be taken. If a second set of samples is taken, they shall be considered part of routine sampling for monthly compliance purposes. NOTE: The initial samples are considered “special purpose” and will not count toward the routine total coliform monitoring requirement.
- If any sample in the initial set is coliform positive, the boil advisory will remain in place until two consecutive sets of samples are coliform negative.
- Submit a report of the incident to DEQ District Office. Include a copy of the sample results and any pertinent notifications with the report.

EMERGENCIES - SUSPECTED BACKFLOW OR CROSS CONNECTION

- Isolate suspected facility/source of the backflow connection.
- Sample to determine the system has become contaminated.
- Attempt to determine the degree of health hazard based on the four broad classifications of contamination found in the Inorganic/Organic Contamination procedure.
- Refer to the appropriate procedure(s) (Inorganic/Organic Contamination, Bacteriological Contamination, Total Coliform Positive Sample Procedure) based on the results of the sample analysis.

EMERGENCIES - SOURCE FAILURE (including pumps, wells)

- In the event of source failure:
    1. Contact critical water users and notify them of the situation and the necessity to boil their water.
    2. Immediately contact the DEQ and any other emergency personnel or agencies that are appropriate for the situation.
    3. Issue use restrictions for the affected area. Determine the supply capacity relative to existing and potential demand. Notify critical water users of the situation. Provide notice by radio, television, handbill, or continuous posting within 72 hours. See the community water needs chart for additional information.
- Alternative sources of water and the method of disinfection that will be used for each source. Options include, but are not limited to:
    1. Hauling water using the approved haulers.
    2. Activating an existing emergency connection to another public water system or installing a new emergency connection to another public water system with approval of DEQ.
    3. Providing bottled water for potable use as needed.
    4. In consultation with DEQ, develop an alternate source of drinking water.

EMERGENCIES - UNPLANNED ABSENCE OF OPERATOR

- Operators are not allowed to leave the plant without completing a shift change with a qualified operator to take over the WTP operation. If an emergency has occurring during the shift, the outgoing operator will work until obtaining a supervisors approval to leave work.

COMMUNITY WATER NEEDS DURING EMERGENCIES

Emergency conditions may be broken into four stages of recovery, each of which require a differing level of water service. Each level more water to more people for more uses than the previous one, starting with basic survival needs to normal operational conditions. The U.S. Department of Defense has published guidance containing practical data on individual water requirements after a nuclear attack. These figures may be readily adapted to determine the needs at each of the previously mentioned four levels of service.

Level of Service	Description	Group	Water Needs
Level 1	Potable water for human consumption, drinking and cooking and sanitation of hospital equipment are the only permitted uses	Individuals	0.5-5.0 gallons per capita per day (gpcpd)
		Hospitals and care centers	5-15 gpcpd
		Mass shelters	3 gpcpd
Level 2	Potable water for human consumption and general sanitation.	Individuals	25 gpcpd
		Hospitals and care centers	25-40 gpcpd
		Mass shelters	25 gpcpd
Level 3	Increased usage for human consumption and general sanitation plus reserves for fire defense	Individuals	40 gpcpd
		Hospitals and care centers	40 gpcpd
		Mass shelters	25 gpcpd
		Fire defense reserves	Based upon past experience of the community's fire fighting demands and the system's ability to produce or obtain additional water.
Level 4	Conditions are near normal relative to the systems production capability and selected industrial, commercial, and agricultural usage is permitted.		

EMERGENCIES – ENVIRONMENTAL SPILLS

In the event of a spill, contact Glenn M. Chinavare, David H. Haut and DEQ Area Engineer. DPW could be called in to prevent the spill from reaching the river. Young's Environmental Cleanup might be called if the spill is significant. The spill must be kept from the drinking water also.

In the event that there is a chemical spill, we must document:

- Date.
- Location of Spill.
- If carrier involved:
  - Company Name.
  - Contact Name.
  - Company Phone Number.
  - Insurance Company Name.
  - Policy Numbers.
- Directions from Highway will be needed.
- A description of the incident will be needed.
- Weather information will be needed.
- Indicate color of placard.
- Indicate UN number on Placard.
- Indicate Hazard class on placard.
- Note if material hazards are flammable, explosive, oxidizer, cryogenic, reactive, corrosive, toxic, biological, carcinogenic, herbicide/pesticide, radioactive, or other hazard.
- Note chemical name.
- If leaking container, note container type, number, and size.
- Note affected area.
- Note site topography.

EMERGENCIES - INORGANIC/ORGANIC CONTAMINATION

- Attempt to determine the specific chemical which has caused the contamination and its hazard classification. There are four broad classifications of contamination as follows:

HAZARD TYPE	DESCRIPTION
Pollution Hazard	A condition through which an aesthetically objectionable or degrading material **NOT** dangerous to health may enter the public water system or a consumer's potable water system (for example - a food grade product)
System Hazard	A condition, device, or practice posing an actual or potential threat of damage to the physical properties of the public water system or a consumer's potable water system **but will not** cause an adverse health effect (for example - an inert material that may clog the water line but not cause illness if ingested)
Health Hazard	Any condition, device, or practice in a water supply system or its operation that creates, or **may create a danger to the health and well being** of others. **(For example, a fluoride overfeed that results in a concentration greater than 10 mg/L in the PWS)**
Severe Hazard	**Any health hazard that could reasonable be expected to result in significant morbidity or death** (for example - the contamination of a water system with a large amount of pesticide)

If the degree of hazard cannot be determined, assume the situation presents a *severe hazard*.

- Determine the following information:
  1. Who made the first observation?
  2. What is their phone number and location?
  3. When did it happen?
  4. What is it?
  5. What are its qualities - color/taste/smell?
  6. Is an MSDS sheet available?
  7. How much of it entered the water system?
  8. Where did it enter the water system?
  9. Where is it now?
  10. Is it isolated to one area or is it wide spread?
  11. What area and population are affected?
  12. Can it be isolated?
  13. Can depressurization and or flushing of the affected area be done quickly and without serious consequences?
- If the contamination is classified as either a ***health hazard*** or a ***severe hazard*** do the following:
  1. Issue a no-use water advisory immediately. A boil advisory will not be adequate for most chemical contamination – boiling the water may only serve to concentrate the contaminant.
  2. If the contaminant could cause serious illness or death, can you isolate the water supply from users?
- If a water advisory will be issued, contact the critical water users and notify them of the situation. Immediately contact emergency personnel and agencies. Notify them of the situation.
- If possible, determine the cause and source of the contamination – eliminate the source. Consider the possibility that the cause may be due to a cross connection, backflow, or back siphonage.
- Begin flushing the distribution system to eliminate the contaminant from the public water supply.

EMERGENCIES - BACTERIOLOGICAL CONTAMINATION

- If only a routine sample has been determined as total coliform positive and no repeat samples have yet been taken, follow the guidance in **2018 City of Owosso Coliform Monitoring Plan.**
- If an "ACUTE"' bacteriological violation has occurred, issue the "BOIL ADVISORY" and public notice and do the following:
    1. Contact critical water users and notify them of the situation and the necessity to boil their water.
    2. Immediately contact the DEQ and any other emergency personnel or agencies that are appropriate for the situation.
    3. Divide the distribution system into sections. Begin bacteriological sampling in each section and at the plant tap to determine the extent and cause of the contamination. (NOTE: if possible use the locations indicated in the "Bacteriological Sample Siting Plan".)
- Ensure that at least a 0.2 mg/l free chlorine residual is maintained in all parts of the distribution system. If the free chlorine residual falls below 0.2 mg/l, increase the chlorine dosage immediately. Dosing the storage tanks, as needed, will quickly increase the chlorine residual to 0.2 mg/l.

DRINKING WATER WARNING

City of Owosso water is

Contaminated with [fecal coliform/*E. coli*]

BOIL YOUR WATER BEFORE USING

Fecal coliform (or *E. coli*) bacteria were found in the water supply on __________(date). These bacteria can make you sick, and are a particular concern for people with weakened immune systems.

What should I do? What does this mean?

- **DO NOT DRINK THE WATER WITHOUT BOILING IT FIRST.** Bring all water to a boil, let it boil for three (3) minutes, and let it cool before using *or* use bottled water. ***Boiled or bottled water*** should be used for drinking, making ice, brushing teeth, washing dishes, and food preparation **until further notice**. Boiling kills bacteria and other organisms in the water.

- *Fecal coliforms and E. coli are bacteria whose presence indicates that the water may be contaminated with human or animal wastes. Microbes in these wastes can cause diarrhea, cramps, nausea, headaches, or other symptoms. They may pose a special health risk for infants, young children, and people with severely compromised immune systems.*

- The symptoms above are not caused only by organisms in drinking water. If you experience any of these symptoms and they persist, you may want to seek medical advice. People at increased risk should seek advice about drinking water from their health care providers.

What happened? What is being done?

Bacterial contamination can occur when increased run-off enters the drinking water source (for example, following heavy rains). It can also happen due to a break in the distribution system (pipes) or a failure in the water treatment process.

Corrective action being taken includes:

We will inform you when tests show no bacteria and you no longer need to boil your water. We anticipate resolving the problem within ________________(estimated time frame).

For more information, please contact David H. Haut at 989-725-0560 or at the City Hall 301 W. Main St., Owosso Michigan 48867.

General guidelines on ways to lessen the risk of infection by microbes are available from the EPA Safe Drinking Water Hotline at 1-800-426-4791.

Please share this information with all the other people who drink this water, especially those who may not have received this notice directly (for example, people in apartments, nursing homes, schools, and businesses). You can do this by posting this notice in a public place or distributing copies by hand or mail.

This notice is being sent to you by the City of Owosso. State Water System ID# 5120. Date _______________.

ATTENTION: PWS OPERATOR/RESPONSIBLE PARTY

Since exceeding the fecal coliform/*E. coli* maximum contaminant level is a Tier 1 violation, you must provide public notice to persons served as soon as practical but ***within 24 hours*** after you learn of the violation (141.202(b)). During this same 24 hour period, you must also contact the MIDEQ. You should also coordinate with your local health department. You may also have to modify this template for your particular circumstances.

You **must** use one or more of the following methods to deliver the notice to consumers (141.202(c)):

- Radio
- Television
- Hand or direct delivery
- Posting in conspicuous locations

You may need to use additional methods (e.g., newspaper, delivery of multiple copies to hospitals, clinics or apartments) since notice must be provided in a manner reasonably calculated to reach all persons served.

This notice template is appropriate for hand delivery or newspaper publication. However, you may wish to modify it before using it for a radio or TV broadcast. If you do, you must still include all required PN elements and leave the health effects language in italics unchanged. This language is mandatory (141.205(d)). If you post or hand deliver the notice, you can print your notice on PWS letterhead.

Corrective Action

In your notice, describe corrective actions you are taking. Listed below are some steps commonly taken by water systems with fecal coliform or *E. coli* violations. You can use one or more of the following actions, if appropriate, or develop your own:

- We are chlorinating and flushing the water system.
- We are switching to an alternate drinking water source.
- We are increasing sampling for coliform bacteria to determine the source of the contamination.
- We are repairing the wellhead seal.
- We are repairing the storage tank.
- We are restricting water intake from a contaminated well to prevent additional bacteria from entering the water system and restricting water use to emergencies.

After Issuing the Notice

Please mail the statement of certification and a copy of the printed notice and the date(s) the notice was either posted or mailed. Send this copy and certification that we have met all the public notice requirements to MIDEQ within ten days from the time you issue the notice (141.31(d)). Be sure to include the population served and clearly indicate the population affected by this action.

It is recommended that you notify health professionals including dentists in the area of the violation so they can use bottled water. People may call their doctors with questions about how the violation may affect their health, and the doctors should have the information they need to respond appropriately.

We also need to issue a “problem corrected” notice when the violation is resolved.

CERTIFICATION OF PUBLIC NOTIFICATION

________________________________ certify that the attached public notice was issued from
(PWS Operator/Responsible Party)

________________________ to ___________________. The notice attached was issued by
(Date) (Date)

___________________________________ for the TCR Violation that occurred on _______________.
(Method of delivery – by hand, mail, etc) (Date)

Signature____Date____________________________

Public Water System Name: _____________________ PWS ID Number: _______________________

IMPORTANT INFORMATION ABOUT YOUR DRINKING WATER
Tests Showed Presence of Coliform Bacteria

Our water system violated a drinking water standard. Although this incident was not an emergency, as our customers, you have a right to know what happened and what we did to correct this situation.

The City of Owosso routinely monitors for drinking water contaminants. In (time --------), we took a total of 20 samples to test for the presence of Coliform bacteria. (Number ex. Two (2)) of our samples tested positive. The standard is that no more than one (1) sample per month may test positive.

What should you do?

You do not need to boil your water or take other corrective actions. However, if you have specific health concerns, consult your doctor.

People with severely compromised immune systems, infants, and some elderly may be at increased risk. These people should seek advice about drinking water from their health care providers. General guidelines on ways to lessen the risk of infection by microbes are available from EPA's Safe Drinking Water Hotline at 1-800-426-4791.

What does this mean?

This is not an emergency. If it had been, you would have been notified immediately. Coliform bacteria are generally not harmful themselves. Coliforms are bacteria, which are naturally present in the environment and are used as an indicator that other, potentially harmful, bacteria may be present. Coliforms were found in more samples than allowed and this was a warning of potential problems.

Usually, Coliforms are a sign that there could be a problem with our treatment or distribution system (pipes). Whenever we detect Coliform bacteria in any sample, we do follow-up testing to see if other bacteria of greater concern, such as Fecal Coliform or E. Coli, are present**. We did not find any of these bacteria in our subsequent testing, and further testing shows that this problem has been resolved**.

What happened? What was done?

We took additional samples for Coliform bacteria which all came back negative. As an added precaution, we flushed the pipes in the distribution system associated with this area to make sure bacteria were eliminated. This situation is now resolved.

For more information, please contact David H. Haut of the City of Owosso Water Treatment Plant at 989-725-0560 or Glenn M. Chinavare, Director of Underground Utilities, City of Owosso 989-725-0555. Or write:

David H. Haut Water Plant Superintendent
City of Owosso
301 West Main Street
Owosso, Michigan 48867

Please share this information with all the other people who drink this water, especially those who may not have received this notice directly (for example, people in apartments, nursing homes, schools, and businesses). You can do this by posting this notice in a public place or distributing copies by hand or mail.

The City of Owosso is sending this notice to you.

State Water System ID# 5120.
Sent (date).

DRINKING WATER WARNING
City of Owosso water has high levels of nitrate—
DO NOT GIVE THE WATER TO INFANTS UNDER 6 MONTHS OLD OR USE IT TO MAKE INFANT FORMULA

Water sample results received (date) __________ showed nitrate levels of (level and units) ___________. This is above the nitrate standard or maximum contaminant level (MCL), of (Michigan MCL). Nitrate in drinking water is a serious health concern for infants less than six months old.

What should I do?

DO NOT GIVE THE WATER TO INFANTS. Infants below the age of six months who drink water containing nitrate in excess of the MCL could become seriously ill and, if untreated, may die. Symptoms include shortness of breath and blue baby syndrome. Blue baby syndrome is indicated by blueness of the skin. Symptoms in infants can develop rapidly, with health deteriorating over a period of days. If symptoms occur, seek medical attention immediately.

Water, juice, and formula for children under six months of age should not be prepared with tap water. Bottled water or other water low in nitrates should be used for infants until further notice.

DO NOT BOIL THE WATER. Boiling, freezing, filtering, or letting water stand does not reduce the nitrate level. Excessive boiling can make the nitrates more concentrated, because nitrates remain behind when the water evaporates.

Adults and children older than six months can drink the tap water (nitrate is a concern for infants because they can't process nitrates in the same way adults can). However, if you are pregnant or have specific health concerns, you may wish to consult your doctor.

WHAT HAPPENED? WHAT IS BEING DONE?

Nitrate in drinking water can come from natural, industrial, or agricultural sources (including septic systems and run-off). Levels of nitrate in drinking water can vary throughout the year. We'll let you know when the amount of nitrate is again below the limit.

The system expects to be in compliance (date) ________________

For more information, please contact David H. Haut at 989-725-0560 or City Hall 301 W. Main St., Owosso Michigan 48867.

Please share this information with all the other people who drink this water, especially those who may not have received this notice directly (for example, people in apartments, nursing homes, schools, and businesses). You can do this by posting this notice in a public place or distributing copies by hand or mail.

The City of Owosso is sending this notice to you. State Water System ID#5120.
Date distributed________________.

Emergency Response Plan Certification of Public Notification

Public Water System Name: City of Owosso Water Treatment Plant
Public Water System ID # 5120
Violation: (Describe violation)
Occurring on (date)

The public water system indicated above hereby affirms that public notice has been provided to consumers in accordance with the delivery, content, and formal requirements and deadlines in (regulatory citation)

Consultation with primacy agency (if required) on (insert date) ______________________________

Notice distributed by (insert method) _______________________ on (insert date) ________________

Content-required elements.

____
Signature of operator   Date

PLANS & AGREEMENTS

1. General Layout. Attach the general layout (piping schematic) of the waterworks system or indicate the location of the General Plan as well as valve and hydrant records and any other information that would be helpful in fully describing the water system.

A full size copy of the CITY OF OWOSSO WATER DISTRIBUTION SYSTEM MAP is located in the control room on a wall in the WTP and is attached to this document.

2. Personnel Safety Plans. List relevant plans and indicate their locations. Examples may include evacuation plans, lock down procedures, location of personal protective equipment (PPE) and procedures for use, and location of Material Safety Data Sheets (MSDS).

- Evacuation plan:

  Possible events include natural disasters, fires or structural and mechanical failures that endanger people.

  - Emergency 911 notifications are critical.
  - Next notify management.
  - Determine if the plant process needs to be shut down.
  - Complete **City of Owosso WTP Shut Down SOP** - if it is safe to do.
  - Complete **City of Owosso Raw Water Emergency Supply SOP**.

- Lock down procedure: All yard and road gates are locked after normal working hours. The outside lobby door is locked on 2nd and 3rd shifts. All gates and doors are to be checked and locked by the on duty operator during a lockdown event. 911 notification and notification to management of the Lock down occurrence and the reason for it. Additional department personal and police assistance will be initiated by the operator on duty. Refer to the attached “A Utility Guide for Security Decision Making” document for appropriate response actions.

✓ **All contact with MIDEQ or County Health will be made by Supervisors unless directed otherwise.**

✓ **After 911 notifications, then supervisors will be given priority notification also.**

A Utility Guide For Security Decision Making

These guidelines are designed to assist utilities in determining the level of secuity concern if a break-in or threat occurs at the water system and to assist the utility in appropriate decision making and response actions. These various steps and actions can be adjusted to meet the needs of specific situations and to comply with individual state requirements. **Specific actions should be undertaken in consultation with your State Drinking Water Primacy Agency.** Technical assistance is available from your state drinking water primacy agency and state rural water association for prevention initiatives such as vulnerability assessments, emergency response planning, and security enhancements.

SYSTEM

Take any suspicious activity or evidence of vandalism or sabotage seriously.

Prevention is the best practice. Conduct a security vulnerability assessment. Develop and practice your Emergency Response Plan.

Establish relationships with local law enforcement and emergency response entities before an incident occurs.

Upon discovery of vandalism, receipt of a threat, or knowledge of a potential contamination event.

Notify local law enforcement.

Notify your State Drinking Water Primacy Agency if there is any indication or a potential of contamination.

Make decisions in consultation with your State Drinking Water Primacy Agency and local law enforcement. Technical Assistance is available from them and your State Rural Water Association.

In consultation with your State Drinking Water Primacy Agency and local law enforcement, evaluate and determine whether the incident is vandalism or a potential threat and/or possibility of contamination.

Look at chlorine residuals, visually inspect the damage, or physical evidence, determine whether there is a change in turbidity, odor color, or pH.

Establish the incident in relation to critical system components. Evaluate any customer complaints.

Vandalism/Prank

Precautionary Options

Continue monitoring for residuals. Conduct additional testing as recommended by your State Drinking Water Primacy Agency.

Possibility of Contamination

Options

- Implement Emergency Response Plan.
- Isolate portion of system or backflush.
- Issue boil order (if appropriate).
- Issue "Do Not Drink" notification (if appropriate).
- Shut down system if obvious or verified contamination warrants.
- Conduct actions and testing as recommended by State Drinking Water Primacy Agency and those with water expertise.

- **Do not disturb evidence and document what you see. Keep notes and take photos as you go.**
- **Collect samples for future analysis and store them appropriately.**
- **Alert other officials as appropriate and keep the public informed (designate one spokesperson).**
- **Use the expertise in public drinking water supplies and public health in the decision making process.**
- **Preventative measures are the best practice to prevent such an incident.**
- **Prior communication with the local law enforcement authorities and local emergency response entities prevents confusion and defines who has responsibility for what, when an incident occurs.**

A Joint Collaboration between the National Rural Water Association and the Association of State Drinking Water Administrators

Prevention First Simple security precautions and procedures should be a first priority for all size systems. Conducting a security vulnerability self-assessment and developing and practicing your Emergency Response Plan in cooperation with your local law enforcement and local emergency response entities prior to an incident is essential for a proper response to any emergency.

Discovery or receipt of threat

- Take any suspicious activity or evidence of vandalism or sabotage seriously.
- Document what you see and take photos and keep notes as you go.
- Contact local law enforcement.
- Notify the regulatory authority (State Drinking Water Primacy Agency).
- Notify other agencies and organizations as appropriate.
- Map customer complaints.

In The Event of An Incident (break-in, damage or threat) - Local law enforcement should be notified. Notify the state drinking water primacy agency if there is any question or potential of contamination.

An initial evaluation must be made by the system owner or operator to make appropriate decisions on any actions that should be taken. The initial evaluation should include a review of:

- Physical evidence such as containers or material in the intrusion area.
- A quick check for chlorine residuals in all parts of system.
- A visual check of finished water as to turbidity, odor, color, or pH.
- Intrusion or incident location in relation to critical system components such as finished water supply.
- Other items and areas relevant to the system operation and environment.

Consultations in Decision Making - The system may want to obtain assistance in the evaluation process and obtain input as to the appropriate actions to take. This input is best obtained from those with expertise in law enforcement, and drinking water treatment, distribution, and its impact on public health. The system should work with the state drinking water primacy agency, the National Rural Water Association and other drinking water professional organizations, as well as emergency response agencies, in the decision making process. These decisions must be made jointly to ensure public health protection and to avoid adverse affects. For example, a non-water person may suggest that the system be drained. This has ramifications in fire protection and could impact the integrity and safety of the water supply.

Technical assistance to assist in the implementation of preventative or remedial measures is available from your state drinking water primacy agency or State Rural Water Association.

Actions to Consider

The system must make decisions as to what level of actions must be taken to perform due diligence in protecting the public health and provide a safe quality water supply. Actions can range from a determination that the incident is a prank with no action needed to implementing additional monitoring as a precautionary measure. If contamination is indicated, the system may declare an emergency and implement their emergency response plan. **These decisions impact public health and safety and should be made in cooperation with law enforcement and your State Drinking Water Primacy Agency.**

- Location of personal protective equipment (PPE) and procedures for use:

  All operators are assigned protective equipment and all additional inventory of protective equipment is located in the locker room. Emergency eyewash and shower locations are at each hazard location.

- Location of Material Safety Data Sheets (MSDS)

  The current MSDS sheets are located in the WTP Lab in Binders on the top shelf.

3. Water Sampling and Monitoring Plans.

   2015 Bacteriological Sample Siting Plan
   ERP - Page 10 Section on *Suspected Tampering at System Facilities*
   ERP - Pages 23-24 contains *A Utility Guide for Security Decision Making*
   Membership with: The Water Information Sharing and Analysis Center (WaterISAC)

4. Mutual aid agreements.

   Mutual aid agreements are in place for Public Safety Departments. Water District Agreements are in place for Owosso and Caledonia Charter Townships. All of these are available and stored in the Virtual Clerk directory. Agreements between Corunna and Owosso are in place also. Future agreements on emergency mutual aid including sharing personnel and equipment and supplies are recommended.

5. Emergency Supplies and Equipment Plans

   a. Emergency equipment available.

      DPW and Sewer department equipment are available for any emergency.

   b. Replacement equipment.

      All documentation for replacement equipment is located in the WTP office. Original manufacturers and local suppliers are the primary source. Reliance on equipment redundancy in the WTP is the first option in any emergency. Refer to contacts section of this ERP for equipment suppliers contact information.

   c. First aid supplies and equipment

      First aid supplies and equipment are located in the control room area. Any additional immediate needs are to be requested through 911/central dispatch.

SOURCE

Master Meter Location(s) and Size(s)

Plant Metering

	Y/N	Type
Raw Water:	Yes	16-inch, Mag meter
Finished Water:	Yes	Flow Tube, Bailey Fisher Porter
Backwash Water:	Yes	Flow Tube, Bailey Fisher Porter
Plant Water:	Yes	14-inch totalizer, propeller meter

Groundwater Sources

SOURCE

Well Construction and Maintenance

BASIC DATA				
Well Name/Number	LW1	LW13	PS1	PS2
Wellogic ID	78000000830	78000000831		78000000796
SDWIS Facility ID (Site Code)	WL001	WL013		WL002
Well Log Available?	No	No	No	No
Constructed Date	pre 1960	1955	1963	1963
Well Status	Active	Active	Inactive	Active
Well Status Date	2013	2013	2013	2013
Treatment at Well	None	None	None	None
SDWIS Entry Point ID (Site Code)	TP001	TP001	TP001	TP001
Treatment at Entry Point	Lime softening, Chlorine, Fluoride, Phosphate			
GPS Coordinates Latitude	42.99313	42.99342		42.97948
Longitude	-84.15409	-84.15928		-84.17490
Operator Visit Frequency	<	Once a week		>
Comments:				
1. PS1 has been out of service. The pump and motor were pulled out. The city is keeping the well for monitoring purposes. Routine maintenance of the wellhouse must be maintained for security purposes and to prevent vandalism.				
Grout Type	<	Unknown		>
Rock or Drift	Drift	Drift	Drift	Drift
Casing 12" Above Grade	Yes	Yes	Yes	Yes
Total Depth, ft.	82.75	89		152
Casing Depth, ft.	82.75	89		152
Casing Diameter	60.5			130
Gravel Pack Dimensions				
Gravel Pack Material				
Screen Length, ft.	20	35		25
Screen Diameter, in.	16	12		12
Screen Slot Size, in.	80	70		125
Comments:				
WELL PUMP INFORMATION				
Pump Type	Vert. Turbine	Vert. Turbine		Vert. Turbine
HP	30	20		30
Permit Capacity (gpm)	700	750	840	757
Permit TDH, ft.				
Current Capacity (gpm)	700	750		700
Current TDH, ft.	116			
Basis for Current Capacity	Eff. Test			
Pump Setting, ft.	53			
Static Water Level, ft.	10.4	13		61.9
Pumping Water Level (24 hr), ft.	33.7	42.6		73
Pumping Water Level (100 day), ft.				
Last Cleaning				
Last Pulled for Inspection	2010	Unknown		1992
Last Efficiency Test	2010			
Phase/Surge/Lightning Protection	Yes	No		No

Water Source Comments:

1. Local Well 1 (LW1) is 1 of 2 wells that primarily provides water to the city, due to its better water quality (lower hardness). A permit was issued in 2001 for emergency repairs to LW1 due to corrosion. This repair included a new casing, motor, pump, meter, and VFD controls. Well construction information is from a 2001 pump repair report from Peerless Midwest and 2006 pump installation report from Layne Northern Co. LW1 had a new pump and column pipe installed in 2006 due to corrosion and cathodic protection was installed.

2. Local Well 13 (LW13) is a standby well, which is used during emergencies only. The well is flushed and a bacteriological sample collected every month.

3. Palmer Street 1 (PS1) is an inactive well. The motor and pump were pulled in 1975 (Malcolm Pirnie, Hydrogeological Report, 9/2003). The well seal consists of a steel plate bolted to the concrete base. The city's wellhead delineation consultant has recommended they keep it as a monitoring well for future aquifer testing. The building has been vandalized in the past and it is recommended that routine inspections of this facility be performed.

4. Palmer Street 2 (PS2) is a standby well and is used during emergencies only, due to its poor water quality. Monthly flushing of the well and collection of bacteriological sample is being maintained. Electrical improvements at the PS3 wellhouse were completed in 2009. The well's pump to waste discharge piping is missing a cap or screen.

5. Palmer Street 3 (PS3) well is the 2nd well that primarily provides water for the city. PS3 had emergency repairs completed in 2006 because of well casing failure. These repairs included: new casing, grout, motor, pump, meter, and variable frequency drive (VFD) controls. Current capacity is based on an efficiency test. Well construction from a 2006 pump repair report from Layne Northern Co. Electrical improvements and standby power were proposed for this well in 2008. This has been put on hold due to lack of funds. PS3 has trace level of cis-1, 2 Dichloroethelyne detected in the past.

6. The Hintz well is one of the City's wells that has lower hardness and is used more often than others. However, the well is throttled due to slow recharge of the aquifer. A monitoring well is located northwest of the Hintz well. Replacement of the Hintz well is planned in the near future and is dependent on financial resources.

7. The Osburn well is a standby well which is housed in a dome-like well house (silo). The well is run monthly for flushing, and a bacteriological sample is collected. The recent very cold winter caused the well's check valve to freeze and a crack developed. The check valve was taken off-line to be replaced and the well is currently off-line.

8. Each well is inspected and serviced on a 6-year cycle. Our records are not up-to-date on the last inspections for PS2, HIntz, Oliver, and LW13. Copies of the last inspection reports must be provided to the Department of Environmental Quality (DEQ) for our review and record.

8. Aquifer test/hydrogeological report was completed in 2003 for the wellhead protection program (WHPP).

9. A 2003 hydrogeological report indicates groundwater flow in the vicinity of each well is towards the Shiawassee River.

10. The DEQ approved the city's WHPP on December 29, 2004. The WHPP identified 66 sites as potential sources of contamination. Five sites were classified as a high threat to the public water wells. Four of these sites are within 2000 feet of wells LW #1 and LW #13. One site is located within 2000 feet of PS2 and PS3.

11. The supply's Source Water Assessment (SWA) was issued on December 14, 2005, based on the WHPP.

SOURCE

Well Construction and Maintenance			
BASIC DATA			
Well Name/Number	PS3	Hintz	Osburn
Wellogic ID	78000000797	78000000805	78000000828
SDWIS Facility ID (Site Code)	WL003	WL004	WL005
Well Log Available?	No	No	No
Constructed Date	1964	1968	1968
Well Status	Active	Active	Active
Well Status Date	2013	2013	2013
Treatment at Well	None	None	None
SDWIS Entry Point ID (Site Code)	TP001	TP001	TP001
Treatment at Entry Point	Lime softening, Chlorine, Fluoride, Phosphate		
GPS Coordinates			
Latitude	42.97796	43.01615	43.00446
Longitude	-84.17485	-84.14921	-84.15238
Operator Visit Frequency	<	Once a week	>
Comments:			
WELL CONSTRUCTION			
Grout Type	<	Unknown	>
Rock or Drift	Drift	Drift	Drift
Casing 12" Above Grade	Yes	Yes	Yes
Total Depth, ft.	146.5	88	102
Casing Depth, ft.	123	67.5	81.6
Casing Diameter	12	10	16 → 12
Gravel Pack Dimensions			
Gravel Pack Material			
Screen Length, ft.	21.5	20	20
Screen Diameter, in.	12	12	12
Screen Slot Size, in.		55	#3
Comments:			
WELL PUMP INFORMATION			
Pump Type	Vert. Turbine	Vert. Turbine	
HP	40	20	20
Permit Capacity (gpm)	792	403	722
Permit TDH, ft.			
Current Capacity (gpm)	1000	400	700
Current TDH, ft.	130		
Basis for Current Capacity	Eff. Test		
Pump Setting, ft.	83		
Static Water Level, ft.	45.5	30	21.8
Pumping Water Level (24 hr), ft.	71	41	31
Pumping Water Level (100 day), ft.			
Last Cleaning			
Last Pulled for Inspection	2006	2000	1996
Last Efficiency Test	2006		
Phase/Surge/Lightning Protection	Yes	No	No
Comments:			
Routine efficiency testing for each well is performed every 6 years..			

SOURCE

Well Construction and Maintenance

Well Number	LW1	LW13	PS1	PS2
WELL APPURTENANCES				
Well Seal	Yes	Yes	(In-active)	Yes
Pump to Waste Piping	Yes	Yes		Yes
Screened?	Yes	Yes		Yes
Air/Vac Relief	No	No		Yes
Screened?	NA	NA		Yes
Casing Vent	Yes	Yes		Yes
Screened?	Yes	Yes		Yes
Check Valve (VT or Sub)	Yes	Yes		Yes
Meter	Yes	No		No
Raw Sample Tap	Yes	Yes		Yes
Chemical Injection Tap	Yes	Yes		Yes
Plant Tap	Yes	Yes		Yes
Appropriate Chemical Feed Outlet	No	No		No
Water Level Device	Yes	Yes		Yes
Pressure Gauge	Yes	Yes		Yes
Pressure Relief Valve	NA	NA		NA
Comments:				
WELL CONTROLS				
Run Timer	Yes	Yes		Yes
H-O-A Switch	Yes	Yes		Yes
Alternating Relay	Yes	Yes		Yes
Operating Pressure	<	65 psi		>
Control Signal Type	<	Radio		>
Control System Adequate?				
Comments:				
WELLHOUSE INFORMATION				
Heater / Dehumidifier	Yes	Yes		Yes
Floor Drain	No	No		Yes
Doors open out	Yes	Yes		Yes
Adequate Security Measures?	<	*		>
Comments:				

* Well houses are old and need improvement to maintain structural stability. Roof and insulation need improvement. While all wells are locked, entry alarms are recommended for each well.

