Hubbard Water Master Plan

DRAFT - CITY and OHA-DWS REVIEW

August 2019

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Water System Master Plan

City of Hubbard, Oregon

August 2019

FINAL DRAFT SUBMITTAL

CITY AND OHA-DWS REVIEW COPY

Murraysmith

888 SW 5th Avenue, Suite # 1170
Portland, Oregon
97204

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Section 1

Section 1

Introduction and Existing Water System

1.1 Introduction

The purpose of this Water Master Plan (WMP) is to perform an analysis of the City of Hubbard's (City's) water system and:

- Document water system upgrades completed since the 1996 Water System Master Plan;
- Estimate future water requirements;
- Create a steady state hydraulic model of the distribution system;
- Evaluate potential alternatives to improve system pressure, including raising the elevated tank or constructing a new constant pressure, continuous operation pump station to maintain a higher system pressure;
- Identify deficiencies and recommend water facility improvements that correct deficiencies and provide for growth;
- Explore the future option of an intertie with the City of Woodburn;
- Initiate seismic planning for the system;
- Examine operations and maintenance procedures;
- Update the City's capital improvement program (CIP);
- Create a document that will support future review of existing system development charges (SDCs) and water rates based on the updated CIP.

In order to identify system deficiencies, existing water infrastructure inventoried in this section will be assessed based on the existing and future water needs summarized in Section 2 and water system performance criteria described in Section 3. The results of this analysis are presented in Sections 4, 5, and 6. Section 7 provides recommendations for system improvements and a 20-year capital improvement plan. The planning and analysis efforts presented in this WMP are intended to provide the City with the information needed to inform long-term water supply and distribution infrastructure decisions.

This plan complies with water system master planning requirements established under Oregon Administrative Rules (OAR) for Public Water Systems, Chapter 333, Division 61.

This section describes the water service area and inventories the City's water system facilities including existing supply sources, transmission, pressure zones, finished-water storage reservoirs, pump stations, control valves, and distribution piping.

1.2 Service Area

The City of Hubbard owns and operates a public water system which supplies potable water to its residents. The existing service area consists of the city limits and 5 residential customers outside City limits as illustrated on **Figure 1-1**.

1.3 Supply Sources

Four active wells supply the City with groundwater from the Little Bear Creek Basin and Mill Creek Basin. The four groundwater wells pump independently through water piping to a single water treatment plant (WTP) with treated water stored in two ground level reservoirs. The treated water is then pumped into the distribution system using booster pumps.

Well #1 is always in use, and the other three wells are rotated every Monday. The City reports that they can run more than 2 wells simultaneously, but water demand rarely requires more than 2 wells. The well flow is limited by the treatment plant capacity with a combined maximum capacity of 1,000 gallons per minute (gpm). Wells are signaled to operate based on set points tied to the ground level reservoir levels. Well details are summarized in **Table 1-1** and locations are shown on **Figure 1-1**.

The well capacity in the summer is limited by drawdown of nearby wells. Air is produced when full capacity is used.

Table 1-1
Groundwater Well Summary

Well No.	Location	Year Constructed	Winter Capacity (gpm)	Summer Capacity (gpm)	Drawdown Maximum (ft)
1	3101 2nd St.	1967	480	400	150'
2	Rivenes Park	1975	350	200	140'
3	City Shop 3632 1st St.	1983	230	240	180'
4	2858 J St.	2000	350	300	180'

Note:
1. The wells' capacities in the summer are related to controlling drawdown (from ground WTP inlet) to the prescribed level in the table.

1.3.1 Water Treatment Plant

Water from the wells is naturally high in arsenic, iron, and manganese. Arsenic is a regulated contaminant under the Safe Drinking Water Act. Historically, arsenic concentrations in the groundwater have been below the maximum contaminant level (MCL). The treatment process, described below, provides for reduction of arsenic concentrations in the finished water. Iron and manganese are considered secondary contaminants under the Safe Drinking Water Act, meaning that there is no health concern with elevated concentrations, but these contaminants may affect the taste, color, and odor of the water in a negative manner. The City is not required to provide treatment for removal of organisms, turbidity, or contaminants. The treatment system improves the aesthetic quality of the water by reducing iron and manganese levels and provides residual disinfection in the distribution system through the addition of sodium hypochlorite.

The current treatment process includes oxidation, filtration, and disinfection. Potassium permanganate is added to the raw well water to oxidize iron and manganese. The water then passes through pressurized green sand filters which capture the oxidized iron and manganese acting as a physical barrier and utilizes adsorption for these soluble contaminants, including arsenic, that have not been completely oxidized.

Treatment capacity at the WTP is 500 gpm at each of two filters. Finished water is stored in two ground level reservoirs and pumped to the distribution system as necessary to maintain water level in the elevated tank described later in the section.

1.3.2 Backup power

A diesel generator with an automatic transfer switch powers the treatment plant, Well 1 and the finished water pumps. A mobile generator is available to power any one of the other wells.

1.3.3 Emergency Interties

The City currently has no emergency distribution interties with adjacent water systems.

1.3.4 Water Rights

The City's water rights are presented in **Table 1-2**.

Table 1-2
Water Rights Summary

Source	Well	Application #	Permit #	Certificate #	Transfer	Status	Use	Supply Amount cfs (MGD) [gpm]	Priority Date
Well in Mill Creek Basin[2]	#4	G14954	G13857	90750	-	NC	Municipal	0.668 (0.43) [300]	3/29/99
Three Wells in Mill Creek Basin	#1,2,3	G11998	G10965	84092	-	NC	Municipal	1.56 (1.01) [700]	12/13/89
Well #4 in Little Bear Creek Basin[1,2]	#4	G16491	G16138	-	-	NC	Municipal	0.223 (0.14) [100]	7/1/05
Three wells in Pudding River Basin	#2,3,4	G6913	G5809	84093	T6320	NC	Municipal	1.1 (0.71) [494]	4/28/75

Notes:

1. This water right is only valid December 1st through May 31st and is therefore not included in the total capacity.
2. Usage of water rights are not allowed if static water level reaches 25 feet below the reference level

1.4 Distribution System

1.4.1 Current Operation Summary

Hubbard's existing water distribution system consists of a single pressure zone served primarily by the elevated reservoir. Water is pumped to the elevated reservoir from two ground level storage reservoirs, one at the treatment plant and the other at the Well #4 site. **Figure 1-2** at the end of this section presents a hydraulic schematic of the City's water system facilities. Hubbard's existing distribution system and current operational strategy are described in more detail later in this section. **Figure 1-1** illustrates Hubbard's water service area limits and water system facilities.

1.4.2 Ground Level Pumping

Hubbard's existing water system includes four duty pumps and one backup pump at the WTP that pump water from the ground level reservoirs to the distribution system including the elevated reservoir. Pumps are signaled to turn on based on the level of the elevated reservoir. Pumps 1 through 4 are frame-mounted, electric motor driven, end suction centrifugal pumps. Typically, demand is met from a single pump with two pumps active each week in a lead/lag configuration. Pump 5 is a diesel engine driven, end suction, centrifugal pump that is available for emergency purposes and is typically exercised weekly. An onsite diesel standby generator provides backup power for Pumps 1-4. **Table 1-3** presents a summary of the capacity of the existing pumps.

Table 1-3
Pump Summary

Pump Number	Capacity (gpm)
1	700
2	700
3	650
4	650
5	backup

1.5 Storage Reservoirs

Hubbard's water system includes three active storage reservoirs with a total capacity of 2.05 MG. **Table 1-4** presents a summary of the City's existing active storage reservoirs.

1.5.1 Reservoir 1

The 1 MG welded steel Reservoir #1 was constructed in 1975 with the treatment plant. The reservoir is a 39.75-foot tall ground-level reservoir constructed on the WTP site. Water is pumped from this reservoir and Reservoir 2 by the pump station at the water treatment plant into the distribution system, and to fill the elevated tank.

1.5.2 Reservoir 2

The 1 MG welded steel Reservoir #2 was constructed in 1999 with the treatment plant expansion. The reservoir is a 39.75-foot tall ground-level reservoir constructed on the Well #4 site. Water is pumped from this reservoir and Reservoir 1 by the pump station at the water treatment plant into the distribution system, and to fill the elevated tank.

1.5.3 Elevated Tank

The elevated tank is a 50,000-gallon, multi-legged elevated steel reservoir. The reservoir provides gravity storage for the system and the water surface elevation establishes the hydraulic grade for the water system. The overflow elevation, or maximum operating level of the tank is 278 feet in elevation, or 94.5 feet above grade. The elevated tank is filled by the pump station at the WTP. It was constructed in 1931.

Table 1-4
Active Reservoir Summary

Reservoir Name	Capacity (MG)	Overflow Elevation (feet)
Elevated Reservoir	0.05	278.2
Reservoir 1	1	221.6
Reservoir 2	1	221.6
Total Storage Capacity	**2.05**	

1.5.4 Distribution Pipes

The City of Hubbard's water distribution system contains approximately 17 miles of piping composed of various pipe materials in sizes up to 10 inches in diameter. Pipe types typically include ductile iron, asbestos cement, and polyvinyl chloride (PVC) with installation dates ranging from 1965 to 2019. A large portion of the system has an unknown pipe type, due to incomplete records. It is mostly unknown what type of joint restraints were installed, if any, throughout the system. **Table 1-5** presents an inventory of existing pipes by diameter.

Table 1-5
Distribution System Pipe Summary

Size/Type	Ductile Iron	PVC	Asbestos Cement	Unknown	TOTAL	% of System
raw water lines				4624	**4,624**	5%
hydrant lines				6526	**6,526**	7%
4" and smaller	3389			4865	**8,254**	9%
6"	17617	1262	5126	4858	**28,863**	32%
8"	10508	12722		417	**23,647**	26%
10"	8143	6830	1389	1563	**17,925**	20%
Total	**39,657**	**20,814**	**6,515**	**22,853**	**89,839**	100%
% of System	44%	23%	7%	25%	100%	

1.6 Telemetry

The City of Hubbard's supervisory control and data acquisition (SCADA) system, commonly referred to as telemetry, monitors all storage, pumping, treatment, and metering facilities within the City's distribution system and provides for manual or automatic control of certain facilities and operations. The telemetry system also collects and stores system status and performance data.

All facilities are equipped with radio remote telemetry units (RTUs) that monitor reservoir levels, well on/off status, and well flow rates.

All signals from storage, pumping, and treatment facility RTUs are transmitted to the City's Operations Center where the raw data is interpreted and displayed on a user terminal. The system is also capable of notifying City staff 24 hours a day if an alarm is triggered at any of the water system sites. Alarms can be addressed remotely by logging in to the City remote access technology on a staff cell phone.

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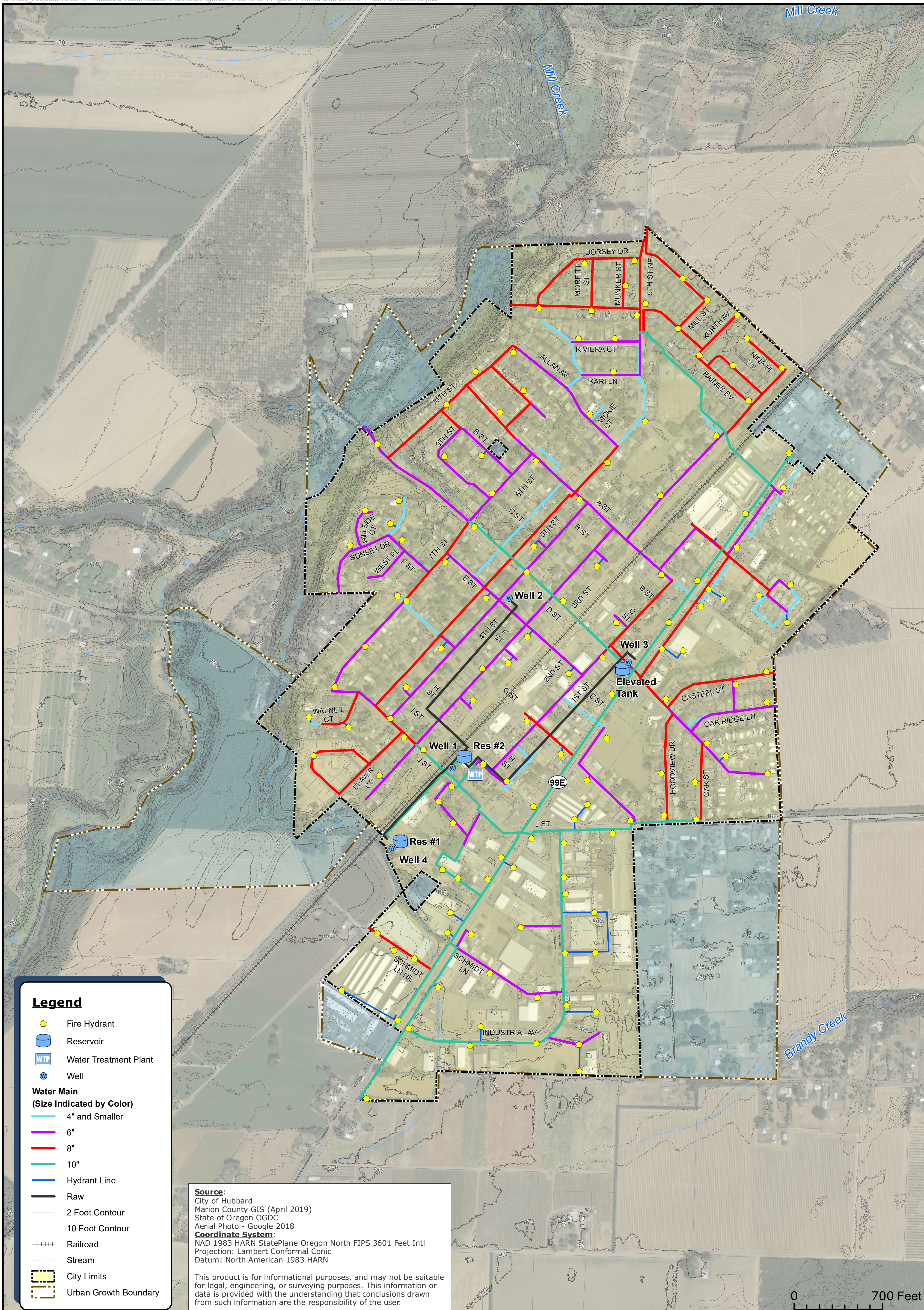

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Figure 1-1
Existing Water System

