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Final Report

Saratoga Master Plan Update and Level I Study

A Wyoming Water Development Commission Project

March 2003

PMPC Civil Engineers
Saratoga, Wyoming

in association with

TST Inc. of Denver
Denver, Colorado

Hinckley Consulting
Laramie, Wyoming

Water Right Services, LLC
Cheyenne, Wyoming

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Professional Engineer (Civil)
Paul McCarthy
1681
Date 3-18-03
WYOMING

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1. INTRODUCTION

1.1 General

The Saratoga Municipal Water System serves the Town of Saratoga located in southern Carbon County, Wyoming. The water system is a shared operation between the Town of Saratoga, Carbon County, Impact Joint Powers Board (Board) and the Town of Saratoga (Town). The Board owns and manages capital improvements made to the water system. The Town operates, maintains and administers the day to day functions of the water system.

On June 3, 2002 PMPC entered into a Consultant Contract for Services No. 05SC0291675 with the Wyoming Water Development Commission (WWDC) to conduct a Level I study of the Saratoga Municipal Water System that includes updating their 1978 master plan, evaluating the existing treatment plant and water system, evaluating alternate treatment methods including membrane filtration, evaluating existing water rights, and investigating potential groundwater sources. The results of these investigations are presented in this report.

1.2 Project History

The water supply for the Saratoga Water Treatment Plant (SWTP) is diverted from the North Platte River. The watershed is uncontrolled and includes heavily grazed pastures for livestock and wildlife. The raw water produced from this watershed has very predictable seasonal variations in water quality characteristics but can also produce dramatic water quality changes that are coincident with localized precipitation events within the drainage basins of the watershed.

1.3 Summary of Existing Problems

- Water treatment conformance with anticipated EPA regulations
- Growth in the community
- Encouraging economic development
- Orderly system development

2. SERVICE AREA AND DEMAND PROJECTIONS

2.1 Meetings

A scoping meeting was held with the Town of Saratoga, Carbon County Impact Joint Powers Board (JPB) to discuss the project, define the project study area and discuss the proposed study area design population. The project study area and projected populations were also discussed with the Saratoga Town Council and the Saratoga Planning Commission.

2.2 Study Area

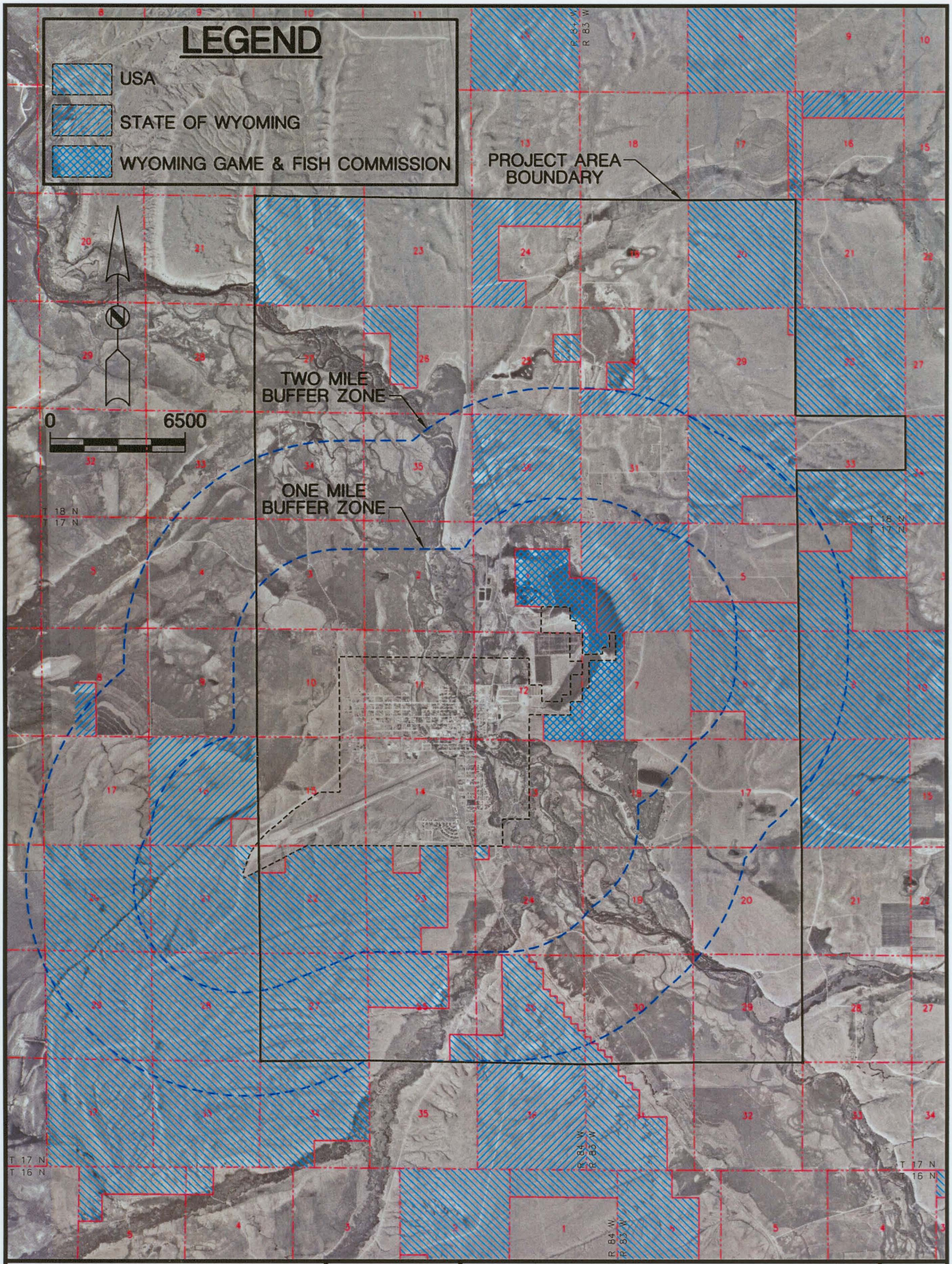
The project study area was reduced from the original 5 mile radius from Saratoga to include only those areas with development potential. Lands controlled by the State and Federal governments were not included in the areas of potential development. The Project Area Map is shown on Figure 2-1.

The Town of Saratoga has jurisdiction over development in the one mile buffer zone outside the Saratoga corporate limits. The Town's jurisdiction can be extended to two miles when the Town's population reaches 2,000. Saratoga is in the process of adopting a land use plan for the one mile buffer zone.

2.3 Population

Saratoga, like many Wyoming communities, has experienced erratic population boom and bust cycles. The 2002 Saratoga population is estimated at 1,900 by the Saratoga Town Clerk. The Wyoming Department of Administration and Information estimates the 2002 population at 1,706 and decreasing to 1,670 by 2010. The population difference is due to summer residents that the clerk's office felt were missed in the 2000 census and are reflected in subsequent forecasts.

Saratoga is presently investigating ways to promote economic development. Saratoga 3000, an ad hoc citizens group, promoting economic development in the Saratoga area determined a population of 3,000 is needed to make the community economically viable. Using a 3,000 population is contrary to commonly accepted population projections but the accepted projections do not account for an aggressive economic development group in a small community. The study area population of 3,000 was discussed with and approved by the JPB and will be used as the planning population in this report.



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JOB NO. 7012.090
FILE NO. SARA8x11.DWG
SCALE: AS SHOWN
DRAWN BY: LMW
DATE: 3-11-03

FIGURE 2-1
PROJECT AREA MAP

SARATOGA – MASTER PLAN UPDATE & LEVEL I STUDY
WYOMING WATER DEVELOPMENT COMMISSION

SHEET
2-2

2.4 Water Consumption

Available water meter records from July 2000 through June 2002 were reviewed. Meter records were reviewed for only these two fiscal years because of changes in the meter reading policy. The Town of Saratoga provided monthly meter readings. Daily water production readings, water tower readings, and estimated Town services usage were obtained from the Saratoga Water Department.

2.4.1 Metered Usage

Historic water consumption data for FY 2001 and FY 2002 are presented in Table 2-2. Wide quantity fluctuations are evident in the "Water Unaccounted For" column. These fluctuations are the result of incomplete meter data with data gaps resulting from unread and broken meters; and from estimates made to supplement the missing data. Estimated consumptions for unmetered uses were based on "one time" Town flow measurements with portable measuring equipment and "reasonable assumptions" where no flow measurements were available.

An examination of water production records over the last 6 years show 15 days with net water production exceeding 1,000,000 gal/day. The peak day production was July 7, 1996 with 1,088,300 gal. The most recent 1,000,000 gal + day was June 05, 2000 with 1,034,000 gal. These figures follow the growth and decline in population for the Town of Saratoga.

2.4.2 Unmetered Usage

Town facilities including municipal buildings, parks and other facilities are generally unmetered. Municipal water consumption was reviewed with water department personnel and estimated consumption values are used in preparing water consumption quantities.

Net water treatment plant production is the metered water quantity pumped from the treatment plant into the distribution system. Treated water used in the treatment process for filter backwash, cooling and other incidental uses is not metered. Estimated unmetered usage of treated water within the plant is included to determine the total water plant production.

Untreated water is used to backwash the river infiltration system and is not included in the water plant production figures.

Water used for fighting fires is another water use that is not practical to meter. Although the quantity of water needed to fight a fire may be large, it is an infrequent event of relatively short duration.

Both Saratoga area golf courses are irrigated independently of the municipal water system.

2.5 Water Usage Projections

The daily water plant production records from July 1, 2000 through June 30, 2002 were reviewed and used to estimate the average and maximum historic water consumption amounts. Saratoga's 2000 census of 1,726 was used to determine the per capita consumption amounts. The average daily per capita consumption of 225 gpcd is higher than the State average of 157 gpcd and the maximum daily per capita consumption of 548 gpcd is lower than the State average of 702 gpcd day for municipalities with 800-1,000 taps, similar to the size of Saratoga.

For the purpose of this study, it is assumed that the Town water consumption will follow historic usage patterns and the following water consumption values are used in this study:

Population	1,726	3,000
Average Daily Water Consumption	387,767 gal/day	673,987 gal/day
Average Daily Water Consumption	270 gpm	468 gpm
Average Daily Water Consumption	0.61 cfs	1.05 cfs
Average Daily Per Capita Water Consumption	225 gpcd	225 gpcd
Annual Water Consumption	435 Acre Ft/Year	755 Acre Ft/Year
Maximum Daily Water Consumption	945,800 gal/day	1,643,917 gal/day
Maximum Daily Water Consumption	657 gpm	1,142 gpm
Maximum Daily Water Consumption	1.47 cfs	2.55 cfs
Maximum Daily Per Capita Water Consumption	548 gpcd	548 gpcd
Maximum Hour Water Consumption (Estimated to be 175% of Maximum Daily Water Consumption)	1,150 gpm	2,000 gpm

Table 2-1 Projected Water Consumption

MONTH	WATER PLANT WATER PRODUCED (Measured)	-	BACKWASH (Estimated)	=	NET WATER PRODUCED	RESIDENTIAL (Metered)	+	COMMERCIAL (Metered)	+	SCHOOLS (Metered)	=	TOTAL METERED USAGE	UNMETERED WATER (Net Water - Metered Usage)	-	ESTIMATED UNMETERED TOWN SERVICES	=	WATER UNACCOUNTED FOR		COMMENTS
	(Gal)		(Gal)		(Gal)	(Gal)		(Gal)		(Gal)		(Gal)	(Gal)		(Gal)		(Gal)	%	
July-00	23,694,800		705,600		22,989,200	15,749,000		2,287,000		326,000		18,362,000	4,627,200		*649,720*		3,977,480	17.3	
August-00	21,280,400		717,600		20,562,800	16,957,000		2,257,000		407,000		19,621,000	941,800		*649,720*		292,080	1.4	1 day flushing hydrants
September-00	11,323,000		678,000		10,645,000	8,588,000		1,468,000		300,000		10,356,000	289,000		*634,720*		-345,720	-3.2	Flushing, parks off early
October-00	7,039,200		687,600		6,351,600	4,352,000		1,249,000		189,000		5,790,000	561,600		*78,000*		483,600	7.6	
November-00	6,493,400		666,000		5,827,400	3,905,000		1,069,000		136,000		5,110,000	717,400		*78,000*		639,400	11.0	
December-00	6,306,500		681,600		5,624,900	3,566,000		874,000		206,000		4,646,000	978,900		*78,000*		900,900	16.0	
January-01	6,423,200		687,600		5,735,600	***3,772,000***		1,488,000		211,000		5,471,000	264,600		*78,000*		186,600	3.3	
February-01	6,132,700		622,800		5,509,900	1,301,000		1,283,000		213,000		2,797,000	2,712,900		*78,000*		2,634,900	47.8	
March-01	7,259,000		705,600		6,553,400	***2,618,000***		1,272,000		174,000		4,064,000	2,489,400		*78,000*		2,411,400	36.8	
April-01	6,801,800		696,000		6,105,800	2,782,000		911,000		***157,000***		3,850,000	2,255,800		*78,000*		2,177,800	35.7	5 days flushing hydrants
May-01	12,086,200		789,600		11,296,600	8,759,000		1,430,000		174,000		10,363,000	933,600		*649,720*		283,880	2.5	Fill swimming pool
June-01	21,411,300		696,000		20,715,300	14,705,000		1,919,000		221,000		16,845,000	3,870,300		*649,720*		3,220,580	15.5	
July-01	23,713,900		765,600		22,948,300	16,550,000		2,852,000		220,000		19,622,000	3,326,300		*649,720*		2,676,580	11.7	
August-01	21,210,700		717,600		20,493,100	15,902,000		2,669,000		317,000		18,888,000	1,605,100		*649,720*		955,380	4.7	
September-01	12,736,500		684,000		12,052,500	8,535,000		1,739,000		349,000		10,623,000	1,429,500		*634,720*		794,780	6.6	
October-02	8,560,700		687,600		7,873,100	5,374,000		1,577,000		212,000		7,163,000	710,100		*78,000*		632,100	8.0	
November-01	7,729,100		678,000		7,051,100	3,767,000		1,094,000		***131,000***		4,992,000	2,059,100		*78,000*		1,981,100	28.1	
December-01	8,729,200		693,600		8,035,600	3,799,000		1,129,000		233,000		5,161,000	2,874,600		*78,000*		2,796,600	34.8	Fill new water tower
January-02	7,397,700		687,600		6,710,100	3,824,000		1,055,000		237,000		5,116,000	1,594,100		*78,000*		1,516,100	22.6	
February-02	6,718,800		628,800		6,090,000	4,383,000		984,000		257,000		5,624,000	466,000		*78,000*		388,000	6.4	
March-02	6,995,600		693,600		6302000	3,961,000		1,049,000		108,000		5,118,000	1,184,000		*78,000*		1,106,000	17.5	
April-02	6,917,200		702,000		6,215,200	4,019,000		1,191,000		149,000		5,359,000	856,200		*78,000*		778,200	12.5	
May-02	14,114,900		711,600		13,403,300	8,628,000		1,538,000		165,000		10,331,000	3,072,300		*649,720*		2,422,580	18.1	5 days flushing hydrants
June-02	21,993,900		714,000		21,279,900	13,593,000		1,879,000		177,000		15,649,000	5,630,900		*649,720*		4,981,180	23.4	Fill swimming pool
Total	283,069,700		16,698,000		266,371,700	179,389,000		36,263,000		5,269,000		220,921,000	45,450,700		7,559,200		37,891,500	14.2	
Avg.	11,794,571		695,750		11,098,821	7,474,542		1,510,958		219,542		9,205,042	1,893,779		314,967		1,578,813		
			Acre Feet / Year		Gallons / Year	Gallons / Day		Gallons / Minute							Gallons / Year				
Total Water Consumed Fiscal- 2001			418		136,251,500	373,292		259							3,779,600				
Total Water Consumed Fiscal- 2002			451		146,818,200	402,242		279							3,779,600				
Average Water Consumption Fiscal 01-02			434		141,534,850	387,767		269							3,779,600				
Average Water Consumption Fiscal 2001 - 2002 (cfs)					0.60										Gallons/Day				
															10,355				
															10,355				
															10,355				

NOTES:

PRODUCTION RECORDS DEVELOPED WITH INCOMPLETE METER READINGS AND ASSUMPTIONS ARE ITALICIZED (***4,923,067***)

ESTIMATIONS FOR MISSING READINGS WERE OBTAINED BY AVERAGING THE PREVIOUS AND FOLLOWING MONTHS
WITH THE READINGS FOR THE SAME THREE MONTH PERIOD FROM THE ADJACENT YEAR.

Table 2-2
Water Production/Consumption Summary
July 2000 through June 2002

3. EXISTING WATER SYSTEM

3.1 Water Supply

The water supply for the Saratoga Water Treatment Plant (SWTP) is diverted from the North Platte River. The watershed is uncontrolled and includes heavily grazed pastures for livestock and wildlife. The raw water produced from this watershed has very predictable seasonal variations in water quality characteristics but can also produce dramatic water quality changes that are coincident with localized precipitation events within the drainage basins of the watershed.

The water quality is generally considered good. The supply has seasonal and predictable changes in water quality but is also subject to rapid, extreme, and unpredictable changes.

3.1.1 Water Quality Requirements

Spring runoff produces raw water that is high in turbidity, low alkalinity, high levels of color, and high concentrations of total organic carbon (TOC). Color is caused by dissolved natural organic matter (NOM) that includes humic and fulvic organic material. NOM is a precursor of disinfection by-products which are formed during its reaction with chlorine. Residual color in the finished water and the taste and musty odor associated with the presence of organic concentrations is a source of customer complaints. TOC data is not available; however, the high color readings indicate a significant presence of organic concentrations in the raw water supply. TOC is a surrogate indicator of disinfection by-product (DBP) formation during disinfection with chlorine. Water systems serving less than 10,000 population were previously exempt from disinfection by-product regulations, this exemption is no longer in force and Saratoga will be regulated by new Safe Drinking Water regulations for disinfection by-products.

The Environmental Protection Agency (EPA) finalized two new drinking water regulations that are scheduled for implementation in 2004; the Stage 1 Disinfectant/Disinfection By-Products Rule (Stage 1 D/DBPR) and the Long Term 1 Enhanced Surface Water Treatment Rule (LT1ESWTR). These rules are very complex and will affect the operation of the SWTP.

Long term compliance by the SWTP must address the requirements of these new SDWA regulations plus the forecasted requirements of pending regulations, most specifically the Stage 2 Disinfectant/Disinfection By-Product Rule (Stage 2 D/DBPR) and the Long Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR). Stage 2 D/DBP and LT2ESWTR are in the process of being drafted and are expected to be implemented in the 2006 to 2009 time period. All water systems, regardless if they are large or small will be affected by these pending regulations. The LT2ESWTR contains regulations being promulgated to address specifically the health threats from Cryptosporidium, a microbial pathogen that is prevalent in surface waters.

Parameter	Criteria
Filter Composite Turbidity*	<0.3 NTU in 95% of the monthly samples collected at 4 hr intervals. Turbidity not to exceed 1.0 NTU, 4-hr sample intervals.
Individual Filter Turbidity Requirements*	Monitor individual filters every 15 minutes. File monthly Exceptions Report to the EPA.
Microbial Bench Marking via Disinfection Profiling**	If DBPs are > 80% of; the new MCLs (TTHMs are > 64 ug/L and HAA_5 are > 48 ug/L) Disinfection Profiling and Bench Marking must be performed.

* The turbidity requirements for DE treatment plants will remain 1.0 NTU.
** Saratoga presently has a wavier that will be revoked if the turbidity exceeds 1.0 NTU.

Table 3-1 Key Components of the LT1ESWTR

Parameter	Criteria
TTHMs MCL	Reduced MCL from 100 ug/L to 80 ug/L, based on running annual average calculated quarterly.
HAA_5 MCL	Enforce an MCL of 60 ug/L for the sum of 5 haloacetic acid species, based on running annual average calculated quarterly.
Precursor Removal Requirements - i.e., Enhanced Coagulation	A treatment technique requirement to control DBP precursors (enhanced coagulation) is mandated for conventional surface water plants. TOC removal requirements must be met based on source water TOC levels and alkalinity. It is also possible to comply by a number of Alternative Compliance Criteria.
Maximum Residual Disinfectant Level	MRDL of 4 mg/L in the distribution system for chlorine based on running annual average calculated quarterly from monthly sampling.

Table 3-2 Key Components of the Stage 1 D/DBPR

3.2 Existing Water Treatment System

3.2.1 North Platte River Diversion

The water supply for the SWTP is diverted either through an infiltration gallery during low turbidity periods or directly to the treatment plant when turbidity is high. The infiltration gallery is equipped with the ability to backwash to restore their capacity after they become plugged with solids. Backwashing is ineffective during high turbidity events in the North Platte River and use of the infiltration gallery must be abandoned. The SWTP must then resort to direct diversion and rely upon coarse screening for solids removal. The solids content in the water supply is often so high that the coarse screens must also be backwashed frequently.

The SWTP does not have the facilities to control or modify the water quality entering the treatment plant and the operation must continually respond to the high turbidity that occurs seasonally or intermittently from localized rainfall events. A capital improvements priority that was expressed by the operators is a pre-sedimentation basin that is equipped with chemical addition for coagulation and mechanical solids removal. The addition of a pretreatment facility will stabilize the influent water quality and improve the treated water quality.

3.2.2 Filtration

The SWTP is a diatomaceous earth (DE) filtration facility. The plant is equipped with two DE filters with a combined treatment capacity of 1.8 MGD. The performance of the treatment plant however, is seriously compromised during periods of high turbidity or high color in the water supply. The operators respond to these events by operating the two DE filters in series using the first unit as a roughing filter and the second unit as the finishing filter. The current operational protocol is to add alum and soda ash mixed in the body feed for coagulation and pH adjustment. The finished water turbidity standards are satisfied but color cannot be totally removed and remains an operational problem.

The maximum single day production for the SWTP is 1.2 MGD during 24 hours of operation. This maximum day production was treated through a single filtration unit. The SWTP has sufficient surplus filtration capacity but is operated under a self imposed production limit of 1.8 MGD. Although the filters have a much greater production capacity each filter is operated at a much lower rate to achieve the turbidity objective of 0.5 NTU. The 1.8 MGD rated capacity will however, provide sufficient treatment capacity for the design population of 3,000 residents.

The plant has consistently met the current standards of the safe drinking water regulations. As a DE treatment facility, the SWTP will avoid all of the new and extremely stringent turbidity limits required by LT1ESWTR. The turbidity requirements for DE treatment plants will remain 1.0 NTU. However, future safe drinking water regulations will require greater safeguards for the water consumer and require enhanced degrees of pathogen removal and inactivation and a reduced level of DBP in the finished water supplies. Compliance with the future safe drinking water regulations by the SWTP is highly problematic unless improvements are added to the facility.

3.2.3 Disinfection

The SWTP is equipped with both ozone and chlorine disinfection systems and both have been operating very effectively. The ozone system has recently been upgraded with a new 100 pound per day ozone generator and new air driers. The upgraded system has been in operation since September 5, 2002 and is operating efficiently and effectively. The operators do not consider the ozone system as the primary disinfectant and use the system as a finishing process to remove color, taste and odor. The ozone contact basin is a 3 chamber structure with a depth of 20 feet and appears to be designed and constructed in accordance with current engineering design standards. The first two chambers are equipped with ozone diffusers. The third is vacant but equipped with provisions to add diffusers if required.

Ozone is a very aggressive oxidant that oxidizes the organic precursors prior to their reaction with chlorine. Ozone's use as an aesthetic agent has the secondary benefit of reducing the disinfectant by-product formation potential within the treated water.

Disinfection and giardia inactivation are a function of several factors, including disinfectant type (chlorine, chloramines, ozone, etc), disinfectant concentration (C), contact time with the disinfectant (T), temperature, pH, and turbidity. The EPA measures inactivation by using CT values, the product of the disinfectant concentration (C) in mg/L times the contact time (T) in minutes. Tables specific to water temperature and pH have been developed and are presented in the EPA publication ***Surface Water Treatment Rule Guidance Document (1991)*** that show the log inactivation for given CT's. The EPA assumes proper turbidity control with a properly functioning DE plant, so this factor is not included in the CT calculations.

The gaseous chlorine system is considered the primary disinfection system. Chlorine concentrations in the finished water are computed to satisfy the CT requirements for pathogen inactivation and not for chlorine residual in the distribution system. Chlorine is added as the finished water leaves the ozone contact basin. The current regulations, the Surface Water Treatment Rule (SWTR) requires a 99.9% (3 log) removal or inactivation of *Giardia lamblia* and a 99.99% (4 log) removal or inactivation of pathogenic viruses. A 2.0 log *Giardia* removal credit is given to properly operated DE treatment plants. Therefore, an additional 1.0 log inactivation must be completed through disinfection practices.

The first step in determining whether SWTP is achieving the appropriate CT is determining the contact time for the disinfectant. The contact time is determined by the water flow in the plant, the volume of the clearwell, and the flow characteristics. The total volume of the clearwell is approximately 42,000 U.S. gallons. In addition, since the clearwell is not baffled, a rating of "poor" flow characteristics must be assigned and the contact time must be multiplied by 0.3 according to Table 3-3. At the historical maximum plant flow of 1.2 MGD, the calculated disinfectant contact time is 15 minutes. Assuming the seasonal water temperatures during the maximum day event of (15^oC) and a pH of 7.5, required CT for 3.0 log Giardia inactivation is 92 mg-min/L at a chlorine concentration of 1.2 mg/L. The CT achieved by the SWTP is 18 mg-min/L or approximately 0.6 log Giardia inactivation and well short of the regulatory objective of 1.0 log inactivation.

Baffling of the clearwell is the recommended method for improving compliance with the CT requirement of the SWTR. Baffling will improve the flow characteristics of the clearwell, thus allowing a multiplier of 0.7 instead of 0.3. This will increase the contact time from 18 minutes to 35 minutes at a flow of 1.2 MGD. Under the same conditions (temperature = 15^{o}C, pH = 7.5, chlorine concentration = 1.2 mg/L), a CT of 42 mg-min/L is achieved, which is given a credit of over 1.4 log inactivation of Giardia. Constructing baffles in the clearwell will definitely improve the level of disinfection provided by the chlorine system.

These calculations show that the SWTP as it is currently configured will have difficulty meeting the disinfection requirements of the SWTR if chlorine alone is used as the disinfectant. Although the chlorine disinfection system has its inherent deficiencies and fell well short of the required CT, the public was never at risk because the SWTP also uses ozone. Although ozone is used primarily as an aesthetic agent it provides a very significant benefit as an aggressive disinfectant.

Baffling Condition	Factor	Baffling Description
Unbaffled	0.1	None, agitated basin, high inlet and outlet flow velocities, variable water level.
Poor	0.3	Single or multiple unbaffled inlets and outlets, no intra-basin baffles.
Average	0.5	Baffled inlet or outlet with some intra-basin baffling.
Superior	0.7	Perforated inlet baffle, serpentine or perforated intra-basin baffles, outlet weir.
Excellent	0.9	Serpentine baffling throughout basin
Perfect (plug flow)	1.0	Pipeline flow

Reproduced from: “Optimizing Water Treatment Plant Performance Using the Composite Correction Program” EPA /625/6-91/027, February 1991

Table 3-3 - Contact Basin Baffle Factors

It is recommended that the normal operation of the SWTP include installing baffles in the clearwell and consider both ozone and chlorine as primary disinfectants. The clearwell must be baffled before chlorine disinfection alone will satisfy the requirements of the Surface Water Treatment Rule. If the ozone generator is out of service for any reason its operation must be restored as soon as possible.

3.3 Existing Water Distribution System

The distribution system is comprised of pvc, ductile iron and asbestos cement water mains and transmission lines in 4" to 14" diameters. The system has been improved periodically as system needs are identified and funding is available.

The entire water system is metered with the exception of several Town owned buildings and all park facilities. There isn't any planned meter replacement program nor is there a large meter maintenance and calibration program.

The distribution system was designed to operate as three distinct pressure zones which are shown in Figure 3-1 and described below.

Zone 1 - West of the North Platte River and south of Cyprus Street
Zone 2 - West of the North Platte River and north of Cyprus Street
Zone 3 - East of the North Platte River

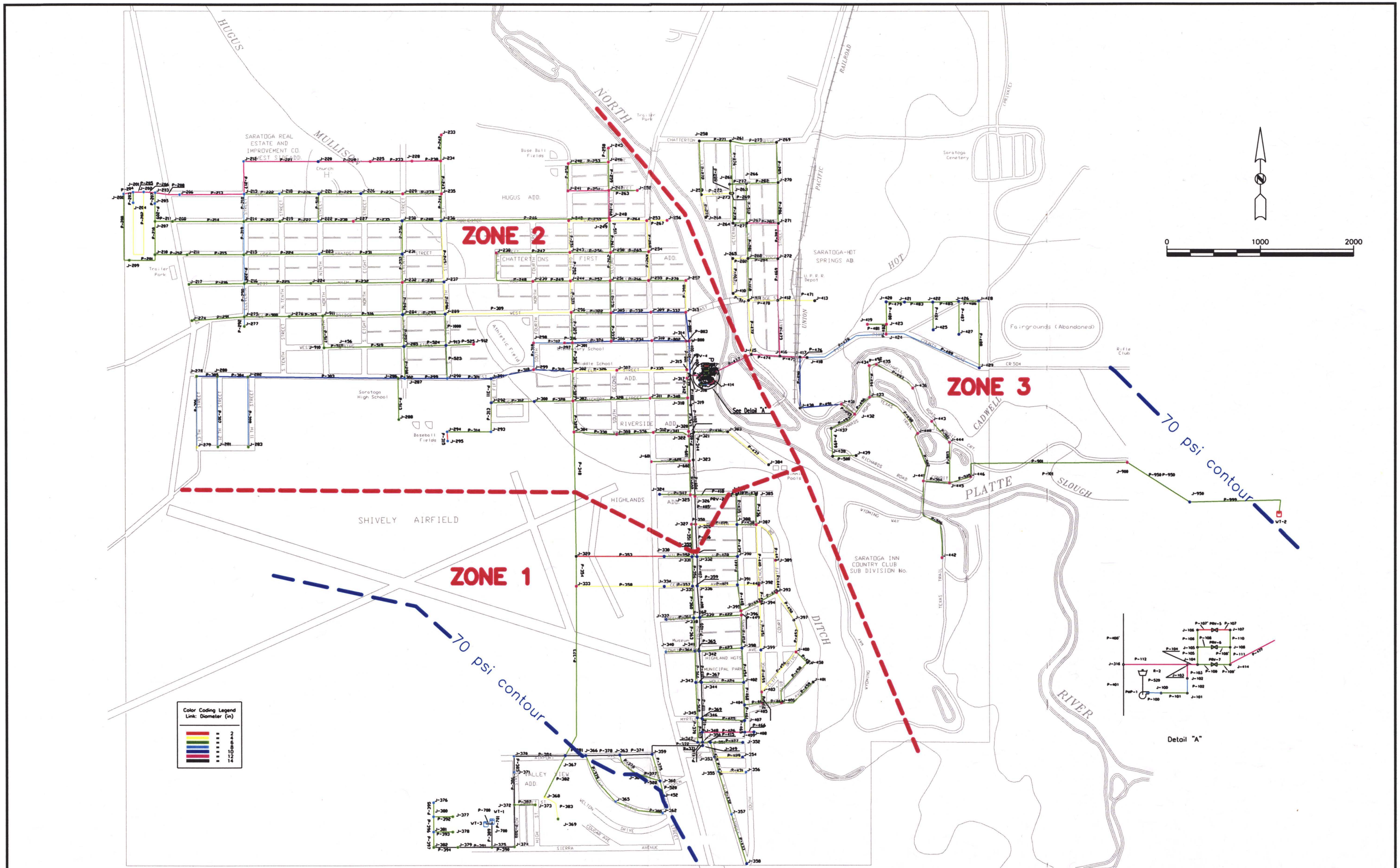
Operation and maintenance of multiple pressure reducing valve (PRV) installations has proved cumbersome. Multiple PRV installations must be coordinated to control Zone 2 & 3 pressures. All PRV installations are in vaults requiring that confined space permit and entry procedures be followed to enter and adjust the valve settings. PRV installations near the SWTP are under water most of the year. The distribution system is now operated as one pressure zone.

The Old Baldy Club is the only water user outside the Town supplied by the Saratoga system. The Old Baldy system is owned and operated by the Old Baldy Club. It operates on Town system pressure to supply water to users in the low area adjacent to Saratoga and to fill their storage tank. Water is pumped from the storage tank to supply the remaining Old Baldy users. Saratoga does not supply irrigation water to Old Baldy; they have a separate irrigation system.

3.3.1 System Analysis

The existing and future distribution system operations were simulated using WaterCad computer modeling software. The basic water system model is shown in Figure 3-1. Multiple piping scenarios were investigated to determine the capacity of the existing system and the effects various operating conditions and piping changes will have on the distribution system's capacity. A list of the scenarios investigated and a representative computer printout are included in Appendix A. Paper printouts and digital files of all system models have been submitted with the project notebook and a separate digital copy provided to the sponsor.

The maximum day plus fire demand was found to be the governing flow criteria for both the 1,726 and 3,000 populations.



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JOB NO. 7012.090
FILE NO. MASTER1.DWG
SCALE: AS SHOWN
DRAWN BY: RWC
DATE: 03/11/03

FIGURE 3-1
EXISTING WATER SYSTEM MODEL

SARATOGA - MASTER PLAN UPDATE & LEVEL I STUDY
WYOMING WATER DEVELOPMENT COMMISSION

SHEET
3-7

The existing distribution system was analyzed with the PRVs operating and again with the PRVs removed to determine how the PRV's operation affects the distribution system. The existing system can supply the present 1,726 population's maximum day demand of 657 gpm, maintain a 20 psi minimum residual system pressure and supply a minimum 1,000 gpm fire flow to most areas of Saratoga. The Saratoga Inn area and the ends of small dead end lines cannot meet these conditions. The minimum fire flow was 537 gpm at the lower end of the Old Baldy connection. Removing the pressure reducing valves increases the minimum fire flow to 579 gpm.

The existing system can supply the design 3,000 population's maximum day demand of 1,142 gpm, maintain a 20 psi minimum residual system pressure and supply a minimum 1,000 gpm fire flow to fewer areas of Saratoga than with the present population. The minimum fire flow was 515 gpm at the lower end of the Old Baldy connection. Removing the pressure reducing valves increases the minimum fire flow to 537 gpm.

3.3.2 Leak Detection

A leak detection test of the distribution system was not conducted. The inconsistent unaccounted for water results obtained from the review of the two most recent year's meter readings do not mandate leak detection testing. The unaccounted for water should be monitored and a leak detection program instituted if a consistent water loss trend is observed.

3.3.3 Meters, Meter Reading and Billing

The Town began requiring water meters in the 1970's. Most water services are now metered. Some municipal buildings and parks are not metered. Water meters are mechanical devices and are subject to wear and mechanical malfunctions. There isn't a meter replacement program nor is there a large meter testing and calibration program in place.

Saratoga's water meters are presently equipped with remote odometer type readouts typically located where they can be read without entering the buildings and meter vaults. The readings are written in a meter book and then transcribed into the Town's utility billing program. Reading meters is time consuming and writing the initial meter reading and transcribing the reading into the billing program introduces multiple chances for introducing errors into the process.

3.4 Existing Water Storage Facilities

The existing storage system includes two 1,000,000 gallon standpipes and a 100,000 gallon tank at the Old Baldy Club.

The initial standpipe is a welded steel tank constructed in 1978. This tank was inspected by divers in 1999 while the tank was in service. The inspection revealed numerous deficiencies in the interior of the tank. Among these deficiencies were blistered and peeled paint allowing tank corrosion, accumulated sediment, inoperable corrosion protection system, and missing structural supports on the tank overflow.

The second standpipe is a bolted steel tank constructed in 2002. Construction of this second standpipe will now allow the initial standpipe to be removed from service for cleaning, painting and other needed maintenance.

Current Wyoming Department of Environmental Quality Rules and Regulations require water systems serving in excess of 500,000 gallons on the design average demand to provide clearwell and system storage capacity equal to 25 percent of the design maximum daily demand plus fire storage. The minimum required storage for 3,000 population is (0.25 X 1,643,917 gal + 120 min. X 2,000 gpm) 651,000 gallons.

Both standpipes are 100 feet in height and are at the same elevation. In order to maintain a minimum 20 psi residual pressure throughout the system, approximately 40 feet of water must be maintained in the tanks, thereby reducing the combined effective tank storage capacity to 1,200,000 gallons which is adequate for the projected 3,000 population.

The 100,000 gallon Old Baldy Club tank is a bolted steel tank installed in 1984 and serves only the Old Baldy Club.

4. WATER RIGHTS

4.1 Existing Water Rights

A review of available data from the Wyoming State Engineer's Office was conducted by Water Right Services, LLC. A tabulation of the Town's surface water rights is presented in Table 4-1.

