DRAPER CITY

DRINKING WATER SYSTEM MASTER PLAN

(HAL Project No.: 160.08.100)

October 2008

HANSEN ALLEN & LUCE INC
ENGINEERS

DRAPER CITY

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Successful completion of this study was made possible by the cooperation and assistance of many individuals, including the Mayor of Draper City, City Council Members, and City Staff, as shown below. We sincerely appreciate the cooperation and assistance provided by these individuals.

DRAPER CITY

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GLOSSARY OF TECHNICAL TERMS

Average Daily Flow: The average yearly demand volume expressed in a flow rate.

Average Yearly Demand: The volume of water used during an entire year.

Build-out: When the development density reaches maximum allowed by planned development.

Demand: Required water flow rate or volume.

Distribution System: The network of pipes, valves and appurtenances contained within a water system.

Drinking Water: Water of sufficient quality for human consumption. Also referred to as Culinary or Potable water.

Dynamic Pressure: The pressure exerted by water within the pipelines and other water system appurtenances when water is flowing through the system.

Equivalent Residential Connection: A measure used in comparing water demand from non-residential connections to residential connections.

Fire Flow Requirements: The rate of water delivery required to extinguish a particular fire. Usually it is given in rate of flow (gallons per minute) for a specific period of time (hours).

Head: A measure of the pressure in a distribution system that is exerted by the water. Head represents the height of the free water surface (or pressure reduction valve setting) above any point in the hydraulic system.

Headloss: The amount of pressure lost in a distribution system under dynamic conditions due to the wall roughness and other physical characteristics of pipes in the system.

Peak Day: The day(s) of the year in which a maximum amount of water is used in a 24-hour period.

Peak Day Demand: The average daily flow required to meet the needs imposed on a water system during the peak day(s) of the year.

Peak Instantaneous Demand: The flow required to meet the needs imposed on a water system during maximum flow on a peak day.

Pressure Reducing Valve (PRV): A valve used to reduce excessive pressure in a water distribution system.

Pressure Zone: The area within a distribution system in which water pressure is maintained within specified limits.

Service Area: Typically the area within the boundaries of the entity or entities that participate in the ownership, planning, design, construction, operation and maintenance of a water system.

Static Pressure: The pressure exerted by water within the pipelines and other water system appurtenances when water is not flowing through the system, i.e., during periods of little or no water use.

Storage Reservoir: A facility used to store, contain and protect drinking water until it is needed by the customers of a water system. Also referred to as a Storage Tank.

Transmission Pipeline: A pipeline that transfers water from a source to a reservoir or from a reservoir to a distribution system.

Water Conservation: Planned management of water to prevent waste.

ABBREVIATIONS

ac-ft	acre-feet
DDW	The State of Utah Division of Drinking Water
ERC	Equivalent Residential Connection
GIS	Geographic Information System
gpd	Gallons per Day
gpd/conn	Gallons per Day per Connection
gpm	Gallons per Minute
HAL	Hansen, Allen & Luce, Inc.
JVWCD	Jordan Valley Water Conservancy District
MG	Million Gallons
PRV	Pressure Reducing Valve
psi	Pounds per Square Inch
SCADA	Supervisory Control And Data Acquisition

CHAPTER I

INTRODUCTION

PURPOSE

The purpose of this master plan is to provide specific direction to Draper City, based on City demand data and standards established by the Utah Division of Drinking Water (DDW), for decisions that will be made over the next 5 to 20 years to help the City provide adequate water to customers at the most reasonable cost.

SCOPE

The scope of this master plan includes a study of the City's drinking water system and customer water use including: build-out growth projections, source requirements, storage requirements, and distribution system requirements. From this study of the water system, an implementation plan with recommended improvements has been prepared. The implementation plan includes conceptual-level cost estimates for the recommended improvements.

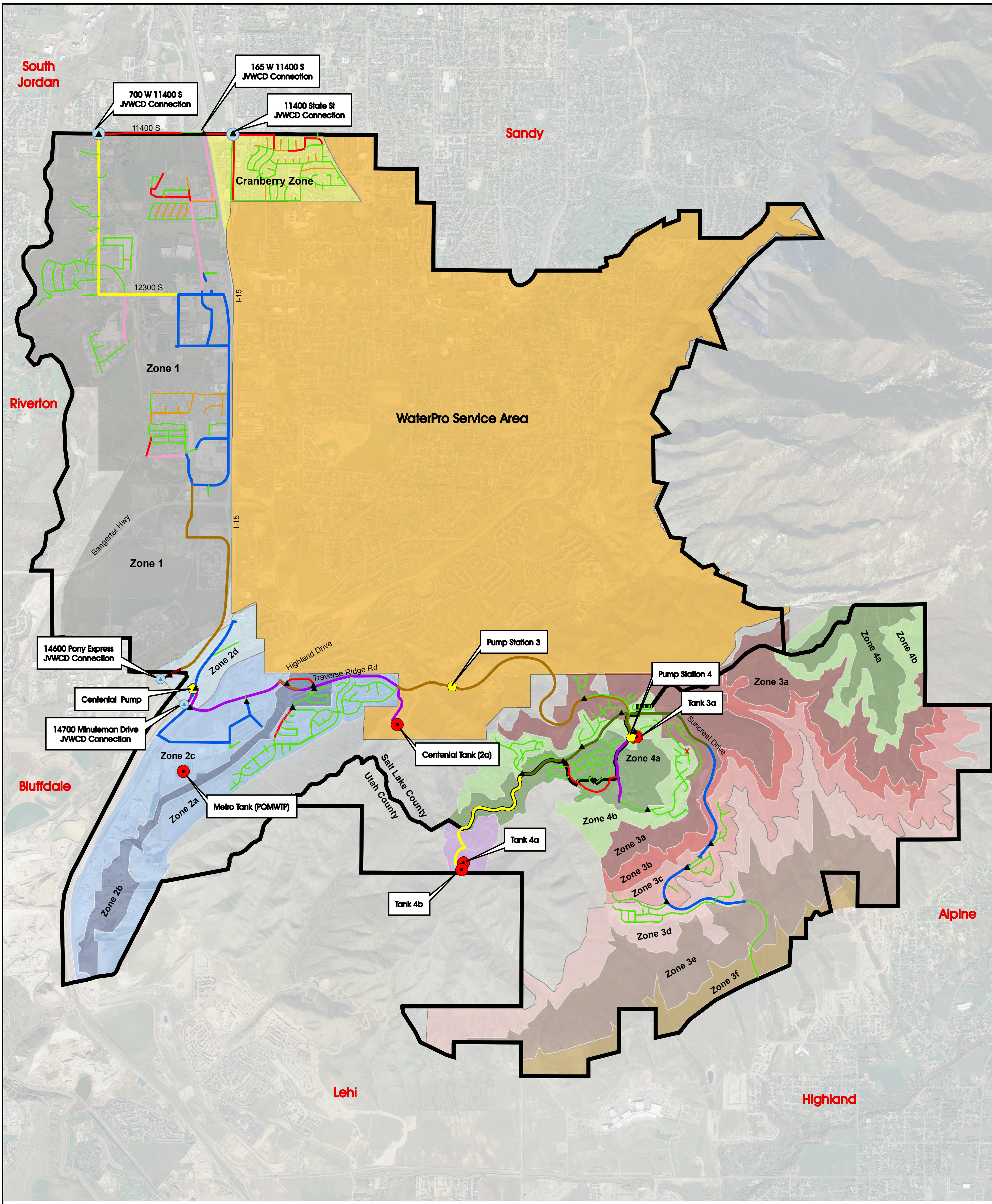
The conclusions and recommendations of this study are limited by the accuracy of the development projections and other assumptions used in preparing the study. It is expected that the City will review and update this master plan every 5-10 years, or more frequently if indicated by a significant change in development.