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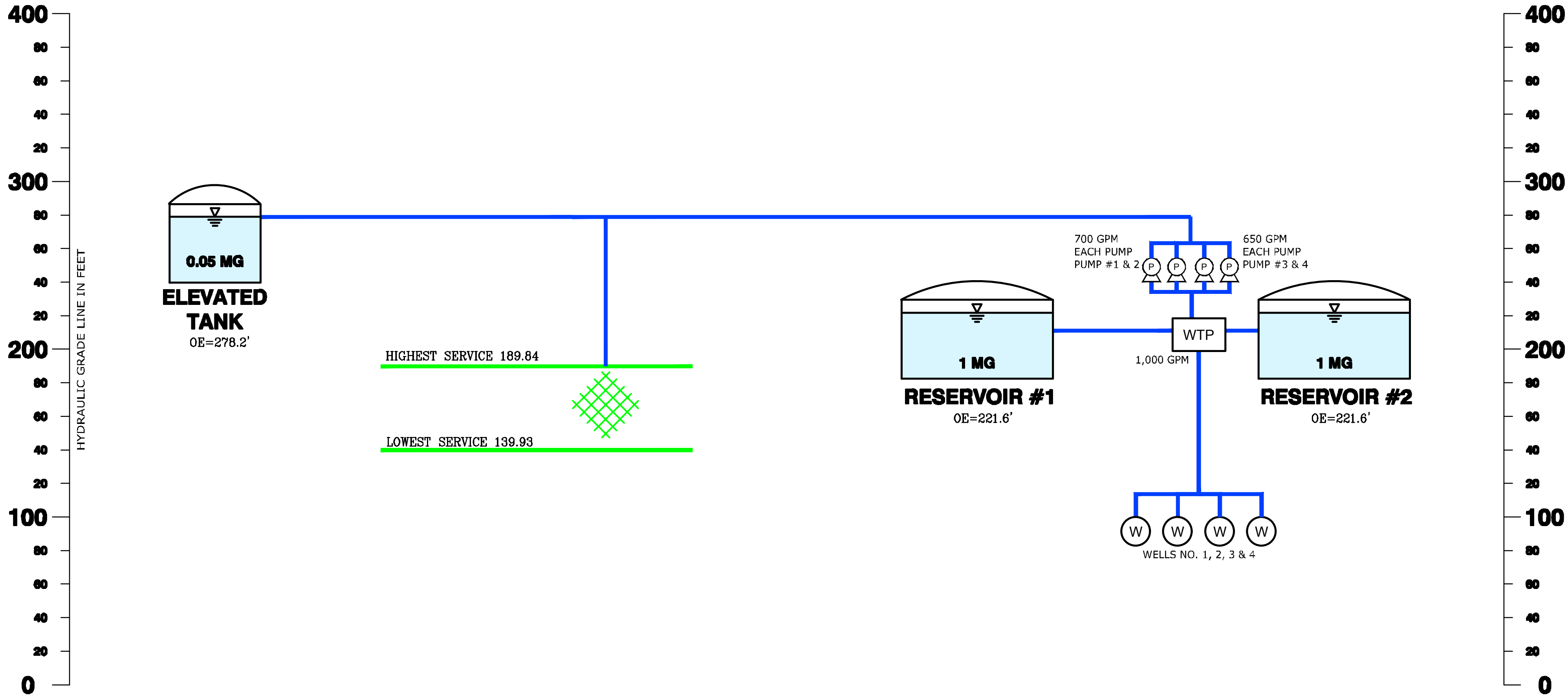

LEGEND

WTP	WATER TREATMENT PLANT	P	PUMP
W	WELL	1.0 MG — CAPACITY; OE=1240' — OVERFLOW ELEVATION	STORAGE TANK

Figure 1-2

CITY OF HUBBARD
WATER MASTER PLAN

EXISTING WATER SYSTEM HYDRAULIC SCHEMATIC

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Section 2

Section 2

Projected Growth and Water Requirements

This section documents future growth scenarios, population projections and estimated water demands for the City of Hubbard's (City's) water service area. Population and water demand forecasts are developed from regional planning data, current land use designations, historical water demand records, and previous City water planning efforts.

2.1 Service Area

2.1.1 Existing

The City's existing water service area includes all areas within the Hubbard city limits, and five customers outside City limits. The City's existing water service area is illustrated on **Figure 1-1** in **Section 1**.

2.1.2 Future

Based on existing development types in the area, limited re-development and densification is expected within the existing water service area. It is anticipated that future expansion of the City's water service area will include continued residential, commercial, and industrial infill developments, and one new major subdivision on the southwestern side of the City.

2.2 Planning Period

The planning period for this Water System Master Plan (WSMP) is 20 years, through the year 2038, consistent with Oregon Administrative Rule (OAR) requirements for Water System Master Plans (OAR 333-061). Some components of the water system will be evaluated using longer planning periods to facilitate "right-sizing" of improvements designed to serve future growth.

2.3 Water Demand and Population

Water demand refers to all potable water required by the system including residential, commercial, industrial, and institutional uses. Water demands are described using three water use metrics: average daily demand (ADD), maximum day demand (MDD), and peak hour demand (PHD). Each of these metrics are stated in volume per unit of time such as million gallons per day (mgd) and in gallons per capita per day (gpcd). ADD is the total annual water volume used system-wide divided by the number of days in a year. MDD is the largest 24-hour water usage volume for a given year. In western Oregon, MDD usually occurs each year between July 1st and September 30th, referred to as the peak season. PHD is estimated as the largest hour of demand during the MDD.

For the purposes of this WMP, water demand within the City's water service area is assumed to correlate with Hubbard population. Future growth and water demand projections are based on estimated population growth within the proposed water service area.

2.3.1 Current Population

The City of Hubbard currently supplies water to approximately 3,300 people through approximately 1,020 service connections.

2.3.2 Historical Water Demand

Water demand can be calculated using either water consumption or water production data. Water consumption data is taken from the City's customer billing records and includes all revenue and metered uses. Water production is measured as the water supplied to the distribution system from the treatment plant and distribution storage. Water production includes unaccounted-for water like loss through minor leaks and unmetered, non-revenue uses, such as hydrant flushing. For this WMP, system-wide historical water demand is based on daily water production data in order to account for all water used including those which are not metered. Customer consumption, water user type, Water Management and Conservation Plan data, and zoning were used to distribute water demands throughout the hydraulic model, discussed in more detail in **Section 4**. System-wide historical water demand is presented in **Table 2-1**.

Table 2-1
Historical System-wide Water Demand

Year	Population	ADD (MGD)	ADD (gpcd)	MDD (MGD)	MDD (gpcd)	MDD: ADD	MDD date
2011	3180	0.246	77	0.510	160	2.1	7/7/2011
2012	3185	0.264	83	0.481	151	1.8	8/5/2012
2013	3200	0.295	92		No	data	
2014	3220	0.272	84	0.457	142	1.7	8/1/2014
2015	3225	0.278	86	0.527	163	1.9	7/6/2015
2016	3225	0.279	87	0.539	167	1.9	8/19/2016
2017	3300	0.227	69	0.510	155	2.2	8/1/2017
Average	-	**0.266**	**83**	**0.504**	**156**	**1.9**	-

2.3.2.1 Peaking Factors

The historical ratios or "peaking factors" of MDD: ADD and PHD: MDD are used to estimate future peak day and peak hour demands. Based on the last seven years of historical system-wide demands presented in **Table 2-1**, the highest ratio of MDD:ADD is approximately 2.2. Peak hour water production is not recorded by the City, so a PHD: MDD peaking factor of similar surrounding communities of 2.0 was used for this analysis.

2.3.3 Population Projections

Future population is estimated based on existing and future population within the existing water service area and proposed future growth areas. Existing and future populations are estimated using the population forecasts by Portland State University, Population Research Center in the report "Population Forecasts for Marion County, its Cities and Unincorporated Area 2010-2030. This study lists a population growth rate of two percent for Hubbard. Although growth has been smaller over the first eight years of this study, this estimate provides a conservative estimate for future water needs. For the purpose of this Master Plan, the projected rate is used beyond 2030 to extend to the end of the planning period.

2.3.4 Water Demand Projections

Projected future system-wide population and water demand are presented in **Table 2-2**. Future ADD is calculated based on an average demand per capita of 83 gpcd multiplied by the future population. Future MDD is estimated using the peaking factors presented in **Section 2.3.2.1**.

Existing commercial and industrial user demands are assumed to be captured in per capita usage. It is assumed that both per capita usage and the ratio of commercial and industrial use to residential use will remain similar in the future.

Table 2–2
Future System-wide Water Demand

Year	Population	ADD (MGD)	MDD (MGD)	PHD (MGD)
2019	3,433	0.29	0.64	1.28
2024	3,790	0.32	0.70	1.40
2029	4,185	0.35	0.77	1.54
2034	4,621	0.39	0.86	1.72
2039	5,102	0.43	0.95	1.90

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Section **3**

Section 3

Planning and Analysis Criteria

3.1 Introduction

This section documents the performance criteria used for water supply and distribution system analysis presented in **Section 4** of this Water Master Plan (WMP). Criteria are established for evaluating water supply, distribution system, service pressures, storage and pumping capacity, water quality, and fire flow availability. These criteria are used in conjunction with the water demand forecasts presented in **Section 2** to complete the water system analysis.

3.2 Performance Criteria

The water distribution system should be capable of operating within certain performance limits under varying customer demand and operational conditions. The recommendations of this plan are based on the performance criteria summarized in **Table 3-3** at the end of this section. These criteria have been developed through a review of City design standards, State requirements, American Water Works Association (AWWA) acceptable practice guidelines, Ten States Standards, the Washington Water System Design Manual, and practices of other water providers in the region.

3.2.1 Water Supply

As described in **Section 1**, the City of Hubbard (City) draws its water from four wells. Water is delivered to the treatment plant through raw water lines.

Based on current water system operations, the City should plan for adequate peak season (summer) supply capacity to provide maximum day demand (MDD) from all sources with the largest duty well out of service (firm capacity). In addition, the water treatment plant (WTP) should be capable of treating water at the same rate, equal to the MDD.

3.2.2 Service Pressure

The City of Hubbard is served by one pressure zone. The topography is very flat, so pressures are nearly uniform across the entire system.

The acceptable service pressure range under normal (ADD) operating conditions is 45 to 80 pounds per square inch (psi). However, the City desires to raise the system pressure to 60 psi minimum. Where mainline pressures exceed 80 psi, services must be equipped with individual PRVs to maintain their static pressures at no more than 80 psi in compliance with the Oregon Plumbing Specialty Code. During a fire flow event or emergency, the minimum service pressure is

20 psi as required by Oregon Health Authority, Drinking Water Program (OHA) regulations. Recommended service pressure criteria are summarized in **Table 3-1**.

Table 3-1
Recommended Service Pressure Criteria

Service Pressure Criterion	Pressure (psi)
Normal range, during ADD	45-80 (60+ desired)
Maximum	80
Minimum, during emergency or fire flow	20

3.2.3 Distribution System Evaluation

The distribution system will be evaluated under two demand scenarios, MDD + fire flow and peak hourly demand (PHD). The system should provide the required fire flow to a given location while, at the same time, supplying MDD and maintaining a minimum residual service pressure at any meter in the system of 20 psi as required by OHA regulations. The system should meet this criterion with all operational storage depleted.

The distribution system should supply PHD while maintaining service pressures within approximately 85 percent of service pressures under ADD conditions but not less than the City standard minimum 40 psi service pressure. The system should meet this criterion with flow velocity in the distribution system of less than 10 fps.

3.2.3.1 Main Size

Typically, new water distribution mains should be at least 8 inches in diameter to supply minimum fire flows. However, 8-inch diameter mains may cause water quality concerns in areas with small, non-emergency demands and minimal looping. Sometimes, 6-inch diameter mains are acceptable on runs less than 300 feet, if no fire hydrant connection is required, there are no more than 8 services on the main, and future extension of the main is not anticipated. Potential water quality issues will be considered on a case by case basis when sizing pipes for any proposed water main improvements identified during distribution system analysis.

3.2.4 Storage Capacity

Hubbard water storage reservoirs should provide capacity for four purposes: operational storage, equalizing storage, fire storage, and standby/emergency storage. A brief discussion of each storage element is provided below.

3.2.4.1 Operational Storage

Operational storage is the volume of water between the pump on and off set points in the reservoirs.

3.2.4.2 Equalizing Storage

Equalizing storage is the volume of water dedicated to supplying demand fluctuations throughout the maximum day. When data is available, it is calculated by the volume of water on an hourly basis needed throughout a full day in excess of the average usage during the 24-hour MDD. Most communities do not track enough data to calculate this, so it is typical to approximate this storage component as 25 percent of MDD. This is consistent with the practices of similar water utilities in the region.

3.2.4.3 Fire Storage

Water stored for fire suppression is typically provided to meet the single most severe fire flow demand within the system. Fire service in the Hubbard water service area is provided by Hubbard Fire Department. Although the final fire flow requirement for any one property is determined by the Fire Marshal, general requirements by building construction and development type are assumed in this report and are the provided level of service for the community. Buildings with higher required fire flows should provide additional fire suppression features such as sprinklers.

The maximum required fire flow for any future development in the service area is 3,000 gallons per minute (gpm) for a recommended duration of 3 hours. The recommended fire storage volume is determined by multiplying the fire flow rate by the duration of that flow. Fire flow requirements by land use type and zoning are discussed later in this section and summarized in **Table 3-2**.

3.2.4.4 Emergency Storage

Emergency storage is provided to supply water from storage during emergencies such as pipeline failures, equipment failures, power outages, or natural disasters. The amount of emergency storage provided can be highly variable depending upon an assessment of risk and the desired degree of system reliability. For the Hubbard system, an emergency storage volume of 2 x ADD is recommended.

3.2.5 Pumps

Pumping capacity requirements vary depending on the water demand, volume of available storage and the number of pumping facilities.

3.2.5.1 Pumping to Storage

When pumping to storage reservoirs, a firm pumping capacity equal to the pressure zone's MDD is recommended. Firm pumping capacity is defined as a station's pumping capacity with the largest pump out of service.

3.2.5.2 Constant Pressure Pumping

Although it is desirable to serve water system customers by gravity from storage, where this is not feasible or cost effective, constant pressure pump stations may be used to boost service pressure in lieu of gravity storage. In this case, the pump station is recommended to have a firm capacity to meet peak instantaneous demand, approximated as PHD plus fire flow.

3.2.5.3 Backup Power

It is recommended that pumps supplying gravity storage reservoirs include, at a minimum, manual transfer switches and connections for a portable back-up generator. The emergency storage volume in a gravity feed reservoir will provide short term water service reliability in case of a power outage at the pump station. Back-up power generators with automatic transfer switches are recommended for all constant pressure pump stations which serve as the sole source of supply.

3.2.6 Required Fire Flow

While the water distribution system provides water for domestic uses, it is also expected to provide water for fire suppression. The amount of water required for fire suppression purposes is associated with the local building size and type or land use of a specific location within the distribution system. Fire flow requirements are typically much greater in magnitude than the MDD in any local area. Adequate hydraulic capacity must be provided for these potentially large fire flow demands. Emergency response in the City of Hubbard is provided by the Hubbard Fire Department. General fire flow guidelines by land use type are summarized in Table 3-2.

