

CITY OF VICTORIA

MASTER WATER PLAN

UPDATE

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MASTER WATER PLAN UPDATE

1. INTRODUCTION

1.1 Objective and Scope

This study is an update to the City of Victoria's Master Water Plan, which was last updated in 2009 by Urban Engineering. The objective of the Master Water Plan is to evaluate the existing pumping, storage and distribution systems for the City, and to propose cost-effective plans for upgrading and expanding the facilities to meet future water consumption estimates. In order to accomplish the project objectives, a computer model was used to simulate various water-use scenarios and predict the effects on the water distribution system. In addition, this model will be used to evaluate capital improvement alternatives and determine the feasibility of servicing various growth areas.

1.2 Background

In January 1996, the City of Victoria received a water rights permit to withdraw 20,000 acre-feet of surface water per year from the Guadalupe River. Prior to this time, the City obtained its water supply solely from the Gulf Coast Aquifer using 15 ground water wells. The water produced from the Gulf Coast Aquifer in the Victoria wells has high concentrations of iron, manganese, barium and hydrogen sulfide. These constituents, although not causing any health risk, do cause taste and odor concerns with the water. After an extensive study, it was determined that the Guadalupe River would be the best alternative to supply dependable, good quality water to the City of Victoria.

In 1999, construction began on a new Surface Water Treatment Plant (SWTP), River Pump Station (RPS) and Off Channel Reservoirs (OCRs). Numerous other projects were also undertaken at this time to complete the changeover from ground water supply to surface water supply, and these projects had a significant impact on the distribution of water within the City. The most significant changes pertinent to this study were:

- a. Abandonment of Water Plants #1 and #2 along with the associated ground storage tanks.
- b. Construction of a new elevated storage tank (Water Tower #6) northwest of the City on Highway 87.
- c. Abandonment and removal of Water Tower #2.
- d. Discontinued use of 5 out of the 15 existing water wells.
- e. Recommendation to relocate the boundary line between the North and South Pressure Planes (to be completed after construction of the Tower #5 Pump Station).

As a result of these sweeping changes in the distribution system, all previous Master Plan concepts and assumptions must be re-designed or re-evaluated in the 2009 Master Water Plan to ensure that they can fulfill the growth needs of Victoria.

Furthermore, additional changes have been made to the system since 2009. A booster pump station is currently under construction at Water Tower #5, which will allow the City to transfer water from the South Pressure Plane to the North Pressure Plane. This booster pump will provide a backup feed to the North Pressure Plane and allow for decommissioning of Water Plant #4, which is currently being operated to transfer water from the South Pressure Plane to the North Pressure Plane. The relocation of the zone split was recommended because the ground elevation is more suitable for the North Pressure Plane and to increase the demands to the north and decrease demands in the South Pressure Plane.

The City has also begun an Aquifer Storage and Recovery Project (ASR), which will store treated ground water in a local aquifer during low demand periods and allow for recovery during high demand periods.

1.3 Definitions

The Texas Commission on Environmental Quality (TCEQ) establishes rules and regulations regarding public water systems in order to protect the public health and safety. This section is intended to provide definitions to common terms used within this report. These definitions are established and defined by TCEQ and are as follows:

1.3.1 Connection – A single family residential unit or each commercial or industrial establishment to which drinking water is supplied from the system. As an example, the number of service connections in an apartment complex would be equal to the number of individual apartment units. When enough data is not available to accurately determine the number of connections to be served or being served, the population served divided by three (3) will be used as the number of connections for calculating system capacity requirements. Conversely, if only the number of connections is known, the connection total multiplied by three (3) will be the number used for population served. For the purposes of this definition, a dwelling or business which is connected to a system that delivers water by a constructed conveyance other than a pipe shall not be considered a connection if:

(A) the water is used exclusively for purposes other than those defined as human consumption (see human consumption);

(B) the executive director determines that alternative water to achieve the equivalent level of public health protection provided by the drinking water standards is provided for residential or similar human consumption, including, but not limited to, drinking and cooking; or

(C) the executive director determines that the water provided for residential or similar human consumption is centrally treated or is treated at the point of entry by a provider, a pass-through entity, or the user to achieve the equivalent level of protection provided by the drinking water standards.

- 1.3.2 Distribution System** – A system of pipes that conveys potable water from a treatment plant to the consumers. The term includes pump stations, ground and elevated storage tanks, potable water mains, and potable water service lines and all associated valves, fittings, and meters, but excludes potable water customer service lines.
- 1.3.3 Elevated Storage Capacity (Tank)** – That portion of water which can be stored at least 80 feet above the highest service connection in the pressure plane served by the storage tank. Also known as a *water tower* or an *elevated tower*.
- 1.3.4 Firm Yield Pumping Capacity** – The combined capacity of a group of pumps, all designed to perform the same function, assuming that the largest pump in the group is out of service.
- 1.3.5 Ground Storage Tank** – A tank for storing potable water that is connected to the distribution through a service pump. When a ground storage tank is located in conjunction with a treatment plant, it is often referred to as a *clearwell*.
- 1.3.6 Pressure Plane** – a service area or zone that is connected to a distribution system having a consistent hydraulic grade elevation at all static pressure sources. A pressure plane is generally defined by the elevation of the elevated storage tanks or the pressure in pressure tanks, which are connected to the distribution system within the service area.
- 1.3.7 Service Pump** - Any pump that takes treated water from storage and discharges to the distribution system. Also known as a high service (HS) pump.
- 1.3.8 Transfer Pump** – Any pump which conveys water from one point to another within the treatment process or which conveys water to storage facilities prior to distribution. Also known as a medium service (MS) pump.