	Permit No.	Source	Facility Name	Priority	Amount	Status	Uses
1	Terr.	North Platte River	Saratoga Municipal Intake	18880816	0.07 cfs*	adj	Municipal
2	6040 Enl.	North Platte River	Saratoga Municipal Intake	19611128	0.04 cfs	adj	Municipal
3	21744	North Platte River	Saratoga Municipal Intake	19560928	2.00 cfs	adj	Municipal
4	6046 Enl.	North Platte River	Saratoga Municipal Intake	19601108	2.00 cfs	adj	Municipal
5	7299 Enl.	North Platte River	Saratoga Municipal Intake	19780815	6.28 cfs	un-adj	Municipal
	1- Limitted to 12.08 af-year to be diverted May 1 to Sept.30 of each year.						
	2- Limitted to 7.65 af-year to be diverted May 1 to Sept.30 of each year.						
	* 1 cfs = 448.8 gpm						
	Also diverted through the Saratoga Municipal Intake is the George B. Storer Appropriation - 0.285 cfs -						
	Terr. - 18830402 and the George B. Storer Appropriation 0.025 cfs - Terr. 1886						
	Total capacity of intake according to the records is 10.70 cfs.						

Table 4-1 Town of Saratoga - Existing Surface Water Rights

The George B. Storer appropriations (0.31 cfs) are for OBC water to be treated at the SWTP and delivered to the Old Baldy Club (OBC). OBC may make water from these appropriations in excess of OBC's needs available to the Town through an appropriate water use agreement.

5. GROUNDWATER INVESTIGATION

5.1 Summary

Groundwater development potential in the vicinity of Saratoga, Wyoming was evaluated based on published reports, the files of the Wyoming State Engineer's Office, original field investigations, local interviews, and laboratory analysis of groundwater samples.

Principle conclusions:

1. The two aquifers with the potential for supplying sufficient quantities of water to replace the current and future Saratoga water supply are the alluvial aquifer along the North Platte River and the North Park Formation underlying the larger Saratoga area.

2. The productivity and, most importantly, the groundwater quality of the alluvial aquifer does not appear suitable due to the limited thickness of these deposits and the pervasive influence of mineralized groundwater from the underlying bedrock.

3. The North Park Formation clearly has the potential to provide suitable quantities of water of acceptable quality in the Saratoga area, but is quite variable in both quality and quantity.

4. The spatial distribution of North Park groundwater characteristics indicates high productivity and acceptable water quality may be available on the order of 3-4 miles east and northeast of Saratoga.

5. An exploration program to confirm the productivity and groundwater quality of the North Park Formation east and northeast of Saratoga is recommended to provide the design information necessary to make informed decisions on long-term water-supply development for the town.

5.2 Introduction

The Town of Saratoga currently draws its municipal water supply from the North Platte River via a riverbed infiltration gallery and a direct intake near the center of town. Peak day consumption is approximately 1.0 million gallons (695 gpm). Because the town relies on the North Platte River, it is subject to priority regulation from downstream senior users. In certain years, this includes Pathfinder Reservoir, a call for which precludes exercise of rights junior to 1904. Current Wyoming State Engineer policy is to honor a call for this right only through April 30. Although such a call has the potential to restrict water diversions by Saratoga, the town's senior rights were sufficient to meet demands in 2002 (Bartlett, pers. comm., 9/02).

If a groundwater supply of sufficient quantity and quality can be identified and verified, it could provide several significant advantages over the current surface-water source:

- more stable quality (i.e. free from springtime turbidity upsets)
- no treatment required beyond disinfection to maintain transmission and distribution system residual
- decreased testing and analysis requirements
- more stable quantity (i.e. available through drought years)

- less subject to regulation for senior users
- higher winter temperature (i.e. fewer line freezing problems)

Figures 5-2 and 5-3 provide schematic cross-sections through the Saratoga area, focusing on the Miocene sandstone sequence (Tnp and Ta). Although designated as "Precambrian rocks" on Figure 5-2, the underlying units could be any of the Mesozoic or Paleozoic-age formations, depending on location, see Figure 5-3.

This chapter presents an investigation of the groundwater resources potentially available to the Town of Saratoga, including considerations of both quantity and quality, and provides recommendations for further exploration of a selected target area.

5.3 Hydrogeologic Setting

5.3.1 Stratigraphy

This section reviews geologic formations (or deposits) in the study area, from youngest to oldest, in terms of lithology and water-bearing characteristics. The general geology of the Saratoga area is depicted on Figure 5-1. The geologic units included on the map, from youngest to oldest, are:

Qal - alluvial deposits
Tnp - North Park Formation
Ta - Arikaree Formation (grouped with the North Park Fm. for this report)
Kmv - Mesaverde Formation
Ks - Steele Shale
K, Tr, and Pz units - rocks of Mesozoic and Paleozoic age, limited outcrops at the periphery of the study area
pCr - Precambrian rocks, “basement”, largely granitic compositions

The youngest geologic materials in the area are the alluvial sands, silts, and gravels along the North Platte River and its tributaries. Due to the manner in which these materials are deposited, alluvial deposits tend to be relatively coarse-grained and thus, relatively permeable to the flow of groundwater. Figure 5-1 shows the lateral extent of these materials. Thickness is a maximum near the original valley center (not necessarily coincident with the present stream channel) and thins to zero at the edges of the deposit.

Well logs in and immediately around Saratoga indicate no great thickness for the alluvial deposits in this area. Typically, the underlying bedrock is encountered at depths of less than 20 feet[1]. Visher (1952) cites an alluvial thickness of 20 feet at the North Platte River bridge on the north side of Saratoga. The logs of six individual wells that penetrated the alluvial deposits along the river were examined. All but one developed their water from the underlying North Park Formation, apparently finding the alluvium insufficiently productive. This was also the experience of two exploratory wells drilled alongside the Saratoga water treatment plant, where the alluvial material was not productive (Bartlett,

[1] A notable exception is the WSEO Statement of Completion for permit no. UW379 (Foote No. 1), located at T17N, R84W, Sec. 3ccc, at the west edge of the North Platte River floodplain 2 miles northwest of Saratoga, which describes 80 ft. of “gravel”. There is currently no sign of this well at the listed location.

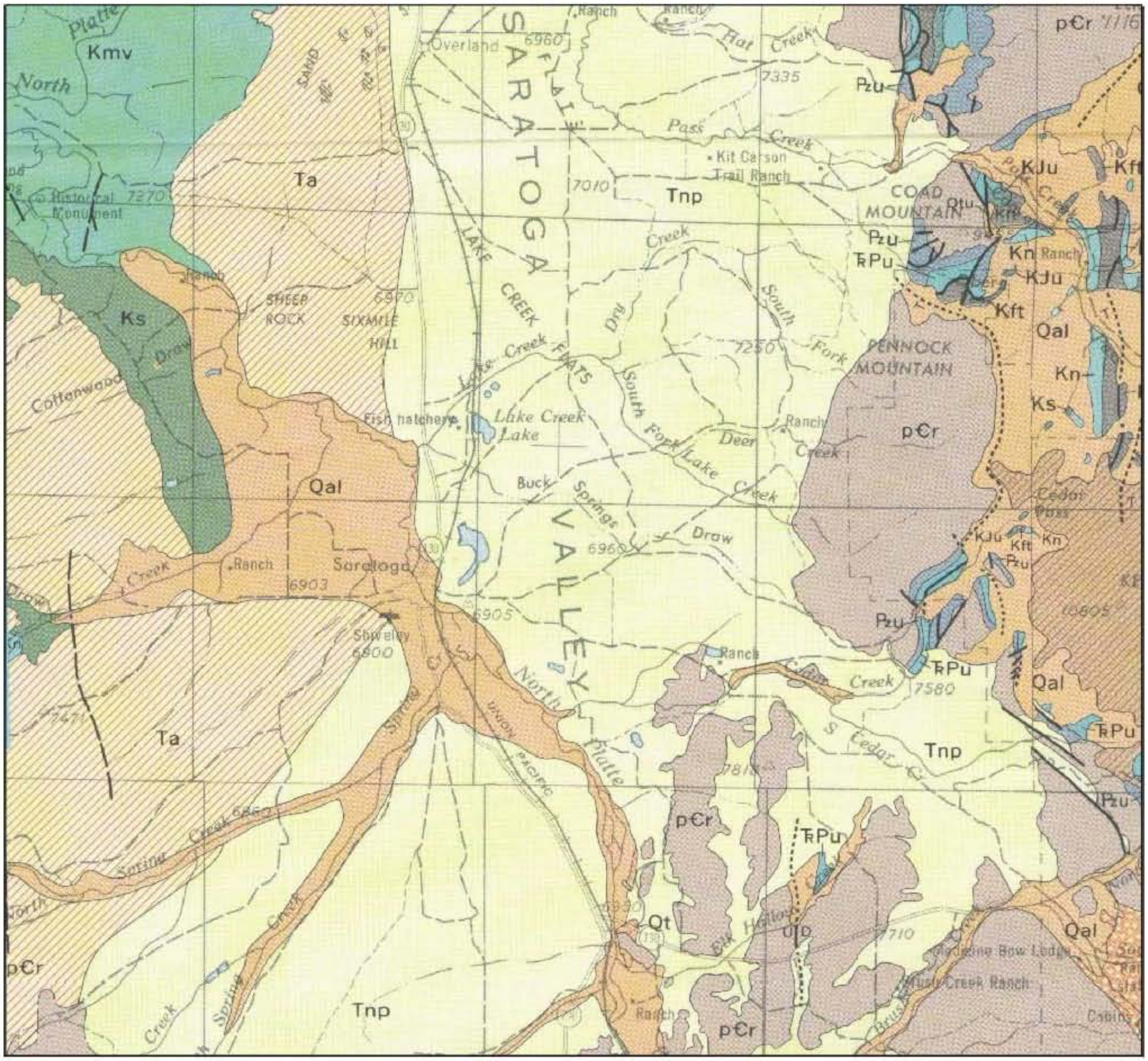

Figure 5-1 - Saratoga Area Geologic Map

Source: Lowry et al., 1973)

pers. comm. 7/02). These wells subsequently encountered mineralized water in the underlying sandstone units and were abandoned.

The North Platte River has been incised into the late-Tertiary (Miocene) North Park Formation[2], which underlies both the alluvial deposits and the surrounding landscape. The North Park Formation, in turn, fills a broad valley eroded into the underlying, much-older bedrock.

Crist (1990, Plate 1) has mapped the bottom of the North Park Formation as an irregular surface beneath the study area, based primarily on wells that have fully penetrated the formation. He indicates a thickness of zero around a small exposure of older bedrock immediately south of the Saratoga Hot Springs, increasing to 650 feet in a local east-west trough 1.5 miles north of Saratoga, with a more general thickening to the northeast beyond Lake Creek. Montagne (1991) presents an alternate interpretation of the subsurface data, with a total North Park thickness of as much as 1800 feet in a north-south trough a few miles northeast of Saratoga. Visher (1952) concluded the North Park Formation was "about 1700 ft" thick beneath the Pass Creek Flats area (15 miles north of Saratoga). The divergence of various investigators on the basic configuration of the pre-North Park surface reflects the general scarcity of sub-North Park data.

The closest outcrops to Saratoga of the geologic materials beneath the North Park Formation (i.e. North Park Formation thickness thins to zero) are the preCambrian basement rocks 6 miles southeast of Saratoga and the Steele Shale approximately 4 miles northwest.

The North Park Formation in the Saratoga area has been described by Luft (1985): "calcareous and conglomeratic sandstone, limestone, and lesser amounts of bentonitic clay and volcanic tuff"; and by Stephens and Bergin (1959): "fine-grained sandstone; white to yellowish-gray tuff; light-gray cherty limestone, bentonitic claystone and marlstone; and volcanic ash". The most detailed descriptions are from Montagne (1955), who subdivided the formation into three facies: 1) a "channel" facies in which sandstone and conglomerate units are dominant; 2) a "back-fill" facies consisting of "fine tuffaceous siltstone and claystone, laminated silty shale, marl, and algal limestone" deposited in backwaters and lakes; and 3) a "flank" facies representing the colluvial input from the margins of the Saratoga basin. All three facies are commonly interbedded, although the flank facies is relatively rare away from the basin margins.

Figure 5-2 is a schematic cross-section of the North Park developed by Montagne (1991) to show the interbedded nature of the various facies. Montagne (1991) describes a pervasive matrix-supported conglomerate at the base of the North Park Formation in the Saratoga area. However, given the complex interlayering of facies within the North Park Formation, it is difficult to predict the subsurface lithology at any specific location.

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[2] Lowry et al (1973) distinguish the North Park Fm. from an underlying sandstone sequence termed the Arikaree Fm; Montagne (1955) termed the upper unit the North Park Formation and the lower unit the Browns Park Formation, but later (Montagne, 1991) termed these simply the "upper" and "lower" units of the Browns Park Formation; Crist (1990) terms the lower unit simply "Sandstone Unit", but notes the similarity of lithology and water quality and treats the combined sequence as one "geohydrologic unit" called "Miocene sandstone". Following Crist's lead, this report treats the entire Miocene-age sequence as one hydrogeologic unit to which is applied the name "North Park".

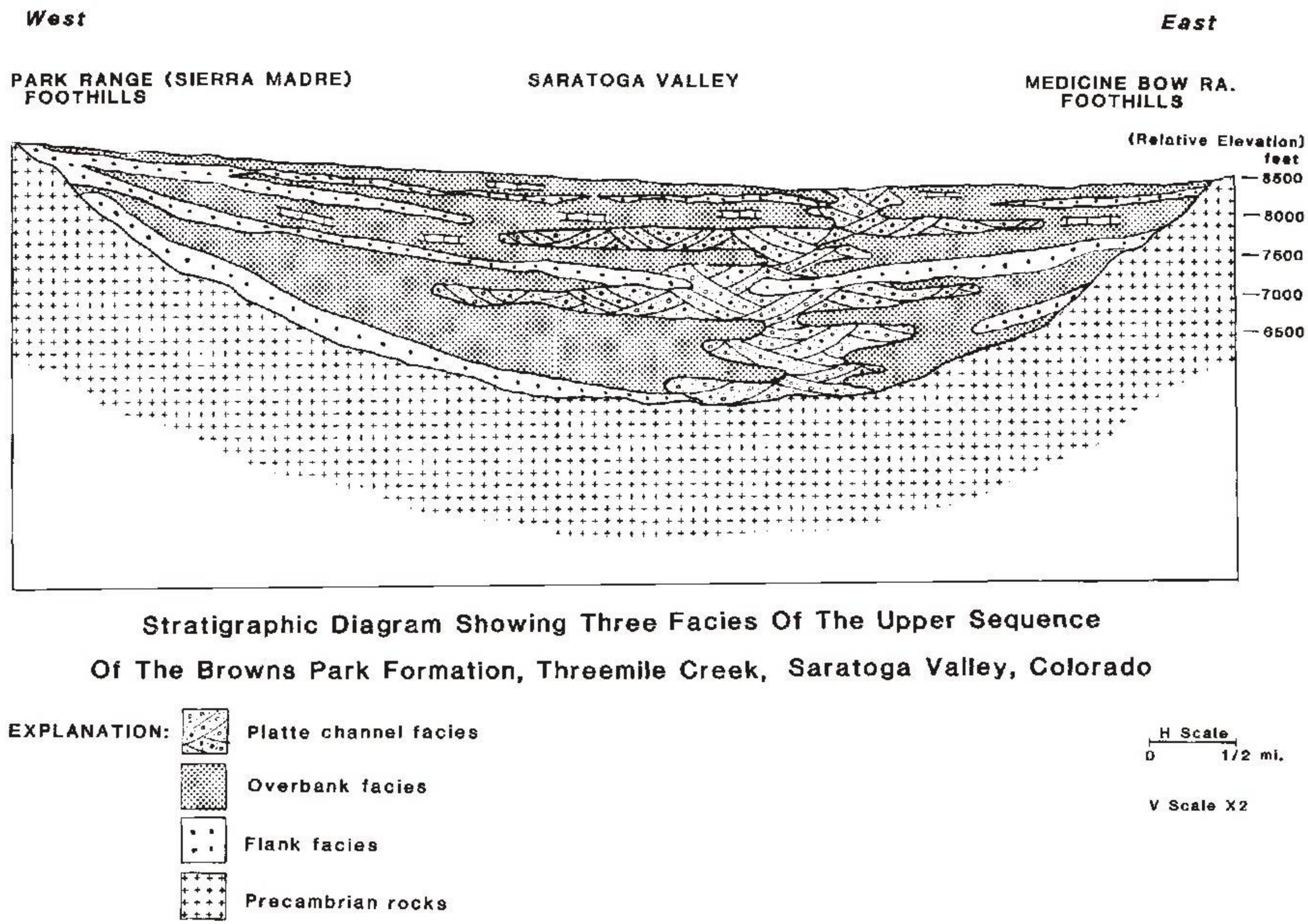


Figure 5-2 - Schematic North Park Formation Stratigraphy

Source: Montagne (1991)

above. “Sandstone”, “sandy shale”, “limestone”, “shale”, “silt”, “clay”, “sandy lime”, and “sandy clay” are common drillers’ descriptions, with variations of “sandstone” predominating. The identified water-bearing zones tend to correspond with the “sandstone” intervals, although the main water zones in the Saratoga Fish Hatchery wells are described as “crevice limestone” (Well No. 1) and “grey shale with thin strips of sandstone” (Well No. 2). While lithologic logs of the water wells in the study area confirm the general character of the North Park Formation, there is little indication of individual units that are sufficiently widespread to allow well-to-well correlation. Table 5-1a presents a compilation of water-supply well information from the study area, including descriptions of the water-bearing zones of the North Park Formation. Table 5-1b presents Wyoming State Engineer’s Office permit information for the same set of wells; well numbers are provided as a cross reference between the well/aquifer data - Table 5-1a - and the permit information - Table 5-1b.

Borings to depths from 30 to 90 ft completed at the Saratoga landfill encountered sandstone (very fine grained, commonly silty) and siltstone units of variable induration and clay content (Maxim, 2000). Slug tests at this site indicate a horizontal hydraulic conductivity of 0.5 ft/day. Hydraulic conductivities on the order of 200 ft/day are required to support the measured production of irrigation wells producing from the North Park Formation within 4 miles north of the landfill. These data indicate the large range in productivity of the various units within this complex formation.

In and around Saratoga, the North Park Formation dips gently, 2 - 10^{o}, to the east. Small normal faults of inconsistent orientations have been mapped in the formation (e.g. Montagne, 1955, 1991). Maxim (2000) observed “vertical and sub-vertical fractures” in well-cemented sandstone layers of the North Park Formation exposed in test pits excavated in the vicinity of the Saratoga landfill (Sec. 8cc, T17, R83). These types of structural features likely provide local enhancement of formation permeability and thus impact groundwater flow patterns locally. Breckenridge and Hinckley (1978) suggest that a northeast-southwest trending fault through the site of the Saratoga Hot Springs (as mapped by Montagne, 1955) may control the spring location.

Montagne (1991, Plate II) maps several “possible basement fracture system” features in the Saratoga area, including one trending north-northeast by south-southwest 3-4 miles east of town. The impact of these conjectured fracture systems on groundwater circulation is unknown although Montagne (1991, p. 37) suggests some connection with “the line of springs ... at Saratoga”.

Beneath the North Park Formation at Saratoga is likely a northward-dipping section of Paleozoic and Mesozoic-age rocks. Montagne (1991) suggests that the North Park Formation rests directly on pre-Cambrian basement rocks east of a northeast-southwest line approximately 3 miles east of Saratoga. The oldest pre-North Park sedimentary formation exposed northwest of Saratoga is the Cretaceous-age Steele Shale. Thus, bedrock directly beneath Saratoga could be any one of many shale, siltstone, sandstone, or limestone formations. Shales and siltstones dominate this interval, but several formations have favorable water-bearing qualities where they have been explored elsewhere in the region, e.g. Nugget Sandstone, Casper Formation, Madison Limestone. In any case, depth and water-quality considerations (see discussion below) likely preclude useful groundwater supply development from geologic units below the North Park Formation.

The pre-Cambrian rocks beneath Saratoga (and exposed at the surface east, south, and southwest of town) are largely granitic in composition, but include a complex of andesite porphyry, hornblende gneiss, black and green schists, diabase porphyry, pegmatites, slate,

Well No.	Location	Depth (ft)	SWL (ft)	Permit Yield (gpm)	Test Data Flow (gpm)	Test Data Drawdown (ft)	Test Data Duration (min)	Specific Capacity (gpm/ft)	Logged Water-Bearing Zone top (ft)	bottom (ft)	lithology	completion	Comments
1	17-83-5ca	130	64.75	24	15	16	180	0.9	10	120	Blue sandstone, light sandstone	PVC casing, 1/8 inch perforations	
2	17-83-5db	125	70	20					82	85	sandy lime	PVC casing, 1/8 inch perforations	
3	17-83-5aa	120	70	25					80	84	coarse blue sandstone	PVC casing, 1/8 inch perforations	
4	17-83-5bc	160	63	25	25	3	120	8.3	135	140	grey sandstone	PVC casing, 1/8 inch perforations	
5	17-83-5db	126	47	25	25	33	120	0.8	58	61	grey sandstone	PVC casing, 1/8 inch perforations	
6	17-83-5da	40	5	25	25	very little	1440			Unknown			
7	17-83-9cc	130	52	20	20	2	60	10.0	52		light grey sandstone	light weight well casing	Does not indicate depth of casing
8	17-83-18bd	350	70	280	280					Unknown		PVC casing, 1/8 inch slotted	
9	17-83-19aa	120	65	20	50	20	120	2.5	65		blue sandstone	black plastic	Does not indicate depth of casing
10	17-83-20cc	192	48	20	20	6	120	3.3	170	173	grey, sandy shale	PVC casing, 1/8 inch factory cut perforations	
11	17-83-28ac	45	15	25							North Park Sandstone	steel casing, perforated from 35-45 ft	
12	17-83-29ab	175	58	24					66	128	grey sandstone	PVC casing, 1/8 inch perforations	
13	17-83-29ab	203	57	25					155	165	grey sandstone	PVC casing, 1/8 inch perforations	
14	17-83-29da	25	10	25	25	0					coarse river gravel		
15	17-83-31dd	250	131	25	25	50	240	0.5	110	250	Shale, sandstone, blue shale, light sandstone	plastic casing, factory cut and 3/8 inch drill	
16	17-83-31dd	70	30	25	20					Unknown			20 gpm on pump test was estimated
17	17-83-33ad	100	60	20	24	0	60		60		compact light gray limey strata of North Park Sandstone	heavy duty galvanized well casing	Does not indicate depth of casing
18	17-84-3cc	220	10	1100					165	220	sandstone	perforated galvanized steel casing, 16 inch	Does not indicate depth of casing
19	17-84-11cb	73	20	200	400	10	480	40.0	70		limestone and marl	cast iron casing	Does not indicate depth of casing
20	17-84-11dc	61	18	50	100	13	300	7.7	18	40	sandstone	steel casing, 1/4 inch slots	
21	17-84-11bc	110	4.5	60	150	5	120	30.0	75	85	blue shale rocks	PVC casing, 1/8 inch perforations	
22	17-84-12cc	39	5	45	55	7	300	7.9	20	39	sandstone	PVC casing, 1/4 inch factory cut perforations	
23	17-84-12db	180	41	35	35	120	120	0.3	150	160	sandstone	PVC casing, 1/8 inch perforations	
24	17-84-13bb	35	5	130	130	0	120		18		gray sandy shale	open hole	
25	17-84-13bb	165	12	200					Unknown	Unknown	sandstone	Unknown	lithology recorded as sandstone with note "(to best of our knowledge)"
26	17-84-14dd	150	140	300	300	0	60				clay	steel casing	Does not indicate depth of casing
27	17-84-14ab	30	8	50	50					Unknown		open hole	
28	17-84-15ac	300	48	350	300	2	240	150.0	160	300		open hole	
29	17-84-22dd	175	6	465	465	13	1440	35.8		Unknown	sand and sandstone	casing with 16" galvanized screen	
30	17-84-23aa	100	75	60	60	85	300	0.7	75	85	grey sandstone	open hole	Application to deepen well to 300 ft was approved 6/20/90 but have no pump test or lithology data subsequent to deepening.
31	18-83-15bc	155	12	400	400	68	240	5.9	69	80	sand	perforations from 27 ft to 152 ft	casing type not listed
32	18-83-17da	100	20	1000	1000	55	360	18.2		Unknown		steel casing, 100 slot	

Table 5-1a. Wyoming State Engineer's Office Statements of Completion examined for this report - well/aquifer data

Continued on page 5-8

Well No.	Location	Depth (ft)	SWL (ft)	Permit Yield (gpm)	Test Data Flow (gpm)	Drawdown (ft)	Duration (min)	Specific Capacity (gpm/ft)	Logged Water-Bearing Zone top (ft)	bottom (ft)	lithology	completion	Comments
33	18-83-17da	120	45	1200	1200	40	360	30.0		Unknown		steel casing, Johnson Well Screen, 100 slot	
34	18-83-17bb	242	97	56	810	75	720	10.8	96	242	soft and hard Bruel clay	steel casing, slot size 100	
35	18-83-17db	145	49	1200					49	145	rock and brown, hard and soft sandstone	PVC casing, 1/4 inch perforations	
36	18-83-17cb	87.5	28	1240					76	85	loose sandstone	100 slot Johnson Wirewound	
37	18-83-18cd	90	15	1000	1500	9	600	166.7	15	90	sand	steel casing, factory perforated, 1/4 inch	
38	18-83-18dc	90	15	1500	1500	9	600	166.7	15	90	sand	steel casing, factory perforated, 1/4 inch	
39	18-83-18da	70	32	0						Unknown		galvanized 18" perforated	
40	18-83-18da	73	12.5	1400						Unknown		steel casing, 1/4 inch slots	
41	18-83-18bd	70	32	1500					32	Unknown	sandstone	galvanized 16" perforated	
42	18-83-21da	110	40	800	800	10	360	80.0	40	56	sand	14", 10 gauge galvanized perforated	
43	18-83-21ab	312	15	565	565	35	1440	16.1		Unknown	sandstone	plain 16" steel casing, Johnson Well Screen 3/8 inch perforations	
44	18-83-21ab	312	15	800	800	76	720	10.5		Unknown		steel casing, slot size 100	
45	18-83-22cd	120	Unknown	500	500	10	360	50.0	60	65	coarse sand	10" gauge, galvanized perforated	
46	18-83-22dc	175	6	465	465	13	1440	35.8		Unknown		Johnson sand screen, 3/16 inch perforations	
47	18-83-29dd	100	20	25	25	very little	1440			Unknown			
48	18-83-30cb	45	10	20					20	30	sandstone and silt	plastic casing with screen	
49	18-83-30cb	30	10	25	25	15	60	1.7	20	30	sandstone and silt	plastic casing, screen with #6 slot size	
50	18-83-30cb	8.6	2	25						Unknown			None of this information provided on SOC
51	18-83-31ab	82	30	25	60	6	180	10.0	48	82	white sandstone	PVC casing, 1/8 inch perforations	
52	18-83-31ad	90	48	25	50	3	240	16.7	40	90	sandy shale	PVC casing	
53	18-83-31db	80	15	25	25	35		0.7	68	Unknown	multi-colored shale, blue water sand	plastic casing, 1/8 inch saw cuts	
54	18-83-32db	103	31	15	20	12	180	1.7	80	103	sand and lime	PVC casing, 1/4 inch factory cut perforations	
55	18-83-32aa	105	Unknown	22						Unknown		steel casing	
56	18-83-33aa	183	72	20	20	2	360	10.0	110	145	red sandstone, soft brown sandstone with sand & gravel	PVC casing, 0.02 inch perforations	
57	18-83-33aa	163	72	20	20	2	360	10.0	98	135	small red gravels & sand, fractured red sandstone	PVC casing, 0.02 inch perforations	
58	18-84-25ad	180	9	350	405	0	120		9	80	limestone, lime blue and sand clay	steel casing	Does not indicate depth of casing
59	18-84-25ad	520	6	500	500	67.5	270	7.4	341	389	shale, grey, with thin strips of sandstone	steel casing, cased to 180 ft, bottom 100 ft and bottom/plate perforated	
60	18-84-25ad	140	33	250	380	34		11.2		Unknown		PVC casing, 0.125 inch and 3/8 inch perforations	

Table 5-1a. Wyoming State Engineer's Office Statements of Completion examined for this report - well/aquifer data

Notes: 1 - all information is owner/driller reported
2 - "permit yield" is the water right flow rate; it may be less than the maximum capability if satisfactory for intended use; it is likely pumped substantially less than all the time

Well No.	Permit No	Applicant	Facility	Priority	Use	Status
1	P61854W	STEVE B. & MARY ANN GLENN	GLENN #1	30-Aug-82	DOM	
2	P80212W	JAMES AND TAMMIE LOGAN	LOGAN #1	10-Jul-89	STO,DOM	UNA
3	P92101W	RICHARD J. STEVENS	STEVENS #1	16-Jun-93	DOM,STO	UNA
4	P98193W	ROGER L. & D. LAVONNE PERSKE	PERSKE #1	19-Jan-95	DOM,STO	UNA
5	P105700W	TERRY RUMMELL**NORMAN BENENTT	RTC #1	15-May-97	DOM	UNA
6	P20664P	C. W. MCILVAINE	EATON #2	31-May-59	STO,DOM	
7	P1151W	GEORGE B. STORER	OAK'S STOCK WATER WELL #1	24-May-58	STO	
8	P45414W	OLD BALDY CORPORATION	OLD BALDY CLUB #1	12-Sep-78	MIS	UNA
9	P1098W	GEORGE B. STORER	STORER DOMESTIC WELL #1	28-Oct-62	DOM	
10	P108292W	MILLIRON RANCHES	MILLIRON 5	19-Dec-97	DOM,STO	UNA
11	P7254P	INC. CEDAR CREEK RANCHES	CHASTAIN DOMESTIC #2		DOM	
12	P73721W	PETER STORER	STORER #2	01-Dec-86	DOM	
13	P88174W	PETER STORER	STORER #3	02-Jun-92	DOM	UNA
14	P7255P	INC. CEDAR CREEK RANCHES	CHASTAIN DOMESTIC #3		DOM	
15	P45589W	C. W. MCILVANE	MCILVAINE #12	17-Oct-78	DOM	
16	P20663P	C. W. MCILVAINE	GROTE #1	31-Dec-00	STO,DOM	
17	P1140W	GEORGE B. STORER	STORER DOM.WELL #2	22-Jun-62	DOM	
18	P379G	L. G. FOOTE**G. L. FOOTE	FOOTE #1	03-Jun-55	STO,IRR	UNA
19	P884W	G. R. GOULD	BANKS WELL #1	11-Jul-62	IRR	
20	P34580W	TOWN OF SARATOGA** PLATTE VALLEY SCHOOLS	ZEIGER PARK #1	06-Aug-76	MIS	ADJ
21	P124903W	RANDY STEVENS	STEVENS 1	21-Apr-00	MIS	UNA
22	P34092W	EDWARD HINES LUMBER CO.	HINES #1	30-Jun-76	IND	
23	P123247W	SARATOGA CEMETERY DISTRICT	CEMETERY #2	04-Feb-00	MIS	UNA
24	P1196W	TOWN OF SARATOGA	SARATOGA HOBO POOL WELL #1	22-Apr-64	MUN	
25	P1206W	SARATOGA INN & RV RESORT, INC.	SARATOGA INN HOT WELL #1	18-May-64	MIS	ADJ
26	P1314W	CHARLES L. ROY WELTON**RICHARD T. BUCHHOLZ	VALLEY VIEW ACRES #1	08-Sep-64	STO,DOM	
27	P9474P	W.L. COVEY	COVEY #1	31-Dec-40	STO,DOM	
28	P13764W	SWANSON BROS.	SWANSON #1	02-May-72	IRR,DOM	
29	P57355W	SARATOGA LAND & CATTLE COMPANY	DOT #3 REFILING	25-Feb-81	RES,IRR,MIS	CAN
30	P9242W	JOSEPH INGLEBY**VIRGINIA INGLEBY	VIRGINIA #1 (DEEPENED)	10-May-71	IRR,MIS,DOM	UNA
31	P1995W	INC. SARATOGA LAND & CATTLE CO.	JACKSON #1	10-May-67	IRR	
32	P44639W	OVERLAND TRAIL LAND & CATTLE	TUTTLE #5	05-May-78	IRR	UNA
33	P44641W	OVERLAND TRAIL LAND & CATTLE	TUTTLE #3	05-May-78	IRR	UNA

Table 5-1b. WSEO Statements of Completion examined for this report - permit data

Continued on Page 5-10

Well No.	Permit No	Applicant	Facility	Priority	Use	Status
34	P52672W	OVERLAND TRAIL LAND & CATTLE	TUTTLE #1N	19-Sep-79	STO,IRR	UNA
35	P76105W	OVERLAND TRAIL LAND & CATTLE	TUTTLE #6	05-Jan-83	IRR	UNA
36	P106506W	OVERLAND TRAIL LAND & CATTLE	TUTTLE 8	19-May-97	STO,IRR	UNA
37	P42264W	OVERLAND TRAIL LAND & CATTLE	TUTTLE #1E	17-Nov-77	IRR	UNA
38	P42265W	OVERLAND TRAIL LAND & CATTLE	TUTTLE #2E	17-Nov-77	IRR	UNA
39	P44636W	OVERLAND TRAIL LAND & CATTLE CO, LLC	ENL EATON #2	05-May-78	IRR	UNA
40	P76106W	OVERLAND TRAIL LAND & CATTLE	TUTTLE #7	05-Jan-83	IRR	UNA
41	P422G	OVERLAND TRAIL LAND & CATTLE CO, LLC	EATON #2	16-Jan-56	IRR	UNA
42	P701W	INC. SARATOGA LAND & CATTLE CO.	RAVENSCROFT #2	06-Oct-60	IRR	
43	P42267W	SARATOGA LAND & CATTLE CO.	DOT #2	13-Jun-77	IRR	CAN
44	P69086W	SARATOGA LAND & CATTLE CO.	DOT #2	28-Aug-84	IRR	
45	P700W	INC. SARATOGA LAND & CATTLE CO.	RAVENSCROFT #1	06-Oct-60	IRR	
46	P69088W	SARATOGA LAND & CATTLE CO.	DOT #3	28-Aug-84	IRR	
47	P20665P	C. W. MCILVAINE	EATON #1	01-May-59	STO,DOM	
48	P50811W	LARRY OR SANDRA CONRAD	CONRAD #1	17-Sep-79	DOM	
49	P50873W	E. LYNN HEEREN	HEEREN #1	15-Jan-80	DOM	
50	P96584W	MARVIN J. AND LILA J. WORDEN	WORDEN #1 SPRING	13-Jul-94	DOM,STO	UNA
51	P39305W	J. R. & ANN WHITE	WHITE #1	01-Jun-77	STO,DOM	
52	P39498W	WM. D. BOUDRIE	BOUDRIE #1	11-Aug-77	STO,DOM	
53	P67493W	EARL D. HUTCHISON	HUTCH #1	01-Jun-84	DOM	
54	P43005W	MILL IRON RANCHES	MILLS IRON EAST #1	24-Apr-78	STO,DOM	
55	P17391P	USDI BLM, RAWLINS DISTRICT	B.B. MC CORMICK #1 (INDEX #1081)	05-Dec-63	STO	
56	P103619W	LARRY M BARRAILLER	BARRAILLER #1	26-Aug-96	DOM,STO	UNA
57	P103894W	RALPH J/PATRICIA A ZORDELL	ZORDELL #1	18-Sep-96	DOM	UNA
58	P285W	U.S.A. DEPT. OF INTERIOR/FISH AND WILDLIFE SERV.	SARATOGA WELL #1	06-Jan-60	DOM,FIS	UNA
59	P392W	USDI FISH & WILDLIFE SERVICE	SARATOGA WELL #2	12-Sep-60	MIS	UNA
60	P84589W	USDA FISH AND WILDLIFE SERVICE	SARATOGA WELL #4	06-Dec-89	MIS	UNA

Table 5-1b. WSEO Statements of Completion examined for this report - permit data

Notes - Locations are owner/driller supplied, field-checked only if adjudicated; 1/4 1/4 Section locations place the well only within a 40-acre tract vermiculite and quartzite (Montagne, 1955). The pre-Cambrian age rocks are commonly referred to as “basement” and likely represent the lower limits of large-scale groundwater circulation.

In summary, the geologic deposits beneath the Saratoga area consists of a complex and laterally variable assemblage of material, the effect of which on groundwater is likely to vary locally. In just the North Park Formation, for example, conditions likely vary from virtually precluding groundwater flow (e.g., bentonitic claystone layers) to providing abundant groundwater supplies (e.g., conglomerate layers). The water-bearing strata within this assemblage may reflect unconfined, confined, or semi-confined conditions, depending upon the local permeability distribution.