3.2.6.1 Single-Family and Duplex Residential

The Oregon Fire Code (OFC) specifies a minimum fire flow of 1,000 gpm for single-family and two-family dwellings with square footage less than 3,600 square feet. For residential structures larger than 3,600 square feet, the minimum fire flow requirement is 1,500 gpm.

For the purposes of this Plan, distribution piping fire flow capacity will be tested in the water system hydraulic model with a minimum requirement of 1,500 gpm to accommodate the range of potential future residential development in the City. Where deficiencies are identified in the existing system based on this 1,500 gpm requirement, existing development will be evaluated to determine if a 1,000 gpm fire flow requirement is appropriate for the local area.

3.2.6.2 Multi-Family Residential, Commercial, Industrial and Institutional

A 3,000 gpm fire flow is recommended for multi-family residential, commercial, and industrial development consistent with OFC maximum fire flow guidelines. This maximum fire flow requirement is also appropriate for institutional and public facilities such as schools or community centers. The City designates medium density residential and community service buildings as 2,500 gpm. Recommended fire flow requirements by land use type are summarized in Table 3-2.

Table 3-2
Required Fire Flow Summary

Land Use Type	Required Fire Flow (gpm)	Required Duration (hours)
Single-Family and Duplex Residential <3,600 sq ft	1,000	2
Single-Family and Duplex Residential >=3,600 sq ft	1,500	2
Medium Density Residential, Neighborhood and Community Service (Commercial)	2,500	2
High Density Residential, Commercial, Industrial and Institutional	3,000	3

3.2.7 Seismic Resilience

As part of this WMP the City of Hubbard (City) has chosen to complete a general seismic assessment of their existing water system. The scope of this evaluation includes mapping and overlaying potential seismic hazards with the City's key water system facilities to identify vulnerabilities and estimate risk to the system from a seismic event.

3.2.8 Water Quality

In Oregon, drinking water quality standards for 95 primary and 12 secondary contaminants are established under the Oregon Drinking Water Quality Act (OAR 333-061) which includes implementation of national drinking water quality standards. To maintain public health, each contaminant has either an established maximum contaminant level (MCL) or a recommended treatment technique.

3.2.8.1 Source Water

Potential for pathogens in groundwater sources like the City's wells are regulated by the Groundwater Rule (GWR). The City's existing wells have high levels of dissolved iron in the water. Iron is a secondary contaminant which causes metallic taste, discoloration, sediment and staining but is not a threat to human health. The City also has elevated levels of arsenic. Other regulated contaminants are monitored as required by the State's drinking water quality standards.

3.2.8.2 Distribution System

There are three drinking water quality standards and potential contaminants that may be exasperated or originate in the distribution system. Specifically, microbial contaminants (Total Coliform Rule), lead and copper (Lead and Copper Rule), and disinfection byproducts (Disinfectants and Disinfection Byproducts Rule).

3.2.8.2.1 Total Coliform Rule

There are a variety of bacteria, parasites, and viruses which can cause health problems when ingested. Testing water for each of these germs would be difficult and expensive. Instead, total coliform levels are measured. The presence of any coliforms in the drinking water suggests that there may be disease-causing agents in the water also. A positive coliform sample may indicate that the water treatment system isn't working properly or that there is a problem in the distribution system. Although many types of coliform bacteria are harmless, some can cause gastroenteritis including diarrhea, cramps, nausea, and vomiting. This is not usually serious for a healthy person, but it can lead to more serious health problems for people with weakened immune systems.

The Total Coliform Rule applies to all public water systems. Total coliforms include both fecal coliforms and E. coli. Compliance with the MCL is based initially on the presence or absence of total coliforms in a sample, then a focus on the presence or absence of E.coli.

3.2.8.2.2 Lead and Copper and Corrosion Control

Lead and copper enter drinking water primarily through corrosion of plumbing materials most commonly caused by a chemical reaction with the water which may be due to dissolved oxygen, low pH or low mineral content. Exposure to lead and copper may cause health problems ranging from gastroenteritis to brain damage. In 1991, the national Lead and Copper Rule (LCR) established action levels for lead and copper concentrations in drinking water. Under the Oregon Drinking Water Quality Act, water utilities are required to implement optimal corrosion control treatment that minimizes the lead and copper concentrations at customers' taps, while ensuring that the treatment efforts do not cause the water system to violate other existing water regulations.

Utilities are required to conduct monitoring for lead and copper from taps in customers' homes. Samples are currently required to be taken every three years at 10 sampling sites. The action level for either compound is exceeded when, in a given monitoring period, more than 10 percent of the samples are greater than the action level.

3.2.8.2.3 Disinfectants and Disinfection Byproducts (DBP) Rule

DBPs form when disinfectants, like chlorine, used to control pathogens in drinking water react with naturally occurring materials in source water. DBPs have been associated with increased cancer risk. The City is required to sample the distribution system on an annual basis.

3.2.9 Summary

The criteria described above is summarized in **Table 3-3**.

Table 3-3
Performance Criteria Summary

Water System Component	Evaluation Criterion	Value	Design Standard/Guideline
Water Supply	Source Capacity (System-wide)	MDD[2] with largest well out of service	Ten States Standards, Washington Water System Design Manual, Murraysmith recommended
	Treatment Capacity (System-wide)	MDD	
	Backup Power for Wells	At least two independent power sources	
Service Pressure	Normal Range, during ADD[1]	60-80 psi @ service	AWWA M32
	Maximum	80 psi	AWWA M32, Oregon Plumbing Specialty Code, Section 608.2
	Minimum, during emergency or fire flow	20 psi	AWWA M32, OAR 333-061
Distribution Mains	Minimum Pipe Diameter	8-inch recommended for fire flow, except in short mains without fire service	Murraysmith recommended
Storage	Operational Storage	Tank level set points	Washington Water System Design Manual
	Equalization Storage	25% of MDD	
	Fire Storage	Required fire flow x flow duration	
	Emergency Storage	2 x ADD	
Pump Stations	Total Capacity	PHD + Fire Flow	Murraysmith recommended
	Backup Power	Automatic transfer switch and on-site generator	
Required Fire Flow and Duration	Single Family Residential	1,500 gpm for 2 hours	Requested by Fire Department
	Medium Density Residential, Commercial, Public, Industrial	3,000 gpm for 3 hours	

Notes:

1. ADD: Average daily demand, defined as the average volume of water delivered to the system or service area during a 24-hour period = total annual demand/number of days per year.
2. MDD: Maximum day demand, defined as the maximum volume of water delivered to the system or service area during any single day.
3. PHD: Peak hour demand, defined as the maximum volume of water delivered to the system or service area during any single hour of the maximum demand day.

Section **4**

Section 4

Water System Analysis

4.1 Water Supply Capacity

Historically, the City's well operational capacities have declined in the summer due to drawdown limitations. When multiple wells in the area are withdrawing at full capacity, drawdown of aquifer levels and water level in the well result in lower production rates. The City believes that other wells in the area are interacting with the municipal wells, reducing their capacity.

Winter and summer well capacities are summarized in **Table 4-1**. The City never runs more than two wells at a time, so it is expected that they will continue to have adequate capacity even in the summer.

The screen of Well #1 has collapsed. Rehab of this well could result in higher production, however, review of recent video inspection of the well shows that attempts to fix the screen may not be feasible. The well is currently the highest producer even with the collapsed screen and doesn't produce any more sand than the other wells despite its lack of filter pack. At this time, it is recommended to leave the well in its current condition to avoid the potential total loss of well production. The existing pump is the original pump but is continuing to function properly. The City should continue to monitor the capacity. If the well capacity drops dramatically or suddenly, well rehabilitation should be reconsidered.

As described further in Section 7, given the uncertainty of future water demands and the potential for continued decline in production capacities, the City should plan for the long-term development of an additional groundwater well.

Table 4-1
Source Capacity Summary

Well	Winter Capacity (gpm)	Summer Capacity (gpm)
1	480	400
2	350	200
3	230	240
4	380	300
Total Well Capacity	**1,410**	**1,140**
Firm Capacity (Well 1 out of service)	930	740
MDD (Year 2039)	660	660
Additional Capacity Needed	**N/A**	**N/A**

4.2 Emergency Supply Considerations

One option the City has in the future emergency supply is constructing an interconnection with the City of Woodburn. This pipeline would be approximately 9,000 feet in length, connecting the 12-inch diameter Woodburn line along Front Street to the 10-inch diameter line in Hubbard. Due to the high construction cost and available reliable firm capacity in the wells, this is likely not needed at this time, but could be explored in the future.

4.3 Service Area and Pressure

4.3.1 Existing

The City's current water service area includes all properties within the city limits and a small number of customers outside the city limits. The entire system is served through a single pressure zone. Pumps at the City's WTP work with an elevated reservoir to supply steady pressure to the system. Since the service area has little change in elevation, pressures are consistent throughout the water system with an average pressure of 42 pounds per square inch (psi). **Figure 4-1** at the end of this section illustrates areas with pressure deficiencies. These areas of higher elevation experience pressures just below 40 psi.

4.3.2 Future

The 20-year future service area for this planning effort is the current Urban Growth Boundary (UGB). Based on existing topography within the City's UGB, it is assumed that the water system will continue to operate as a single pressure zone in the future.

4.3.3 Low System Pressure

The level in the elevated tank determines the overall system pressure, which is typically around 40 psi through the flat service area. Hubbard's existing distribution pumps at the WTP help to maintain service pressures by pumping through the distribution system to fill the elevated reservoir.

Although it is desirable to serve water system customers by gravity from storage, in a relatively flat service area like Hubbard's it may not be economically feasible to provide adequate elevated storage, both in elevation and capacity. To mitigate storage challenges, constant pressure pumping may be used to provide service pressure. This approach is referred to as a "closed pressure zone" or closed system.

4.3.4 Elevated Tank Considerations

When evaluating the alternatives for the elevated tank, the following items should be considered.

- *System Pressure*: The existing system pressure is currently low (approximately 40 psi) and the City is exploring different methods for improving system pressure up to 75 psi. If the pressure is increased, public education will be needed to reduce potential service line and building plumbing issues. It is important to tell residents this will be coming and what to expect. Older pipes, including City mains, (particularly asbestos cement and steel pipes) are susceptible to additional leaking with increased pressure. Despite a few minor challenges with increasing system pressure, the City would like to pursue this for general overall system benefit, functionality, and fire flow.

- *Seismic Resiliency*: The Elevated Tank was constructed in 1931, with little or no consideration of seismic performance. With increasing anticipation of a Cascadia earthquake in the region, seismic resiliency is important to consider. The City's insurance company, CIS, is also interested in reducing risk associated with this tank. The most important risk for the City to consider is this: if the tank falls, what will it fall on? Surrounding the tank are a few homes, a church, a bank, a City garage, a construction company and a state highway. The City would like to minimize risk as much as possible and reduce dependence on a facility likely to fail in a seismic event.

- *Historic Value*: The City is concerned with resident reactions to removing the tank. It is considered iconic to the community and residents may want to keep it even if it is no longer used for water storage. Due to the risk of failure in a seismic event, if major structural upgrades are not completed to improve reliability, then the structure should be dismantled and removed.

- *Contracts with Cell Phone Companies*: The City currently maintains contracts with cellular phone companies to attach their antennas to the tank. If the tank is removed, a new location will need to be found. The loss of revenue from these leases will have an impact on the water utility's financial performance.

- *Continuous Pumping Required*: If the Elevated Tank is removed, the system will require the addition of increased continuous operation pumping capacity. This adds additional maintenance requirements but allows for an increase in system pressure.

- *Cost*: The City must be able to select an option they can afford and that appropriately balances price with other factors.

4.3.5 Elevated Tank Alternatives

There are 5 options the City can take with regards to the Elevated tank. They are described below and summarized in **Table 4-2**. Each is compared using the criteria outlined above.

1. ***No Action***: This alternative involves maintaining the existing configuration.

2. ***Remove Elevated Tank & Add Constant Pressure Pumping***: This alternative removes the existing elevated tank and provides pressure to services through expanded constant pressure pumping at the WTP.

3. ***Seismically Retrofit Existing Reservoir***: This alternative seismically retrofits the existing elevated reservoir to continue to hold water and maintains the same pumps at the WTP.

4. ***Seismically Retrofit for No Water***: This alternative provides seismic retrofits, so the tank can remain empty and in place for historic value and as a cell tower. Expanded constant pressure pumping at the WTP would provide system pressure.

5. ***Raise Elevated Tank***: This alternative raises system pressure by increasing the elevation of the existing elevated tank.

Table 4-2
Pressure Improvement Alternative Analysis Summary

Alternative	Avg. System Pressure (psi)	Improved Seismic Resilience	Historic Value Preserved	Contracts with Cell Companies	Continuous Pumping Required	Relative Cost
1	40	None	Yes	No Change	No	None
2	75	Best	No	Need New Location	Yes	Medium
3	40	Moderate	Yes	No Change	No	High
4	75	Moderate	Yes	No Change	Yes	Medium
5	55	Moderate	Maybe	Temporary Impacts	No	Very High[1]

Notes:
1. The cost of this alternative is extremely high, and it may not even be possible due to physical construction limitations. It is considered for comparison's sake only and is not a recommended alternative.

The recommended alternatives are either 2 or 4. Hydraulically, these alternatives are identical. It will be a non-technical decision whether or not the community wishes to keep the elevated tank for historic purposes and to maintain cell phone leases. The costs listed in this plan assume alternative 2 was selected, as it is the most economical for the water system. **Figure 4-2** illustrates system pressures under future MDD conditions with Alternative 2 completed.

4.4 Storage Capacity and Condition Analysis

Water storage facilities are typically provided for four purposes: operational storage, equalizing storage, fire storage, and emergency storage. As presented in **Section 3**, the total storage required is the sum of these four elements. For the purposes of this analysis, the existing elevated tank is assumed to be out of service. The storage analysis is summarized in **Table 4-3**.

Table 4-3
Storage Capacity Summary

Year	Required Storage Capacity (MG)					Existing Storage to Remain (MG)	Additional Storage Need
	Operational	Equalizing	Fire	Emergency	Total		
2019	0.05	0.13	0.54	0.56	1.28	2.0	-
2024	0.05	0.15	0.54	0.61	1.35	2.0	-
2029	0.05	0.16	0.54	0.68	1.43	2.0	-
2039	0.05	0.20	0.54	0.83	1.62	2.0	-

The City reports that the ground level reservoirs are in functional condition. They are 44 and 19 years old. This is within the typical lifespan of 50-75 years. If steel reservoirs are well maintained, including coating, cleaning, and cathodic protection, they can last even longer. Reservoirs should be cleaned/inspected on the interior and exterior every 5 years. These inspections will determine when coating is needed.