1.4 Population

Accurate population projections are required to properly estimate future water demands and to project updates to current facilities to meet TCEQ standards. The 2010 Census reported a population of 62,592. The current population is estimated by the United States Census Bureau to be 67,670 people.

The City of Victoria Comprehensive Plan 2035 provides for future Growth Capacity and Infrastructure. It projects locations of potential growth in terms of infill growth areas and outlying growth areas. Infill growth areas are defined as, areas currently within the City of Victoria City limits which have potential growth. Outlying growth areas are defined as, areas outside of the city limits with growth potential.

2. SYSTEM INVENTORY

2.1 Summary of Current Facilities

Table 2.1 titled, “*2017 System Inventory*”, contains a summary of the water treatment, ground storage, elevated storage and pumping facilities currently in use in Victoria. The summary includes a location, description and capacity of each facility.

Table 2.1 – 2017 System Inventory

FACILITY TYPE	LOCATION	DESCRIPTION	CAPACITY
Water Treatment	Surface Water Treatment Plant	Guadalupe River Water	25.2 mgd
	Water Plant #3	Ground Water Wells	12.0 mgd
	Total Water Treatment Capacity		37.2 mgd
Ground Storage	Surface Water Treatment Plant	Clearwell #1	2.25 mg
	Surface Water Treatment Plant	Clearwell #2	2.25 mg
	<i>Subtotal SWTP</i>		<i>4.50 mg</i>
	Water Plant #3	Clearwell #1	1.50 mg
	Water Plant #3	Clearwell #2	1.00 mg
	Water Plant #3	Clearwell #3	1.00 mg
	Water Plant #3	Clearwell #4	2.00 mg
	<i>Subtotal WP#3</i>		<i>5.50 mg</i>
	Total Ground Storage Capacity		10.00 mg
Elevated Storage	South Zone - Downtown	Water Tower #1	1.00 mg
	South Zone - Mockingbird/Main	Water Tower #3	0.50 mg
	South Zone - Mockingbird/Loop 463	Water Tower #5	1.00 mg
	<i>Subtotal South Zone</i>		<i>2.50 mg</i>
	North Zone - Glasgow	Water Tower #4	0.50 mg
	North Zone - Highway 87N	Water Tower #6	1.00 mg
	<i>Subtotal North Zone</i>		<i>1.50 mg</i>
	Total Elevated Storage Capacity		4.00 mg
Pumps	Surface Water Treatment Plant	MS Transfer Pump #1	6000 gpm*
		MS Transfer Pump #2	6000 gpm*
		MS Transfer Pump #3	6000 gpm*
	<i>Firm Yield Capacity SWTP M.S.</i>		<i>12,000 gpm</i>

	Surface Water Treatment Plant	HS Pump #1	4000 gpm
		HS Pump #2	4000 gpm
		HS Pump #3	4000 gpm
	<i>Firm Yield Capacity SWTP H.S.</i>		<i>8,000 gpm</i>
	Water Plant #3	HS Pump #1	5750 gpm
		HS Pump #2	5750 gpm
		HS Pump #3	5750 gpm
		HS Pump #4	5750 gpm
	<i>Firm Yield Capacity Water Plant #3</i>		<i>17,250 gpm</i>
	Tower 5 Booster Pump Station	Pump #1	5000 gpm
		Pump #2	5000 gpm
<i>Firm Yield Capacity Water Plant #4</i>		<i>5,000 gpm</i>	

* - As measured by meters at the SWTP. SWTP O&M Manual indicates 5,200 gpm per pump.

2.2 Pressure Zones

The City of Victoria’s existing water distribution system is divided into two (2) separate pressure zones. They are commonly referred to as the “North Zone” and the “South Zone”. Currently the North Zone has a service area of approximately 10 square miles and the South Zone has a service area of 25 square miles. The North Zone operates with a maximum water tower level of 256 feet (USCGS Datum) and is best suited for serving areas with a natural ground elevation between 100 and 135 feet. The South Zone operates with a maximum water tower level of 220 feet (USCGS Datum) and is best suited for serving areas with a natural ground below elevation 100. The North and South Zones are normally operated independently of one another, but the zones are connected at various locations and water can be transferred from one zone to another when necessary. Please refer to *Exhibit 1*, titled “*Ultimate Service Area North and South Pressure Zone*” for the current and ultimate service areas for both zones, as limited by topography.

2.3 System Narrative

2.3.1 General - The primary source of raw water for the City of Victoria is the Guadalupe River. River water flows by gravity through an intake screen structure to the wetwell at the River Pump Station (RPS). Four pumps at the RPS then transfer the water from the wetwell to the Off-Channel Reservoirs (OCR). The Raw Water Pump Station (RWPS) draws water from OCR # 8 and pumps it to the SWTP. The RPS also has the ability to pump directly to the pipeline that carries the water from the OCR to the SWTP. In addition, one (1) water well (well #21) can supply additional water to the SWTP. Water is then treated at the SWTP and finished water flows to the two clearwells located at the plant site. From this point, the water is pumped to either the North or South Pressure Zones. The primary distribution network is shown on *Exhibit 2*, titled “*Primary Distribution Network with Recommended Improvements*”.