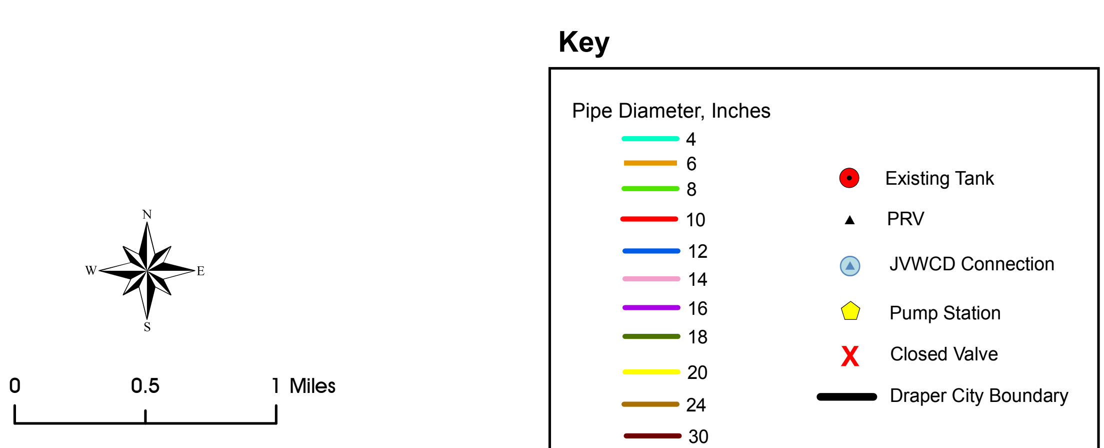
BACKGROUND

Draper City covers an area of approximately 30.2 square miles in Salt Lake and Utah Counties. Draper City does not supply the whole City with drinking water. WaterPro, a private water company, serves approximately 60 percent of the City in the center, north and east sides of the City. Draper City's water system serves west of I-15 and the south side of the City including South Mountain and Traverse Ridge. The service area of this master plan includes the area inside Draper City corporate boundaries that is served by the Draper City water system (see Figure I-1). The water system is divided into 4 main pressure zones each served by storage tanks. Other sub pressure zones are served by the tanks through Pressure Reducing Valves (PRVs). The Draper City water system contains approximately 60 miles of distribution pipe ranging in size from 6 to 30 inches in diameter, 650 fire hydrants, 1,100 valves and 5 water storage reservoirs totaling 9.1 million gallons. Water supply for the City's water system comes from the Jordan Valley Water Conservancy District (JVWCD).

WATER SYSTEM MASTER PLANNING APPROACH

Draper City's water system consists of water sources, storage facilities, and a distribution system. Water system components must be designed so they operate efficiently under a range of water demand requirements. The water system must be capable of responding to daily and seasonal variations in demand. Additionally, the system must have sufficient capacity for fire fighting and other emergency situations.





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DRAPER CITY

DRINKING WATER SYSTEM MASTER PLAN

EXISTING SYSTEM MAP

FIGURE I-1

Identifying present and future water system needs is essential for management and planning of water system facilities. For this study, present water needs were calculated from DDW requirements and compared with actual water use records (including billing data and Supervisory Control And Data Acquisition (SCADA) system data). The City's future water needs were predicted based on current demand requirements and on the anticipated demand at build-out. This report is organized to follow the outline of the DDW requirements found in section R309-510 of the Utah Administrative Code entitled "Minimum Sizing Requirements".

A computer model of the City's drinking water system was prepared and calculations were completed to analyze the performance of existing facilities with existing water demands and future predicted water demands at build-out. System improvement recommendations were prepared based on the analysis.

KEY SYSTEM DESIGN CRITERIA AND PERFORMANCE FINDINGS

A summary of the key water system design criteria and performance findings is included in Table I-1. The design criteria were used in evaluating system performance and in recommending future water system improvements. Table I-2 is a summary of the flows for and the ratio between: average day, peak day, and peak instantaneous.