5.3.2 Groundwater Circulation

Based on groundwater elevation measurements throughout the Saratoga valley, Crist (1990) has mapped the general flow of groundwater in the North Park Formation from recharge areas along the sides of the valley to discharge into the North Platte River – basically a subdued reflection of the surface drainage patterns. The Crist contours define a gradient - east to west - of approximately 0.05 in the area east of Saratoga. The detailed study of groundwater elevations across the 1200-ft. wide landfill site in Sec. 8 (T17N, R83W) indicates a westward gradient at that point of 0.0093 (Maxim, 2000). As with other aspects of this formation, local variations in groundwater gradient are likely a function of variations in composition and thus, permeability.

In the case of the Saratoga area specifically, recharge to groundwater likely occurs over a broad area east of town through the direct infiltration of precipitation (including snowmelt), and infiltration from the channel and sub-irrigated areas associated with the various forks of Lake Creek, Buck Springs Draw, and Cedar Creek. Additional groundwater recharge also occurs from scattered tracts of surface-irrigated lands north of Cedar Creek (see Lenfest, 1986). The precise boundaries of the potential recharge area cannot be determined from currently available data, but an area on the order of 100 sq. mi. is indicated by surface topography.

From recharge areas, groundwater moves generally westward to discharge naturally via springs, as evapotranspiration from areas of shallow water table, and as baseflow to the lower reaches of Lake Creek, Cedar Creek and the North Platte River. Spring and seep discharges appear to form a band of occurrence along a northwest-southeast trend from the large Lake Creek Lake springs serving the Saratoga Fish Hatchery 3 miles north-northeast of town through the areas of smaller seeps and springs 3-4 miles east-southeast of Saratoga. This is inferred to represent a lateral change in aquifer permeability; westward migrating groundwater encounters lower permeability material and is forced to the shallow subsurface. Under this model, both the quantity and quality of groundwater should be markedly better to the east of this band. See Figure 5-3.

5.3.3 Groundwater Development

The Wyoming State Engineer’s Office has issued 286 groundwater permits in the area within 5 miles of Saratoga[3]. The great majority (85%) of these are for domestic or stock

[3] This includes only wells with active permit status (not cancelled, expired, or abandoned) and non-zero yields (not monitoring wells or permits for enlargements of use).

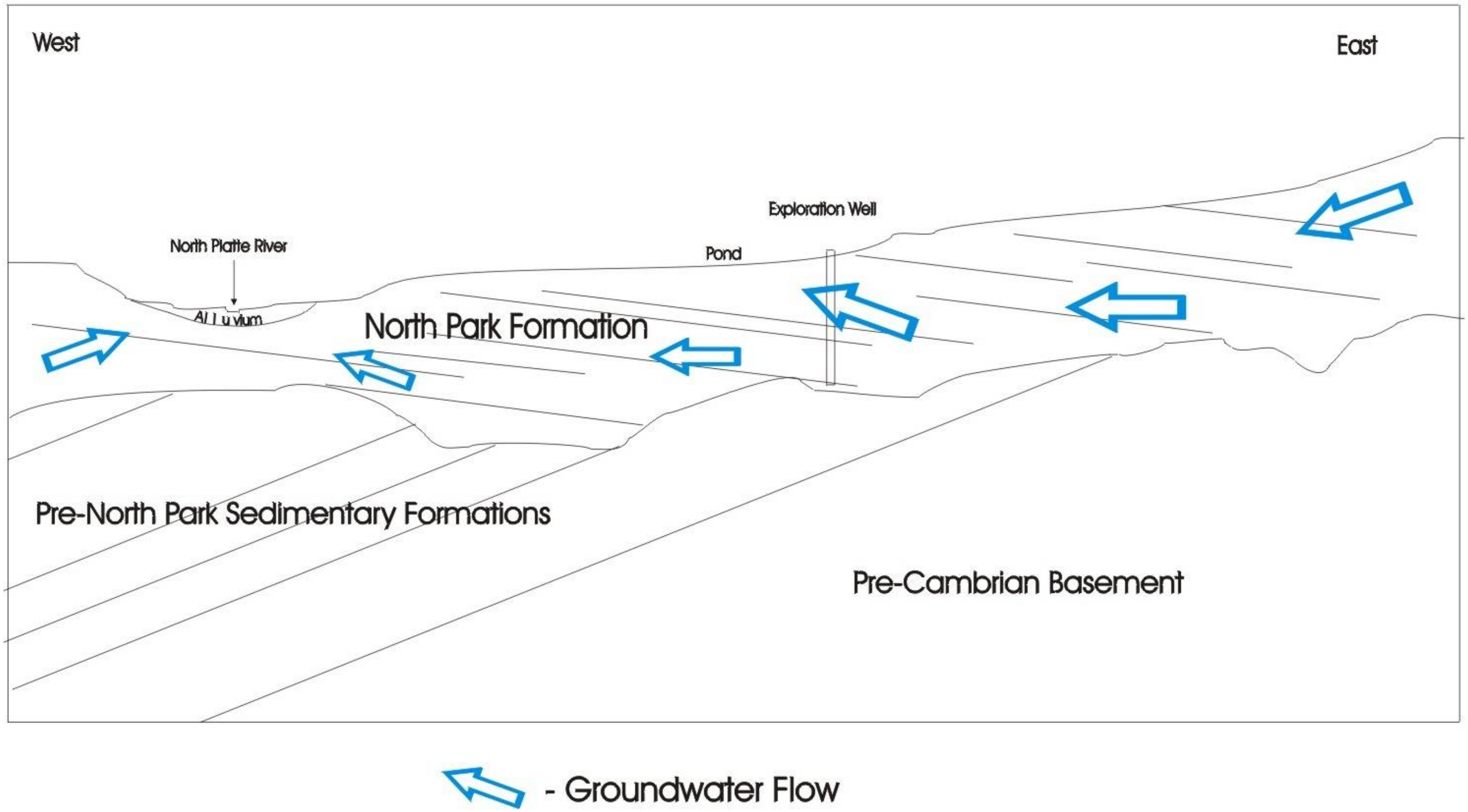


Figure 5-3 - Saratoga Schematic Cross-Section use. These are typically 2 - 10 gpm wells on individual lots.

Not surprisingly, the greatest concentration of wells is in the town of Saratoga. Rather than pre-dating the Saratoga water treatment plant, however, most of the Saratoga wells have been drilled over the last 30 years. Just under 50% of the permitted wells in Saratoga have permit dates in 1976 - 1978. The most recent well of record was drilled in 2000. Although in-town wells encounter alluvial deposits immediately beneath the surface, review of select well logs suggests groundwater development is commonly from the underlying North Park Formation rather than from the relatively thin alluvial deposits. Across the larger area, Visher (1952, p. 8) concluded that the alluvial deposits along the North Platte River and its tributaries, although adequate for domestic and stock use, were of insufficient thickness to allow development of sufficient water for irrigation.

Our investigations indicate the in-town wells are primarily used for individual-lot lawn and landscaping watering rather than for human consumption due to high levels of mineralization. The mineral content is readily apparent in some cases, as staining on walls and fences. We received one suggestion that the Town water supply at one time had been from wells on Veterans Island in the North Platte River, but we have been unable to confirm this. Saratoga has had a river-based municipal supply for 40 years or more.

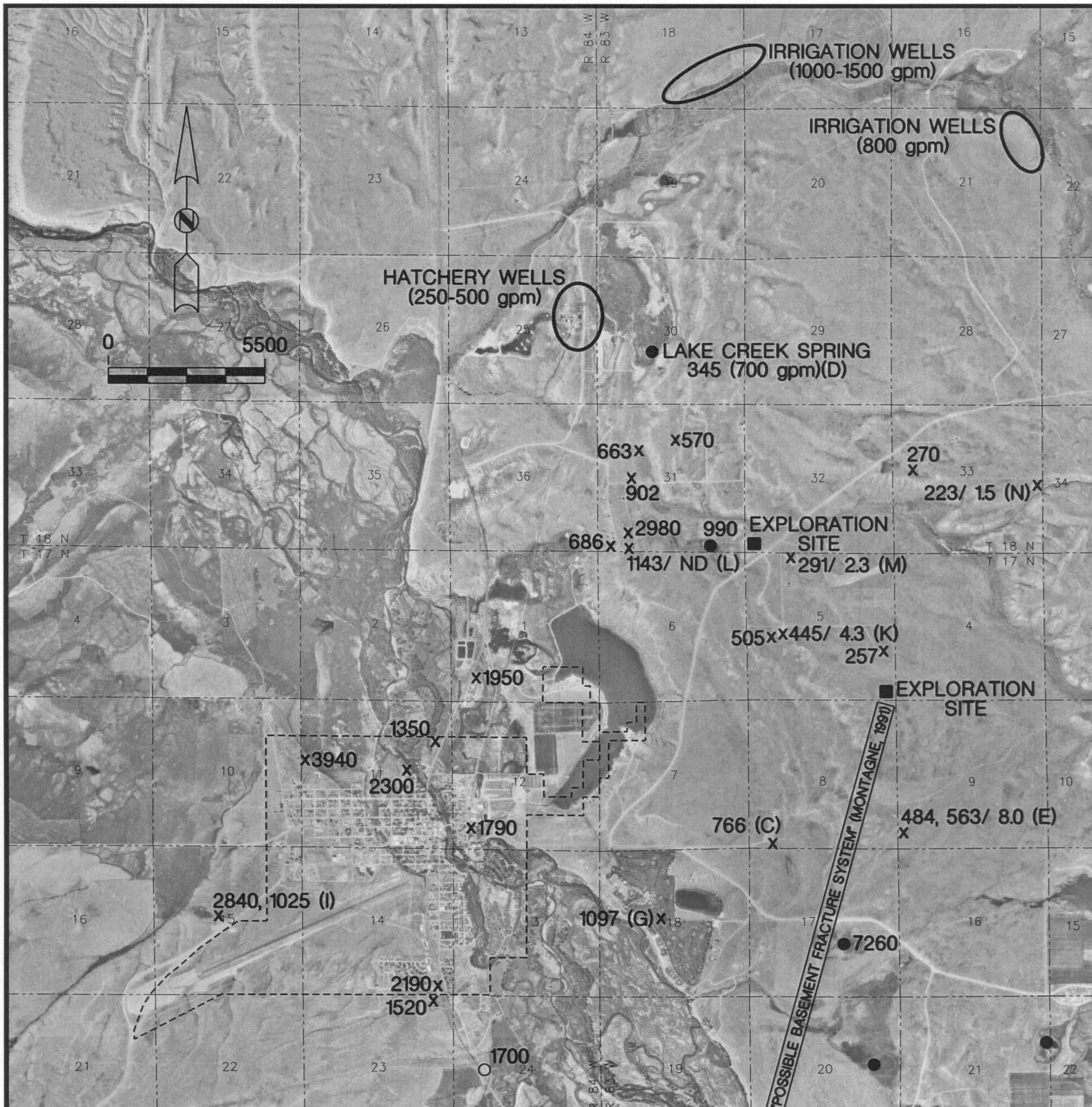
There is also a concentration of wells in T18N, R83W, Sec. 31 - 33 (3 -5 miles northeast of Saratoga). This area encompasses the several filings of the Mountain View Estates Subdivision. These wells produce from the North Park Formation. Surrounding areas are relatively undeveloped, with sparsely distributed wells serving individual ranch facilities.

Irrigation wells have been developed in a few locations, most notably along Lake Creek, northeast of Saratoga. Yields as high as 1,500 gpm have been reported, although these appear to be related to particularly favorable local conditions rather than to widespread high permeability. High capacity irrigation wells have also been developed on the west side of Saratoga, although these were found to have high mineral concentrations (see Figure 5-4[4]). The US Fish and Wildlife Service has completed 5 wells yielding up to 500 gpm in Section 25 ,T18N, R84W. These wells produce from the North Park Formation.

Visher (1952) investigated the potential for groundwater development from the North Park Formation in the area between Lake Creek and Pass Creek. He concluded that while the North Park Formation could produce yields sufficient for domestic and stock use, "because this formation is fine-grained and is not very permeable, the development of large amounts of water would be difficult." He concluded that the large North Park spring at the Saratoga Fish Hatchery (1,300 gpm) is "probably" the result of a fault zone, that fault zones are "the only possible locations for the development of sufficient quantities of water for irrigation", and that "the location of these fault zones is extremely difficult because in most places they lack surface expression".

Lowry et al. (1973) came to a very different conclusion regarding the North Park

[4] Where Table 5-2a or 5-2b provides a chemical analyses for one of the wells on Figure 5-4, a location letter (e.g. "K") is indicated on the figure. Where a Table 5-2 well can be identified with a Wyoming State Engineer permit, the location letter is also included on Table 5-1a. Due to discrepancies between current owner name and permit applicant and the density of well permits in some areas, however, it is not always possible to identify the well permit (Table 5-1) corresponding with each well located in the field (Figure 5-4).



x GROUNDWATER SAMPLE

o SURFACE WATER SAMPLE

● SPRINGFED POND

NOTE: THE VALUE LISTED FIRST IS CONDUCTIVITY (umhos/cm), FOLLOWED BY GROSS ALPHA ACTIVITY (pCi/l). THE LETTER ID CORRESPONDS WITH TABLES 5-2a & 5-2b.

PMPC 118 E. BRIDGE AVE. P.O. BOX 370 SARATOGA, WYOMING 82331 307-326-8301
CIVIL ENGINEERS

JOB NO. 7012.090
FILE NO. GRNDWATER.DWG
SCALE: AS SHOWN
DRAWN BY: LMW
DATE: 3-11-03

FIGURE 5-4
GROUNDWATER INVESTIGATION MAP

SARATOGA – MASTER PLAN UPDATE & LEVEL I STUDY
WYOMING WATER DEVELOPMENT COMMISSION

large part of the Saratoga valley from less permeable deposits because of the large saturated thickness in much of the area." Perhaps this difference of opinion was brought about by the intervening successful completion of the first of the large irrigation wells on Lake Creek (Eaton #2, 1,500 gpm, 1956) and two of the wells serving the Saratoga Fish Hatchery (#1 and #2, 350 and 500 gpm, 1960).

Crist (1990) developed a preliminary groundwater model of this area in response to reports of substantial declines in North Park Formation groundwater levels. His investigations concluded that these reports were a local issue resulting from the temporary suspension of historical surface water flood irrigation in the immediate vicinity. As a whole, he concluded (p. 12) "there is no evidence of significant water-level changes from year to year, it is assumed that long-term change in ground-water storage is negligible for most of the area." Since Crist's study, irrigation use of the North Park Formation northeast of Saratoga has increased dramatically, however. The Wyoming State Engineer's Office is currently investigating the potential impacts of irrigation pumping along Lake Creek on the flow of Lake Creek Lake springs serving the Saratoga Fish Hatchery.

No water-supply wells producing from the underlying bedrock units or basement rocks have been identified in the immediate area of Saratoga. Breckenridge and Hinckley (1978) concluded that the underlying strata are the source of the Saratoga Hot Springs. Lowry et al (1973) concluded that yields on the order of 5 gpm of good quality water are likely available from locally favorable sites in the Precambrian rocks.

Table 5-1a provides a general overview of groundwater production characteristics as encountered in State Engineer permitted water supply wells in the Saratoga area. Based on their location and depth, nearly all of these wells are completed in the North Park Formation. Static water levels vary between flowing at the surface and depths of 100 feet or more, as a function of surface elevation and aquifer variations. Wells have been completed both as open holes (i.e. not requiring casing material to keep the hole from collapsing) and with perforated casing. 1/8-inch slots in PVC well casing is the most common completion, indicating little need to carefully size screen openings to control sediment production into the well. This conclusion is consistent with local well-user interviews. (The only sediment problem noted for our main area of investigation was occasional "face powder sand" which is adequately controlled by once-a-year filter replacement at well "O"; see Figure 5-4.)

The specific capacity values (gallons per minute for each foot of drawdown in the well) calculated in Table 5-1a provide an approximate assessment of North Park Formation permeability, but again, the picture is one of variation rather than clear patterns. Values on the order of 150 gpm/ft demonstrate that highly-productive wells are possible. Over 50% of the reported specific capacity values are 10 gpm/ft or higher, which would be adequate for municipal well development given a suitable saturated thickness.

5.4 Groundwater Quality

Groundwater quality for this study was evaluated using several sources: 1) published chemical analyses and select new laboratory analyses (Tables 5-2a and 5-2b); 2) field conductivity measurements (Figure 5-4); and 3) groundwater-user interviews. Laboratory analyses provide detailed, component-by-component analysis. The electrical conductivity of water provides an approximation of total mineralization. (Groundwater samples from this area indicate that the total dissolved solids concentrations (TDS) in

Constituent		Laboratory Analysis									EPA Drinking Water Standards	
	Water Treatment Plant	Saratoga Hot Springs	North Park Formation							alluvium		
	A	B	C	D	E	F	G	H	I	J	Primary	Secondary
Calcium		125	128	54	70	131			110	59		
Magnesium		9.0	15	4.5	12	92			100	12		
Sodium	25	453	28	9.4	9.6	222	130	72	400	59		
Potassium		29	11	6.6	6.9	2.3			17	1.7		
Bicarbonate		77	258	190	212	217			410	267		
Sulfate	37	568	203	16	55	951	340	590	1000	73		250
Chloride		511	35	4.5	13	14			150	16		250
Nitrate	<0.1		0.9	1.4	1.5	1.6		0.2	<.1	1.9	10.0	
Fluoride	0.4	6.5	0.9	0.3	0.6	3.8			1.8	0.6	4.0	2.0
Total Dissolved Solids	(360)	1830	607	242	370	1620	768	1090	1980	384		500
Hardness as CaCo3		349	375	153	224	706	310	520	687	196		
pH			8.1	7.9					7.5			
Arsenic	<.005	0.05	0.01						<.001		.05 (.01)	

Table 5-2a - Saratoga Groundwater Study Area Groundwater Chemistry (mg/l) **Continued on page 5-17**

Iron		0.05	0.16	0.06		.012			0.78	0.13		0.3
Constituent	A	B	C	D	E	F	G	H	I	J	Primary	Secondary
Manganese		ND	ND						.092			0.050
Selenium		ND	.047								0.050	
Gross Alpha											15	
conductivity (umhos/cm)	458				484	1990			3000	609		

A - August, 2002 analysis from the Saratoga Water Treatment Plant. (TDS inferred from conductivity.)
B - Breckenridge and Hinckley (1975)
C - composite of 4 samples from Saratoga Landfill monitoring wells (Sec. 8, T17N, R83W; Maxim, 2000)
D - Lake Creek Lake spring (Visher, 1952)
E - Lowry et. al (1973), T17N, R83W, Sec. 9ccb (3 miles east of Saratoga)
F - Lowry et. al (1973), T17N, R84W, Sec. 9bbb (3 miles west of Saratoga)
G - Wyoming State Engineer’s Office Permit UW45414, T17N, R83W, Sec. 18bd (1 mi. eastsoutheast of Saratoga)
H - Wyoming State Engineer’s Office Permit UW45589, T17N, R83W, Sec. 31dd (4 mi. southsoutheast of Saratoga)
I - 1 mi. southwest of Saratoga (Permit UW13764; sampled for the present study)
J – Lowry et. al (1973), T18N, R84W, Sec. 7dad (North Platte River alluvium 10 miles downstream of Saratoga)

Table 5-2a - Saratoga Groundwater Study Area Groundwater Chemistry (mg/l)

Constituent	Sample ID (North Park Formation)					EPA Drinking Water Standards
	E	K	L	M	N	Primary
Uranium (ugm/l)	35.8	14	2.4	4.1	2.3	30
Gross Alpha (pci/l)	8.0	4.3	ND	2.3	1.5	15 (if >5, analyze for $Ra^{226/228}$)
As (ug/l)	4	6	13	6	1	50 – current standard; 10 as of 1/23/06
conductivity (umhos/cm)	563	445	1143	291	223	
Notes: see Figure 5-4 for sample locations (samples were analyzed for this study)						

Table 5-2b - Saratoga Groundwater Study Area Supplemental Groundwater Chemistry

mg/l are approximately 70% of the conductivity readings in umhos/cm., e.g. an electrical conductivity of 715 umhos/cm corresponds to a TDS value of about 500 mg/l.) Tables 5-2a and 5-2b provide EPA Drinking Water Standards for reference. The current Saratoga municipal water supply (withdrawing water from the North Platte River) has an electrical conductivity of approximately 450 umhos/cm. This is good quality water. Water with conductivity values in excess of 700 begin to exceed desirable drinking water mineralization.

5.4.1 Alluvium

Alluvial groundwater in Saratoga is commonly considered to be of poor quality. Iron staining can be observed on the sides and fences of houses with well-water irrigated lawns. A sulphur smell was reported by several of those interviewed. A flow of highly-mineralized bedrock groundwater into and through the alluvial deposits to discharge into the river appears to fit the general evidence compiled.

Electrical conductivities (umhos/cm) were measured in the North Platte River on Sept. 8, 2002. From a value of 358 south of Saratoga, the conductivity increased to 390 upstream of the hot springs, and was measured between 450 and 476 at several locations between the hot springs and the north edge of town. We assume this increase is primarily due to the inflow of groundwater which is of sufficient volume and salinity to impact the overall mineral content of the river itself. (The North Platte River was at record low flows during the sampling period; a much smaller impact of discharging groundwater would be expected at normal flows.) Electrical conductivities (umhos/cm) of 2300 and 1350 were measured in shallow wells alongside the river at the north edge of town; 1790 was measured from a shallow well serving the LP sawmill on the east side of Saratoga.

Table 5-2a includes one laboratory analysis from an alluvial well alongside the North Platte River 10 miles downstream of Saratoga. This sample suggests good water quality, but it was taken in late May of 1967, a time when the diluting influence of river flows was likely substantial.

The best groundwater quality available to an alluvial well appears to that produced by direct river recharge. If native groundwater were developed by the drawdown from an alluvial well, water quality would likely deteriorate substantially. Thus, the value of the alluvial deposits lies in their ability to filter river water (e.g. via a river-bed infiltration gallery as is presently in use) rather than as a source of abundant, high-quality groundwater themselves.

5.4.2 North Park Formation

Most of the conductivity measurements on Figure 5-4 are from the North Park Formation. Tables 5-2a and 2b and Figure 5-4 indicate a wide range in groundwater quality, from clearly acceptable to clearly unacceptable. At the high end of this range are the water-supply wells for the Saratoga Fish Hatchery (TDS = 242 mg/l) and the domestic well at location “O” (conductivity = 223 umhos/cm indicates TDS of approximately 150 mg/l). At the low end are the wells west of Saratoga (e.g. TDS = 1980 mg/l). Local reports of poor water quality throughout the area west of town are common. The conductivity of 1700 umhos/cm measured in Spring Creek at the highway bridge south of Saratoga substantiates the relatively poor quality of groundwater discharging to the surface in that area. User satisfaction, local concepts of groundwater quality, and measured conductivities east of Saratoga are generally substantially more favorable.

Detailed groundwater investigations associated with the Saratoga Landfill (Sec. 8, T17N, R83W) (Maxim, 2000) provide “background” quality data with respect to heavy metals and organic compounds. Four analyses of North Park Formation water found only arsenic (3 - 14 ugm/l), barium (110 - 150 ugm/l), lead (2 - 9 ugm/l), selenium (1 - 169 ugm/l), and zinc (10 - 60 ugm/l) above detection limits. No detectable concentrations were measured for antimony, berylium, cadmium, chromium, cobalt, copper, nickel, silver, thallium, or vanadium at any of the four wells. In addition, these samples were analyzed for a suite of 48 organic compounds. Only one concentration above detection limits was measured: in one of the four samples, chloromethane was detected at a concentration of 1.82 ugm/l.

Two analyses on Table 5-2a are provided for reference consideration: 1) the current output from the Saratoga Water Treatment Plant (treated North Platte River water; sample “A”); and 2) the flow from the Saratoga Hot Springs (sample “B”).

Tables 5-2a and 2b include EPA Drinking Water Standards. Compliance with “primary" standards (also called Maximum Contaminant Levels – MCLs) is required. “Secondary” standards are largely addressed to aesthetic qualities (color, odor, staining); compliance is not required. (For example, drinking water is still considered “suitable” up to a total dissolved solids concentration of 1500 mg/l.) Even the lower-TDS North Park samples would be classified as “hard”, a function of the calcium carbonate that is pervasive in the North Park Formation. Constituents of concern in the available analyses include:

A. Radioactivity. This is measured as gross alpha activity (a result of radioactive disintegrations) from all sources. Although the EPA limit is 15 picocuries per liter (pCi/l) for gross alpha activity, if the gross alpha level is greater than 5 pCi/l, the sample could be in excess of specific standards for Radium^{226} and Radium^{228}, for which the combined Maximum Contaminant Level is 5 pCi/l. Of 5 samples analyzed for gross alpha activity, one (location “E”) was above the 5 pCi/l threshold, although well within the 15 pCi/l standard. This sample was not subsequently analyzed for individual radioactive isotopes.

B. Uranium. Beginning December 8, 2003 the EPA will enforce a drinking water standard for uranium of 30 micrograms per liter (ugm/l). Of 5 samples analyzed for uranium, one (location “E”) was above the future limit, with a uranium concentration of 35.8 ugm/l.

C. Arsenic. The previous EPA MCL for arsenic was 50 ugm/l, but regulated water supplies are required to come into compliance with the new standard of 10 ugm/l by January 23, 2006. Tables 5-2a and 5-2b provide 6 analyses for arsenic for the North Park Formation in the study area. Of these, only the domestic well at location “L” (As = 13 ugm/l) would be out of compliance as a community water supply. However, the Table 5-2a entry for the Saratoga landfill (sample “C”) is an average of 4 samples, for which the individual arsenic concentrations were 14, 10, 3, and 14 ugm/l.

D. Selenium. The EPA MCL for selenium is 50 ugm/l. The only selenium analyses identified for this study are from 4 wells at the Saratoga landfill, from which the reported selenium concentrations were 169, 4, 1, and 13 ugm/l. The 169 value is obviously anomalous in this small set, but serves to flag selenium as another element of potential concern in development of a municipal water supply in this area.

E. Sodium. Although there is no primary drinking water standard for sodium, it may be of concern to some users. A level less than or equal to 20 mg/l is recommended by EPA for individuals with high blood pressure or otherwise on low-sodium diets. However, sodium levels up to 115 mg/l level are still considered as “good quality drinking water”.

The specific quality constituents in groundwater will vary in response to specific geochemical conditions. The above discussion highlights the importance of local variations. For example, uranium deposits in the Tertiary-age rocks of Wyoming commonly occur as migrating groundwater transitions from the oxidizing conditions in recharge areas to chemically reducing conditions at depth. Beyond this zone of mineral precipitation within the aquifer, uranium concentrations (and accompanying gross alpha levels) may drop dramatically. The absence of detectable alpha activity in well “L” may be a result of this pattern.

However, behind these considerable local variations in groundwater chemistry, the general distribution of mineral concentrations fits the overall groundwater flow directions discussed above, with groundwater quality deteriorating as it flows westward from recharge along the west flank of the Medicine Bow Mountains towards discharge areas along the North Platte River. This characteristic directs groundwater-supply exploration interest in the North Park Formation to the area east and northeast of Saratoga.

5.5 Groundwater Exploration Program

Figure 5-4 includes two suggested exploration sites to evaluate the North Park Formation; a primary site in the southeast corner of Section 5, T17N, R83W and an alternate site in the southwest corner of Section 32, T18N, R83W. The primary site is assumed to be the easier of the two to develop if an acceptable groundwater resource were verified, due to land ownership, access, and isolation from existing groundwater users. Groundwater interference concerns like those previously discussed were also voiced by various well owners interviewed for the present study. The primary site also corresponds with the north end of a speculative "basement fracture system" mapped by Montagne (1991).

The alternate site is suggested by balancing proximity to Saratoga (reducing development expense), proximity to the "known quantity" represented by the large spring and irrigation wells along Lake Creek, initial indications of acceptable groundwater quality, a nearby small spring, and public land ownership. Table 5.3 presents summary data for these two sites.

	Primary Site	**Alternate Site**	**Notes**
Location	T17N, R83W, Sec. 5ddd	T18N, R83W, Sec. 32ccc	
Land Ownership	BLM	BLM	
Surface Elevation	6880	6860	
Depth-to-Water (ft)	30	40	
North Park Fm. Thickness (ft)	400 1000	400 1600	Crist (1990) Montagne (1991)
Total Dissolved Solids (mg/l)	300	350	
Temperature (^oF)	55	55	

Table 5-3 - Inferred Characteristics of Groundwater Exploration Sites

At either site, the target would be sandstone and conglomerate layers within the North Park Formation of sufficient thickness to produce the desired quantities of groundwater. In the absence of a detailed stratigraphic model of the North Park Formation, and given the wide disparity in thickness estimates (Table 5-3), drilling to depths on the order of 800 - 1000 feet should be anticipated. The local experience provided by Table 5-1a indicates that a casing-and-screen well completion should be allowed for.

The current peak day demands of the Town of Saratoga would be met with a supply of 660 gpm; the projected peak-day demand under the aggressive economic growth scenario is 1,100 gpm, see Table 2-1. Thus, the exploration program should be directed at evaluating the feasibility of groundwater production on the order of 1,000 gpm. It is not necessary, however, to achieve this level of production from a single well.

Water quality is obviously a key consideration. Exploratory drilling should provide for monitoring gross water quality (e.g. conductivity) at various depths in order to allow selective completion of a well if necessary. There is little reason to expect groundwater quality to improve with depth, so drilling could best be discontinued at an appropriate threshold water quality (with due consideration for the possibility of blending water from different zones). The groundwater-quality discussion above gives additional guidance on individual constituents of concern.

Assuming favorable results from an exploration program, evaluation of the economic and engineering aspects of full-scale development of a well field and associated pumping, storage, and transmission facilities could proceed. This could include evaluation of the feasibility of a partial or full replacement of the current municipal water supply (although the former would almost certainly be the most desirable if sufficient groundwater was available) and a timeline for the development of additional wells to meet future demands. Unfavorable results would leave the choices of additional exploration, e.g. closer to the areas of known success further north, or abandonment of a groundwater alternative to the current surface water supply.

An additional alternative may be available through the acquisition of existing high-capacity wells. The closest potentially available wells of suitable capacity are those in Sec. 21 (T18N, R83W; the northeast corner of Figure 5-14; well nos. 42 through 46 on Tables 5-1a and 5-1b) at a distance of approximately 6 miles. Table 5-1a provides summary information for these irrigation wells. All of these wells are permitted for irrigation, although according to the present owner, none are currently in use and the surrounding ranch is for sale. The owner reports sand production and mineral residues associated with groundwater use in that area. Both the productivity and groundwater quality of wells in this area should be evaluated through an appropriate testing program if a purchase option appeared financially viable.

Both of the suggested exploration sites have access to 3-phase power from the Carbon Power & Light system. 3-phase power is available approximately one mile west of the primary site and one-half mile west of the secondary site.

5.6 References

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6. AREA WATER SUPPLY MASTER PLAN

6.1 Saratoga Area Master Plan

The Town of Saratoga is presently developing a Saratoga Area Master Plan that includes the Town and a one mile buffer zone outside the Town limits. The one mile buffer zone and recommended land uses are shown on Figure 6-1. The buffer zone can be increased to two miles when the Town's population exceeds 2,000. The Saratoga Planning Commission has approved a land use plan and submitted it to the Town Council with a recommendation for adoption.

The intent is for the Town of Saratoga to incorporate portions of this Level I Study into the final Saratoga Area Master Plan. The Town of Saratoga will be provided a digital copy of this report that can be adapted to the Town Master Plan format as it is developed.

Expanding the water service area outside the current Town Limits will require annexation of the new service areas or modification of current Town Ordinances that prohibit supplying water to additional areas outside the Town Limits.

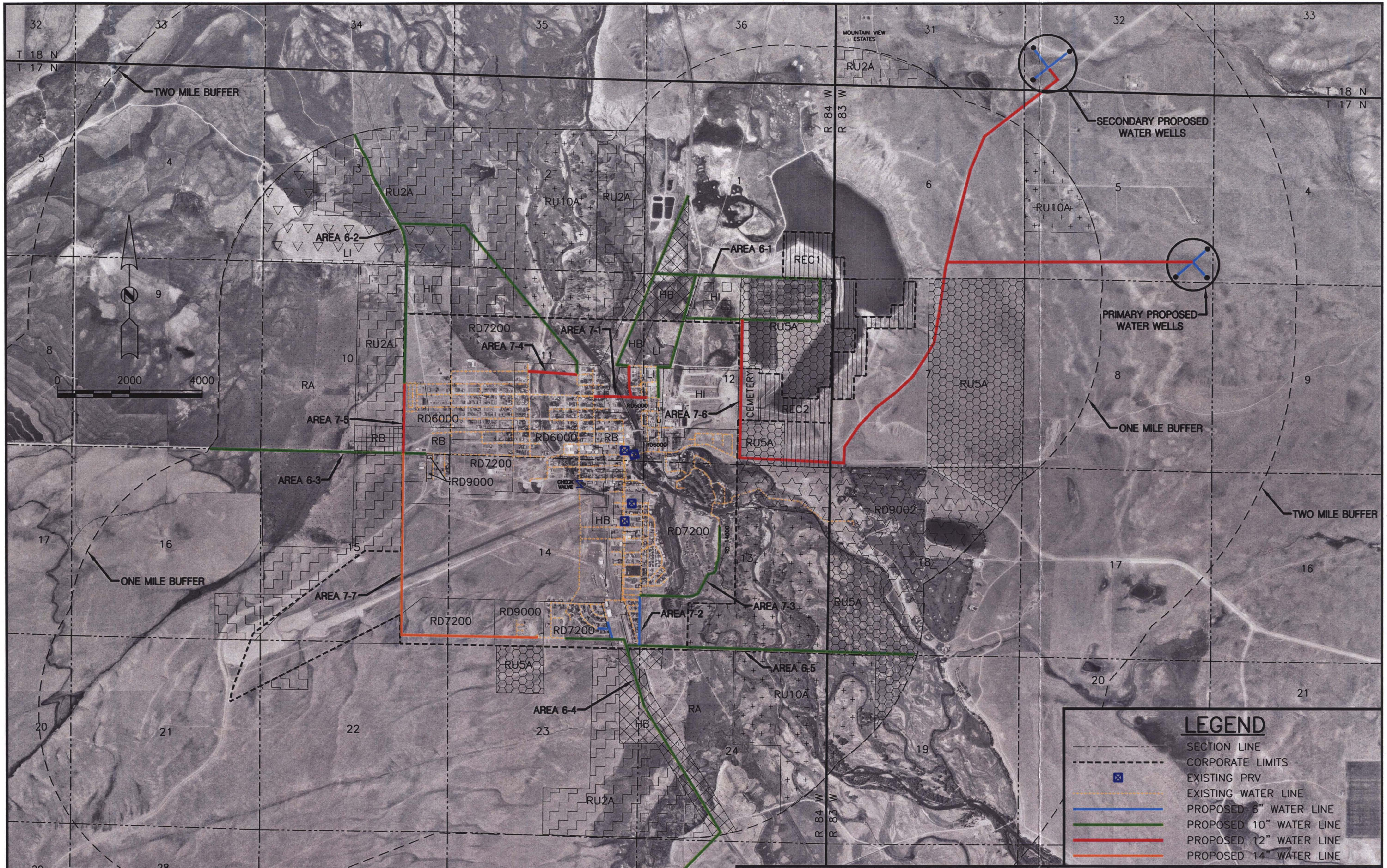
6.2 New Water Service Areas

The land use plan delineates several preferred development types and development areas in the one mile buffer zone. The following recommendations were developed to supply a 3,000 design population and to supply reasonable water demands to these areas. If the recommended land uses are changed the computer model can be easily changed to simulate the new conditions.

The line sizes and locations are to be used for conceptual planning and general guidance. Actual line sizes need to be verified during subsequent design phases when the water requirements and final land use can be further refined. The final line sizes in Areas 6-1 and 6-2 will depend on how much of the system is initially installed. The pipe sizes shown assume the entire loops will not be installed at one time.

Area 6-1: Highway Business (HB), Heavy Industrial (HI) and 5 Acre Residential (RU5A) Areas Northeast of Saratoga. A network of 10" mains were developed to serve this area. Two connections to the existing system are shown; the initial connection is at Rochester Ave and East River St., a second connection at Hwy 130/230 and Chatterton Drive will loop the new system. Installing the river crossing and other piping show in Area 7-1 will increase available flows and improve system reliability in this area.

Area 6-2: 2 Acre Residential (RU2A), 10 Acre Residential (RU10A), Light Industrial (LI) and Heavy Industrial (HI) Areas Northwest of Saratoga. A 10" loop with a 10" dead end main was developed to serve this area. The east end of the loop will connect to an existing 12" main at Hugus Ave. and 3rd St. The west end will connect to the 12" main at the north side the Triangle S Mobile Home Park. Installing the improvements shown in Areas 7-1 and 7-4 will increase available flows and improve system reliability in this area.