Standby Power

WELL AUXILIARY POWER				
Well Number	LW1	LW13	PS1	PS2
Power Type	Permanent	None	None	None
Power Rating (kWh or KVA)	500 kW			
Fuel Type	Diesel			
Capacity (gpm)				
Horse Power (HP)				
Starting Frequency	Monthly			
Load Testing Frequency	Monthly			
Basis for Auxiliary Power Waiver:				

Comments:

1. Each well site's electrical feed is from a different electric sub-station.

SOURCE

Well Construction and Maintenance

Well Number	PS3	Hintz	Osburn
WELL APPURTENANCES			
Well Seal	Yes	Yes	Yes
Pump to Waste Piping	Yes	Yes	Yes
Screened?	Yes	Yes	Yes
Air/Vac Relief	Yes	No	No
Screened?	No	NA	NA
Casing Vent	Yes	Yes	Yes
Screened?	Yes	Yes	Yes
Check Valve (VT or Sub)	Yes	Yes	Yes
Meter	Yes	No	No
Raw Sample Tap	Yes	Yes	Yes
Chemical Injection Tap	Yes	Yes	No
Plant Tap	No	No	No
Appropriate Chemical Feed Outlet	Yes	Yes	No
Water Level Device	Yes	Yes	Yes
Pressure Gauge	Yes	Yes	Yes
Pressure Relief Valve	No	No	No

Comments:

1. PS3's vacuum relief valve discharge piping needs screen.

WELL CONTROLS			
Run Timer	Yes	Yes	Yes
H-O-A Switch	Yes	Yes	Yes
Alternating Relay	Yes	Yes	Yes
Operating Pressure	<	65 psi	>
Control Signal Type	Radio	Manual	Radio
Control System Adequate?	<	Yes	>

Comments:

1. All wells are controlled by SCADA system except LW1 and Hintz. The City wants to maintain flexibility in well controls.

WELLHOUSE INFORMATION			
Heater / Dehumidifier	Yes	Yes	Yes
Floor Drain	Yes	No	No
Doors open out	Yes	Yes	Yes
Adequate Security Measures?	No fence, but locked	Fenced & locked	Fenced & locked

Comments:

1. The wellhouses are old and need improvement. An entry alarm is recommended for each well.

Standby Power

WELL AUXILIARY POWER			
Well Number	None	None	None
Power Type	NA	NA	NA
Power Rating (kWh or KVA)	NA	NA	NA
Fuel Type	NA	NA	NA
Capacity (gpm)	NA	NA	NA
Horse Power (HP)	NA	NA	NA
Starting Frequency	NA	NA	NA
Load Testing Frequency	NA	NA	NA
Basis for Auxiliary Power Waiver:	NA	NA	NA

Comments:

1. PS3, Hintz and Osburn wells do not have auxiliary power but are on separate electrical substations.

xx

2. It is recommended that provision of additional auxiliary power be pursued to improve water system reliability in case an area wide power outage occurs.

Well Appurtenance Comments:

1. Well control for LW1 includes a VFD. Flow is monitored by a mag meter installed in a manhole immediately outside the wellhouse. Auxillary power for LW1 is through the WTP's power generator unit. The auxiliary power generator is housed in a trailer and there is evidence of oil spills on the ground under the trailer. Proper containment of oil spills must be provided to prevent contamination of the ground surface which can eventually reach the groundwater.

A transducer was installed to monitor drawdown in LW1 when it was renovated in 2001. The transducer has not been connected to the telemetry system to allow staff to remotely monitor drawdown from WTP. The door for LW1 needs to be fixed and sealed to prevent vermin from accessing the well house.

2. PS2 and PS3 wells are located in a city park off of Palmer Street.

3. Each well house is equipped with loss of power alarms.

4. LW 13, PS2, Hintz, and Osburn wells lack flow meters. Flow is measured by runtimers and known pumping capacity of each well. A common meter monitors raw water flow from these wells at the WTP.

5. All wells except the Hintz well are controlled by radio telemetry from the WTP. Dial up telemetry is used to control the Hintz well. Operators normally visit each well house once a week.

1. Describe method to operate wells for groundwater sources, or pumps for surface water sources (manual or automatic).

   Local Well 1 LW1 is controlled from inside the plant via direct wiring. Other wells are controlled by the SCADATA software and radio telemetry if it is functioning or by manually turning the wells on. Flow is adjusted manually, if no VFD is present.

2. Auxiliary power available:

Type:
Two power feeds are supplied to the WTP and a Diesel Generator is available to provide primary back-up power. This will supply power to LW1 and the entire WTP.

Location:
The generator is located behind the WTP. There is an annunciator on the main panel in the control room.

Capacity:
350 kW

CITY OF OWOSSO WATER FILTRATION PLANT WSSN 5120

Power Interruption Procedures 09/08/2017

When alerted that there is a power outage, the operator on duty must perform the following:

1. ***Determine which Utility circuit is out***
   - *A. A light or an audible alarm in the lab/office indicates problems with the south circuit*
   - *B. Problems with the North circuit are indicated by lights and equipment shutting off*
   - *C. Indicator lights outside the electrical room show which Consumers circuit(s) are working. If neither light is lit, both circuits are out (complete power outage)*
2. ***If the 500 KW circuit is out (the generator will start automatically)***

   A. The generator will start when the 500 KW side is off. The generator will remain on until the power is restored and then continue to run for ten minutes of stable utility power. A timer displays on the Automatic Transfer Switch to indicate when it will switch back to Utility power automatically.

   B. Go to the main switchgear in the electrical room – the ATS display will indicate active power sources, the 500KW utility feed and the generator power feed

   C. Make sure the lagoon pump is shut off, as Wright Street. Lift station is probably down, and the potential for basement flooding in the area

   D. In sub-basement, unplug the lead sump pump #1, which pumps to Wright Street. Lift station. Lag sump pump #2 will take over and pump to storm water sewer.

   E. Check equipment to ensure proper operation/feed rates in this order:

   1) Pressure controller for high service pump – make sure it is in the "automatic" mode, Well pumps; Chemical feed pumps, Slakers, Collectors, and Flocculators

   H. Call the Waste Water Treatment Plant and inform them of the condition, as sewer maintenance personnel will have to respond to the Wright Street. Lift station situation

   I. Call Consumers Energy (1-800-805-0490). Tell them both circuits are out as the 1111 Allendale St. "The North circuit is referred to as "Smith substation, Oakwood Circuit" "The South circuit is referred to as "Smith substation, Stewart St. Circuit". +Call the plant superintendent and inform them of the situation. If the superintendent cannot be reached, contact the Utilities Director
3. *If only the South circuit is out*
   - *A. Make sure the lagoon pump is shut off, as Wright St. lift station is probably down, and the potential exists for basement flooding in the area*

B. *In sub-basement, unplug the lead sump pump #1, which pumps to the Wright Street lift station. Lag sump pump #2 will take over and pump to the storm water sewer.*
C. *Call the Waste Water Treatment Plant and inform them of the condition, as sewer maintenance personnel will have to respond to the lift station situation.*
D. *Make sure that the high service pumps #3 or #4 are working. If they are not, in the electrical room, go to the main switchgear. Using the Kirk Key system, switch everything from the south circuit to the North circuit.*
    1) *Shut down the south circuit – push switch to "off" – then turn the key, which will put a safety bar into place, and take the key out. Insert the same key into the "tie breaker" keyhole, turn to the right, which will clear the safety bar out of the way, then push switch to "on".*
    2) *All lighting and equipment is now running off the North Circuit – turn on high service pumps #1 or #2, but do not attempt to run more than one high service pump at a time.*
E. *Call Consumers Energy (1-800-805-0490) and tell them the circuit out at 1111 Allendale St. "The South circuit is referred to as "Smith substation, Stewart St. circuit"*
F. *Call the plant superintendent and inform them of the situation. If the superintendent cannot be reached, contact the Utilities Director.*

4. *If only the North circuit is out*
    A. *In the electrical room, go to the main switchgear. Using the Kirk Key system, switch everything from the North circuit to the South circuit.*
        1) *Shut down the North circuit – push switch to "off" – then turn key which will put a safety bar into place, and take key out. Insert the same key into the tiebreaker keyhole, turn the key to the right, which will clear the safety bar out of the way, then push to "on", keeping your face turned away as you push the switch. All lighting and equipment is now running off the South circuit – do not attempt to run more than two high service pumps at a time.*
    B. *Check equipment to ensure proper operation/feed rates in this order, Pressure controller for high service pump- in "automatic" mode , well pumps, chemical feed pumps, slakers, clarifiers, controls and alarms.*
    C. *Call Consumers Energy (1-800-805-0490) and tell them the circuit at 1111 Allendale St. "Smith substation, Oakwood" is out. Call the plant superintendent and inform them of the situation. If the superintendent cannot be reached, contact the Utilities Director.*

If auxiliary power is leased, rented, shared or otherwise not immediately available on the property, describe the procedure for securing the equipment:

United Rentals
1331 W Hill Rd Ste 2, Flint, MI
(810) 235-2743

TREATMENT

1. Method to provide emergency chlorination:

Chlorine comments :

1. The Sodium hypochlorite is located in the chemical feed room. The transfer pump, day tank, and chemical feeders are located adjacent to the bulk Cl storage room. Two chemical feed pumps are provided.

2. Chlorine is applied prior to the recarbonation tank and post filtration. The WTP has the ability to apply chlorine to the west suction well.

3. A calcium hypochlorite erosion tablet chemical feed system is provided as a backup to the sodium hypchlorite system. Calcium hypochlorite erosion tablets (pucks) in stock are replaced once a year. The erosion feeder is routinely used to make sure that the operators remembers and knows how to operate the system when needed. Secondary containment for the calcium hypochlrite tank must be provided.

4. It is recommended that an on-line monitor for chlorine be provided to confirm finished water quality and real-time disinfectant levels.

Backup Cl2 System:				
Chemical:	Calcium Hypochlorite		Form:	Tablet
Supplier:	Vopak			
ANSI/NSF Standard 60 Approval? (Y/N)	YES			
ANSI/NSF Maximum Dosage:	15	mg/L		
Make:	PPG AccuTab		Model:	3000
Type:	Erosion			
Storage:	55	lbs. container		
Secondary Containment:	No			
Minimum days of storage:	10	Days		

DISTRIBUTION

1. Storage

PLANT TREATED WATER STORAGE/CLEARWELL

Location:	WTP
Size:	1.75 MG
Percent above grade:	0
Low water level:	7 feet
Isolation capabilities:	Can be isolated and bypassed
Vents:	Yes with screens
Reservoir Baffling:	None
Drains:	None
Overflow:	None
Access Hatches:	5 manholes are provided
Alarms:	No alarms but fenced
Last Inspection:	2002
C*T applied or applicability:	NA

High Service Suction Wells:	
Size and Location:	A 30,000 gallon (west well) suction well is located immediately west of the WTP.
	A 20,000 gallon (south well), the second suction well is located immediately south of the WTP.
Operation:	Both wells are in operation. High service pumps #3 and #4 take suction from both well.
	High service pumps #1 and #2 take suction from the south well only.
Isolation:	Each suction well can be isolated
Vents:	A vent is provided at each suction well
Overflow:	None
Drain:	None
Alarms	None
Flooding Potential	Vent elevations of both suction wells are at least 2 ft above the 100 year flood elevation
Access	the west well
Inspection:	2002

1. The WTPs finished water reservoir can be bypassed when needed for inspection or maintenace. The procedure involves maintaining adequate operating levels in the Gute Hill standpipe and both suction wells. The WTP operated for three days with the reservoir taken out of service in August 2002 for a wet dive inspection. The reservoir was found to be in generally good condition. Some possible leakage around the expansion joints was noted. Our records indicate the last dry inspection of the reservoir occurred in when rehabilitaion work was completed on the tank in 1990. The city needs to plan for a dry inspection the next time the reservoir is inspected.

2. The bottom of the reservoir is below the Shiawassee flood stage. Access hatches are above the 100-year flood stage for the reservoir and suction wells.

3. The West and South suction wells are both in operation. HS pump 3 takes suction from both suction wells. HS pumps 1 and 2 take suction from the West suction well only. HS pump 4 takes suction from the South suction well only.

4. Inspection of the reservoir is recommended, for it has been more than ten years since it was last inspected.

DISTRIBUTION

Pump Stations

	Location:	Gute Hill Standpipe
	Function:	Boost pressure
	Adequate Security?	Yes

Pump Number	1			
Year Installed	1970			
Type	Hor. Cent.			
Permit Capacity	500-1500 (with VFD)			
Permit TDH				
Current Capacity	500-1500			
Current TDH				
Basis				
HP	40			
Last Complete Inspection	1993			
Last Efficiency Test	1993			
Control Signal Type	SCADA System			
Controls Adequate?	Yes			
Operator Visit Frequency	Once/week			

Comments:

1. The pump station was added to the Gute Hill standpipe in 1970. The booster pump is manually controlled from the WTP and staff manually turn on the pump each day to turn over water within the standpipe. An altitude valve is provided to prevent the tank from overflowing. Upgrades to the pump station were proposed in 2008. These upgrades included 2 new pumps, controls, and standby power. These upgrades have been on hold until now.

2. The city of Corunna connected to the city of Owosso water system in 1993 through a 12-inch watermain and this pump station. The pump station is owned and maintained by the city of Corunna. The pumps are controlled by the city of Owosso through radio telemetry. Corunna staff can override the controls for pump maintenance or emergency situations. Corunna staff contacts the city of Owosso WTP staff when the control needs override.

AUXILIARY POWER

Power Type	NA	Power Rating (kWh)	
Fuel Type	NA	Starting Frequency	
Capacity (gpm)	NA	Load Testing Frequency	

Total Pump Capacity (gpm)			mgd
Firm Pump Capacity (gpm)			mgd
Auxiliary Power Capacity (gpm)			mgd
Max Day Demand @ this location			mgd
Peak Hour @ this location			gpm (Hydropneumatic Stations)
Avg Day Demand @ this location			mgd
Firm Pump Capacity/Max Day			%
Peak Hour/Firm Pumping Capacity			% (Hydropneumatic Stations)
Aux. Power Capacity/Avg Day			%

Comments:

1. No auxiliary power provided at this pump station.

STORAGE

Construction, Controls & Maintenance

Type	Standpipe	Elevated
Location:	Gute Hill	Delaney Rd
Date Constructed	1950's	1997
Volume, MG	1.25	0.60
Material	Steel	Steel
Percent Below Grade	0%	0%
O.F. Elevation, ft	73.5	
Total Head Range, ft	75	
Range of Operation	20	7.5
Upper, ft	65	34.5
Lower, ft	45	27
Date Inspected	2006	2006
Date Painted Inside	1997	1997
NSF Std 61 (Y/N)	Yes	Yes
Date Painted Outside	1998	1997
Cathodic Protection	Yes	Yes
Tank Isolation Valve	Yes	Yes
Tank Drain	Yes	Yes
Altitude Valve	Yes	Yes
Mud Valve	No	Yes
High Alarm	No	No
Low Alarm	No	No
Controls:	Radio	Radio
Vents Screened	Yes	Yes
Overflow	Yes	Yes
Overflow Screened	Yes	Yes
Hatches Locked	Yes	No
Site Fenced/Locked	Yes	No
CT applied or applicability?	NA	NA

Capacity

Usable Storage (MG)	1.25		0.60
Total Usable Storage (MG)	1.85		
Storage/Max Day	65.14	%	
Storage/Avg. Day	105.78	%	

COMMENTS:

1. The total water storage for this community water supply system is > 30 % of the ten year maximum day demand and is considered adequate. Additional storage is also available at the WTP.

2. SCADA system monitors the city of Owosso's standpipe and elevated tank. Transducers monitor pressure in feet through the SCADA system.

3. The Gute Hill standpipe was inspected in 2006 by Dixon Engineering, Inc. A copy of the inspection report was received on 9/30/2008.

4. The elevated tank has not been inspected since 1998. As part of the city's preventative maintenance program, the DEQ , Office of Drinking Water and Municipal Assistance, recommends routine inspections of the elevated tank be completed. It is important to maintain appropriate security for the elevated tank to protect the water system from unauthorized entry. The access door into the base of the elevated tank must be kept locked.

5. The DEQ recommends perimeter fencing, lighting, intrusion alarms, and security cameras for storage tanks. The city should take the necessary precautions to protect their elevated storage tank from trespassers. The city should also educate their local law enforcement on the importance of their storage tanks and encourage them to assist in surveillance.

DISTRIBUTION SYSTEM STORAGE – STANDPIPE

LOCATION: Gute Hill between Walnut and Pearce Streets

- Diameter = 52 feet
- Height to overflow = 75 feet
- Volume = 15,900 gallons per foot
- Nominal storage = 1.1 million gallons
- System static pressure = 38 psi (88 feet) at yard hydrant under normal summer day conditions (July, 1991)
- Fill controlled by 6 inch Model 30AWR. Ross Altitude Valve installed Nov. 1991. Remote operation from WTP. Previous 8 inch Ross Valve remains in position for local emergency fill operation only.
- Discharge by Peerless 6A13 pump with 40 HP motor. Variable output depending on differential head and position of throttling valve as controlled from WTP. Design point of 1000 GPM at 100 feet TDH, maximum rate estimated at 1600 GPM at 40 feet TDH.

ELEVATION	VOLUME	CONDITION
75 FEET	**1,192,000 GAL**	**TANK OVERFLOWS**

5 FT OF FREEBOARD = 79,500 GAL ALLOWS ABOUT 2 HOURS RESPONSE TIME FOR ALTITUDE VALVE FAILURE TO CLOSE ASSUMING FILL RATE OF 600 GPM.

70 FEET	**1,113,000 GAL**	**NORMAL HIGH LEVEL - SHUTOFF POINT FOR ALTITUDE VALVE**

30 FT WORKING STORAGE = 477(000 GAL STORAGE AVAILABLE FOR DAILY DRAWDOWN TO MEET MAXIMUM HOUR DEMANDS AND EQUALIZE PLANT OPERATIONS.

40 FEET	**636,000 GAL**	**NORMAL LOW LEVEL - REMAINDER OF STORAGE RESERVED FOR FIRE FLOWS**

34 FT RESERVE STORAGE OF 540,000 GAL FOR FIRE FLOWS. EQUIVALENT TO A 1500 GPM WITHDRAWAL RATE FOR 6 HRS.

6 FEET	**96,000 GAL**	**LOW LOW LEVEL**

6 FT EMERGENCY STORAGE REMAINING. OPERATOR SHOULD BE THROTTLING OR STOPPING BOOSTER PUMP DISCHARGE.

0 FEET	**0 GAL**	**TANK EMPTY**

DETECTION STRATEGIES

This section contains strategies that can be used to aid in the detection of malevolent acts or natural hazards that threaten the security or resilience of the system. The checklists are attached to this document.

Detection Strategies		
Threat	**Detection Method**	**Procedure**
Unauthorized entry	Notification from utility staff	Call 911
Distribution system contamination	Customer complaint surveillance Public health surveillance	Distribution System Contamination Response Procedure
Cyber intrusion	Notification from utility staff	Cybersecurity Incident Action Checklist
Hazardous chemical release	Notification from utility staff	Call fire department, 911
Tornado	Weather service alerts	Tornado Incident Action Checklist
Flood	Notification from Army Corp	Flood Incident Action Checklist
Power outage	Notification from energy provider	Refer to procedure for startup outlined above in ERP (automatic startup)
Extreme Cold and Winter Storms	Weather Service Alert	Extreme Cold and Winter Storms Incident Action Checklist

CYBERSECURITY

Item	Description
Disconnect procedure	If possible, disconnect compromised computers from the network to isolate breached components and prevent further damage, such as the spreading of malware.
Notification	In the event of a cybersecurity attack, contact the following: Jeffrey Kish Jeff.Kish@ci.owosso.mi.us Michigan State Police 877-642-9237 National Cybersecurity Communications Integration Center (NCCIC) 888-282-0870 NCCIC@hq.dhs.gov
Assess procedure	Assess any damage to utility systems and equipment, along with disruptions to utility operations.
Implementation processes	Implement actions to restore operations of mission critical processes (e.g., switch to manual operation if necessary) and provide public notification (if required).
Documentation	Provide notes document key information on the incident, including any suspicious calls, emails, or messages before or during the incident, damage to utility systems, and steps taken in response to the incident (including dates and times).

ADDITIONAL INSTRUCTIONS

The Emergency Response Plan shall be located and distributed as necessary to assure effective use by all necessary waterworks personnel.

A copy of the approved ERP will be available at the following locations:

- WTP Superintendent Office.
- Utility Directors Office.
- City Manager's Office.
- DPW Superintendent Office.
- DEQ: Kurt Swendsen District Engineer.

This plan shall be updated every year or as necessary (as changes occur in personnel, contact information, or other factors).

Signature: David H. Haut

Title: Water Plant Superintendent

School Name	Address	City
Bentley Bright Beginnings	1375 WEST NORTH ST	Owosso
Bryant School	925 HAMPTON ST	Owosso
Central School	600 WEST OLIVER ST	Owosso
Emerson School	515 EAST OLIVER ST	Owosso
Lincoln Alternative High School	645 Alger Street	Owosso
Owosso High School	765 EAST NORTH ST	Owosso
Owosso Middle School	219 NORTH WATER ST	Owosso
Shiawassee RESD Student Learning Center West	2261 SOUTH M 52	Owosso
Child Care Facilities	**Address**	**Owosso**
Amber Coe	1000 State Street	Owosso
Barbara Schmidt	1200 Ada Street	Owosso
Bentley Bright Beginnings	1375 W North Street	Owosso
Congregational CDC Owosso	327 N Washington	Owosso
Country Bumpkins	7119 S Delaney	Owosso
Crites Jodine Sue	2421 MeadowDown Dr	Owosso
Debbra Lynn Arnett	2674 Copas	Owosso
Elaine Fuller	615 N Shiawassee	Owosso
Elite Early Learning Center	912 S Washington	Owosso
Emilee Porter	845 W Wilkinson Rd	Owosso
Joann Weinert	530 Martin	Owosso
Kids Connection Before and After School	718 W Main	Owosso
Deborah Nash	723 Rowley	Owosso
Noah's Ark Childrens Center	1500 N Water	Owosso
Robin Woodworth	2330 S M-52	Owosso
Roosevelt Head Start	201 W Brooks	Owosso
Salem Lutheran Preschool Owosso	520 W Stewart	Owosso
Sharon Brand	1308 Walnut	Owosso
Stanfield, Michelle	451 Cherry Lane	Owosso
Susan's Day Care	724 N Dewey	Owosso

City of Owosso
Water Distribution System
0 600 1,200 2,400 3,600 4,800
Feet
Compiled by City of Owosso Engineering Department. Last updated November, 2020.
N
W
E
S
1103
1102
1203
1202
0703
0702
1404
1304
1301
1804
1801
1704
1701
1403
1402
1303
1302
1803
1802
1703
1702
1603
1602
2304
2301
2404
1904
1901
2004
2001
2104
2101
2303
2302
2403
1903
1902
2003
2604
2601
2501
3004
3001
2904
Map Explanation
Water Mains
Diameter
Unknown
3/4" - 3"
4"
6"
8"
10"
12"
14"
16"
20"
24"
Raw Water
Water Network Structure
Structure Type
Production Well
Pump Station
Filtration Plant
Other Assets
Hydrants
System Valves
Other Features
Shiawassee River

Incident Action Checklist – Cybersecurity

For on-the-go convenience, the actions in this checklist are divided up into three “rip & run” sections and provide a list of activities that water and wastewater utilities can take to prepare for, respond to and recover from a cyber incident. You can also populate the “My Contacts” section with critical information that your utility may need during an incident.

Cyber Incidents and Water Utilities

Cyberspace and its underlying infrastructure are vulnerable to a wide range of hazards from both physical attacks as well as cyberthreats. Sophisticated cyber actors and nation-states exploit vulnerabilities to steal information and money and are developing capabilities to disrupt, destroy or threaten the delivery of essential services such as drinking water and wastewater.

As with any critical enterprise or corporation, drinking water and wastewater utilities must evaluate and mitigate their vulnerability to a cyber incident and minimize impacts in the event of a successful attack. Impacts to a utility may include, but are not limited to:

- Interruption of treatment, distribution or conveyance processes from opening and closing valves, overriding alarms or disabling pumps or other equipment
- Theft of customers’ personal data such as credit card information and social security numbers stored in on-line billing systems
- Defacement of the utility’s website or compromise of the email system
- Damage to system components
- Loss of use of industrial control systems (e.g., SCADA system) for remote monitoring of automated treatment and distribution processes

Cyber incidents can compromise the ability of water and wastewater utilities to provide clean and safe water to customers, erode customer confidence and result in financial and legal liabilities. The following sections outline actions drinking water and wastewater utilities can take to prepare for, respond to and recover from cyber incidents.

Actions to Prepare for a Cyber Incident

Utility

- [ ] Identify all mission critical information technology (IT) systems, considering business enterprise, process control and communications. Document the key functions of the mission critical objectives, and identify the personnel or entity responsible for operating and maintaining each IT system.

- [ ] Identify an overall IT security lead to coordinate with each IT system manager and oversee all cyber-related duties.

- [ ] Ensure that IT system managers enforce cybersecurity practices on all business enterprise, process control and communications systems. For example, verify adherence to user authentication, current anti-virus software and installation of security patches.

- [ ] Identify priority points of contact for reporting a cyber incident and requesting assistance with response and recovery. Include any state resources that may be available such as State Police, National Guard Cyber Division or mutual aid programs, as well as the Department of Homeland Security National Cybersecurity and Communications Integration Center (NCCIC) (888-282-0870 or NCCIC@hq.dhs.gov).

- [ ] Review and update the utility's emergency response plan (ERP) to address a cyber incident impacting business enterprise, process control and communications systems. Account for all potential impacts on operations, and ensure emergency contacts are current.

- [ ] Prevent unauthorized physical access to IT systems through security measures such as locks, sensors and alarms. Include workstations and process control systems (e.g., programmable logic controllers or PLCs).

- [ ] Train all essential personnel to perform mission critical functions during a cyber incident that disables business enterprise, process control and communications systems. Include the manual operation of water collection, storage, treatment and conveyance systems.

- [ ] Conduct drills and exercises for responding to a cyber incident that disables critical business enterprise, process control and communications systems.

Actions to Prepare for a Cyber Incident *(continued)*

IT Staff or Vendor

- [ ] Establish a program for maintaining updated anti-virus software on all critical IT systems, along with rapid installation of all security patches.
- [ ] Set up an automatic back-up on critical systems and ensure the process is producing a readable, uncorrupted restore file on a routine basis.
- [ ] Implement rigorous user authentication, including multi-factor authentication where possible. Use individual accounts and unique passwords for each employee, and restrict IT system access privileges to the level needed for a user's duties.
- [ ] Restrict internet access to process control systems unless absolutely necessary.
- [ ] Where possible, separate process control system traffic from business traffic through the use of a firewall. If this is not possible, logically filter traffic through the use of a firewall.
- [ ] Identify all routes of remote access to IT systems. Eliminate remote access where possible, and restrict remaining access (e.g., do not allow persistent remote access to control networks).
- [ ] Assess the use of additional strategies to protect IT systems, such as application whitelisting, network segmentation with restricted communication paths and active monitoring for adversarial system penetration.
- [ ] Conduct a detailed assessment of vulnerabilities in all mission critical IT systems. Consider use of the tools and subject matter experts provided by the DHS Industrial Control System Cyber Emergency Response Team (ICS-CERT) (www.ics-cert.us-cert.gov). Develop an action plan to mitigate all significant vulnerabilities identified in the assessment.

Notes:

Actions to Respond to a Cyber Incident

Utility

- [ ] If possible, disconnect compromised computers from the network to isolate breached components and prevent further damage, such as the spreading of malware. Do not turn off or reboot systems – this preserves evidence and allows for an assessment to be performed.
- [ ] Notify IT personnel and/or IT vendor of the incident and the need for emergency response assistance. In addition, NCCIC can assist with IT system response and recovery (888-282-0870 or NCCIC@hq.dhs.gov).
- [ ] Assess any damage to utility systems and equipment, along with disruptions to utility operations.
- [ ] Execute the utility ERP as needed, including notification of utility personnel, actions to restore operations of mission critical processes (e.g., switch to manual operation if necessary), and public notification (if required).
- [ ] Report the cyber incident as required to law enforcement and regulatory agencies.
- [ ] Notify any external entities (e.g., vendors, other government offices) that may have remote connections to the affected network(s).
- [ ] Document key information on the incident, including any suspicious calls, emails, or messages before or during the incident, damage to utility systems, and steps taken in response to the incident (including dates and times).

IT Staff or Vendor

- [ ] Review system and network logs, and use virus and malware scans to identify affected equipment, systems, accounts and networks.
- [ ] Document which user accounts were or are logged on, which programs and processes were or are running, any remote connections to the affected IT systems or network(s) and all open ports and their associated applications.
- [ ] If possible, take a "forensic image" of the affected IT systems to preserve evidence. Tools to take forensic images include Forensic Tool Kit (FTK) and EnCase.
- [ ] If possible, identify any malware used in the incident, any remote servers to which data may have been sent during the incident, and the origin of the incident. NCCIC can assist with the forensic analysis (888-282-0870 or NCCIC@hq.dhs.gov).
- [ ] Research and identify if any employee or customer personally identifiable information (PII) was compromised.
- [ ] Check the system back-up time stamp to determine if the back-up was compromised during the incident.
- [ ] Document all findings, and avoid modifying or deleting any data that might be attributable to the incident.

Notes:

Actions to Recover from a Cyber Incident

Utility

- [ ] Continue to work with IT staff, vendors and integrators, government partners and others to obtain needed resources and assistance for recovery.
- [ ] Notify affected employees and customers if any PII was compromised.
- [ ] Submit an incident report through WaterISAC (866-H2O-ISAC). Membership is not required to submit a report.
- [ ] Develop a lessons learned document and/or an after action report (AAR) to document utility response activities, successes, and areas for improvement. Create an improvement plan (IP) based on your AAR and use the IP to update your vulnerability assessment, ERP and contingency plans.
- [ ] Register for cybersecurity alerts and advisories from water sector and government partners to be aware of new vulnerabilities and threats. Two sources of cybersecurity alerts are WaterISAC, which has a basic membership that is free, and ICS-CERT (https://ics-cert.us-cert.gov/alerts).

IT Staff or Vendor

- [ ] Remove any malware, corrupted files and other changes made to IT systems by the incident.
- [ ] Restore IT systems as required (e.g., re-image hard drives, reload software). NCCIC can assist with the IT system recovery (888-282-0870 or NCCIC@hq.dhs.gov).
- [ ] Restore compromised files from a system back-up that has not been compromised.
- [ ] Install patches and updates, disable unused services and perform other countermeasures to harden the system against known vulnerabilities that may have been exploited.

Notes:

My Contacts and Resources

CONTACT NAME	UTILITY/ORGANIZATION NAME	PHONE NUMBER
	Law Enforcement	
	IT Staff/Vendor	
	SCADA Staff/Vendor	
	DHS NCCIC	888-282-0870
	Local Laboratory	
	State Primacy Agency	
	Local Emergency Management Agency	
	Local Health Department	
	WARN Chair	
	State Emergency Management Agency	

Resources

- Best Cybersecurity Practices (WaterISAC)
- Cyber Security Evaluation Tool (DHS ICS-CERT)
- Advisories (DHS ICS-CERT)
- Cybersecurity Advisors (DHS)
- National Cybersecurity and Communications Integration Center (NCCIC) (DHS)
- Cybersecurity Guidance and Tool (AWWA)
- Cybersecurity Resource Guide (WaterISAC)
- Cybersecurity Insurance (National Rural Water Association)

Notes:

Incident Action Checklist – Tornado

The actions in this checklist are divided up into three "rip & run" sections and are examples of activities that water and wastewater utilities can take to: prepare for, respond to and recover from a tornado. For on-the-go convenience, you can also populate the "My Contacts" section with critical information that your utility may need during an incident.

Tornado Impacts on Water and Wastewater Utilities

Tornadoes can occur in any location with little to no notice. Tornadoes can have wind gusts from 65 to over 200 miles per hour (mph) and are often accompanied by floods, high straight-line winds up to 140 mph, hail and lightning. About 1,200 tornadoes occur in the United States each year, and they can have devastating impacts to water and wastewater utilities. Impacts may include, but are not limited to:

- Damage to infrastructure (e.g., storage tanks, hydrants, residential plumbing fixtures, distribution system) due to hail, wind, debris and flash flooding, resulting in loss of service and/or reduced pressure throughout the system
- Restricted access to the facility due to debris and damaged roads
- Loss of power and communication lines
- Potential contamination due to chemical leaks from ruptured containers
- Severe water and pressure loss due to ruptured service lines in damaged buildings and broken fire hydrants from airborne debris

NOAA

The following sections outline actions water and wastewater utilities can take to prepare for, respond to and recover from a tornado.

Example of Water Sector Impacts and Response to a Tornado

Smithville, Mississippi 2011 Tornado

An EF-5 tornado with estimated winds of 205 mph and a half-mile wide base hit Smithville, Mississippi in April 2011, destroying 150 homes and several businesses and city facilities, including the water system. The utility's elevated storage tank was damaged and several pipes were bent due to a car striking the structure. The tornado also tore out appliances and plumbing fixtures from homes and destroyed at least three fire hydrants.

Both the drinking water and wastewater systems lost power immediately after the tornado hit, and half of the town was without water due to damage to infrastructure and the power outage. Generators were coordinated through the Mississippi Rural Water Association to provide temporary power. The drinking water and wastewater utilities conducted damage assessments and teams were quickly deployed to fix leaks, turn off meters in destroyed homes and restore service throughout the systems.