TABLE I-1
KEY SYSTEM DESIGN CRITERIA AND RECOMMENDATIONS

	CRITERIA	2007 EXISTING REQUIREMENTS	ESTIMATED BUILD-OUT REQUIREMENTS
EQUIVALENT RESIDENTIAL CONNECTIONS	Calculated	4,210	15,600
SOURCE			
Peak Day Demand	Based on measured flow	5,400 gpm	18,300 gpm
Average Yearly Demand	Based on measured flow	3,773 ac-ft/year	14,000 ac-ft/year
STORAGE			
Equalization	½ Peak Day Demand	3.9 MG	13.3 MG
Fire Suppression	Highest fire flow volumes	2.2 MG	2.2 MG
Pump Operation	1/4 Pumped on Peak Day	0.5 MG	2.9 MG
Emergency	20 percent	1.3 MG	3.6 MG
Total		7.9 MG	22.0 MG
DISTRIBUTION			
Peak Instantaneous	Based on measured flow	10,800 gpm	36,600 gpm
Minimum Fire Flow	2,000 gpm at 40 psi	2,000 gpm	2,000 gpm
Max Operating Pressure	City Preference	150 psi	150 psi
Min. Operating Pressure	City Preference	50 psi	50 psi

TABLE I-2
DESIGN FLOW SUMMARY [1]

DEMAND	DEMAND PER ERC	TOTAL EXISTING DEMAND	TOTAL BUILD-OUT DEMAND	FLOW RATIO
Average Day	0.56 gpm	2,400 gpm	8,000 gpm	1.0
Peak Day	1.28 gpm	5,400 gpm	18,300 gpm	2.3
Peak Instantaneous	2.56 gpm	10,800 gpm	36,600 gpm	4.6

1. Average for all pressure zones

CHAPTER II

CONNECTIONS

EXISTING CONNECTIONS

The City currently has about 3,550 connections, with about 3,350 being residential and the remaining 200 being non-residential. The City maintains a monthly updated Geographical Information System (GIS) data base of water use at each water meter. This data base contains the individual water use history of every connection in the system. An Existing Equivalent Residential Connection (ERC) is a measure used in comparing water demand from non-residential connections to residential connections. ERCs were calculated for each main pressure zone to compare water use and to aid in the assignment of demands in the build-out model. Table II-1 is a summary of ERCs by pressure zone. Total existing ERCs for the City were estimated to be **4,210** in 2007.

TABLE II-1
2007 EXISTING ERCs

PRESSURE ZONE	ERCs
1	2,000
2	1,260
3	270
4	680
TOTAL	**4,210**

Using the GIS water meter use database, the active residential accounts were selected by Zone and the total water use for the year was divided by the number of selected accounts to get the average water use per residential connection for the pressure zone. The total water use for the year for the pressure zone was then divided by this average water use per residential connection to get the number of ERCs in the pressure zone. Water meter use data from September 2006 through August 2007 was used for this study.

CONNECTIONS PROJECTED AT BUILD-OUT

The GIS meter water use database was used with the GIS databases of Parcels, Zoning, and Potentially Developable Areas to estimate the future potential number of ERCs at build-out. Undeveloped residential zoned parcels and residential parcels with potential to be redeveloped before build-out were divided by the units per acre allowed by the City's Development Code (see Table II-2). Existing developed residential parcels that were too small to feasibly be subdivided according to the current zoning ordinance were left unchanged. It was assumed that existing subdivisions and developments would not be redeveloped to the maximum density allowed by the zoning ordinance. A twenty five percent reduction for roads and public right-of-way was assumed for larger lots when calculating potential units for a parcel. The number of potential

ERCs from undeveloped non-residential zoned parcels were calculated by using the ratio of ERCs per acre of parcels with the same zoning in existing non-residential areas in the City. Table II-3 includes the number of ERCs estimated for each pressure zone for build-out conditions.

TABLE II-2
ZONING DENSITIES USED TO CALCULATE BUILD-OUT ERCs

Zoning	Units / Acre
Agricultural	2.5
R3	2.5
RA1	0.8
RA2	1.6
RM1	8.0
RM2	12.0
RM	12.0
RR-22	2.5
RR-43	2.5
Commercial/Public	2.0
Manufacturing	5.0

TABLE II-3
BUILD-OUT ERC COUNT

ZONE	ERC
1	7,000
2	2,100
3	3,750
4	2,750
TOTAL	**15,600**

CHAPTER III

SOURCES

EXISTING SOURCES

The City's sole source of water comes from wholesale connections from JVWCD, which are all located in Zone 1. Therefore, all drinking water required in Pressure Zones 2 through 4 must be pumped with booster stations. The locations of the JVWCD connections and booster stations are included on Figure I-1.

JVWCD Connections

The City has 4 active metered wholesale connections from JVWCD and one currently under construction. The flow capacity of each connection with JVWCD is listed in Table III-1. "Physical Flow Capacity" represents system capacity based on SCADA data and the water model. "Contract Peak Day Maximum" are values in the contract between the City and JVWCD, and represent values closer to actual use. Figure III-1 illustrates the flow from the active JVWCD connections on the Peak Day, July 17^{th}, 2007.

The City is currently constructing a new JVWCD connection at 14600 South and Pony Express Road just west of I-15. This new connection will serve Zone 1 and will have a capacity of about 12,000 gpm. Another future JVWCD connection is planned at 14600 South just east of I-15 near the existing Centennial Pump Station. This new connection will be incorporated in a new parallel booster station with the existing Centennial Pump Station.

TABLE III-1
JVWCD CONNECTIONS

CONNECTION	PHYSICAL FLOW CAPACITY [1] gpm	CONTRACT PEAK DAY MAXIMUM gpm
700 W 11400 S	4,000	1,000
165 W 11400 S	3,000	1,000
11400 State Street	2,500	900
14700 Minuteman Dr.	6,000	1,700
14600 S Pony Express	12,000	NA [2]
TOTAL	**27,500**	**4,602**

1. Maximum flow capacity based on SCADA data and the water model.
2. This connection is under construction as of the date of this report: value unknown.