PMPC CIVIL ENGINEERS
118 E. BRIDGE AVE. P.O. BOX 370
SARATOGA, WYOMING 82331
307-326-8301

JOB NO. 7012.090
FILE NO. SARA11x17.DWG
SCALE: AS SHOWN
DRAWN BY: LMW
DATE: 3-11-03

FIGURE 6-1
WATER SYSTEM IMPROVEMENT AREAS

SARATOGA – MASTER PLAN UPDATE & LEVEL I STUDY
WYOMING WATER DEVELOPMENT COMMISSION

SHEET 6-2

Area 6-3: Retail Business (RB) Area Along Bridge Ave. West of Saratoga. Extending the 10" main in Elm Ave. is proposed to serve this area. Installing the improvements shown in Area 7-5 will increase available flows and improve system reliability in this area.

Area 6-4: Highway Business (HB) and 2 Acre Residential (RU2A) Areas South of Saratoga. Installing a 10" main from the improvements recommended in Area 7-2 is proposed to serve this area.

Area 6-5: 5 Acre Residential (RU5A) and 10 Acre Residential (RU10A) Areas Southeast of Saratoga. Installing a 10" main from the improvements recommended in Area 7-2 is proposed to serve this area.

6.3 Water Supply Planning

The Town's water rights are limited and subject to call when the North Platte is regulated in favor of the Bureau of Reclamation storage rights (1904).

The important item to consider when looking for water to satisfy the current and projected demands for the Town of Saratoga is what is now referred to as the **critical period,** February 1, through April 30 of each year. This time frame comes from the Bureau of Reclamation calling for regulation of the upper North Platte River system to fill Pathfinder Reservoir which has a priority of December 6, 1904. If regulation of the river is imposed then Saratoga could be with out water because of its current water right priorities. To find additional water for the town the following options are available.

1. Cheyenne Stage II Water – A contract between Cheyenne and Saratoga could be used to provide water during times of regulation but would not guarantee a permanent water supply.

2. A transfer of existing water rights, purchase of irrigated lands, is an option but would not provide water during the critical period. This is the least attractive approach.

3. Look for stored water close to Saratoga and enter into a temporary use agreement. Again this does not provide for a permanent water supply.

4. Develop a groundwater supply for municipal purposes. It is important to keep in mind that wells must be in a location that is not considered as inter-connected with the North Platte River. This is necessary as the Town does not want the well regulated if a call is put on the river. This is the best option for the Town to consider as it would provide a year round water supply which would not be subject to regulation.

6.4 Groundwater Supply

Development of a groundwater supply northeast of Saratoga will require a pipeline to deliver water from the wells to the present distribution system in Pic Pike Road at the Overlook Subdivision. A preliminary investigation indicates a 12" to be the optimum size when considering pipe costs and the energy costs to pump the water.

Supplying water from the primary well site (if a viable groundwater source is located at this site) located in the SE ¼ of Section 5, T17N, R83W is expected to require three wells equipped with 75 horsepower submersible pumps. Computer modeling predicts that 520 gpm can be delivered to the storage tanks with one pump running and 1,275 gpm with all three pumps operating.

Connections can be made to the well transmission line to supply future development along the pipeline.

7. WATER SYSTEM ALTERNATIVES

7.1 Treatment Plant Improvements

The SWTP must comply with the regulatory standards for the Stage 1 D/DBPR and LT1ESWTR by January 2004. In addition more restrictive safe drinking water regulations are being proposed and will certainly be implemented within the planning horizon of this study. The LT2ESWTR will strengthen particulate removal and inactivation requirements, especially with respect to Cryptosporidium. Utilities will be required to complete baseline source water pathogen monitoring to determine whether increased log removal credits are required. Utilities such as Saratoga who serve populations of less than 10,000 will likely be required to monitor for E. coli on a bi-weekly basis over a year period. If concentrations exceed 50/100 ml monitoring for Cryptosporidium may be required. If Cryptosporidium are detected in the source waters, additional log removal credits will be required as defined within the following table:

Bin Number	Average Cryptosporidium Concentration	Additional treatment requirements for systems with conventional and DE treatment that are in full compliance with IESWTR
1	Cryptosporidium < 0.075/L	No action
2	0.075/L ≤ Cryptosporidium < 1.0/L	1.0 log treatment (systems may use any technology or combination of technologies from toolbox as long as total credit is at least 1-log)
3	1.0/L ≤ Cryptosporidium < 3.0/L	2.0 log treatment (systems must achieve at least 1-log of the required 2-log treatment using ozone, chlorine dioxide, UV, membranes, bag/cartridge filters, or in-bank filtration)
4	Cryptosporidium ≥ 3.0/L	2.5 log treatment (systems must achieve at least 1-log of the required 2.5-log treatment using ozone, chlorine dioxide, UV, membranes, bag/cartridge filters, or in-bank filtration)

Table 7-1 - Additional Treatment Requirements

The additional treatment requirements are based, in part, on the assumption that conventional treatment plants in compliance with the IESWTR or LT1ESWTR will achieve an average of 3 logs removal of Cryptosporidium. The SWTP is not a conventional treatment plant but based upon published documents regarding the LT2ESWTR, it is assumed that DE filtration will also receive 3 log credits for the removal of Crytosporidium. The actual removal credits must be confirmed by Region VIII EPA, the agency with the primacy jurisdiction for safe drinking water in Wyoming.

APPROACH	Potential Log Credit			
	0.5	**1**	**2**	**>2.5**
Watershed Control				
Watershed Control Program (1)	X			
Reduction in oocyst concentration (3)	As measured			
Reduction in viable oocyst concentration (3)	As measured			
Alternative Source				
Intake Relocation (3)	As measured			
Change to Alternative Source of Supply (3)	As measured			
Management of Intake to Reduce Capture of Oocysts in Source Water (3)	As measured			
Managing Timing of Withdrawal (3)	As measured			
Managing Level of Withdrawal in Water Column (3)	As measured			
Pretreatment				
Off-Stream Raw Water Storage w/Detention ~ X days (1)	X			
Off-Stream Raw Water Storage w/Detention ~ Y wks (1)		X		
Pre-Settling Basin w/Coagulant	X	>>>		
Lime Softening (1)	>>>	>>>		
In-Bank Filtration (1)		X	>>>	>>>
Improved Treatment				
Lower Finished Water Turbidity (0.15 NTU 95% tile CFE)	X			
Slow Sand Filters (1)				X
Roughing Filter (1)	X	>>>	>>>	>>>
Membranes (MF, UF, NF, RO) (1)				X
Bag Filters (1)		X	>>>	>>>
Cartridge Filters (1)			X	
Improved Disinfection				
Chlorine Dioxide (2)	X	X		
Ozone (2)	X	X	X	
UV (2)				X
Peer Review/Other Demonstration/Validation or System Performance				
Peer Review Program (ex. Partnership Phase IV)		X		
Performance studies demonstrating reliable specific log removals for technologies not listed above. This provision does not supercede other inactivation requirements.	As demonstrated			

X Indicates potential log credit based on proper design and implementation in accordance with EPA guidance.
>>> Indicates estimation of potential log credit based on site specific or technology specific demonstration of performance.
(1) Criteria to be specified in guidance to determine allowed credit.
(2) Inactivation dependent on dose and source water characteristics.
(3) Additional monitoring for Cryptosporidium after this action would determine new bin classification and whether additional treatment is required.

Table 7-2 - Microbial Toolbox - Components To Be Added to Existing Treatment

Critical to the selection of the best direction for the SWTP is balancing the expected microbial and DBP control requirements (long-term regulations) with the financial and operational resources available to the Town. Treatment alternatives must consider the following treatment objectives.

- Organic precursor removal
- Particulate removal
- Microbial inactivation

Long term compliance strategies must consider the use of any of the technologies listed in the Tool Box Table 7-2 above. The Tool Box lists treatment technologies such as (1) pre-sedimentation with coagulant addition; (2) membranes; (3) ozone disinfection; and (4) ultraviolet light disinfection. Ultraviolet (UV) light is another option for advanced disinfection but is less feasible in the case of the SWTP which currently has ozone disinfection in place and operational.

Based upon our knowledge of the Town's water supply, water system and the operation of the water treatment plant, we propose that the Town of Saratoga consider one of the following alternatives. Each alternative is capable of supplying the Town's projected water supply requirements of 1,150 gpm, barring unforeseen regulatory developments.

7.1.1 Alternate No. 1

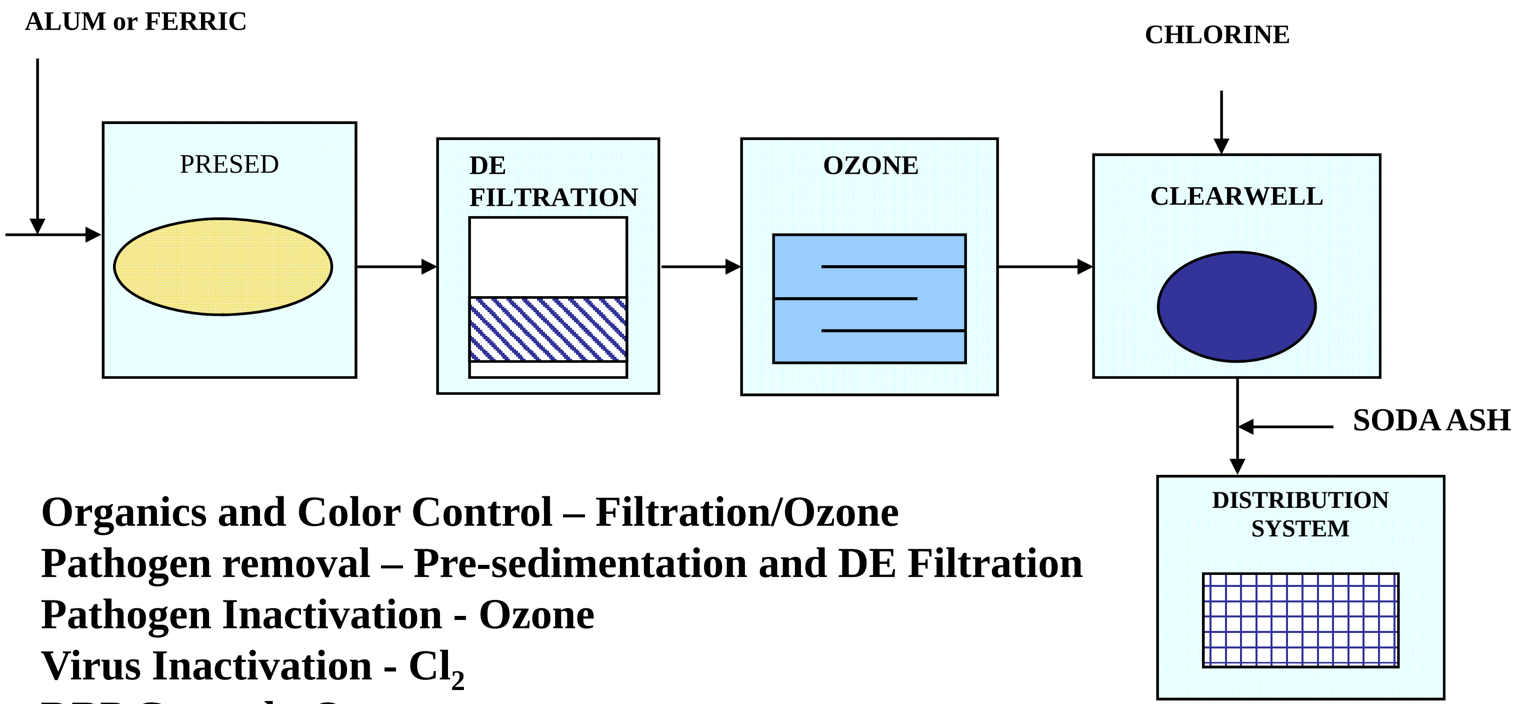
Construct a pre-sedimentation basin to provide an added barrier when the water supply has significant water quality fluctuations (e.g., turbidity). Improve the ozone system to be the primary disinfection system. Add a second ozone generator identical to the generator that was recently installed. The second generator will provide total redundancy for primary disinfection. The existing chlorination system will become the secondary disinfection system to provide residual disinfection within the distribution system. Improve the chlorination system by constructing baffles in the existing contact basin. ***Note: If the results of the monitoring test of the source water show average cryptosporidium concentrations fall in Bin No. 1 no additional treatment processes will be required. The second and redundant ozone generator can be eliminated from this alternative.***

The treatment processes proposed for Alternate No. 1 are illustrated schematically by Figure 7-1.

Figure 7-1

Alternate No. 1

DE Filtration with Advanced Disinfection (Ozone)



Organics and Color Control – Filtration/Ozone
Pathogen removal – Pre-sedimentation and DE Filtration
Pathogen Inactivation - Ozone
Virus Inactivation - Cl_2
DBP Control - Ozone

7.1.1.1 Pre-sedimentation Clarifier

The pre-sedimentation clarification process is proposed to stabilize the raw water quality prior to its application onto the DE filters. In addition to the stabilization of the raw water turbidities, the pre-sedimentation clarifier will also be an additional process to control the formation of disinfection by-products. Chemical coagulants such as alum or iron (ferric) salts will be added at the pre-sedimentation clarifier to reduce DBP precursors prior to disinfection. The pre-sedimentation clarifier will be designed in accordance with EPA's criteria for consideration of an additional 0.5 log credits towards cryptosporidium treatment.

1. The pre-sedimentation process must be in continuous operation and treat all the flow reaching the treatment plant.

2. The pre-sedimentation process must have the capability to add coagulants.

3. The maximum day settling surface loading rate must be 1.6 GPM/Ft^2 or less.

4. The source water turbidity must have an annual average of at least 10 NTU or a maximum of at least 100 NTU.

There are several commercially available pre-sedimentation clarifiers that can meet the above criteria. The process will be located north and east of the SWTP and will be enclosed within an all weather structure. The addition of the pre-sedimentation process will also require a low lift pump station.

7.1.1.2 DE Filtration

This alternative proposes no major modifications to the existing DE filtration process. The filtration process will however be considerably improved. The effluent turbidities from the pre-sedimentation clarifier will be less than 5.0 NTU and result in much longer filter runs and finished water turbidities well within the regulatory requirements. High turbidity events will no longer require the two DE filters to be run in series. Both units can be run in parallel and the total treatment plant capacity will then be the combined treatment capacity of each unit. It is expected that the pre-sedimentation clarifier will improve the filtration processes and the self imposed limit of 1.8 MGD will no longer be applicable.

7.1.1.3 Ozone Disinfection

As stated previously during this report the LT2ESWTR will require all surface water treatment plants to monitor their source water for the presence of cryptosporidium. If the results of these tests indicate that the SWTP must provide additional log removal credits, Alternate No 1 proposes the ozone system be operated as the primary disinfection system. The system must then be upgraded in accordance with EPA's safe drinking water criteria for ozone disinfection to qualify as a treatment technology from the Microbial Toolbox. Properly designed and operated ozone disinfection systems can provide additional 2 log credits for cryptosporidium treatment. The actual inactivation credits will depend upon the disinfection efficiency of SWTP's ozone system. The ozone disinfection system is also a vital process to achieve compliance with Stage I and Stage II D/DBP Rules. Ozone as a strong oxidant will control the formation of disinfection byproducts by oxidation of the organic precursors. The proposed improvements for the existing ozone system include the following items:

1. Install a second ozone generator that is identical to the recently purchased generator to serve as a redundant source of disinfectant. The redundant ozone generator shall be equipped complete with its own air drier and instrumentation and be a totally independent operating system. Again, please note that if the source water monitoring tests show that the cryptosporidium threat fall within the Bin No. 1 classification this redundant ozone generator can be eliminated from this alternative.

2. Add ozone diffusers to the third chamber of the contact basin.

3. Modify the existing contact basin to improve the gas/liquid transfer efficiency for ozone.

4. Install a new ozone destruct unit to control the off gas in the contact basin. The existing ozone destruct unit is 20 years old and should be scheduled for replacement.

5. Install ozone residual analyzers at each ozone contact chamber.

The existing ozone disinfection system does not comply with the design standards of the Wyoming Department of Environmental Quality (WDEQ), specifically the detention time of the contact basin and production capacity of the ozone generator. Our Level I recommendations do not recommend structural modifications to the ozone contact chambers or the increase in the production capacity of the ozone generator to achieve compliance with WDEQ standards. Cryptosporidium inactivation credits will be determined by the CT values calculated from data gathered at the SWTP and from the regulatory criteria that will be defined within the pending LT2ESWTR. Actual inactivation credits will be dependent upon the dose and source water characteristics specific to the SWTP. Inactivation credits will be assigned based upon the performance of individual treatment plants with a potential of two additional log credits. Our preliminary calculations indicate that the existing ozone system with the above listed improvements will produce significant inactivation credits.

The use of ozone as the primary disinfectant will not be without consequences. Ozone can oxidize organic compounds to form aldehydes, aldo- and keto-acids, and organic acids. Many of these by-products are simple organic compounds that are more assimilable as a substrate to microorganisms and appear as biodegradable dissolved organic carbon (BDOC) and assimilable organic carbon (AOC) in the treated water. Elevated AOC and BDOC levels can result in significant biological growth in the distribution system and measures must be implemented to minimize the biological activity in the distribution system or to remove the AOC during treatment. The maintenance of a disinfection residual in the distribution system does not guarantee the prevention of bacterial occurrences. Bio-growth within the pipelines can contain coliforms and other bacteria. Metabolism will occur if an energy source or other nutrients i.e. AOC are available and growth and the population forming the bio-growth can increase. Violations of the Total Coliform Rule (TCR) become a possibility and a compliance issue for the SWTP.

Bio-growth can be controlled by maintaining a disinfectant residual throughout the distribution system and by the systematic flushing of the entire distribution system. In addition, coagulation using either alum or ferric salts at the pre-sedimentation clarifier will reduce the concentrations of TOC and therefore reducing the formation of AOC and BDOC when reacted with ozone. The SWTP has 20 years of operating history using ozone as a disinfectant and aesthetic process. Bio-growth has not been an issue and has been controlled with periodic flushing. The formation of AOC and BDOC and the resultant bio-growth are issues that may be associated with Alternate No. 1. However, the historical operating history and the fact that Alternate No 1 proposes additional processes to control TOC prior to disinfection provide us the assurances that Alternate No. 1 is a viable alternative for this Level I study.

7.1.1.4 Chlorine Disinfection

The improvements proposed for the chlorination system include the installation of baffles in the chlorine contact basin to reduce the dead zones and short circuiting; and improve the mixed flow zones and maximize the basin volume. Baffling can be nonstructural construction using materials such as redwood boards. Several baffling configurations that will be applicable to the SWTP are illustrated in ***SWTR Guidance Document (1991)***. The addition of baffles to the chlorine contact basin will allow the chlorination system to comply fully with the SWTR for the inactivation of *Giardia.*

Chloramines were considered as a secondary disinfectant to control disinfectant by-product formation and to maintain disinfectant residual within the distribution system. Chloramines are weaker disinfectants and less reactive with organic cells resulting in the formation of fewer disinfectant by-products than are formed using normal chlorination. This disinfection strategy was abandoned after the treatment plant records were examined and found to show that the current system complies with the Stage 1 D/DBP Rule.

7.1.1.5 Chemical Feed

The SWTP currently uses soda ash to add alkalinity to the finished water to reduce lead and copper corrosion. A review of the plant records show some elevated lead and copper test results but no violations of the regulatory standards. Soda ash is currently batched with the body feed to the DE filters. This alternative proposes a separate chemical feed system to add soda ash to the finished water prior to the first consumer. A separate and dedicated feed system will provide a more positive control and a response for lead and copper control.

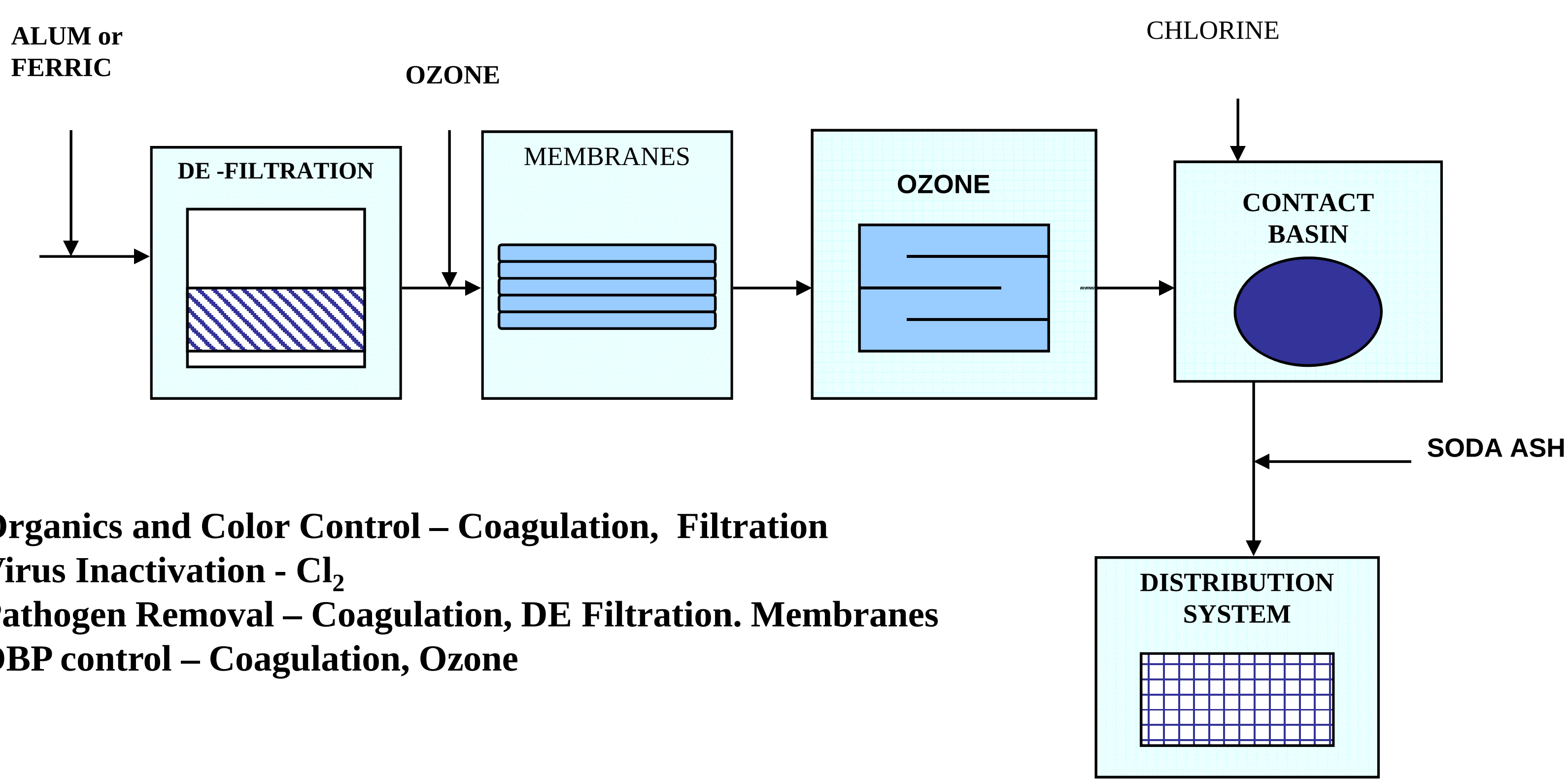
7.1.2 Alternate No. 2

Convert the existing DE filters to roughing filters and add coagulation assisted micro-filtration for particle and DBP precursor removal. Retain the ozone system to oxidize organic precursors prior to chlorination and for taste, odor and color control. Install baffles in the clearwell and retain the existing chlorination system as the primary disinfection system and for disinfectant residual in the distribution system.

The treatment processes proposed for Alternate No. 2 are illustrated schematically by Figure 7-2.

Figure 7-2

Alternate No. 2
Membrane Filtration



Organics and Color Control – Coagulation, Filtration
Virus Inactivation - Cl_2
Pathogen Removal – Coagulation, DE Filtration. Membranes
DBP control – Coagulation, Ozone

7.1.2.1 DE Filtration

The existing DE filters will be used as roughing filters to remove the suspended solids during high turbidity events. The filters can be run in series or parallel or bypassed completely depending upon the quality of the raw water supply. The primary purpose of using the existing DE filters is to stabilize the raw water quality prior to its application onto the membrane filters.

7.1.2.2 Membrane Filtration

Microfiltration (MF) is a low-pressure membrane filtration process using feed pressures of 30 psi or less. Typically, MF units consist of filter modules containing hollow membrane fibers of 0.2 μm nominal pore size. MF membranes demonstrate excellent particulate and turbidity removal with typical finished water turbidity levels of < 0.1 NTU. These membranes are also capable of > 3-log removal for Giardia and Cryptosporidium, although virus removal is limited to approximately 0.5 to 1-log. MF is limited in its ability to remove disinfection by product precursors, but when coupled with coagulation pretreatment is capable of obtaining equivalent precursor removal at lower coagulant dose than conventional treatment.

Microfiltration units are commercially available and can be installed as multiple self-contained units. When in operation, the membranes require periodic backwashing which is automatically activated at a given pressure drop across the membrane or at a preset time interval. Depending upon water quality, backwashes, which take approximately 90 seconds, occur from 1 to 4 times an hour. Again, depending upon water quality, manually initiated chemical cleaning of the membranes is required every 50 to 100 days.

Membrane filters will provide enhanced particle removal but have high energy requirements

7.1.2.3 Ozone Disinfection

Membrane systems have excellent particle and turbidity removal capabilities and will easily satisfy the requirements the LT1ESWTR and the forecasted requirements of pending regulations such as the LT2ESWTR. Ozone disinfection is therefore not needed to gain additional Cryptosporidium inactivation credits and improvements to the ozone system are not proposed under this alternative. The ozone system will remain as it is currently operated and used as an aesthetic process to control taste, odor, and color.

7.1.2.4 Chlorine Disinfection

The improvements proposed for the chlorination system include the installation of baffles in the chlorine contact basin to reduce the dead zones and short circuiting; and improve the mixed flow zones and maximize the basin volume. Baffling can be nonstructural construction using materials such as redwood boards. Several baffling configurations that will be applicable to the SWTP are illustrated in ***SWTR Guidance Document (1991)***. The addition of baffles to the chlorine contact basin will allow the chlorination system to comply fully with the SWTR for the inactivation of *Giardia.*

7.1.2.5 Chemical Feed

The SWTP currently uses soda ash to add alkalinity to the finished water to reduce lead and copper corrosion. A review of the plant records show some elevated lead and copper test results but no violations of the regulatory standards. Soda ash is currently batched with the body feed to the DE filters. This alternative proposes a separate chemical feed system to add soda ash to the finished water prior to the first consumer. A separate and dedicated feed system will provide a more positive control and a response for lead and copper control.

7.1.3 Treatment Summary

It is the design intent for either alternative to provide the treatment technologies required to achieve long term compliance with EPA's safe drinking water regulations with the realistic realization that these regulations will be more stringent in the future. The technologies proposed are proven and in operation in many water treatment facilities today. Both alternatives will have no difficulty producing potable water that is in full compliance with current and future safe drinking water regulations. However, based upon the preliminary opinion of capital costs presented in the next section it is the recommendation of this Level I study to pursue the proposed improvements defined by Alternate No. 1.

7.2 Water Supply Alternatives

Surface water and groundwater are the only practical sources of water available to the Town.

7.2.1 Surface Water

Saratoga's entire water supply is diverted from the North Platte River under the water rights tabulated in Chapter 4. The Town's water rights are limited and subject to call when the North Platte is regulated in favor of the Bureau of Reclamation storage rights (1904).

7.2.2 Groundwater

Chapter 5 discusses the possibility of developing a municipal groundwater supply northeast of Saratoga and the obvious benefits of using a groundwater supply.

Development of a groundwater supply northeast of Saratoga will require a pipeline to deliver water from the wells to the present distribution system in Pic Pike Road at the Overlook Subdivision. A preliminary investigation indicates a 12" to be the optimum size when considering pipe costs and the energy costs to pump the water.

Supplying water from the primary well site (if a viable groundwater source is located at this site) located in the SE ¼ of Section 5, T17N, R83W is expected to require three wells equipped with 75 horsepower submersible pumps. Computer modeling predicts that 520 gpm can be delivered to the storage tanks with one pump running and 1,275 gpm with all three pumps operating.

Connections can be made to the well transmission line to supply future development along the pipeline.

7.3 Distribution System Improvements

7.3.1 Internal Distribution System Improvements

The following distribution system improvements were developed to improve the existing systems ability to increase fire flows and improve system reliability to existing developed areas of Saratoga.

Area 7-1: North Platte River Crossing. Installing a second 12" line across the North Platte River in Rochester Avenue from 2nd St. east to East River St. will improve system reliability and increase system capacity. A 12" stub in Sharp St. to Chatterton Drive will improve flows to the pipe network previously described for Area 6-1

Area 7-2: Sierra Ave. - Veterans St. Loops. This loop includes installing a new 10" line in Sierra Ave. beginning at the 14" main at Rainbow St. and running east under Hwy 130/230 to Veterans St. A new 6" line running north in Veterans St. to the alley north of Pine Ave. will complete one loop. Installing connecting piping in Clearview St. and Welton Dr. will complete two additional loops. This system looping will dramatically improve system flows in this area and provide a second large main connecting the storage tanks with the residential area east of Hwy 130/230. Completing the Area 7-2 looping is necessary for future development in Areas 6-4 and 6-5.

Area 7-3: Texas Trail Loop. This loop will increase fire protection and improve system reliability for the Saratoga Inn and lower Old Baldy areas. A 10" main will connect the existing 12" main at the east end of the alley north of Pine Ave. with the 6" main in Texas Trail south of the North Platte River.

Area 7-4: Farm St. Loop. Installing a 12" main in Farm Ave. connecting the existing 12" lines at 3rd St. and 6th St. will complete the north portion of 12" loop and provide increased flows and system reliability.

Area 7-5: 15th St. Loop. Installing a 12" main in 15th St. connecting the existing 12" line at the north end of the Triangle S Mobile Home Park with the new main proposed for Area 6-3 will complete a large diameter loop and provide increased flows and system reliability.

Area 7-6: Cemetery Loop. Installing a 12" main from the existing 8" main in Pic Pike Road north past the cemetery connecting to the 10" new main proposed for Area 6-1 will complete a large diameter loop and provide increased flows and system reliability.

Area 7-7: Airport Loop. Installing a 14" main west from the water storage tanks and north to Elm Ave connecting to the mains proposed for Areas 6-3 and 7-5 will complete a large diameter loop and provide increased flows and system reliability.

7.3.2 Pressure Zone Operation

The distribution system was designed with three operating pressure zones with a fourth zone operating in the upper area of the Old Baldy system, as previously discussed in section 3.3. The system is now essentially operated as one pressure zone in Town with a second zone in the upper Old Baldy system.

The present operation results in 110 psi operating pressures in the lower system areas. This is not an unusually high operating pressure but it has resulted in broken domestic appliances and residential water damages.

If the system is to continue as a one zone operation, the four existing pressure reducing valve stations should be removed and individual pressure reducing valves installed on all individual water services having a residual operating pressure exceeding 70 psi. Individual pressure reducing valves will be needed on the services located between the 70 psi contours shown on Figure 3-1. The individual pressure reducing valves should be set to provide a 65 psi, or lower, discharge pressure. These pressure valves should be located with the water meter.

The Town distribution system has been operated as one pressure zone for some time and continuing this operation is not expected to cause a significant increase in main breakage or leaking problems. The higher system pressure and prv removal will provide a slight increase in available fire flows.

Installing individual pressure reducing valves will reduce domestic water consumption and extend the life of some components of water related appliances.

7.3.3 Meters, Meter Reading

Wide fluctuations of "Water Unaccounted For" was previously discussed in Section 2.4 Water Consumption. Installing and reading water meters on all unmetered services, installing the correct types of meters and proper meter maintenance will reduce the fluctuations in the "Water Unaccounted For" category and will normally increase water revenues. It will then be possible to determine system leakage and take necessary steps to reduce leakage if it is found to be excessive.

7.3.3.1 Large Meters

Water flows to the Louisiana Pacific sawmill and the Valley View Nursing Home are measured with 4" turbine meters, Old Baldy Club flow is measured with a 6" turbine meter and all other meters in the system are positive displacement meters. 4" and 6" turbine meters do not accurately measure flows below 40 gpm and 80 gpm respectfully. The turbine meters should be replaced with more accurate compound meters that incorporate a low flow meter and a high flow meter in one meter housing. A 4" compound meter can accurately measure flows above 0.75 gpm and a 6" can accurately measure flows above 1.5 gpm.

Compound (and turbine) meters are mechanical devices and need periodic checking and maintenance. The time interval for checking meter accuracy depends on both the flow rate and total flow measured. The recommended initial calibration interval is 2 years for 4" meters and 1 year for 6" meters with these intervals being adjusted once an operational history is established. Meter testing can be accomplished without removing the meter if provisions are made to bypass the meter to supply water to the customer and a meter testing outlet is installed or incorporated in the meter. The meter can also be removed and sent to a testing and calibration facility.

7.3.3.2 Small Meters

All meters in the system, except those discussed in Section 7.3.3.1, are positive displacement meters with the majority being 5/8" X 3/4" size with a few larger sizes.

Positive displacement meters are mechanical devices and need periodic checking and maintenance. The time interval for checking meter accuracy depends on both the flow rate and total flow measured. The recommended initial calibration interval is 10 years for 5/8" meters, 8 years for 3/4" and 6 years for 1" meters. These intervals should be adjusted once an operational history is established. Meter testing can be accomplished by removing the meter and testing it in the Town shop or replacing the meter with another previously tested meter. Measuring chambers and registers are easily replaceable without replacing the entire meter.

7.3.3.3 Meter Reading

Meter reading and billing procedures should be changed to take advantage of developing technology. A touch read or radio read system can be incorporated into the existing system that will reduce human errors, decrease man hours needed to read meters and increase water accountability.

8. CONCEPTUAL COST ESTIMATES

8.1 Surface Water Treatment Alternatives

These conceptual opinions of capital costs are based upon conceptual designs of the proposed water treatment system components, actual equipment quotes from suppliers and the assumption that land will be available to expand the existing facility to house additional treatment processes.

The conceptual cost estimates for water treatment Alternative No. 1 and No. 2 are included in Table 8-1 and Table 8-2.

8.2 Groundwater Alternative

An analysis was performed to determine the distance from Saratoga that groundwater could be economically developed and be cost competitive with improving the existing surface water treatment plant. The groundwater search area was established by adjusting the transmission line length to make the total Groundwater Alternative Budget approximately equal to the Surface Water Treatment Alternate No. 1 cost plus the present worth value of the anticipated annual operation and maintenance savings realized with a groundwater source.

The estimated annual operation and maintenance savings will result from reduced chemical and labor costs. Electrical power costs were investigated and found to be approximately equal for both surface and groundwater alternates.

The economical transmission line search length was determined to be 16,100 ft. from the existing water distribution system as shown in Table 8-3. Both well exploration sites shown on Figure 5-4 are within the 16,100 ft. transmission line search length.