2.3.2 South Zone - Water for the South Zone is pumped using three (3) medium service (MS) transfer pumps from the clearwells at the SWTP to ground storage tanks located at Water Plant #3 (WP #3). From there, four (4) high service (HS) pumps at WP #3 pump the water directly into the south distribution system and into three (3) elevated storage tanks located in this zone.

Ground water is also available at WP #3 from eight (8) water wells, but mixing is limited to 20%. The water is treated at WP #3 and mixed with the water from the SWTP inside the ground storage tanks. Ground water is only used as under emergency conditions. Additionally, water is available for the South Zone from the North Zone distribution system.

A solenoid-controlled valve, located on the North Zone distribution line at the SWTP can direct flow directly to Water Tower #1 (WT #1) through a dedicated 12-inch main. This main is typically used to control the levels in WT #1.

2.3.3 North Zone - Water for the North Zone is pumped from the clearwells at the SWTP using three high service (HS) pumps. The water is pumped directly into the North distribution system and the two (2) elevated storage tanks located in this zone. Upon completion of the Tower #5 Pump Station, water will be available to be transferred from the South Zone to the North Zone. This will allow Plant #4 to be decommissioned.

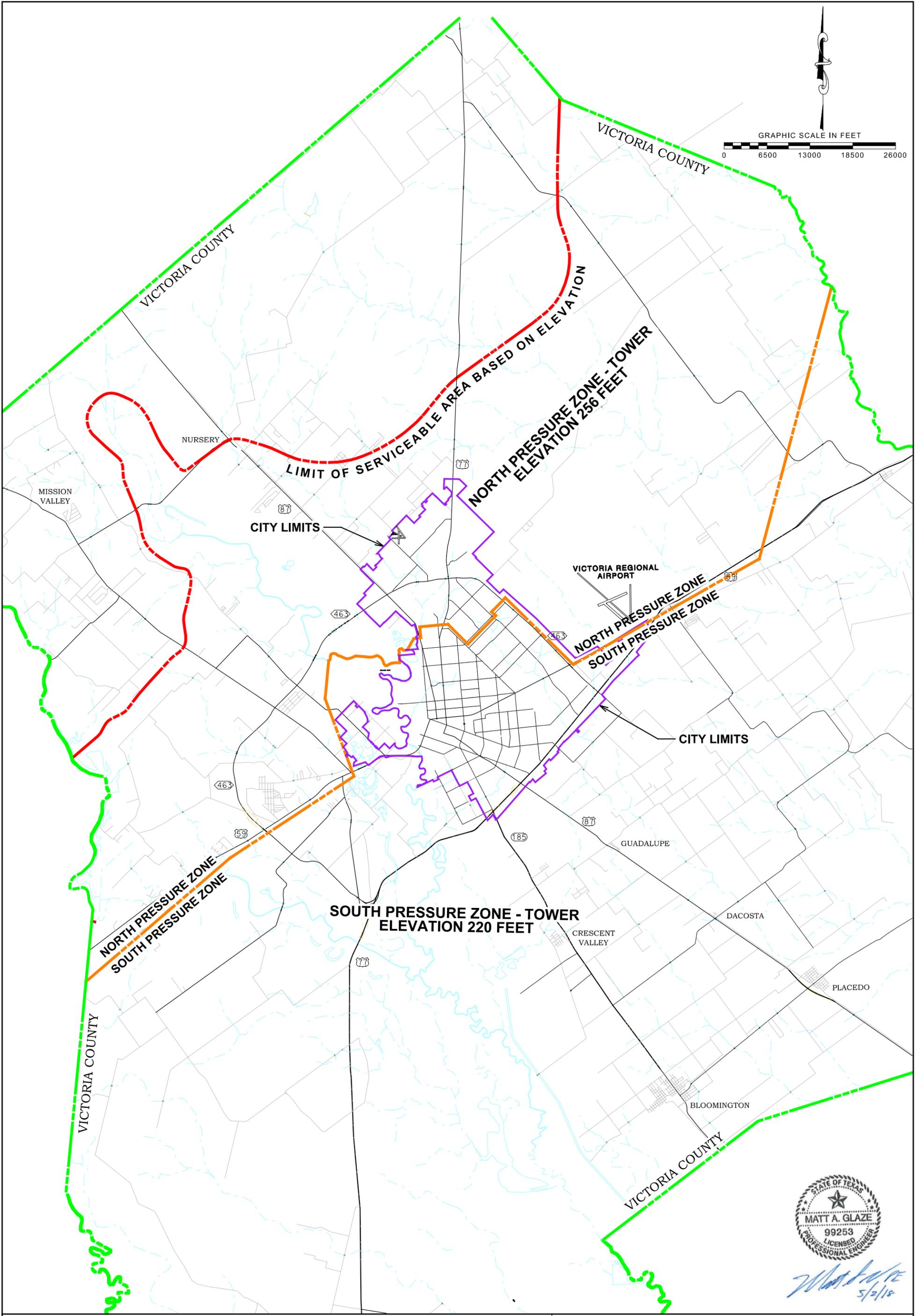
2.3.4 Aquifer Storage and Recovery (ASR)

The Aquifer Storage and Recovery Demonstration Project, if found to be successful, will provide additional pumping to the water system. These ASR wells can not only provide water during periods of low river flow, they can provide an additional pressure source to distribution system. The demonstration project consists of retrofitting Well #19 and will produce approximately 1,500 gallons per minute.