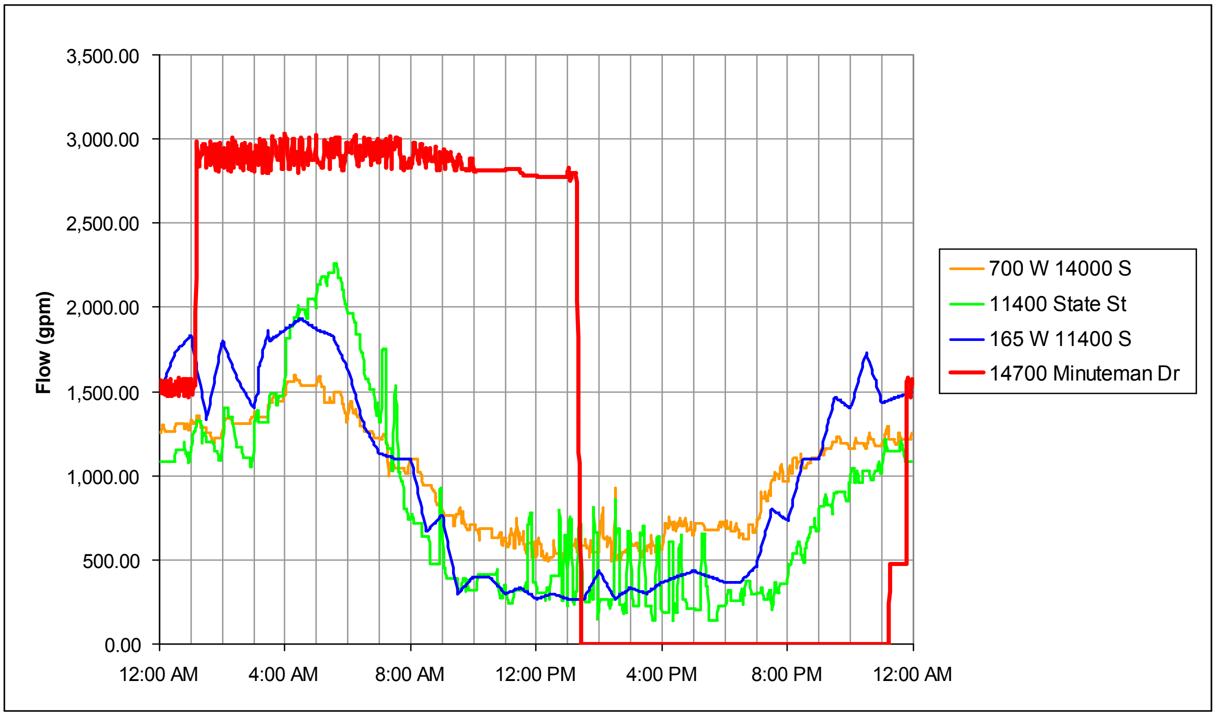


FIGURE III-1 Flow from the JVWCD Connections on the Peak Day, July 17, 2007.

Pump Stations

The City has three existing booster stations. The Centennial Pump Station boosts water from Zone 1 to Zone 2, Pump Station 3 boosts water from Zone 2 to Zone 3, and Pump Station 4 boosts water from Zone 3 to Zone 4. The rated safe capacity of the pump stations was evaluated by assuming that the largest pump is out of service to account for redundancy (Sanks, 1989; Utah R309-540-5(4)(b)). In addition, the rated capacity was further reduced by a safety factor of 25% (Utah R309-540-5(3)(a)(i)). This safety factor is arbitrary and is recommended as a minimum value for the Draper City drinking water system. The safety factor reduction accounts for fluctuations in peak day demand verses how many hours the booster station should be expected to pump in a 24 hour period. These reductions in capacity are particularly important because each booster pump station is the only source of water for the portion of the water system served. Although the existing booster stations are entirely functional with the existing arrangement of pump sizes, the City may want to consider redesigning the pump sizes to arrive at a rating which is more appropriate. Total existing flow capacity and the recommended rated flow capacity is presented in Table III-2.

TABLE III-2
BOOSTER PUMP STATION CAPACITIES

NAME	MAXIMUM FLOW CAPACITY gpm	RATED FLOW CAPACITY [1] gpm
Centennial Pump Station	3,000	2,240
Pump Station 3	3,000	1,200
Pump Station 4	4,775	1,160
TOTAL	**10,775**	**4,600**

1. Rated capacity is the total capacity reduced by the capacity of the largest pump plus a safety factor of 1.25

The pump stations currently do not have backup power supply capability as required by the DDW (Utah R309-540-5(6)(f)). Short power outages of less than a few hours would not result in a water outage, since the water storage reservoirs would keep the mainlines full. Should power outages last longer than 24 hours, however, outages would probably occur in the water system. Backup power capability at each of the booster stations would allow the City to keep the water system in operation.

EXISTING SOURCE REQUIREMENTS

According to DDW standards, water sources must be able to meet the expected water demand for two conditions. First, the water sources must be able to provide an adequate supply of water for the peak day demand. Second, the water sources must also be able to produce one year's supply of water, or the Average Yearly Demand.

Existing Peak Day Demand

Peak day demand is the water demand on the day of the year with the highest water use. The peak day demand is used to determine required source water capacity under existing and build-out conditions. July 17, 2007 was the day chosen to represent Peak Day Demand because it was a day high demand was anticipated and complete data was collected. Figure III-2 is a plot of total water use in the City on July 17, 2007. The demand flow is highest in the early morning at about 5:00 am and again at about 10:00 pm. The lowest period is during the middle of the day at about 4:00 pm. This pattern of high water use at night is most likely due to automatic sprinklers and a City ordinance encouraging outdoor watering to occur at night. The actual measured peak day flow on July 17, 2007 was 4,910 gpm. For master planning purposes, existing peak day demand includes an additional ten percent safety factor. The resulting total existing peak day demand was estimated to be **5,400 gpm.**

Existing source requirements and capacities for each pressure zone are summarized in Table III-3. The "Zone Demand (gpm)" column is the actual demand measured for each zone on the Peak Day, July 17, 2007, plus 10 percent. The "Zone Demand (gpm/ERC)" column is the average demand per ERC calculated from the measured data for each zone on the Peak Day and the number of ERCs calculated for each Zone using the GIS meter water use data. The "ERCs" column is calculated by dividing the "Zone Demand (gpm)" column by the "Zone Demand (gpm/ERC)" column. The "Demand for Other Zones" column is the flow required for zones located higher in the system; which are served by the zone referenced.

A total of 2,809 gpm is needed to meet existing demands in Zone 1, plus 2,591 gpm is needed to be pumped up to the other zones. The "Existing Source Capacity (gpm)" for Zone 1 is split into "Maximum" capacity and "Rated" capacity. The "Maximum" capacity is the JVWCD wholesale connection physical maximum capacity which is about 15,500 gpm, leaving a "Capacity Remaining (gpm)" of about 10,100 gpm. The "Rated" capacity is the JVWCD contract peak day maximum which is currently 4,600 gpm, leaving a deficit "Capacity Remaining (gpm)" of 800 gpm. The "Existing Source Capacity (gpm)" for pressure zones 2 through 4 is also split into "Maximum" capacity and "Rated" capacity. The "Maximum" capacity for pressure zones 2 through 4 is the "Maximum Flow Capacity (gpm)" of the pump stations found in Table III-2. The "Rated" capacity for pressure zones 2 through 4 is the "Rated Flow Capacity (gpm)" of the pump stations found in Table III-2.