Source: NRWA's "Rural Water assists tornado-ravaged Mississippi"

My Contacts and Resources

CONTACT NAME	UTILITY/ORGANIZATION NAME	PHONE NUMBER
	Local EMA	
	State EMA	
	State Primacy Agency	
	WARN Chair	
	Power Utility	

Planning

- Incident monitoring:
  - Storm Prediction Center (National Oceanic and Atmospheric Administration [NOAA])
- U.S. Tornado Climatology (NOAA)
- Enhanced F Scale for Tornado Damage (NOAA)
- Severe Weather 101: Tornado Basics (NOAA)
- National Weather Service Weather Alerts (NOAA)
- Planning for an Emergency Drinking Water Supply (EPA)
- All-Hazard Consequence Management Planning for the Water Sector (Water Sector Emergency Response Critical Infrastructure Partnership Advisory Council [CIPAC] Workgroup)
- Vulnerability Self Assessment Tool (VSAT) (EPA)
- Preparing for Extreme Weather Events: Workshop Planner for the Water Sector (EPA)
- Tabletop Exercise Tool for Water Systems: Emergency Preparedness, Response, and Climate Resiliency (EPA)
- How to Develop a Multi-Year Training and Exercise (T&E) Plan (EPA)
- Make a Plan (FEMA)

Coordination

- Water/Wastewater Agency Response Network (WARN) (EPA)
- Community Based Water Resiliency (EPA)

Facility and Service Area

- Emergency Response and Preparedness Florida WARN Best Management Practices for Water and Wastewater Systems (University of Florida Center for Training)
- Water Agencies Respond to Tornadoes (Florida Rural Water Association and Florida WARN)

Documentation and Reporting

- Federal Funding for Utilities In National Disasters (Fed FUNDS) (EPA)

Power, Energy and Fuel

- EPA Region 1 Water/Wastewater System Generator Preparedness Brochure (EPA)

Mitigation

- Climate Resilience Evaluation and Awareness Tool (CREAT) (EPA)
- Adaptation Strategies Guide (EPA)

Actions to Prepare for a Tornado

Planning

- [ ] Review and update your utility's emergency response plan (ERP), and ensure all emergency contacts are current.
- [ ] Conduct briefings, training and exercises to ensure utility staff is aware of all preparedness, response and recovery procedures.
- [ ] Identify priority water customers (e.g., hospitals), obtain their contact information, map their locations and develop a plan to restore those customers first.
- [ ] Develop an emergency drinking water supply plan and establish contacts (potentially through your local emergency management agency [EMA] or mutual aid network) to discuss procedures, which may include bulk water hauling, mobile treatment units or temporary supply lines, as well as storage and distribution.
- [ ] Conduct a hazard vulnerability analysis in which you review historical records to understand the past frequency and intensity of tornado events and how your utility may have been impacted. Consider taking actions to mitigate tornado impacts to the utility, including those provided in the "Actions to Recover from a Tornado: Mitigation" section.
- [ ] Complete pre-disaster activities to help apply for federal disaster funding (e.g., contact state/local officials with connections to funding, set up a system to document damage and costs, take photographs of the facility for comparison to post-damage photographs).

Coordination

- [ ] Join your state's Water/Wastewater Agency Response Network (WARN) or other local mutual aid network.
- [ ] Coordinate with WARN members and other neighboring utilities to discuss:
    - Outlining response activities, roles and responsibilities and mutual aid procedures (e.g., how to request and offer assistance)
    - Conducting joint tabletop or full-scale exercises
    - Obtaining resources and assistance, such as equipment, personnel, technical support or water
    - Establishing interconnections between systems and agreements with necessary approvals to activate this alternate source. Equipment, pumping rates and demand on the water sources need to be considered and addressed in the design and operations
    - Establishing communication protocols and equipment to reduce misunderstandings during the incident
- [ ] Coordinate with other key response partners, such as your local EMA, to discuss:
    - How restoring system operations may have higher priority than establishing an alternative water source
    - Potential points of distribution for the delivery of emergency water supply (e.g., bottled water) to the public, as well as who is responsible for distributing the water
- [ ] Understand how the local and utility emergency operations center (EOC) will be activated and what your utility may be called on to do, as well as how local emergency responders and the local EOC can support your utility during a response. If your utility has assets outside of the county EMA's jurisdiction, consider coordination or preparedness efforts that should be done in those areas.
- [ ] Ensure credentials to allow access will be valid during an incident by checking with local law enforcement.
- [ ] Sign up for mobile and/or email alerts from your local EMA, if available.

Actions to Prepare for a Tornado *(continued)*

Communication with Customers

- [ ] Develop outreach materials to provide your customers with information they will need after a tornado (e.g., clarification about water advisories, instructions for private well and septic system maintenance and information about tornado mitigation).

- [ ] Review public information protocols with local EMA and public health/primacy agencies. These protocols should include developing water advisory messages (e.g., boil water) and distributing them to customers using appropriate mechanisms, such as reverse 911.

Facility and Service Area

- [ ] Inventory and order extra equipment and supplies, as needed:
  - Motors
  - Fuses
  - Chemicals (ensure at least a two week supply)
  - Cellular phones or other wireless communications device
  - Emergency Supplies
    - Tarps/tape/rope
    - Cots/blankets
    - First aid kits
    - Foul weather gear
    - Plywood
    - Flashlights/flares
    - Sandbags (often, sand must be ordered as well)
    - Bottled water
    - Batteries
    - Non-perishable food

- [ ] Ensure communication equipment (e.g., radios, satellite phones) works and is fully charged.

- [ ] Develop a GIS map of all system components and prepare a list of coordinates for each facility.

- [ ] Document pumping requirements and storage capabilities, as well as critical treatment components and parameters.

Personnel

- [ ] Identify essential personnel and ensure they are trained to perform critical duties in an emergency (and possibly without communication), including the shut down and start up of the system.

- [ ] Establish communication procedures with essential and non-essential personnel. Ensure all personnel are familiar with emergency evacuation and shelter in place procedures.

- [ ] Pre-identify emergency operations and clean-up crews. Establish alternative transportation strategies if roads are impassable.

- [ ] Consider how evacuations or limited staffing due to transportation issues (potentially all utility personnel) will impact your response procedures.

- [ ] Identify possible staging areas for mutual aid crews if needed in the response, and the availability of local facilities to house the crews.

- [ ] Encourage personnel, especially those that may be on duty for extended periods of time, to develop family emergency plans.

Power, Energy and Fuel

- [ ] Evaluate condition of electrical panels to accept generators; inspect connections and switches.
- [ ] Document power requirements of the facility; options for doing this may include:
    - Placing a request with the US Army Corps of Engineers 249th Engineer Battalion (Prime Power): http://www.usace.army.mil/249thEngineerBattalion.aspx
    - Using the US Army Corps of Engineers on-line Emergency Power Facility Assessment Tool (EPFAT): http://epfat.swf.usace.army.mil/
- [ ] Confirm and document generator connection type, capacity load and fuel consumption. Test regularly, exercise under load and service backup generators.
- [ ] Fill fuel tanks to full capacity and ensure that you have the ability to manually pump gas in the event of a power outage. Ensure this equipment and other hazardous materials are located in a safe zone.
- [ ] Contact fuel vendors and inform them of estimated fuel volumes needed if utility is impacted. Determine your ability to establish emergency contract provisions with vendors and your ability to transport fuel if re-fueling contractors are not available. Develop a backup fueling plan and a prioritization list of which generators to fuel in case of a fuel shortage.
- [ ] Collaborate with your local power provider and EOC to ensure that your water utility is on the critical facilities list for priority electrical power restoration, generators and emergency fuel.

FEMA

Notes:

Actions to Respond to a Tornado

Coordination

- [ ] Notify your local EMA and state regulatory/primacy agency of system status.
- [ ] If needed, request or offer assistance (e.g., water buffalos, water sampling teams, generators) through mutual aid networks, such as WARN.
- [ ] Assign a representative of the utility to the incident command post or the community's EOC.

Communication with Customers

- [ ] Notify customers of any water advisories and consider collaborating with local media (television, radio, newspaper, etc.) to distribute the message. If emergency water is being supplied, provide information on the distribution locations.

Facility and Service Area

Overall

- [ ] Conduct damage assessments of the utility to prioritize repairs and other actions.
- [ ] Check that back-up equipment and facility systems, such as controls and pumps, are in working order, and ensure that chemical containers and feeders are intact.

Drinking Water Utilities

- [ ] Inspect the utility and service area for damage. Identify facility components (e.g., valve boxes) and fire hydrants that have been buried, are inaccessible or have been destroyed.
- [ ] Ensure pressure is maintained throughout the system and isolate those sections where it is not.
- [ ] Isolate and control leaks in water transmission and distribution piping.
- [ ] Turn off water meters at destroyed homes and buildings.
- [ ] Monitor water quality, develop a sampling plan and adjust treatment as necessary.
- [ ] Notify regulatory/primacy agency if operations and/or water quality or quantity are affected.
- [ ] Utilize pre-established emergency connections or setup temporary connections to nearby communities, as needed. Alternatively, implement plans to draw emergency water from pre-determined tanks or hydrants. Notify employees of the activated sites.

Wastewater Utilities

- [ ] Inspect the utility and service area, including lift stations, for damage, downed trees and power availability. Inspect the sewer system for debris and assess the operational status of the mechanical bar screen. If necessary, run system in manual operation.
- [ ] Notify regulatory/primacy agency of any changes to the operations or required testing parameters.

Notes:

Actions to Respond to a Tornado *(continued)*

Documentation and Reporting

- [ ] Document all damage assessments, mutual aid requests, emergency repair work, equipment used, purchases made, staff hours worked and contractors used during the response to assist in requesting reimbursement and applying for federal disaster funds. When possible, take photographs of damage at each work site (with time and date stamp). Proper documentation is critical to requesting reimbursement.
- [ ] Work with your local EMA on the required paperwork for public assistance requests.

Personnel

- [ ] Account for all personnel and provide emergency care, if needed. Caution personnel about known hazards resulting from tornadoes.
- [ ] Deploy emergency operations and clean-up crews (e.g., securing heavy equipment). Identify key access points and roads for employees to enter the utility and critical infrastructure; coordinate the need for debris clearance with local emergency management or prioritize it for employee operations.
- [ ] Ensure personnel are aware of potential hazards and delays while traveling within the affected service area (i.e., flat tires caused by debris, navigation issues caused by uprooted/missing street signs).

Power, Energy and Fuel

- [ ] Use backup generators, as needed, to supply power to system components.
- [ ] Monitor and plan for additional fuel needs in advance; coordinate fuel deliveries to the generators.
- [ ] Maintain contact with electric provider for power outage duration estimates.

Notes:

Actions to Recover from a Tornado

Coordination

- [ ] Continue work with response partners to obtain funding, equipment, etc.

Communication with Customers

- [ ] Assign a utility representative to continue to communicate with customers concerning a timeline for recovery and other pertinent information.

Facility and Service Area

- [ ] Complete damage assessments.
- [ ] Complete permanent repairs, replace depleted supplies and return to normal service.

FEMA

Documentation and Reporting

- [ ] Compile damage assessment forms and cost documentation into a single report to facilitate the sharing of information and the completion of state and federal funding applications. Visit EPA's web-based tool, Federal Funding for Utilities—Water/Wastewater—in National Disasters (Fed FUNDS), for tailored information and application forms for various federal disaster funding programs: http://water.epa.gov/infrastructure/watersecurity/funding/fedfunds/
- [ ] Develop a lessons learned document and/or an after action report to keep a record of your response activities. Update your vulnerability assessment, ERP and contingency plans.
- [ ] Revise budget and asset management plans to address increased costs from response-related activities.

Mitigation

- [ ] Identify mitigation and long-term adaptation measures that can prevent damage and increase utility resilience. Consider impacts related to the increased frequency and intensity of tornadoes when planning for system upgrades (e.g., ensure adequate backup power supply for key assets, pursue interconnections with neighboring utilities).

Notes:

Incident Action Checklist – Extreme Cold and Winter Storms

The actions in this checklist are divided up into three "rip & run" sections and are examples of activities that water and wastewater utilities can take to: prepare for, respond to and recover from extreme cold. For on-the-go convenience, you can also populate the "My Contacts" section with critical information that your utility may need during an incident.

Extreme Cold and Winter Storm Impacts on Water and Wastewater Utilities

Cold weather brings with it the potential for freezing temperatures, heavy snowfall and ice incidents that can have multiple impacts on a community. Impacts to drinking water and wastewater utilities may include, but are not limited to:

- Pipe breaks throughout the distribution system, due to freeze/thaw cycles
- Loss of power and communication lines
- Limited access to facilities due to icy roads or debris such as downed tree limbs
- Reduced work force due to unsafe travel conditions throughout the service area
- Source water quality impacts due to increased amount of road salt in stormwater runoff
- Potential flooding risk due to snowpack melt and ice jams (accumulations of ice in rivers or streams)
- Potential surface water supply challenges as ice and frozen slush can block valves and restrict intakes

The following sections outline actions water and wastewater utilities can take to prepare for, respond to and recover from extreme cold and winter storms.

Example of Water Sector Impacts and Response to a Winter Storm

Kentucky 2009 Ice Storm

Kentucky experienced a severe winter storm in January 2009 that resulted in the largest power outage in the state's history. The storm began as a mixture of snow, followed by sleet and freezing rain coupled with strong winds. Although there was advanced notice of hazardous weather, the storm was more severe than anticipated and significant impacts to the water sector occurred. Ninety water utilities regulated by the Kentucky Public Service Commission (PSC) were impacted by the ice storm, and over 32,000 customers were without water at some point during the storm. One utility, the Hickory Water District in Graves County, Kentucky, lost all service during the storm. Although the Water District had approximately 48 hours of water storage, they were unable to supply water to their customers once that storage was exhausted, as they were without power and had no back-up power source.

A significant number of utilities had service restored the day after the ice storm as a result of prioritization by electric providers. Following the ice storm response, the PSC provided a number of recommendations to water and wastewater utilities on how to better prepare for future incidents. Recommendations included issuing consumer advisories prior to incidents that may result in service disruptions, considering the establishment of interconnections, and joining a mutual aid network, such as WARN.

Source: Kentucky Public Service Commission,

"Ike and Ice: The Kentucky Public Service Commission Report on the September 2008 Wind Storm and the January 2009 Ice Storm."

My Contacts and Resources

CONTACT NAME	UTILITY/ORGANIZATION NAME	PHONE NUMBER
	Local EMA	
	State EMA	
	State Primacy Agency	
	WARN Chair	
	Power Utility	

Planning

- Incident monitoring:
  - Storm Prediction Center (National Oceanic and Atmospheric Administration [NOAA])
  - Winter Weather Safety and Awareness (NOAA)
- Winter Storms: The Deceptive Killers (NOAA)
- Planning for an Emergency Drinking Water Supply (EPA)
- National Weather Service Weather Alerts (NOAA)
- All-Hazard Consequence Management Planning for the Water Sector (Water Sector Emergency Response Critical Infrastructure Partnership Advisory Council [CIPAC] Workgroup)
- Vulnerability Self Assessment Tool (VSAT) (EPA)
- How to Develop a Multi-Year Training and Exercise (T&E) Plan (EPA)
- Preparing for Extreme Weather Events: Workshop Planner for the Water Sector (EPA)
- Tabletop Exercise Tool for Water Systems: Emergency Preparedness, Response, and Climate Resiliency (EPA)
- Make a Plan (FEMA)

Coordination

- Water/Wastewater Agency Response Network (WARN) (EPA)

Communication with Customers

- Salt Pollutes postcard (tips for customers on ways to reduce salt) (Minnesota Pollution Control Agency [MPCA])

Facility and Service Area

- A Fresh Look at Road Salt: Aquatic Toxicity and Water-Quality Impacts on Local, Regional, and National Scales (United States Geological Survey [USGS] and Wisconsin State Laboratory of Hygiene [WSLH])
- The Kentucky Public Service Commission Report on the September 2008 Wind Storm and the January 2009 Ice Storm (Kentucky Public Service Commission [KYPSC])

Power, Energy and Fuel

- EPA Region 1 Water/Wastewater System Generator Preparedness Brochure (EPA)

Documentation and Reporting

- Federal Funding for Utilities In National Disasters (Fed FUNDS) (EPA)

Mitigation

- Climate Resilience Evaluation and Awareness Tool (CREAT)
- Adaptation Strategies Guide (EPA)

Actions to Prepare for Extreme Cold and Winter Storms

Planning

- [ ] Actively monitor weather conditions for inclement weather.
- [ ] Review and update your utility's emergency response plan (ERP), and ensure all emergency contacts are current.
- [ ] Conduct briefings, training and exercises to ensure utility staff is aware of all preparedness, response and recovery procedures.
- [ ] Identify priority water customers (e.g., hospitals), obtain their contact information, map their locations and develop a plan to restore those customers first, in case of water service disruptions.
- [ ] Develop an emergency drinking water supply plan and establish response partner contacts (potentially through your local emergency management agency [EMA] or mutual aid network) to discuss procedures, which may include bulk water hauling, mobile treatment units or temporary supply lines, as well as storage and distribution.
- [ ] Conduct a hazard vulnerability analysis in which you review historical records to understand the past frequency and intensity of winter storms and how your utility may have been impacted. Consider taking actions to mitigate extreme cold, snow and ice storm impacts to your utility, including those provided in the "Actions to Recover from Extreme Cold and Winter Storms: Mitigation" section.
- [ ] Complete pre-disaster activities to help apply for federal disaster funding (e.g., contact state/local officials with connections to funding, set up a system to document damage and costs, take photographs of the facility for comparison to post-damage photographs).

Coordination

- [ ] Join your state's Water/Wastewater Agency Response Network (WARN) or other local mutual aid network.
- [ ] Coordinate with WARN members and other neighboring utilities to discuss:
    - Outlining response activities, roles and responsibilities and mutual aid procedures (e.g., how to request and offer assistance)
    - Conducting joint tabletop or full-scale exercises
    - Obtaining resources and assistance, such as equipment, personnel, technical support or water
    - Establishing interconnections between systems and agreements with necessary approvals to activate this alternate source. Equipment, pumping rates and demand on the water sources need to be considered and addressed in the design and operations
    - Establishing communication protocols and equipment to reduce misunderstandings during the incident
- [ ] Coordinate with other key response partners, such as your local EMA, to discuss:
    - How restoring system operations may have higher priority than establishing an alternative water resource
    - Potential points of distribution for the delivery of emergency water supply (e.g., bottled water) to the public, as well as who is responsible for distributing the water
- [ ] Understand how the local and utility emergency operations center (EOC) will be activated and what your utility may be called on to do, as well as how local emergency responders and the local EOC can support your utility during a response. If your utility has assets outside of the county EMA's jurisdiction, consider coordination or preparedness efforts that should be done in those areas.

Actions to Prepare for Extreme Cold and Winter Storms *(continued)*

- [ ] Work with community partners to ensure the utility is properly prioritized when determining plowing and road salting/sanding operations.
- [ ] Ensure credentials to allow access will be valid during an incident by checking with local law enforcement.
- [ ] Sign up for mobile and/or email alerts from your local EMA, if available.

Communication with Customers

- [ ] Review public information protocols with local EMA and public health/primacy agencies. These protocols should include developing water advisory messages (e.g., boil water, warnings that service disruptions are likely due to extreme winter weather) and distributing them to customers using appropriate mechanisms, such as reverse 911. Keep in mind that the notice may need to be delivered prior to the storm to be effective.
- [ ] Instruct customers on how to prevent pipe breaks in their homes (e.g., insulating outdoor faucets, drip warm water from an indoor faucet) and what to do if a pipe breaks.

Facility and Service Area

- [ ] Inventory and order extra equipment and supplies, as needed:
  - Motors
  - Fuses
  - Chemicals (ensure at least a two week supply)
  - Cellular phones or other wireless communications device
  - Emergency Supplies
    - Salt
    - Shovels/snow blowers
    - Tarps/tape/rope
    - Cots/blankets
    - First aid kits
    - Foul weather gear
    - Plywood
    - Flashlights/flares
    - Bottled water
    - Batteries
    - Non-perishable food
- [ ] Ensure communication equipment (e.g., radios, satellite phones) works and is fully charged.
- [ ] Prepare equipment and vehicles to start and run in cold weather (e.g., tune ups, batteries, engine block heaters).
- [ ] Develop a GIS map of all system components and prepare a list of coordinates for each facility.
- [ ] Document pumping requirements and storage capabilities, as well as critical treatment components and parameters.
- [ ] Prior to a storm, apply road salt/sand as necessary, and pre-stage snowplow equipment.
- [ ] Consider installing wind or snow drift barriers at critical facilities.
- [ ] If surface water systems are equipped with intake heaters, ensure they are maintained and in working order before winter begins.

Personnel

- [ ] Identify essential personnel and ensure they are trained to perform critical duties in an emergency (and possibly without communication), including the shut down and start up of the system.
- [ ] Establish communication procedures with essential and non-essential personnel. Ensure all personnel are familiar with emergency evacuation and shelter in place procedures.
- [ ] Pre-identify emergency operations and clean-up crews. Establish alternative transportation strategies if roads are impassable.

Actions to Prepare for Extreme Cold and Winter Storms
(continued)

- ☐ Consider how evacuations or limited staffing due to transportation issues (potentially all utility personnel) will impact your response procedures.
- ☐ Identify possible staging areas for mutual aid crews if needed in the response, and the availability of local facilities to house the crews.
- ☐ Encourage personnel, especially those that may be on duty for extended periods of time, to develop family emergency plans.

Power, Energy and Fuel

- ☐ Evaluate condition of electrical panels to accept generators; inspect connections and switches.
- ☐ Document power requirements of the facility; options for doing this may include:
  - Placing a request with the US Army Corps of Engineers 249th Engineer Battalion (Prime Power): http://www.usace.army.mil/249thEngineerBattalion.aspx
  - Using the US Army Corps of Engineers on-line Emergency Power Facility Assessment Tool (EPFAT): http://epfat.swf.usace.army.mil/
- ☐ Confirm and document generator connection type, capacity load and fuel consumption. Test regularly, exercise under load and service backup generators.
- ☐ Fuel vehicles and fill fuel tanks to full capacity and ensure that you have the ability to manually pump gas in the event of a power outage. Ensure this equipment and other hazardous materials are located in a safe zone.
- ☐ Contact fuel vendors and inform them of estimated fuel volumes needed if utility is impacted. Determine your ability to establish emergency contract provisions with vendors and your ability to transport fuel if re-fueling contractors are not available. Develop a backup fueling plan and a prioritization list of which generators to fuel in case of a fuel shortage.
- ☐ Collaborate with your local power provider and EOC to ensure that your water utility is on the critical facilities list for priority electrical power restoration, generators and emergency fuel.

Example of Water Sector Impacts and Response to a Winter Storm

2014 Northern Ohio Winter Water Shortage

In January 2008, ice accumulation on the intake valves for Avon Lake Regional Water severely reduced water production and caused the utility to ask customers to reduce usage. Avon Lake Regional Water's source water is Lake Erie, and it provides water to over 200,000 residential and commercial customers in multiple communities in and around the western Cleveland suburbs. The utility contracted with another company to put six additional pumps into Lake Erie to increase water flow to the plant. This involved workers cutting through ice 300 feet from shore to put new pipes in the water. The utility was forced to deliver two sets of automated phone calls to residents: the first asked them to reduce water use by refraining from washing clothes or taking long showers; the second asked people to stop using water altogether, if possible. Mayors in communities affected by the water shortages worked with their local EMAs to discuss contingency plans in the event of a fire. At least one county declared a State of Emergency in order to free up resources around the state if they were needed.

The City of Cleveland was able to supply water to several communities served by Avon Lake Regional Water Authority through interconnections. Its intakes were not affected, as they are farther out into Lake Erie where the water is deeper.

Source: The Cleveland Plain Dealer, "Water shortage reaching critical point in Avon as utility tries another way to pull water from the frozen lake."

Actions to Respond to Extreme Cold and Winter Storms

Coordination

- [ ] Notify your local EMA and state regulatory/primacy agency of system status.
- [ ] If needed, request or offer assistance (e.g., equipment, personnel) through mutual aid networks, such as WARN.
- [ ] Assign a representative of the utility to the incident command post or the EOC for the community.

Communication with Customers

- [ ] Notify customers of any water advisories and consider collaborating with local media (television, radio, newspaper, etc.) to distribute the message. If emergency water is being supplied, provide information on the distribution locations.

Facility and Service Area

Overall

- [ ] Conduct damage assessments of the utility to prioritize repairs and other actions.
- [ ] Check that back-up equipment and facility systems, such as controls and pumps, are in working order, and ensure that chemical containers and feeders are intact.

Drinking Water Utilities

- [ ] Inspect the utility and service area for damage. Identify facility components (e.g., valve boxes) and fire hydrants that have been buried in snow, frozen in ice or are inaccessible.
- [ ] Systems that utilize surface water should monitor intakes, as ice and frozen slush can block valves and cause restrictions.
- [ ] Ensure pressure is maintained throughout the system and isolate those sections where it is not.
- [ ] Isolate and control leaks in water transmission and distribution piping.
- [ ] Monitor source water quality, develop a sampling plan and adjust treatment as necessary; increased usage of road salt within the service area may be a concern for utilities.
- [ ] Notify regulatory/primacy agency if operations and/or water quality or quantity are affected.
- [ ] Utilize pre-established emergency connections or setup temporary connections to nearby communities, as needed. Alternatively, implement plans to draw emergency water from pre-determined tanks or hydrants. Notify employees of the activated sites.

Wastewater Utilities

- [ ] Inspect the utility and service area, including lift stations, for damage and power availability. Inspect the sewer system for debris and assess the operational status of the mechanical bar screen. If necessary, run system in manual operation.
- [ ] Notify regulatory/primacy agency of any changes to the operations or required testing parameters.
- [ ] Monitor the type and amount of bacteria in the treatment process, as severe cold can affect growth rates.
- [ ] Consider curtailing or ceasing secondary treatment wasting procedures during periods of heavy freezing rain or snowmelt to conserve bacteria and prevent it from washing out of the plant.

Documentation and Reporting

- [ ] Document all damage assessments, mutual aid requests, emergency repair work, equipment used, purchases made, staff hours worked and contractors used during the response to assist in requesting reimbursement and applying for federal disaster funds. When possible, take photographs of damage at each work site (with time and date stamp). Proper documentation is critical to requesting reimbursement.

- [ ] Work with your local EMA on the required paperwork for public assistance requests.

Personnel

- [ ] Account for all personnel and provide emergency care, if needed. Caution personnel about known hazards resulting from severe winter weather.
- [ ] Deploy emergency operations and clean-up crews. Identify key access points and roads for employees to enter the utility and critical infrastructure; coordinate the need for snow and ice clearance with local officials and/or emergency management or prioritize it for employee operations.

Power, Energy and Fuel

- [ ] Use backup generators, as needed, to supply power to system components.
- [ ] Monitor and plan for additional fuel needs in advance; coordinate fuel deliveries to generators.
- [ ] Maintain contact with electric provider for power outage duration estimates.

Image by Nick Fillipelli, Northeast Ohio Regional Sewer District

Notes:

Actions to Recover from Extreme Cold and Winter Storms

Coordination

- ☐ Continue work with response partners to obtain funding, equipment, etc.

Communication with Customers

- ☐ Assign a utility representative to continue to communicate with customers concerning a timeline for recovery and other pertinent information.

Facility and Service Area

- ☐ Complete damage assessments.
- ☐ Complete permanent repairs, replace depleted supplies and return to normal service.

FEMA

Documentation and Reporting

- ☐ Compile damage assessment forms and cost documentation into a single report to facilitate the sharing of information and the completion of state and federal funding applications. Visit EPA's web-based tool, Federal Funding for Utilities—Water/Wastewater—in National Disasters (Fed FUNDS), for tailored information and application forms for various federal disaster funding programs: http://water.epa.gov/infrastructure/watersecurity/funding/fedfunds/
- ☐ Develop a lessons learned document and/or an after action report (AAR) to keep a record of your response activities. Update your vulnerability assessment, ERP and corresponding extreme cold and winter storm contingency plans.
- ☐ Revise budget and asset management plans to address increased costs from response-related activities.

Mitigation

- ☐ Identify mitigation and long-term adaptation measures that can prevent damage and increase utility resilience. Consider impacts related to the increased frequency of extreme cold and intense snow and ice storms when planning for system upgrades (e.g., replacing weak pipes to reduce the risk of main breaks, landscaping and tree trimming to minimize debris issues).

Notes:

Appendix 3

City of Owosso Water System Storage Volume Analysis
City of Owosso, Michigan
Water System Reliability Study
Project 221152

Year	Average Day Demand (mgd)	Maximum Day Demand (mgd)	Peak Hour Demand (mgd)	Suggested Fire-Flow[1] (gpm)	Duration[1] (hours)	Average Day Demand per 10 States[2] (gallons)	25% of Maximum Day Demand[2,3] (gallons)	Lowest of Two EQ Calculations (gallons)	Fire Demand[4] (gallons)	Emergency Storage 50% of ADD (gallons)	Greater of Fire Demand or Emergency Storage (gallons)	Total Storage Needed (gallons)	Existing Storage Volume (gallons)	Recommended Additional Storage Vol. (gallons)
2022	1.55	2.49	3.74	1,500	2	1,550,000	622,500	623,000	180,000	775,000	775,000	1,550,000	1,656,000	0
2022	1.55	2.49	3.74	2,500	2	1,550,000	622,500	623,000	300,000	775,000	775,000	1,550,000	1,656,000	0
2022	1.55	2.49	3.74	3,500	3	1,550,000	622,500	623,000	630,000	775,000	775,000	1,550,000	1,656,000	0
2022	1.55	2.49	3.74	3,500	4	1,550,000	622,500	623,000	840,000	775,000	840,000	1,615,000	1,656,000	0
2027	1.57	2.53	3.80	1,500	2	1,570,000	632,500	633,000	180,000	785,000	785,000	1,570,000	1,656,000	0
2027	1.57	2.53	3.80	2,500	2	1,570,000	632,500	633,000	300,000	785,000	785,000	1,570,000	1,656,000	0
2027	1.57	2.53	3.80	3,500	3	1,570,000	632,500	633,000	630,000	785,000	785,000	1,570,000	1,656,000	0
2027	1.57	2.53	3.80	3,500	4	1,570,000	632,500	633,000	840,000	785,000	840,000	1,625,000	1,656,000	0
2042	1.63	2.62	3.93	1,500	2	1,630,000	655,000	655,000	180,000	815,000	815,000	1,630,000	1,656,000	0
2042	1.63	2.62	3.93	2,500	2	1,630,000	655,000	655,000	300,000	815,000	815,000	1,630,000	1,656,000	0
2042	1.63	2.62	3.93	3,500	3	1,630,000	655,000	655,000	630,000	815,000	815,000	1,630,000	1,656,000	0
2042	1.63	2.62	3.93	3,500	4	1,630,000	655,000	655,000	840,000	815,000	840,000	1,655,000	1,656,000	0

Notes:

1. Fire demand and duration based on AWWA M-31 Manual recommendations. **A four-hour 3,500 gpm fire flow is the goal of City.**
2. Equalization volume was calculated using two different methods (the minimum determined EQ volume was used): 1 - Equal to ADD, 2 - Equal to 25% of MDD
3. Equalization volume = 25% of Maximum Day Demand
4. Fire demand is based on the suggested fire flow over the duration
5. Example calculation: (Year 2042 with a 4-hour 3,500 gpm desired fire flow)

    Maximum Day Demand = 2.62 mgd = 1,818 gpm (2042 projected maximum day demand)

    Peak Hour Demand = 3.93 mgd = 2,727 gpm (2042 projected peak hour demand)

    Equalization Volume = 25% * maximum day demand = 25% * 2.62 = 655,000 gallons (lowest of 2 methods used to calculate equalization volume)

    Fire Demand = Suggested Fire-Flow * Duration = 3,500 gpm * 4 hr * 60min/hr = 840,000 gallons

    Emergency Storage (12 hr) = 50% of ADD = 0.5 * 1,630,000 = 815,000 gallons

    Total Storage Needed = Fire Demand + Emergency Storage = 840,000 + 815,000 = 1,655,000 gallons

    Storage Volume Provided = total working volume of existing storage tanks = 1,656,000 gallons

    Recommended Additional Storage Volume = Recommended Storage Volume - Existing Storage Volume = 1,655,000 - 1,656,000 = -1,000 gallon surplus = 0 gallons additional storage

Appendix 4

City of Owosso

Water System Improvements

Shiawasee County, Michigan

Issued for Owner and Permit Review June 27, 2008
Project Number 07887CD

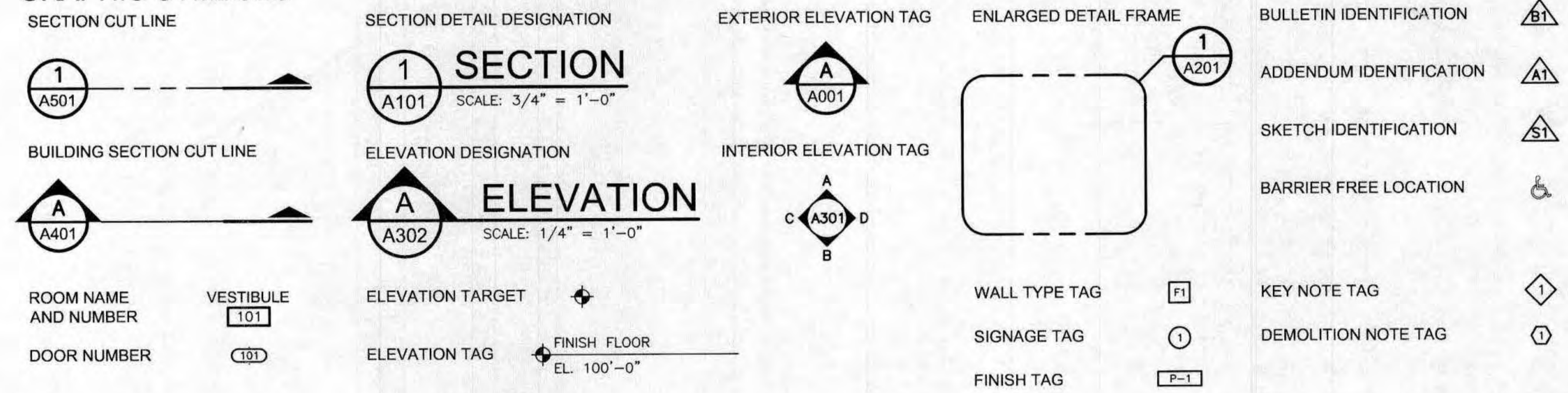
ftc&h

Fishbeck, Thompson, Carr & Huber, Inc.
Engineers • Scientists • Architects • Constructors
1515 Arboretum Drive, Grand Rapids, Michigan 49546
(800) 456-3824 www.ftch.com