4.5 Pumping Capacity Analysis

As previously discussed, it is assumed that the City's WTP booster pumps operate as a closed system. Pump stations supplying constant pressure service to a closed system should have a firm pumping capacity adequate to meet PHD while simultaneously supplying the largest fire flow demand. Backup power is needed for all pumps. The pumping capacity analysis is summarized in Table 4-4.

Table 4-4
Pumping Capacity Summary

Year	Existing Total Capacity (gpm)	Exiting Firm Capacity (gpm)	Required Capacity (PHD+FF)	Additional Pumping Need
2019	2,700	2,000	3,900	1,900
2024	2,700	2,000	3,975	1,975
2029	2,700	2,000	4,070	2,070
2039	2,700	2,000	4,320	2,320

Hydraulic head will also need to be increased to provide the higher system pressure. A pressure of 75 psi for the majority of the system will provide adequate fire flows for the majority of the City without additional piping improvements. Exceptions are shown in Section 7.

4.6 Water Quality

4.6.1 Distribution System Water Quality

The City of Hubbard meets all current drinking water quality regulations. This analysis focuses on arsenic, microbial contaminants (Total Coliform Rule), lead and copper (Lead and Copper Rule) and disinfection by-products (Stage 2 Disinfectants and Disinfection Byproducts Rule) which may be exacerbated or originate in the distribution system.

4.6.2 Total Coliform Rule Compliance

The City is currently meeting all applicable requirements for the Total Coliform Rule. It is important to maintain active circulation of water throughout the distribution system, in both pipes and reservoirs in order to retain a chlorine residual. The absence of chlorine residual and accumulation of sediments contribute to bacterial growth, which in turn, can result in failure to comply with this rule.

4.6.3 Lead and Copper Rule Compliance

Hubbard is in compliance with the Lead and Copper Rule without any treatment adjustment.

4.6.4 Stage 2 Disinfectants and Disinfection Byproducts Rule (D/DBPR) Compliance

The City conducts annual sampling for DBP and is currently in compliance.

4.6.5 Iron and Manganese

Although iron and manganese are considered secondary contaminants (or aesthetic qualities), the City treats for both. The City reports that Iron is a larger problem. Currently the system feeds potassium permanganate a constant rate for each well that was programmed in when the plant was constructed. It is recommended that the City install a system that paces chemical addition with the actual amount of flow coming into the plant. This will improve contaminant removal with optimized oxidation and filter media generation.

4.6.6 Arsenic

Test results for arsenic in 2016 resulted in levels above the maximum contaminant level (MCL). The City tested again in 2018, and the results were close to, but not above the MCL. To avoid future arsenic levels above the MCL, action will need to be taken to improve treatment for arsenic. As with iron removal, above, it is likely that optimization of the existing water treatment process will allow the city to achieve a significant reduction in finished water arsenic concentrations that are well below the MCL.

The current WTP and chemical dosing result in very little arsenic reduction from the source to the finished water. With chemical dosing adjustments and, potentially, filter media replacement, the existing WTP can be configured to remove more arsenic.

The green sand filter media has a lifespan of 5-20 years depending upon the conditions in the plant. It is recommended that a core sample be collected and tested to verify that it needs to be replaced. The media was last replaced in 2000, so it is very close to the end of the 20-year window.

Arsenic is removed by the green sand filter when it is attached to oxidized iron which is then captured and retained by the green sand media. The likely cause of the reduced arsenic reduction can be attributed to one of three things. These items and solutions are shown in Table 4-5.

Table 4-5
Potential Arsenic Problems, Indicators, and Solutions

Problem	Indicator	Solution
The iron is not adequately oxidized	Low reduction of iron in WTP	Increase potassium permanganate dosage
There is not enough source iron	Low iron in source tests	Add ferric chloride before permanganate
The filter media isn't removing the oxidized iron/arsenic	Filter media age, core sample	Replace filter media

4.7 System Metering

Meter accuracy is important for properly quantifying demands, reporting, quantifying unaccounted for water, and appropriately charging customers. The current meters are showing potential inaccuracies because there are times when metered consumption volumes have been greater than production. The total of the well production meters minus the backwash meters also does not equal the amount of flow leaving the treatment plant.

Meters at all production facilities (wells, reservoirs, finished water pumps, and backwash pumps) should be calibrated or replaced to achieve more accurate measurements. Customer meters should be replaced on a rotating cycle of approximately every 20 years/ meter.

4.8 Distribution Capacity and Hydraulic Performance

A steady-state hydraulic network analysis model was used to evaluate the performance of the City's existing distribution system and identify proposed piping improvements based on hydraulic performance criteria, such as system pressure, described in **Section 3**. The purpose of the model is to determine pressure and flow relationships throughout the distribution system for average and peak water demands under existing and projected future conditions. Modeled pipes are shown as "links" between "nodes" which represent pipeline junctions, fire hydrants, or pipe size changes. Diameter, length, and head loss coefficients are specified for each pipe and an approximate ground elevation is specified for each node.

The hydraulic model was developed using the InfoWater modeling software platform, water system mapping from the City, geographic information systems (GIS) base mapping, and Google Earth to spot-check model node elevations. The model was calibrated using fire hydrant flow test results and operations data provided by the City. Analysis scenarios were created to evaluate existing and projected 20-year water demands.

For distribution system modeling of the existing system, it is assumed that the system is fully gravity fed from elevated tank (no pumps are supplying distribution) for steady state analysis, and firm capacity of the pumps are used for the fire flow scenarios in addition to the elevated reservoir. The elevated reservoir level is at an approximate elevation of 280 ft. The proposed scenario eliminates the elevated reservoir, so proposed scenarios only use recommended constant pressure pumping from an upgraded pump station at the WTP.

4.8.1 Modeled Water Demands

Existing and projected future demands are summarized in **Section 2.** Within the existing water service area, demands are assigned to the model based on current land use type and percentage of consumption. Most future demand growth is anticipated to occur through infill development, thus the existing demands are scaled for projected future system-wide demand.

4.8.2 Steady-state Model Calibration

Model calibration typically involves adjusting the model parameters such that pressure and flow results from the model more closely reflect those measured at the City's fire hydrants. This calibration process tests the accuracy of model pipeline friction factors, demand distribution, valve status, network configuration, and facility parameters such as tank elevations and pump curves. The required level of model accuracy can vary according to the intended use of the model, the type and size of water system, the available data, and the way the system is controlled and operated. Pressure and flow measurements are recorded for the City's fire hydrants through a process called fire flow testing.

4.8.3 Fire Flow Testing

Fire flow testing consists of recording static pressure at a fire hydrant and then "stressing" the system by flowing adjacent hydrants. While the adjacent hydrants are flowing, residual pressure is measured at nearby hydrants to determine the pressure drop that occurs when the system is "stressed". Boundary condition data, such as reservoir levels and pump on/off status, must also be known to accurately model the system conditions during the time of the flow test. For this WSMP, hydrant flow tests were conducted in July 2018. The recorded time of each fire hydrant flow test was used to collect boundary condition information from the City's supervisory control and data acquisition (SCADA) system.

4.8.4 Steady-State Calibration Results

For any water system, a portion of the data describing the distribution system will be missing or inaccurate and assumptions will be required. This does not necessarily mean the accuracy of the hydraulic model will be significantly compromised. Models which do not meet the highest degree of calibration can still be useful for planning purposes.

In general, the Hubbard water system hydraulic model simulates slightly different pressures (-3 psi to +4 psi) than observed field pressures. The results are within 10 percent of observed pressure and are considered adequate for master planning analysis.

4.8.5 Fire Flow Analysis

Fire flow scenarios test the distribution system's ability to provide required fire flows at a given location while simultaneously supplying MDD and maintaining a minimum residual service pressure of 20 psi at all services. Required fire flows are assigned based on the zoning surrounding each node as summarized in **Section 3**, **Table 3-2**. **Figure 4-3** at the end of this section illustrates areas with fire flow deficiencies under future conditions. Recommended improvements to address these deficiencies are presented in **Section 7**.

4.8.6 Peak Hour Demand Analysis

Distribution system pressures were evaluated under peak hour demand conditions to confirm identified piping improvements. No additional pressure deficiencies were identified under these conditions, because the fire flow demand is much higher.

4.9 Telemetry

The telemetry system is very old, and radio telemetry is becoming outdated. The City experiences problems when something goes wrong and there aren't people skilled in their software available to fix it, or parts available. The alarms do not call the City directly. The City would like to upgrade to a more modern system and has contacted their system integrator to get the process started.

4.10 Summary

Key findings or the water system analysis presented in this section are summarized in **Table 4-6**.

Table 4-6
Capacity Summary

Infrastructure	Improvements Needed in Planning Period?
Wells	No
Water Rights	No
Service Pressure	Yes, it is 42 psi, desired to be approx. 75 psi
Storage	No
Pumping	Yes, need fire pump(s), and to raise system pressure
Water Quality	Yes, Rising Arsenic levels need treatment adjustment
Fire Flow	Yes, piping & pumping improvements needed
Water Meters	Yes, need calibration or replacement

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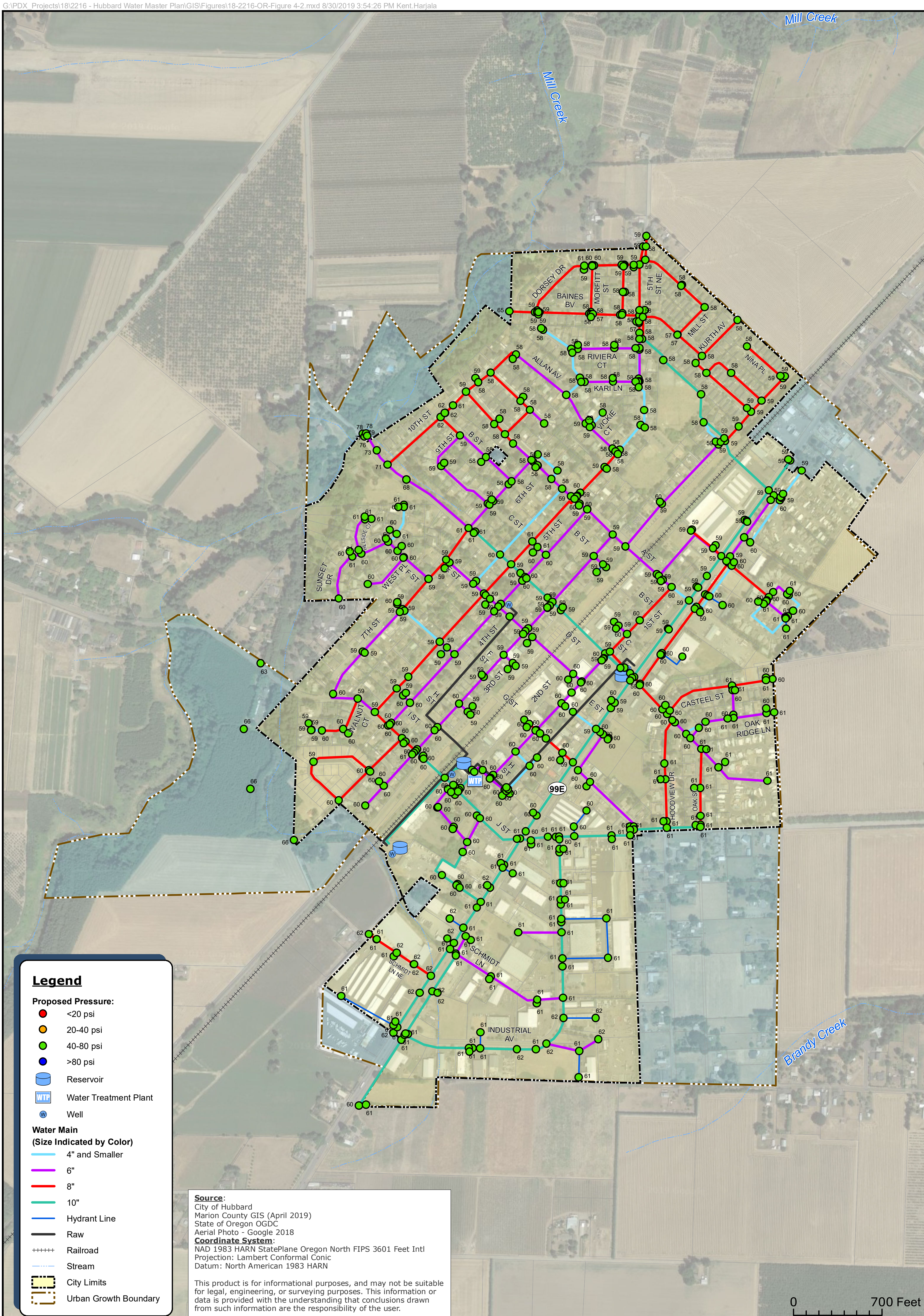

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City of Hubbard
Water System Master Plan
August 2019

Figure 4-2
Proposed Maximum Day Demand Pressures

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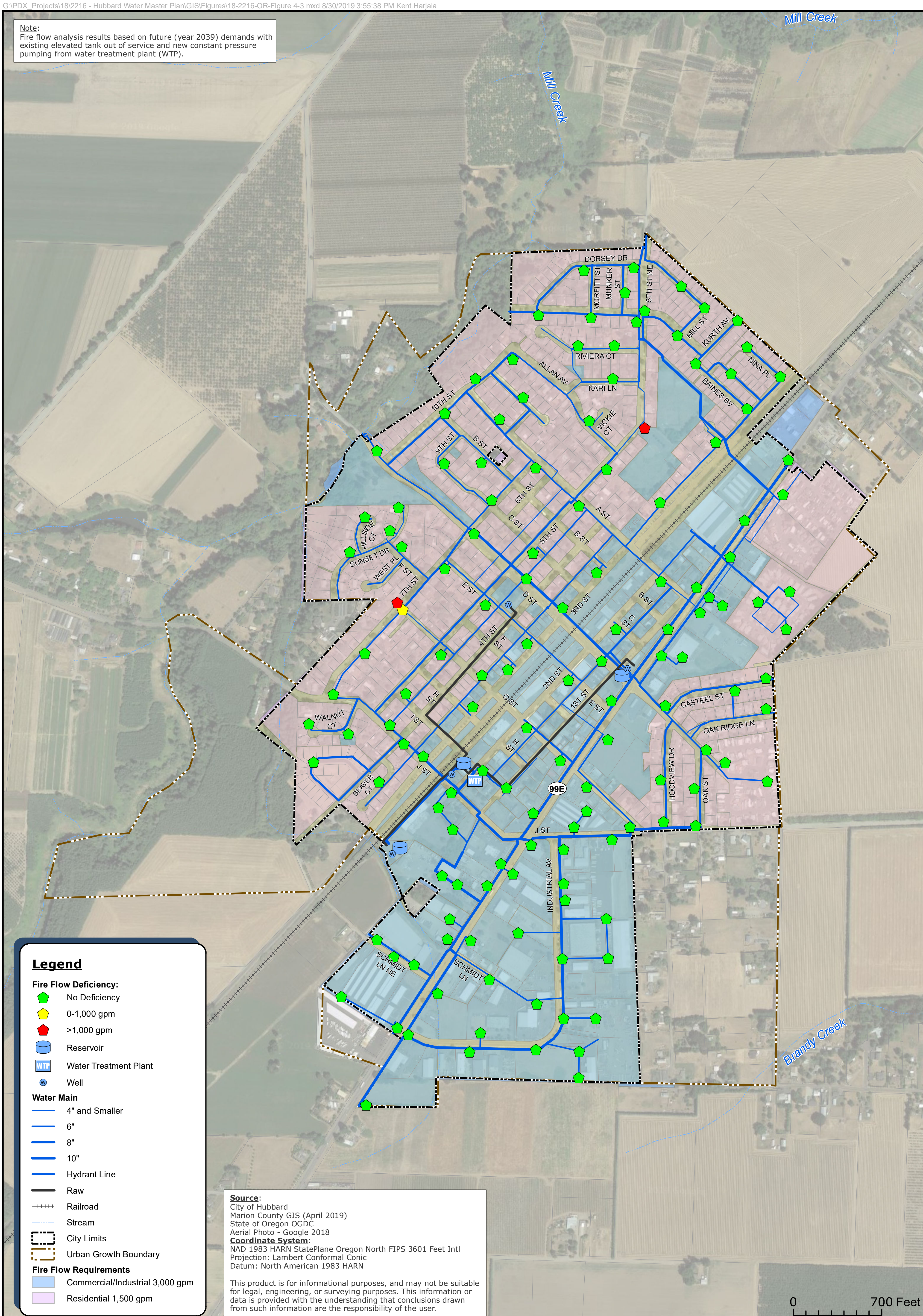