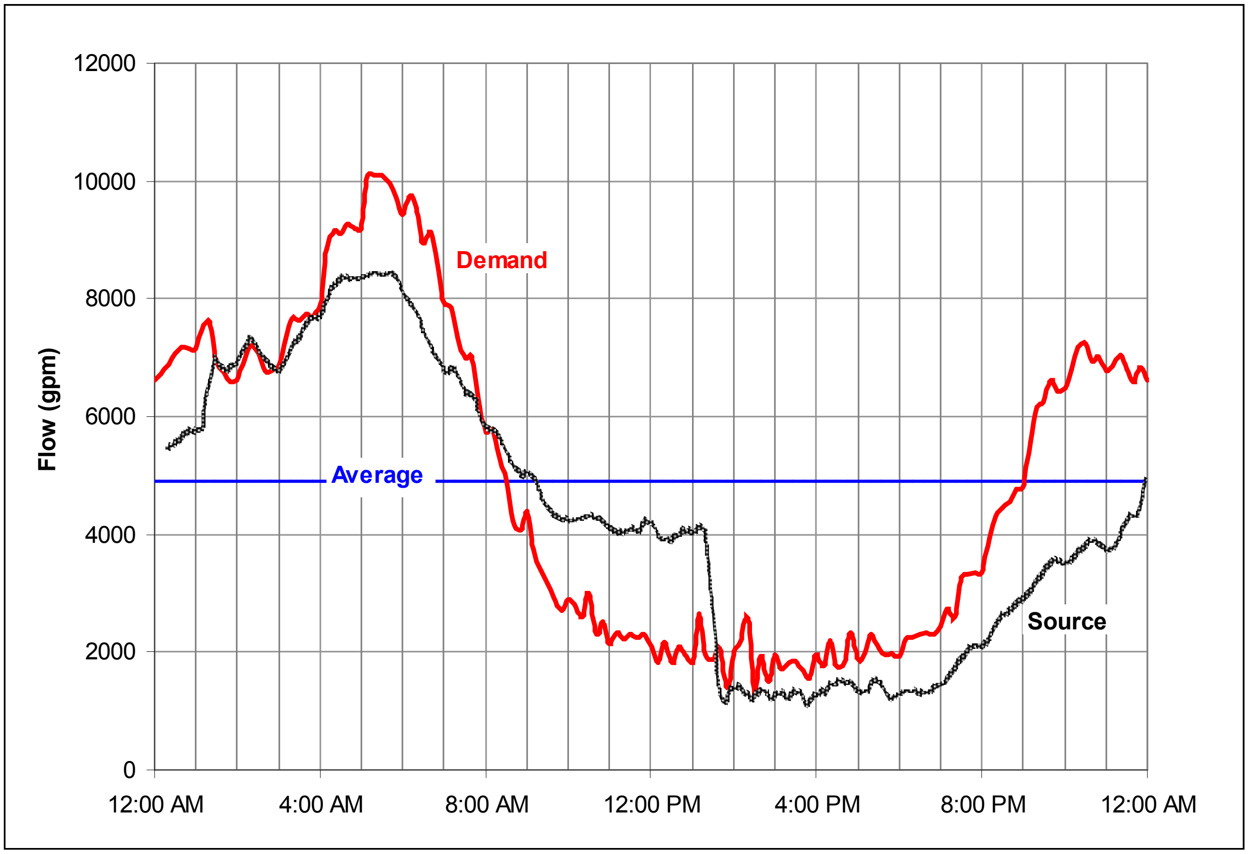


FIGURE III-2 Water use on the Peak Day, July, 17, 2007

TABLE III-3
EXISTING SOURCE REQUIREMENTS

ZONE	EXISTING SOURCE (PEAK DAY) DEMAND					EXISTING SOURCE CAPACITY (gpm)		CAPACITY REMAINING (gpm)	
	ERCs [1]	Zone [2] Demand (gpm/ERC)	Zone [2] Demand (gpm)	Demand for [2] Other Zones (gpm)	Total (gpm)	Max.	Rated	Max.	Rated
1	2,000	1.4	2,809	2,591	5,400	15,500	4,600 [3]	10,100	-800
2	1,260	1.4	1,764	827	2,591	3,000	2,240 [4]	409	-351
3	270	0.8	216	611	827	3,000	1,200 [4]	2,173	373
4	680	0.9	611	0	611	4,775	1,160 [4]	4,164	549
TOTAL	**4,210**	**NA**	**5,402**	**NA**	**9,429**	**26,275**	**9,200**	**16,846**	**-229**

1. "Zone Demand (gpm)"/"Zone Demand (gpm/ERC)." The residential average yearly water use based on billing data was divided by the number of residential billing accounts to calculate the number of ERCs for each zone.
2. The demands are based on SCADA data collected on July 17th ,2007 to represent the peak day and increased by 10% to account for annual variations in the peak day demand.
3. JVWCD contract Peak Day maximum.
4. Existing source capacity is based on pump station capacity assuming the largest pump out of service to account for redundancy and assuming a safety factor of 1.25.

Existing Average Yearly Demand

Average yearly demand is the volume of water used during an entire year. It is used to ensure the sources have enough volume to meet demand. All of Draper City's water comes from JVWCD. For the year 2008, Draper City's minimum contract volume amount is 3,100 ac-ft. This amount is the minimum contract amount that the City must use, or they have to pay JVWCD whether they use it or not. The Average Yearly Demand for 2007 was **3,773 ac-ft**. The City's contract with JVWCD states that the City can go up to 20% over their minimum amount in a year without written approval. The City should monitor the Average Yearly Demand to make sure the JVWCD contract is neither too high or too low to responsibly meet the needs of the City's drinking water system.

BUILD-OUT SOURCE REQUIREMENTS

As with existing water source requirements, future water source needs were evaluated based on two criteria. First, sufficient water source capacity is needed to meet peak day flow. Second, the water sources must also be capable of supplying the average yearly demand.