GENERAL ABBREVIATIONS

AFF	ABOVE FINISH FLOOR	EL.	ELEVATION	IN.	INCH/INCHES	NRC	NOISE REDUCTION COEFFICIENT	SIM.	SIMILAR
AHU	AIR HANDLING UNIT	EJ	EXPANSION JOINT	INSUL.	INSULATION	NTS	NOT TO SCALE	SP.	SPACE/SPACING
AL.	ALUMINUM	EQ.	EQUAL	LAV.	LAVATORY	OC	ON CENTER	SQ.	SQUARE
ALT.	ALTERNATE	EWC	ELECTRIC WATER COOLER	LED	LIGHT EMITTING DIODE	OD	OUTSIDE DIAMETER	SS	STAINLESS STEEL
BF	BARRIER FREE	FD	FLOOR DRAIN	LLH	LONG LEG HORIZONTAL	OH.	OVERHEAD	STD.	STANDARD
BRG.	BEARING	FRT	FIRE RETARDANT TREATED	LLV	LONG LEG VERTICAL	OPP.	OPPOSITE	TAN.	TANGENT
CJ	CONTROL JOINT	FT.	FOOT/FEET	LP	LOW POINT	ORD	OVERFLOW ROOF DRAIN	TYP.	TYPICAL
CL.	CENTERLINE	GA.	GAUGE/GAGE	MFR.	MANUFACTURER	PERP.	PERPENDICULAR	UL	UNDERWRITER'S LABORATORY
CLG.	CEILING	GALV.	GALVANIZED	MAX.	MAXIMUM	PL.	PLATE	UNO	UNLESS NOTED OTHERWISE
CMU	CONCRETE MASONRY UNIT	GC	GENERAL CONTRACTOR	MEZZ.	MEZZANINE	PSF	POUNDS PER SQUARE FOOT	VERT.	VERTICAL
CO.	CLEANOUT	HB	HOSE BIBB	MIN.	MINIMUM	PSI	POUNDS PER SQUARE INCH	VTR	VENT THROUGH ROOF
CONC.	CONCRETE	HP	HIGH POINT	MO	MASONRY OPENING	PVC	POLYVINYL CHLORIDE	W/	WITH
CONST.	CONSTRUCTION	HORIZ.	HORIZONTAL	MTD.	MOUNTED	R	RADIUS	WC	WATER CLOSET
CONT.	CONTINUOUS	HVAC	HEATING VENTILATING AIR CONDITIONING	N/A	NOT APPLICABLE	REQD.	REQUIRED	WH	WATER HEATER
DIA.	DIAMETER	ID	INSIDE DIAMETER	NC	NOISE CRITERIA	RD	ROOF DRAIN	W/O	WITHOUT
DN.	DOWN	IE	INVERT ELEVATION	NIC	NOT IN CONTRACT	RO	ROUGH OPENING	WP.	WEATHERPROOF
DS.	DOWNSPOUT			NO.	NUMBER	SCH.	SCHEDULE	WT.	WEIGHT
EF	EXHAUST FAN					SF	SQUARE FOOT		

GRAPHIC SYMBOLS

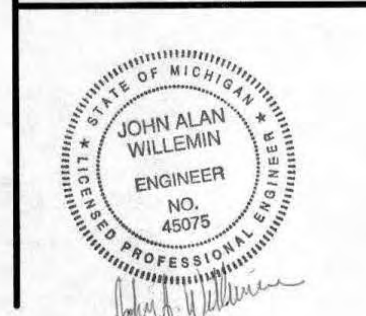


LOCATION MAP

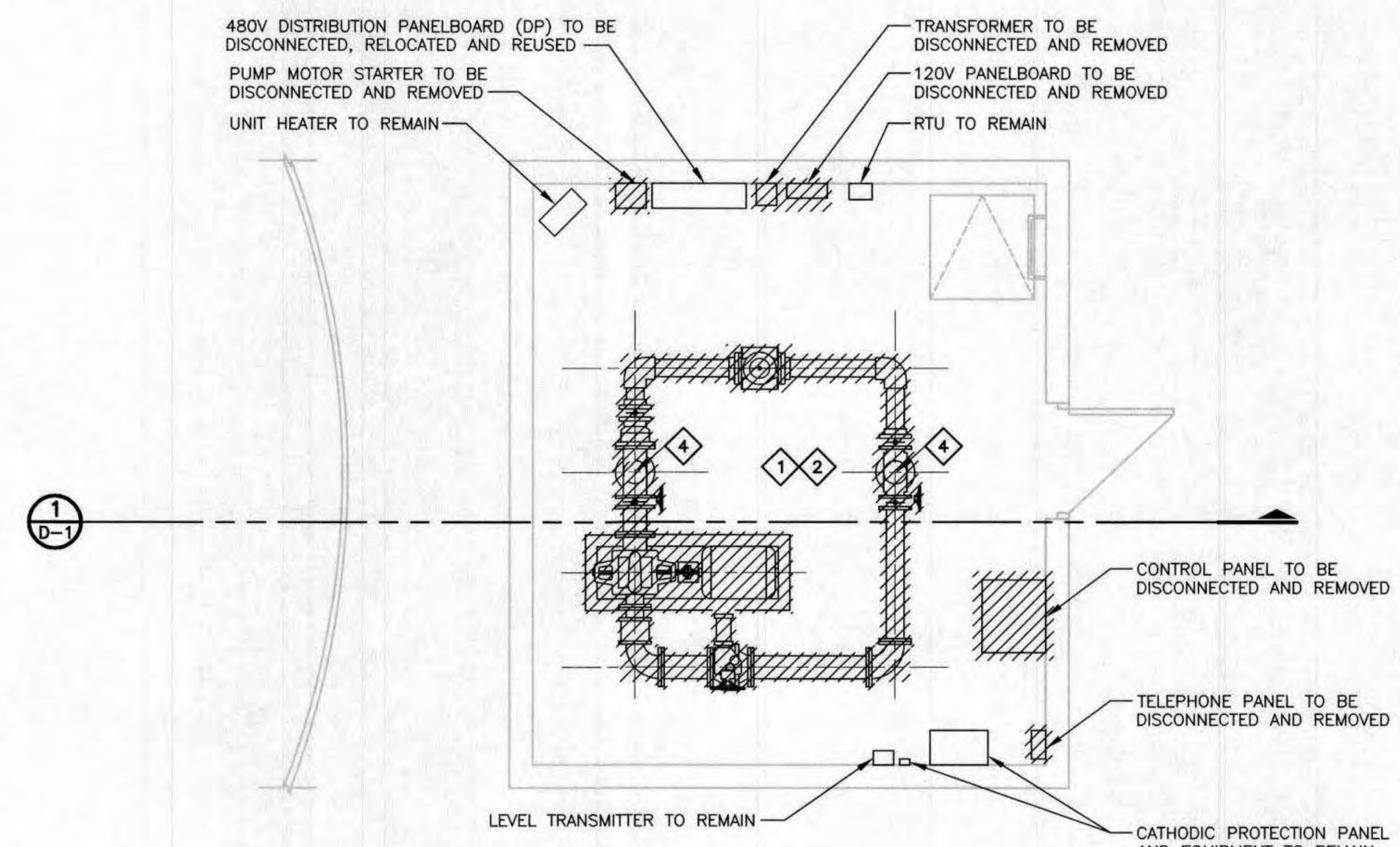
Project Number 07887CD
City of Owosso
Water System Improvements
Issued for Level 2 QA/QC June 23, 2008

BUILDING CODE INFORMATION

SEAL

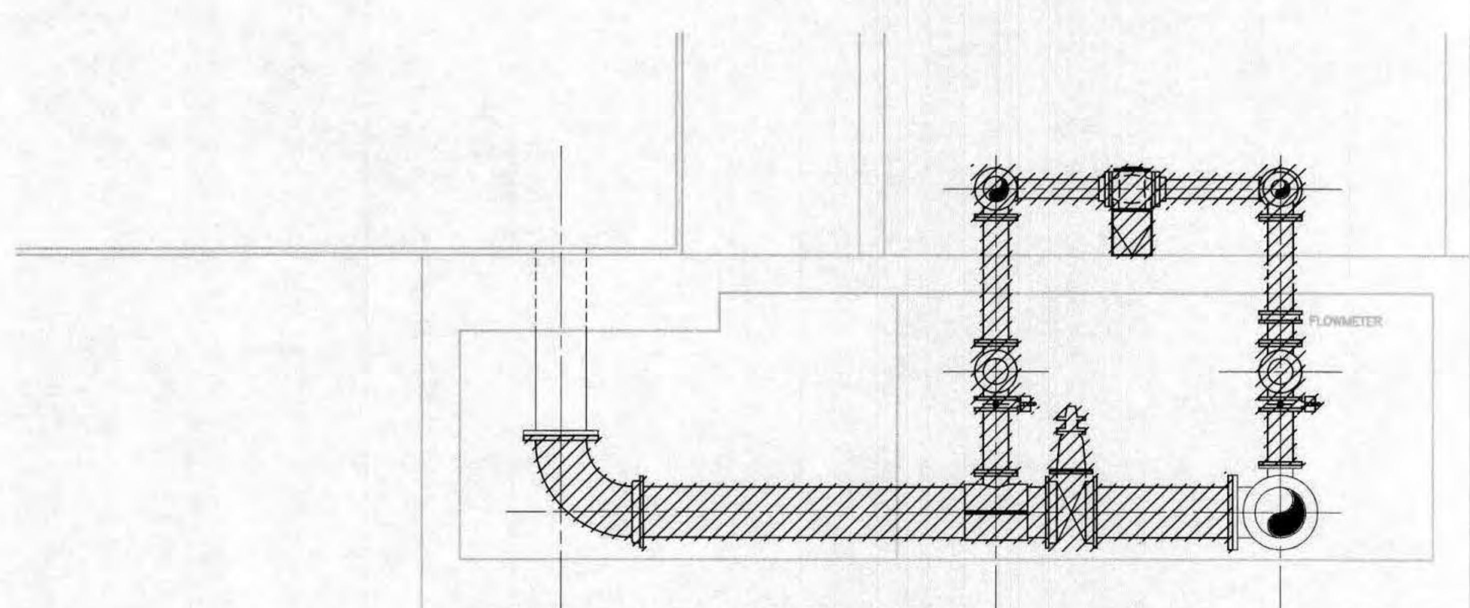


John A. Willemin
6/27/08

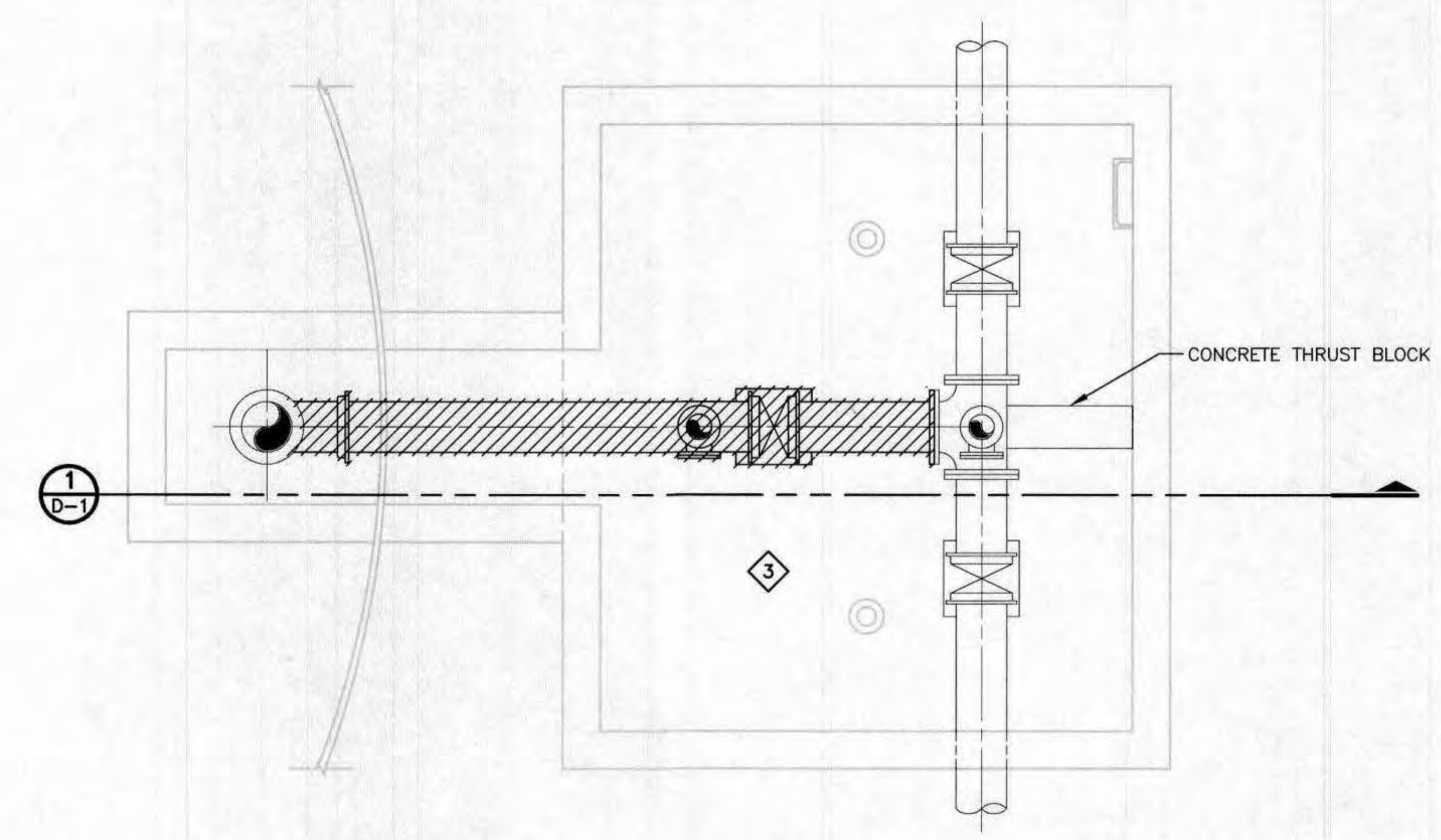


NORTH

STANDPIPE BOOSTER STATION
UPPER LEVEL DEMOLITION PLAN
SCALE: 1/4" = 1'-0"
0 2 4 8



1 D-1 SECTION
SCALE: 1/4" = 1'-0"



STANDPIPE BOOSTER STATION
LOWER LEVEL DEMOLITION PLAN
SCALE: 1/4" = 1'-0"

SYMBOL LEGEND

ITEMS TO BE REMOVED

NOTES

1. CONTRACTOR SHALL FIELD VERIFY EXISTING CONDITIONS INCLUDING POWER AND CONTROL WIRING FOR EQUIPMENT TO REMAIN. EQUIPMENT TO REMAIN SHALL BE REWIRED TO NEW AND/OR RELOCATED EQUIPMENT TO PROVIDE SAME CONTROL AND FUNCTIONALITY. DOCUMENT EXISTING WIRING PRIOR TO PERFORMING ANY DEMOLITION.
2. FIELD VERIFY EXISTING CONDITIONS TO DETERMINE EXTENT OF WORK AND INCLUDE ALL COSTS ASSOCIATED WITH DEMOLITION IN BASE BID.
3. COORDINATE DEMOLITION WORK WITH OTHER TRADES. DISCONNECT AND REMOVE ALL CONDUIT, WIRING AND DEVICES ASSOCIATED WITH PROCESS EQUIPMENT BEING REMOVED. ALL DEVICES/EQUIPMENT TO BE DEMOLISHED ARE NOT NECESSARILY INDICATED. VERIFY WITH ENGINEER PRIOR TO DEMOLISHING ANY DEVICES IN QUESTION.
4. REMOVE EMBEDDED EQUIPMENT A MINIMUM OF 1 INCH BELOW THE SURFACE IT IS ATTACHED TO AND SQUARE UP ALL EDGES. PATCH CONCRETE IN ACORDANCE WITH CONCRETE SPECIFICATIONS.
5. FIELD VERIFY LOCATIONS OF EXISTING PIPES AND STRUCTURES.
6. FILL PENETRATIONS IN CONCRETE WALLS AND DECK W/CONCRETE, EXPOSED AS A RESULT OF PIPE AND EQUIPMENT REMOVAL.
7. REMOVE ALL METAL AND CONCRETE PIPE SUPPORTS/PIERS/HANGERS ASSOCIATED WITH PIPING AND EQUIPMENT TO BE DEMOLISHED. PATCH CONCRETE SURFACES SMOOTH.

KEY NOTES

1. EXISTING CEILING MOUNTED LIGHT FIXTURES AND ASSOCIATED SWITCHES, RECEPTACLES, AND CONDUIT/WIRING TO REMAIN.
2. EXISTING THERMOSTATS, EXHAUST FAN, LOUVER/DAMPER/ACTUATOR, AND ASSOCIATED CONTROLS AND CONDUIT/WIRING TO REMAIN.
3. EXISTING LIGHTING ON LOWER LEVEL AND ASSOCIATED SWITCHES, RECEPTACLES, AND CONDUIT/WIRING TO REMAIN.
4. PATCH PIPE PENETRATION.

ftc&h

engineers
scientists
architects
constructors

fishbeck, thompson, carr & huber, inc.

City of Owosso
Shiawasee County, Michigan

Water System Improvements

6/27/2008	OWNER & MDEQ REVIEW
6/23/2008	LEVEL 2 REVIEW
6/12/2008	95% COORDINATION

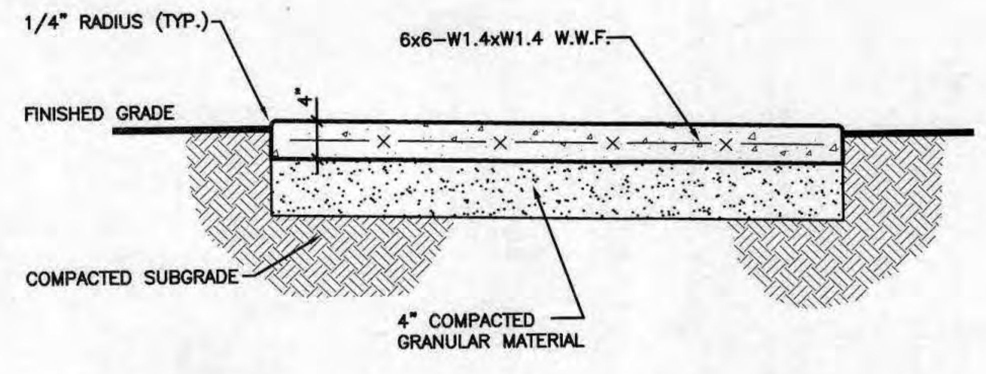
Drawn By	SG
Designer	JME
Reviewer	TDM
Manager	JW

Hard copy is intended to be 24"x36" when plotted. Scale(s) indicated and graphic quality may not be accurate for any other size.

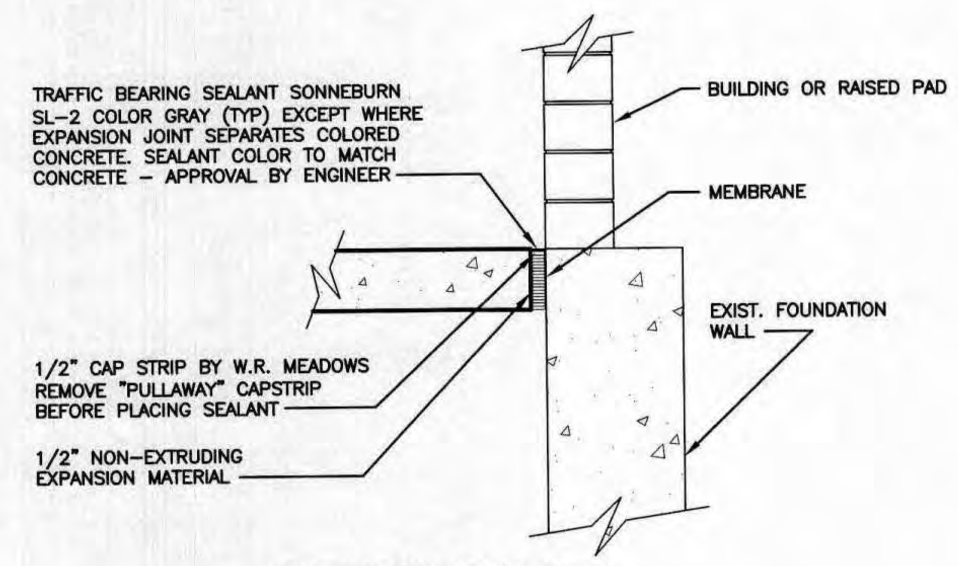
PROJECT NO.
G07887CD

FIGURE NO.
D-1

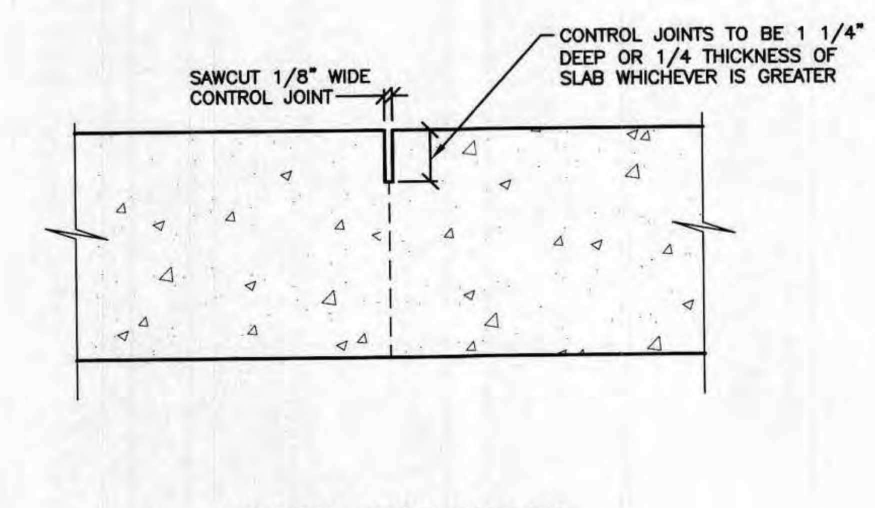
PLOT INFO: U:\CADD\07887CD\CD\D0010788 7CD.DWG DATE: 6/27/2008 TIME: 9:45:30 AM USER: RS2



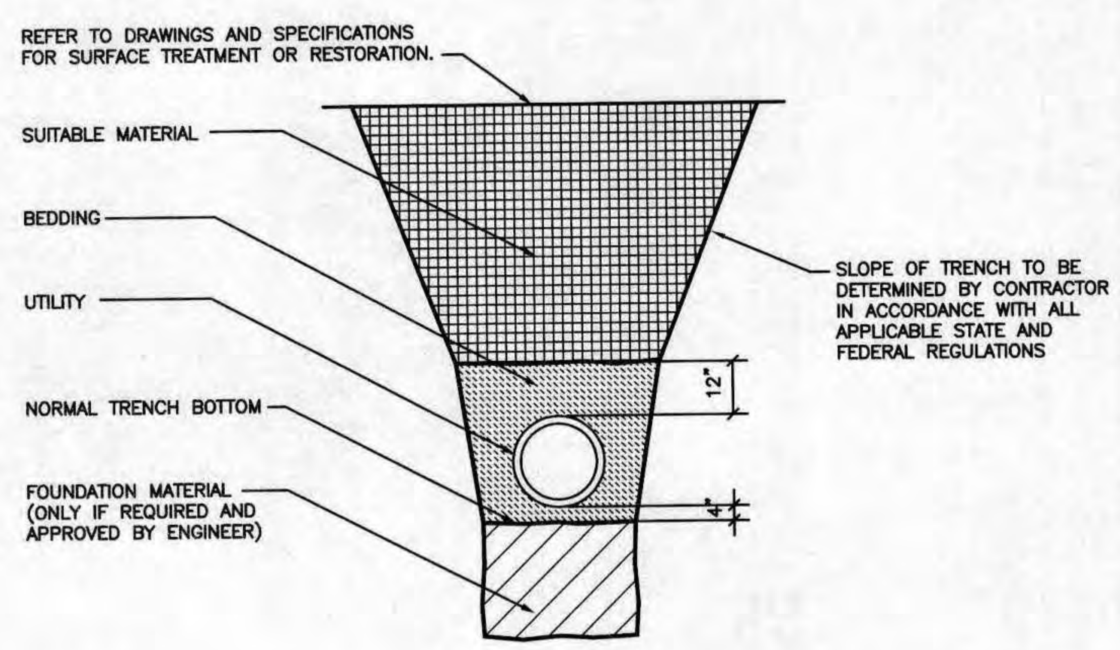
CONCRETE SLAB SECTION
NO SCALE



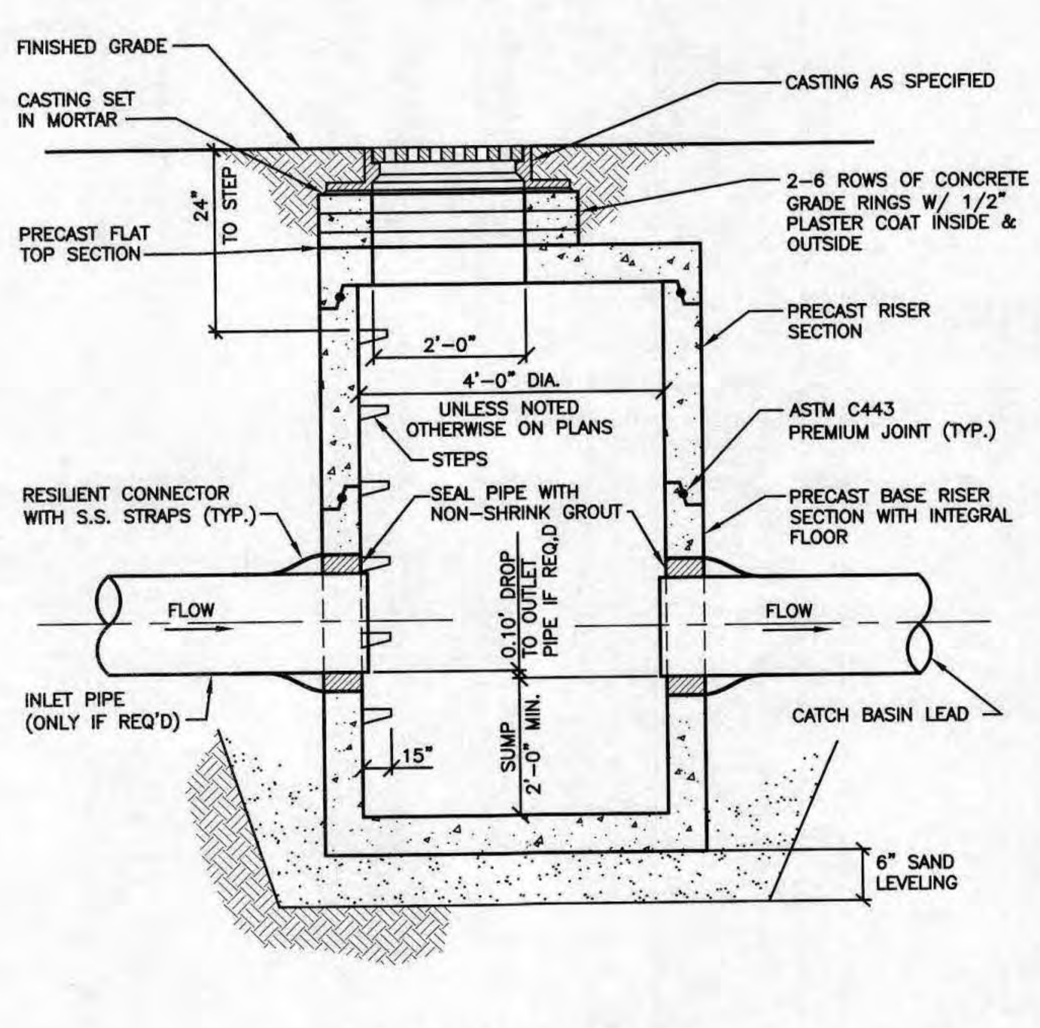
EXPANSION JOINT DETAIL
NO SCALE



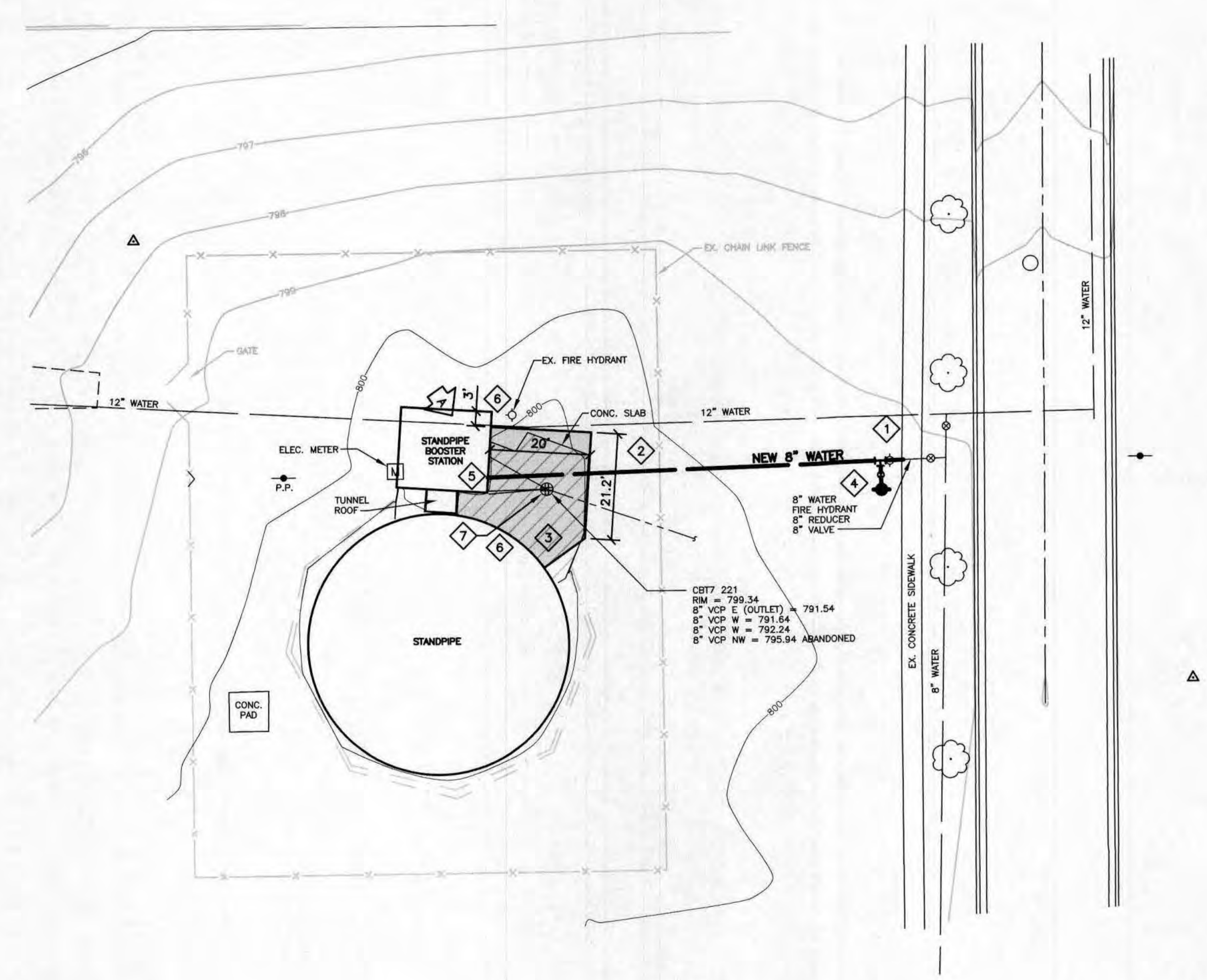
CONTROL JOINT SECTION
NO SCALE
CI-055



TRENCH NOT ADJACENT TO DRIVING SURFACE OR STRUCTURE
NO SCALE
02222-01



STANDARD CATCH BASIN
NO SCALE
02720-01



STANDPIPE BOOSTER STATION
SITE PLAN
SCALE: 1" = 20'
NORTH
0 10 20 40

Call MISS DIG
3 full working days before you dig:
Michigan's One-Call
Utility Notification Organization
1-800-482-7171
on the net at: www.missdig.org

BENCH MARKS

BENCH MARK A ELEVATION: 800.83
FINISH FLOOR ELEVATION OF BOOSTER PUMP BUILDING

SYMBOL LEGEND

REMOVE CONCRETE SLAB
NEW CONCRETE SLAB
BENCHMARK

NOTES

1. ALL WORK SHALL BE COMPLETED IN ACCORDANCE WITH APPLICABLE LOCAL, STATE AND FEDERAL CODES, RULES AND REGULATIONS. OBTAIN ALL NECESSARY LOCAL, STATE AND FEDERAL PERMITS AND PAY PERMIT FEES FOR THE WORK OR CONFIRM REQUIRED PERMITS HAVE BEEN OBTAINED BY OTHERS PRIOR TO COMMENCING CONSTRUCTION.
2. BE RESPONSIBLE AT ALL TIMES FOR SITE SAFETY IN ACCORDANCE WITH THE LATEST REQUIREMENTS OF THE OCCUPATIONAL HEALTH AND SAFETY AUTHORITY HAVING JURISDICTION.
3. CALL MISS DIG @ 1-800-482-7171 AND OWNER @ 989-725-0555 AT LEAST 72 HOURS PRIOR TO ANY EXCAVATION TO CONFIRM THE LOCATIONS OF EXISTING BURIED UTILITIES. THIS DOES NOT RELIEVE THE CONTRACTOR OF THE RESPONSIBILITY OF NOTIFYING UTILITY OWNERS WHO MAY NOT BE PART OF THE "MISS DIG" ALERT SYSTEM. COORDINATE THE RELOCATION OF EXISTING UTILITIES WITH THE UTILITY OWNER. BE RESPONSIBLE FOR PROTECTING EXISTING UTILITIES AND REPAIRING DAMAGE TO EXISTING UTILITIES RESULTING FROM THE WORK. BE RESPONSIBLE FOR THE COSTS OF REPAIRING OR REPLACING ANY DAMAGED UTILITIES AT NO EXPENSE TO THE OWNER.
4. MAINTAIN A CLEAN WORK AREA. THOROUGHLY CLEAN AND/OR SWEEP STREETS AND ROADWAYS AS REQUIRED BY THE GOVERNING AUTHORITY.
5. RESTORE ALL DISTURBED AREAS NOT COVERED BY OTHER SURFACE TREATMENT WITH 4" TOPSOIL, SEED, FERTILIZER, MULCH OR MULCH BLANKET.
6. PROTECT EXISTING SITE IMPROVEMENTS TO REMAIN FROM DAMAGE. RESTORE/REPLACE DAMAGED IMPROVEMENTS TO ORIGINAL CONDITION ACCEPTABLE TO PARTIES HAVING JURISDICTION.
7. THE INFORMATION CONTAINED ON THESE DRAWINGS PERTAINING TO EXISTING CONDITIONS, SUCH AS BUT NOT LIMITED TO, UTILITIES, TOPOGRAPHY, SUBSURFACE CONDITIONS, IS FURNISHED SOLELY AS THE BEST INFORMATION AVAILABLE AND ITS ACCURACY IS NOT GUARANTEED. THE USE OF THIS INFORMATION DOES NOT PROVIDE RELIEF FOR ANY RESPONSIBILITY FOR DAMAGES DUE TO ANY INACCURACIES.
8. CONTAIN SEDIMENT ON THE SITE. DO NOT ALLOW SEDIMENT TO COLLECT IN OFF SITE AREAS OR IN WATERWAYS. WATERWAYS INCLUDE NATURAL AND MANMADE OPEN DITCHES, STREAMS, STORM DRAINS, LAKES AND PONDS.
9. PROVIDE AND MAINTAIN INLET FILTERS AT ALL NEW AND EXISTING CATCH BASINS AND INLET STRUCTURES WHERE IMPACTED BY CONSTRUCTION DRAINAGE UNTIL PERMANENT EROSION CONTROL MEASURES ARE IN PLACE.
10. PROVIDE AND MAINTAIN INLET FILTERS IN ACCORDANCE WITH THE MANUFACTURER'S RECOMMENDATIONS. MAINTENANCE CONSISTS OF REMOVING ALL SEDIMENT WITH A STIFF BRISTLE BROOM OR SQUARE POINT SHOVEL. IF THE INLET FILTER IS DAMAGED, REPLACE BOTH THE STONE AND GEOTEXTILE FILTER FABRIC.
11. PROMPTLY REMOVE ALL MUD, DIRT AND DEBRIS TRACKED ONTO EXISTING ROADS FROM THE SITE.
12. UNLESS SPECIFICALLY NOTED FOR REMOVAL ON THE PLANS, ALL SIDEWALKS, DRIVES, CULVERTS, DRAINAGE STRUCTURES, AND ABOVE AS WELL AS BELOW GRADE UTILITIES SHALL BE PROTECTED. ALL SUCH ITEMS DAMAGED OR DESTROYED DURING CONSTRUCTION SHALL BE REMOVED AND REPLACED WITH NEW AT NO ADDITIONAL COST TO THE OWNER.
13. LOCATIONS OF ALL EXISTING UTILITIES SHOWN ON THIS DRAWING HAVE BEEN DETERMINED FROM THE BEST INFORMATION AVAILABLE AND ARE GIVEN FOR THE CONVENIENCE OF THE CONTRACTOR. VERIFY CRITICAL INVERT INFORMATION PRIOR TO BEGINNING CONSTRUCTION.