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Water System Master Plan
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Figure 4-3
Fire Flow Deficiencies

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Section 5

Section 5

Seismic Resilience Evaluation

5.1 Introduction

Cities throughout the region are increasingly aware of the risk to their infrastructure from potential seismic activity. Following recent seismic research which presented persuasive evidence on the imminent threat and extreme risk of a Cascadia Subduction Zone (CSZ) earthquake, the State of Oregon developed the Oregon Resilience Plan (ORP). The ORP established target timelines for water utilities to provide service following a seismic event. The ORP also recognized that currently, water providers and existing water infrastructure are unable to meet these recovery goals. To improve existing water systems' seismic resilience, one of the ORP's key recommendations was for water utilities to complete a seismic risk assessment and mitigation plan as part of their periodic Water Master Plan (WMP) update.

As part of this WMP, the City of Hubbard (City) has chosen to complete a general seismic assessment of their existing water system. The scope of this evaluation includes creating a map of existing geologic/geotechnical and seismic data to develop a preliminary understanding of subsurface conditions and potential seismic hazards. Critical water supply locations will be identified. Recommended improvements to mitigate specific facility risks are to be assessed by the City as follow-on work to this WMP.

5.2 Key Water System Facilities

Key water system facilities should have water service uninterrupted or quickly restored, consistent with ORP Target States of Recovery table for Water utilities in the Willamette Valley, see Figure 5-1. The City of Hubbard is relatively small and has a well supply on the same site as the treatment plant and storage. This complex serves as the backbone for the system. There are no critical customers such as hospitals, emergency shelters, schools, or nursing homes in Hubbard that would need water immediately. Even if the distribution system is destroyed, residents can come to this site to get drinking water.

Figure 5-1
Oregon Resilience Plan (ORP) Target States of Recovery for Willamette Valley Water Utilities

KEY TO THE TABLE

TARGET TIMEFRAME FOR RECOVERY:

Desired time to restore component to 80–90% operational	G
Desired time to restore component to 50–60% operational	Y
Desired time to restore component to 20–30% operational	R
Current state (90% operational)	X

TARGET STATES OF RECOVERY: WATER & WASTEWATER SECTOR (VALLEY)

	Event occurs	0–24 hours	1–3 days	3–7 days	1–2 weeks	2 weeks–1 month	1–3 months	3–6 months	6 months –1 year	1–3 years	3 + years
Domestic Water Supply											
Potable water available at supply source (WTP, wells, impoundment)		R	Y		G			X			
Main transmission facilities, pipes, pump stations, and reservoirs (backbone) operational		G					X				
Water supply to critical facilities available		Y	G				X				
Water for fire suppression—at key supply points		G		X							
Water for fire suppression—at fire hydrants				R	Y	G			X		
Water available at community distribution centers/points			Y	G	X						
Distribution system operational			R	Y	G				X		

5.2.1 Water System Backbone

A water system backbone of key supply, treatment, and storage facilities was identified based on typical system operations. Key City water facilities and their critical supply and distribution functions are summarized in **Table 5-1**.

Table 5-1
Key Water System Facilities

Priority	Facility Name	Critical Functions
1	Well 1	▪ Onsite Supply Source for WTP
2	Reservoir 1	▪ Onsite Reservoir at WTP
3	WTP	▪ Main supply for the City

5.3 Seismic Hazards Evaluation

The seismic hazards evaluation for the Hubbard water service area was conducted by geotechnical engineers McMillen Jacobs and Associates, as summarized in the following paragraphs.

5.3.1 Seismicity and Assessment Earthquake

The Pacific Northwest is located near an active tectonic plate boundary. Off the coast, the Juan de Fuca oceanic plate is subducting beneath the North American crustal plate. This tectonic regime has resulted in seismicity in the Pacific Northwest occurring from three primary sources:

- Shallow crustal faults within the North American plate
- CSZ intraplate faults within the subducting Juan de Fuca plate
- CSZ megathrust events generated along the boundary between the subducting Juan de Fuca plate and the overriding North America plate

Among these three sources, CSZ megathrust events are considered as having the most hazard potential due to the anticipated magnitude and duration of associated ground shaking. Recent studies indicate that the CSZ can potentially generate large earthquakes with magnitudes ranging from 8.0 to 9.2, depending on rupture length. The recurrence intervals for CSZ events are estimated at approximately 500 years for the meg-magnitude full rupture events (magnitude 9.0 to 9.2) and 200 to 300 years for the large-magnitude partial rupture events (magnitude 8.0 to 8.5). Goldfinger et al. (2016) recently completed research on prehistoric recurrence based on the investigation of ocean sediments. The research indicates the region is "past due," thus, future occurrence is anticipated. For example, over the next 50 years, the CSZ earthquake has an estimated probability of occurrence on the order of 16 to 22 percent.

Results of a CSZ event may include hazards such as severe ground shaking, liquefaction settlement, lateral spreading, and/or seismic-induced landslides. The hazards have the potential to damage facilities (i.e., pipelines, reservoirs, pump stations, treatment plants) through either permanent ground deformation (PGD) or intense shaking. The analysis of the seismic hazards is based on Oregon Department of Geology and Mineral Industries (DOGAMI) hazard maps and publicly available geotechnical information of the area.

DOGAMI issued their report titled Ground Motion, Ground Deformation, Tsunami Inundation, Coseismic Subsidence, and Damage Potential Maps for the 2012 Oregon Resilience Plan for Cascadia Subduction Zone Earthquakes (DOGAMI, 2013). This report was based on the previous DOGAMI published documents, one of which included the Woodburn-Hubbard area.

5.3.2 Subsurface Condition Assessment

Seismic hazards were evaluated based on existing M9 CSZ earthquake hazard maps by DOGAMI (Madin and Burns, 2012). Geotechnical exploration data and subsurface boring logs from Marion County and well logs from Oregon Water Resources Department (OWRD) were used in conjunction with the DOGAMI mapping to assess this area.

5.3.3 Seismic Hazard Findings

The likelihood and magnitude of three sources of seismic hazard were analyzed:

- Ground shaking
- Liquefaction
- Landslides

These hazards all have the potential to damage buried water mains and other water facilities.

5.3.3.1 Ground Shaking

The rapid and extreme shaking during an earthquake can cause transient stress and strain in pipelines that can be damaging if the pipe material and joints are not strong enough to withstand the shaking. Damage from ground shaking occurs even when there is no permanent ground deformation. The intensity of ground shaking can be quantified with the peak ground velocity (PGV) at a site due to an earthquake.

The estimated ground shaking intensity (PGV) depends on the subsurface materials. The ground shaking near the surface will be amplified by thick soil units overlying deep bedrock. In most the water service area, the PGV is estimated to be 9-10 in/s. **Figure 5-2** shows estimated PGV for the water service area.

5.3.3.2 Liquefaction

Liquefaction occurs when saturated soil experiences enough shaking that it loses its shear strength and transforms from a solid into a nearly liquid state. The results of soil liquefaction include loss of bearing capacity, loss of soil materials through sand boils or flow, flotation of buried chambers and pipes, and post-liquefaction reconsolidation (ground settlement). The DOGAMI mapping for the area shows the area within Hubbard city limits as "Not Liquefiable", but some areas surrounding the city limits are mapped as "Medium (5 to 15 percent)" probability of liquefaction. A review of subsurface conditions in the area as silt, sandy silt, and silty sand of the alluvial deposits contradict the mapping and are potentially liquefiable to a depth of 50 feet below ground surface. The anticipated liquefaction settlement hazards for the Hubbard water service area are illustrated on **Figures 5-3** and **5-4**.

5.3.3.3 Landslide

Earthquake induced landslides can occur due to the inertial force from an earthquake adding load to a slope. The ground movement due to landslides can be extremely large and damaging to pipelines.

The hazard to earthquake-induced Landslide Probability in the majority of Hubbard during an M9 Cascadia event is shown as "None" by DOGAMI's most recent regional seismic hazard report. DOGAMI's 1999 mapping shows a low potential for earthquake-induced landslide hazards, however, it includes regions of a moderate hazard located adjacent to banks of small streams.

According to the Statewide Landslide Information Database for Oregon (SLIDO) sloping regions within the city limits are shown to have a moderate level landslide hazard. This area, mapped, is shown along the banks of Mill Creek and what appears to be an ancient drainage feature that runs east-west through the central part of Hubbard along D Street. No known historic or ancient landslides are mapped within Hubbard. It is noted that DOGAMI's SLIDO is a mapping system for landslide risks based on static conditions only. The map is mostly derived by reviewing LIDAR imaging and is generally dependent on the existing topography. The potential landslide hazard zones are shown in **Figure 5-5**.

5.3.3.4 Seismic Hazard Findings Summary

In the absence of site-specific boring information at the water facilities, and the limited subsurface information available for Hubbard, generalized engineering estimates regarding potential magnitudes of settlement and lateral spread due to liquefiable soils were used to analyze the system. This can be considered a conservative approach. Those soils below the static water level to be potentially liquefiable up to a depth of 50 feet below the surface were considered. Fine grained and coarse-grained soils beneath the water level, as described on the well logs and geotechnical hole reports, were assumed to have a potential vertical settlement of 1 and 3 percent of strata thicknesses, respectively.

This evaluation resulted in potential vertical settlement up to 3 inches within most of Hubbard. Where well logs and geotechnical hole reports cited sandy subsurface condition, such as the south quadrant of Hubbard at D and G Streets, 3 to 6 inches of potential vertical settlement due to liquefiable subsurface conditions can be expected.

Based on the general level topography of the area, the risk of lateral spread due to liquefiable conditions was considered to be low. However, at the northwest edge of Hubbard limits along the sloping banks of Mill Creek, it is estimated that the magnitude of displacement during a Cascadia event would be on the order of 6 to 12 inches. The risks along the sloping portions adjacent to D Street are considered to have a similar level of risk.

Since the rest of the City is mostly flat, it is generally considered that the risk of landslides during a Cascadia event would be negligible. However, similar to the risks of lateral spreading, the northwest limits of Hubbard where sloping ground is present is considered to be of moderate to high level of risk. The sloping portions adjacent to D Street are considered to have moderate risk of movement during an M9 Cascadia event as well. Without specific subsurface information for the site, it is also recommended to have a 200-foot wide buffer for the sloping regions of the site.

The DOGAMI seismic hazard mapping was modified to include the recommendations of risk level. This revised mapping is provided in Figures 5-2 through 5-5.

Due to the lack of subsurface information it is recommended that a site-specific geotechnical evaluation be conducted where critical water system facilities are located. This should be considered prudent to effectively evaluate the conditions of existing structures within the water system.

5.4 Water Facility Seismic Vulnerability

5.4.1 Impact of Site Conditions

Most of the City's area including storage and pumping facilities are located on flat or relatively gentle slopes or hills, where slope instability is not common.

5.4.1.1 Structure Condition Findings Summary

Most facilities identified are in generally good condition. However, significant updates to code provisions for seismic design and detailing criteria have occurred since most structures were designed, which may lead to additional upgrades depending on the level of risk the City is willing to accept.

Storage racks, piping, HVAC, tanks, pumps, and control panels in WTP generally were designed before adequate bracing for seismic resistance was prevalent. It is recommended that these be evaluated and upgraded with code compliant seismic bracing. Specific ratings and notes for each water facility structure are summarized in Table 5-2.

Table 5-2
Structure Seismic Performance Investigation

Water Facility	Notes
Well 1	▪ Historically wells have survived seismic events better than other source types
Well 2	▪ Historically wells have survived seismic events better than other source types
Well 3	▪ Historically wells have survived seismic events better than other source types
Well 4	▪ Historically wells have survived seismic events better than other source types
WTP/pumps	▪ Since this is a critical facility, an in-depth seismic investigation is recommended.
Elevated Reservoir	▪ No seismic upgrades have been completed for this reservoir, and it is aging, so could potentially cause damage in a seismic event
Reservoir 1	▪ Unable to verify seismic performance, recommend more in-depth seismic investigation
Reservoir 2	▪ Unable to verify seismic performance, recommend more in-depth seismic investigation

5.5 Design Standards for Seismic Resilience

Oregon Structural Specialty and Mechanical Specialty Codes will dictate that all new water facility construction meet current earthquake standards which are based on an M9 event. Suggestions for City design and construction standards include the following.

5.5.1 Pipelines

Restrained joint ductile iron pipe provides the best balance of cost, performance, and life cycle. Fully restrained ductile iron pipe reduces the risk of separation at standard push-on joints and allows limited deflection as a result of ground shaking and ground deformation.

5.5.2 Reservoirs

It is assumed that future reservoir structures will be designed to meet earthquake standards consistent with current Structural and Mechanical Specialty codes, but existing reservoirs likely need to be retrofitted. There are two key design considerations associated with reservoir configuration and connections to the distribution system:

- Pipe to reservoir connections
- Automated isolation valves

5.5.2.1 Pipe to Reservoir Connections

At each distribution or transmission piping connection to the reservoir, significant stress can be placed on the pipe as a result of the difference in response to ground motion and deformation by the pipe and reservoir foundation. To minimize the risk of pipe breakage at this location, it is recommended that a flexible expansion joint be installed at this interface. Flexible expansion joints must be capable of allowing axial expansion/contraction and differential movement that results in a vertical or horizontal offset.