Build-Out Peak Day Demand

The projected peak day demand at build-out is **18,500 gpm** (see Table III-4). The "ERCs" column is the estimated number of ERCs for each Pressure Zone at build-out, as presented in Chapter II. The "Zone Demand (gpm/ERC)" column is the existing average demand per ERC calculated from the measured data for each zone on the Peak Day, July 17, 2007. The "Zone Demand (gpm)" column is calculated by multiplying the "ERCs" column with the "Zone Demand (gpm/ERC)" column to get the estimated demand needed for build-out. The "Demand for Other Zones" column is the flow required for above zones. For example, all the source for the entire system is needed in Zone 1. A total of 9,800 gpm is needed to meet existing demands in Zone 1 plus 8,500 gpm is needed in Zone 1 to be pumped up to the other zones. The "Existing Source Capacity (gpm)" for Zone 1 is the JVWCD wholesale connection capacities. The capacity of the existing JVWCD connections is about 15,500 gpm. Adding the new JVWCD connection currently under construction adds an additional 12,000 gpm for a total capacity in Zone 1 of 27,500 gpm. For Pressure Zones 2 through 4 the "Existing Source Capacity (gpm)" is the rated capacity of the pump stations.

Build-Out Average Yearly Demand

The projected average yearly demand at build-out is **14,000 ac-ft**, assuming water continues to be used in the same pattern as Draper City customers are using water now. It is recommended that the City monitor the Average Yearly Demand to make sure the JVWCD contract is neither too high or too low to responsibly meet the needs of the City's drinking water system.

TABLE III-4
BUILD-OUT SOURCE REQUIREMENTS

ZONE	EXISTING SOURCE (PEAK DAY) DEMAND					EXISTING SOURCE CAPACITY (gpm)		ADDITIONAL CAPACITY NEEDED (gpm)	
	ERCs [1]	Zone [2] Demand (gpm/ERC)	Zone [2] Demand (gpm)	Demand for [2] Other Zones (gpm)	Total (gpm)	Max.	Rated	Max.	Rated
1	7,000	1.4	9,800	8,500	18,300	15,500	4,600 [3]	2,800	13,700
2	2,100	1.4	3,000	5,500	8,500	3,000	2,240 [4]	5,500	6,260
3	3,750	0.8	3,000	2,500	5,500	3,000	1,200 [4]	2,500	4,300
4	2,750	0.9	2,500	0	2,500	4,775	1,160 [4]	-2,275	1,340
TOTAL	**15,600**	**NA**	**18,300**	**NA**	**34,800**	**27,475**	**9,200**	**16,846**	**-229**

1. "Zone Demand (gpm)"/"Zone Demand (gpm/ERC)." The residential average yearly water use based on billing data was divided by the number of residential billing accounts to calculate the number of ERCs for each zone.
2. The demands are based on SCADA data collected on July 17th ,2007 to represent the peak day and increased by 10% to account for annual variations in the peak day demand.
3. JVWCD contract Peak Day maximum.
4. Existing source capacity is based on pump station capacity assuming the largest pump out of service to account for redundancy and assuming a safety factor of 1.25.

SOURCE REDUNDANCY

Source redundancy can be defined as the duplication of the source water and a duplication of critical components of the water system that supply the source of water to the system usually in the form of backup. Within the Draper City water system the booster pump stations are the only source of water for the portion of the water system the stations serve. Redundancy and backup of the booster stations include a backup pump and a backup power supply to increase the reliability of the system. Outside of the Draper City water system JVWCD is the sole source of water. Even though JVWCD has redundancy in their own system to supply water to Draper City, the City's water system would be vulnerable to shortages or water outages if the source of water from JVWCD is interrupted for any reason.

One source redundancy option is to establish emergency water interconnections with other nearby water suppliers would help to decrease the City's vulnerability to water outages due to system failures. This option is generally a good practice for water supply agencies because it gives the system operators more flexibility in dealing with system failures or scheduled system shut downs. Two system interconnection options discussed in this section are interconnections with WaterPro and Interconnections with other water suppliers in North Utah County.

Another source redundancy option would be for the City to develop their own new water sources to serve as backup for the water system. This source redundancy option is discussed further in the following section entitled New Water Resources.

Interconnections with WaterPro

A meeting with City staff and WaterPro staff was held to discuss increasing the reliability of both systems through the use of interconnections. Three new interconnections with WaterPro were identified as being advantageous to both Draper City and WaterPro:

- 11400 South 700 East - Would provide emergency backup to Draper City's Cranberry area, which currently has only one source from a JVWCD meter station
- Pony Express Road (west freeway frontage road) at 13800 South - Would provide emergency backup on a two way flow basis to both Draper City and WaterPro
- Minuteman Road (east freeway frontage road) at 14200 South - Would provide emergency backup on a two way flow basis to both Draper City and WaterPro

These connections would be designed to provide emergency water supply in the event of mainline breaks or other water emergencies. In normal day-to-day operations, these interconnections would remain closed. The interconnections would have meters to record the volumes of water used when the interconnections are opened.

Interconnections with Other Water Suppliers in North Utah County

Another option that may merit investigation would be for Draper City to approach nearby existing water suppliers in northern Utah County, about creating interconnections for emergency water supply backup as a mutual benefit to both parties.

One potential difficulty with this option is that Draper City's water supply to Zones 2 through 4 is currently supplied from JVWCD located in Salt Lake County, where fluoridation is mandated. Water service in Salt Lake County cannot have un-fluoridated water, so this issue would need to be addressed.

NEW WATER RESOURCES

A preliminary water resources plan was completed to identify other potential sources of water that Draper City could investigate further. After several discussions were had with City staff, State Division of Water Rights staff, and staff from other water agencies, the following were options selected by the City as the most desirable.

Draper City Groundwater Development Program

Draper City could consider purchasing existing wells or investigate the feasibility of drilling new wells in the City. In a water system emergency, a City owned source could be very valuable in terms of providing an alternative source of water to the system.

Before embarking on this option, it is important for the City to understand that a groundwater development program is not assured of success. Groundwater development programs typically involve many years of planning along with a major investment of financial resources. This is particularly true where the City would be starting with no water rights. A typical list of activities for developing a successful groundwater development program would include the following:

- Hydrogeologic investigation to determine the feasibility for well drilling opportunities, with consideration for water quantity and water quality
- Water rights search for rights that the City could lease or purchase
- Water rights transfer feasibility with respect to the groundwater management plan for the Salt Lake Valley
- Drinking water source protection planning
- Other regulatory approvals
- Property acquisition
- Well drilling
- Pump station construction
- Water treatment facilities including chlorination and fluoridation
- Operator training

It is recommended that the City first weigh carefully the long term potential cost and benefits before proceeding with this option. If the City decides to proceed, it is recommended that an initial study be conducted to investigate the feasibility of this option including hydrogeologic, legal, and economic factors.