3.0 SYSTEM ANALYSIS

3.1 TCEQ Capacity Requirements

The City of Victoria's water system was evaluated based on the Texas Commission of Environmental Quality (TCEQ) requirements contained in 30 Texas Administrative Code (TAC) Chapter 290 – Public Drinking Water, Subchapter D - Rules and Regulations for Public Water Systems, Section 290.45 – Minimum Water System Capacity Requirements, effective date March 30, 2017. The TCEQ minimum system capacity standards were applied to each component of the City's existing facilities for the year 2017 and the resulting capacity ratings have been expressed as a percentage. For the purposes of this analysis, the current population was estimated to be 67,670 persons. Because sufficient data to determine the exact number of connections is not available, the TCEQ recommends dividing the population by three (3) to estimate the number of



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EXHIBIT 1
ULTIMATE SERVICE AREA
NORTH AND SOUTH PRESSURE ZONE
 CITY OF VICTORIA - 2018 MASTER WATER PLAN

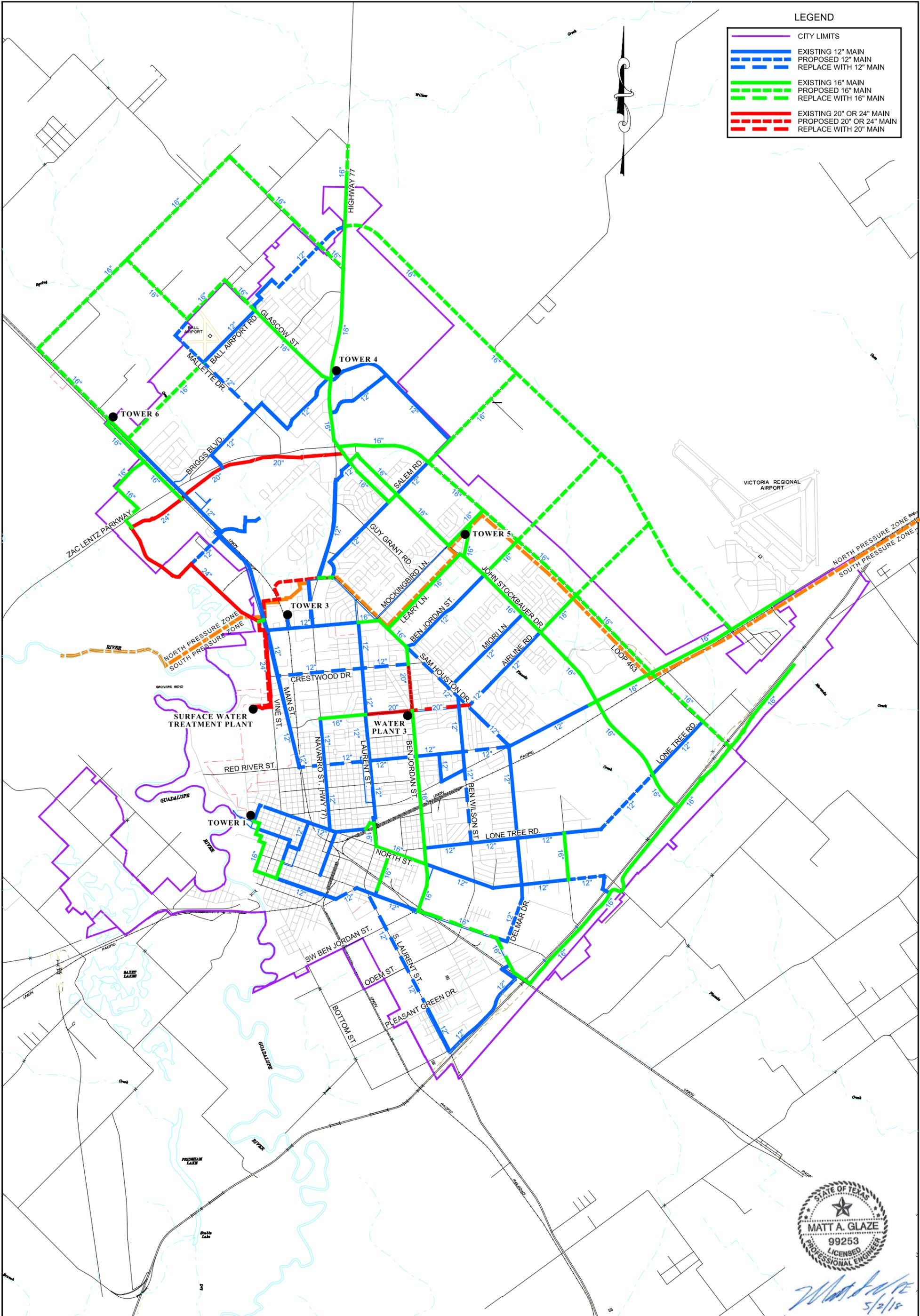
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LEGEND