KEY NOTES

1 SALVAGE AND REUSE EXISTING FIRE HYDRANT AND REDUCER

2 SALVAGE AND REINSTALL EXISTING FENCING. REMOVE ONLY AS NECESSARY FOR WATER MAIN INSTALLATION.

3 REMOVE AND REPLACE CONCRETE SLAB. SEE SECTION AND DETAILS THIS SHEET. SET SLAB ELEVATIONS TO MATCH EXISTING CONDTIONS. SLOPE SLAB TO CATCH BASIN. PLACE EXPANSION JOINTS AT INTERFACE WITH STRUCTURES AND AT 10' MAXIMUM SPACING IN SLAB. PLACE CONTROL JOINT AT 5' MAXIMUM SPACING IN SLAB. PREVENT SEDIMENT FROM ENTERING CATCH BASIN.

4 REINSTALL SALVAGED FIRE HYDRANT AND REDUCER WITH NEW 8" GATE VALVE AND 8" TEE.

5 CONNECT NEW WATER MAIN TO NEW WATER MAIN FROM BUILDING. SEE PROCESS.

6 PROTECT EXISTING FIRE HYDRANT, STANDPIPE AND BUILDING FROM DAMAGE DURING CONSTRUCTION.

7 REMOVE AND REPLACE CATCH BASIN. SEE DETAIL THIS SHEET. RIM ELEVATION = 799.35. CATCH BASIN CASTING TO BE EJIW 1040 WITH TYPE M1 FLAT GRATE. RECONNECT ACTIVE PIPES TO CATCH BASIN WITH COMPATIBLE MATERIALS.

ftc&h
engineers
scientists
architects
constructors
fishbeck, thompson, carr & huber, inc.

City of Owosso
Shiawassee County, Michigan
Water System Improvements

6/27/2008	OWNER & MDEQ REVIEW
6/23/2008	LEVEL 2 REVIEW
6/12/2008	95% COORDINATION

Drawn By	KER
Designer	KER
Reviewer	TDM
Manager	JW

Hard copy is intended to be 24"x36" when plotted. Scale(s) indicated and graphic quality may not be accurate for any other size.

PROJECT NO.
G07887CD

FIGURE NO.
C-1

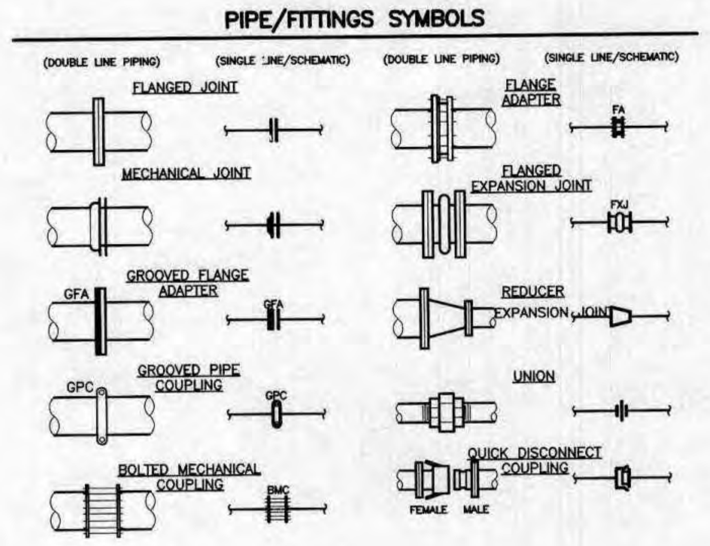
PLOT INFO: U:\CAD\07887CD\CD\CD0107887CD.DWG DATE: 6/27/2008 TIME: 9:52:09 AM USER: RS2

ABBREVIATIONS

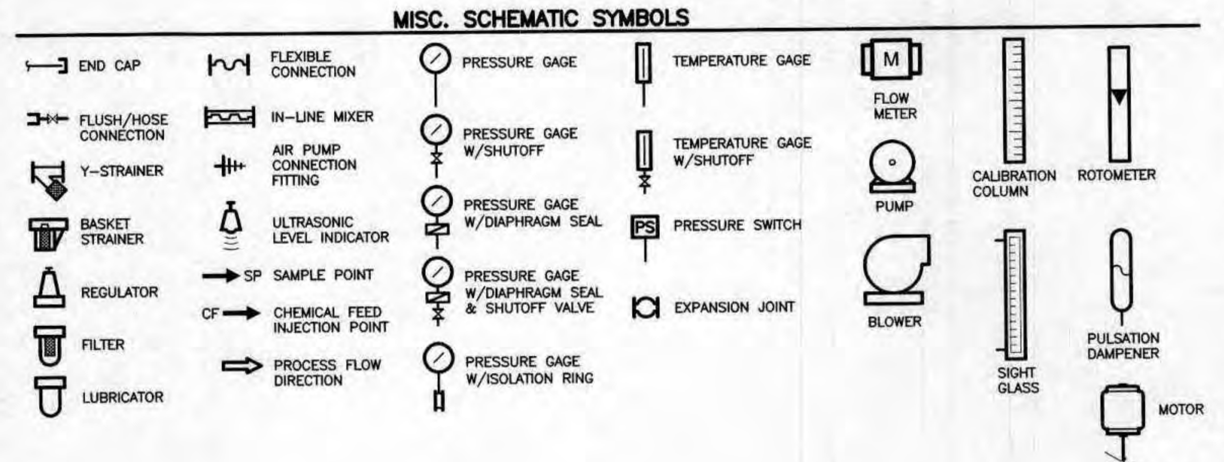
A	AIR
ABAN	ABANDON
ADJ	ADJACENT
AGGR	AGGREGATE
AL	ALUMINUM
ALT	ALTERNATE (IVE)
APPROX	APPROXIMATE
AS	ACTIVATED SLUDGE
ASSY	ASSEMBLY
B/B	BACK TO BACK
BFV	BUTTERFLY VALVE
BIP	BLACK IRON PIPE
BLDG	BUILDING
BLWDN	BLOW DOWN
BOT	BOTTOM
BSMT	BASEMENT
BSP	BLACK STEEL PIPE
BW	BACKWASH
BWR	BACKWASH RETURN
BWS	BACKWASH SUPPLY
BWW	BACKWASH WATER
C/C	CENTER TO CENTER
CA	COMPRESSED AIR
CF	CUBIC FEET
CG	CHLORINE GAS
CIP	CAST IRON PIPE
CL	CENTERLINE
CN	CENTRATE
CO	CLEANOUT
CONC	CONCRETE
CONC	CONCENTRIC
CONST	CONSTRUCTION
COORD	COORDINATE
CP	COPPER PIPE
CPVC	CHLORINATED POLYVINYL CHLORIDE
CS	CHLORINE SOLUTION
CSP	CORRUGATED STEEL PIPE
CSP	CARBON STEEL PIPE
CTR	COOLING TOWER RETURN
CTS	COOLING TOWER SUPPLY
CW	COLD WATER
CY	CUBIC YARD
DEG	DEGREE
DEMO	DEMOLITION
DG	DIGESTER GAS
DIA	DIAMETER
DIM	DIMENSION
DIP	DUCTILE IRON PIPE
DISCH	DISCHARGE
DIST	DISTANCE
DIW	DEIONIZED WATER
DR	DRAIN
DS	DIGESTED SLUDGE
DWS	DRINKING WATER SUPPLY
DWV	DRAIN WASTE VENT
ECC	ECCENTRIC
EFF	EFFLUENT
EL	ELEVATION
ELL	ELBOW
ENGR	ENGINEER
EQUIP	EQUIPMENT
EXC	EXCAVATE (ION)
EXIST	EXISTING
EXT	EXTERIOR
F/F	FACE TO FACE
FIG	FIGURE
FILT	FILTRATE
FIN FL	FINISHED FLOOR
FL	FLUORIDE
FM	FORCE MAIN
FO	FUEL OIL
FRP	FIBERGLASS REINFORCED PLASTIC
FSP	FABRICATED STEEL PIPE
FW	FILTERED WATER
GA	GAUGE
GAC	GRANULAR ACTIVATED CARBON
GPD	GALLONS PER DAY
GPM	GALLONS PER MINUTE
GSP	GALVANIZED STEEL PIPE
GV	GATE VALVE
HCL	HYDROCHLORIC ACID
HDPE	HIGH DENSITY POLYETHYLENE EXTRUSION
HDWL	HEADWALL
HFA	HYDROFLUOSILICIC ACID
HORIZ	HORIZONTAL
HP	HIGH POINT
HT	HEIGHT
HW	HOT WATER
HWL	HIGH WATER LEVEL
I.E.	INVERT ELEVATION
IA	INSTRUMENT AIR
I.D.	INSIDE DIAMETER
INCL	INCLUDE
INFL	INFLUENT
INT	INTERIOR
IPS	IRON PIPE SIZE
INV	INVERT
LAT	LATERAL
LF	LINEAL FEET
LGTH	LENGTH
LIQ	LIQUID
LP	LOW POINT
LPG	LIQUEFIED PETROLEUM GAS
LS	LIME SLURRY
LWL	LOW WATER LEVEL
MAINT	MAINTENANCE
MATL	MATERIAL
MAX	MAXIMUM
MFGR	MANUFACTURER
MGD	MILLION GALLONS PER DAY
MH	MANHOLE
MIN	MINIMUM
MIP	MALLEABLE IRON PIPE
MISC	MISCELLANEOUS
MJ	MECHANICAL JOINT
NA	NOT APPLICABLE
NC	NORMALLY CLOSED
NG	NATURAL GAS
NIC	NOT IN CONTRACT
NO	NORMALLY OPENED
NPW	NON-POTABLE WATER
NTS	NOT TO SCALE
OA	OUTSIDE AIR
OC	ON CENTER
O.D.	OUTSIDE DIAMETER
OE	OVERHEAD ELECTRICAL
OPNG	OPENING
ORIG	ORIGINAL
OXY	OXYGEN
P	POLYMER
PA	PLANT AIR
PAC	POWDERED ACTIVATED CARBON
PCCP	PRESTRESSED CONCRETE CYLINDRICAL PIPE
PD	PROCESS DRAIN
PE	POLYETHYLENE
PERF	PERFORATED
PIV	POST INDICATOR VALVE
PL	PROCESS LIQUID
PP	POLYPROPYLENE PIPE
PPH	POLYPHOSPHATE
PROP	PROPOSED
PS	PRIMARY SLUDGE
PSF	POUNDS PER SQUARE FOOT
PSI	POUNDS PER SQUARE INCH
PV	PLUG VALVE
PVC	POLYVINYL CHLORIDE PIPE
PW	POTABLE WATER
PUW	PLANT UTILITY WATER
QTY	QUANTITY
RAS	RETURN ACTIVATED SLUDGE
RCP	REINFORCED CONCRETE PIPE
RECIRC	RECIRCULATE (ING, ION)
RED	REDUCER
REF	REFERENCE
REQD	REQUIRED
REV	REVISION
RJ	RESTRAINED JOINT
RW	RAW WATER
SA	SODA ASH
SAN	SANITARY
SC	SCUM
SL	SAMPLE LINE
SN	SUPERNATANT
SP	SAMPLE POINT
SQ. FT.	SQUARE FOOT
SQ. YD.	SQUARE YARD
SS	STAINLESS STEEL
SSP	STAINLESS STEEL PIPE
STD	STANDARD
STL	STEEL
SUCT	SUCTION
SW	SEAL WATER
SYS	SYSTEM
TDH	TOTAL DYNAMIC HEAD
TEMP	TEMPORARY
TS	THICKENED SLUDGE
TW	TREATED WATER
TYP	TYPICAL
UTIL	UTILITY
UW	UTILITY WATER
VAC	VACUUM
VB	VALVE BOX
VCP	VITRIFIED CLAY PIPE
VERT	VERTICAL
W/	WITH
W/O	WITH OUT
WAS	WASTE ACTIVATED SLUDGE
WG	WASTE GAS
WL	WATER LEVEL
WS	WASTE SLUDGE
WTR	WATER
WW	WASTE WATER

PROCESS SYMBOL LEGEND

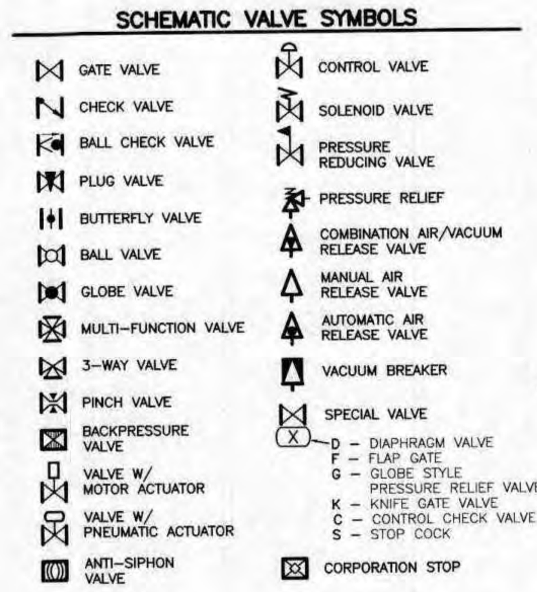
PIPE/FITTINGS SYMBOLS



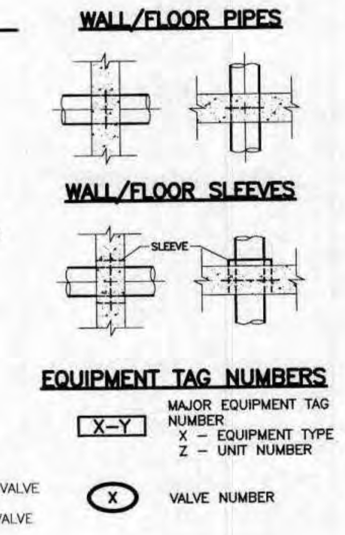
MISC. SCHEMATIC SYMBOLS



SCHEMATIC VALVE SYMBOLS



WALL/FLOOR PIPES



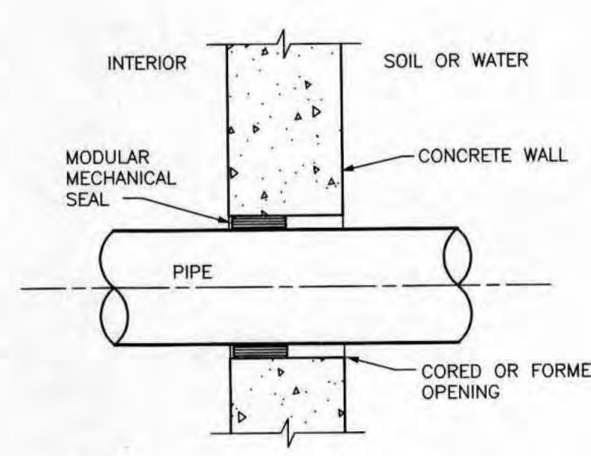
PROCESS GENERAL NOTES

1. GRAPHICAL REPRESENTATION OF EXISTING SYSTEMS WERE OBTAINED FROM PREVIOUS CONSTRUCTION AND/OR RECORD DRAWINGS MAY NOT FULLY REPRESENT EXISTING CONDITIONS AND IS FOR REFERENCE ONLY. CONTRACTOR TO FIELD VERIFY EXISTING CONDITIONS TO DETERMINE EXTENT OF WORK.
2. REFER TO PIPING PLAN VIEWS FOR CORRECT PIPE ORIENTATION TO BUILDINGS AND STRUCTURES.
3. (NOT USED)
4. WALL SLEEVES AND WALL PIPE SHALL BE PAINTED PRIOR TO EMBEDMENT/PIPE INSTALLATION.
5. PAINT PIPE SURFACES THAT WILL BE CONCEALED BY PIPE SUPPORTS PRIOR TO INSTALLING PIPE.
6. COORDINATE NEW WORK WITH DEMOLITION.
7. RESTRAIN ALL PIPE JOINTS NEW AND EXISTING RELATED TO NEW WORK.
8. ENCASE BURIED PIPING UNDER STRUCTURES WITH 1'-0" MINIMUM CONCRETE ENCASEMENT AROUND PIPE AND FROM FURTHEST EXTENTIONS OF FITTING JOINTS, AFTER PIPE HAS BEEN PRESSURE TESTED.

PROCESS SITE PIPING NOTES

1. VERIFY DEPTH, SIZE, MATERIAL AND LOCATION OF ALL EXISTING BELOW GRADE PIPING FOR NEW BURIED PIPE INSTALLATION, PRIOR TO COMMENCING WORK.
2. (NOT USED)
3. FIELD VERIFY ALL EXISTING UTILITIES AND BURIED PIPING PRIOR TO ABANDONMENT AND INSTALLATION OF PIPING.
4. MOUNT VALVE BOXES ON ALL BELOW GRADE VALVES.
5. USE APPROPRIATE FITTINGS AND/OR PIPE JOINT DEFLECTION AS NECESSARY TO INSTALL PIPE ℄ ELEVATIONS INDICATED.
6. RESTRAIN ALL NEW BURIED PIPE JOINTS AND EXISTING JOINTS RELATED TO NEW WORK.

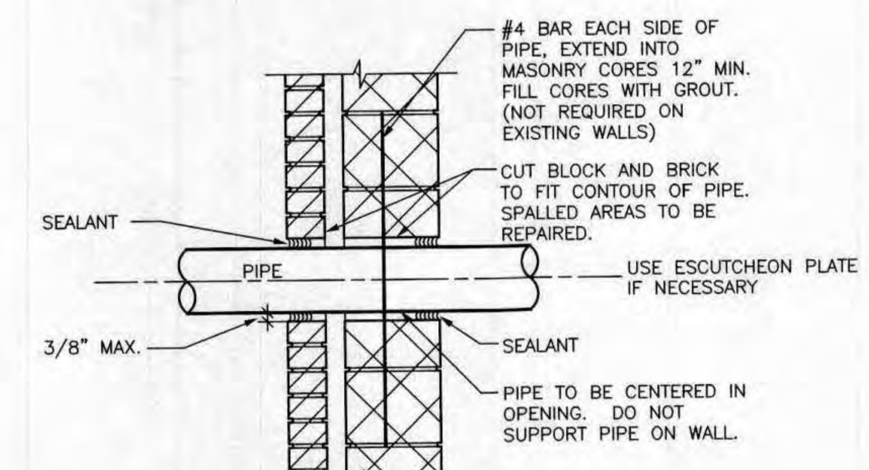
ALL PROCESS NOTES, SYMBOLS, LEGENDS AND ABBREVIATIONS SHOWN ON THIS SHEET MAY NOT BE ALL INCLUSIVE, AND ONLY REFER TO THE P-SERIES DRAWINGS FOR THIS SET.



NOTE

1. USE TYPE 1 WALL PENETRATION FOR ALL PIPING PASSING THROUGH CORED OR FORMED OPENING IN CONCRETE WALLS WITH SOIL OR WATER ON ONE SIDE WHERE NO WALL SLEEVE IS USED.

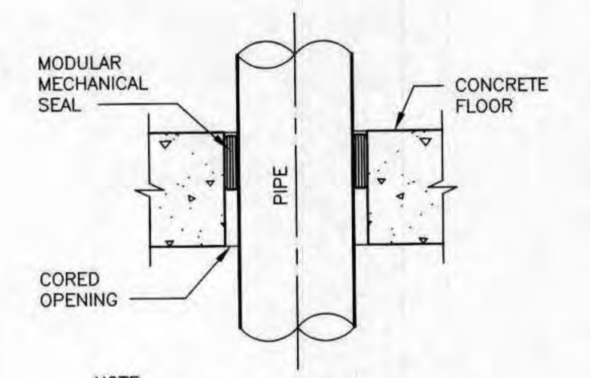
WALL PENETRATION DETAIL – TYPE 1
NO SCALE 15460-07



NOTE

1. USE TYPE 3 WALL PENETRATION FOR ALL PIPING PASSING THROUGH EXTERIOR BLOCK OR BLOCK AND BRICK WALLS WHERE NO WALL SLEEVE IS USED.

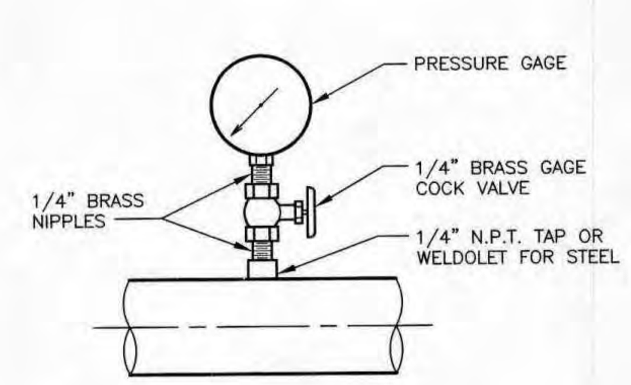
WALL PENETRATION DETAIL – TYPE 3
NO SCALE 15460-08



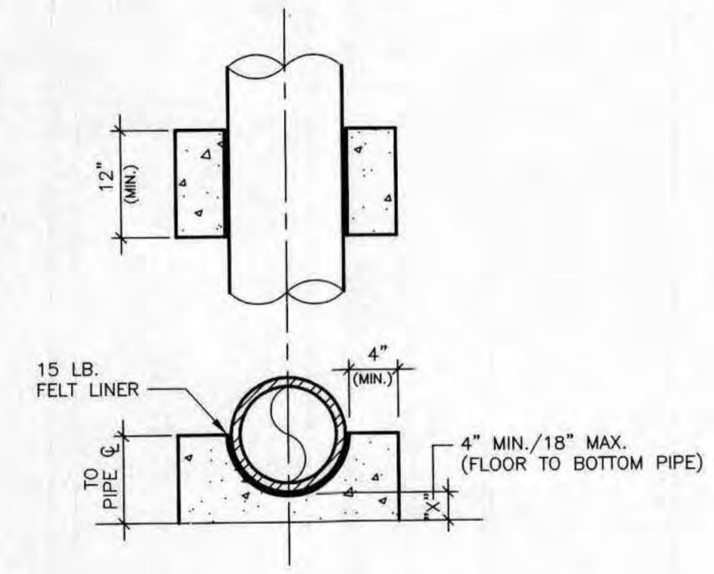
NOTE

1. USE TYPE 2 PIPE PENETRATION FOR ALL PIPING PASSING THROUGH CORED OPENINGS IN EXISTING CONCRETE FLOORS.

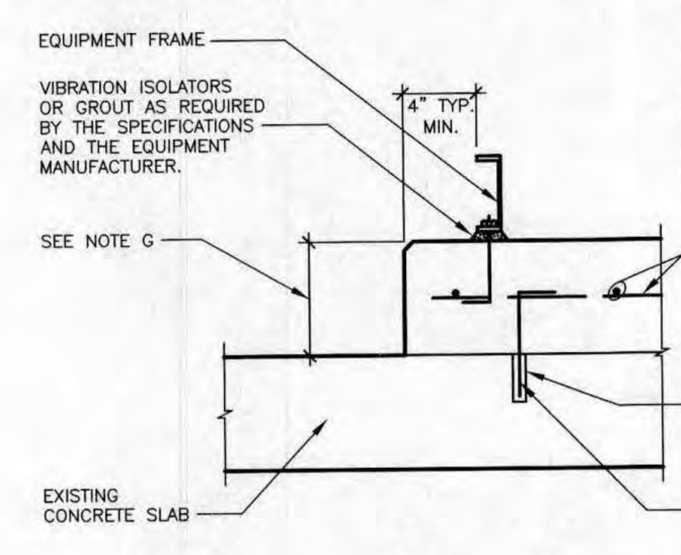
FLOOR PENETRATION DETAIL – TYPE 2
NO SCALE 15460-19



PRESSURE GAGE TAP
NO SCALE P00002



PIPE SUPPORT – CONCRETE
NO SCALE PS10002



EQUIPMENT PAD ON CONCRETE SLAB
NO SCALE

NOTES:

A) ANCHOR BOLTS AS SPECIFIED OR SUPPLIED BY EQUIPMENT MANUFACTURER
B) ALL ANCHOR BOLTS TO BE CAST INTO BASE PAD
C) COORDINATE ANCHOR BOLT LENGTH WITH PAD THICKNESS
D) SET EQUIPMENT FRAME ON ANCHOR BOLTS CAST INTO EQUIPMENT PAD.
E) SHIM EQUIPMENT FRAME AND GROUT WITH NON-METALLIC NON-SHRINK GROUT, OR PROVIDE VIBRATION ISOLATORS AS REQUIRED BY THE SPECIFICATIONS AND THE EQUIPMENT MANUFACTURER.
F) USE ADJUSTABLE SLEEVED ANCHOR BOLT WHERE NOTED ON PLANS
G) COORDINATE PAD HEIGHT WITH EQUIPMENT AND PIPING ELEVATIONS – 3 1/2" MIN.

PLOT INFO: U:\CADD\07887CD\CD\P001078 87CD.DWG DATE: 6/27/2008 TIME: 9:45:35 AM USER: RS2

ftc&h
engineers
scientists
architects
constructors
fishbeck, thompson, carr & huber, inc.

City of Owosso
Shiawassee County, Michigan
Water System Improvements

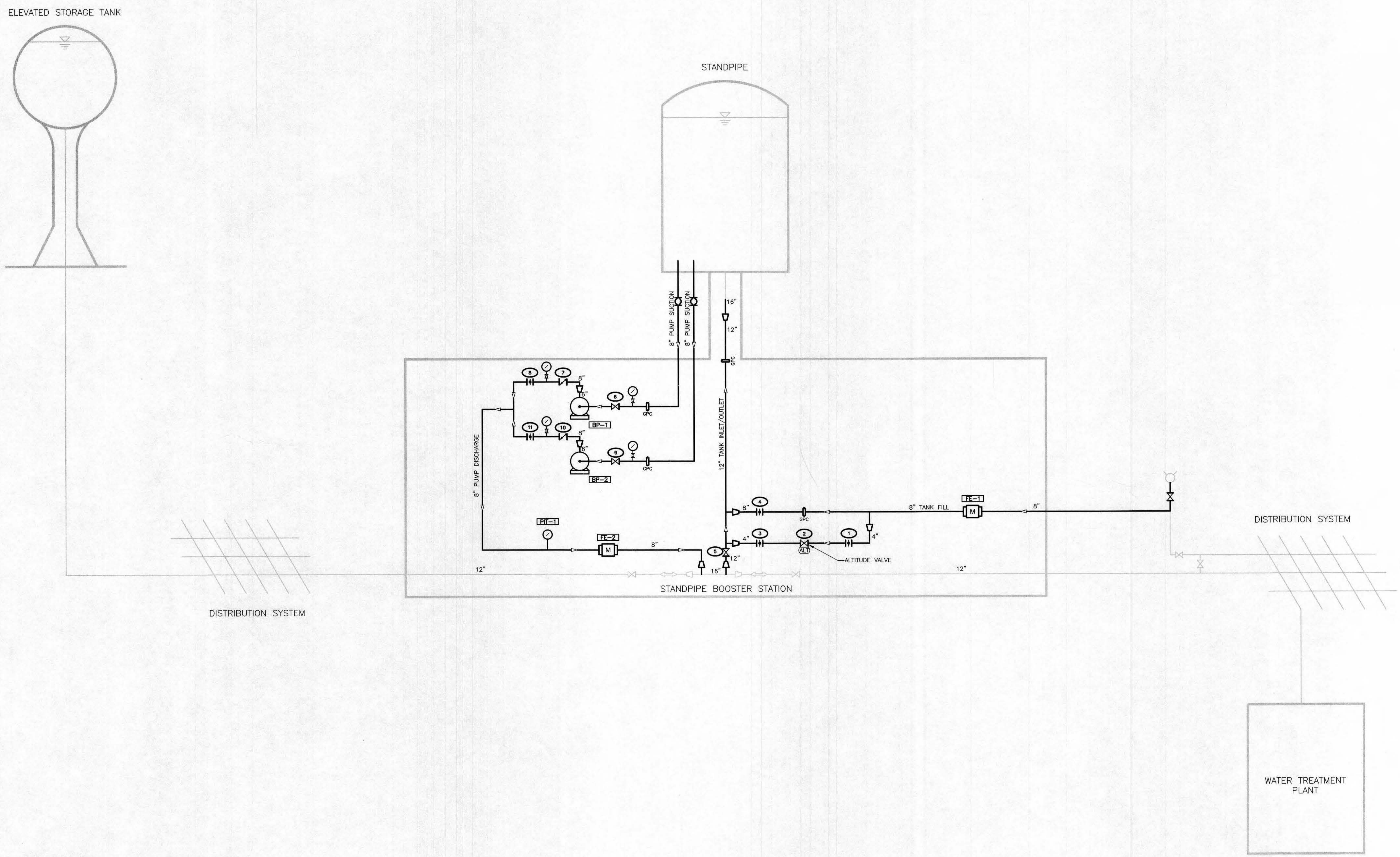
6/27/2008	OWNER & MDEQ REVIEW
6/23/2008	LEVEL 2 REVIEW
6/12/2008	95% COORDINATION

Drawn By	SG
Designer	JME
Reviewer	TDM
Manager	JW

Hard copy is intended to be 24"x36" when plotted. Scale(s) indicated and graphic quality may not be accurate for any other size.

PROJECT NO.
G07887CD

FIGURE NO.
P-1



STANDPIPE BOOSTER STATION PROCESS FLOW SCHEMATIC

NO SCALE

PLOT INFO: U:\CADD\07887CD\CD\P00207887CD.DWG DATE: 6/27/2008 TIME: 9:45:37 AM USER: RS2

ftc&h

engineers
scientists
architects
constructors

fishbeck, thompson, carr & huber, inc.