Surface Water Alternate No. 1 (Table 8-1)		$1,191,985
Anticipated net annual O&M savings with groundwater source:		
Chemical savings	$20,000	
Labor savings	$20,000	
Total	$40,000	
Present worth value of annual O&M savings ($40,000, 6%, 20 years)		$458,800
Groundwater Alternative Budget		$1,650,785

TST, Inc. of Denver
Consulting Engineers

OPINION OF COST

Client: **PMPC** Job No: 096-002

Project: **Saratoga WTP Level I - Alternate No. 1** By: RMT

No.	Item	Quantity	Unit	Unit Cost	Total Cost	Comments
1	Mobilization	1	LS	$25,000	$25,000	
2	Sludge Drying Basin	1	LS	$35,000	$35,000	
3	Pond Liner	1	LS	$55,000	$55,000	
4	Yard Piping	1	LS	$35,000	$35,000	
5	Foundation and Slabs On Grade	1	LS	$25,000	$25,000	
6	Pre-Sed Clarifier	1	LS	$100,000	$100,000	
7	Prefabricated Building	1	LS	$75,000	$75,000	
8	Raw Water Pumping	1	LS	$35,000	$35,000	
9	Plant Piping	1	LS	$35,000	$35,000	
10	Chemical Feed	1	LS	$35,000	$35,000	
11	Reclaim Pumps	1	LS	$35,000	$35,000	
12	Modify Ozone Basin	1	LS	$45,000	$45,000	
13	Redundant Ozone Generator	1	LS	$120,000	$120,000	
14	Baffles for Chlorine Basin	1	LS	$15,000	$15,000	
15	HVAC	1	LS	$24,000	$24,000	
16	Electrical	1	LS	$75,000	$75,000	
17	Instrumentation	1	LS	$45,000	$45,000	
18	SCADA	1	LS	$35,000	$35,000	
19						
20						
21						
22	**Subtotal - (1)**				**$849,000**	
23						
24	Engineering - 10% Subtotal (1)				$84,900	
25	**Subtotal - (2)**				**$933,900**	
26	Contingency - 15% Subtotal 2				$140,085	
27	**TOTAL CONSTRUCTION COSTS**				**$1,073,985**	
28	Survey Costs				$3,000	
29	Permitting Costs				$5,000	
30	Access/Easements				$5,000	
31	Legal Fees				$5,000	
32	Plans and Specifications				$100,000	
33	**Total Project Costs**				**$1,191,985**	
34						
35						
36						
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38						
39						
40						
41						
42						
43						

Table 8-1

TST, Inc. of Denver
Consulting Engineers

O P I N I O N O F C O S T

Client: **PMPC** Job No: 096-001

Project: **Saratoga WTP Level I- Alternate No. 2** By: RMT

No.	Item	Quantity	Unit	Unit Cost	Total Cost	Comments
1	Mobilization	1	LS	$25,000	$25,000	
2	Foundation and Slabs On Grade	1	LS	$25,000	$25,000	
3	Prefabricated Building	1	LS	$75,000	$75,000	
4	Yard Piping	1	LS	$24,000	$24,000	
5	Plant Piping	1	LS	$45,000	$45,000	
6	Plant Pumping	1	LS	$45,000	$45,000	
7	Membrane Filters	1	LS	$1,100,000	$1,100,000	
8	Baffles for Chlorine Basin	1	LS	$15,000	$15,000	
9	Chemical Feed	1	LS	$35,000	$35,000	
10	HVAC	1	LS	$24,000	$24,000	
11	Electrical	1	LS	$65,000	$65,000	
12	Instrumentation	1	LS	$35,000	$35,000	
13	SCADA	1	LS	$35,000	$35,000	
14						
15						
16	**Subtotal - (1)**				**$1,548,000**	
17						
18	Engineering - 10% Subtotal (1)				$154,800	
19	**Subtotal - (2)**				**$1,702,800**	
20	Contingency - 15% Subtotal 2				$255,420	
21	**TOTAL CONSTRUCTION COSTS**				**$1,958,220**	
22	Survey Costs				$3,000	
23	Permitting Costs				$5,000	
24	Access/Easements				$5,000	
25	Legal Fees				$5,000	
26	Plans and Specifications				$170,000	
27	**Total Project Costs**				**$2,146,220**	
28						
29						
30						
31						
32						
33						
34						
35						
36						
37						

Table 8-2

PMPC Civil Engineers
Saratoga, Wyoming

O P I N I O N   O F   C O S T

Client: **WWDC** Job No: 7012.090

Project: **Saratoga Level I - Groundwater Alternative - Three Wells** By: PMc

No.	Item	Quantity	Unit	Unit Cost	Total Cost	Comments
1	**Well Costs - Three Wells**					
2	Driller Mob/Demob & Site Prep	1	LS	$20,000	$20,000	
3	Surface Casing	120	LF	$100	$12,000	
4	Production Casing	2,100	LF	$65	$136,500	
5	Well Screen	300	LF	$90	$27,000	
6	Misc. Rig Time	100	Hour	$100	$10,000	
7	Testing	3	Each	$11,000	$33,000	
8	Pumping Equipment	3	Each	$25,000	$75,000	
9	Power Line Extension	1	Mile	$33,000	$33,000	
10						
11	**Transmission Line Costs**					
12	Mobilization	1	LS	$25,000	$25,000	
13	Misc. Piping & Site Work	1	LS	$75,000	$75,000	
14	12" Transmission Line	16,100	LF	$45	$724,500	
15						
16						
17						
18						
19						
20						
21						
22	**Subtotal - (1)**				**$1,171,000**	
23						
24	Engineering - 10% Subtotal (1)				$117,100	
25	**Subtotal - (2)**				**$1,288,100**	
26	Contingency - 15% Subtotal 2				$193,215	
27	**TOTAL CONSTRUCTION COSTS**				**$1,481,315**	
28	Survey Costs				$20,000	
29	Permitting Costs				$20,000	
30	Access/Easements				$5,000	
31	Legal Fees				$5,000	
32	Plans and Specifications				$117,000	
33	**Total Project Costs**				**$1,648,315**	
34						
35						
36						
37						
38						
39						

Table 8-3

8.3 Distribution System Improvements

8.3.1 Combine Pressure Zones

The preferred method to combine the three existing pressure zones is to remove the existing pressure reducing valves and check valves and replace them with the same size pipe that is in place on each side of the valves. Most of the pressure reducing valves are at least one pipe size smaller than the pipe in which they are installed. The pressure reducing valve vaults should also be removed.

The Opinion Of Cost to remove the pressure reducing valves is shown in Table 8-4.

Combining the three existing pressure zones can also be accomplished by adjusting the pressure reducing valves so they are inoperative. With this solution the flow restrictions associated with flow through the valve bodies and reduced approach and exit pipe sizes will reduce system performance.

8.3.2 Meter Replacement Program

The Opinion Of Cost to replace the existing turbine meters with compound meters, install meters on unmetered Town services, replace all small meters and implement a "Radio Read" meter reading program is included in Table 8-5. The cost preparation assumed 50% of the small meters will be installed in new meter pits and 50% will be installed in buildings and crawl spaces. Table 8-5 shows the anticipated SLIB grant eligible and local share project costs.

PMPC Civil Engineers
Saratoga, Wyoming

O P I N I O N O F C O S T

Client: **WWDC** Job No: 7012.090

Project: **Saratoga Level I - Remove Pressure Reducing Valve Installations** By: PMc

No.	Item	Quantity	Unit	Unit Cost	Total Cost	Comments
1	Mobilization	1	LS	$5,000	$5,000	
2						
3	Remove PRV Installations					
4	At WTP Serving Zone 3	1	LS	$10,000	$10,000	
5	At WTP Serving Zone 2	1	LS	$7,000	$7,000	
6	At Cyprus & S. Veterans	1	LS	$10,000	$10,000	
7	At Mt. View and S. River	1	LS	$12,000	$12,000	
8						
9	Remove Check Valve Installations					
7	At Mt. View and S. River	1	LS	$5,000	$5,000	
11	South of 4th & Walnut	1	LS	$2,000	$2,000	
12						
13						
14						
15						
16						
17						
18						
19						
20						
21						
22	**Subtotal - (1)**				**$51,000**	
23						
24	Engineering - 10% Subtotal (1)				$5,100	
25	**Subtotal - (2)**				**$56,100**	
26	Contingency - 15% Subtotal 2				$8,415	
27	**TOTAL CONSTRUCTION COSTS**				**$64,515**	
28						
29						
30						
31						
32	Plans and Specifications				$5,000	
33	**Total Project Costs**				**$69,515**	
34						
35						
36						
37						
38						
39						

Table 8-4

PMPC Civil Engineers
Saratoga, Wyoming

O P I N I O N O F C O S T

Client: **WWDC** Job No: 7012.090

Project: **Saratoga Level I - Water Meter Replacement Program** By: PMc

No.	Item	Quantity	Unit	Unit Cost	SLIB Eligible Costs	Town Share
1	5/8" X 3/4" Meter, Pit, PRV	530	Each	$1,500	$795,000	$397,500
2	5/8" X 3/4" Meter, PRV	530	Each	$300	$159,000	$79,500
3	1" Meter, Pit, PRV	5	Each	$1,650	$8,250	$4,125
4	1" Meter, PRV	5	Each	$400	$2,000	$1,000
5	4" Compound Meter and Vault	2	Each	$10,000	$20,000	$10,000
6	6" Compound Meter and Vault	1	Each	$12,000	$12,000	$6,000
7	Miscellaneous Piping	1	LS	$10,000	$10,000	$5,000
8	Meter Reading/Billing Equipment	1	Each	$35,000	$0	$35,000
9	Meter Radio Equipment (MXU)	1,073		$340	$0	$364,820
10						
11						
12						
13						
14	**Subtotal - (1)**				**$1,006,250**	**$902,945**
15						
16	Engineering - 10% Subtotal (1)				$100,625	$90,295
17	Subtotal - (2)				$1,106,875	$993,240
18	Contingency - 10% Subtotal 2				$110,688	$99,324
19	**Total Construction Costs**				**$1,217,563**	**$1,092,563**
20	Survey Costs				$5,000	$2,500
21	Plans and Specifications				$100,625	$90,295
22	Project Costs				$1,323,188	$1,185,358
23	**Project Costs**			**Use**	**$1,324,000**	**$1,186,000**
24						
25						
26						
27	**SLIB Grant Amount Requested (50% of Eligible Project Costs)**				**$662,000**	**36%**
28	**Saratoga JPB's Share**				**$1,186,000**	**64%**
29	**Engineer's Preliminary Opinion of Probable Project Cost**				**$1,848,000**	**100%**
30						
31						
32						
33						
34						

Table 8-5

9. ECONOMIC ANALYSIS AND PROJECT FINANCING

This ability to pay analysis was prepared to assist the WWDC in determining a fair and equitable financing plan for the water system improvements and to provide information which can be used to determine the conditions and level of state assistance.

9.1 GRANT & LOAN FUNDING OPTIONS

State and Federal loan and grant programs commonly available to Wyoming municipal water systems and how they might be used in Saratoga are discussed below. With present interest rates, the most attractive funding approach is to secure a 50% grant from the State Lands and Investments Board or the Wyoming Water Development Commission and finance the remaining 50% of the project with a 2 ½% interest loan from the Wyoming State Revolving Fund.

9.1.1 Wyoming Water Development Commission (WWDC)

Eligible items are water source development, storage, transmission and irrigation.
50% grant, 50% loan or funding from other non-state sources.
WWDC present loan rate is 6% with variable loan periods.

9.1.2 State Lands and Investments Board (SLIB)

Eligible items are water treatment, distribution, water meters and services.
50% grant, 50% loan or funding from other non-state sources.
Current loan rate is 6% with variable loan periods; a 1% loan origination fee is charged.
SLIB requires individual water meters for water system grants over 50% and looks favorably on 50% grant applications for systems that have individual water meters. Water meter installations are SLIB grant eligible. Meter reading equipment and computer billing software are not SLIB grant eligible, but are eligible for SLIB loans.

9.1.3 USDA Rural Utilities Service (RUS)

Saratoga's median family income exceeds the state median making Saratoga ineligible for RUS grant funding.

9.1.4 Abandoned Mine Lands Program (AML)

AML grant applications for municipal projects are being reviewed in conjunction with the SLIB applications. Saratoga qualifies for this program, but will have to prove a documented threat to the health and safety of the Town residents to receive serious consideration for these limited funds.

9.1.5 Wyoming State Revolving Fund (SRF)

Saratoga has requested it be placed on the State Intended Use Plan (IUP) for this funding source. This program is intended to provide low interest loans, presently at 2 ½% to finance water system improvements.

9.2 LOCAL FUNDING SOURCES

9.2.1 1% Capital Facilities Tax

Saratoga water system improvements are not included in the projects listed in the current ballot scheduled for May 2003.

9.2.2 User Fees

Saratoga's water system is metered using a base rate with an increasing step rate for additional water consumption. The current residential rates are shown below. Saratoga's current residential monthly bill for 20,000 gallons is $36.10; the state average is $38.67. Water rates are reviewed annually.

Residential Water Rates	
0 – 7,000 gals.	$14.00 per month
7,001 – 20,000 gals.	$14.00 per month plus $1.70 per 1,000 gals. for water used in excess of 7,000 gals. to 20,000 gals.
20,001 – 60,000 gals.	$36.10 per month plus $1.80 per 1,000 gals. for water used in excess of 20,000 gals. to 60,000 gals.
>60,001 gals.	$108.10 per month plus $1.90 per 1,000 gals. for water used in excess of 60,000 gals.

9.2.3 Water Fund Reserves

Water rates are set to generate revenues adequate to meet normal system expenses and provide $100,000 annually for major rehabilitation and capital construction projects. The Board has aggressively pursued grant funds to augment system reserves to fund water system projects. The Board attempts to accumulate funds to operate on a 'pay as you go' improvement program. The Board is hesitant to incur additional debt because of the uncertain national, state and local economic conditions.

9.2.4 Bond Issue

Pursuing a bond issue to fund water system improvements is possible and would be more attractive if bond interest rates dropped below the 2 1/2 % SRF interest rate. The costs of preparing and issuing bonds are significant and needs to be considered when evaluating this funding option.

10. PERMITTING

Permits needed for construction will probably include:

- BLM special use permit, permission to drill
- State Engineer's Office (SEO) permit to drill
- DEQ/WQD permit to construct, well design approval and well pump test water discharge permit
- Pipeline and access easements and rights-of-ways
- NEPA compliance for work on federal lands and if a State Revolving Loan is desired
- Corp of Engineer's (COE) Section 404 Permit

Appendix A

WaterCAD Model Scenarios Report

Maximum Day + Fire, Existing System, 1,726 Population

WaterCAD Model Scenarios Report

Scenario	Scenario Descriptions					File Name	NOTE
	Existing or Proposed system?	Consumption	Population	PRV and Check Valve	Water Wells		
POPULATION 1726						MASTER1-11x17.dwg	Served as base scenario, not in use
1	Existing	Maximum Hour (1,150 gpm)	1726	Active, 90 psi	N/A	MASTER1-11x17.dwg	
2	Existing	Maximum Day (657 gpm)	1726	Active, 90 psi	N/A	MASTER1-11x17.dwg	
3	Existing	Maximum Day (657 gpm)	1726	Deleted	N/A	MASTER1-11x17.dwg	
4	Existing	0 gpm	N/A	Deleted	N/A	MASTER1-11x17.dwg	For the calculation of node pressure, tanks full
5	Existing	Maximum Day + Fire Flow@School (2,657 gpm)	1726	Active, 90 psi	N/A	MASTER1-11x17.dwg	
6	Existing	Maximum Day + Fire Flow@Wolf Hotel (2,657 gpm)	1726	Active, 90 psi	N/A	MASTER1-11x17.dwg	
POPULATION 3000						MASTER1-11x17.dwg	Served as base scenario, not in use
7	Existing	Maximum Hour (2,000 gpm)	3000	Active, 90 psi	N/A	MASTER1-11x17.dwg	
8	Existing	Maximum Day (1142 gpm)	3000	Active, 90 psi	N/A	MASTER1-11x17.dwg	
24	Existing	Maximum Day (1142 gpm)	3000	Deleted	N/A	MASTER1-11x17.dwg	
9	Existing	Maximum Day + Fire Flow @School (3,142 gpm)	3000	Active, 90 psi	N/A	MASTER1-11x17.dwg	

WaterCAD Model Scenarios Report (cont.)

Scenario	Scenario Descriptions					File Name	NOTE
	Existing or Proposed system?	Consumption	Population	PRV and Check Valve	Water Wells		
10	Existing	Maximum Day + Fire Flow @ Wolf Hotel (3,142 gpm)	3000	Active, 90 psi	N/A	MASTER1-11x17.dwg	
11	Proposed	Maximum Day (1,142 gpm)	3000	Deleted	N/A	PROPOSED.dwg	
12	Proposed Wells @Sec. 32	Maximum Day (1,142 gpm)	3000	Deleted	Three well pumps on	PROPOSED.dwg	12" Transmission line
13	Proposed Wells @Sec. 32	Maximum Day (1,142 gpm)	3000	Deleted	Three well pumps on	PROPOSED.dwg	10" Transmission line
14	Proposed Wells @Sec. 32	Maximum Day (1,142 gpm)	3000	Deleted	One well pump on	PROPOSED.dwg	12" Transmission line
15	Proposed Wells @Sec. 32	Maximum Day (1,142 gpm)	3000	Deleted	Two well pumps on	PROPOSED.dwg	12" Transmission line
16	Proposed for Area 6-4	Maximum Day (1,142 gpm)	3000	Deleted	N/A	PROPOSED.dwg	
17	Proposed for Area 6-5	Maximum Day (1,142 gpm)	3000	Deleted	N/A	PROPOSED.dwg	
18	Proposed for Area 6-3	Maximum Day (1,142 gpm)	3000	Deleted	N/A	PROPOSED.dwg	
19	Proposed for Area 6-2	Maximum Day (1,142 gpm)	3000	Deleted	N/A	PROPOSED.dwg	
20	Proposed for Area 6-1	Maximum Day (1,142 gpm)	3000	Deleted	N/A	PROPOSED.dwg	With 12" river crossing
21	Proposed for Area 6-1	Maximum Day (1,142 gpm)	3000	Deleted	N/A	PROPOSED.dwg	Without 12" river crossing
22	Proposed for Area 7-3	Maximum Day (1,142 gpm)	3000	Deleted	N/A	PROPOSED.dwg	
23	Proposed for Area 7-2	Maximum Day (1,142 gpm)	3000	Deleted	N/A	PROPOSED.dwg	

Scenario Summary Report

Scenario: No. 1 - EXISTING SYSTEM, MAXIMUM HOUR, 1726 POPULATION, PRVs ACTIVE

Scenario Summary	
Physical Alternative	CheckValve-PRVs active
Active Topology Alternative	PRVs active
Demand Alternative	MAXHOUR-1726POP
Initial Settings Alternative	all PRVs are active, Tank at 70 ft
Operational Alternative	Base-Operational
Logical Control Set Alternat	<All Logical Controls>
Age Alternative	Base-Age Alternative
Constituent Alternative	Base-Constituent
Trace Alternative	Base-Trace Alternative
Fire Flow Alternative	Base-Fire Flow
Capital Cost Alternative	Base-Capital Cost
Energy Cost Alternative	Base-Energy Cost
User Data Alternative	Base-User Data

Hydraulic Analysis Summary	
Analysis	Steady State
Friction Method	Hazen-Williams Formula
Accuracy	0.001000
Trials	50

Quality Analysis Summary			
Analysis	Constituent	Quality Time Step	N/A hr
Age Tolerance	0.01 hr	Constituent Tolerance	0.0 mg/l
Trace Tolerance	1.0 %		

Global Adjustments			
Demand Operation	<None>	Roughness Operation	<None>
Demand	0.00	Roughness	0.00

EXISTING SYSTEM
MAXIMUM HOUR, 1150 gpm
1726 POPULATION
PRVs ACTIVE
Created: 12/11/02 12:01:19 PM

Scenario: No. 1 - EXISTING SYSTEM, MAXIMUM HOUR, 1726 POPULATION, PRVs ACTIVE

Fire Flow Analysis

Fire Flow Report

Label	Zone	Fire Flow Balanced?	Satisfies Fire Flow Constraints?	Needed Fire Flow (gpm)	Available Fire Flow (gpm)	Total Flow Needed (gpm)	Total Flow Available (gpm)	Residual Pressure (psi)	Calculated Residual Pressure (psi)	Minimum Zone Pressure (psi)	Base Flow (gpm)	Type	Calculated Hydraulic Grade (ft)	Pressure (psi)	Pressure Head (ft)
J-100	Zone-2	true	true	2,000.00	2,075.34	2,000.00	2,075.34	20.00	20.00	20.00	0.00	Demand	7,005.84	94.68	218.84
J-101	Zone-2	true	true	2,000.00	2,485.60	2,000.00	2,485.60	20.00	45.72	20.00	0.00	Demand	7,005.84	94.68	218.84
J-102	Zone-2	true	true	2,000.00	2,485.60	2,000.00	2,485.60	20.00	50.67	20.00	0.00	Demand	7,005.84	94.68	218.84
J-103	Zone-2	true	true	2,000.00	2,485.61	2,000.00	2,485.61	20.00	51.87	20.00	0.00	Demand	7,005.84	94.68	218.84
J-104	Zone-2	true	true	2,000.00	2,485.61	2,000.00	2,485.61	20.00	50.87	20.00	0.00	Demand	7,005.73	94.63	218.73
J-105	Zone-2	true	true	2,000.00	2,485.61	2,000.00	2,485.61	20.00	25.75	20.00	0.00	Demand	7,005.09	94.36	218.09
J-106	Zone-2	true	true	2,000.00	2,232.64	2,000.00	2,232.64	20.00	20.00	20.00	0.00	Demand	7,005.09	94.36	218.09
J-107	Zone-2	true	true	2,000.00	2,313.61	2,000.00	2,313.61	20.00	20.00	20.00	0.00	Demand	6,994.47	89.76	207.47
J-108	Zone-2	true	true	2,000.00	2,485.61	2,000.00	2,485.61	20.00	27.90	20.00	0.00	Demand	6,994.46	89.76	207.46
J-200	Zone-2	true	false	2,000.00	1,318.85	2,004.86	1,323.71	20.00	24.75	20.00	4.86	Demand	6,990.91	70.48	162.91
J-201	Zone-2	true	false	2,000.00	1,322.31	2,004.86	1,327.17	20.00	24.93	20.00	4.86	Demand	6,990.91	70.48	162.91
J-202	Zone-2	true	false	2,000.00	1,325.10	2,004.86	1,329.96	20.00	24.65	20.00	4.86	Demand	6,990.91	70.05	161.91
J-203	Zone-2	true	false	2,000.00	1,328.20	2,004.86	1,333.06	20.00	24.81	20.00	4.86	Demand	6,990.91	70.05	161.91
J-204	Zone-2	true	false	2,000.00	1,218.28	2,004.86	1,223.14	20.00	20.00	20.00	4.86	Demand	6,990.91	69.62	160.91
J-205	Zone-2	true	false	2,000.00	1,308.67	2,004.86	1,313.53	20.00	20.00	20.00	4.86	Demand	6,990.91	68.32	157.91
J-206	Zone-2	true	false	2,000.00	1,331.52	2,004.86	1,336.38	20.00	24.40	20.00	4.86	Demand	6,990.91	69.62	160.91
J-207	Zone-2	true	false	2,000.00	1,279.73	2,004.86	1,284.59	20.00	20.00	20.00	4.86	Demand	6,990.91	66.16	152.91
J-208	Zone-2	true	false	2,000.00	1,229.76	2,004.86	1,234.62	20.00	20.00	20.00	4.86	Demand	6,990.91	66.59	153.91
J-209	Zone-2	true	false	2,000.00	1,124.99	2,004.86	1,129.85	20.00	20.00	20.00	4.86	Demand	6,990.91	64.43	148.91
J-210	Zone-2	true	false	2,000.00	1,215.60	2,004.86	1,220.46	20.00	20.00	20.00	4.86	Demand	6,990.91	64.00	147.91
J-211	Zone-2	true	false	2,000.00	1,156.29	2,004.86	1,161.15	20.00	20.00	20.00	4.86	Demand	6,990.93	63.14	145.93
J-212	Zone-2	true	false	2,000.00	1,342.03	2,007.29	1,349.32	20.00	29.80	20.00	7.29	Demand	6,990.91	75.24	173.91
J-213	Zone-2	true	false	2,000.00	1,339.87	2,007.29	1,347.16	20.00	23.43	20.00	7.29	Demand	6,990.91	68.32	157.91
J-214	Zone-2	true	false	2,000.00	1,342.22	2,007.29	1,349.51	20.00	21.34	20.00	7.29	Demand	6,990.93	65.73	151.93
J-215	Zone-2	true	false	2,000.00	1,337.13	2,007.29	1,344.42	20.00	20.54	20.00	7.29	Demand	6,990.98	63.59	146.98
J-216	Zone-2	true	false	2,000.00	1,302.64	2,007.29	1,309.93	20.00	20.01	20.00	7.29	Demand	6,991.06	61.03	141.06
J-217	Zone-2	true	false	2,000.00	987.37	2,003.65	991.02	20.00	20.00	20.00	3.65	Demand	6,991.06	61.03	141.06
J-218	Zone-2	true	false	2,000.00	1,352.33	2,007.29	1,359.62	20.00	20.51	20.00	7.29	Demand	6,990.91	75.24	173.91
J-219	Zone-2	true	false	2,000.00	1,237.30	2,007.29	1,244.59	20.00	20.00	20.00	7.29	Demand	6,990.93	66.60	153.93
J-220	Zone-2	true	false	2,000.00	1,345.29	2,007.29	1,352.58	20.00	38.45	20.00	7.29	Demand	6,990.91	84.76	195.91
J-221	Zone-2	true	false	2,000.00	1,363.18	2,007.29	1,370.47	20.00	30.50	20.00	7.29	Demand	6,990.92	83.04	191.92
J-222	Zone-2	true	false	2,000.00	1,359.12	2,007.29	1,366.41	20.00	23.22	20.00	7.29	Demand	6,990.94	73.96	170.94
J-223	Zone-2	true	false	2,000.00	1,195.15	2,014.58	1,209.73	20.00	20.00	20.00	14.58	Demand	6,991.01	67.93	157.01
J-224	Zone-2	true	false	2,000.00	1,174.13	2,014.58	1,188.71	20.00	20.00	20.00	14.58	Demand	6,991.12	64.52	149.12
J-225	Zone-2	true	false	2,000.00	1,347.28	2,007.29	1,354.57	20.00	40.50	20.00	7.29	Demand	6,990.91	87.36	201.91

Scenario: No. 1 - EXISTING SYSTEM, MAXIMUM HOUR, 1726 POPULATION, PRVs ACTIVE
Fire Flow Analysis
Fire Flow Report

Label	Zone	Fire Flow Balanced?	Satisfies Fire Flow Constraints?	Needed Fire Flow (gpm)	Available Fire Flow (gpm)	Total Flow Needed (gpm)	Total Flow Available (gpm)	Residual Pressure (psi)	Calculated Residual Pressure (psi)	Minimum Zone Pressure (psi)	Base Flow (gpm)	Type	Calculated Hydraulic Grade (ft)	Pressure (psi)	Pressure Head (ft)
J-226	Zone-2	true	false	2,000.00	1,362.52	2,007.29	1,369.81	20.00	26.68	20.00	7.29	Demand	6,990.92	86.93	200.92
J-227	Zone-2	true	false	2,000.00	1,385.25	2,007.29	1,392.54	20.00	33.86	20.00	7.29	Demand	6,990.98	89.55	206.98
J-228	Zone-2	true	false	2,000.00	1,348.64	2,007.29	1,355.93	20.00	40.10	20.00	7.29	Demand	6,990.91	87.36	201.91
J-229	Zone-2	true	false	2,000.00	1,365.95	2,007.29	1,373.24	20.00	27.36	20.00	7.29	Demand	6,990.93	87.37	201.93
J-230	Zone-2	true	false	2,000.00	1,393.72	2,007.29	1,401.01	20.00	36.10	20.00	7.29	Demand	6,991.09	84.41	195.09
J-231	Zone-2	true	false	2,000.00	1,398.59	2,007.29	1,405.88	20.00	36.15	20.00	7.29	Demand	6,991.12	83.56	193.12
J-232	Zone-2	true	false	2,000.00	1,419.92	2,007.29	1,427.21	20.00	47.32	20.00	7.29	Demand	6,991.31	90.56	209.31
J-233	Zone-2	true	false	2,000.00	1,332.22	2,003.65	1,335.87	20.00	20.00	20.00	3.65	Demand	6,990.91	87.36	201.91
J-234	Zone-2	true	false	2,000.00	1,350.16	2,007.29	1,357.45	20.00	40.97	20.00	7.29	Demand	6,990.91	88.66	204.91
J-235	Zone-2	true	false	2,000.00	1,376.40	2,007.29	1,383.69	20.00	40.10	20.00	7.29	Demand	6,990.96	89.11	205.96
J-236	Zone-2	true	false	2,000.00	1,415.15	2,010.94	1,426.08	20.00	38.57	20.00	10.94	Demand	6,991.12	85.72	198.12
J-237	Zone-2	true	false	2,000.00	1,440.72	2,010.94	1,451.65	20.00	32.01	20.00	10.94	Demand	6,991.31	84.94	196.31
J-238	Zone-2	true	false	2,000.00	1,582.59	2,007.29	1,589.88	20.00	20.00	20.00	7.29	Demand	6,992.66	92.01	212.66
J-239	Zone-2	true	false	2,000.00	1,655.81	2,007.29	1,663.10	20.00	20.00	20.00	7.29	Demand	6,992.73	91.60	211.73
J-240	Zone-2	true	false	2,000.00	1,637.35	2,007.29	1,644.64	20.00	20.00	20.00	7.29	Demand	6,992.29	92.71	214.29
J-241	Zone-2	true	false	2,000.00	1,801.04	2,007.29	1,808.33	20.00	24.77	20.00	7.29	Demand	6,992.29	92.28	213.29
J-242	Zone-2	true	false	2,000.00	1,205.73	2,007.29	1,213.02	20.00	20.00	20.00	7.29	Demand	6,992.43	91.48	211.43
J-243	Zone-2	true	false	2,000.00	1,872.64	2,007.29	1,879.93	20.00	21.37	20.00	7.29	Demand	6,992.61	91.12	210.61
J-244	Zone-2	true	false	2,000.00	1,882.08	2,007.29	1,889.37	20.00	27.07	20.00	7.29	Demand	6,992.81	91.21	210.81
J-245	Zone-2	true	false	2,000.00	1,432.59	2,002.43	1,435.02	20.00	20.00	20.00	2.43	Demand	6,992.29	91.85	212.29
J-246	Zone-2	true	false	2,000.00	1,640.21	2,003.65	1,643.85	20.00	20.00	20.00	3.65	Demand	6,992.29	91.85	212.29
J-247	Zone-2	true	false	2,000.00	1,801.04	2,007.29	1,808.33	20.00	26.18	20.00	7.29	Demand	6,992.29	91.85	212.29
J-248	Zone-2	true	false	2,000.00	1,801.04	2,000.00	1,801.04	20.00	27.50	20.00	0.00	Demand	6,992.29	91.42	211.29
J-249	Zone-2	true	false	2,000.00	1,801.82	2,007.29	1,809.11	20.00	27.56	20.00	7.29	Demand	6,992.29	91.42	211.29
J-250	Zone-2	true	false	2,000.00	1,867.19	2,007.29	1,874.48	20.00	32.15	20.00	7.29	Demand	6,992.60	91.12	210.60
J-251	Zone-2	true	false	2,000.00	1,887.41	2,007.29	1,894.70	20.00	38.29	20.00	7.29	Demand	6,992.88	90.81	209.88
J-252	Zone-2	true	false	2,000.00	1,343.04	2,002.43	1,345.47	20.00	20.00	20.00	2.43	Demand	6,992.29	91.41	211.29
J-253	Zone-2	true	false	2,000.00	1,154.55	2,004.86	1,159.41	20.00	20.43	20.00	4.86	Demand	6,992.41	91.04	210.41
J-254	Zone-2	true	false	2,000.00	1,747.20	2,007.29	1,754.49	20.00	20.00	20.00	7.29	Demand	6,992.60	90.25	208.60
J-255	Zone-2	true	false	2,000.00	1,899.17	2,007.29	1,906.46	20.00	21.08	20.00	7.29	Demand	6,992.89	89.94	207.89
J-256	Zone-2	true	false	2,000.00	763.40	2,001.82	765.22	20.00	20.00	20.00	1.82	Demand	6,992.41	90.60	209.41
J-257	Zone-2	true	false	2,000.00	1,686.65	2,003.65	1,690.30	20.00	20.00	20.00	3.65	Demand	6,993.00	89.99	208.00
J-258	Zone3	true	false	2,000.00	1,539.34	2,004.86	1,544.20	20.00	20.00	20.00	4.86	Demand	6,992.88	92.10	212.88
J-259	Zone3	true	false	2,000.00	1,355.90	2,004.86	1,360.76	20.00	20.87	20.00	4.86	Demand	6,992.88	91.67	211.88
J-260	Zone3	true	false	2,000.00	755.87	2,002.43	758.30	20.00	20.00	20.00	2.43	Demand	6,992.88	90.80	209.88

Scenario: No. 1 - EXISTING SYSTEM, MAXIMUM HOUR, 1726 POPULATION, PRVs ACTIVE
Fire Flow Analysis
Fire Flow Report

Label	Zone	Fire Flow Balanced?	Satisfies Fire Flow Constraints?	Needed Fire Flow (gpm)	Available Fire Flow (gpm)	Total Flow Needed (gpm)	Total Flow Available (gpm)	Residual Pressure (psi)	Calculated Residual Pressure (psi)	Minimum Zone Pressure (psi)	Base Flow (gpm)	Type	Calculated Hydraulic Grade (ft)	Pressure (psi)	Pressure Head (ft)
J-261	Zone3	true	false	2,000.00	1,789.94	2,002.43	1,792.37	20.00	20.00	20.00	2.43	Demand	6,992.88	92.10	212.88
J-262	Zone-2	true	false	2,000.00	1,901.97	2,000.00	1,901.97	20.00	20.00	20.00	0.00	Demand	6,992.89	91.67	211.89
J-263	Zone-2	true	false	2,000.00	1,928.01	2,007.29	1,935.30	20.00	20.00	20.00	7.29	Demand	6,992.89	91.24	210.89
J-264	Zone3	true	true	2,000.00	2,009.91	2,006.08	2,015.99	20.00	20.00	20.00	6.08	Demand	6,992.89	91.68	211.89
J-265	Zone-2	true	false	2,000.00	1,205.71	2,006.08	1,211.78	20.00	20.00	20.00	6.08	Demand	6,992.90	90.38	208.90
J-266	Zone-2	true	true	2,000.00	2,026.89	2,003.65	2,030.53	20.00	20.00	20.00	3.65	Demand	6,992.89	91.24	210.89
J-267	Zone3	true	true	2,000.00	2,154.63	2,006.08	2,160.71	20.00	27.48	20.00	6.08	Demand	6,992.90	90.82	209.90
J-268	Zone3	true	true	2,000.00	2,138.97	2,006.08	2,145.04	20.00	20.00	20.00	6.08	Demand	6,992.91	89.95	207.91
J-269	Zone3	true	false	2,000.00	1,747.78	2,003.65	1,751.42	20.00	20.00	20.00	3.65	Demand	6,992.89	91.67	211.89
J-270	Zone3	true	true	2,000.00	2,001.38	2,003.65	2,005.03	20.00	20.00	20.00	3.65	Demand	6,992.89	90.81	209.89
J-271	Zone3	true	true	2,000.00	2,154.56	2,006.08	2,160.63	20.00	27.96	20.00	6.08	Demand	6,992.91	89.95	207.91
J-272	Zone-2	true	true	2,000.00	2,343.28	2,003.65	2,346.93	20.00	20.00	20.00	3.65	Demand	6,992.91	89.52	206.91
J-273	Zone3	true	false	2,000.00	1,875.62	2,000.00	1,875.62	20.00	20.00	20.00	0.00	Demand	6,992.89	91.24	210.89
J-274	Zone-2	true	false	2,000.00	881.42	2,003.65	885.07	20.00	20.00	20.00	3.65	Demand	6,991.11	60.18	139.11
J-275	Zone3	true	false	2,000.00	1,284.81	2,002.43	1,287.24	20.00	20.00	20.00	2.43	Demand	6,991.11	61.05	141.11
J-276	Zone-2	true	false	2,000.00	1,309.84	2,009.11	1,318.95	20.00	20.00	20.00	9.11	Demand	6,991.38	62.90	145.38
J-277	Zone-2	true	false	2,000.00	1,232.23	2,001.22	1,233.45	20.00	20.00	20.00	1.22	Demand	6,991.11	60.19	139.11
J-278	Zone-2	true	false	2,000.00	1,239.32	2,004.86	1,244.18	20.00	20.87	20.00	4.86	Demand	6,992.30	56.81	131.30
J-279	Zone-2	true	false	2,000.00	1,062.90	2,004.86	1,067.76	20.00	20.00	20.00	4.86	Demand	6,992.30	55.94	129.30
J-280	Zone-2	true	false	2,000.00	1,274.06	2,004.86	1,278.92	20.00	21.73	20.00	4.86	Demand	6,992.30	57.67	133.30
J-281	Zone-2	true	false	2,000.00	1,099.66	2,004.86	1,104.52	20.00	20.00	20.00	4.86	Demand	6,992.30	56.81	131.30
J-282	Zone-2	true	false	2,000.00	1,305.88	2,007.29	1,313.17	20.00	22.16	20.00	7.29	Demand	6,992.30	58.11	134.30
J-283	Zone-2	true	false	2,000.00	1,126.97	2,004.86	1,131.83	20.00	20.00	20.00	4.86	Demand	6,992.30	57.24	132.30
J-284	Zone-2	true	false	2,000.00	1,505.51	2,007.29	1,512.80	20.00	37.27	20.00	7.29	Demand	6,991.71	79.05	182.71
J-285	Zone-2	true	false	2,000.00	1,571.93	2,007.29	1,579.22	20.00	38.61	20.00	7.29	Demand	6,991.97	80.03	184.97
J-286	Zone-2	true	false	2,000.00	1,506.47	2,003.65	1,510.11	20.00	30.39	20.00	3.65	Demand	6,992.32	66.33	153.32
J-287	Zone-2	true	false	2,000.00	1,524.46	2,003.65	1,528.10	20.00	31.69	20.00	3.65	Demand	6,992.32	67.63	156.32
J-288	Zone-2	true	false	2,000.00	1,109.33	2,006.08	1,115.40	20.00	20.00	20.00	6.08	Demand	6,992.31	65.03	150.31
J-289	Zone-2	true	false	2,000.00	1,549.52	2,007.29	1,556.81	20.00	38.50	20.00	7.29	Demand	6,991.84	83.00	191.84
J-290	Zone-2	true	false	2,000.00	1,571.09	2,004.86	1,575.95	20.00	39.48	20.00	4.86	Demand	6,992.39	75.45	174.39
J-291	Zone-2	true	false	2,000.00	1,654.01	2,007.29	1,661.30	20.00	47.70	20.00	7.29	Demand	6,992.67	83.79	193.67
J-292	Zone-2	true	false	2,000.00	1,611.40	2,003.65	1,615.05	20.00	29.97	20.00	3.65	Demand	6,992.71	77.75	179.71
J-293	Zone-2	true	false	2,000.00	1,160.15	2,002.43	1,162.58	20.00	22.61	20.00	2.43	Demand	6,992.70	70.39	162.70
J-294	Zone-2	true	false	2,000.00	893.15	2,002.43	895.58	20.00	20.88	20.00	2.43	Demand	6,992.70	68.66	158.70
J-295	Zone-2	true	false	2,000.00	186.98	2,002.43	189.41	20.00	20.00	20.00	2.43	Demand	6,992.67	67.78	156.67