	CITY LIMITS
	EXISTING 12" MAIN PROPOSED 12" MAIN REPLACE WITH 12" MAIN
	EXISTING 16" MAIN PROPOSED 16" MAIN REPLACE WITH 16" MAIN
	EXISTING 20" OR 24" MAIN PROPOSED 20" OR 24" MAIN REPLACE WITH 20" MAIN



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EXHIBIT 2
PRIMARY DISTRIBUTION NETWORK
WITH RECOMMENDED IMPROVEMENTS
 CITY OF VICTORIA - 2018 MASTER WATER PLAN

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connections. The total number of service connections was estimated to be 22,557. The North Zone population was estimated at 18,350 persons and 6,117 service connections and the South Zone population was estimated at 49,320 persons and 16,440 service connections.

Table 3.1 – 2017 Population Estimate

	NORTH ZONE	SOUTH ZONE	TOTAL
POPULATION	18,350	49,320	67,670
CONNECTIONS	6,117	16,440	22,557

3.1.1 Raw Water Pump Station

Untreated water is pumped from the OCRs to the SWTP by three (3) pumps each rated at 8,100 gallons per minute (gpm). The resulting firm yield capacity is 16,200 gpm. TCEQ rule 290.45(b)(2)(A) requires a minimum of 0.6 gpm per connection of raw water pumping capacity; therefore, the City’s existing raw water pump station has the capacity rating of 120% (81,000 persons).

3.1.2 Surface Water Treatment Plant (SWTP) & Water Well Capacity

The SWTP has a rated flow capacity of 25.2 million gallons per day (mgd).

TCEQ rule 290.45(b)(2)(B) requires that the treatment plant capacity, under normal rated design flow, be a minimum of 0.6 gpm per connection. The existing SWTP has a capacity rating of 129%. In addition to surface water, the City maintains eight (8) water wells capable of supplying an additional 12.0 mgd to WP #3. Because of potential taste and odor problems, it is recommended that ground water mixing be restricted to 20%, resulting in a usable ground water supply of approximately 5.0 mgd. The combined treatment capacity of the SWTP and WP #3 is therefore 30.2 mgd providing a total water supply capacity rating of 159% (105,000 persons).

3.1.3 Transfer Pumps

The transfer pumps at the SWTP pump treated water to WP #3 where it is re-boostered into the South Zone distribution system. Transfer pumps are required by TCEQ rule 290.45(b)(2)(C) to have a firm yield capacity of 0.6 gpm per connection. Since the transfer pumps are dedicated to pumping water only to the South Pressure Zone, the pump’s capacity relates only to the South Zone population. The existing transfer pumps have a firm yield capacity of 12,000 gpm, resulting in a capacity rating of 122% (60,000 persons South Zone only). An additional 3.7 mgd (2,570 gpm) is available at WP #3 from the eight (8) existing water wells extending the capacity rating of the transfer pumps to 150% (73,750 persons South Zone only).

3.1.4 Clearwell Storage

TCEQ rule 290.45(b)(2)(D) requires that water systems with over 250 connections have 5% of the daily plant capacity in covered clearwell storage. Based on the rated capacity of the SWTP, the minimum required covered clearwell storage is 1.51 million gallons. The City has 10 million gallons of covered clearwell storage giving it a capacity rating of 622%.

3.1.5 Total Water Storage

TCEQ rule 290.45(b)(2)(E) requires a total storage capacity (combined ground storage, elevated storage and clearwell storage) of 200 gallons per connection. Victoria's current operates 14.0 million gallons of total storage resulting in an overall capacity rating of 310% (210,000 persons).

3.1.6 High Service Pumps (HS)

TCEQ rule 290.45(b)(2)(F) requires that each pump station or pressure plane have two (2) or more pumps that have a total capacity of 2.0 gpm per connection, or a total capacity of at least 1000 gpm and the ability to meet peak hourly demands with the largest pump out of service, whichever is less. Because of the City's ability to readily transfer water between the zones, the HS Pumps should be analyzed as total pumping for the town. The peak hour is approximately 0.3756 gallons per minute per person (see section 3.2.3 Demands).

3.1.7 Elevated Storage

TCEQ rule 290.45(b)(2)(G) requires an elevated storage capacity of 100 gallons per connection. Existing elevated storage in the North Pressure Zone is 1.5 million gallons and 2.5 million gallons is available in the South Pressure Zone. Combined, the capacity rating for elevated storage is 177% (120,000 persons). Individually, the capacity rating for the North Zone is 245% (45,000 persons) and the capacity rating for the South Zone is 152% (75,000 persons).

3.1.8 Summary of TCEQ Regulations

Table 3.1.8 summarizes the capacity of all the current facilities as determined by TCEQ Regulations.