City of Owosso
Shiawassee County, Michigan
Water System Improvements

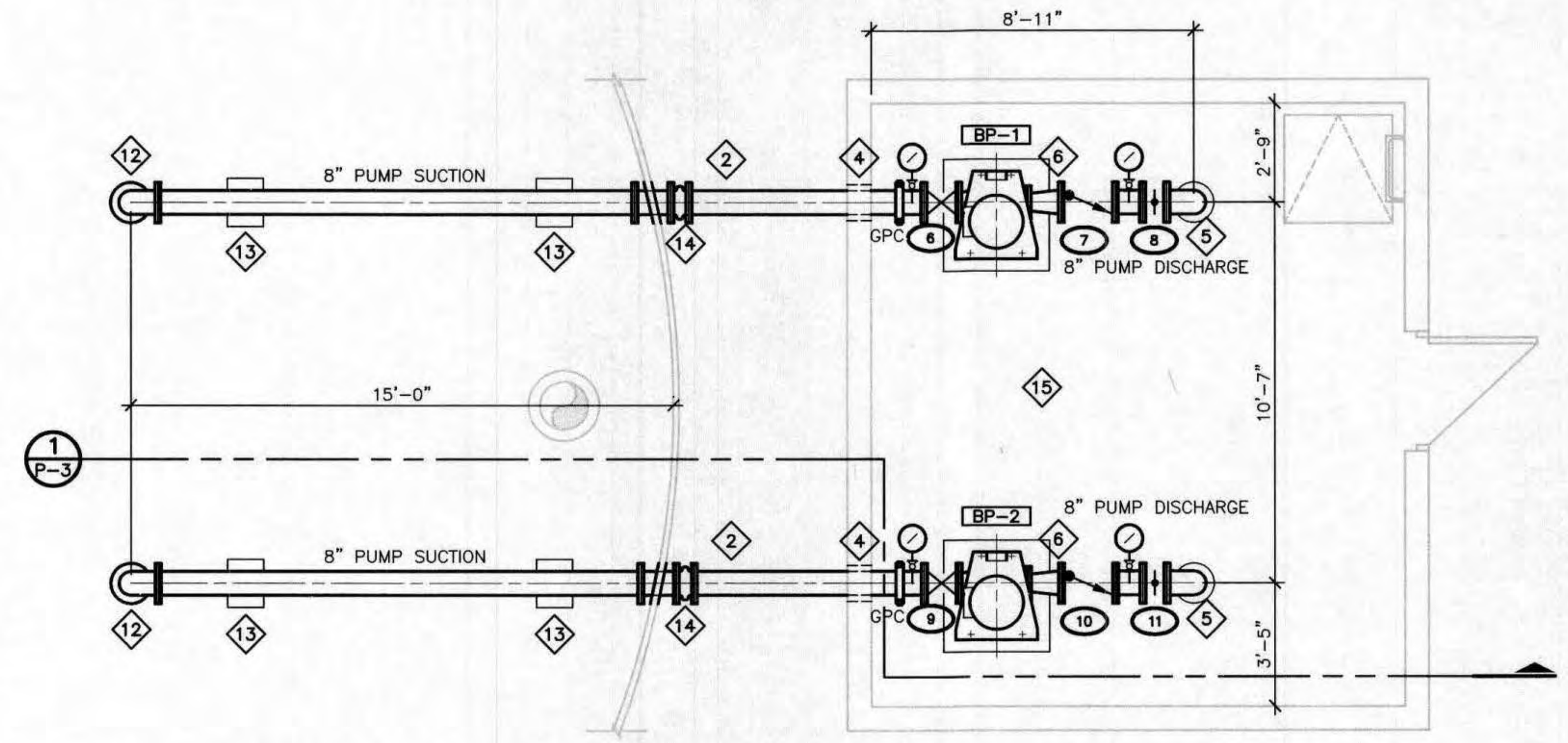
6/27/2008	OWNER & MDEQ REVIEW
6/23/2008	LEVEL 2 REVIEW
6/12/2008	95% COORDINATION

Drawn By	JME
Designer	JME
Reviewer	TDM
Manager	JW

Hard copy is intended to be 24"x36" when plotted. Scale(s) indicated and graphic quality may not be accurate for any other size.

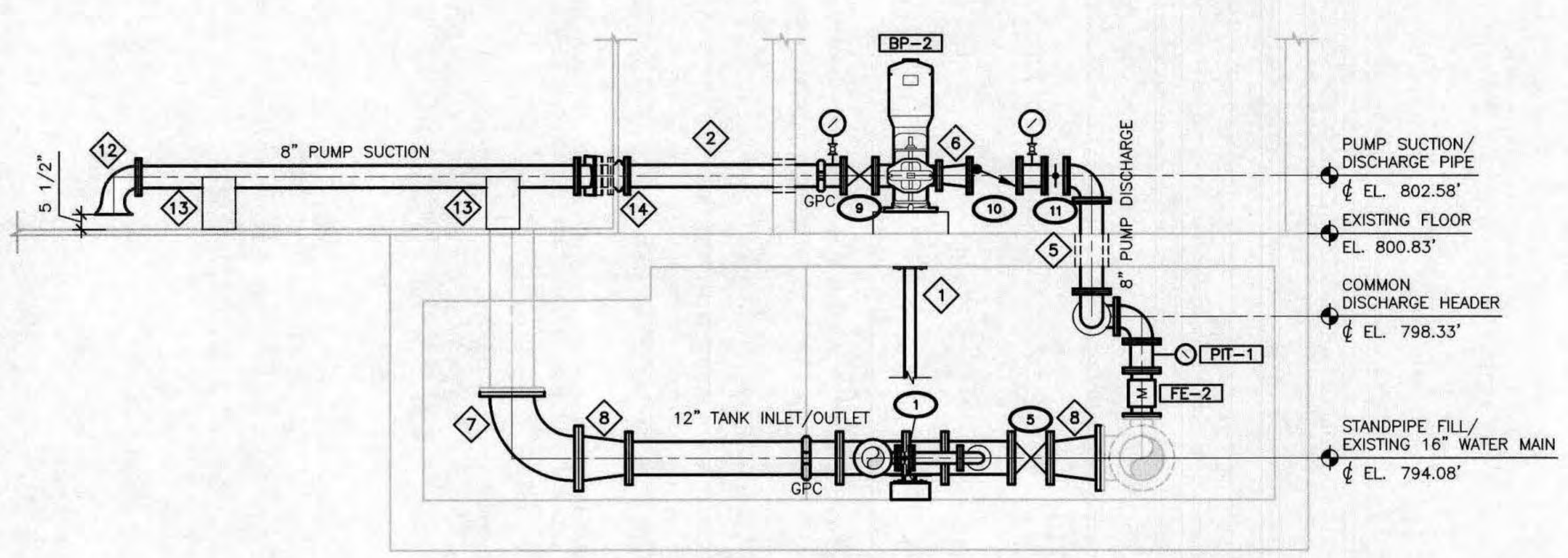
PROJECT NO.
G07887CD

SHEET NO.
P-2

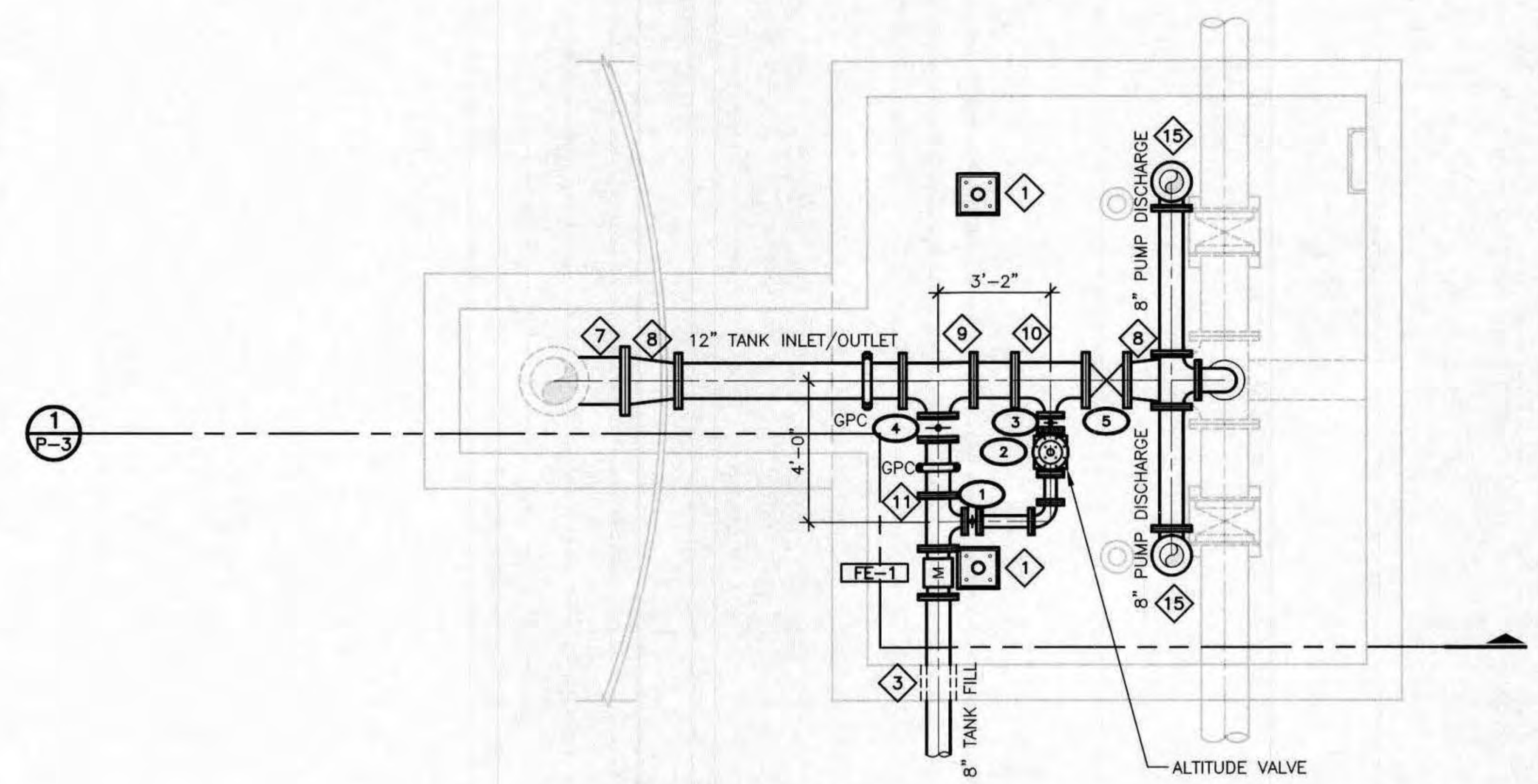


STANDPIPE BOOSTER STATION
UPPER LEVEL PIPING PLAN
SCALE: 1/4" = 1'–0"

NORTH



1 P-3 **SECTION**
SCALE: 1/4" = 1'–0"



STANDPIPE BOOSTER STATION
LOWER LEVEL PIPING PLAN
SCALE: 1/4" = 1'–0"

KEY NOTES

1. PROVIDE GALVANIZED 4" DIAMETER STANDARD STEEL PIPE COLUMN WITH TOP AND BOTTOM PLATES 3/4" X 12" X 12" AND (4) 5/8" ø ANCHORS. SHIM AND GROUT COLUMN SOLID TO UNDERSIDE OF SLAB. PROVIDE 14" X 14" X 6" HIGH CONCRETE BASE FOR COLUMN SUPPORT. DOWEL TO FLOOR WITH (4) #4 DOWELS.
2. HEAT TRACE AND INSULATE EXPOSED EXTERIOR PROCESS PIPING
3. CORE NEW PIPE THROUGH EXISTING CONCRETE WALL
4. CORE NEW PIPE THROUGH EXISTING BLOCK AND BRICK WALL
5. CORE NEW PIPE THROUGH EXISTING CONCRETE FLOOR SLAB
6. 8" X 6" CONCENTRIC REDUCER
7. 16" LONG RADIUS 90° ELBOW
8. 16" X 12" CONCENTRIC REDUCER
9. 12" X 8" TEE
10. 12" X 4" TEE
11. 8" X 4" TEE
12. 8" 90° FLANGE AND FLARE ELBOW
13. CONCRETE PIPE SUPPORTS AS NECESSARY TO PROPERLY SUPPORT THE PUMP SUCTION PIPING IN THE STANDPIPE
14. 8" EXPANSION JOINT
15. COORDINATE PIPE LAYOUT WITH ACTUAL PUMP SUPPLIED TO ACCOMMODATE OFFSET BETWEEN SUCTION AND DISCHARGE PIPE THAT MAY BE PROVIDED.

ftc&h
engineers
scientists
architects
constructors
fishbeck, thompson, carr & huber, inc.

City of Owosso
Shiawassee County, Michigan
Water System Improvements

6/27/2008	OWNER & MDEQ REVIEW
6/23/2008	LEVEL 2 REVIEW
6/12/2008	95% COORDINATION

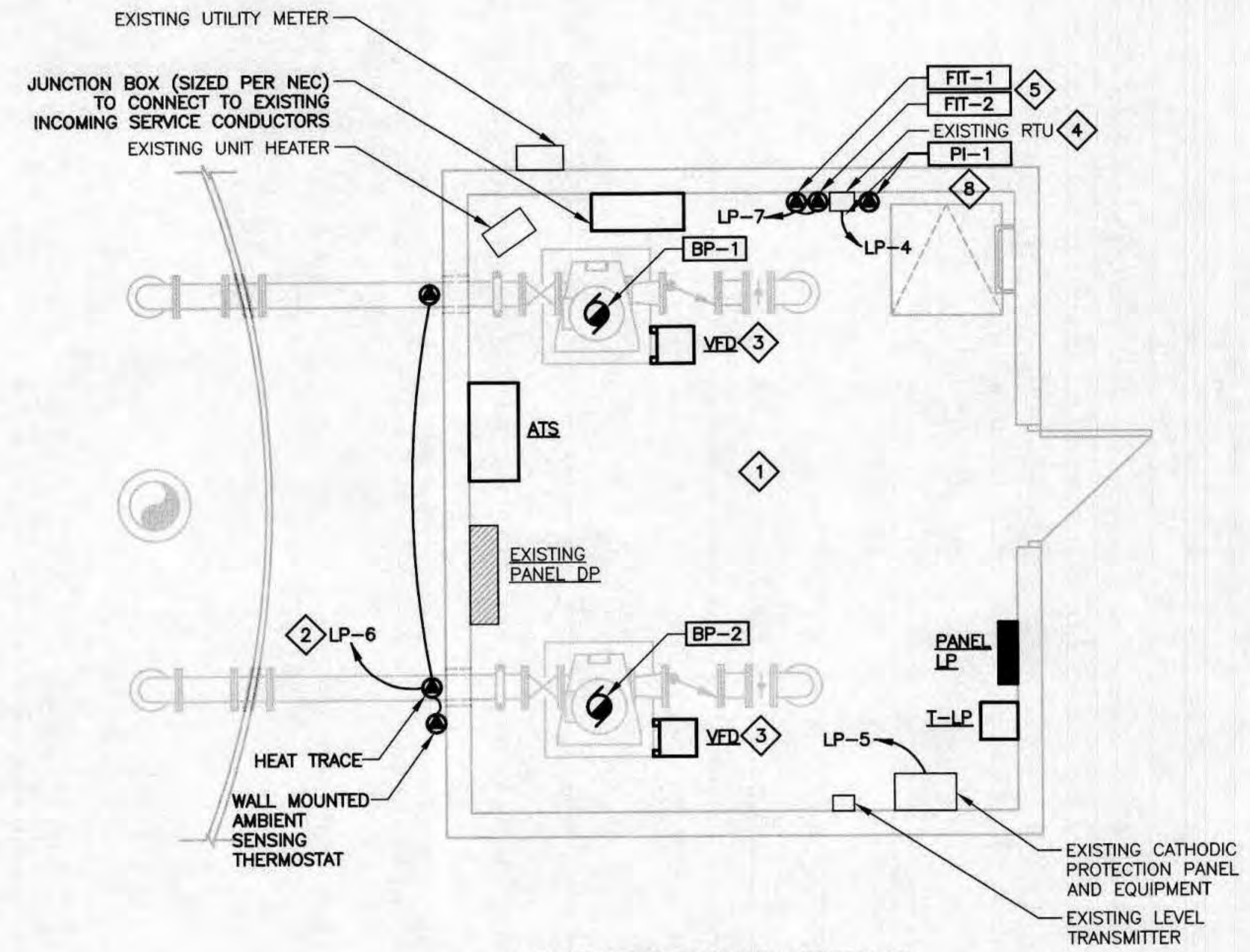
Drawn By	SG
Designer	JME
Reviewer	
Manager	JW

Hard copy is intended to be 24"x36" when plotted. Scale(s) indicated and graphic quality may not be accurate for any other size.

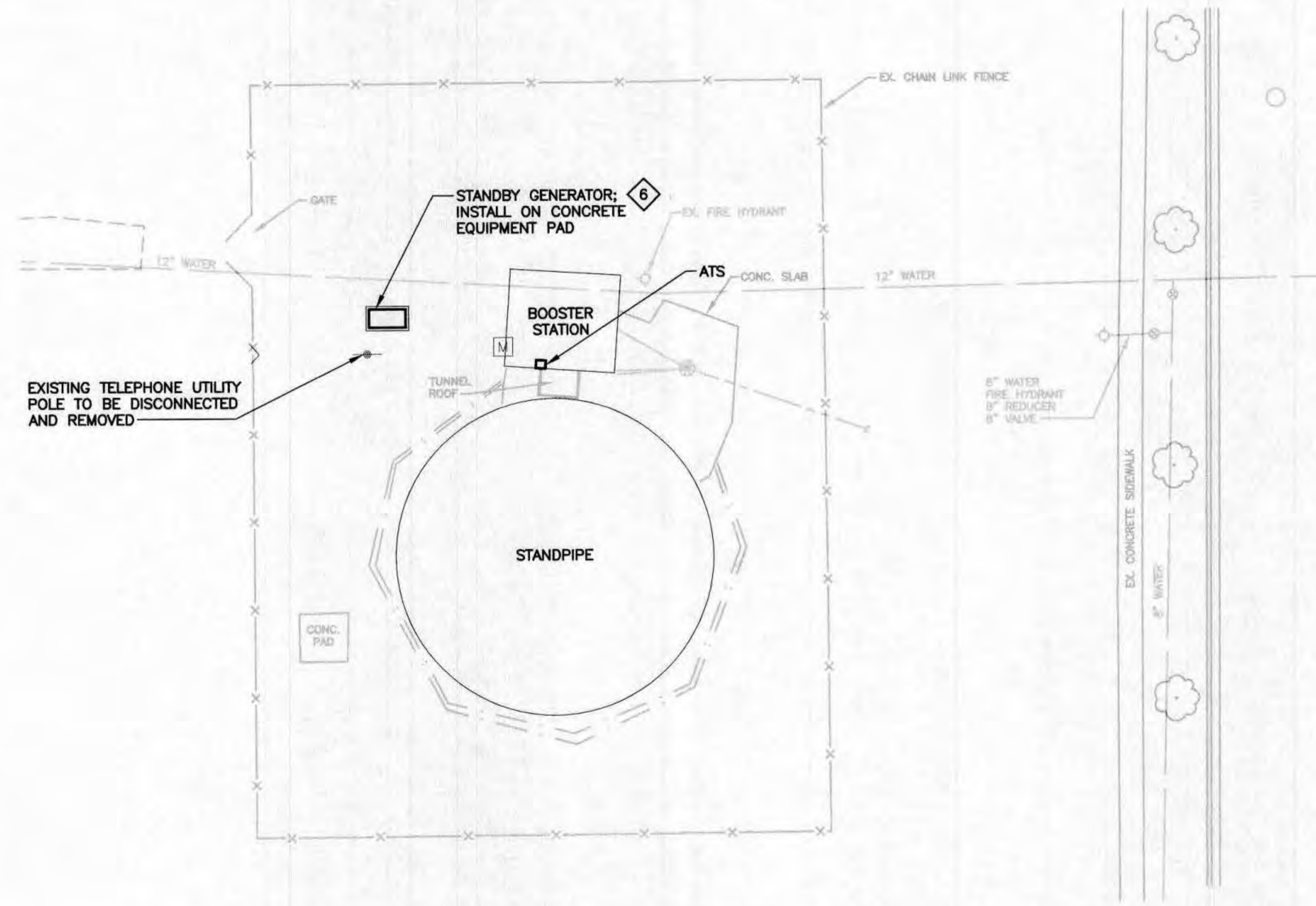
PROJECT NO.
G07887CD

FIGURE NO.
P-3

PLOT INFO: U:\CADD\07887CD\CD\P00307887CD.DWG DATE: 6/27/2008 TIME: 9:45:39 AM USER: RS2



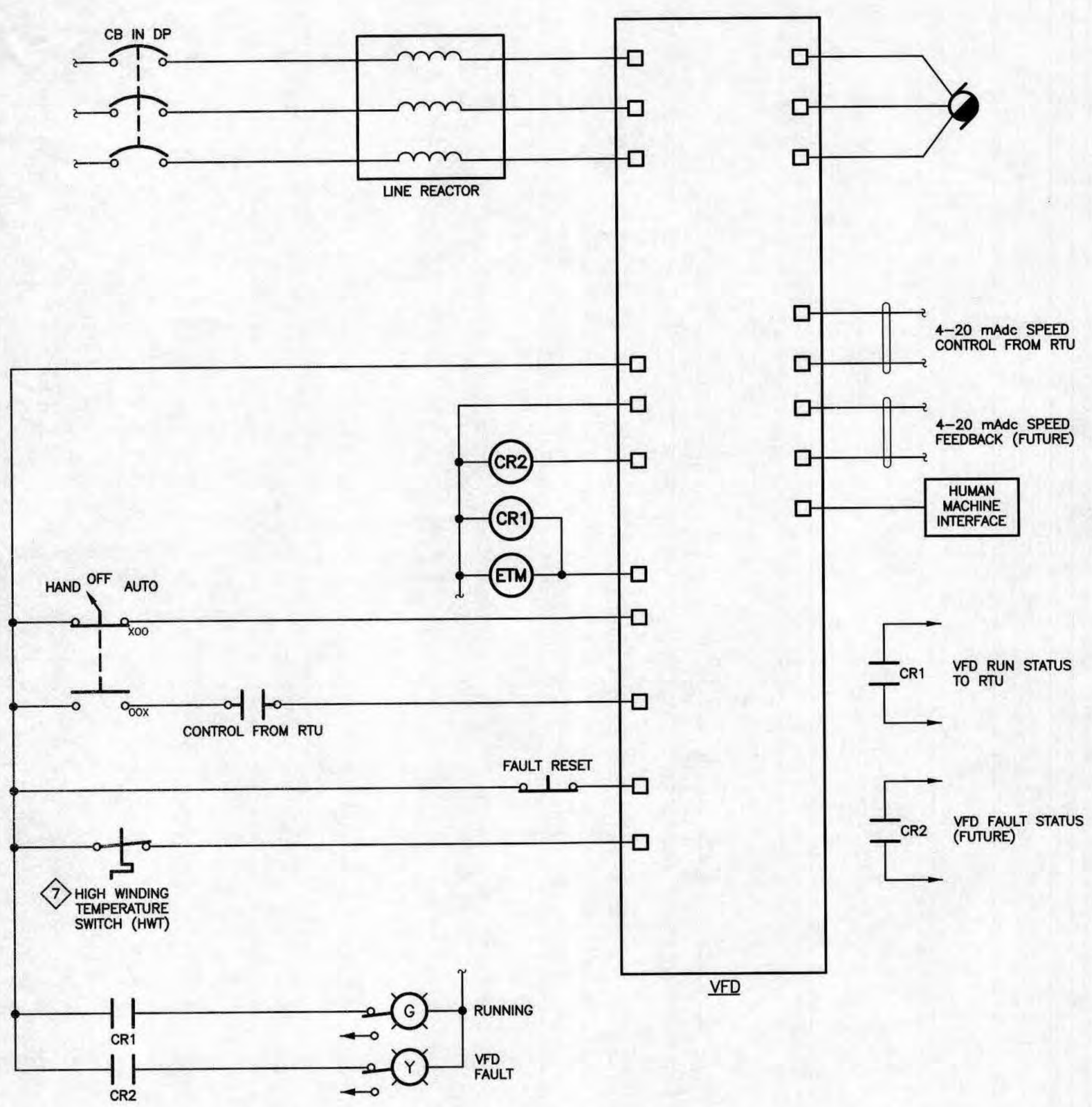
STANDPIPE BOOSTER STATION
POWER PLAN



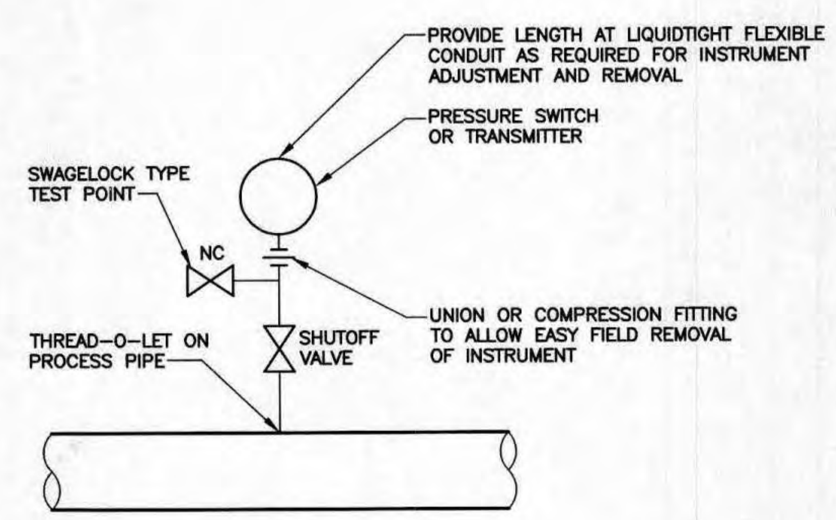
STANDPIPE BOOSTER STATION
ELECTRICAL SITE PLAN

NOTES

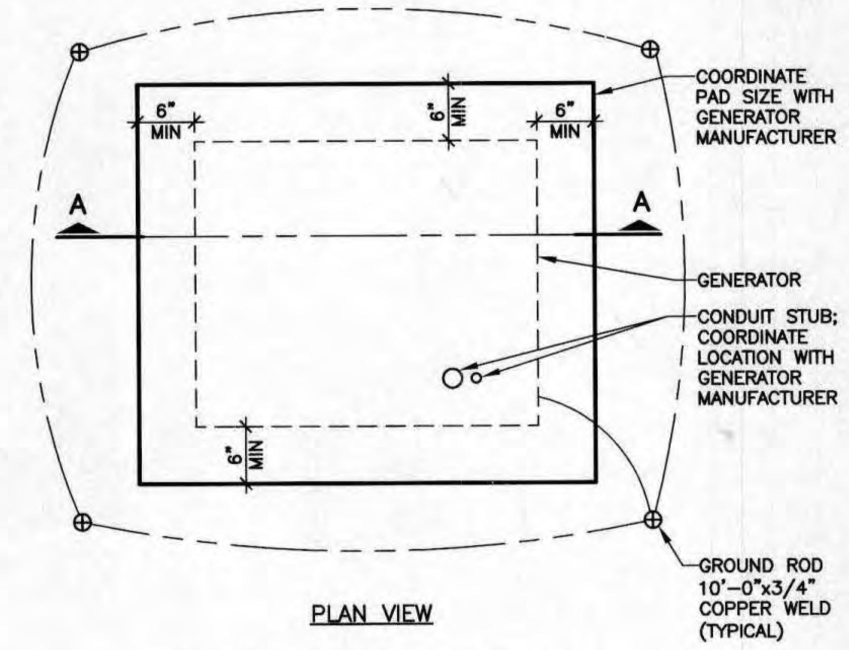
1. CONFIRM EXACT LOCATION TO INSTALL STANDBY GENERATOR WITH OWNER. LOCATE EXISTING UNDERGROUND 480V ELECTRICAL SERVICE PRIOR TO PERFORMING AND WORK.
2. OWNER WILL COORDINATE NATURAL GAS SERVICE FOR STANDBY GENERATOR WITH LOCAL UTILITY COMPANY.
3. COORDINATE RTU WIRING CONNECTIONS WITH OTHERS, THAT ARE UNDER SEPARATE RTU CONTRACT, AND AS DIRECTED BY OWNER.



STANDPIPE BOOSTER STATION – BOOSTER PUMP WIRING DIAGRAM
NO SCALE
TYPICAL FOR BP-1, BP-2

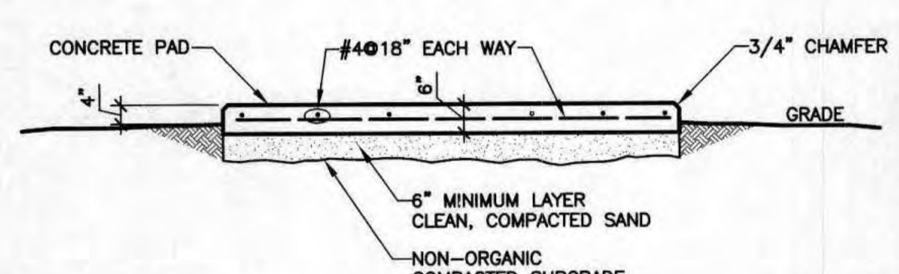


PIPE MOUNTED TRANSMITTER INSTALLATION DETAIL
NO SCALE



PLAN VIEW

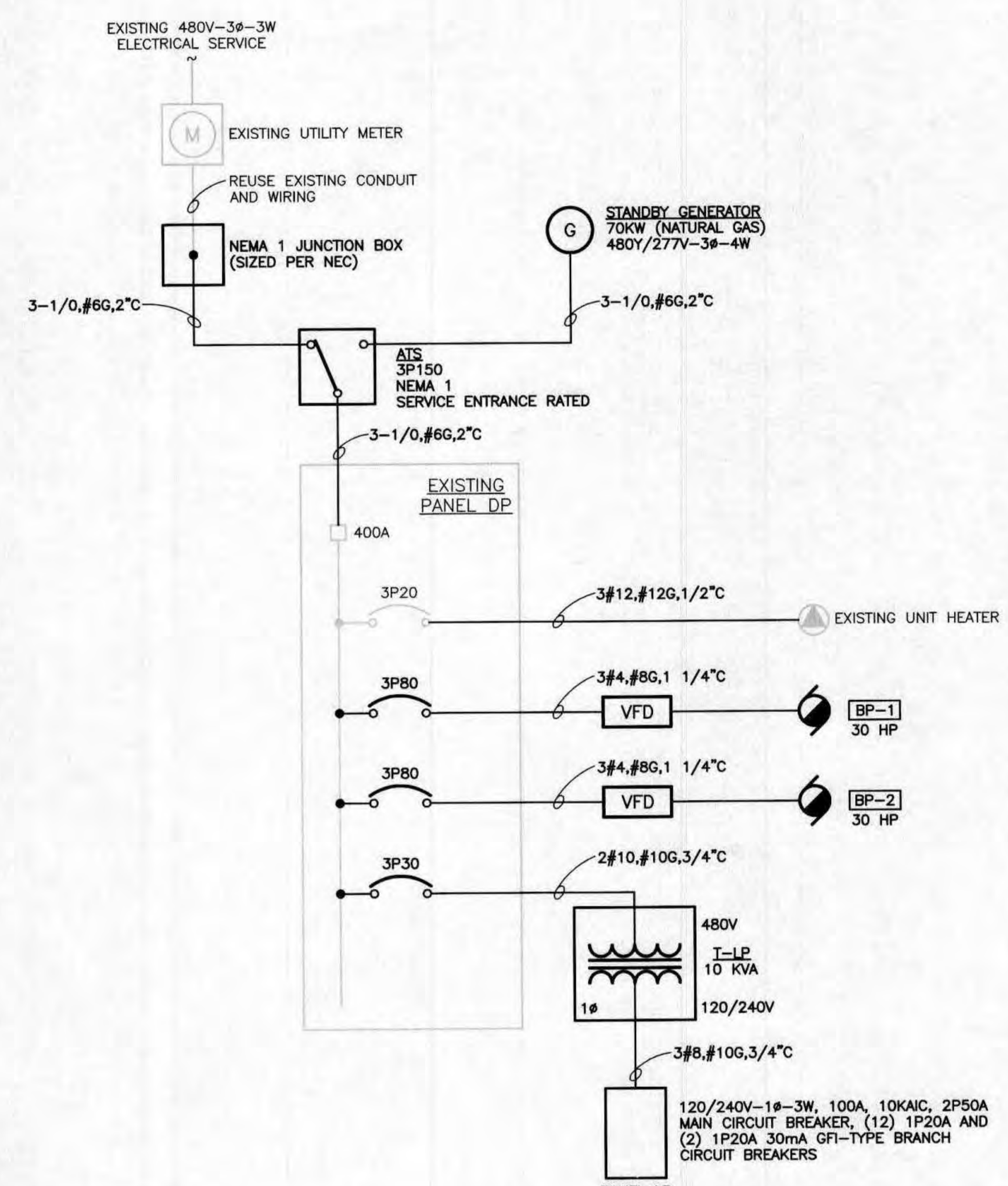
NOTE: PROVIDE GROUNDING TO EQUIPMENT.



SECTION A–A

NOTE: FOLLOW MANUFACTURER'S DRAWINGS FOR SIZE AND ANCHOR BOLT SETTINGS.