5.5.2.2 Automated Isolation Valves

Automated isolation valving with seismic valve actuators should be considered at all reservoir piping connections. There are several considerations to be weighed in determining whether to use an automatic shut-off valve at each reservoir as summarized in **Table 5-3**.

Table 5-3
Automatic Shut-off Valve Considerations at Reservoirs

If a seismic valve actuator is used for automatic shut-off at reservoirs:	YES	NO
Water Available for Fire Suppression Immediately After Event?		✓
Reservoir Water Volume Preserved for Use During Recovery?	✓	
Requires Maintenance of Batteries for Valve Actuation?	✓	
Vulnerable to Accidental Closure due to False Alarm?	✓	

The City should consider the specific performance objectives of each reservoir associated with a seismic event and the anticipated response and recovery period to determine whether the installation of seismically actuated valves is warranted. For example, since both reservoirs serve the City, one may be equipped with seismic valves to preserve the water volume for future use during recovery while the other will remain connected to the system to provide fire suppression and emergency water with the risk that this volume may be lost through main breaks.

5.5.3 Ground-level Pumps

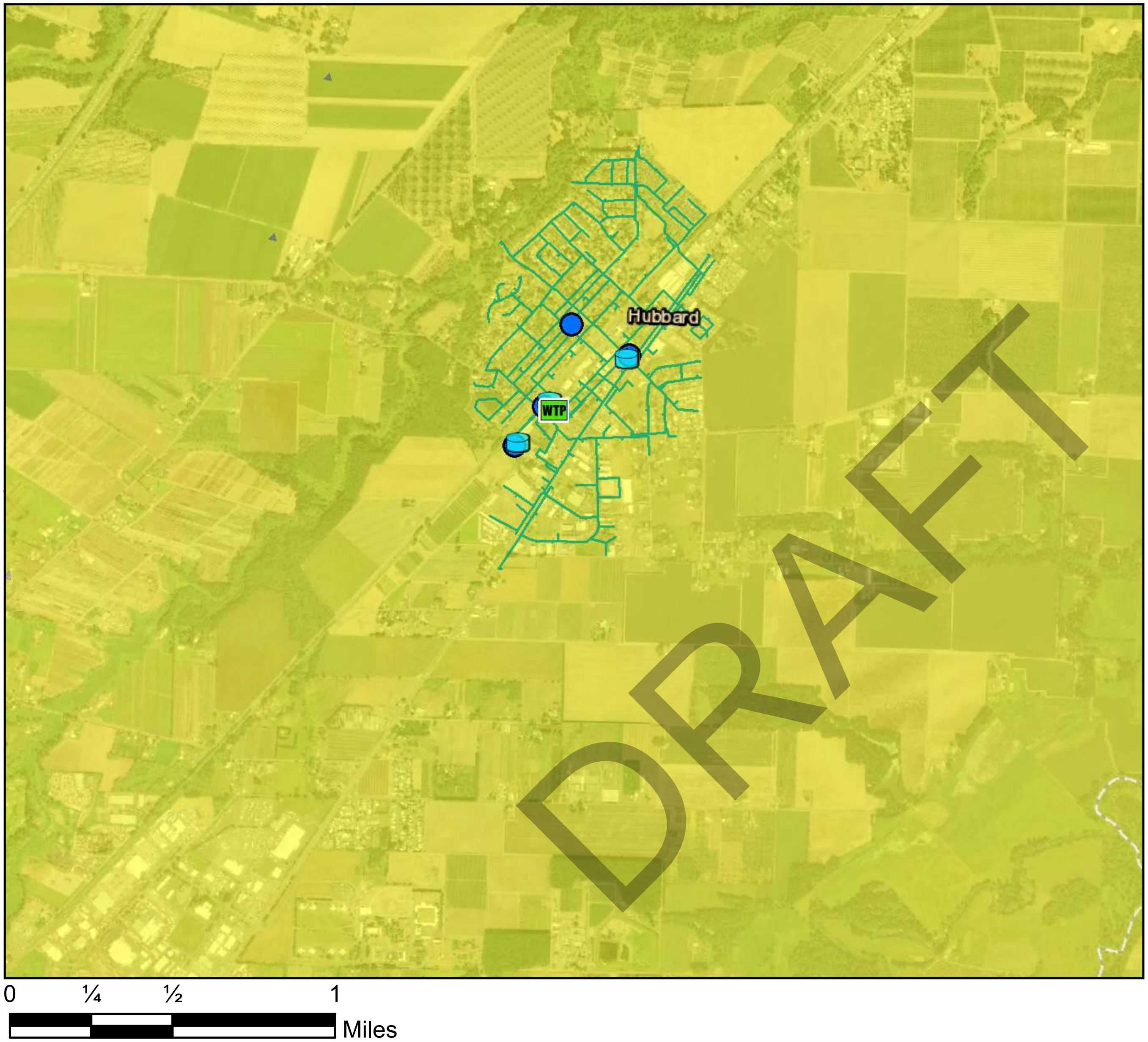
Similar to reservoir structures, pipe connections at the WTP building present specific vulnerability as a result of differential movement and settlement. To minimize the risk of pipe breakage at this location, it is recommended that a flexible expansion joint be installed at this interface. Flexible expansion joints must be capable of allowing axial expansion/contraction and differential movement that results in a vertical or horizontal offset.

Standby power should also be provided, in the form of a standby generator, at all critical pumps. The standby generator should be equipped with on-site fuel storage for at least 48 hours of operation. While a significantly greater volume of fuel will likely be required to sustain operation of the generator through the recovery period following a seismic event, storage of greater volumes of fuel present complications and are likely not economically feasible.

5.6 Next Steps

This initial seismic evaluation demonstrates that there are moderate risks to the City's water system during a seismic event. It is recommended that the City:

- Continue coordination with emergency managers to refine understanding of post-disaster water needs which will inform water facility performance goals and design choices.
- Pursue a more detailed analysis of vulnerable facilities to develop a 50-year seismic Capital Improvement Program (CIP) consistent with the Oregon Resilience Plan.



Legend

- Water Treatment Plant
- Reservoirs
- Wells
- Pipes

PGV (in/s)

- 7 - 8
- 9 - 10
- 11 - 13

PEAK GROUND VELOCITY MAP

NOTES:

PEAK GROUND VELOCITY ESTIMATES SHOWN ARE BASED ON DATA FROM EXISTING BORINGS AND DOGAMI OPEN FILE REPORT O-13-06.

AREAS OUTSIDE OF EXISTING BORINGS HAVE NOT BEEN VERIFIED.

BASEMAP: Esri, HERE, Garmin, © OpenStreetMap contributors, and the GIS user community
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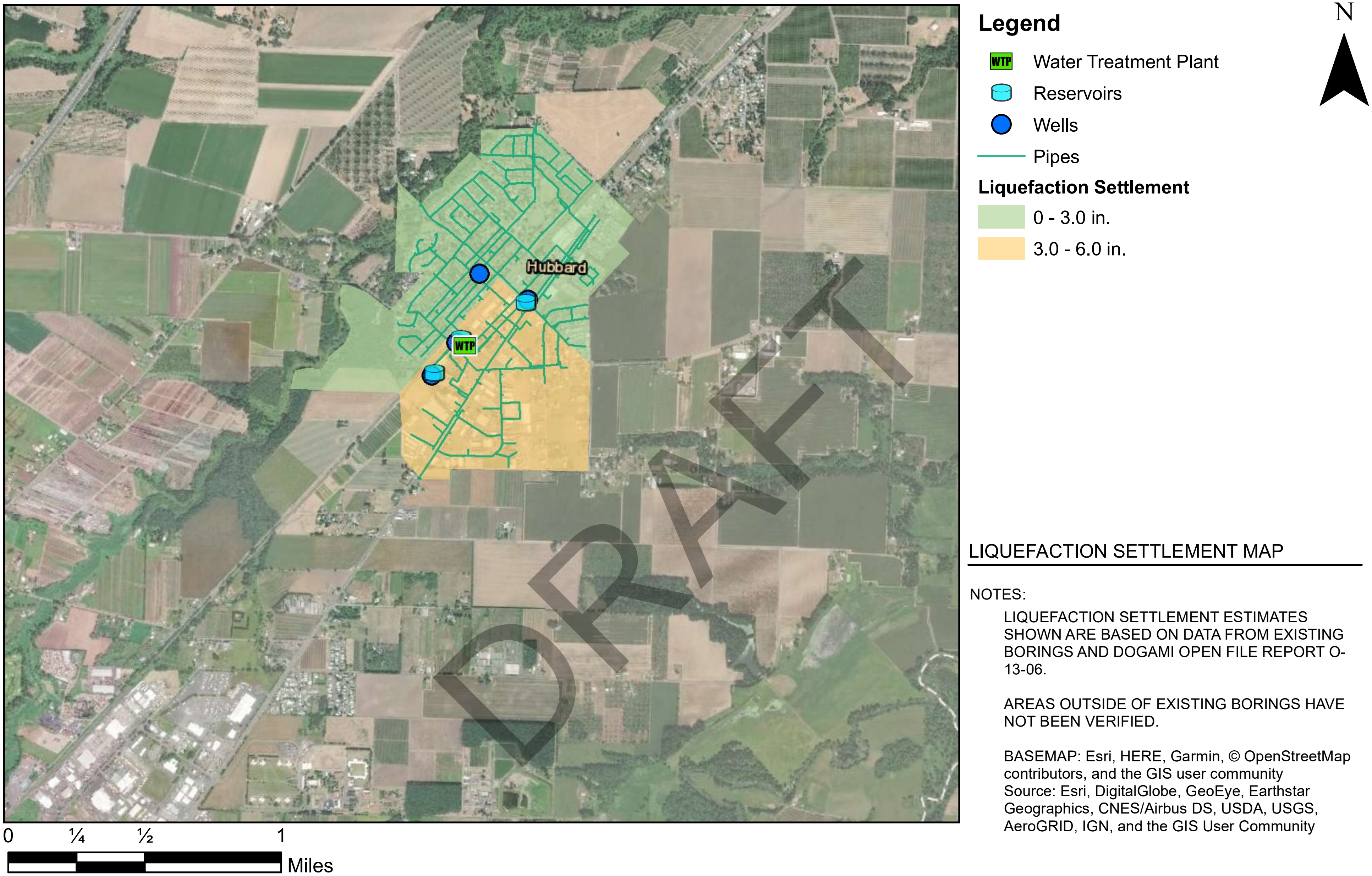
McMILLEN JACOBS ASSOCIATES

HUBBARD WATER SYSTEM SEISMIC RESILIENCY EVALUATION
HUBBARD, OR

October 2018

LIQUEFACTION SEISMIC HAZARDS TECHNICAL MEMORANDUM
PEAK GROUND VELOCITY MAP

FIGURE 5-2



LIQUEFACTION SETTLEMENT MAP

NOTES:

LIQUEFACTION SETTLEMENT ESTIMATES SHOWN ARE BASED ON DATA FROM EXISTING BORINGS AND DOGAMI OPEN FILE REPORT O-13-06.

AREAS OUTSIDE OF EXISTING BORINGS HAVE NOT BEEN VERIFIED.

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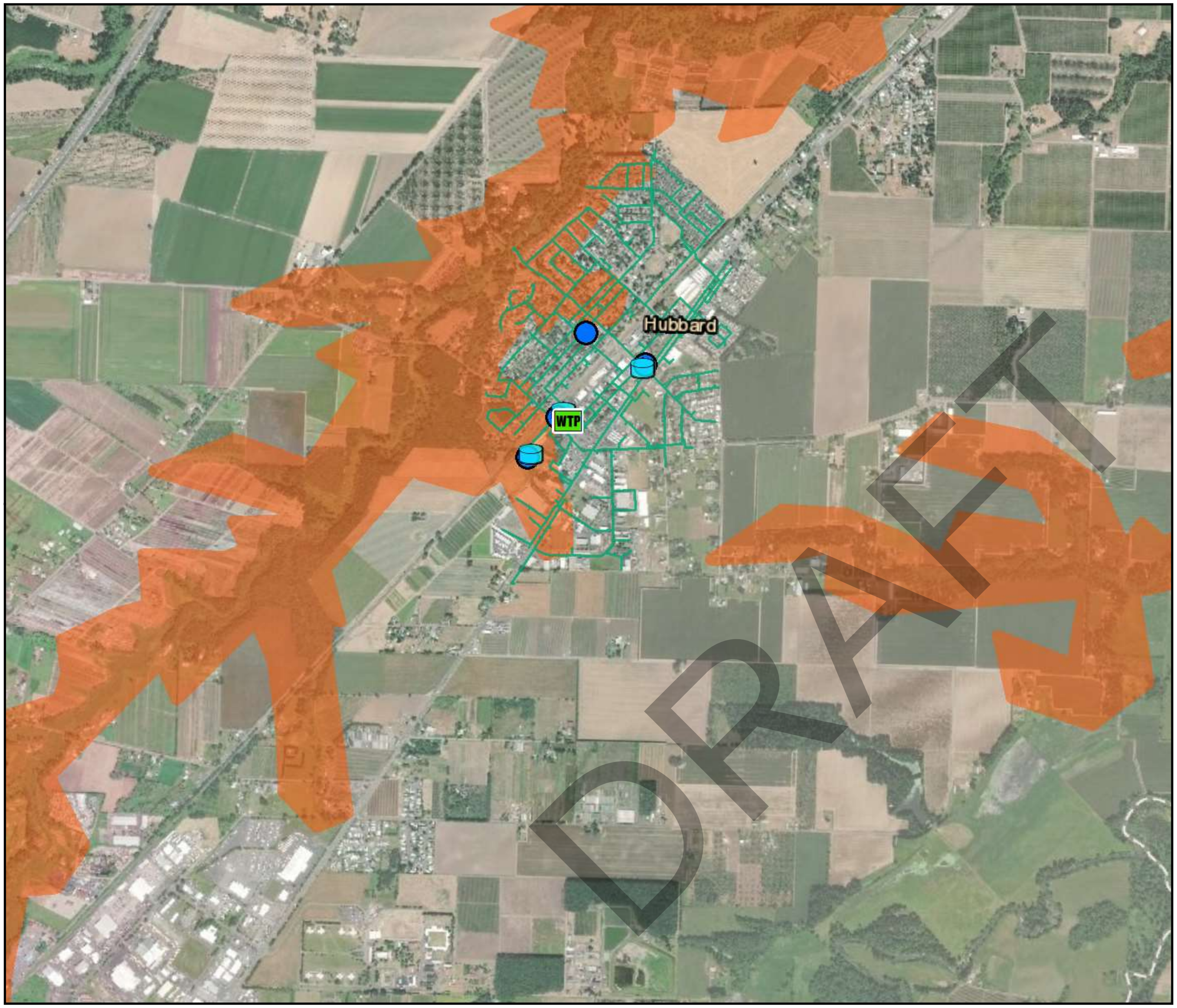
HUBBARD WATER SYSTEM SEISMIC RESILIENCY EVALUATION
HUBBARD, OR

October 2018

LIQUEFACTION SEISMIC HAZARDS TECHNICAL MEMORANDUM
LIQUEFACTION SETTLEMENT MAP

FIGURE 5-3



0 ¼ ½ 1
Miles

N

Legend

- WTP Water Treatment Plant
- Reservoirs
- Wells
- Pipes

Lateral Spreading PGD

- No displacement
- Up to 12.0 in. displacement

LIQUEFACTION LATERAL SPREADING MAP

NOTES:

LIQUEFACTION LATERAL SPREADING ESTIMATES SHOWN ARE BASED ON DATA FROM EXISTING BORINGS AND DOGAMI OPEN FILE REPORT O-13-06.