Scenario: No. 1 - EXISTING SYSTEM, MAXIMUM HOUR, 1726 POPULATION, PRVs ACTIVE

Fire Flow Analysis

Fire Flow Report

Label	Zone	Fire Flow Balanced?	Satisfies Fire Flow Constraints?	Needed Fire Flow (gpm)	Available Fire Flow (gpm)	Total Flow Needed (gpm)	Total Flow Available (gpm)	Residual Pressure (psi)	Calculated Residual Pressure (psi)	Minimum Zone Pressure (psi)	Base Flow (gpm)	Type	Calculated Hydraulic Grade (ft)	Pressure (psi)	Pressure Head (ft)
J-296	Zone-2	true	false	2,000.00	1,874.22	2,007.29	1,881.51	20.00	45.25	20.00	7.29	Demand	6,993.25	90.53	209.25
J-297	Zone-2	true	false	2,000.00	1,825.09	2,000.00	1,825.09	20.00	53.85	20.00	0.00	Demand	6,993.23	90.95	210.23
J-298	Zone-2	true	false	2,000.00	1,767.11	2,007.29	1,774.40	20.00	52.98	20.00	7.29	Demand	6,993.03	91.30	211.03
J-299	Zone-2	true	false	2,000.00	1,706.76	2,007.29	1,714.05	20.00	54.60	20.00	7.29	Demand	6,992.84	90.79	209.84
J-300	Zone-2	true	false	2,000.00	1,734.70	2,007.29	1,741.99	20.00	24.38	20.00	7.29	Demand	6,992.82	80.40	185.82
J-301	Zone-2	true	false	2,000.00	1,835.68	2,007.29	1,842.97	20.00	54.00	20.00	7.29	Demand	6,993.25	90.53	209.25
J-302	Zone-2	true	false	2,000.00	1,728.88	2,007.29	1,736.17	20.00	52.98	20.00	7.29	Demand	6,992.90	89.95	207.90
J-303	Zone-2	true	false	2,000.00	1,779.33	2,007.29	1,786.62	20.00	44.87	20.00	7.29	Demand	6,992.95	89.54	206.95
J-304	Zone-2	true	false	2,000.00	1,818.10	2,004.86	1,822.96	20.00	25.68	20.00	4.86	Demand	6,993.02	90.00	208.02
J-305	Zone-2	true	false	2,000.00	1,928.31	2,007.29	1,935.60	20.00	51.29	20.00	7.29	Demand	6,993.48	90.20	208.48
J-306	Zone-2	true	false	2,000.00	1,892.72	2,007.29	1,900.01	20.00	53.49	20.00	7.29	Demand	6,993.48	90.20	208.48
J-307	Zone-2	true	false	2,000.00	1,047.91	2,007.29	1,055.20	20.00	20.00	20.00	7.29	Demand	6,993.00	89.56	207.00
J-308	Zone-2	true	false	2,000.00	1,767.13	2,007.29	1,774.42	20.00	20.00	20.00	7.29	Demand	6,993.16	89.63	207.16
J-309	Zone-2	true	false	2,000.00	1,955.03	2,007.29	1,962.32	20.00	51.00	20.00	7.29	Demand	6,993.65	89.84	207.65
J-310	Zone-2	true	false	2,000.00	1,944.21	2,007.29	1,951.50	20.00	52.89	20.00	7.29	Demand	6,993.73	89.87	207.73
J-311	Zone-2	true	false	2,000.00	1,840.44	2,007.29	1,847.73	20.00	21.57	20.00	7.29	Demand	6,993.18	89.20	206.18
J-312	Zone-2	true	false	2,000.00	1,805.08	2,007.29	1,812.37	20.00	20.00	20.00	7.29	Demand	6,993.30	88.39	204.30
J-313	Zone-2	true	false	2,000.00	1,982.07	2,003.65	1,985.72	20.00	51.61	20.00	3.65	Demand	6,993.79	89.47	206.79
J-314	Zone-2	true	true	2,000.00	2,028.69	2,003.65	2,032.33	20.00	53.61	20.00	3.65	Demand	6,993.98	89.98	207.98
J-315	Zone-2	true	false	2,000.00	1,696.26	2,003.65	1,699.91	20.00	20.00	20.00	3.65	Demand	6,993.41	89.31	206.41
J-316	Zone-2	true	true	2,000.00	2,485.61	2,000.00	2,485.61	20.00	53.48	20.00	0.00	Demand	7,006.02	94.76	219.02
J-317	Zone-2	true	false	2,000.00	1,876.33	2,000.00	1,876.33	20.00	21.28	20.00	0.00	Demand	6,993.39	89.29	206.39
J-318	Zone-2	true	false	2,000.00	1,873.34	2,001.82	1,875.17	20.00	30.57	20.00	1.82	Demand	6,993.38	89.29	206.38
J-319	Zone-2	true	true	2,000.00	2,546.39	2,001.82	2,548.21	20.00	53.60	20.00	1.82	Demand	7,006.61	95.01	219.61
J-320	Zone-2	true	false	2,000.00	1,919.22	2,001.82	1,921.04	20.00	28.32	20.00	1.82	Demand	6,993.48	88.90	205.48
J-321	Zone-2	true	true	2,000.00	2,595.06	2,001.82	2,596.89	20.00	53.28	20.00	1.82	Demand	7,007.05	94.77	219.05
J-322	Zone-2	true	false	2,000.00	1,938.42	2,001.82	1,940.24	20.00	29.88	20.00	1.82	Demand	6,993.51	88.91	205.51
J-323	Zone-2	true	true	2,000.00	2,655.70	2,000.00	2,655.70	20.00	49.10	20.00	0.00	Demand	7,007.58	90.68	209.58
J-324	Zone-2	true	false	2,000.00	1,307.60	2,004.86	1,312.46	20.00	20.00	20.00	4.86	Demand	6,994.46	75.91	175.46
J-325	Zone-2	true	false	2,000.00	1,778.11	2,004.86	1,782.97	20.00	21.73	20.00	4.86	Demand	6,994.46	77.65	179.46
J-326	Zone-2	true	true	2,000.00	2,735.26	2,004.86	2,740.12	20.00	41.96	20.00	4.86	Demand	7,008.22	83.60	193.22
J-327	Zone1	true	false	2,000.00	1,737.43	2,004.86	1,742.29	20.00	52.00	20.00	4.86	Demand	7,009.42	78.92	182.42
J-328	Zone1	true	false	2,000.00	1,739.50	2,004.86	1,744.36	20.00	56.64	20.00	4.86	Demand	7,009.32	78.88	182.32
J-329	Zone-2	true	false	2,000.00	1,618.81	2,000.00	1,618.81	20.00	20.00	20.00	0.00	Demand	7,016.27	74.53	172.27
J-330	Zone1	true	false	2,000.00	1,621.54	2,003.65	1,625.18	20.00	20.00	20.00	3.65	Demand	7,009.87	71.33	164.87

Scenario: No. 1 - EXISTING SYSTEM, MAXIMUM HOUR, 1726 POPULATION, PRVs ACTIVE
Fire Flow Analysis
Fire Flow Report

Label	Zone	Fire Flow Balanced?	Satisfies Fire Flow Constraints?	Needed Fire Flow (gpm)	Available Fire Flow (gpm)	Total Flow Needed (gpm)	Total Flow Available (gpm)	Residual Pressure (psi)	Calculated Residual Pressure (psi)	Minimum Zone Pressure (psi)	Base Flow (gpm)	Type	Calculated Hydraulic Grade (ft)	Pressure (psi)	Pressure Head (ft)
J-331	Zone1	true	false	2,000.00	1,732.54	2,004.86	1,737.40	20.00	48.12	20.00	4.86	Demand	7,009.87	71.76	165.87
J-332	Zone1	true	false	2,000.00	1,732.85	2,004.86	1,737.71	20.00	50.48	20.00	4.86	Demand	7,009.86	71.76	165.86
J-333	Zone1	true	false	2,000.00	1,597.79	2,000.00	1,597.79	20.00	20.00	20.00	0.00	Demand	7,016.28	69.35	160.28
J-334	Zone1	true	false	2,000.00	965.09	2,004.86	969.95	20.00	20.00	20.00	4.86	Demand	7,011.73	67.81	156.73
J-335	Zone-2	true	true	2,000.00	2,861.34	2,004.86	2,866.20	20.00	20.00	20.00	4.86	Demand	7,010.47	71.16	164.47
J-336	Zone1	true	false	2,000.00	1,726.99	2,004.86	1,731.85	20.00	50.66	20.00	4.86	Demand	7,010.39	71.12	164.39
J-337	Zone1	true	false	2,000.00	1,421.08	2,004.86	1,425.94	20.00	20.00	20.00	4.86	Demand	7,010.83	62.66	144.83
J-338	Zone1	true	false	2,000.00	1,722.05	2,004.86	1,726.91	20.00	44.83	20.00	4.86	Demand	7,010.84	67.42	155.84
J-339	Zone1	true	false	2,000.00	1,722.17	2,004.86	1,727.03	20.00	47.68	20.00	4.86	Demand	7,010.83	67.42	155.83
J-340	Zone1	true	false	2,000.00	1,436.13	2,004.86	1,440.99	20.00	20.00	20.00	4.86	Demand	7,011.40	61.18	141.40
J-341	Zone1	true	false	2,000.00	1,716.64	2,002.43	1,719.07	20.00	41.30	20.00	2.43	Demand	7,011.40	63.34	146.40
J-342	Zone1	true	false	2,000.00	1,716.43	2,002.43	1,718.86	20.00	44.44	20.00	2.43	Demand	7,011.40	63.34	146.40
J-343	Zone1	true	false	2,000.00	1,711.85	2,002.43	1,714.28	20.00	41.20	20.00	2.43	Demand	7,011.91	62.69	144.91
J-344	Zone1	true	false	2,000.00	1,711.61	2,004.86	1,716.47	20.00	44.54	20.00	4.86	Demand	7,011.91	62.69	144.91
J-345	Zone1	true	false	2,000.00	1,706.91	2,002.43	1,709.34	20.00	41.14	20.00	2.43	Demand	7,012.45	62.06	143.45
J-346	Zone1	true	false	2,000.00	1,706.48	2,004.86	1,711.34	20.00	44.72	20.00	4.86	Demand	7,012.45	62.06	143.45
J-347	Zone1	true	false	2,000.00	1,702.70	2,000.00	1,702.70	20.00	37.46	20.00	0.00	Demand	7,013.01	60.58	140.01
J-348	Zone1	true	false	2,000.00	1,702.88	2,004.86	1,707.74	20.00	43.74	20.00	4.86	Demand	7,012.85	60.51	139.85
J-349	Zone1	true	false	2,000.00	1,697.27	2,000.00	1,697.27	20.00	44.96	20.00	0.00	Demand	7,013.50	60.79	140.50
J-350	Zone1	true	false	2,000.00	1,699.59	2,000.00	1,699.59	20.00	44.45	20.00	0.00	Demand	7,013.22	60.67	140.22
J-351	Zone1	true	false	2,000.00	1,699.59	2,003.65	1,703.23	20.00	29.60	20.00	3.65	Demand	7,013.21	61.09	141.21
J-352	Zone1	true	false	2,000.00	1,225.61	2,001.22	1,226.82	20.00	20.00	20.00	1.22	Demand	7,013.21	63.69	147.21
J-353	Zone1	true	false	2,000.00	1,068.16	2,003.65	1,071.81	20.00	26.49	20.00	3.65	Demand	7,013.19	60.65	140.19
J-354	Zone1	true	false	2,000.00	543.80	2,003.65	547.44	20.00	20.00	20.00	3.65	Demand	7,013.18	62.38	144.18
J-355	Zone1	true	false	2,000.00	850.99	2,003.65	854.64	20.00	21.30	20.00	3.65	Demand	7,013.18	55.46	128.18
J-356	Zone1	true	false	2,000.00	534.86	2,003.65	538.51	20.00	20.00	20.00	3.65	Demand	7,013.17	57.19	132.17
J-357	Zone1	true	false	2,000.00	697.58	2,000.00	697.58	20.00	20.00	20.00	0.00	Demand	7,013.18	54.16	125.18
J-358	Zone1	true	false	2,000.00	697.58	2,003.65	701.23	20.00	20.32	20.00	3.65	Demand	7,013.18	59.78	138.18
J-359	Zone1	true	false	2,000.00	1,681.15	2,004.86	1,686.01	20.00	45.98	20.00	4.86	Demand	7,015.45	59.04	136.45
J-360	Zone3	true	true	2,000.00	2,187.85	2,004.86	2,192.71	20.00	20.00	20.00	4.86	Demand	7,015.75	55.27	127.75
J-362	Zone1	true	false	2,000.00	679.04	2,004.86	683.90	20.00	20.00	20.00	4.86	Demand	7,017.25	48.56	112.25
J-363	Zone1	true	false	2,000.00	1,673.77	2,004.86	1,678.63	20.00	46.88	20.00	4.86	Demand	7,016.39	58.58	135.39
J-364	Zone1	true	false	2,000.00	1,677.37	2,004.86	1,682.23	20.00	29.44	20.00	4.86	Demand	7,015.87	53.16	122.87
J-365	Zone1	true	false	2,000.00	892.70	2,004.86	897.56	20.00	20.00	20.00	4.86	Demand	7,017.25	46.40	107.25
J-366	Zone1	true	false	2,000.00	1,667.18	2,004.86	1,672.04	20.00	44.19	20.00	4.86	Demand	7,017.26	54.63	126.26

Scenario: No. 1 - EXISTING SYSTEM, MAXIMUM HOUR, 1726 POPULATION, PRVs ACTIVE
Fire Flow Analysis
Fire Flow Report

Label	Zone	Fire Flow Balanced?	Satisfies Fire Flow Constraints?	Needed Fire Flow (gpm)	Available Fire Flow (gpm)	Total Flow Needed (gpm)	Total Flow Available (gpm)	Residual Pressure (psi)	Calculated Residual Pressure (psi)	Minimum Zone Pressure (psi)	Base Flow (gpm)	Type	Calculated Hydraulic Grade (ft)	Pressure (psi)	Pressure Head (ft)
J-367	Zone1	true	false	2,000.00	1,661.99	2,004.86	1,666.85	20.00	43.36	20.00	4.86	Demand	7,017.97	52.77	121.97
J-368	Zone1	true	false	2,000.00	601.49	2,000.00	601.49	20.00	20.00	20.00	0.00	Demand	7,017.97	29.41	67.97
J-369	Zone3	true	false	2,000.00	328.24	2,004.86	333.10	20.00	20.00	20.00	4.86	Demand	7,017.95	39.35	90.95
J-370	Zone1	true	true	2,000.00	2,080.51	2,004.86	2,085.37	20.00	35.90	20.00	4.86	Demand	7,019.77	45.33	104.77
J-371	Zone1	true	true	2,000.00	2,303.04	2,000.00	2,303.04	20.00	27.96	20.00	0.00	Demand	7,020.44	37.40	86.44
J-372	Zone1	true	true	2,000.00	2,723.88	2,004.86	2,728.74	20.00	20.56	20.00	4.86	Demand	7,021.38	30.02	69.38
J-373	Zone1	true	false	2,000.00	665.80	2,004.86	670.66	20.00	20.00	20.00	4.86	Demand	7,021.38	29.59	68.38
J-374	Zone1	true	true	2,000.00	3,531.49	2,004.86	3,536.35	20.00	20.00	20.00	4.86	Demand	7,023.08	27.29	63.08
J-375	Zone1	true	true	2,000.00	4,000.00	2,000.00	4,000.00	20.00	24.96	20.00	0.00	Demand	7,024.11	29.04	67.11
J-376	Zone1	true	false	2,000.00	691.39	2,001.22	692.61	20.00	20.00	20.00	1.22	Demand	7,024.11	32.06	74.11
J-377	Zone1	true	false	2,000.00	578.64	2,001.22	579.86	20.00	20.00	20.00	1.22	Demand	7,024.11	30.77	71.11
J-378	Zone1	true	false	2,000.00	700.03	2,001.22	701.24	20.00	20.00	20.00	1.22	Demand	7,024.11	29.90	69.11
J-379	Zone1	true	true	2,000.00	3,979.74	2,001.22	3,980.95	20.00	20.00	20.00	1.22	Demand	7,024.11	27.74	64.11
J-380	Zone1	true	false	2,000.00	774.57	2,001.22	775.78	20.00	21.73	20.00	1.22	Demand	7,024.11	32.50	75.11
J-381	Zone1	true	false	2,000.00	1,075.26	2,001.22	1,076.47	20.00	21.73	20.00	1.22	Demand	7,024.11	31.63	73.11
J-382	Zone1	true	true	2,000.00	3,772.64	2,001.22	3,773.86	20.00	20.87	20.00	1.22	Demand	7,024.11	30.77	71.11
J-383	Zone-2	true	false	2,000.00	1,751.83	2,003.65	1,755.48	20.00	20.00	20.00	3.65	Demand	7,007.05	93.47	216.05
J-384	Zone-2	true	false	2,000.00	537.11	2,002.43	539.54	20.00	20.00	20.00	2.43	Demand	7,007.04	93.90	217.04
J-385	Zone1	true	false	2,000.00	1,730.77	2,002.43	1,733.20	20.00	30.62	20.00	2.43	Demand	7,009.26	88.37	204.26
J-386	Zone-2	true	false	2,000.00	1,903.95	2,004.86	1,908.81	20.00	20.00	20.00	4.86	Demand	7,009.13	87.45	202.13
J-387	Zone1	true	false	2,000.00	1,730.47	2,004.86	1,735.33	20.00	31.22	20.00	4.86	Demand	7,009.44	77.20	178.44
J-388	Zone-2	true	true	2,000.00	2,074.16	2,004.86	2,079.02	20.00	20.00	20.00	4.86	Demand	7,009.44	74.61	172.44
J-389	Zone1	true	false	2,000.00	1,119.74	2,004.86	1,124.60	20.00	20.00	20.00	4.86	Demand	7,009.98	82.20	189.98
J-390	Zone1	true	false	2,000.00	1,730.90	2,004.86	1,735.76	20.00	41.62	20.00	4.86	Demand	7,009.86	73.06	168.86
J-391	Zone-2	true	true	2,000.00	2,486.63	2,004.86	2,491.49	20.00	20.00	20.00	4.86	Demand	7,010.32	72.39	167.32
J-392	Zone1	true	false	2,000.00	1,663.38	2,003.65	1,667.03	20.00	20.00	20.00	3.65	Demand	7,010.32	75.42	174.32
J-393	Zone1	true	false	2,000.00	1,724.79	2,004.86	1,729.65	20.00	33.57	20.00	4.86	Demand	7,010.58	82.46	190.58
J-394	Zone1	true	false	2,000.00	1,725.22	2,004.86	1,730.08	20.00	41.84	20.00	4.86	Demand	7,010.59	76.40	176.59
J-395	Zone1	true	false	2,000.00	1,725.10	2,004.86	1,729.96	20.00	45.96	20.00	4.86	Demand	7,010.62	73.39	169.62
J-396	Zone1	true	false	2,000.00	1,722.78	2,004.86	1,727.64	20.00	46.61	20.00	4.86	Demand	7,010.82	72.61	167.82
J-397	Zone1	true	false	2,000.00	1,113.34	2,004.86	1,118.20	20.00	20.00	20.00	4.86	Demand	7,010.90	82.60	190.90
J-398	Zone1	true	false	2,000.00	1,717.41	2,004.86	1,722.27	20.00	44.65	20.00	4.86	Demand	7,011.38	70.68	163.38
J-399	Zone1	true	false	2,000.00	963.75	2,004.86	968.61	20.00	20.00	20.00	4.86	Demand	7,011.13	70.58	163.13
J-400	Zone1	true	false	2,000.00	1,543.46	2,002.43	1,545.89	20.00	20.00	20.00	2.43	Demand	7,011.62	77.71	179.62
J-401	Zone1	true	false	2,000.00	1,330.28	2,002.43	1,332.71	20.00	20.00	20.00	2.43	Demand	7,011.69	92.02	212.69

Scenario: No. 1 - EXISTING SYSTEM, MAXIMUM HOUR, 1726 POPULATION, PRVs ACTIVE
Fire Flow Analysis
Fire Flow Report

Label	Zone	Fire Flow Balanced?	Satisfies Fire Flow Constraints?	Needed Fire Flow (gpm)	Available Fire Flow (gpm)	Total Flow Needed (gpm)	Total Flow Available (gpm)	Residual Pressure (psi)	Calculated Residual Pressure (psi)	Minimum Zone Pressure (psi)	Base Flow (gpm)	Type	Calculated Hydraulic Grade (ft)	Pressure (psi)	Pressure Head (ft)
J-402	Zone1	true	false	2,000.00	1,714.05	2,004.86	1,718.91	20.00	41.36	20.00	4.86	Demand	7,011.82	66.55	153.82
J-403	Zone1	true	false	2,000.00	1,714.90	2,002.43	1,717.33	20.00	23.04	20.00	2.43	Demand	7,011.69	72.12	166.69
J-404	Zone1	true	false	2,000.00	1,711.91	2,002.43	1,714.34	20.00	41.51	20.00	2.43	Demand	7,012.00	66.20	153.00
J-405	Zone1	true	false	2,000.00	1,714.39	2,002.43	1,716.82	20.00	31.68	20.00	2.43	Demand	7,011.75	72.14	166.75
J-406	Zone1	true	false	2,000.00	1,714.97	2,002.43	1,717.40	20.00	21.23	20.00	2.43	Demand	7,011.69	79.91	184.69
J-407	Zone-2	true	true	2,000.00	2,745.71	2,002.43	2,748.14	20.00	20.00	20.00	2.43	Demand	7,012.33	64.61	149.33
J-408	Zone1	true	false	2,000.00	1,704.16	2,001.22	1,705.38	20.00	48.61	20.00	1.22	Demand	7,012.82	67.42	155.82
J-409	Zone1	true	false	2,000.00	1,704.16	2,004.86	1,709.02	20.00	45.66	20.00	4.86	Demand	7,012.82	63.95	147.82
J-410	Zone3	true	false	2,000.00	1,230.90	2,003.65	1,234.54	20.00	20.00	20.00	3.65	Demand	6,992.91	89.95	207.91
J-411	Zone3	true	false	2,000.00	1,915.47	2,006.08	1,921.55	20.00	20.00	20.00	6.08	Demand	6,992.92	89.09	205.92
J-412	Zone3	true	true	2,000.00	2,153.70	2,007.29	2,160.99	20.00	31.30	20.00	7.29	Demand	6,992.92	88.66	204.92
J-413	Zone3	true	false	2,000.00	691.12	2,002.43	693.55	20.00	20.00	20.00	2.43	Demand	6,992.91	88.22	203.91
J-414	Zone-2	true	true	2,000.00	2,485.61	2,000.00	2,485.61	20.00	28.73	20.00	0.00	Demand	6,993.83	89.48	206.83
J-415	Zone3	true	true	2,000.00	2,204.94	2,003.65	2,208.59	20.00	36.08	20.00	3.65	Demand	6,993.26	89.24	206.26
J-416	Zone3	true	true	2,000.00	2,150.83	2,003.65	2,154.48	20.00	33.89	20.00	3.65	Demand	6,992.93	86.93	200.93
J-417	Zone3	true	true	2,000.00	2,115.42	2,000.00	2,115.42	20.00	34.32	20.00	0.00	Demand	6,992.77	87.29	201.77
J-418	Zone3	true	true	2,000.00	2,103.74	2,004.86	2,108.60	20.00	34.32	20.00	4.86	Demand	6,992.77	87.29	201.77
J-419	Zone3	true	false	2,000.00	1,200.09	2,001.82	1,201.91	20.00	20.00	20.00	1.82	Demand	6,992.70	77.75	179.70
J-420	Zone3	true	false	2,000.00	1,306.28	2,003.65	1,309.93	20.00	20.00	20.00	3.65	Demand	6,992.69	76.01	175.69
J-421	Zone3	true	false	2,000.00	1,229.68	2,003.65	1,233.33	20.00	20.00	20.00	3.65	Demand	6,992.68	74.71	172.68
J-422	Zone3	true	false	2,000.00	1,174.08	2,004.86	1,178.94	20.00	20.00	20.00	4.86	Demand	6,992.68	73.41	169.68
J-423	Zone3	true	false	2,000.00	1,420.23	2,001.22	1,421.44	20.00	20.96	20.00	1.22	Demand	6,992.70	77.32	178.70
J-424	Zone3	true	false	2,000.00	1,549.32	2,001.82	1,551.14	20.00	26.07	20.00	1.82	Demand	6,992.71	79.05	182.71
J-425	Zone3	true	false	2,000.00	992.12	2,002.43	994.55	20.00	20.00	20.00	2.43	Demand	6,992.68	73.41	169.68
J-426	Zone3	true	false	2,000.00	1,158.33	2,006.08	1,164.40	20.00	20.00	20.00	6.08	Demand	6,992.68	72.98	168.68
J-427	Zone3	true	false	2,000.00	962.15	2,003.04	965.19	20.00	20.00	20.00	3.04	Demand	6,992.68	72.98	168.68
J-428	Zone3	true	false	2,000.00	1,171.01	2,006.08	1,177.09	20.00	20.00	20.00	6.08	Demand	6,992.68	72.98	168.68
J-429	Zone3	true	false	2,000.00	1,317.34	2,004.86	1,322.20	20.00	20.00	20.00	4.86	Demand	6,992.70	72.99	168.70
J-430	Zone3	true	false	2,000.00	1,975.76	2,010.94	1,986.70	20.00	33.09	20.00	10.94	Demand	6,992.01	86.97	201.01
J-431	Zone3	true	false	2,000.00	1,867.56	2,002.43	1,869.99	20.00	31.78	20.00	2.43	Demand	6,991.43	85.42	197.43
J-432	Zone3	true	false	2,000.00	1,482.58	2,001.22	1,483.80	20.00	32.15	20.00	1.22	Demand	6,988.36	84.52	195.36
J-433	Zone3	true	false	2,000.00	1,243.90	2,003.65	1,247.55	20.00	32.52	20.00	3.65	Demand	6,985.05	83.52	193.05
J-434	Zone3	true	false	2,000.00	1,117.09	2,001.82	1,118.92	20.00	21.30	20.00	1.82	Demand	6,985.04	83.09	192.04
J-435	Zone3	true	false	2,000.00	1,050.20	2,001.82	1,052.02	20.00	20.87	20.00	1.82	Demand	6,985.04	82.66	191.04
J-436	Zone3	true	false	2,000.00	882.27	2,002.43	884.70	20.00	20.00	20.00	2.43	Demand	6,985.04	81.79	189.04

Scenario: No. 1 - EXISTING SYSTEM, MAXIMUM HOUR, 1726 POPULATION, PRVs ACTIVE
Fire Flow Analysis
Fire Flow Report

Label	Zone	Fire Flow Balanced?	Satisfies Fire Flow Constraints?	Needed Fire Flow (gpm)	Available Fire Flow (gpm)	Total Flow Needed (gpm)	Total Flow Available (gpm)	Residual Pressure (psi)	Calculated Residual Pressure (psi)	Minimum Zone Pressure (psi)	Base Flow (gpm)	Type	Calculated Hydraulic Grade (ft)	Pressure (psi)	Pressure Head (ft)
J-437	Zone3	true	false	2,000.00	1,321.13	2,001.22	1,322.34	20.00	20.43	20.00	1.22	Demand	6,988.36	85.82	198.36
J-438	Zone3	true	false	2,000.00	1,145.97	2,001.22	1,147.19	20.00	20.43	20.00	1.22	Demand	6,988.36	85.82	198.36
J-439	Zone3	true	false	2,000.00	1,009.83	2,002.43	1,012.26	20.00	20.00	20.00	2.43	Demand	6,988.36	85.39	197.36
J-440	Zone3	true	false	2,000.00	890.62	2,001.22	891.83	20.00	31.53	20.00	1.22	Demand	6,975.28	78.43	181.28
J-441	Zone3	true	false	2,000.00	757.99	2,003.65	761.63	20.00	31.43	20.00	3.65	Demand	6,968.08	75.31	174.08
J-442	Zone3	true	false	2,000.00	693.30	2,001.82	695.12	20.00	20.00	20.00	1.82	Demand	6,968.07	74.45	172.07
J-443	Zone3	true	false	2,000.00	666.44	2,003.65	670.08	20.00	20.00	20.00	3.65	Demand	6,963.20	72.77	168.20
J-444	Zone3	true	false	2,000.00	692.69	2,004.86	697.55	20.00	21.30	20.00	4.86	Demand	6,963.20	72.77	168.20
J-445	Zone3	true	false	2,000.00	692.69	2,003.65	696.34	20.00	30.94	20.00	3.65	Demand	6,963.21	72.78	168.21
J-446	Zone3	true	false	2,000.00	653.82	2,003.65	657.47	20.00	30.49	20.00	3.65	Demand	6,959.79	70.86	163.79
J-450	Zone1	true	false	2,000.00	1,641.70	2,002.43	1,644.13	20.00	21.38	20.00	2.43	Demand	7,011.64	84.21	194.64
J-452	Zone3	true	false	2,000.00	1,547.56	2,004.86	1,552.42	20.00	20.00	20.00	4.86	Demand	7,015.75	55.27	127.75
J-456	Zone-2	true	false	2,000.00	1,399.08	2,000.00	1,399.08	20.00	20.00	20.00	0.00	Demand	6,991.79	65.67	151.79
J-601	Zone3	true	false	2,000.00	1,354.91	2,004.86	1,359.77	20.00	20.00	20.00	4.86	Demand	6,993.94	84.78	195.94
J-602	Zone3	true	false	2,000.00	1,938.80	2,004.86	1,943.66	20.00	20.00	20.00	4.86	Demand	6,993.95	84.78	195.95
J-700	Zone1	true	true	2,000.00	4,000.00	2,000.00	4,000.00	20.00	30.13	20.00	0.00	Demand	7,024.97	30.27	69.97
J-800	Zone-2	true	true	2,000.00	2,023.21	2,000.00	2,023.21	20.00	53.56	20.00	0.00	Demand	6,993.96	89.98	207.96
J-900	Zone3	true	false	2,000.00	514.88	2,032.40	547.28	20.00	28.65	20.00	32.40	Demand	6,941.93	61.40	141.93
J-910	Zone-2	true	false	2,000.00	1,396.79	2,000.00	1,396.79	20.00	20.00	20.00	0.00	Demand	6,991.74	65.65	151.74
J-911	Zone-2	true	false	2,000.00	1,446.27	2,000.00	1,446.27	20.00	20.58	20.00	0.00	Demand	6,991.64	65.61	151.64
J-912	Zone-2	true	false	2,000.00	1,583.23	2,001.50	1,584.73	20.00	20.00	20.00	1.50	Demand	6,992.01	88.26	204.01
J-913	Zone-2	true	false	2,000.00	1,585.96	2,001.50	1,587.46	20.00	42.68	20.00	1.50	Demand	6,992.01	84.80	196.01
J-950	Zone3	true	false	2,000.00	424.22	2,000.00	424.22	20.00	20.00	20.00	0.00	Demand	6,923.23	44.66	103.23

Scenario: No. 1 - EXISTING SYSTEM, MAXIMUM HOUR, 1726 POPULATION, PRVs ACTIVE
Steady State Analysis
Junction Report

Label	Elevation (ft)	Base Flow (gpm)	Type	Zone	Demand (Calculated) (gpm)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Pressure Head (ft)	Residual Pressure (psi)
J-100	6,787.00	0.00	Demand	Zone-2	0.00	7,005.84	94.68	218.84	20.00
J-101	6,787.00	0.00	Demand	Zone-2	0.00	7,005.84	94.68	218.84	20.00
J-102	6,787.00	0.00	Demand	Zone-2	0.00	7,005.84	94.68	218.84	20.00
J-103	6,787.00	0.00	Demand	Zone-2	0.00	7,005.84	94.68	218.84	20.00
J-104	6,787.00	0.00	Demand	Zone-2	0.00	7,005.73	94.63	218.73	20.00
J-105	6,787.00	0.00	Demand	Zone-2	0.00	7,005.09	94.36	218.09	20.00
J-106	6,787.00	0.00	Demand	Zone-2	0.00	7,005.09	94.36	218.09	20.00
J-107	6,787.00	0.00	Demand	Zone-2	0.00	6,994.47	89.76	207.47	20.00
J-108	6,787.00	0.00	Demand	Zone-2	0.00	6,994.46	89.76	207.46	20.00
J-200	6,828.00	4.86	Demand	Zone-2	4.86	6,990.91	70.48	162.91	20.00
J-201	6,828.00	4.86	Demand	Zone-2	4.86	6,990.91	70.48	162.91	20.00
J-202	6,829.00	4.86	Demand	Zone-2	4.86	6,990.91	70.05	161.91	20.00
J-203	6,829.00	4.86	Demand	Zone-2	4.86	6,990.91	70.05	161.91	20.00
J-204	6,830.00	4.86	Demand	Zone-2	4.86	6,990.91	69.62	160.91	20.00
J-205	6,833.00	4.86	Demand	Zone-2	4.86	6,990.91	68.32	157.91	20.00
J-206	6,830.00	4.86	Demand	Zone-2	4.86	6,990.91	69.62	160.91	20.00
J-207	6,838.00	4.86	Demand	Zone-2	4.86	6,990.91	66.16	152.91	20.00
J-208	6,837.00	4.86	Demand	Zone-2	4.86	6,990.91	66.59	153.91	20.00
J-209	6,842.00	4.86	Demand	Zone-2	4.86	6,990.91	64.43	148.91	20.00
J-210	6,843.00	4.86	Demand	Zone-2	4.86	6,990.91	64.00	147.91	20.00
J-211	6,845.00	4.86	Demand	Zone-2	4.86	6,990.93	63.14	145.93	20.00
J-212	6,817.00	7.29	Demand	Zone-2	7.29	6,990.91	75.24	173.91	20.00
J-213	6,833.00	7.29	Demand	Zone-2	7.29	6,990.91	68.32	157.91	20.00
J-214	6,839.00	7.29	Demand	Zone-2	7.29	6,990.93	65.73	151.93	20.00
J-215	6,844.00	7.29	Demand	Zone-2	7.29	6,990.98	63.59	146.98	20.00
J-216	6,850.00	7.29	Demand	Zone-2	7.29	6,991.06	61.03	141.06	20.00
J-217	6,850.00	3.65	Demand	Zone-2	3.64	6,991.06	61.03	141.06	20.00
J-218	6,817.00	7.29	Demand	Zone-2	7.29	6,990.91	75.24	173.91	20.00
J-219	6,837.00	7.29	Demand	Zone-2	7.29	6,990.93	66.60	153.93	20.00
J-220	6,795.00	7.29	Demand	Zone-2	7.29	6,990.91	84.76	195.91	20.00
J-221	6,799.00	7.29	Demand	Zone-2	7.29	6,990.92	83.04	191.92	20.00
J-222	6,820.00	7.29	Demand	Zone-2	7.29	6,990.94	73.96	170.94	20.00
J-223	6,834.00	14.58	Demand	Zone-2	14.58	6,991.01	67.93	157.01	20.00
J-224	6,842.00	14.58	Demand	Zone-2	14.58	6,991.12	64.52	149.12	20.00
J-225	6,789.00	7.29	Demand	Zone-2	7.29	6,990.91	87.36	201.91	20.00
J-226	6,790.00	7.29	Demand	Zone-2	7.29	6,990.92	86.93	200.92	20.00