CONCRETE EQUIPMENT PAD DETAIL
NO SCALE



STANDPIPE BOOSTER STATION ONE LINE DIAGRAM
480V-3Ø-3W; 120/240V-1Ø-3W

KEY NOTES

1. CIRCUIT EXISTING LIGHTS TO LP-1. CIRCUIT EXISTING EXHAUST FAN AND LOUVER TO LP-2. CIRCUIT EXISTING RECEPTACLES TO LP-3.
2. CIRCUIT HEAT TRACE AND THERMOSTAT TO 1P20A 30mA GFI-TYPE CIRCUIT BREAKER. MOUNT THERMOSTAT APPROXIMATELY 24" ABOVE FINISHED GRADE NEAR PIPE PENETRATION.
3. CONSTRUCT SUPPORT STRUCTURE FOR VFD USING UNISTRUT SUPPORTS; ATTACH TO CONCRETE PUMP BASE.
4. MODIFICATIONS TO EXISTING RTU WILL BE MADE BY OTHERS UNDER SEPARATE CONTRACT WITH OWNER. PROVIDE THE FOLLOWING CONDUIT AND WIRING TO EXISTING RTU FOR I/O SIGNALS: #16TSP,1/2"C FROM BP-1 VFD FOR PUMP SPEED CONTROL (AO), #16TSP,1/2"C FROM BP-2 VFD FOR PUMP SPEED CONTROL (AO), 4#14,1/2"C FROM BP-1 VFD FOR PUMP CONTROL AND RUN STATUS (DO,DI), 4#14,1/2"C FROM BP-2 VFD FOR PUMP CONTROL AND RUN STATUS (DO,DI), 4#14,1/2"C FROM ALTITUDE VALVE FOR OVERRIDE CLOSE CONTROL AND CLOSED POSITION STATUS (DO,DI), #16TSP,1/2"C FROM FIT-1 FOR FLOW (AI), #16TSP,1/2"C FROM FIT-2 FOR FLOW (AI), #16TSP,1/2"C FROM PIT-1 FOR PRESSURE (AI), #16TSP,1/2"C FROM EXISTING LEVEL TRANSMITTER FOR TANK LEVEL (AI).
5. PROVIDE 1/2"C FROM FIT-1 TO FE-1 AND FIT-2 TO FE-2 WITH MANUFACTURER PROVIDED CABLE. SEE SHEET P-3 FOR EQUIPMENT LOCATIONS. WALL MOUNT TRANSMITTERS AT APPROXIMATELY 50" AFF.
6. CIRCUIT ALTERNATOR HEATER TO LP-8. CIRCUIT BATTERY HEATER AND CHARGER TO LP-9. CIRCUIT COOLANT HEATER TO LP-10. PROVIDE 10#14,1"C CIRCUIT FROM RTU TO ATS AND FROM ATS TO GENERATOR FOR THE FOLLOWING CIRCUITS: REMOTE "CALL TO START" SIGNAL FROM RTU TO GENERATOR, REMOTE "CALL TO START" SIGNAL FROM ATS TO GENERATOR, GENERATOR "RUNNING" SIGNAL FROM GENERATOR TO RTU, GENERATOR "FAULT" SIGNAL FROM GENERATOR TO RTU, REMAINING TO BE SPARE. WIRE "CALL TO START" SIGNALS IN PARALLEL.
7. CONFIGURE VFD TO SHUT DOWN PUMP WHEN HIGH WINDING TEMPERATURE SWITCH OPENS; 2#14,1/2"C.
8. CIRCUIT LOOP POWERED PRESSURE INDICATOR INTO ANALOG SIGNAL LOOP WITH PIT-1 LOCATED ON LOWER LEVEL. SEE SHEET P-3 FOR EQUIPMENT LOCATION. WALL MOUNT INDICATOR AT APPROXIMATELY 50' AFF. PRECISION DIGITAL PD683 OR EQUAL WITH NEMA 4X ENCLOSURE; SUBMIT SHOP DRAWINGS.

ftc&h
engineers
scientists
architects
constructors
fishbeck, thompson, carr & huber, inc.

City of Owosso
Shiawassee County, Michigan
Water System Improvements

6/27/2008	OWNER & MDEQ REVIEW
6/23/2008	LEVEL 2 REVIEW
6/12/2008	95% COORDINATION

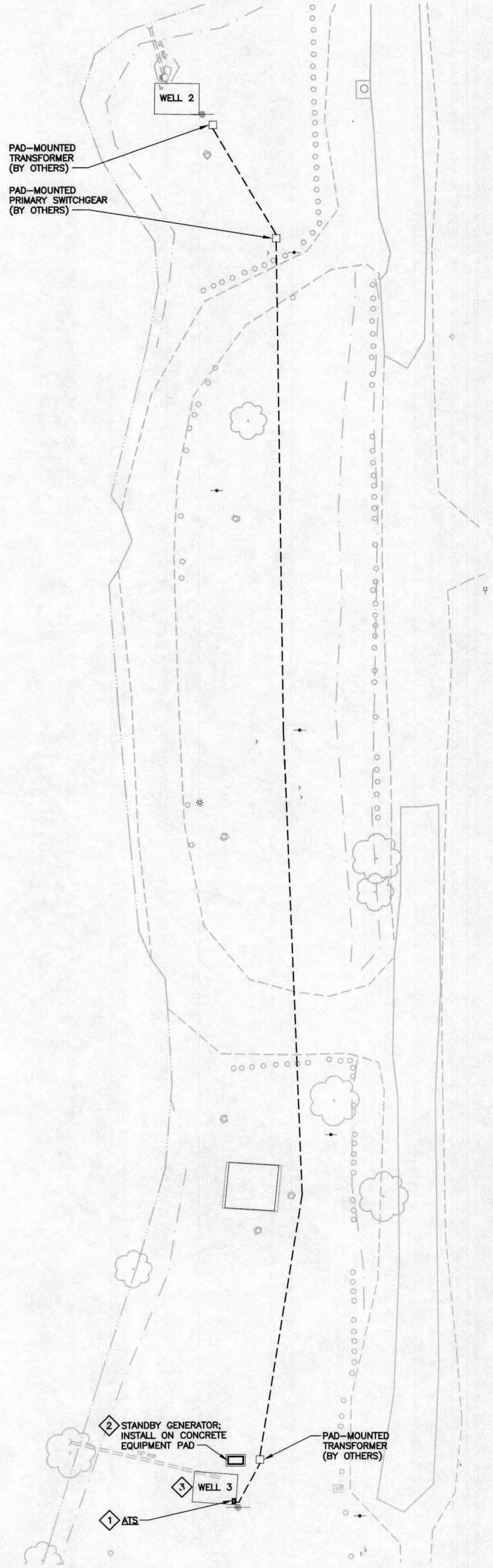
Drawn By	MRF
Designer	JAC
Reviewer	TLM
Manager	JW

Hard copy is intended to be 24"x36" when plotted. Scale(s) indicated and graphic quality may not be accurate for any other size.

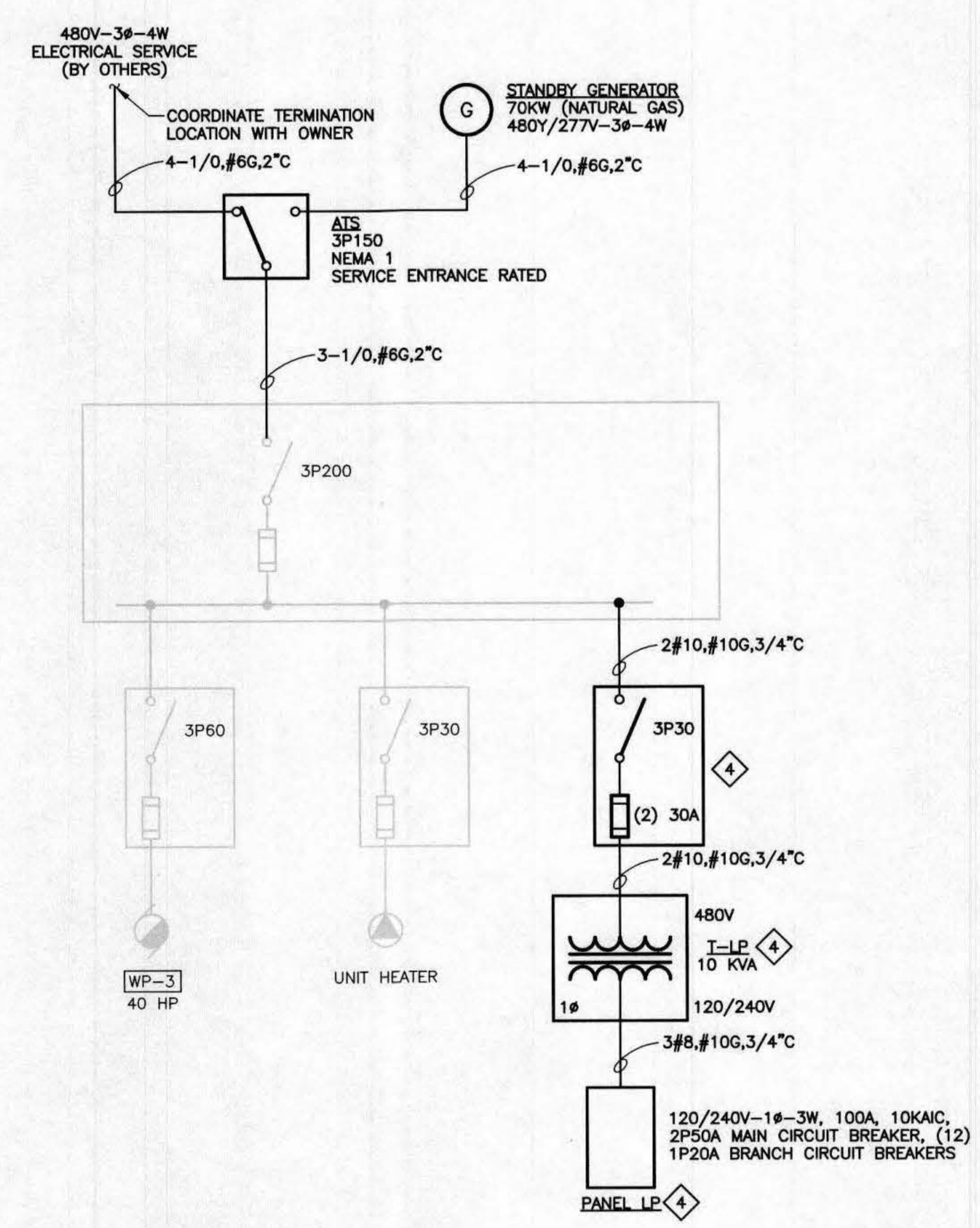
PROJECT NO.
G07887CD

FIGURE NO.
E-1

PLOT INFO: U:\CADD\07887CD\CD\E0010787CD.DWG DATE: 6/27/2008 TIME: 9:42:26 AM USER: MRF



PALMER WELL FIELD
ELECTRICAL SITE PLAN
SCALE: 1" = 30'
0 15 30 60



PALMER WELL FIELD ONE LINE DIAGRAM
480Y/277V-3ø-4W; 120/240-1ø-3W

NOTES

1. OWNER WILL COORDINATE MODIFICATIONS TO EXISTING ELECTRICAL SERVICE(S) WITH LOCAL UTILITY COMPANY. PAD-MOUNTED EQUIPMENT INDICATED IS APPROXIMATE FOR INFORMATION ONLY; WORK WILL BE DONE BY OTHERS UNDER SEPARATE CONTRACT WITH OWNER.
2. OWNER WILL COORDINATE NATURAL GAS SERVICE FOR STANDBY GENERATOR WITH LOCAL UTILITY COMPANY.
3. CONFIRM EXACT LOCATION TO INSTALL STANDBY GENERATOR WITH OWNER.
4. COORDINATE RTU WIRING CONNECTIONS WITH OTHERS, THAT ARE UNDER SEPARATE RTU CONTRACT, AND AS DIRECTED BY OWNER.

KEY NOTES

1. LOCATE ATS IN SOUTHEAST CORNER OF WELL 3 WELLHOUSE ALONG EAST WALL. PROVIDE UNISTRUT SUPPORT RACK SUCH THAT ATS IS NOT SUPPORTED FROM WELLHOUSE WALL.
2. CIRCUIT ALTERNATOR HEATER TO LP-4. CIRCUIT BATTERY HEATER AND CHARGER TO LP-5. CIRCUIT COOLANT HEATER TO LP-6. PROVIDE 10#14,1"C CIRCUIT FROM RTU TO ATS AND FROM ATS TO GENERATOR FOR THE FOLLOWING CIRCUITS: REMOTE "CALL TO START" SIGNAL FROM RTU TO GENERATOR, REMOTE "CALL TO START" SIGNAL FROM ATS TO GENERATOR, GENERATOR "RUNNING" SIGNAL FROM GENERATOR TO RTU, GENERATOR "FAULT" SIGNAL FROM GENERATOR TO RTU, REMAINING TO BE SPARE. WIRE "CALL TO START" SIGNALS IN PARALLEL. MODIFICATIONS TO EXISTING RTU WILL BE MADE BY OTHERS UNDER SEPARATE CONTRACT WITH OWNER.
3. CIRCUIT EXISTING 120V EQUIPMENT TO LP-1, LP-2, AND LP-3. FIELD VERIFY REQUIREMENTS.
4. DISCONNECT AND REMOVE EXISTING DISCONNECT SWITCH, TRANSFORMER AND FUSE BOX. FIELD VERIFY AND COORDINATE NEW LOCATION FOR NEW DISCONNECT SWITCH, TRANSFORMER, AND PANELBOARD WITH OWNER.

ftc&h
engineers
scientists
architects
constructors
fishbeck, thompson, carr & huber, inc.

City of Owosso
Shiawassee County, Michigan
Water System Improvements

6/27/2008	OWNER & MDEQ REVIEW
6/23/2008	LEVEL 2 REVIEW
6/12/2008	95% COORDINATION
Drawn By	MRF
Designer	JAC
Reviewer	TLM
Manager	JW

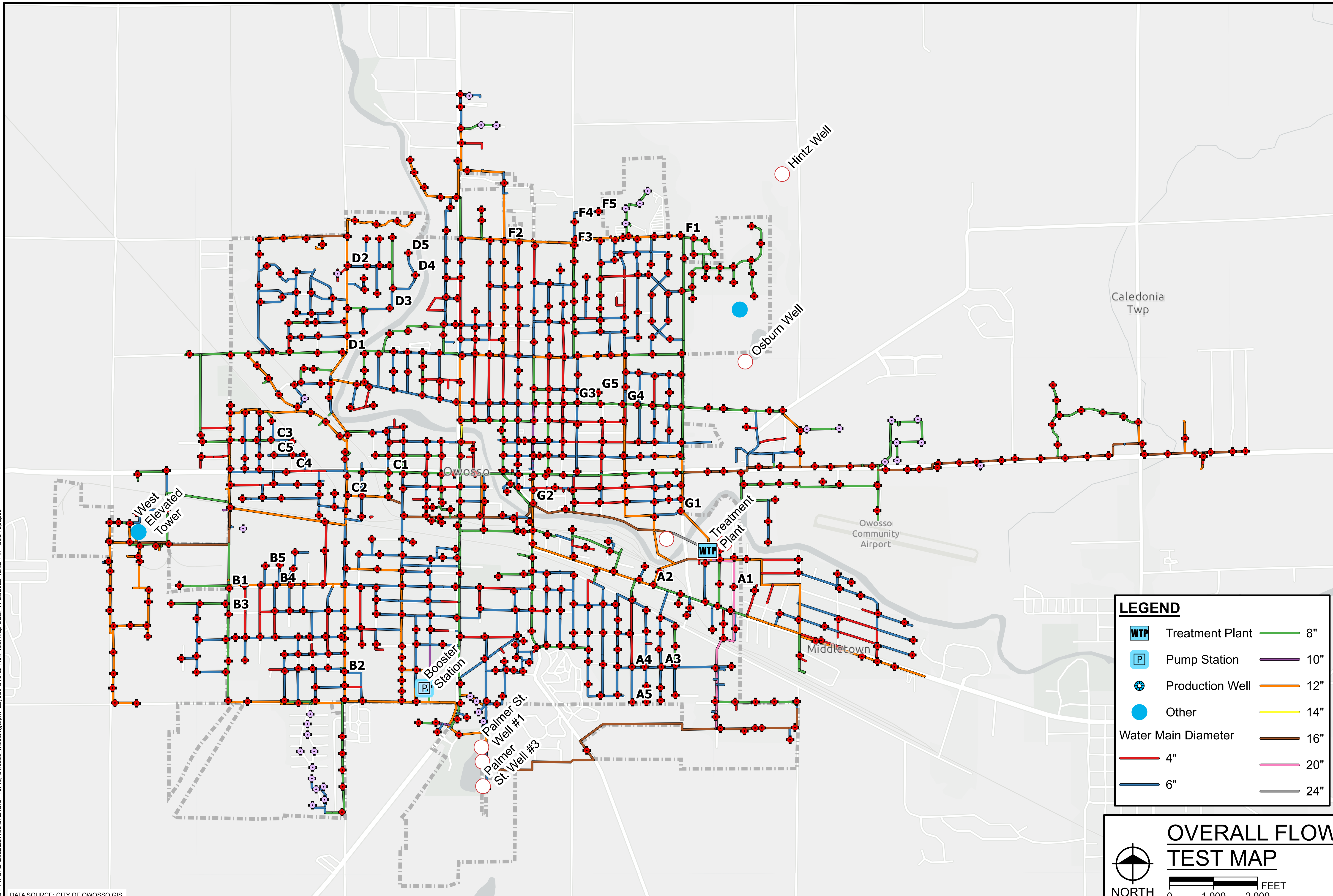
Hard copy is intended to be 24"x36" when plotted. Scale(s) indicated and graphic quality may not be accurate for any other size.

PROJECT NO.
G07887CD

FIGURE NO.
E-2

PLOT INFO: U:\CADD\07887CD\CD\E00207887CD.DWG DATE: 6/27/2008 TIME: 9:44:10 AM USER: MRF

Appendix 5



OVERALL FLOW TEST MAP

fishbeck
Engineers | Architects | Scientists | Constructors

Hard copy is intended to be 11"x17" when plotted. Scale(s) indicated and graphic quality may not be accurate for any other size.

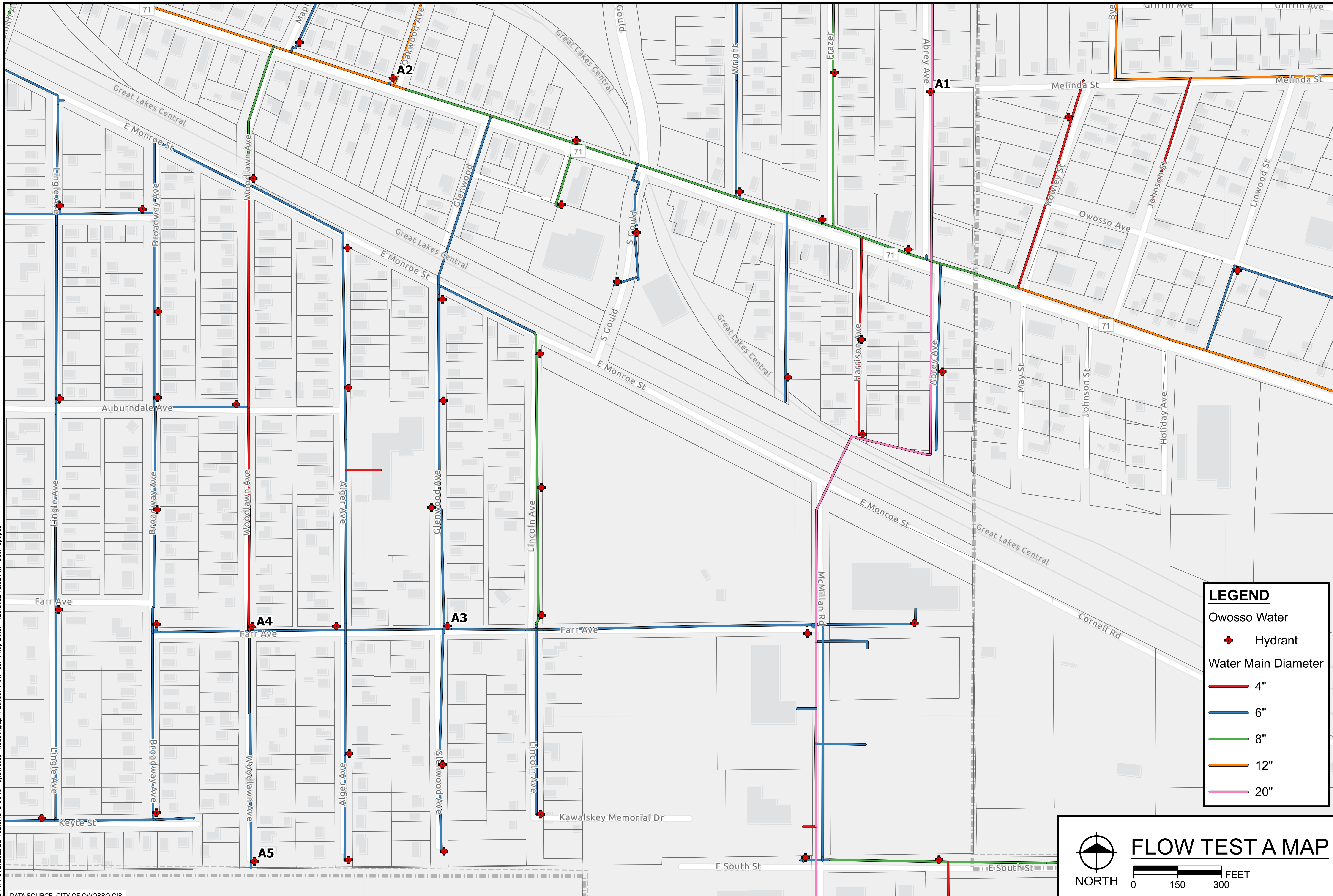
City of Owosso
Shiawassee County, Michigan

Water System Reliability Study

PROJECT NO.
221152

FIGURE NO.
1

PLOT INFO: Z:\2022\221152\CAD\GIS\ProProj\Owosso_Modeling.aprx Layout: Overall Flow Test Map Date: 11/29/2022 12:02 PM User: bpapes



FLOW TEST A MAP

fishbeck

Engineers | Architects | Scientists | Constructors

Hard copy is intended to be 11"x17" when plotted. Scale(s) indicated and graphic quality may not be accurate for any other size.

City of Owosso

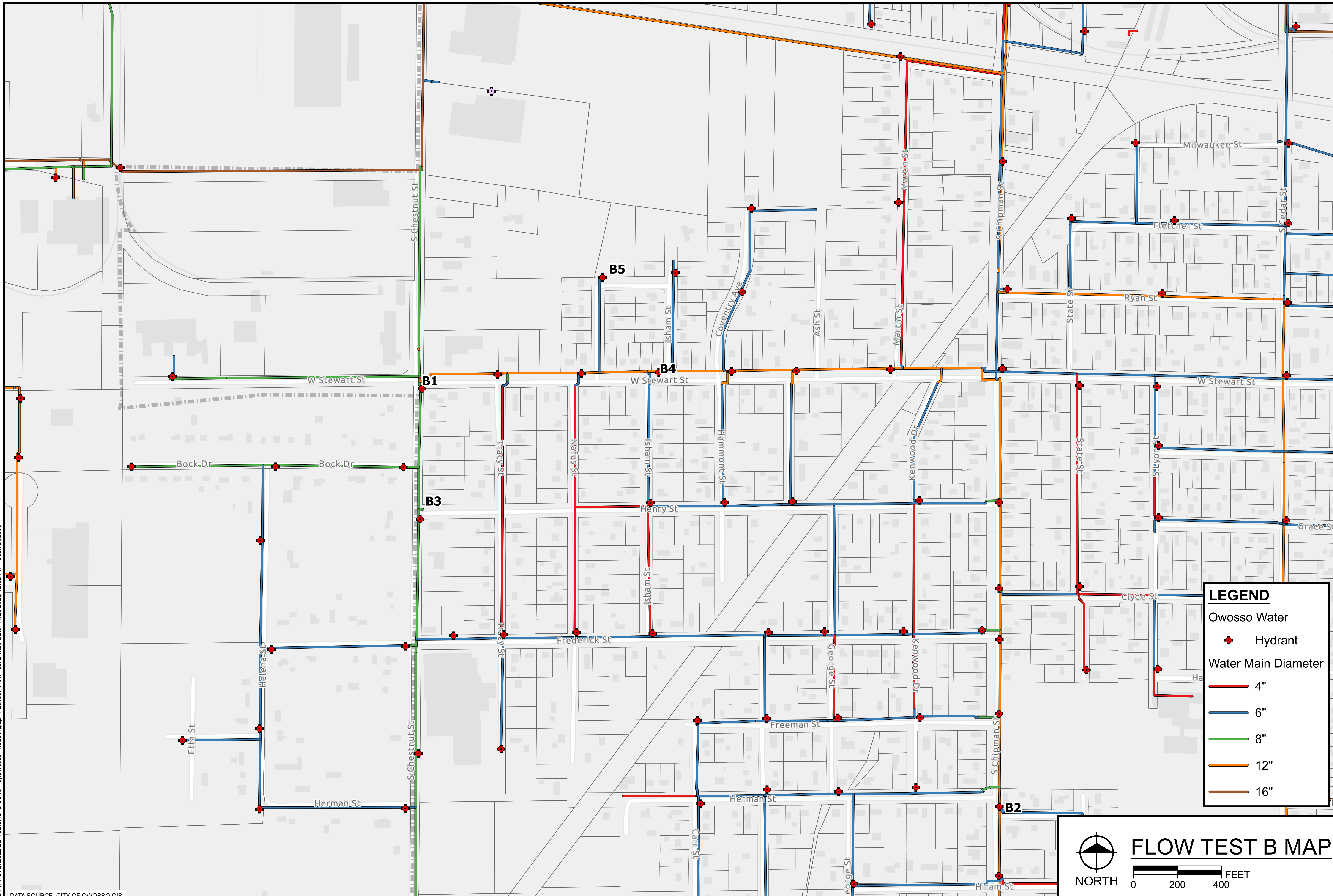
Shiawassee County, Michigan

Water System Reliability Study

PROJECT NO.
221152

FIGURE NO.
2

PLOT INFO: Z:\2022\221152\CAD\GIS\ProProj\Owosso_Modeling.aprx Layout: Flow Test A Map Date: 11/29/2022 12:02 PM User: bpapes



PLOT INFO: Z:\2022\221152\CAD\GIS\ProProj\Owosso_Modeling.aprx Layout: Flow Test B Map Date: 11/29/2022 12:02 PM User: bpapes

fishbeck
Engineers | Architects | Scientists | Constructors

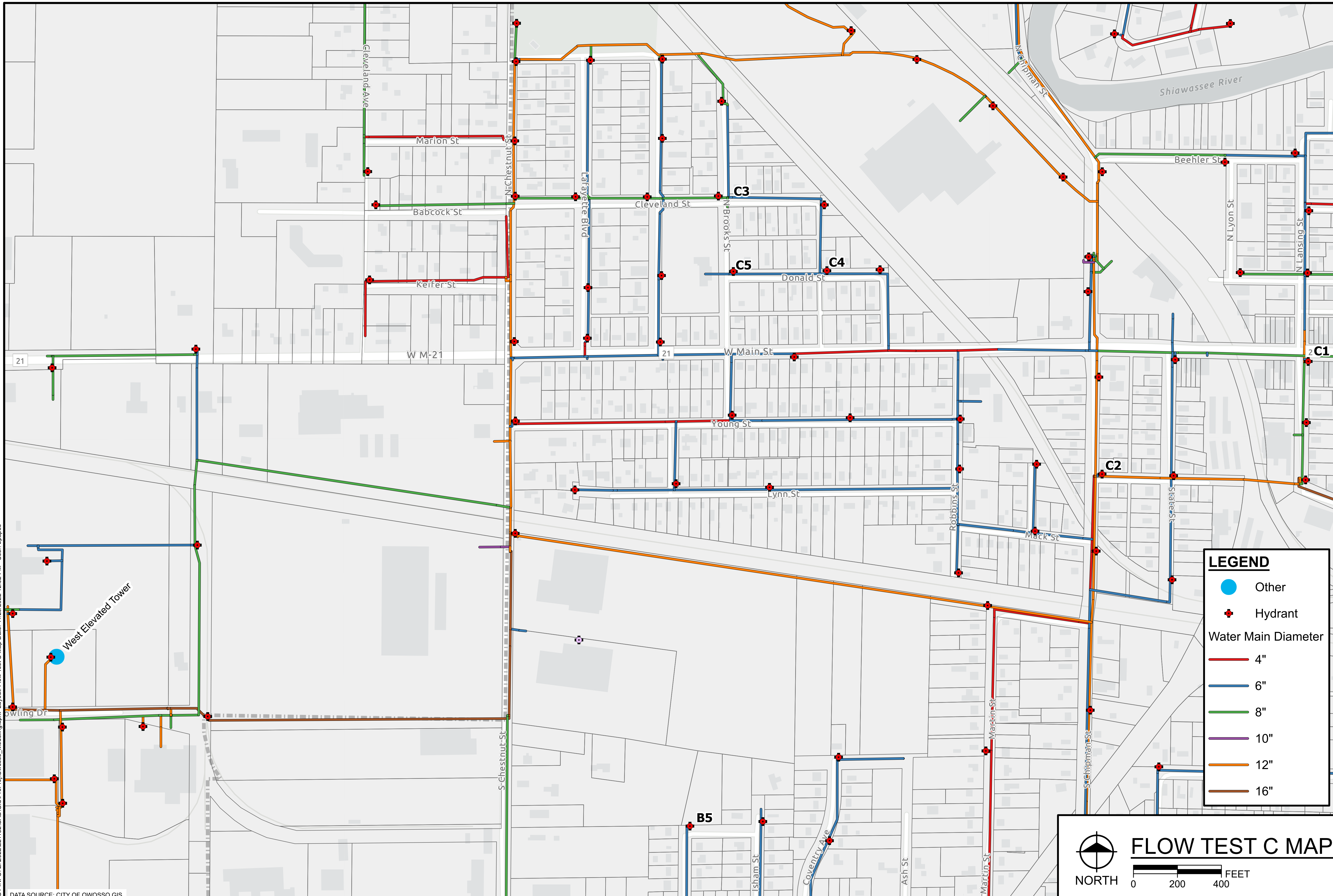
Hard copy is intended to be 11"x17" when plotted. Scale(s) indicated and graphic quality may not be accurate for any other size.

City of Owosso
Shiawassee County, Michigan

Water System Reliability Study

PROJECT NO.
221152

FIGURE NO.
3



PLOT INFO: Z:\2022\221152\CAD\GIS\Pro\Owosso_Modeling.aprx Layout: Flow Test C Map Date: 11/29/2022 12:02 PM User: bpapes

fishbeck
Engineers | Architects | Scientists | Constructors

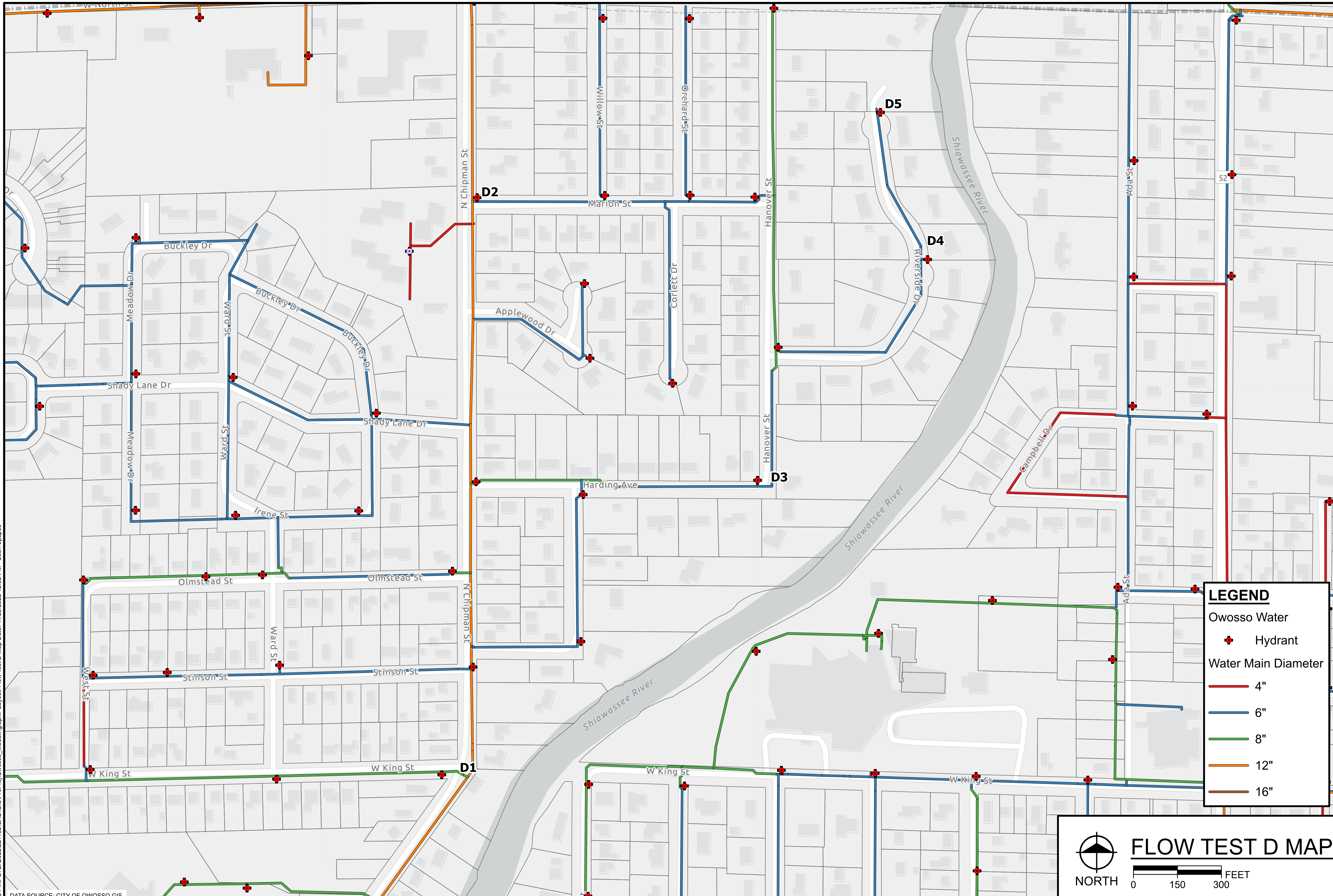
Hard copy is intended to be 11"x17" when plotted. Scale(s) indicated and graphic quality may not be accurate for any other size.