JVWCD Groundwater Development in North Utah County

JVWCD has invested years of planning towards development of groundwater sources in northern Utah County, specifically for the benefit of Draper City. JVWCD has prepared water rights filings and has purchased several pieces of land for potential future well drilling sites, two of which are located within Draper City limits in Utah County. JVWCD is currently working with Central Utah Project (CUP) to obtain groundwater rights from CUP as part of CUP's water project in northern Utah County, and has earmarked 3,000 acre feet of water to be potentially used for Draper City.

Unfortunately, JVWCD encountered significant public opposition during the public hearing phase of water rights change applications, so JVWCD is reevaluating the feasibility of this project. If JVWCD decides to move ahead, Draper City could use this source on the Utah County side Traverse Ridge. Booster stations would have to constructed to lift the water up to the City's distribution system.

Utah County Booster Stations

In order for the Utah County supply options to benefit Draper, booster stations would need to be constructed on the Utah County side of Traverse Mountain.

SOURCE RECOMMENDATIONS

The following are recommended source projects.

Centennial Pump Station

The Centennial Pump Station currently has a rated capacity of 2,240 gpm and the existing peak day demand to be pumped by the Centennial Pump Station is 2,591 gpm. It is recommended that the Centennial Pump Station be upgraded to be able to meet existing and future demand with full redundancy and safety factor. The build-out rated capacity should be at least 8,500 gpm. It is also recommended that a generator be available for the pump station in case of a power outage.

Pump Station 3

Pump Station 3 currently has a rated capacity of 1,200 gpm, and the existing peak day demand needed is 827 gpm. However, the peak day demand predicted for build-out is estimated to be 5,500 gpm. It is recommended that City monitor the peak day demand needed for Zone 3 and upgrade Pump Station 3 to be able to meet future demand with full redundancy and safety factor before it is needed. It is also recommended that a generator be available for the pump station in case of a power outage.

Pump Station 4

Pump Station 4 currently has a rated capacity of 1,160 gpm, and the existing peak day demand needed is 611 gpm. The peak day demand predicted for build-out is estimated to be about 2,500 gpm. It is recommended that the City monitor the peak day demand needed for Zone 4 and consider modifying Pump Station 4 to be able to meet future demand with full redundancy and safety factor. The peak day needed for build-out could not be met by the existing pump station if the largest pump went offline. It is also recommended that a generator be available for the pump station in case of a power outage.

Peaking Flow Control Valves

It is recommended that the City install flow control valves on the 165 West 11400 South and 700 West 11400 South JVWCD connections to control peaking from JVWCD into Zone 1. JVWCD imposes peaking factor fees to reflect peak usage through their wholesale connections. The flow control valves will give the City control over peaking through the existing meter stations and force peaking to occur on the new 14600 South JVWCD connection, where the City would rather have peaking occur from the 5 MG storage at the POMWTP.

Source Redundancy

It is recommended that the City work with WaterPro to construct the three metered system interconnections mentioned in this section. It is recommended that the City work towards the possibility of constructing backup water supply interconnections with other existing water suppliers as well.

New Water Resources

It is recommended that the City give consideration to whether or not to pursue groundwater development programs in Salt Lake and/or Utah Counties.

CHAPTER IV

STORAGE

EXISTING STORAGE

The City's current drinking water system includes five storage facilities (see Table IV-1). Total existing storage capacity is 9.1 million gallons (MG). Four of the tanks are underground reinforced concrete tanks owned by Draper City. Draper City also has purchased 5.0 MG of storage at the Metropolitan Water District of Salt Lake and Sandy--Point of the Mountain Water Treatment Plant (Metro Tank). This storage will be connected to the City's water system via the new JVWCD meter station which is being constructed at 14600 South Pony Express Road.

The location of storage facilities are on Figure III-1. Figure IV-1 is a plot of water level fluctuations in the City's storage facilities on the peak day, July 17, 2007.

TABLE IV-1
EXISTING STORAGE

Storage Facility	PRESSURE ZONE	STORAGE (MG)
Tank 4a	4	1.0
Tank 4b	4	1.4
Tank 3a	3	0.5
Centennial Tank (Tank 1)	2	1.2
Metro Tank	1	5.0
TOTAL		**9.1**

EXISTING STORAGE REQUIREMENTS

According to DDW standards, storage tanks must be able to provide: 1) equalization storage volume to make up the difference between the peak day flow rate and the peak instantaneous demand; 2) fire suppression storage volume to supply water for fire fighting; and 3) emergency storage, if deemed necessary. In addition, it is recommended that tanks with booster stations pumping out of the pressure zone have pump operation storage to allow storage volume to fluctuate as source is pumped into and out of the zone. Each of these requirements are addressed in the following discussion.

Equalization Storage

The need for equalization storage is highest during the irrigation season on days of peak water use. Equalization storage is used to meet peak demands during the time when demand exceeds the capacity of the sources. Based on actual use data and the computer model, the greatest amount of equalization storage is required on the peak day. Given the typical demand curve