Table 3.1.8 – Summary of TCEQ Requirements

FACILITY TYPE	FACILITY DESCRIPTION	REQUIRED CAPACITY	AVAILABLE CAPACITY	CAPACITY RATING PERCENT OF CURRENT POPULATION (POPULATION)		
				NORTH	SOUTH	TOTAL
CURRENT POPULATION				(18,350)	(49,320)	(67,670)
RAW WATER PUMPING	RAW WATER PUMPS	13,534 gpm	16,200 gpm	-	-	120% (81,000)

WATER TREATMENT	SURFACE WATER TREATMENT PLANT (25.2 mgd)	13,354 gpm	17,500 gpm	-	-	129% (87,500)
	INCLUDING 20% GROUND WATER (3.7 mgd)	13,354 gpm	21,000 gpm	-	-	157% (105,000)
TRANSFER PUMPS	MS TRANSFER PUMPS	9,864 gpm	12,000 gpm	-	122% (60,000)	-
	INCLUDING 20% GROUND WATER (3.7 mgd)	9,864 gpm	14,570 gpm	-	150% (73,750)	-
CLEARWELL STORAGE		1.26 mg	11.5 mg	-	-	-
TOTAL STORAGE	TOTAL ELEVATED & CLEARWELL	4.5 mg	14.0 mg	-	-	311% (210,000)
SERVICE PUMPS	HS PUMPS (SWTP)	6,892 gpm	8,000 gpm	116% (21,299)	-	-
	PLANT 3 SERVICE PUMPS	18,525 gpm	17,250 gpm	-	-0.93% (45,927)	
	TOTAL	25,417 gpm	25,400 gpm	-	-	-0.98% (67,625)
ELEVATED STORAGE		2.26 mgal	4 mgal	245% (45,000)	152% (75,000)	177% (120,000)

3.2 Computer Modeling

3.2.1 Computer Program

WaterCAD by Bentley Systems, Incorporated, was used to model the City's existing water distribution system. This software provides an efficient method to analyze the water system under different demand and pumping scenarios.

3.2.2 Existing Distribution Network

The City of Victoria's Geographic Information System (GIS) department provided GIS maps of the existing water system, which includes water main diameter and material. The water main materials along with the diameters are used by the computer in the calculation to determine how much water can be transferred in a given pipe. The GIS data also included the location of water meters. This information was imported into WaterCAD and used to create a new model of the City of Victoria's water distribution system. Elevated storage tanks (water towers) and pumps were added to the model from information provided by the City.

3.2.3 Demands

Customer demands are an important component to developing a computer model. In 2013, the City installed new water meters throughout town with the capability of Automatic Meter Reading (AMR). With the previous meters, meter readings were collected manually once a month. The new AMRs give a reading every hour, which is transmitted to a database and stored in a computer.

Victoria's all-time peak occurred on August 22, 2011, in which the City's SWTP produced 18.957 million gallons of treated water. But because this peak occurred before the AMR, data from that day are not available. The most recent peak day occurred on August 10, 2016, which had a peak of 16.695 million gallons. During the 2016 peak, data are available from the AMRs. These data were incorporated into the WaterCAD model and applied to each corresponding meter. These demands were increased by a factor of 1.14 to simulate the all time peak water demand of 18.957 million gallons.

Furthermore, in 2011 the population of Victoria was estimated to be 63,440, which equates to 299 gallons per capita per day, or 0.2075 gallons per minute per capita of peak daily flow.

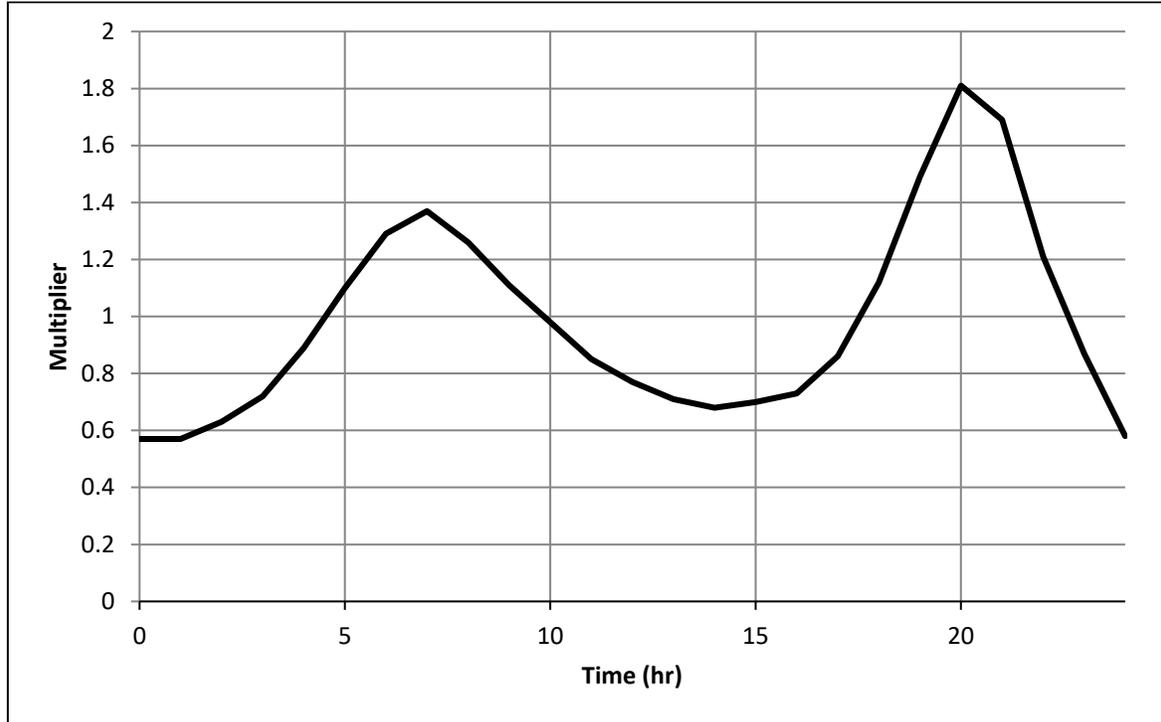
3.2.4 Diurnal Pattern

Typical water demands follow a daily pattern, which is known as a diurnal pattern. Residential usage makes up a majority of the City's water demands. Diurnal patterns made up of a large portion of residential customers typically have a morning peak and an evening peak which coincides with people being home and using water for washing clothes, bathing and irrigation.