City of Owosso
Shiawassee County, Michigan

Water System Reliability Study

PROJECT NO.
221152

FIGURE NO.
4



fishbeck
Engineers | Architects | Scientists | Constructors

Hard copy is intended to be 11"x17" when plotted. Scale(s) indicated and graphic quality may not be accurate for any other size.

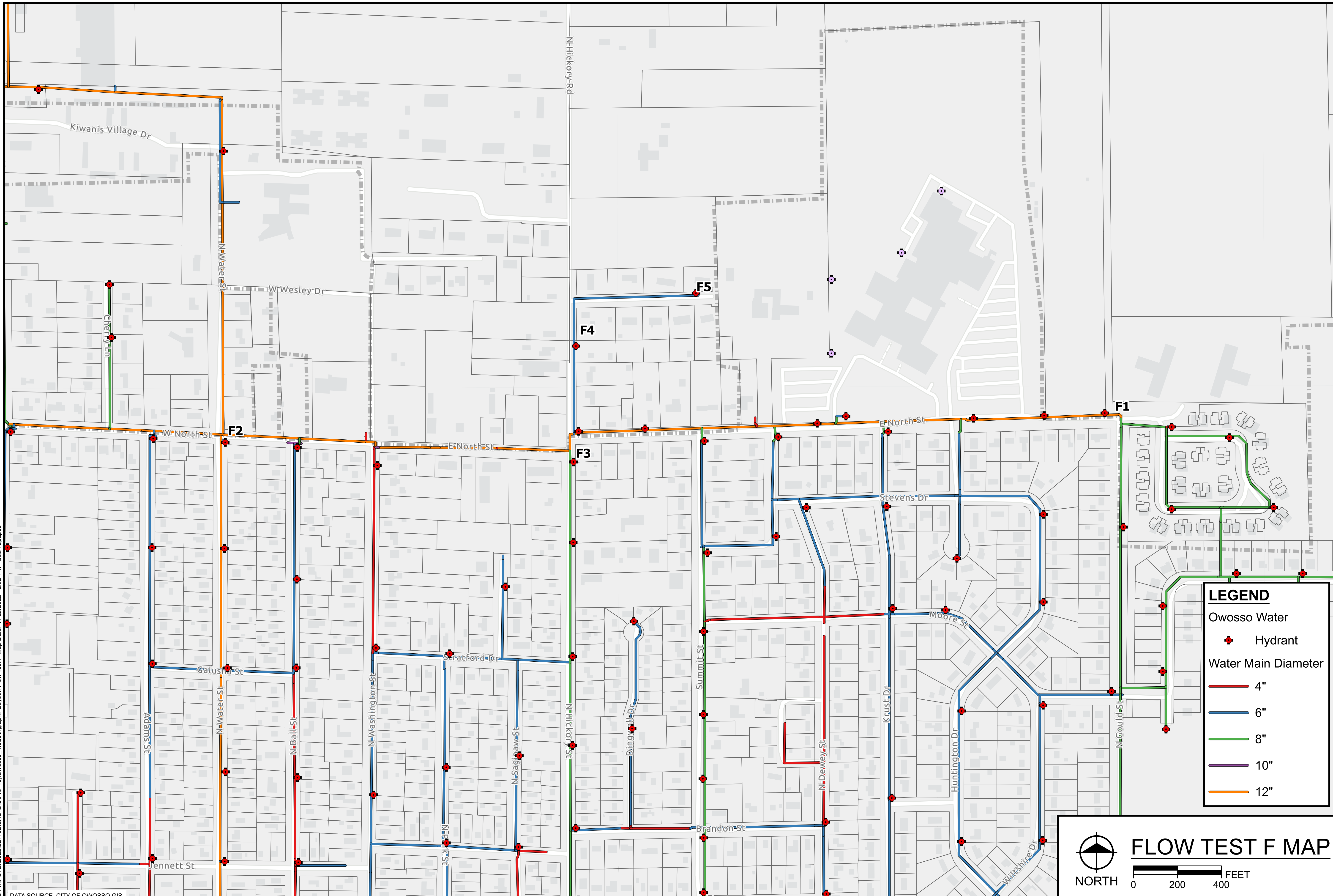
City of Owosso
Shiawassee County, Michigan

Water System Reliability Study

PROJECT NO.
221152

FIGURE NO.
5

PLOT INFO: Z:\2022\221152\CAD\GIS\Pro\Owosso_Modeling.aprx Layout: Flow Test D Map Date: 11/29/2022 12:02 PM User: bpapes



FLOW TEST F MAP

fishbeck
Engineers | Architects | Scientists | Constructors

Hard copy is intended to be 11"x17" when plotted. Scale(s) indicated and graphic quality may not be accurate for any other size.

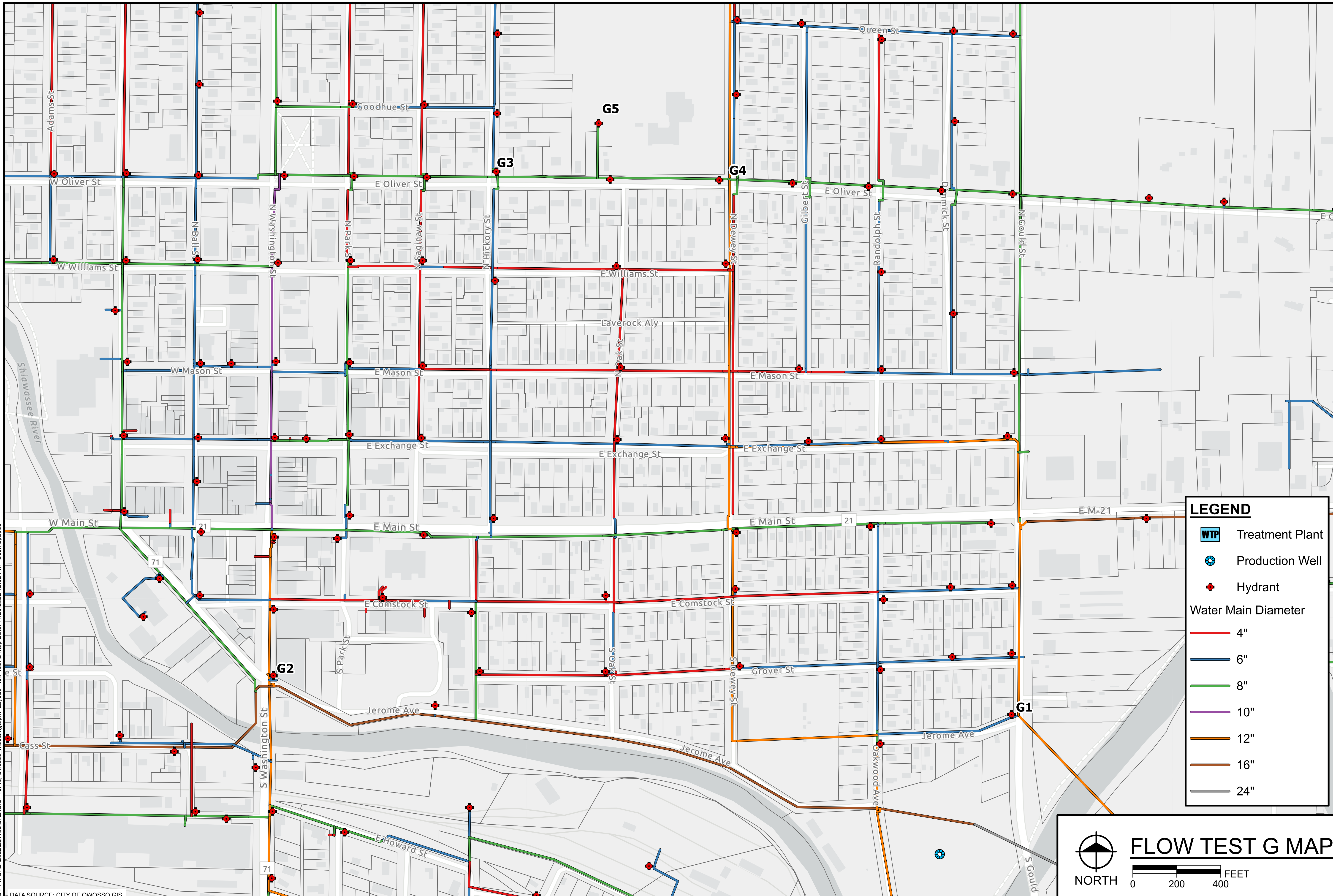
City of Owosso
Shiawassee County, Michigan

Water System Reliability Study

PROJECT NO.
221152

FIGURE NO.
6

PLOT INFO: Z:\2022\221152\CAD\GIS\ProProj\Owosso_Modeling.aprx Layout: Flow Test F Map Date: 11/29/2022 12:02 PM User: bnapes



fishbeck
Engineers | Architects | Scientists | Constructors

Hard copy is intended to be 11"x17" when plotted. Scale(s) indicated and graphic quality may not be accurate for any other size.

City of Owosso
Shiawassee County, Michigan

Water System Reliability Study

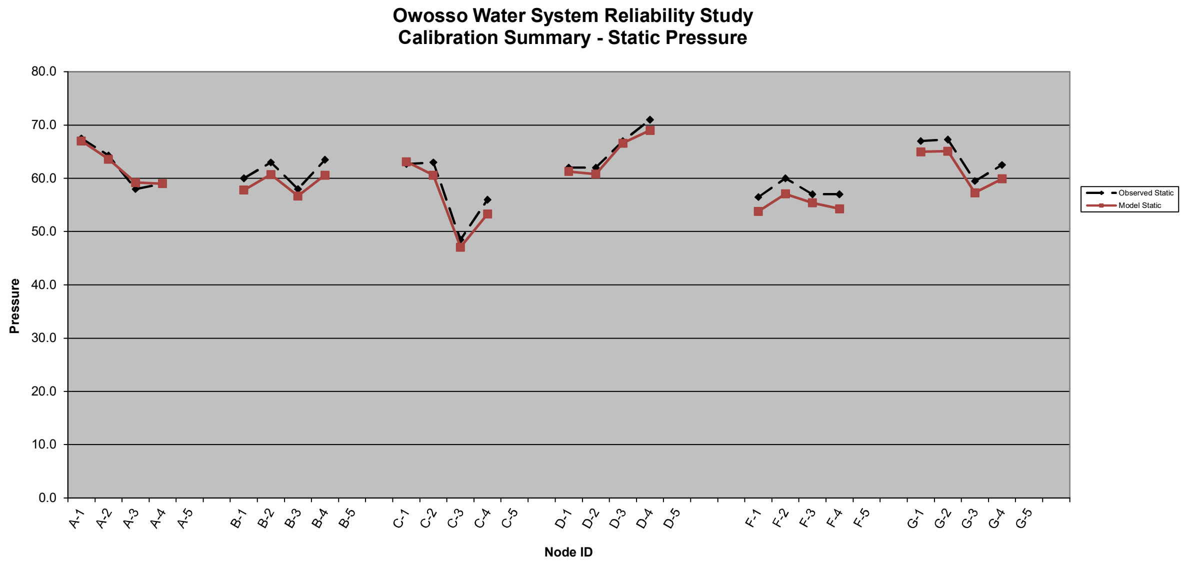
PROJECT NO.
221152

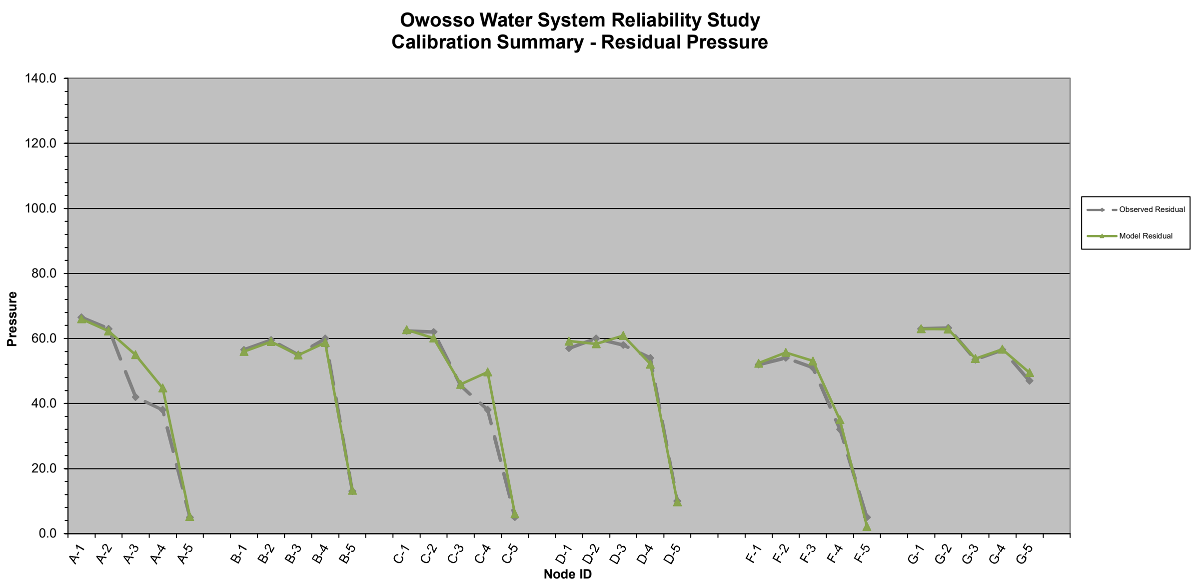
FIGURE NO.
7

PLOT INFO: Z:\2022\221152\CAD\GIS\ProProj\Owosso_Modeling.aprx Layout: Flow Test G Map Date: 11/29/2022 12:02 PM User: bpapes

Appendix 6

Owosso Reliability Study
Calibration Spreadsheet
Project No. 221152





Owosso Reliability Study
Calibration Spreadsheet
Project No. 221152

Model Node ID	Field Observed Static Hyd Pressure (psi)	Field Observed Residual Hyd Pressure (psi)	Field Observed Hyd Flow (gpm)	Trial 1 Model Static Pressure (PSI)	Trial 1 Static Pressure difference (PSI)	Trial 1 Model Residual Pressure (PSI)	Trial 1 Residual Pressure difference (PSI)	Trial 8 Model Static Pressure (PSI)	Trial 8 Static Pressure difference (PSI)	Trial 8 Model Residual Pressure (PSI)	Trial 8 Residual Pressure difference (PSI)
A-1	67.5	66.5		73.8	-6.3	66.4	0.1	67.0	0.5	66.0	0.5
A-2	64.3	63.0		70.4	-6.1	63.0	0.0	63.6	0.7	62.3	0.7
A-3	58.0	42.0		66.1	-8.1	58.0	-16.0	59.2	-1.2	55.0	-13.0
A-4	59.0	38.0		65.8	-6.8	56.4	-18.4	59.0	0.0	44.8	-6.8
A-5	-	5.0	1067.2	-	-	38.6	-33.6	-	-	5.3	-0.3
B-1	60.0	56.5		60.7	-0.7	56.2	0.3	57.9	2.1	56.0	0.5
B-2	63.0	59.5		63.7	-0.7	59.3	0.2	60.8	2.2	59.0	0.5
B-3	58.0	55.0		59.6	-1.6	55.1	-0.1	56.8	1.2	54.9	0.1
B-4	63.5	60.0		62.9	0.6	58.5	1.5	60.7	2.8	58.7	1.3
B-5	-	13.0	430.2	-	-	43.2	-30.2	-	-	13.3	-0.3
C-1	62.7	62.3		70.1	-7.4	63.4	-1.1	63.1	-0.4	62.7	-0.4
C-2	63.0	62.0		67.4	-4.4	60.9	1.1	60.7	2.3	60.1	1.9
C-3	48.5	45.5		53.9	-5.4	47.6	-2.1	47.0	1.5	45.9	-0.4
C-4	56.0	38.0		59.0	-3.0	52.7	-14.7	53.3	2.7	49.7	-11.7
C-5	-	5.0	266.8	-	-	45.9	-40.9	-	-	6.1	-1.1
D-1	62.0	57.0		67.7	-5.7	63.2	-6.2	61.2	0.8	59.2	-2.2
D-2	62.0	60.0		67.3	-5.3	62.5	-2.5	60.8	1.2	58.4	1.6
D-3	67.0	58.0		73.1	-6.1	66.7	-8.7	66.6	0.4	60.9	-2.9
D-4	71.0	54.0		75.5	-4.5	46.5	7.5	69.0	2.0	52.1	1.9
D-5	-	10.0	377.3	-	-	31.5	-21.5	-	-	9.7	0.3
F-1	56.5	52.0		57.0	-0.5	54.0	-2.0	53.8	2.7	52.4	-0.4
F-2	60.0	54.0		60.3	-0.3	57.3	-3.3	57.1	2.9	55.7	-1.7
F-3	57.0	51.0		57.7	-0.7	54.7	-3.7	54.5	2.5	53.1	-2.1
F-4	57.0	32.0		57.6	-0.6	52.1	-20.1	54.3	2.7	35.0	-3.0
F-5	-	5.0	266.8	-	-	46.9	-41.9	-	-	2.1	2.9
G-1	67.0	63.0		75.5	-8.5	70.8	-7.8	65.0	2.0	63.0	0.0
G-2	67.3	63.3		75.1	-7.8	70.3	-7.0	65.1	2.2	62.9	0.4
G-3	59.5	53.5		67.5	-8.0	61.9	-8.4	57.4	2.1	53.8	-0.3
G-4	62.5	56.5		70.1	-7.6	64.7	-8.2	59.9	2.6	56.7	-0.2
G-5	-	47.0	818.0	-	-	62.9	-15.9	-	-	49.5	-2.5

Appendix 7

City of Owosso
Owosso Reliability Study
Project No:221152

5-Year Water Main Improvements					
Project number	Description/Location	Diameter (in)	Completion Year	Length of Main (ft)	Estimated Cost
1*	Replace 12" main on North St from N Shiawassee St to Hickory St	12	2023	2,000	$ 996,000
2*	Replace 4" main on Lynn St from Howell to west end	6	2023	275	$ 93,000
3*	Replace 1.5" main on Huron St from Huggins to east end	8	2023	310	$ 113,000
4*	Replace 4" main on Lee St from Clark to Ada	8	2023	370	$ 135,000
5*	Replace 6" and 4" main on Clyde St from Walnut St to Shiawassee St	6	2023	665	$ 224,000
6	Replace 12" main on Dewey St from Main St to King St	12	2024	2,600	$ 1,294,000
7	Replace 4" main on Young St from S Chestnut St to S Brooks St	8	2024	950	$ 347,000
8	Replace 4" main on Tracy St from Frederick St to W Stewart St	8	2024	1,140	$ 416,000
9	Replace 6" main on Nafus St from W Stewart St north to dead end	8	2024	430	$ 157,000
10	Replace 4" main on Dingwall Dr	8	2024	720	$ 263,000
11	Replace 6" main on Huntington Dr from Moore St to Stevens Dr	8	2025	660	$ 241,000
12	Replace 4" main on Brandon St from Hickory St to Summit St	8	2025	450	$ 164,000
13	Replace 8" main on Gould St from Exchange St to Huntington Dr	12	2025	2,720	$ 1,354,000
14	Replace 4" main on Jennett St from N Shiawassee St to Adams St	8	2025	600	$ 219,000
15	Replace 6" main on Grace St from Cedar St to Shiawassee St	8	2025	940	$ 343,000
16	Replace 6" main on Stinson St from West St to Chipman St	8	2026	610	$ 223,000
17	Replace 8" main on Gould St from Huntington Dr to North St	12	2026	2,230	$ 1,110,000
18**	Replace 12" main from WTP to intersection with Gould St and Jerome Ave	12	2026	1100	$ 599,000
19***	Replace 12" main and 20" main on Allendale Avenue from WTP to Frazer Avenue	12 & 20	2026	560	$ 560,000
20	Replace 4" main on Dewey St from Moore to Brandon St	8	2026	1,000	$ 365,000
21***	Replace 8" main on Frazer from Allendale Ave to 71	8	2027	1080	$ 394,000
22	Replace 4" main on Woodlawn from Farr Ave to Auburndale Ave	8	2027	850	$ 310,000
23	Replace 4" main on West St from King St to Stinson St	8	2027	660	$ 241,000
24**	Replace 24" main from WTP to the 16" main intersection in Kiwanis Park	24	2027	1130	$ 967,000
25	Replace 6" main on Monroe St from Washington St to Broadway Ave	8	2027	2080	$ 758,000
			Total	**26,130**	**$ 11,886,000**

*DWSRF Projects
**River Crossing
***Main Parallel to Raw Water Main

City of Owosso
Owosso Reliability Study
Project No:221152

20-Year Water Main Improvements					
Project number	Description/Location	Diameter (in)	Completion Year	Length of Main (ft)	Estimated Cost
26***	Replace 6" main on Garfield Ave from 71 to dead end	8	2028	590	$ 215,000
27	Replace 4" main on Williams St from Wahington St to Oak St	8	2028	1600	$ 583,000
28**	Replace 12" main from the west end of Allendale Ave to dead end of Oakwood Ave	12	2028	580	$ 525,000
29	Replace 4" main on Adams St from King St to Oliver St	8	2028	1,000	$ 365,000
30	Replace 6" main on Gilbert St from Mason St to Oliver St	8	2039	800	$ 292,000
31	Replace 6" main on Huntington Dr from Moore St to Wiltshire Dr	8	2028	1,070	$ 390,000
32***	Replace 20" mains on McMillan Rd from Monroe St to South St	20	2029	800	$ 528,000
33	Replace 6" mains on McMillan Rd from Monroe St to South St	8	2029	800	$ 292,000
34**	Replace 16" main from Cass St to South of Water St where the main tees to the 16" and 8" mains	16	2029	300	$ 218,000
35	Replace 4" main on Cass St from Green St to Shiawassee St	8	2029	740	$ 270,000
36**	Replace 12" main on Washington St from Howard St to Jerome Ave	12	2029	580	$ 289,000
37	Replace 6" main on Elmwood Ave from Abbott St to King St	8	2029	530	$ 194,000
38	Replace 4" main on Oak St from Main St to Williams St	8	2029	1,070	$ 390,000
39	Replace 6" main on Shady Lane Dr from Ward St to Chipman St	8	2029	800	$ 292,000
40	Replace 6" main on Hampton St from Shiawassee St to Pearce St	8	2030	1000	$ 365,000
41	Replace 4" main on State St from Stewart St south to dead end	8	2030	1,270	$ 463,000
42	Replace 6" main on Adams St from Williams St to Oliver St	8	2030	340	$ 124,000
43	Replace 6" main on Milwaukee from Cedar St to Lyon St	8	2030	670	$ 245,000
44	Replace 6" main on Ball St from Prindle St to Ridge St	8	2030	580	$ 212,000
45	Replace 6" main from Cedar St to Shiawassee St between Fletcher St and Ryan St	8	2030	1,220	$ 445,000

46	Replace 4" main on Lee St from Ada St to Shiawassee St	8	2030	430	$ 157,000
47	Replace 4" main on Mason St from Saginaw St to Gilbert St	8	2031	1,640	$ 598,000
48***	Replace 16" main until Vandekarr Rd	16	2031	2400	$ 1,214,000
49	Replace 2" main on Genesee St from Michigan Ave to Green St and loop with main on Green St	8	2031	670	$ 245,000
50	Replace 6" main on Ball St from Oliver St to King St	8	2031	1000	$ 365,000
51	Replace 6" main on Broadway Ave from Auburndale Ave to Franklin St	8	2032	660	$ 241,000
52	Replace 6" and 12" main on Cedar St from Main St to Hampton St	12	2032	3,660	$ 1,822,000
53***	Replace 16" main south east down Vandekarr Rd and west to Cook Rd	16	2032	1360	$ 688,000
54***	Replace 16" main from Cook Rd to Palmer Ave	16	2033	2200	$ 1,113,000
55	Replace 4" main loop on Campbell Dr	8	2033	1300	$ 474,000
56	Replace 4" and 6" main on Woodhall Ct to Curwood Dr	8	2033	1940	$ 707,000
57***	Replace 6" main on Palmer Ave from Hopkins to dead end	8	2034	1260	$ 459,000
58***	Replace 16" main on Palmer Ave from Hopins to dead end	16	2034	860	$ 435,000
59	Replace 4" and 6" main on Clinton St from Cedar St to Shiwassee St	8	2034	1200	$ 438,000
60	Replace 6" main on Goodhue St from Washington St to Hickory St	8	2034	1000	$ 365,000
61	Replace 8" main on Water St from Oliver St to Mason St	8	2034	900	$ 328,000
62	Replace 6" main on Carmody St from Donald St to Cleveland St	8	2035	350	$ 128,000
63	Replace 6" main on Stewart St from Cedar St to Shiawassee St	8	2035	1340	$ 489,000
64	Replace 6" main on Stevens Dr from Krust Dr to Huntington Dr	8	2035	650	$ 237,000
65	Replace 6" main on Krust Dr from Stevens Dr to North St	8	2035	270	$ 99,000
66	Replace 4" and 6" main on Ament St from Cedar St to Shiawassee St	8	2035	1,150	$ 419,000
67	Replace 6" main on Devonshire Ct from Stratford Dr north to dead end	8	2035	450	$ 164,000
68	Replace 6" main on Rubelman Dr from North St to Summit St	8	2035	860	$ 314,000
69	Replace 6" main on Lincoln Ave from Farr Ave south to dead end	8	2035	630	$ 230,000

70	Replace 6" and 4" main on Comstock St from Gould St to Oak St	8	2036	1,680	$ 612,000
71	Replace 6" main on Oliver St from Washington St to Shiawassee St	8	2036	1530	$ 558,000
72	Replace 6" main on Hickory Rd from North St to Velma Dr and 6" main on Velma Dr to dead end	8	2036	1,140	$ 416,000
73	Replace 4" main on Harrison Ave from Corunna Ave to the dead end	8	2036	630	$ 230,000
74	Replace 6" main on Dewey St from King St to Brandon St	8	2036	730	$ 266,000
75	Replace 6" main on Herman St from Chipman St west to dead end	8	2037	1,530	$ 558,000
76	Replace 6" main on Buckley Dr from Olmstead St to Irene St	8	2037	2020	$ 736,000
77	Replace 6" main on Ball St from Main St to Williams St	8	2037	1,010	$ 368,000
78	Replace 8" main on Mason St from Water St to Saginaw St	8	2037	1000	$ 365,000
79	Replace main on Adams St from Elizabeth St to Galusha St	8	2038	1200	$ 438,000
80	Replace 4" and 6" main on Grace St from Shiawassee St and north up Michigan Ave to Stewart St	8	2038	1100	$ 401,000
81	Replace 6" main on Brandon St from Summit St to Dewey St	8	2038	570	$ 208,000
82	Replace 6" main on Oliver St west of Chipman St until intersection with 12" main	8	2038	1100	$ 401,000
83	Replace 4" main on Howard St from Division St to dead end	8	2038	460	$ 168,000
84	Replace 4" main on Pine St from King St to Oliver St	8	2038	1,040	$ 379,000
85	Replace 6" main on Candlewick Ct from South St south to dead end	8	2039	2170	$ 791,000
86	Replace 16" main on North St from Chipman St west	16	2039	1000	$ 506,000
87	Replace 8" main on Jackson Dr from dead end west to Bluestem Ct	8	2039	1060	$ 387,000
88	Replace 8" main on Woodlawn Ave from Corunna Ave to Monroe St	8	2039	460	$ 168,000
89	Replace 8" main on Universal Dr from Washington St west to dead end	8	2039	780	$ 285,000
90	Replace 6" main on Campbell Dr from Ada St to Shiawassee St	8	2040	340	$ 124,000
91	Replace 6" main on State St from Ryan St to Fletcher St	8	2040	330	$ 121,000
92	Replace 8" main on South St from McMillan Rd to Aiken Rd	8	2040	1250	$ 456,000

93	Replace 6" main on College Ln from Palmer Ave to Vandekarr Rd	8	2040	840	$ 306,000
94	Replace 6" main on Ball St from King St to Galusha St	8	2040	1440	$ 525,000
95	Replace 6" and 4" main on Stewart St from Washington St to Shiawassee St	8	2040	1,360	$ 496,000
96	Replace 4" and 2" main on Nafus St from Stewart St to dead end	8	2041	1,570	$ 572,000
97	Replace 4" main on Pine St from King St north to dead end	8	2041	900	$ 328,000
98	Replace 6" main on Exchange St from Park St to Dewey St	8	2041	1650	$ 601,000
99	Replace 6" main on Ball St from Galusha St to North St	8	2041	1010	$ 368,000
100	Replace 6" on State St from Mary St to South St	8	2041	630	$ 230,000
101	Replace 4" main on Comstock from Oak St to Washington St	8	2042	1,500	$ 547,000
102	Replace 4" and 6" main on Howell St from Bradley St to Clinton St	8	2042	520	$ 190,000
103	Replace 4" main on Prindle St from Shiawassee St to Gute St	8	2042	1,200	$ 438,000
104	Replace 6" main on Alturas Dr to Alta Vista Dr	8	2042	1,190	$ 434,000
105	Replace 4" main on Park St from Williams St to King St	8	2030	1,240	$ 452,000
			Total	**83,700**	**$ 32,855,000**

**River Crossing

***Main Parallel to Raw Water Main

City of Owosso
Owosso Reliability Study
Project No:221152

Caledonia Township Water Distribution Improvements					
Project number	Description/Location	Diameter (in)	Completion Year	Length of Main (ft)	Estimated Cost
201	Replace 12" main on Aiken St from Melinda St south to dead end	12	2025	2000	$ 996,000
202	Replace 12" main on Melinda St from Byerly St to Aiken St	12	2026	870	$ 433,000
203	Replace 4" main on Grove from Aiken St to Division St	8	2027	2080	$ 758,000
204	Replace 6" main on Exchange St from Rawleigh Ave to Hintz Rd	8	2029	1,130	$ 412,000
205	Replace 4" main on Allendale Ave from Byerly St to dead end	8	2030	890	$ 325,000
206*	Replace 8" main on Copas Rd from Hintz Rd to Fairview Ave	8	2037	530	$ 194,000
207*	Replace 6" main on Fairview Ave from Copas Rd to M-21	8	2038	1250	$ 456,000
208*	Replace 8" main on Rawleigh south and along Grover St from M-21 to dead end	8	2039	1,305	$ 476,000
*Water main runs parallel with raw water main			Total	10,055	$ 4,050,000

City of Owosso
Owosso Reliability Study
Project No:221152

Owosso Township Water Distribution Improvements					
Project number	Description/Location	Diameter (in)	Completion Year	Length of Main (ft)	Estimated Cost
301	Replace 8" main on King St from Cleveland Ave west to dead end	8	2024	300	$ 110,000
302	Replace 4" main on Keifer St from Chipman St to Cleveland Ave, 4" main on Cleveland off Keifer	8	2027	1,010	$ 368,000
303	Replace 12" main on Delaney Rd from Sequoia Trail south to dead end	12	2031	1,625	$ 809,000
304	Replace 8" main on Cleveland Ave from King St to Marion St	8	2034	1,640	$ 598,000
			Total	4,575	$ 1,885,000

City of Owosso
Owosso Reliability Study
Project No:221152

Raw Water Main Improvements					
Project number	Description/Location	Diameter (in)	Completion Year	Length of Main (ft)	Estimated Cost
401	Replace 16" main from WTP and along Allendale Ave until Frazer	16	2026	340	$ 172,000
402	Replace 16" main on Frazer from Allendale Ave to 71	16	2027	1080	$ 547,000
403	Replace 16" main on Garfield Ave from 71 to dead end and continue past to intersection with Monroe St	16	2028	800	$ 405,000
404	Replace 16" main along Monroe St and down McMillan Rd to South St	16	2029	1420	$ 719,000
405	Replace 16" main along South St to dead end and south until the main runs parallel with potable water main	16	2030	910	$ 461,000
406	Replace 16" main until Vandekarr Rd	16	2031	2400	$ 1,214,000
407	Replace 16" main south east down Vandekarr Rd and west to Cook Rd	16	2032	1360	$ 688,000
408	Replace 16" main from Cook Rd to Palmer Ave	16	2033	2200	$ 1,113,000
409	Replace 10" and 12" main for Palmer Well 2 from well to transmission	12	2034	370	$ 185,000
410	Replace 10" and 12" main for Palmer Well 3 from well to transmission	12	2034	470	$ 234,000
411	Replace 10" and 12" main for Palmer Well 1 from well to transmission	12	2034	455	$ 227,000
412	Replace 16" main from Hintz Well along Hintz Rd until Copas Rd	16	2035/2036	5420	$ 2,741,000
413	Replace 16" main on Copas Rd from Hintz Rd to Fairview Ave	16	2037	530	$ 269,000
414	Replace 16" main on Fairview Ave from Copas Rd to M-21	16	2038	1250	$ 633,000
415	Replace 16" main on Rawleigh south and along Grover St from M-21 to dead end	16	2039	1305	$ 660,000
416	Replace 16" main from Rawleigh Rd under the Shiawassee River to the treatment plant	16	2040	1310	$ 663,000
			Total	21,620	$ 10,931,000