Steady State Analysis

Junction Report

Label	Elevation (ft)	Base Flow (gpm)	Type	Zone	Demand (Calculated) (gpm)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Pressure Head (ft)	Residual Pressure (psi)
J-227	6,784.00	7.29	Demand	Zone-2	7.29	6,990.98	89.55	206.98	20.00
J-228	6,789.00	7.29	Demand	Zone-2	7.29	6,990.91	87.36	201.91	20.00
J-229	6,789.00	7.29	Demand	Zone-2	7.29	6,990.93	87.37	201.93	20.00
J-230	6,796.00	7.29	Demand	Zone-2	7.29	6,991.09	84.41	195.09	20.00
J-231	6,798.00	7.29	Demand	Zone-2	7.29	6,991.12	83.56	193.12	20.00
J-232	6,782.00	7.29	Demand	Zone-2	7.29	6,991.31	90.56	209.31	20.00
J-233	6,789.00	3.65	Demand	Zone-2	3.64	6,990.91	87.36	201.91	20.00
J-234	6,786.00	7.29	Demand	Zone-2	7.29	6,990.91	88.66	204.91	20.00
J-235	6,785.00	7.29	Demand	Zone-2	7.29	6,990.96	89.11	205.96	20.00
J-236	6,793.00	10.94	Demand	Zone-2	10.94	6,991.12	85.72	198.12	20.00
J-237	6,795.00	10.94	Demand	Zone-2	10.94	6,991.31	84.94	196.31	20.00
J-238	6,780.00	7.29	Demand	Zone-2	7.29	6,992.66	92.01	212.66	20.00
J-239	6,781.00	7.29	Demand	Zone-2	7.29	6,992.73	91.60	211.73	20.00
J-240	6,778.00	7.29	Demand	Zone-2	7.29	6,992.29	92.71	214.29	20.00
J-241	6,779.00	7.29	Demand	Zone-2	7.29	6,992.29	92.28	213.29	20.00
J-242	6,781.00	7.29	Demand	Zone-2	7.29	6,992.43	91.48	211.43	20.00
J-243	6,782.00	7.29	Demand	Zone-2	7.29	6,992.61	91.12	210.61	20.00
J-244	6,782.00	7.29	Demand	Zone-2	7.29	6,992.81	91.21	210.81	20.00
J-245	6,780.00	2.43	Demand	Zone-2	2.43	6,992.29	91.85	212.29	20.00
J-246	6,780.00	3.65	Demand	Zone-2	3.64	6,992.29	91.85	212.29	20.00
J-247	6,780.00	7.29	Demand	Zone-2	7.29	6,992.29	91.85	212.29	20.00
J-248	6,781.00	0.00	Demand	Zone-2	0.00	6,992.29	91.42	211.29	20.00
J-249	6,781.00	7.29	Demand	Zone-2	7.29	6,992.29	91.42	211.29	20.00
J-250	6,782.00	7.29	Demand	Zone-2	7.29	6,992.60	91.12	210.60	20.00
J-251	6,783.00	7.29	Demand	Zone-2	7.29	6,992.88	90.81	209.88	20.00
J-252	6,781.00	2.43	Demand	Zone-2	2.43	6,992.29	91.41	211.29	20.00
J-253	6,782.00	4.86	Demand	Zone-2	4.86	6,992.41	91.04	210.41	20.00
J-254	6,784.00	7.29	Demand	Zone-2	7.29	6,992.60	90.25	208.60	20.00
J-255	6,785.00	7.29	Demand	Zone-2	7.29	6,992.89	89.94	207.89	20.00
J-256	6,783.00	1.82	Demand	Zone-2	1.82	6,992.41	90.60	209.41	20.00
J-257	6,785.00	3.65	Demand	Zone-2	3.64	6,993.00	89.99	208.00	20.00
J-258	6,780.00	4.86	Demand	Zone3	4.86	6,992.88	92.10	212.88	20.00
J-259	6,781.00	4.86	Demand	Zone3	4.86	6,992.88	91.67	211.88	20.00
J-260	6,783.00	2.43	Demand	Zone3	2.43	6,992.88	90.80	209.88	20.00
J-261	6,780.00	2.43	Demand	Zone3	2.43	6,992.88	92.10	212.88	20.00
J-262	6,781.00	0.00	Demand	Zone-2	0.00	6,992.89	91.67	211.89	20.00

Scenario: No. 1 - EXISTING SYSTEM, MAXIMUM HOUR, 1726 POPULATION, PRVs ACTIVE
Steady State Analysis
Junction Report

Label	Elevation (ft)	Base Flow (gpm)	Type	Zone	Demand (Calculated) (gpm)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Pressure Head (ft)	Residual Pressure (psi)
J-263	6,782.00	7.29	Demand	Zone-2	7.29	6,992.89	91.24	210.89	20.00
J-264	6,781.00	6.08	Demand	Zone3	6.07	6,992.89	91.68	211.89	20.00
J-265	6,784.00	6.08	Demand	Zone-2	6.07	6,992.90	90.38	208.90	20.00
J-266	6,782.00	3.65	Demand	Zone-2	3.64	6,992.89	91.24	210.89	20.00
J-267	6,783.00	6.08	Demand	Zone3	6.07	6,992.90	90.82	209.90	20.00
J-268	6,785.00	6.08	Demand	Zone3	6.07	6,992.91	89.95	207.91	20.00
J-269	6,781.00	3.65	Demand	Zone3	3.64	6,992.89	91.67	211.89	20.00
J-270	6,783.00	3.65	Demand	Zone3	3.64	6,992.89	90.81	209.89	20.00
J-271	6,785.00	6.08	Demand	Zone3	6.07	6,992.91	89.95	207.91	20.00
J-272	6,786.00	3.65	Demand	Zone-2	3.64	6,992.91	89.52	206.91	20.00
J-273	6,782.00	0.00	Demand	Zone3	0.00	6,992.89	91.24	210.89	20.00
J-274	6,852.00	3.65	Demand	Zone-2	3.64	6,991.11	60.18	139.11	20.00
J-275	6,850.00	2.43	Demand	Zone3	2.43	6,991.11	61.05	141.11	20.00
J-276	6,846.00	9.11	Demand	Zone-2	9.11	6,991.38	62.90	145.38	20.00
J-277	6,852.00	1.22	Demand	Zone-2	1.22	6,991.11	60.19	139.11	20.00
J-278	6,861.00	4.86	Demand	Zone-2	4.86	6,992.30	56.81	131.30	20.00
J-279	6,863.00	4.86	Demand	Zone-2	4.86	6,992.30	55.94	129.30	20.00
J-280	6,859.00	4.86	Demand	Zone-2	4.86	6,992.30	57.67	133.30	20.00
J-281	6,861.00	4.86	Demand	Zone-2	4.86	6,992.30	56.81	131.30	20.00
J-282	6,858.00	7.29	Demand	Zone-2	7.29	6,992.30	58.11	134.30	20.00
J-283	6,860.00	4.86	Demand	Zone-2	4.86	6,992.30	57.24	132.30	20.00
J-284	6,809.00	7.29	Demand	Zone-2	7.29	6,991.71	79.05	182.71	20.00
J-285	6,807.00	7.29	Demand	Zone-2	7.29	6,991.97	80.03	184.97	20.00
J-286	6,839.00	3.65	Demand	Zone-2	3.64	6,992.32	66.33	153.32	20.00
J-287	6,836.00	3.65	Demand	Zone-2	3.64	6,992.32	67.63	156.32	20.00
J-288	6,842.00	6.08	Demand	Zone-2	6.07	6,992.31	65.03	150.31	20.00
J-289	6,800.00	7.29	Demand	Zone-2	7.29	6,991.84	83.00	191.84	20.00
J-290	6,818.00	4.86	Demand	Zone-2	4.86	6,992.39	75.45	174.39	20.00
J-291	6,799.00	7.29	Demand	Zone-2	7.29	6,992.67	83.79	193.67	20.00
J-292	6,813.00	3.65	Demand	Zone-2	3.64	6,992.71	77.75	179.71	20.00
J-293	6,830.00	2.43	Demand	Zone-2	2.43	6,992.70	70.39	162.70	20.00
J-294	6,834.00	2.43	Demand	Zone-2	2.43	6,992.70	68.66	158.70	20.00
J-295	6,836.00	2.43	Demand	Zone-2	2.43	6,992.67	67.78	156.67	20.00
J-296	6,784.00	7.29	Demand	Zone-2	7.29	6,993.25	90.53	209.25	20.00
J-297	6,783.00	0.00	Demand	Zone-2	0.00	6,993.23	90.95	210.23	20.00
J-298	6,782.00	7.29	Demand	Zone-2	7.29	6,993.03	91.30	211.03	20.00

Scenario: No. 1 - EXISTING SYSTEM, MAXIMUM HOUR, 1726 POPULATION, PRVs ACTIVE
Steady State Analysis
Junction Report

Label	Elevation (ft)	Base Flow (gpm)	Type	Zone	Demand (Calculated) (gpm)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Pressure Head (ft)	Residual Pressure (psi)
J-299	6,783.00	7.29	Demand	Zone-2	7.29	6,992.84	90.79	209.84	20.00
J-300	6,807.00	7.29	Demand	Zone-2	7.29	6,992.82	80.40	185.82	20.00
J-301	6,784.00	7.29	Demand	Zone-2	7.29	6,993.25	90.53	209.25	20.00
J-302	6,785.00	7.29	Demand	Zone-2	7.29	6,992.90	89.95	207.90	20.00
J-303	6,786.00	7.29	Demand	Zone-2	7.29	6,992.95	89.54	206.95	20.00
J-304	6,785.00	4.86	Demand	Zone-2	4.86	6,993.02	90.00	208.02	20.00
J-305	6,785.00	7.29	Demand	Zone-2	7.29	6,993.48	90.20	208.48	20.00
J-306	6,785.00	7.29	Demand	Zone-2	7.29	6,993.48	90.20	208.48	20.00
J-307	6,786.00	7.29	Demand	Zone-2	7.29	6,993.00	89.56	207.00	20.00
J-308	6,786.00	7.29	Demand	Zone-2	7.29	6,993.16	89.63	207.16	20.00
J-309	6,786.00	7.29	Demand	Zone-2	7.29	6,993.65	89.84	207.65	20.00
J-310	6,786.00	7.29	Demand	Zone-2	7.29	6,993.73	89.87	207.73	20.00
J-311	6,787.00	7.29	Demand	Zone-2	7.29	6,993.18	89.20	206.18	20.00
J-312	6,789.00	7.29	Demand	Zone-2	7.29	6,993.30	88.39	204.30	20.00
J-313	6,787.00	3.65	Demand	Zone-2	3.64	6,993.79	89.47	206.79	20.00
J-314	6,786.00	3.65	Demand	Zone-2	3.64	6,993.98	89.98	207.98	20.00
J-315	6,787.00	3.65	Demand	Zone-2	3.64	6,993.41	89.31	206.41	20.00
J-316	6,787.00	0.00	Demand	Zone-2	0.00	7,006.02	94.76	219.02	20.00
J-317	6,787.00	0.00	Demand	Zone-2	0.00	6,993.39	89.29	206.39	20.00
J-318	6,787.00	1.82	Demand	Zone-2	1.82	6,993.38	89.29	206.38	20.00
J-319	6,787.00	1.82	Demand	Zone-2	1.82	7,006.61	95.01	219.61	20.00
J-320	6,788.00	1.82	Demand	Zone-2	1.82	6,993.48	88.90	205.48	20.00
J-321	6,788.00	1.82	Demand	Zone-2	1.82	7,007.05	94.77	219.05	20.00
J-322	6,788.00	1.82	Demand	Zone-2	1.82	6,993.51	88.91	205.51	20.00
J-323	6,798.00	0.00	Demand	Zone-2	0.00	7,007.58	90.68	209.58	20.00
J-324	6,819.00	4.86	Demand	Zone-2	4.86	6,994.46	75.91	175.46	20.00
J-325	6,815.00	4.86	Demand	Zone-2	4.86	6,994.46	77.65	179.46	20.00
J-326	6,815.00	4.86	Demand	Zone-2	4.86	7,008.22	83.60	193.22	20.00
J-327	6,827.00	4.86	Demand	Zone1	4.86	7,009.42	78.92	182.42	20.00
J-328	6,827.00	4.86	Demand	Zone1	4.86	7,009.32	78.88	182.32	20.00
J-329	6,844.00	0.00	Demand	Zone-2	0.00	7,016.27	74.53	172.27	20.00
J-330	6,845.00	3.65	Demand	Zone1	3.64	7,009.87	71.33	164.87	20.00
J-331	6,844.00	4.86	Demand	Zone1	4.86	7,009.87	71.76	165.87	20.00
J-332	6,844.00	4.86	Demand	Zone1	4.86	7,009.86	71.76	165.86	20.00
J-333	6,856.00	0.00	Demand	Zone1	0.00	7,016.28	69.35	160.28	20.00
J-334	6,855.00	4.86	Demand	Zone1	4.86	7,011.73	67.81	156.73	20.00

Scenario: No. 1 - EXISTING SYSTEM, MAXIMUM HOUR, 1726 POPULATION, PRVs ACTIVE

Steady State Analysis

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Label	Elevation (ft)	Base Flow (gpm)	Type	Zone	Demand (Calculated) (gpm)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Pressure Head (ft)	Residual Pressure (psi)
J-335	6,846.00	4.86	Demand	Zone-2	4.86	7,010.47	71.16	164.47	20.00
J-336	6,846.00	4.86	Demand	Zone1	4.86	7,010.39	71.12	164.39	20.00
J-337	6,866.00	4.86	Demand	Zone1	4.86	7,010.83	62.66	144.83	20.00
J-338	6,855.00	4.86	Demand	Zone1	4.86	7,010.84	67.42	155.84	20.00
J-339	6,855.00	4.86	Demand	Zone1	4.86	7,010.83	67.42	155.83	20.00
J-340	6,870.00	4.86	Demand	Zone1	4.86	7,011.40	61.18	141.40	20.00
J-341	6,865.00	2.43	Demand	Zone1	2.43	7,011.40	63.34	146.40	20.00
J-342	6,865.00	2.43	Demand	Zone1	2.43	7,011.40	63.34	146.40	20.00
J-343	6,867.00	2.43	Demand	Zone1	2.43	7,011.91	62.69	144.91	20.00
J-344	6,867.00	4.86	Demand	Zone1	4.86	7,011.91	62.69	144.91	20.00
J-345	6,869.00	2.43	Demand	Zone1	2.43	7,012.45	62.06	143.45	20.00
J-346	6,869.00	4.86	Demand	Zone1	4.86	7,012.45	62.06	143.45	20.00
J-347	6,873.00	0.00	Demand	Zone1	0.00	7,013.01	60.58	140.01	20.00
J-348	6,873.00	4.86	Demand	Zone1	4.86	7,012.85	60.51	139.85	20.00
J-349	6,873.00	0.00	Demand	Zone1	0.00	7,013.50	60.79	140.50	20.00
J-350	6,873.00	0.00	Demand	Zone1	0.00	7,013.22	60.67	140.22	20.00
J-351	6,872.00	3.65	Demand	Zone1	3.64	7,013.21	61.09	141.21	20.00
J-352	6,866.00	1.22	Demand	Zone1	1.22	7,013.21	63.69	147.21	20.00
J-353	6,873.00	3.65	Demand	Zone1	3.64	7,013.19	60.65	140.19	20.00
J-354	6,869.00	3.65	Demand	Zone1	3.64	7,013.18	62.38	144.18	20.00
J-355	6,885.00	3.65	Demand	Zone1	3.64	7,013.18	55.46	128.18	20.00
J-356	6,881.00	3.65	Demand	Zone1	3.64	7,013.17	57.19	132.17	20.00
J-357	6,888.00	0.00	Demand	Zone1	0.00	7,013.18	54.16	125.18	20.00
J-358	6,875.00	3.65	Demand	Zone1	3.64	7,013.18	59.78	138.18	20.00
J-359	6,879.00	4.86	Demand	Zone1	4.86	7,015.45	59.04	136.45	20.00
J-360	6,888.00	4.86	Demand	Zone3	4.86	7,015.75	55.27	127.75	20.00
J-362	6,905.00	4.86	Demand	Zone1	4.86	7,017.25	48.56	112.25	20.00
J-363	6,881.00	4.86	Demand	Zone1	4.86	7,016.39	58.58	135.39	20.00
J-364	6,893.00	4.86	Demand	Zone1	4.86	7,015.87	53.16	122.87	20.00
J-365	6,910.00	4.86	Demand	Zone1	4.86	7,017.25	46.40	107.25	20.00
J-366	6,891.00	4.86	Demand	Zone1	4.86	7,017.26	54.63	126.26	20.00
J-367	6,896.00	4.86	Demand	Zone1	4.86	7,017.97	52.77	121.97	20.00
J-368	6,950.00	0.00	Demand	Zone1	0.00	7,017.97	29.41	67.97	20.00
J-369	6,927.00	4.86	Demand	Zone3	4.86	7,017.95	39.35	90.95	20.00
J-370	6,915.00	4.86	Demand	Zone1	4.86	7,019.77	45.33	104.77	20.00
J-371	6,934.00	0.00	Demand	Zone1	0.00	7,020.44	37.40	86.44	20.00

Scenario: No. 1 - EXISTING SYSTEM, MAXIMUM HOUR, 1726 POPULATION, PRVs ACTIVE
Steady State Analysis
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Label	Elevation (ft)	Base Flow (gpm)	Type	Zone	Demand (Calculated) (gpm)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Pressure Head (ft)	Residual Pressure (psi)
J-372	6,952.00	4.86	Demand	Zone1	4.86	7,021.38	30.02	69.38	20.00
J-373	6,953.00	4.86	Demand	Zone1	4.86	7,021.38	29.59	68.38	20.00
J-374	6,960.00	4.86	Demand	Zone1	4.86	7,023.08	27.29	63.08	20.00
J-375	6,957.00	0.00	Demand	Zone1	0.00	7,024.11	29.04	67.11	20.00
J-376	6,950.00	1.22	Demand	Zone1	1.22	7,024.11	32.06	74.11	20.00
J-377	6,953.00	1.22	Demand	Zone1	1.22	7,024.11	30.77	71.11	20.00
J-378	6,955.00	1.22	Demand	Zone1	1.22	7,024.11	29.90	69.11	20.00
J-379	6,960.00	1.22	Demand	Zone1	1.22	7,024.11	27.74	64.11	20.00
J-380	6,949.00	1.22	Demand	Zone1	1.22	7,024.11	32.50	75.11	20.00
J-381	6,951.00	1.22	Demand	Zone1	1.22	7,024.11	31.63	73.11	20.00
J-382	6,953.00	1.22	Demand	Zone1	1.22	7,024.11	30.77	71.11	20.00
J-383	6,791.00	3.65	Demand	Zone-2	3.64	7,007.05	93.47	216.05	20.00
J-384	6,790.00	2.43	Demand	Zone-2	2.43	7,007.04	93.90	217.04	20.00
J-385	6,805.00	2.43	Demand	Zone1	2.43	7,009.26	88.37	204.26	20.00
J-386	6,807.00	4.86	Demand	Zone-2	4.86	7,009.13	87.45	202.13	20.00
J-387	6,831.00	4.86	Demand	Zone1	4.86	7,009.44	77.20	178.44	20.00
J-388	6,837.00	4.86	Demand	Zone-2	4.86	7,009.44	74.61	172.44	20.00
J-389	6,820.00	4.86	Demand	Zone1	4.86	7,009.98	82.20	189.98	20.00
J-390	6,841.00	4.86	Demand	Zone1	4.86	7,009.86	73.06	168.86	20.00
J-391	6,843.00	4.86	Demand	Zone-2	4.86	7,010.32	72.39	167.32	20.00
J-392	6,836.00	3.65	Demand	Zone1	3.64	7,010.32	75.42	174.32	20.00
J-393	6,820.00	4.86	Demand	Zone1	4.86	7,010.58	82.46	190.58	20.00
J-394	6,834.00	4.86	Demand	Zone1	4.86	7,010.59	76.40	176.59	20.00
J-395	6,841.00	4.86	Demand	Zone1	4.86	7,010.62	73.39	169.62	20.00
J-396	6,843.00	4.86	Demand	Zone1	4.86	7,010.82	72.61	167.82	20.00
J-397	6,820.00	4.86	Demand	Zone1	4.86	7,010.90	82.60	190.90	20.00
J-398	6,848.00	4.86	Demand	Zone1	4.86	7,011.38	70.68	163.38	20.00
J-399	6,848.00	4.86	Demand	Zone1	4.86	7,011.13	70.58	163.13	20.00
J-400	6,832.00	2.43	Demand	Zone1	2.43	7,011.62	77.71	179.62	20.00
J-401	6,799.00	2.43	Demand	Zone1	2.43	7,011.69	92.02	212.69	20.00
J-402	6,858.00	4.86	Demand	Zone1	4.86	7,011.82	66.55	153.82	20.00
J-403	6,845.00	2.43	Demand	Zone1	2.43	7,011.69	72.12	166.69	20.00
J-404	6,859.00	2.43	Demand	Zone1	2.43	7,012.00	66.20	153.00	20.00
J-405	6,845.00	2.43	Demand	Zone1	2.43	7,011.75	72.14	166.75	20.00
J-406	6,827.00	2.43	Demand	Zone1	2.43	7,011.69	79.91	184.69	20.00
J-407	6,863.00	2.43	Demand	Zone-2	2.43	7,012.33	64.61	149.33	20.00

Scenario: No. 1 - EXISTING SYSTEM, MAXIMUM HOUR, 1726 POPULATION, PRVs ACTIVE
Steady State Analysis
Junction Report

Label	Elevation (ft)	Base Flow (gpm)	Type	Zone	Demand (Calculated) (gpm)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Pressure Head (ft)	Residual Pressure (psi)
J-408	6,857.00	1.22	Demand	Zone1	1.22	7,012.82	67.42	155.82	20.00
J-409	6,865.00	4.86	Demand	Zone1	4.86	7,012.82	63.95	147.82	20.00
J-410	6,785.00	3.65	Demand	Zone3	3.64	6,992.91	89.95	207.91	20.00
J-411	6,787.00	6.08	Demand	Zone3	6.07	6,992.92	89.09	205.92	20.00
J-412	6,788.00	7.29	Demand	Zone3	7.29	6,992.92	88.66	204.92	20.00
J-413	6,789.00	2.43	Demand	Zone3	2.43	6,992.91	88.22	203.91	20.00
J-414	6,787.00	0.00	Demand	Zone-2	0.00	6,993.83	89.48	206.83	20.00
J-415	6,787.00	3.65	Demand	Zone3	3.64	6,993.26	89.24	206.26	20.00
J-416	6,792.00	3.65	Demand	Zone3	3.64	6,992.93	86.93	200.93	20.00
J-417	6,791.00	0.00	Demand	Zone3	0.00	6,992.77	87.29	201.77	20.00
J-418	6,791.00	4.86	Demand	Zone3	4.86	6,992.77	87.29	201.77	20.00
J-419	6,813.00	1.82	Demand	Zone3	1.82	6,992.70	77.75	179.70	20.00
J-420	6,817.00	3.65	Demand	Zone3	3.64	6,992.69	76.01	175.69	20.00
J-421	6,820.00	3.65	Demand	Zone3	3.64	6,992.68	74.71	172.68	20.00
J-422	6,823.00	4.86	Demand	Zone3	4.86	6,992.68	73.41	169.68	20.00
J-423	6,814.00	1.22	Demand	Zone3	1.22	6,992.70	77.32	178.70	20.00
J-424	6,810.00	1.82	Demand	Zone3	1.82	6,992.71	79.05	182.71	20.00
J-425	6,823.00	2.43	Demand	Zone3	2.43	6,992.68	73.41	169.68	20.00
J-426	6,824.00	6.08	Demand	Zone3	6.07	6,992.68	72.98	168.68	20.00
J-427	6,824.00	3.04	Demand	Zone3	3.04	6,992.68	72.98	168.68	20.00
J-428	6,824.00	6.08	Demand	Zone3	6.07	6,992.68	72.98	168.68	20.00
J-429	6,824.00	4.86	Demand	Zone3	4.86	6,992.70	72.99	168.70	20.00
J-430	6,791.00	10.94	Demand	Zone3	10.94	6,992.01	86.97	201.01	20.00
J-431	6,794.00	2.43	Demand	Zone3	2.43	6,991.43	85.42	197.43	20.00
J-432	6,793.00	1.22	Demand	Zone3	1.22	6,988.36	84.52	195.36	20.00
J-433	6,792.00	3.65	Demand	Zone3	3.64	6,985.05	83.52	193.05	20.00
J-434	6,793.00	1.82	Demand	Zone3	1.82	6,985.04	83.09	192.04	20.00
J-435	6,794.00	1.82	Demand	Zone3	1.82	6,985.04	82.66	191.04	20.00
J-436	6,796.00	2.43	Demand	Zone3	2.43	6,985.04	81.79	189.04	20.00
J-437	6,790.00	1.22	Demand	Zone3	1.22	6,988.36	85.82	198.36	20.00
J-438	6,790.00	1.22	Demand	Zone3	1.22	6,988.36	85.82	198.36	20.00
J-439	6,791.00	2.43	Demand	Zone3	2.43	6,988.36	85.39	197.36	20.00
J-440	6,794.00	1.22	Demand	Zone3	1.22	6,975.28	78.43	181.28	20.00
J-441	6,794.00	3.65	Demand	Zone3	3.64	6,968.08	75.31	174.08	20.00
J-442	6,796.00	1.82	Demand	Zone3	1.82	6,968.07	74.45	172.07	20.00
J-443	6,795.00	3.65	Demand	Zone3	3.64	6,963.20	72.77	168.20	20.00

Scenario: No. 1 - EXISTING SYSTEM, MAXIMUM HOUR, 1726 POPULATION, PRVs ACTIVE
Steady State Analysis
Junction Report

Label	Elevation (ft)	Base Flow (gpm)	Type	Zone	Demand (Calculated) (gpm)	Calculated Hydraulic Grade (ft)	Pressure (psi)	Pressure Head (ft)	Residual Pressure (psi)
J-444	6,795.00	4.86	Demand	Zone3	4.86	6,963.20	72.77	168.20	20.00
J-445	6,795.00	3.65	Demand	Zone3	3.64	6,963.21	72.78	168.21	20.00
J-446	6,796.00	3.65	Demand	Zone3	3.64	6,959.79	70.86	163.79	20.00
J-450	6,817.00	2.43	Demand	Zone1	2.43	7,011.64	84.21	194.64	20.00
J-452	6,888.00	4.86	Demand	Zone3	4.86	7,015.75	55.27	127.75	20.00
J-456	6,840.00	0.00	Demand	Zone-2	0.00	6,991.79	65.67	151.79	20.00
J-601	6,798.00	4.86	Demand	Zone3	4.86	6,993.94	84.78	195.94	20.00
J-602	6,798.00	4.86	Demand	Zone3	4.86	6,993.95	84.78	195.95	20.00
J-700	6,955.00	0.00	Demand	Zone1	0.00	7,024.97	30.27	69.97	20.00
J-800	6,786.00	0.00	Demand	Zone-2	0.00	6,993.96	89.98	207.96	20.00
J-900	6,800.00	32.40	Demand	Zone3	32.40	6,941.93	61.40	141.93	20.00
J-910	6,840.00	0.00	Demand	Zone-2	0.00	6,991.74	65.65	151.74	20.00
J-911	6,840.00	0.00	Demand	Zone-2	0.00	6,991.64	65.61	151.64	20.00
J-912	6,788.00	1.50	Demand	Zone-2	1.50	6,992.01	88.26	204.01	20.00
J-913	6,796.00	1.50	Demand	Zone-2	1.50	6,992.01	84.80	196.01	20.00
J-950	6,820.00	0.00	Demand	Zone3	0.00	6,923.23	44.66	103.23	20.00

Scenario: No. 1 - EXISTING SYSTEM, MAXIMUM HOUR, 1726 POPULATION, PRVs ACTIVE
Steady State Analysis
Pipe Report

Label	From Node	To Node	Length (ft)	Diameter (in)	Hazen-Williams C	Discharge (gpm)	Velocity (ft/s)	Pressure Pipe Headloss (ft)	Headloss Gradient (ft/1000ft)	Minor Loss Coefficient	Calculated Minor Headloss (ft)
P-100	PMP-1	J-100	75.00	8	120.0	-0.00	0.00	0.00	0.00	0.00	0.00
P-101	J-101	J-100	250.00	6	120.0	0.00	0.00	0.00	0.00	0.00	0.00
P-102	J-102	J-101	100.00	8	120.0	0.00	0.00	0.00	0.00	0.00	0.00
P-103	J-103	J-102	175.00	12	120.0	0.00	0.00	0.00	0.00	0.00	0.00
P-104	J-103	J-104	125.00	12	120.0	521.60	1.48	0.11	0.88	0.00	0.00
P-105	J-104	J-105	125.00	6	120.0	216.86	2.46	0.63	5.07	0.00	0.00
P-106	J-106	J-105	100.00	6	120.0	-14.76	0.17	0.00	0.03	0.00	0.00
P-107	J-106	PRV-5	75.00	2	120.0	14.76	1.51	0.55	7.38	0.00	0.00
P-107'	J-107	PRV-5	75.00	2	120.0	-14.76	1.51	0.55	7.37	0.00	0.00
P-108	PRV-6	J-105	150.00	6	120.0	-202.10	2.29	0.67	4.45	0.00	0.00
P-108'	PRV-6	J-108	125.00	6	120.0	202.10	2.29	0.56	4.45	0.00	0.00
P-109	PRV-7	J-104	125.00	6	120.0	-304.73	3.46	1.19	9.53	0.00	0.00
P-109'	J-414	PRV-7	125.00	6	120.0	-304.73	3.46	1.19	9.52	0.00	0.00
P-110	J-107	J-108	100.00	6	120.0	14.76	0.17	0.00	0.04	0.00	0.00
P-111	J-108	J-414	125.00	6	120.0	216.86	2.46	0.63	5.07	0.00	0.00
P-112	J-316	J-103	200.00	12	120.0	521.60	1.48	0.18	0.88	0.00	0.00
P-200	J-200	J-209	950.00	6	120.0	-2.17	0.02	0.00	0.00	0.00	0.00
P-201	J-210	J-209	525.00	6	120.0	7.03	0.08	0.00	0.01	0.00	0.00
P-202	J-202	J-204	1,375.00	4	120.0	0.61	0.02	0.00	0.00	0.00	0.00
P-203	J-201	J-204	225.00	6	120.0	4.25	0.05	0.00	0.00	0.00	0.00
P-204	J-201	J-200	225.00	12	120.0	2.69	0.01	0.00	0.00	0.70	0.00
P-205	J-201	J-202	200.00	12	120.0	-11.81	0.03	0.00	0.00	0.00	0.00
P-206	J-202	J-203	200.00	12	120.0	-17.27	0.05	0.00	0.00	0.00	0.00
P-207	J-203	J-205	225.00	6	120.0	-3.11	0.04	0.00	0.00	0.00	0.00
P-208	J-203	J-206	225.00	12	120.0	-19.02	0.05	0.00	0.00	0.00	0.00
P-209	J-205	J-207	225.00	6	120.0	-7.97	0.09	0.00	0.01	0.00	0.00
P-210	J-207	J-210	400.00	6	120.0	-5.37	0.06	0.00	0.01	0.00	0.00
P-211	J-207	J-208	275.00	6	120.0	-7.46	0.08	0.00	0.01	0.00	0.00
P-212	J-210	J-211	425.00	6	120.0	-17.25	0.20	0.02	0.05	0.00	0.00
P-213	J-206	J-213	750.00	12	120.0	-23.88	0.07	0.00	0.00	0.00	0.00
P-214	J-208	J-214	700.00	6	120.0	-12.32	0.14	0.02	0.03	0.00	0.00
P-215	J-211	J-215	650.00	6	120.0	-22.11	0.25	0.05	0.07	0.00	0.00
P-216	J-217	J-216	400.00	6	120.0	-3.64	0.04	0.00	0.00	0.00	0.00
P-217	J-212	J-213	450.00	12	120.0	-10.51	0.03	0.00	0.00	0.00	0.00
P-218	J-213	J-214	400.00	8	120.0	-38.74	0.25	0.02	0.05	0.00	0.00

Scenario: No. 1 - EXISTING SYSTEM, MAXIMUM HOUR, 1726 POPULATION, PRVs ACTIVE

Steady State Analysis

Pipe Report

Label	From Node	To Node	Length (ft)	Diameter (in)	Hazen-Williams C	Discharge (gpm)	Velocity (ft/s)	Pressure Pipe Headloss (ft)	Headloss Gradient (ft/1000ft)	Minor Loss Coefficient	Calculated Minor Headloss (ft)
P-219	J-214	J-215	450.00	8	120.0	-58.60	0.37	0.05	0.11	0.00	0.00
P-220	J-215	J-216	475.00	8	120.0	-74.71	0.48	0.08	0.17	0.00	0.00
P-221	J-212	J-220	800.00	12	120.0	3.22	0.01	0.00	0.00	0.00	0.00
P-222	J-213	J-218	450.00	6	120.0	-2.94	0.03	0.00	0.00	0.00	0.00
P-223	J-214	J-219	450.00	6	120.0	0.25	0.00	0.00	0.00	0.00	0.00
P-224	J-215	J-223	875.00	6	120.0	-13.30	0.15	0.02	0.03	0.00	0.00
P-225	J-216	J-224	850.00	6	120.0	-21.43	0.24	0.06	0.07	0.00	0.00
P-226	J-218	J-221	550.00	6	120.0	-10.23	0.12	0.01	0.02	0.00	0.00
P-227	J-219	J-222	550.00	6	120.0	-7.04	0.08	0.00	0.01	0.00	0.00
P-228	J-220	J-225	600.00	12	120.0	-4.07	0.01	0.00	0.00	0.00	0.00
P-229	J-221	J-226	500.00	6	120.0	-3.19	0.04	0.00	0.00	0.00	0.00
P-230	J-222	J-227	400.00	6	120.0	-28.66	0.33	0.05	0.12	0.00	0.00
P-231	J-223	J-231	1,025.00	6	120.0	-27.88	0.32	0.12	0.11	0.00	0.00
P-232	J-224	J-232	1,000.00	6	120.0	-36.01	0.41	0.18	0.18	0.00	0.00
P-233	J-225	J-228	500.00	12	120.0	-11.36	0.03	0.00	0.00	0.00	0.00
P-234	J-226	J-229	475.00	6	120.0	-10.48	0.12	0.01	0.02	0.00	0.00
P-235	J-227	J-230	575.00	6	120.0	-35.95	0.41	0.10	0.18	0.00	0.00
P-236	J-230	J-231	400.00	6	120.0	-23.91	0.27	0.03	0.09	0.00	0.00
P-237	J-232	J-231	400.00	6	120.0	59.08	0.67	0.18	0.46	0.00	0.00
P-238	J-228	J-234	600.00	12	120.0	-18.65	0.05	0.00	0.00	0.00	0.00
P-239	J-229	J-235	575.00	6	120.0	-17.77	0.20	0.03	0.05	0.00	0.00
P-240	J-230	J-236	500.00	6	120.0	-19.33	0.22	0.03	0.06	0.00	0.00
P-241	J-232	J-237	475.00	6	130.0	-11.12	0.13	0.01	0.02	0.00	0.00
P-242	J-233	J-234	325.00	6	120.0	-3.64	0.04	0.00	0.00	0.00	0.00
P-243	J-234	J-235	375.00	6	120.0	-29.59	0.34	0.05	0.13	0.00	0.00
P-244	J-235	J-236	400.00	6	120.0	-54.64	0.62	0.16	0.40	0.00	0.00
P-245	J-236	J-237	725.00	4	120.0	-15.34	0.39	0.20	0.27	0.00	0.00
P-246	J-236	J-248	1,900.00	6	120.0	-69.57	0.79	1.17	0.62	0.00	0.00
P-247	J-238	J-243	925.00	6	120.0	18.27	0.21	0.05	0.05	0.00	0.00
P-248	J-238	J-239	750.00	6	120.0	-25.56	0.29	0.07	0.10	0.00	0.00
P-249	J-239	J-244	525.00	6	120.0	-32.85	0.37	0.08	0.15	0.00	0.00
P-250	J-240	J-241	450.00	6	120.0	-6.23	0.07	0.00	0.01	0.00	0.00
P-251	J-242	J-243	375.00	4	130.0	-22.56	0.58	0.18	0.48	0.00	0.00
P-252	J-243	J-244	375.00	4	120.0	-22.20	0.57	0.20	0.54	0.00	0.00
P-253	J-240	J-246	500.00	6	120.0	-1.06	0.01	0.00	0.00	0.00	0.00

Scenario: No. 1 - EXISTING SYSTEM, MAXIMUM HOUR, 1726 POPULATION, PRVs ACTIVE
Steady State Analysis
Pipe Report