Using data available from the AMRs, a diurnal curve was developed for the City of Victoria. Hourly usage data from every meter in town was analyzed based on the proportion of total usage for the day. A plot of the hourly usage data is shown in *Figure 1*. This data is used to determine the peak hourly flow and modeled to evaluate challenges for the infrastructure to maintain water supply throughout the day.

The peak hour is 1.81 times the peak daily flow. Using the peak daily demands, this equates to a peak hourly flow of 0.3756 gallons per minute per capita.

Figure 1 - Diurnal Water Demand



3.2.5 Growth

In order to evaluate future demand on the system, growth was added to the model. Initial growth was added to complete build out of existing subdivisions. To estimate growth beyond the areas, demands were globally increased to reach limitations of existing and recommended improvements. The population for the corresponding demands is reported along with the recommended improvements.

4.0 CONCLUSIONS

4.1 TCEQ Capacity Recommendations

The overall capacity rating for the City of Victoria’s water treatment, storage and pumping system is good. Because of the availability of ground water in the South Zone, the elevation difference between the North and South Pressure Zones and the pumping capacity in the North Zone, the water distribution system is extremely flexible. This flexibility will allow the City to make adjustments to the system in response to growth and increased demands in either the North or the South Pressure Zones.

The SWTP along with groundwater have the current capacity to supply water to 105,000 people, which will be used as a benchmark for other components throughout the system. The TCEQ rated capacity and general method for expansion of each of the major water system components is outlined below:

4.1.1 Storage

The existing clearwell storage and elevated storage facilities both have ample capacity to serve the needs of the City well into the future.

4.1.2 Raw Water Pump Station and Medium Service (MS) Transfer Pumps

The raw water pumps at the Raw Water Pump Station, the HS pumps at the SWTP and the MS transfer pumps at the SWTP are currently adequate, but improvements will be required as the population grows to meet TCEQ requirements.

A MS pump will be required when the South Zone population reaches 60,000 people to meet the minimum requirements. This additional pump will allow for another 10,000 people in this zone. The need for this additional pump could be offset by utilizing existing water wells or construction of ASR wells that will pump to WP #3.

Another raw water pump will be required when the population reaches 81,000, but as described in Section 4.1.4, groundwater can be used to supplement the water supply and delay this improvement. The addition of a raw water pump will support a population of 121,500.

4.1.3 Water Treatment

The SWTP has capacity to support 87,500 people. The plant was designed to be expanded by 1.5 times, but due to the significant costs, it may be more feasible to supplement the system with groundwater or utilize the ASR wells to extend the capacity of this plant.

4.1.4 Ground Water

The capacity of the SWTP, raw water pumps, HS pumps at the SWTP and the MS transfer pumps at the SWTP can all be extended by supplementing the water supply with the eight (8) remaining ground water wells serving WP #3. By introducing approximately 20% ground water (3.7 mgd) at WP #3, the City's total treatment capacity can be increased to serve 105,000 persons.

The ASR wells can further increase the amount of people the system can support. Treated surface water stored in the aquifer has the same chemical makeup as the water produced by the SWTP, therefore it is not limited to the 20% mixing guideline.

4.1.5 High Service (HS) Pumps and Zone to Zone Transfer

The North Zone HS pumps were designed to allow the installation of one additional pump increasing the firm yield capacity of the North Zone to 12,000 gpm. The capacity of the South Zone HS pumps at WP #3 can be extended by transferring (bleeding) water from the North Zone to the South Zone through the installation of control valves in the existing pipe network and utilizing the Tower #5 Pump Station to transfer water from the South Zone to the North Zone. This

topic is discussed in further detail in Section 4.2.3. Table 4.1.5 demonstrates how the existing pumping capacity of the City can be expanded and distributed to serve a total future population of 81,869 persons (Assuming the peak hourly demand of 0.3756 gallons per minute per person). The amount of water transferred between zones can be adjusted as needed to accommodate growth in either pressure zone.

Table 4.1.5 Serviceable Population with Minimal Capital Expenditure (TCEQ Reqs)

YEAR	WATER SOURCE/POPULATION	NORTH ZONE	SOUTH ZONE	TOTAL
2017	Current Population	18,350 persons	49,320 persons	67,670 persons
	Required HS Pumping	6,892 gpm	18,525 gpm	25,417 gpm
FUTURE	Existing HS Pumping Capacity	8,000 gpm	17,250 gpm	24,400 gpm
	Proposed HS Pumps	4,000 gpm	-	4000 gpm
	Zone Transfer North to South	-2,400 gpm	+2,400 gpm	-
	ASR Well#19		+1,500 gpm	1,500 gpm
	Total Water Delivered	9,600 gpm	21,150 gpm	29,400 gpm
	Supportable Population	25,559 persons	56,310 persons	81,869 persons

4.2 Water Distribution System Recommendations

The current water distribution network is adequate for the existing demands. Growth to outlying areas should follow the recommendations set forth in *Exhibit 2 - Primary Distribution Network with Recommended Improvements*. Furthermore, the areas north of Highway 59 Business and east of Loop 463 have natural ground elevations near or above elevation 100 and would be best served in the North Zone. As development allows, areas currently in the South Zone should be connected or transferred to the North Zone.