AREAS OUTSIDE OF EXISTING BORINGS HAVE NOT BEEN VERIFIED.

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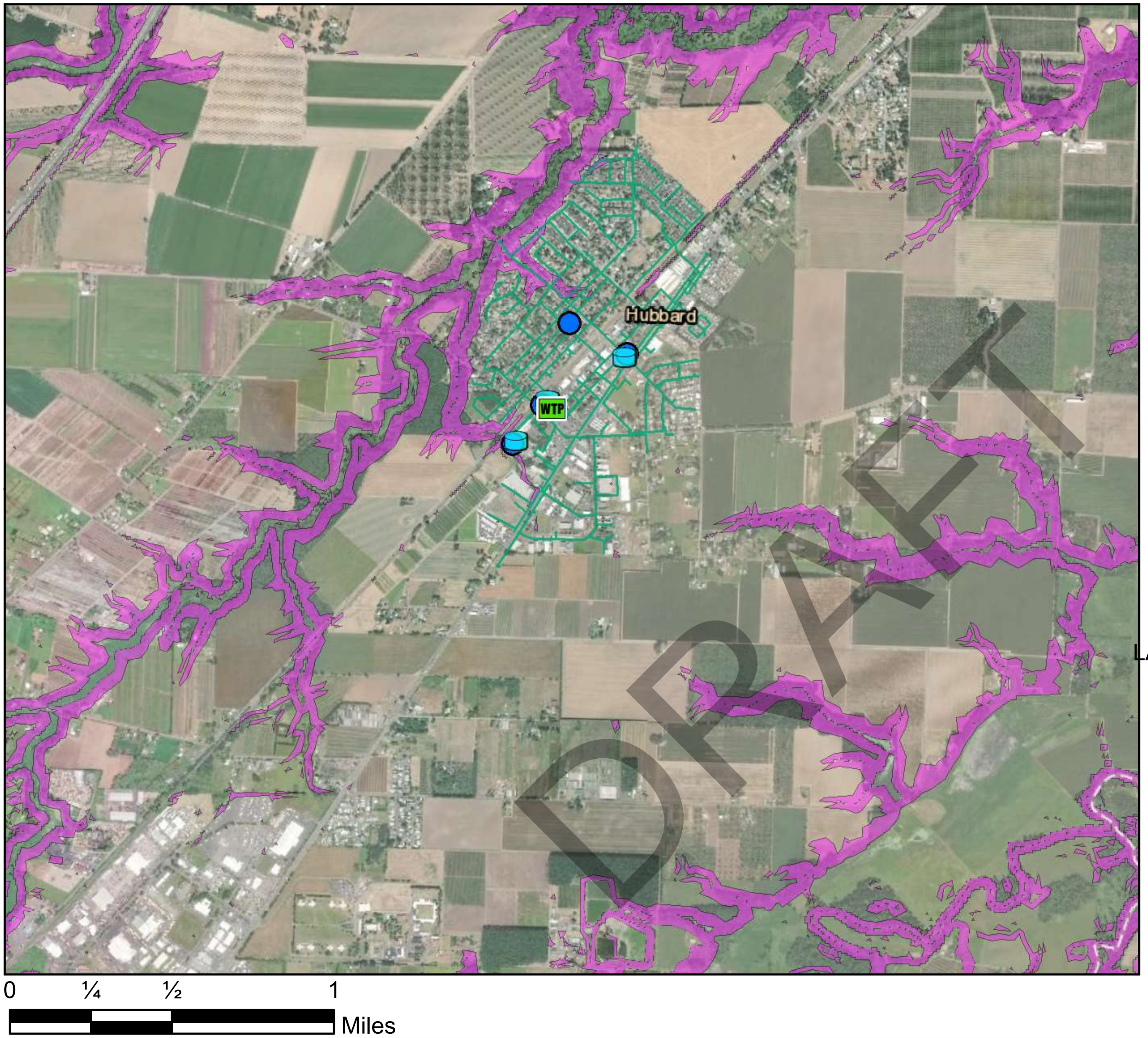
McMILLEN JACOBS ASSOCIATES	HUBBARD WATER SYSTEM SEISMIC RESILIENCY EVALUATION HUBBARD, OR	October 2018
	LIQUEFACTION SEISMIC HAZARDS TECHNICAL MEMORANDUM LIQUEFACTION LATERAL SPREADING MAP	FIGURE 5-4



LANDSLIDE SUSCEPTIBILITY MAP

NOTES:

LANDSLIDE SUSCEPTIBILITY ESTIMATES SHOWN ARE BASED ON DATA FROM EXISTING BORINGS AND DOGAMI OPEN FILE REPORT O-13-06.

AREAS OUTSIDE OF EXISTING BORINGS HAVE NOT BEEN VERIFIED.

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HUBBARD WATER SYSTEM SEISMIC RESILIENCY EVALUATION
HUBBARD, OR

October 2018

LIQUEFACTION SEISMIC HAZARDS TECHNICAL MEMORANDUM
LANDSLIDE SUSCEPTIBILITY MAP

FIGURE 5-5

Section **6**

Section 6

Operations and Maintenance

6.1 Introduction

This section presents an assessment of the City of Hubbard's (City's) Water System Operations and Maintenance (O&M) program. The assessment is based on information from City staff compared with American Water Works Association (AWWA) standards, the O&M practices of similarly sized utilities, and pertinent regulatory requirements. Recommendations for improvements to the City's O&M program, described at the end of this section, are based on the results of this assessment.

6.2 Existing O&M Structure

The City's Public Works Department staff are responsible for the maintenance and operation of the water distribution and treatment systems. Hubbard Public Works staff also are responsible for wastewater, streets, and parks. Public Works is currently budgeted for 5.5 FTEs.

6.3 O&M Regulations and Guidelines

Oregon Administrative Rules (OAR) 333-061-0065 govern O&M of public water systems with the primary directive that they be "operated and maintained in a manner that assures continuous production and distribution of potable water." These rules establish general requirements for leak repair, proper and functioning equipment, emergency planning, and current documentation.

The AWWA G200 Distribution Systems Operation and Management standard provides recommendations for routine maintenance programs, handling customer complaints, and record keeping which address the O&M goals and requirements of the OAR.

The City has also established ordinances regarding connection to the water system, cross-connection, backflow prevention, and water conservation and curtailment as described in Hubbard Municipal Code Chapter 13.15 and 13.25.

6.4 Operator Certification

OAR 333-061-0235 defines requirements for water system operator certification. Personnel in charge of operations for all community water systems, like Hubbard's water system, are required to be certified through the Oregon Water System Operator's Certification Program. Water distribution and water treatment operators must receive certification in accordance with the classification of the system they operate. The City's classifications are:

- Water Treatment 1 – based on the complexity of water treatment required

- **Water Distribution 2** - based on a service area population between 1,500 and 15,000 people

State guidelines also require water suppliers to identify an operator with these levels of certification as being in "direct responsible charge" (DRC) of the treatment and distribution systems. In Hubbard, these roles are currently filled by the Public Works Superintendent, Michael Krebs.

6.5 Current O&M Practices and Procedures

City staff implement procedures to ensure that the water system facilities function efficiently and meet level-of-service requirements (e.g., water quality and adequate service pressure). Routine procedures include visual inspection of system facilities, monitoring flow- and reservoir-level recording, and responding to customer inquiries and complaints. City staff handle the majority of O&M duties; however, tasks such as major water main repairs, well rehabilitation and reservoir painting are sourced to outside contractors.

6.5.1 System Operation

The City maintains and operates all facilities and appurtenances within the system, including customer meters. The customer is responsible for maintaining the water service line beyond the meter. Meter reading is performed using Sensus Meters that are touch read.

Each well and reservoir is typically inspected two times weekly to ensure security, proper operation, and site maintenance. Chlorine residual and water levels are hand measured bi-weekly to verify well level and that reservoir indicators are reading accurately.

Field personnel monitor the water system's performance every day at the City's Water Treatment Plant (WTP). SCADA records metered flow at all wells, pressure at the ground level pumps, and water levels in the City's finished water storage reservoirs. Flow out of the WTP to distribution mains and storage reservoirs is recorded at the ground level pumps. The volume of water produced at the WTP is totalized and recorded. Water personnel can use this data to detect any major abnormalities in the water system.

Water quality monitoring, as described in **Table 6-1**, is also performed by operations staff.

6.5.2 System Preventive Maintenance

The City's current preventive maintenance program consists of the regularly- scheduled activities shown in **Table 6-1**.

Table 6-1
Regularly Scheduled Maintenance

Scheduled Activities	Frequency
Uni-directional flushing of water mains	Annually
Servicing pumps (motor, seals, etc.)	Annually
Exercising valves	Annually
Inspecting and cleaning reservoirs	Every 5-6 years
Control valves inspected and serviced	Annually or as needed
Filters backwashed	Every 16 hours
Chlorine changed	Every month
Generator Exercised	Weekly
Non-duty pumps exercised	Weekly

Other maintenance activities regularly performed by City staff include:

- Maintain grounds around City facilities
- Address customer complaints

6.5.3 Record Keeping

Current water system mapping is maintained by the City using Geographic Information Systems (GIS). The City does not currently use asset management techniques but is in the process of setting up their GIS system to function in this capacity.

6.5.4 Customer Complaints

Customers may call or email to file a complaint with any member of City staff. The initial contact forwards the complaint to the correct department, and depending on the nature of the complaint, it is investigated immediately or as much as several days later. Complaints are addressed in the order of their severity and major issues are recorded by the City.

6.6 Conclusions and Recommendations

An effective O&M program addresses issues with customer interaction, water quality, and infrastructure operations and maintenance. The City's current O&M program does not include some common best management practices of water utilities in the region. The City is currently evaluating water maintenance programs and assessing the need for additional routine maintenance.

Water distribution system O&M programs typically include the following maintenance programs:

- Pipeline replacement programs

- Leak detection.

To maintain a high level of service, the City should assess and identify critical components of the distribution system. To improve water distribution system O&M, it is recommended that the City develop the following programs:

1. A pipe replacement program based on a 100-year cycle as presented in **Section 7**.
2. A leak-detection program may provide value to the City. Typically, a leak detection program will provide value for systems with water loss rates in excess of 10 percent of annual water production.

Section **7**

Section 7

Recommendations and Capital Improvement Program (CIP)

7.1 Introduction

This section presents recommended improvements for the City of Hubbard's (City's) water distribution system based on the analysis and findings presented in Section 4. These improvements include well, pump, reservoir, treatment, and water main projects. The capital improvement program (CIP) presented in Table 7-3 later in this section summarizes recommended improvements and provides an approximate timeframe for project completion. Proposed distribution system improvements are illustrated in Figure 7-1.

7.2 Cost Estimating Data

An estimated project cost has been developed for each improvement project recommended in this section. Cost estimates represent opinions of cost only, acknowledging that final costs of individual projects will vary depending on actual labor and material costs, market conditions for construction, regulatory factors, final project scope, project schedule, and other factors. The Association for the Advancement of Cost Engineering International (AACE) classifies cost estimates depending on project definition, end usage, and other factors. The cost estimates presented here are considered Class 4 with an end use being a study or feasibility evaluation and an expected accuracy range of -30 percent to +50 percent. As the project is better defined, the accuracy level of the estimates can be narrowed.

Estimated project costs are based upon recent experience with construction costs for similar work in Oregon and southwest Washington and assume improvements will be accomplished by private contractors. Estimated project costs include approximate construction costs and an aggregate 45 percent allowance for administrative, engineering, and other project related costs. Estimates do not include the cost of property acquisition. Since construction costs change periodically, an indexing method to adjust present estimates in the future is useful. The Engineering News-Record (ENR) Construction Cost Index (CCI) is a commonly used index for this purpose. For purposes of future cost estimate updating; the current ENR CCI for Seattle, Washington is 12026 (May 2019).

7.3 Water System Capital Improvement Program

A summary of all recommended improvement projects and estimated project costs is presented in **Table 7-3** at the end of this section. This CIP table provides for project sequencing by showing prioritized projects for the 5-year, 10-year, and 20-year timeframes defined as follows:

- 5-year timeframe - recommended completion between 2020 and 2024
- 10-year timeframe - recommended completion between 2025 and 2029
- 20-year timeframe - recommended completion between 2030 and 2039

7.3.1 CIP Cost Allocation to Growth

Water system improvement projects are recommended to mitigate existing system deficiencies and to provide capacity to accommodate growth and water service area expansion. Projects that benefit future water system customers by providing capacity for growth may be funded through system development charges (SDCs). SDCs are sources of funding generated through development and water system growth and are typically used by utilities to support capital funding needs. SDCs are determined as part of a financial evaluation and are based in part on a utility's current CIP. To facilitate this financial evaluation, a preliminary percentage of the cost of each project which benefits future water system growth is allocated in **Table 7-3**. At the end of this section, an updated SDC Improvement Fee is presented based on the proposed CIP.

Improvements to existing facilities that benefit existing and future customers are considered water system performance improvements which benefit all customers. Their estimated costs are allocated 47 percent to future growth based on the ratio of current (year 2017) to projected future (year 2039) system-wide average day demands.

7.4 Water Source and Treatment

As presented in **Table 4-1** the City has adequate system-wide source and treatment capacity to meet projected maximum day demand (MDD) through the 20-year planning horizon, but water quality may become an issue if left in the current condition. Preventative maintenance is also important.

7.4.1 On-going Well Rehabilitation

It is recommended that the City continue their current program of well rehabilitation to mitigate the effects of well screen biofouling and maintain existing well capacity to the greatest extent possible. The City currently rehabilitates 1-2 wells every 5-6 years.

Since some of the City's water rights are draw-down dependent, it is important that the City monitor pumping rates with drawdown to see if there are any downward trends over time.