Label	From Node	To Node	Length (ft)	Diameter (in)	Hazen-Williams C	Discharge (gpm)	Velocity (ft/s)	Pressure Pipe Headloss (ft)	Headloss Gradient (ft/1000ft)	Minor Loss Coefficient	Calculated Minor Headloss (ft)
P-254	J-241	J-247	575.00	12	120.0	-13.52	0.04	0.00	0.00	0.00	0.00
P-255	J-242	J-249	500.00	4	120.0	15.27	0.39	0.13	0.27	0.00	0.00
P-256	J-243	J-250	550.00	6	120.0	10.62	0.12	0.01	0.02	0.00	0.00
P-257	J-244	J-251	550.00	6	120.0	-30.79	0.35	0.07	0.14	0.00	0.00
P-258	J-246	J-245	200.00	6	120.0	2.43	0.03	0.00	0.00	0.00	0.00
P-259	J-246	J-247	400.00	6	120.0	-7.13	0.08	0.00	0.01	0.00	0.00
P-260	J-247	J-248	450.00	12	120.0	-30.37	0.09	0.00	0.00	0.00	0.00
P-261	J-249	J-250	400.00	6	120.0	-77.60	0.88	0.30	0.76	0.00	0.00
P-262	J-250	J-251	400.00	6	120.0	-75.41	0.86	0.29	0.72	0.00	0.00
P-263	J-247	J-252	475.00	6	120.0	2.43	0.03	0.00	0.00	0.00	0.00
P-264	J-249	J-253	500.00	4	120.0	-14.37	0.37	0.12	0.24	0.00	0.00
P-265	J-250	J-254	525.00	6	120.0	1.14	0.01	0.00	0.00	0.00	0.00
P-266	J-251	J-255	525.00	6	120.0	-8.23	0.09	0.01	0.01	0.00	0.00
P-267	J-253	J-256	225.00	4	120.0	1.82	0.05	0.00	0.00	0.00	0.00
P-268	J-253	J-254	375.00	4	120.0	-21.05	0.54	0.18	0.49	0.00	0.00
P-269	J-254	J-255	375.00	4	120.0	-27.20	0.69	0.29	0.78	0.00	0.00
P-270	J-255	J-257	450.00	6	120.0	-42.72	0.48	0.11	0.25	0.00	0.00
P-271	J-258	J-261	400.00	6	120.0	-7.74	0.09	0.00	0.01	0.00	0.00
P-272	J-258	J-259	700.00	6	120.0	2.88	0.03	0.00	0.00	0.00	0.00
P-273	J-259	J-273	375.00	4	120.0	-4.41	0.11	0.01	0.03	0.00	0.00
P-274	J-259	J-260	275.00	4	120.0	2.43	0.06	0.00	0.01	0.00	0.00
P-275	J-261	J-269	525.00	6	120.0	-4.70	0.05	0.00	0.00	0.00	0.00
P-276	J-261	J-263	650.00	6	120.0	-5.47	0.06	0.00	0.01	0.00	0.00
P-277	J-262	J-266	250.00	6	120.0	-7.53	0.09	0.00	0.01	0.00	0.00
P-278	J-263	J-264	400.00	6	120.0	-9.64	0.11	0.01	0.02	0.00	0.00
P-279	J-264	J-267	250.00	6	120.0	-15.71	0.18	0.01	0.04	0.00	0.00
P-280	J-265	J-268	275.00	4	120.0	-3.60	0.09	0.01	0.02	0.00	0.00
P-281	J-267	J-268	500.00	6	120.0	-6.42	0.07	0.00	0.01	0.00	0.00
P-282	J-266	J-270	425.00	6	120.0	0.07	0.00	0.00	0.00	0.00	0.00
P-283	J-267	J-271	500.00	12	120.0	-26.62	0.08	0.00	0.00	0.00	0.00
P-284	J-268	J-272	425.00	6	120.0	-6.11	0.07	0.00	0.01	0.00	0.00
P-285	J-269	J-270	575.00	6	120.0	-8.35	0.09	0.01	0.01	0.00	0.00
P-286	J-270	J-271	525.00	6	120.0	-11.92	0.14	0.01	0.02	0.00	0.00
P-287	J-271	J-272	525.00	12	120.0	-44.61	0.13	0.00	0.01	0.00	0.00
P-288	J-262	J-273	200.00	6	120.0	7.53	0.09	0.00	0.01	0.00	0.00

Scenario: No. 1 - EXISTING SYSTEM, MAXIMUM HOUR, 1726 POPULATION, PRVs ACTIVE
Steady State Analysis
Pipe Report

Label	From Node	To Node	Length (ft)	Diameter (in)	Hazen-Williams C	Discharge (gpm)	Velocity (ft/s)	Pressure Pipe Headloss (ft)	Headloss Gradient (ft/1000ft)	Minor Loss Coefficient	Calculated Minor Headloss (ft)
P-289	J-273	J-263	75.00	4	120.0	3.12	0.08	0.00	0.01	0.00	0.00
P-290	J-216	J-275	450.00	8	140.0	-64.21	0.41	0.04	0.10	0.00	0.00
P-291	J-274	J-275	600.00	6	120.0	-3.64	0.04	0.00	0.00	0.00	0.00
P-292	J-275	J-277	175.00	8	140.0	1.22	0.01	0.00	0.00	0.00	0.00
P-294	J-232	J-284	400.00	6	120.0	-91.26	1.04	0.41	1.02	0.00	0.00
P-295	J-284	J-289	500.00	6	140.0	-50.63	0.57	0.13	0.26	0.00	0.00
P-296	J-237	J-289	375.00	4	120.0	-37.40	0.95	0.53	1.41	0.00	0.00
P-297	J-284	J-285	450.00	6	140.0	-77.88	0.88	0.26	0.57	0.00	0.00
P-298	J-285	J-287	375.00	6	140.0	-100.97	1.15	0.35	0.93	0.00	0.00
P-299	J-287	J-290	475.00	10	140.0	-145.92	0.60	0.07	0.15	0.00	0.00
P-301	J-290	J-291	650.00	10	140.0	-253.73	1.04	0.28	0.42	0.00	0.00
P-302	J-287	J-286	125.00	10	140.0	41.31	0.17	0.00	0.02	0.00	0.00
P-303	J-286	J-282	1,800.00	10	140.0	31.59	0.13	0.02	0.01	0.00	0.00
P-304	J-282	J-280	375.00	10	140.0	19.44	0.08	0.00	0.00	0.00	0.00
P-305	J-280	J-278	450.00	10	140.0	9.72	0.04	0.00	0.00	0.00	0.00
P-306	J-278	J-279	775.00	8	120.0	4.86	0.03	0.00	0.00	0.00	0.00
P-307	J-280	J-281	775.00	8	120.0	4.86	0.03	0.00	0.00	0.00	0.00
P-308	J-282	J-283	775.00	8	120.0	4.86	0.03	0.00	0.00	0.00	0.00
P-309	J-289	J-296	1,475.00	4	120.0	-30.24	0.77	1.40	0.95	0.00	0.00
P-310	J-291	J-299	475.00	10	140.0	-234.13	0.96	0.17	0.36	0.00	0.00
P-311	J-291	J-292	375.00	6	120.0	-26.89	0.31	0.04	0.11	0.00	0.00
P-312	J-292	J-300	575.00	6	120.0	-37.83	0.43	0.12	0.20	0.00	0.00
P-313	J-292	J-293	400.00	6	120.0	7.29	0.08	0.00	0.01	0.00	0.00
P-314	J-293	J-294	575.00	6	120.0	4.86	0.06	0.00	0.01	0.00	0.00
P-315	J-294	J-295	125.00	2	120.0	2.43	0.25	0.03	0.26	0.00	0.00
P-316	J-301	J-297	150.00	10	120.0	131.20	0.54	0.02	0.17	0.00	0.00
P-317	J-298	J-297	400.00	8	120.0	-131.20	0.84	0.20	0.49	0.00	0.00
P-318	J-298	J-299	425.00	8	120.0	123.91	0.79	0.19	0.44	0.00	0.00
P-319	J-299	J-302	550.00	10	140.0	-117.51	0.48	0.06	0.10	0.00	0.00
P-320	J-300	J-303	450.00	6	120.0	-45.12	0.51	0.12	0.28	0.00	0.00
P-321	J-244	J-296	425.00	4	120.0	-31.55	0.81	0.44	1.03	0.00	0.00
P-322	J-296	J-305	475.00	6	120.0	-61.88	0.70	0.24	0.50	0.00	0.00
P-323	J-296	J-301	400.00	6	120.0	-7.19	0.08	0.00	0.01	0.00	0.00
P-324	J-301	J-306	500.00	10	120.0	-227.47	0.93	0.23	0.46	0.00	0.00
P-325	J-301	J-302	425.00	6	120.0	81.79	0.93	0.35	0.83	0.00	0.00

Scenario: No. 1 - EXISTING SYSTEM, MAXIMUM HOUR, 1726 POPULATION, PRVs ACTIVE
Steady State Analysis
Pipe Report

Label	From Node	To Node	Length (ft)	Diameter (in)	Hazen-Williams C	Discharge (gpm)	Velocity (ft/s)	Pressure Pipe Headloss (ft)	Headloss Gradient (ft/1000ft)	Minor Loss Coefficient	Calculated Minor Headloss (ft)
P-326	J-302	J-307	500.00	4	120.0	-13.64	0.35	0.11	0.22	0.00	0.00
P-327	J-302	J-303	400.00	6	120.0	-29.37	0.33	0.05	0.13	0.00	0.00
P-328	J-303	J-311	850.00	6	120.0	-45.06	0.51	0.23	0.28	0.00	0.00
P-329	J-303	J-304	400.00	6	120.0	-36.71	0.42	0.08	0.19	0.00	0.00
P-330	J-304	J-308	575.00	6	120.0	-41.57	0.47	0.14	0.24	0.00	0.00
P-331	J-251	J-305	450.00	6	120.0	-105.26	1.19	0.60	1.33	0.00	0.00
P-332	J-305	J-309	550.00	10	120.0	-179.73	0.73	0.16	0.30	0.00	0.00
P-333	J-305	J-306	450.00	6	120.0	5.30	0.06	0.00	0.01	0.00	0.00
P-334	J-306	J-310	525.00	10	120.0	-229.45	0.94	0.25	0.47	0.00	0.00
P-335	J-307	J-315	850.00	4	120.0	-20.93	0.53	0.41	0.48	0.00	0.00
P-336	J-308	J-312	450.00	6	120.0	-48.86	0.55	0.14	0.32	0.00	0.00
P-337	J-309	J-313	450.00	10	120.0	-187.02	0.76	0.14	0.32	0.00	0.00
P-339	J-315	J-317	150.00	4	120.0	12.30	0.31	0.03	0.18	0.00	0.00
P-340	J-311	J-318	550.00	6	120.0	-52.35	0.59	0.20	0.36	0.00	0.00
P-341	J-312	J-322	500.00	6	120.0	-56.15	0.64	0.21	0.42	0.00	0.00
P-342	J-318	J-317	225.00	6	120.0	-12.30	0.14	0.01	0.02	0.00	0.00
P-343	J-318	J-320	400.00	6	120.0	-41.88	0.48	0.10	0.24	0.00	0.00
P-344	J-320	J-322	125.00	6	120.0	-43.70	0.50	0.03	0.26	0.00	0.00
P-347	J-325	J-324	375.00	6	120.0	4.86	0.06	0.00	0.00	0.00	0.00
P-348	J-304	J-329	1,415.00	6	120.0	0.00	0.00	0.00	0.00	0.00	0.00
P-350	J-327	J-328	100.00	6	120.0	88.12	1.00	0.10	0.96	0.00	0.00
P-351	J-327	J-331	425.00	6	120.0	-92.98	1.06	0.45	1.06	0.00	0.00
P-352	J-331	J-330	350.00	6	120.0	-9.84	0.11	0.01	0.02	0.00	0.00
P-353	J-330	J-329	1,025.00	2	120.0	-13.48	1.38	6.39	6.24	0.00	0.00
P-354	J-329	J-333	400.00	6	120.0	-13.48	0.15	0.01	0.03	0.00	0.00
P-355	J-331	J-332	75.00	6	120.0	21.18	0.24	0.00	0.07	0.00	0.00
P-356	J-331	J-335	425.00	6	120.0	-109.18	1.24	0.60	1.42	0.00	0.00
P-357	J-334	J-335	325.00	4	120.0	64.57	1.65	1.26	3.88	0.00	0.00
P-358	J-334	J-333	1,025.00	4	120.0	-69.43	1.77	4.55	4.44	0.00	0.00
P-359	J-335	J-336	75.00	4	120.0	33.40	0.85	0.09	1.15	0.00	0.00
P-360	J-335	J-338	425.00	6	120.0	-82.87	0.94	0.36	0.85	0.00	0.00
P-361	J-338	J-337	350.00	6	120.0	4.86	0.06	0.00	0.00	0.00	0.00
P-362	J-338	J-339	100.00	6	120.0	12.79	0.15	0.00	0.02	0.00	0.00
P-363	J-338	J-341	425.00	6	120.0	-105.38	1.20	0.57	1.33	0.00	0.00
P-364	J-341	J-340	325.00	6	120.0	4.86	0.06	0.00	0.00	0.00	0.00

Scenario: No. 1 - EXISTING SYSTEM, MAXIMUM HOUR, 1726 POPULATION, PRVs ACTIVE
Steady State Analysis
Pipe Report

Label	From Node	To Node	Length (ft)	Diameter (in)	Hazen-Williams C	Discharge (gpm)	Velocity (ft/s)	Pressure Pipe Headloss (ft)	Headloss Gradient (ft/1000ft)	Minor Loss Coefficient	Calculated Minor Headloss (ft)
P-365	J-341	J-342	125.00	6	120.0	-6.53	0.07	0.00	0.01	0.00	0.00
P-366	J-341	J-343	375.00	6	120.0	-106.15	1.20	0.51	1.35	0.00	0.00
P-367	J-343	J-344	150.00	6	120.0	1.36	0.02	0.00	0.00	0.00	0.00
P-368	J-343	J-345	375.00	6	120.0	-109.94	1.25	0.54	1.44	0.00	0.00
P-369	J-345	J-346	150.00	6	120.0	-4.02	0.05	0.00	0.00	0.00	0.00
P-370	J-345	J-347	400.00	6	120.0	-108.34	1.23	0.56	1.40	0.00	0.00
P-371	J-347	J-350	150.00	6	120.0	-108.34	1.23	0.21	1.40	0.00	0.00
P-372	J-359	J-349	875.00	14	120.0	1,292.80	2.69	1.95	2.23	0.00	0.00
P-373	J-333	J-367	1,975.00	6	120.0	-82.92	0.94	1.69	0.85	0.00	0.00
P-374	J-359	J-363	475.00	14	120.0	-1,211.66	2.53	0.94	1.98	0.00	0.00
P-375	J-359	J-360	325.00	6	120.0	-86.00	0.98	0.30	0.91	0.00	0.00
P-376	J-363	J-364	425.00	6	120.0	100.58	1.14	0.52	1.22	0.00	0.00
P-377	J-364	J-360	400.00	6	120.0	47.86	0.54	0.12	0.31	0.00	0.00
P-378	J-363	J-366	375.00	14	120.0	-1,317.10	2.75	0.87	2.31	0.00	0.00
P-379	J-366	J-365	700.00	6	120.0	9.72	0.11	0.01	0.02	0.00	0.00
P-380	J-365	J-362	650.00	6	120.0	4.86	0.06	0.00	0.00	0.00	0.00
P-381	J-366	J-367	300.00	14	120.0	-1,331.68	2.78	0.71	2.36	0.00	0.00
P-382	J-367	J-368	450.00	6	120.0	4.86	0.06	0.00	0.00	0.00	0.00
P-383	J-368	J-369	450.00	4	120.0	4.86	0.12	0.01	0.03	0.00	0.00
P-384	J-367	J-370	675.00	14	120.0	-1,424.32	2.97	1.80	2.67	0.00	0.00
P-385	J-370	J-371	250.00	14	120.0	-1,429.18	2.98	0.67	2.69	0.00	0.00
P-386	J-371	J-372	350.00	14	120.0	-1,429.18	2.98	0.94	2.69	0.00	0.00
P-387	J-372	J-373	450.00	6	120.0	4.86	0.06	0.00	0.00	0.00	0.00
P-388	J-374	J-372	625.00	14	120.0	1,438.90	3.00	1.70	2.72	0.00	0.00
P-389	J-700	J-375	310.00	14	120.0	1,452.26	3.03	0.86	2.77	0.00	0.00
P-390	J-374	J-375	375.00	14	120.0	-1,443.76	3.01	1.03	2.74	0.00	0.00
P-391	J-375	J-379	475.00	14	120.0	8.51	0.02	0.00	0.00	0.00	0.00
P-392	J-380	J-377	325.00	6	120.0	1.22	0.01	0.00	0.00	0.00	0.00
P-393	J-381	J-378	275.00	6	120.0	1.22	0.01	0.00	0.00	0.00	0.00
P-394	J-379	J-382	400.00	14	120.0	7.29	0.02	0.00	0.00	0.00	0.00
P-395	J-380	J-376	175.00	6	120.0	1.22	0.01	0.00	0.00	0.00	0.00
P-396	J-381	J-380	225.00	6	120.0	3.65	0.04	0.00	0.00	0.00	0.00
P-397	J-382	J-381	200.00	6	120.0	6.08	0.07	0.00	0.01	0.00	0.00
P-398	J-257	J-313	375.00	4	120.0	-46.37	1.18	0.79	2.10	0.00	0.00
P-400	PRV-4	J-314	500.00	10	120.0	514.30	2.10	1.04	2.08	0.00	0.00

Scenario: No. 1 - EXISTING SYSTEM, MAXIMUM HOUR, 1726 POPULATION, PRVs ACTIVE
Steady State Analysis
Pipe Report

Label	From Node	To Node	Length (ft)	Diameter (in)	Hazen-Williams C	Discharge (gpm)	Velocity (ft/s)	Pressure Pipe Headloss (ft)	Headloss Gradient (ft/1000ft)	Minor Loss Coefficient	Calculated Minor Headloss (ft)
P-400'	J-316	PRV-4	225.00	10	120.0	514.30	2.10	0.47	2.09	0.00	0.00
P-401	J-316	J-319	400.00	14	120.0	-1,035.89	2.16	0.59	1.48	0.00	0.00
P-402	J-319	J-321	300.00	14	120.0	-1,037.72	2.16	0.45	1.49	0.00	0.00
P-403	J-321	J-323	350.00	14	120.0	-1,045.62	2.18	0.53	1.51	0.00	0.00
P-404	J-323	J-326	425.00	14	120.0	-1,045.62	2.18	0.64	1.51	0.00	0.00
P-405'	J-326	J-328	725.00	14	120.0	-1,050.48	2.19	1.10	1.52	0.00	0.00
P-406	J-328	J-332	425.00	14	120.0	-953.40	1.99	0.54	1.27	0.00	0.00
P-407	J-332	J-336	425.00	14	120.0	-938.41	1.96	0.52	1.23	0.00	0.00
P-408	J-336	J-339	375.00	14	120.0	-920.31	1.92	0.45	1.19	0.00	0.00
P-409	J-339	J-342	475.00	14	120.0	-924.73	1.93	0.57	1.20	0.00	0.00
P-410	J-342	J-344	400.00	14	120.0	-950.86	1.98	0.51	1.26	0.00	0.00
P-411	J-344	J-346	400.00	14	120.0	-986.43	2.06	0.54	1.35	0.00	0.00
P-412	J-346	J-348	275.00	14	120.0	-1,032.97	2.15	0.41	1.47	0.00	0.00
P-413	J-348	J-350	200.00	14	120.0	-1,161.37	2.42	0.37	1.83	0.00	0.00
P-414	J-350	J-349	125.00	14	120.0	-1,292.80	2.69	0.28	2.23	0.00	0.00
P-415	J-350	J-351	150.00	6	120.0	23.08	0.26	0.01	0.08	0.00	0.00
P-416	J-321	J-383	450.00	6	120.0	6.07	0.07	0.00	0.01	0.00	0.00
P-418	PRV-2	J-325	300.00	6	120.0	121.12	1.37	0.52	1.73	0.00	0.00
P-418'	J-386	PRV-2	450.00	6	120.0	121.12	1.37	0.78	1.72	0.00	0.00
P-419	J-328	J-388	525.00	4	120.0	-13.81	0.35	0.12	0.22	0.00	0.00
P-420	J-332	J-390	600.00	6	120.0	1.33	0.02	0.00	0.00	0.00	0.00
P-421	J-336	J-391	525.00	4	120.0	10.44	0.27	0.07	0.13	0.00	0.00
P-422	J-339	J-396	575.00	6	120.0	12.36	0.14	0.01	0.03	0.00	0.00
P-423	J-342	J-398	600.00	6	120.0	17.17	0.19	0.03	0.05	0.00	0.00
P-424	J-344	J-402	600.00	6	120.0	32.07	0.36	0.09	0.15	0.00	0.00
P-425	J-346	J-407	600.00	6	120.0	37.66	0.43	0.12	0.20	0.00	0.00
P-426	J-348	J-409	575.00	12	120.0	123.54	0.35	0.04	0.06	0.00	0.00
P-427	J-351	J-352	450.00	6	120.0	1.22	0.01	0.00	0.00	0.00	0.00
P-428	J-351	J-353	425.00	6	120.0	18.22	0.21	0.02	0.05	0.00	0.00
P-429	J-353	J-354	350.00	4	120.0	3.64	0.09	0.01	0.02	0.00	0.00
P-430	J-353	J-355	375.00	6	120.0	10.93	0.12	0.01	0.02	0.00	0.00
P-431	J-355	J-356	250.00	4	120.0	3.64	0.09	0.00	0.02	0.00	0.00
P-432	J-355	J-357	500.00	6	120.0	3.64	0.04	0.00	0.00	0.00	0.00
P-433	J-357	J-358	275.00	6	120.0	3.64	0.04	0.00	0.00	0.00	0.00
P-434	J-386	J-385	325.00	6	120.0	-54.51	0.62	0.13	0.39	0.00	0.00

Scenario: No. 1 - EXISTING SYSTEM, MAXIMUM HOUR, 1726 POPULATION, PRVs ACTIVE
Steady State Analysis
Pipe Report

Label	From Node	To Node	Length (ft)	Diameter (in)	Hazen-Williams C	Discharge (gpm)	Velocity (ft/s)	Pressure Pipe Headloss (ft)	Headloss Gradient (ft/1000ft)	Minor Loss Coefficient	Calculated Minor Headloss (ft)
P-435	J-386	J-388	475.00	6	120.0	-71.47	0.81	0.31	0.65	0.00	0.00
P-436	J-385	J-387	425.00	6	120.0	-56.94	0.65	0.18	0.43	0.00	0.00
P-437	J-383	J-384	725.00	4	120.0	2.43	0.06	0.01	0.01	0.00	0.00
P-438	J-388	J-387	275.00	6	120.0	-2.93	0.03	0.00	0.00	0.00	0.00
P-439	J-388	J-390	450.00	6	120.0	-87.21	0.99	0.42	0.94	0.00	0.00
P-440	J-387	J-392	775.00	4	120.0	-33.17	0.85	0.87	1.13	0.00	0.00
P-441	J-390	J-391	450.00	6	120.0	-90.75	1.03	0.45	1.01	0.00	0.00
P-442	J-391	J-392	275.00	4	120.0	1.92	0.05	0.00	0.01	0.00	0.00
P-443	J-387	J-389	525.00	4	120.0	-31.56	0.81	0.54	1.03	0.00	0.00
P-444	J-389	J-393	450.00	4	120.0	-36.42	0.93	0.60	1.34	0.00	0.00
P-445	J-393	J-394	350.00	6	120.0	-12.80	0.15	0.01	0.03	0.00	0.00
P-446	J-392	J-394	225.00	4	120.0	-34.90	0.89	0.28	1.24	0.00	0.00
P-447	J-394	J-395	325.00	6	120.0	-23.44	0.27	0.03	0.08	0.00	0.00
P-448	J-391	J-395	325.00	6	120.0	-87.08	0.99	0.30	0.94	0.00	0.00
P-449	J-395	J-396	125.00	6	120.0	-115.38	1.31	0.20	1.58	0.00	0.00
P-450	J-393	J-397	375.00	4	120.0	-28.48	0.73	0.32	0.85	0.00	0.00
P-451	J-394	J-399	600.00	4	120.0	-29.12	0.74	0.53	0.89	0.00	0.00
P-452	J-396	J-398	400.00	6	120.0	-107.88	1.22	0.56	1.39	0.00	0.00
P-453	J-397	J-400	625.00	4	120.0	-33.34	0.85	0.71	1.14	0.00	0.00
P-454	J-398	J-402	400.00	6	120.0	-95.58	1.08	0.44	1.11	0.00	0.00
P-455	J-399	J-403	475.00	4	120.0	-33.98	0.87	0.56	1.18	0.00	0.00
P-456	J-400	J-403	475.00	4	120.0	-11.13	0.28	0.07	0.15	0.00	0.00
P-457	J-400	J-450	250.00	6	120.0	-24.64	0.28	0.02	0.09	0.00	0.00
P-458	J-450	J-406	475.00	6	120.0	-27.07	0.31	0.05	0.11	0.00	0.00
P-459	J-406	J-401	525.00	6	120.0	2.43	0.03	0.00	0.00	0.00	0.00
P-460	J-402	J-404	300.00	6	120.0	-68.37	0.78	0.18	0.60	0.00	0.00
P-461	J-404	J-407	125.00	6	120.0	-152.69	1.73	0.33	2.65	0.00	0.00
P-462	J-403	J-405	200.00	6	120.0	-47.54	0.54	0.06	0.31	0.00	0.00
P-463	J-404	J-405	300.00	6	120.0	81.90	0.93	0.25	0.84	0.00	0.00
P-464	J-405	J-406	400.00	6	120.0	31.93	0.36	0.06	0.15	0.00	0.00
P-465	J-407	J-409	300.00	6	120.0	-117.47	1.33	0.49	1.63	0.00	0.00
P-466	J-409	J-408	150.00	12	120.0	1.22	0.00	0.00	0.00	0.00	0.00
P-467	J-265	J-410	400.00	4	120.0	-2.48	0.06	0.00	0.01	0.00	0.00
P-468	J-268	J-411	575.00	6	120.0	-9.98	0.11	0.01	0.02	0.00	0.00
P-469	J-412	J-272	575.00	12	120.0	54.37	0.15	0.01	0.01	0.00	0.00

Scenario: No. 1 - EXISTING SYSTEM, MAXIMUM HOUR, 1726 POPULATION, PRVs ACTIVE
Steady State Analysis
Pipe Report

Label	From Node	To Node	Length (ft)	Diameter (in)	Hazen-Williams C	Discharge (gpm)	Velocity (ft/s)	Pressure Pipe Headloss (ft)	Headloss Gradient (ft/1000ft)	Minor Loss Coefficient	Calculated Minor Headloss (ft)
P-470	J-411	J-412	375.00	4	120.0	-1.17	0.03	0.00	0.00	0.00	0.00
P-471	J-412	J-413	425.00	4	120.0	2.43	0.06	0.00	0.01	0.00	0.00
P-472	J-411	J-415	700.00	4	120.0	-21.01	0.54	0.34	0.48	0.00	0.00
P-473	J-412	J-416	875.00	12	120.0	-65.25	0.19	0.02	0.02	0.00	0.00
P-474	J-415	J-416	400.00	12	120.0	496.94	1.41	0.32	0.81	0.00	0.00
P-475	J-416	J-417	275.00	12	120.0	428.04	1.21	0.17	0.61	0.00	0.00
P-476	J-417	J-418	100.00	12	120.0	44.35	0.13	0.00	0.01	0.00	0.00
P-477	J-414	J-415	650.00	12	120.0	521.60	1.48	0.57	0.88	0.00	0.00
P-478	J-418	J-424	975.00	8	120.0	39.49	0.25	0.05	0.05	0.00	0.00
P-479	J-420	J-421	250.00	6	120.0	13.27	0.15	0.01	0.03	0.00	0.00
P-480	J-423	J-420	250.00	6	120.0	16.91	0.19	0.01	0.04	0.00	0.00
P-481	J-423	J-419	275.00	6	120.0	1.82	0.02	0.00	0.00	0.00	0.00
P-482	J-424	J-423	200.00	6	120.0	19.95	0.23	0.01	0.06	0.00	0.00
P-483	J-421	J-422	325.00	6	120.0	9.62	0.11	0.01	0.02	0.00	0.00
P-484	J-422	J-425	350.00	6	120.0	2.43	0.03	0.00	0.00	0.00	0.00
P-485	J-422	J-426	300.00	6	120.0	2.33	0.03	0.00	0.00	0.00	0.00
P-486	J-426	J-428	325.00	6	120.0	-6.78	0.08	0.00	0.01	0.00	0.00
P-487	J-426	J-427	400.00	6	120.0	3.04	0.03	0.00	0.00	0.00	0.00
P-488	J-429	J-428	700.00	6	120.0	12.86	0.15	0.02	0.03	0.00	0.00
P-489	J-424	J-429	1,200.00	8	120.0	17.72	0.11	0.01	0.01	0.00	0.00
P-490	J-417	J-430	625.00	10	120.0	383.69	1.57	0.76	1.21	0.00	0.00
P-491	J-430	J-431	500.00	10	120.0	372.75	1.52	0.57	1.15	0.00	0.00
P-492	J-434	J-435	175.00	6	120.0	4.25	0.05	0.00	0.01	0.00	0.00
P-493	J-435	J-436	500.00	6	120.0	2.43	0.03	0.00	0.00	0.00	0.00
P-494	J-434	J-433	450.00	6	120.0	-6.08	0.07	0.00	0.01	0.00	0.00
P-495	J-431	J-432	225.00	6	120.0	370.32	4.20	3.07	13.67	0.00	0.00
P-496	J-433	J-432	250.00	6	120.0	-364.25	4.13	3.31	13.25	0.00	0.00
P-497	J-432	J-437	375.00	6	120.0	4.86	0.06	0.00	0.00	0.00	0.00
P-498	J-433	J-440	775.00	6	120.0	354.53	4.02	9.77	12.61	0.00	0.00
P-499	J-437	J-438	325.00	6	120.0	3.65	0.04	0.00	0.00	0.00	0.00
P-500	J-438	J-439	275.00	6	120.0	2.43	0.03	0.00	0.00	0.00	0.00
P-501	J-443	J-444	325.00	6	120.0	-3.64	0.04	0.00	0.00	0.00	0.00
P-502	J-440	J-441	575.00	6	120.0	353.31	4.01	7.20	12.53	0.00	0.00
P-503	J-444	J-445	500.00	6	120.0	-8.51	0.10	0.01	0.01	0.00	0.00
P-504	J-441	J-445	400.00	6	120.0	347.84	3.95	4.87	12.17	0.00	0.00

Scenario: No. 1 - EXISTING SYSTEM, MAXIMUM HOUR, 1726 POPULATION, PRVs ACTIVE
Steady State Analysis
Pipe Report

Label	From Node	To Node	Length (ft)	Diameter (in)	Hazen-Williams C	Discharge (gpm)	Velocity (ft/s)	Pressure Pipe Headloss (ft)	Headloss Gradient (ft/1000ft)	Minor Loss Coefficient	Calculated Minor Headloss (ft)
P-505	J-445	J-446	300.00	6	120.0	335.69	3.81	3.42	11.39	0.00	0.00
P-506	J-441	J-442	1,000.00	6	120.0	1.82	0.02	0.00	0.00	0.00	0.00
P-510	J-221	J-222	450.00	6	120.0	-14.33	0.16	0.02	0.03	0.00	0.00
P-511	J-248	J-249	75.00	12	120.0	-99.94	0.28	0.00	0.04	0.00	0.00
P-512	J-266	J-267	500.00	6	120.0	-11.25	0.13	0.01	0.02	0.00	0.00
P-513	J-286	J-288	500.00	6	120.0	6.07	0.07	0.00	0.01	0.00	0.00
P-514	J-410	J-411	225.00	4	120.0	-6.12	0.16	0.01	0.05	0.00	0.00
P-515	J-276	J-911	425.00	6	140.0	-80.61	0.91	0.26	0.61	0.00	0.00
P-516	J-911	J-284	800.00	6	140.0	-29.95	0.34	0.08	0.10	0.00	0.00
P-517	J-911	J-910	400.00	6	140.0	-50.66	0.57	0.10	0.26	0.00	0.00
P-518	J-910	J-456	200.00	6	140.0	-50.66	0.57	0.05	0.26	0.00	0.00
P-519	J-456	J-285	700.00	6	140.0	-50.66	0.57	0.18	0.26	0.00	0.00
P-520	J-360	J-452	175.00	6	120.0	4.86	0.06	0.00	0.00	0.00	0.00
P-522	J-364	J-360	400.00	6	120.0	47.86	0.54	0.12	0.31	0.00	0.00
P-523	J-913	J-290	400.00	6	140.0	-102.95	1.17	0.38	0.96	0.00	0.00
P-524	J-285	J-913	275.00	6	140.0	-34.87	0.40	0.04	0.13	0.00	0.00
P-525	J-913	J-912	400.00	6	140.0	1.50	0.02	0.00	0.00	0.00	0.00
P-529	PMP-1	R-2	10.00	12	120.0	0.01	0.00	0.00	0.00	0.00	0.00
P-600	J-602	J-601	450.00	6	120.0	4.86	0.06	0.00	0.01	0.00	0.00
P-601	J-322	J-602	350.00	6	120.0	-101.68	1.15	0.44	1.25	0.00	0.00
P-602	J-602	J-325	350.00	6	120.0	-111.40	1.26	0.52	1.48	0.00	0.00
P-700	WT-3	J-700	40.00	14	120.0	726.13	1.51	0.03	0.77	0.00	0.00
P-701	WT-1	J-700	40.00	14	120.0	726.13	1.51	0.03	0.77	0.00	0.00
P-800	J-313	J-314	375.00	10	120.0	-237.03	0.97	0.19	0.50	0.00	0.00
P-801	J-800	J-315	400.00	4	120.0	36.88	0.94	0.55	1.37	0.00	0.00
P-802	J-310	J-800	480.00	10	120.0	-236.74	0.97	0.24	0.50	0.00	0.00
P-803	J-800	J-314	20.00	10	120.0	-273.62	1.12	0.01	0.66	0.00	0.00
P-900	J-275	J-276	550.00	6	140.0	-71.50	0.81	0.27	0.49	0.00	0.00
P-901	J-446	J-900	1,600.00	6	120.0	332.05	3.77	17.86	11.17	0.00	0.00
P-950	J-900	J-950	2,025.00	6	120.0	299.65	3.40	18.69	9.23	0.00	0.00
P-999	J-950	WT-2	1,000.00	6	120.0	299.65	3.40	9.23	9.23	0.00	0.00
P-1000	J-289	J-913	400.00	6	140.0	-65.08	0.74	0.16	0.41	0.00	0.00

Scenario: No. 1 - EXISTING SYSTEM, MAXIMUM HOUR, 1726 POPULATION, PRVs ACTIVE
Steady State Analysis
Tank Report

Label	Zone	Base Elevation (ft)	Minimum Elevation (ft)	Initial HGL (ft)	Maximum Elevation (ft)	Tank Diameter (ft)	Current Status	Calculated Hydraulic Grade (ft)	Calculated Percent Full (%)	Elevation (ft)	Outflow (gpm)
WT-1	Zone1	6,955.00	6,955.00	7,025.00	7,055.00	40.00	Draining	7,025.00	70.0	6,955.00	726.13
WT-2	Zone3	6,914.00	6,914.00	6,914.00	6,921.50	34.00	Filling	6,914.00	0.0	6,914.00	-299.65
WT-3	Zone1	6,955.00	6,955.00	7,025.00	7,055.00	40.00	Draining	7,025.00	70.0	6,955.00	726.13

Scenario: No. 1 - EXISTING SYSTEM, MAXIMUM HOUR, 1726 POPULATION, PRVs ACTIVE
Steady State Analysis
Valve Report

Label	Elevation (ft)	Diameter (in)	Minor Loss Coefficient	Control Status	Discharge (gpm)	From HGL (ft)	To HGL (ft)	Headloss (ft)	Active?	Calculated Flow Setting (gpm)	Calculated Grade Setting (ft)	Calculated Headloss Coefficient Setting	Calculated Pressure Setting (psi)	Element Type
PRV-2	6,811.00	4	0.00	Throttling	121.12	7,008.36	6,994.98	13.37	true		6,994.92		79.60	PRV
PRV-4	6,787.00	10	0.00	Throttling	514.30	7,005.55	6,995.02	10.53	true		6,994.94		90.00	PRV
PRV-5	6,787.00	6	0.00	Throttling	14.76	7,004.54	6,995.02	9.52	true		6,994.94		90.00	PRV
PRV-6	6,787.00	6	0.00	Throttling	202.10	7,004.43	6,995.02	9.41	true		6,994.94		90.00	PRV
PRV-7	6,787.00	6	0.00	Throttling	304.73	7,004.54	6,995.02	9.52	true		6,994.94		90.00	PRV