As the population grows, the WaterCAD model begins to exhibit some areas of concern. The City's distribution network is of sufficient size to generally eliminate any localized pressure problems. Because of this, system limitations are identified by checking the levels of the water towers, the discharge of HS pumps and the pressures just downstream of the high service pumps. It is recommended to keep water tower levels at or above 50% during peak demand periods to allow for emergencies such as a main break or fire. The allowable water main pressures are determined by the water main material properties. These pressures require distribution improvements, in addition to pumping, to increase the supply of water to the system. Below are incremental system improvements to meet future water demands:

4.2.1 Distribution Main

It is recommended that a 16-inch high service main be installed to the existing 12-inch main located at Main Street and North Vine Street and a 24-inch valve be installed on the high service main at this location. This improvement has a minor increase in allowable growth, but provides a redundant feed of water to the North Zone in the event of a main break on the high service main between Mockingbird Lane and Loop 463.

4.2.2 Addition High Service (HS) Pump

The peak hour demands put a strain on the water levels in Towers #4 and #5. As population increases, the demands drop Tower #4 to near 50% threshold and requires supplementing water from the South Zone via Tower #5 Pump Station. This then drops the level in Tower #5. Water to the North Zone is pumped from the SWTP in Riverside Park along Vine Street, to Loop 463 west of Highway 87 thence along Navarro Street to Tower #4 at Glasgow Street. Given this distance and that the bulk of the demand is located north of Mockingbird Lane and Sam Houston Drive and east of Navarro Street it is a challenge for the system to supply water. Adding another HS pump at the SWTP allows for additional growth of 6,000 people in town, and increases the number people allow per TCEQ requirements. This improvement supports a total population of 74,000 people.

4.2.3 High Service Transmission Main

Adding the new HS pump increases the velocities in the High Service Main, which does increase head losses. In order to increase output from the SWTP, a new main needs to be constructed from the SWTP to the North Zone. A new 24-inch main is recommended to be constructed from the SWTP along Vine Street to Magruder Drive, connected to the existing 12-inch main in Navarro Street. Thence, the proposed main shall be reduced to a 16-inch main along Sam Houston Drive and connected to the existing 12-inch main in Lilac Lane. This main allows for increased flows from the existing pumps because of less head loss and provides water to the opposite side of the North Zone than the existing high service main. This main will support 90,000 residences in the City of Victoria.

4.2.4 Ball Airport Road Main

Development in the vicinity of Tower #6 and along Highway 87 has been less than anticipated. There has been an ongoing disproportional high demand placed on Tower #4 and a low demand on Tower #6. In order to better utilize Tower #6, it is recommended that a 16-inch main be constructed from Tower #6 along the future Ball Airport Road corridor to Mallette Drive.

4.2.5 High Service (HS) Pump

As the population exceeds 90,000 people, more improvements are required to maintain the water supply. Installing another high service pump at the SWTP provides service to a population of 101,000 people.

4.2.6 Future

If the City continues to grow and supply water beyond 101,000 people, the SWTP will have to be expanded and a new pump station will have to be constructed. If the growth continues as projected to the north and east, the location of this pump station should be east of Loop 463 near Mockingbird Lane and provide high service pumping to both pressure zones. Water should be transferred via pipeline from the SWTP to the new pump station and stored in clearwells until pumped into the system. These expansions are beyond the scope of this project but could support populations in excess of 160,000 or more.

Table 4.2.1 Summary of Recommended Improvements

Report Section	Recommended Improvement	Population*
4.2.1	16-inch Main @ Main/Vine	68,000
4.2.5	High Service Pump	71,000**
4.1.2	Raw Water Pump	81,000
4.1.2	Medium Service Pump	84,000
4.2.3	High Service Transfer Main (24")	90,000
4.2.4	Ball Airport Main	90,000
4.2.6	High Service Pump	101,000

* - City of Victoria Total Population

** - High Service pumps are required to pump peak flow. This number is based on the 2011 Peak Day with a population of 63,440.

If the ASR demonstration project proves to be successful, ASR can be a viable solution to solve future water demands. ASR wells located near areas of high demand can provide additional pressure supplies and reduce strains on the distribution system. These wells can offset the requirements for the major improvements outlined in the report.

4.2.7 Projected Costs

Costs for proposed improvements were estimated for project which may occur within the next ten years. The City of Victoria Comprehensive Plan 2035 estimates that the 2028 population will be 75,000. Improvements recommended within the next 10 years are construction of a 16-inch main as discussed in section 4.2.1 and installation of an additional high service pump as discussed in section 4.2.2. The 16-inch main is estimated to cost \$500,000. Adding a high service pump is estimated to cost \$500,000.