7.4.2 Treatment Improvements

It is recommended that the City modify their current treatment regimen in the treatment plant for arsenic. The City should install a system that paces chemical addition with the actual amount of flow coming into the plant. Contaminant removal through the green sand filter will increase if potassium permanganate injection is optimized for iron oxidation. The existing filter media will need to be replaced in the near-term as it is reaching the end of its useful life.

7.4.3 Meter Calibration and Replacement

There have been years in recent history where meter readings for consumption have been larger than readings for production. Meters should be calibrated at the wells, reservoirs, and WTP to better account for system usage. Residential meters are difficult or impossible to calibrate, so it is recommended to replace them after their useful life of 20 years. If the production meters cannot be calibrated properly, they should be replaced as well. Near-term CIP improvements (5-year) include calibrating and replacing production meters, as necessary. Beyond 10 years, a budget for systematic replacement of residential meters is included.

7.4.4 New Groundwater Production Well

While the City has adequate groundwater supply, at current production capacities, for the 20-year planning horizon, it is recommended that the City plan for the future construction of a new well to meet long-term water demands. Planning for the development of an additional groundwater well also addresses the potential for decline in production capacity in the City's existing wells. For the purposes of the CIP presented in this Plan document, the future production well (referred to herein as Well 5) is included in the 10-20 year CIP timeframe. The City should evaluate water production capacities against customer water demands every 2 to 3 years. Currently, maximum day demand is approximately 60 percent of the City's firm groundwater supply. If reduced production capacity or increased water demand results in demands approaching 80% of firm supply capacity, the City should plan to implement the design and construction of Well 5 within 2 years. In the near-term, the City should evaluate potential sites for Well 5 and review the status of water rights to support the development of additional groundwater capacity.

7.5 Pump Stations

7.5.1 Pumping Capacity Upgrade

Based on the pumping capacity analysis presented in Section 4, it is recommended that the City expand capacity at the existing WTP pumps. The pumps were designed to match the head from the elevated tank. The City desires to raise the pressure in the system, by raising pump head. This cannot be done with the existing end-suction pumps, so all of the pumps will need to be replaced. It is also recommended to add 2,500 gpm of additional fire flow capacity to reduce the need for additional pipe replacement projects and allow for one duty pump to be offline during a fire event.

During design, the total capacity of the system should be evaluated to determine the ideal pump configuration, but likely 5 pumps (the number the City currently has) are not needed. The new pumps should be connected to a generator and automatic transfer switch to allow for water service in case of a power outage. The estimates here assume that the existing generator will be sufficient for the proposed pumps. Total power requirements will be determined in the design phase. For cost estimating purposes, it is assumed a new pump station will be constructed at the WTP site.

It is recommended that the City implement a mitigation strategy to offset the potential negative impacts of an increase in distribution system pressure associated with this improvement. In particular, the City should expect to see an increase in the number of main breaks, especially on older cast iron mains, as a result of the pressure increase. In addition, a program of informing the public and providing technical assistance is recommended to address customer side water service breaks and other house plumbing issues. The City should expect the majority of issues to occur within the first year after the pump station improvement is completed and water system pressure is increased. The City's O&M budget should be increased to support the increased labor and materials burden associated with this transition.

7.5.2 SCADA Improvements

The SCADA system software is old, radios are obsolete, and the system no longer meets the needs of the City. The City is currently working with The Automation Group (TAG) to identify a budget for SCADA upgrades. For the purposes of this Master Plan, a CIP project with a preliminary cost of $100,000 is assumed.

7.6 Reservoirs

7.6.1 Elevated Reservoir

The elevated reservoir is aging, doesn't have proper seismic restraint, and is at an elevation that is too low to deliver desired pressures to the City. The elevated reservoir should be abandoned and replaced with a new constant pressure pump station. The City has noted existing agreements with cell phone companies to use the reservoir as a location for antennae. It is beyond the scope of a water master plan to evaluate whether it would be more beneficial to retrofit the reservoir to be seismically stable when empty to maintain these contracts, but the City should initiate investigations to determine the future of the elevated reservoir as a historic landmark and revenue source from cell antenna lease agreements.

7.7 Distribution Mains

Recommended water main projects are illustrated in **Figure 7-1** to increase fire flow in strategic areas. Water main project costs are estimated based on unit costs by diameter shown in **Table 7-1**. With improvements to system pressures, there are two water main improvement projects recommended to address fire flow, G Street (to be completed in multiple phases) and 6th Street between Allen Avenue and Kari Lane.

Two future main extensions are shown in areas of potential growth. It is anticipated that these system expansions will be funded and constructed by development and are not included in the CIP.

7.7.1 Fire Hydrant Replacement Program

The City has approximately 40 hydrants throughout town that are either in poor condition or are an older style of 2-port hydrant that is not compatible with existing fire fighting apparatus. It is recommended that the City complete a program over the next 10 years to replace all of these aging hydrants. A CIP budget item is included to fund the replacement of an average of 4 hydrants per year over a 10-year period.

Table 7-1
Unit Cost for Water Main Projects

Pipe Diameter	Cost per Linear Foot ($/LF)
8-inch	$219
10-inch	$264
12-inch	$330

1. Assumptions:
2. Includes approximately 45 percent allowance for administrative, engineering and other project related costs
3. Ductile iron pipe with an allowance for fittings, valves and services
4. Surface restoration is assumed to be asphalt paving
5. No rock excavation
6. No dewatering
7. No property or easement acquisitions
8. No specialty construction included

7.7.2 Routine Main Replacement Program

In addition to distribution main projects to address capacity deficiencies, the City should plan for replacement of pipes based on a 100-year life cycle to maintain reliable operation, without significant unexpected main breaks and leaks. **Table 7-2** summarizes the total length of pipe for each diameter (size), the replacement diameter, and estimated cost to replace all the mains of that size. While costs will vary for each individual main depending on the piping location, surface conditions, and other constructability issues, this analysis provides a preliminary estimate of the required capital budget to execute an effective and proactive water main replacement program.

The cost for routine main replacement included in this plan is based on the average annual cost for the first 10 years of a 100-year program, approximately $197,000 annually, beginning in the year 2030. While it is understood that funding at this level for pipeline replacement may not be feasible, it should be recognized that an adequately funded main replacement program is necessary to minimize the risk of failure for critical water system components that will result in significantly greater costs to repair and replace in the future.

Table 7-2
Distribution Main Replacement Cost Summary

Diameter	Approx. Length (ft)	Replacement Diameter	Estimated Replacement Cost	Annual Replacement Cost
≤4”	8,254	8”	$1,812,000	$19,000
6”	35,389	8”	$7,767,000	$78,000
8”	23,647	8”	$5,190,000	$52,000
10”	17,925	10”	$4,725,000	$48,000
Total Length	**85,215**	**Total Cost**	**$19,494,000**	**$197,000**

Table 7-3
CIP Summary

Improvement Category	CIP No.	Project Description	CIP Schedule and Project Cost Summary 5-year thru 2024	10-year 2025-2029	20-year 2030-2039	TOTAL	Preliminary Cost % to Growth
Water Supply	W-1	Well rehabilitation (1 well every 5 years)	$150,000	$150,000	$300,000	$600,000	47%
	W-2	New Groundwater Production Well			$2,100,000	$2,100,000	100%
		Subtotal	$150,000	$150,000	$2,400,000	$2,700,000	$2,382,000
Treatment	T-1	Treatment Process Improvements	$150,000			$150,000	47%
		Subtotal	$150,000			$150,000	$70,500
Pumps	P-1	Booster Pump Station Replacement	$1,600,000			$1,600,000	47%
		Subtotal	$1,600,000			$1,600,000	$752,000
Meters	R-1	Production Meter Calibration/Replacement	$50,000			$50,000	0%
	R-2	Customer Meter Replacement			$332,000	$332,000	0%
		Subtotal	$50,000		$332,000	$382,000	$0
Distribution Mains	FH	Fire Hydrant Replacement Program	50000	$50,000		$100,000	47%
	M-2	G St.: 3rd/ 4th St. Alley to 4th/5th St. Alley		$65,000		$65,000	47%
	M-3	G St.: 5th Ave. to 7th Ave.		$157,000		$157,000	47%
	M-4	5th St.: Allen Ave. to Kari Ln.		$155,000		$155,000	47%
	M-5	Routine Main Replacement Program			$1,970,000	$1,970,000	0%
		Subtotal		$427,000	$1,970,000	$2,397,000	$224,190
Other	O-1	SCADA System Upgrades	$100,000			$100,000	47%
		Subtotal	$100,000			$100,000	$47,000
		CIP Total	**$2,050,000**	**$577,000**	**$4,702,000**	**$7,329,000**	**$3,475,690**

7.8 CIP Funding

The City may fund the water system CIP from a variety of sources including; governmental grant and loan programs, publicly issued debt and cash resources and revenue. The City's cash resources and revenue available for water system capital projects include water rate funding, cash reserves, and SDCs. An evaluation of the Water SDC Improvement Fee in support of the water system CIP is presented below.

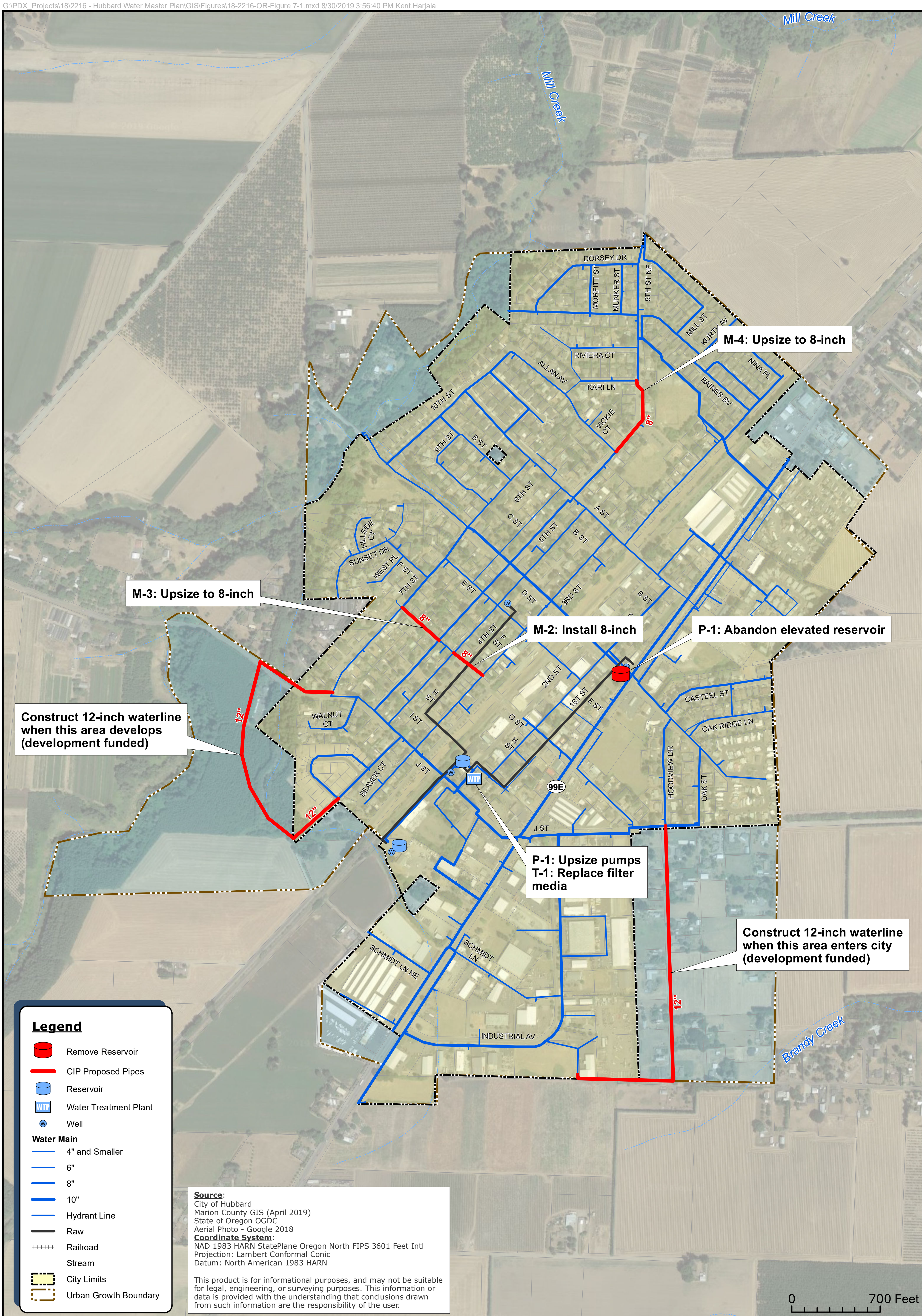
In order to calculate a current maximum Water SDC Improvement Fee, applying the methodology adopted by the City under Resolution No. 533-2012, a current number of ERUs in the system was calculated, the average use per ERU determined, and the potential future number of ERUs established based on the water demand forecast presented in Section 2. **Table 7-4** summarizes this data and analysis.

Table 7-4
Current and Future ERU Estimate

Meter Size	AWWA Rated Flow (gpm) [1]	Flow Factor Equivalence	Number of Meters in Service [2]	ERUs
5/8 - x 3/4 - inch	10	1.0	949	949
1.0-inch	25	2.5	56	140
1.5 -inch	50	5.0	7	35
2.0-inch	80	8.0	2	16
3.0-inch	175	17.5	1	17.5
4.0-inch	300	30.0	0	0
6.0-inch	625	62.5	0	0
8.0-inch	900	90.0	0	0
TOTAL EXISTING ERUs				*1,157.5*
EXISTING AVERAGE DAY DEMAND (GPD)				*227,000*
DEMAND PER ERU (GPD)				*196*
ESTIMATED FUTURE AVERAGE DAY DEMAND (GPD)				*430,000*
ESTIMATED FUTURE NUMBER OF ERUs				*2,192.6*
NUMBER OF GROWTH RELATED ERUs				1,035

Notes:
1. Per American Water Works Association (AWWA) Standard C700-15.
2. Source – City utility billing system records; 2018

In order to calculate the updated Water SDC Improvement Fee, the total eligible cost of projects presented in Table 7-3 is divided by the number of estimated new ERUs from continued growth presented in Table 7-4. Table 7-5 summarizes the proposed new Water Improvement Fee calculation. Table 7-6 summarizes the proposed Water SDC Update using the existing Reimbursement Fee and Administrative Fee (2018 Proposed Schedule of Water SDCs, Resolution No. 643-2018).



Source:
City of Hubbard
Marion County GIS (April 2019)
State of Oregon OGDC
Aerial Photo - Google 2018
Coordinate System:
NAD 1983 HARN StatePlane Oregon North FIPS 3601 Feet Intl
Projection: Lambert Conformal Conic
Datum: North American 1983 HARN

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City of Hubbard
Water System Master Plan
August 2019

Figure 7-1
Capital Improvment Plan

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