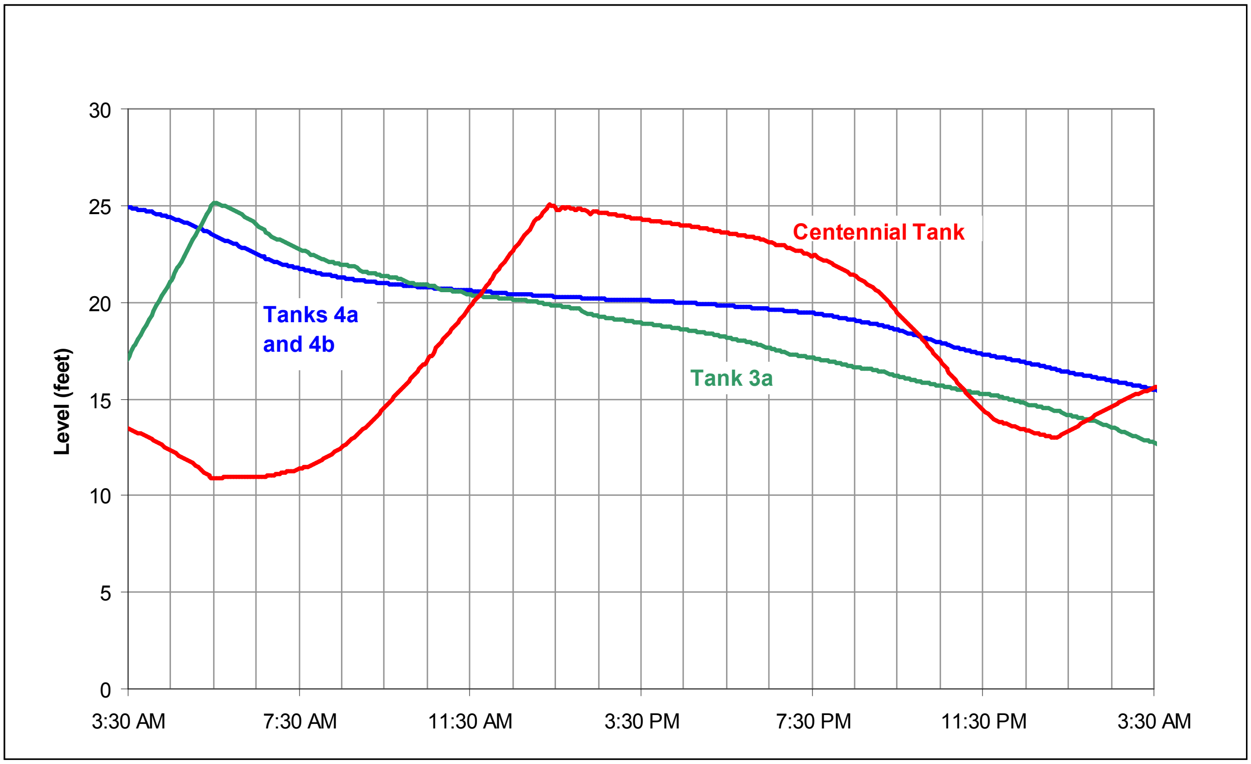


FIGURE IV-1 Water level fluctuations on the Peak Day, July 17, 2007

for Draper City and the various booster pump set points to be able to use the greatest amount of storage, the most equalization the system can use is about one half the peak day demand which is about Average Day Demand. It is recommended that one half the peak day demand be used to calculate the required equalization storage. This value includes a safety factor of 2.0 to help cover equalization storage demand variations and emergencies. The total existing equalization storage requirement was estimated to be **7.9 MG.** A summary of existing equalization storage requirements by pressure zone is included in Table IV-2.

Fire Suppression Storage

Fire suppression storage is required for water systems that provide water for fire fighting. The minimum fire suppression storage value of **2,000 gpm for 2 hours** for Draper City's water system was selected based on discussions with the Unified Fire Authority. Larger fire flows are required for larger structures throughout the system based on the International Fire Code and the Unified Fire Authority recommendations. Assumed fire flow requirements by pressure zone are presented in Table IV-2 and Table IV-3. The amount of fire flow assumed by storage tank is presented in Table IV-4.

The water system should be managed so that the storage volume dedicated for fire suppression is available to meet fire flow requirements whenever or wherever it is needed. This can be accomplished by designating minimum storage tank water levels that provide a reserve storage equal to the fire suppression storage required. Even though it is important to utilize equalization storage, typical daily water fluctuations in the tanks should not be allowed below the minimum established levels except during fire or emergency situations.

TABLE IV-2
EXISTING STORAGE REQUIREMENTS

ZONE	RECOMMENDED STORAGE REQUIREMENTS						EXISTING STORAGE	EXISTING STORAGE CAPACITY REMAINING
	ERCs	Equalization (MG) [1]	Pump Operation (MG) [2]	Fire Suppression (MG)	Emergency Storage [7] (MG)	Total (MG)	Total (MG)	(MG)/(ERCs [8])
1	2,000	2.0	0.0 [3]	1.0 [4]	0.6	3.6	5.0	1.4 /1,400
2	1,260	1.3	0.3	0.6 [5]	0.4	2.6	1.2	-1.4/(-1,400)
3	270	0.2	0.2	0.0 [6]	0.1	0.5	0.5	0/0
4	680	0.4	0.0	0.6 [6]	0.2	1.2	2.4	1.2/1,900
TOTAL	4,210	3.9	0.5	2.2	1.3	7.9	9.1	1.2/1,900

1. Half of the peak day demand shown in Table III-3 or Average Day Demand.
2. 1/4 of the pumped peak day flow rate for the next higher zone.
3. No pump operation assumed for Zone 1 because Centennial Pump Station pumps directly out of a JVWCD connection.
4. Fire flow 4,000 gpm for 4 hours.
5. Fire flow 3,500 gpm for 3 hours.
6. Fire flow from the SunCrest Master Plan (3,500 gpm for 3 hours) stored in Zone 4.
7. 20% of equalization + pump operation + fire suppression.
8. Surplus divided by equalization storage per ERC.

TABLE IV-3
FIRE FLOW DEMAND BY PRESSURE ZONE

PRESSURE ZONE	REQUIRED FIRE FLOW (gpm)	FIRE FLOW DURATION (Hours)	FIRE FLOW VOLUME (MG)
1	4,000	4	1.0
2	3,500	3	0.6
3	3,500	3	0.6
4	3,500	3	0.6

TABLE IV-4
EXISTING FIRE SUPPRESSION STORAGE BY STORAGE FACILITY

STORAGE FACILITY	FIRE SUPPRESSION STORAGE REQUIREMENT (MG)
Tank 4a	0.3
Tank 4b	0.3
Tank 3a	0.0
Centennial Tank (Tank 1)	0.6
Metro Tank	1.0
TOTAL	**2.2**

Emergency Storage

DDW standards suggest that emergency storage be considered in the sizing of storage facilities. Emergency storage is intended to provide a safety factor that can be used in the case of unexpectedly high demands, pipeline failures, equipment failures, electrical power outages, water supply contamination, or natural disasters. It is recommended that an additional 20 percent of the sum of the other storage requirements be added as emergency storage. A summary of existing emergency storage requirements by pressure zone is in Table IV-2.

Pump Operation Storage

It is recommended that pump operation storage be included in pressure zones that have water pumped out of the zone to a zone higher in elevation. Booster stations create a large demand on the zone as they pump out of the zone at any time of the day. Pump operation storage allows the tank that feeds the zone to fluctuate to meet this demand without affecting other storage needs. It is recommended that the required pump operation storage be calculated by taking a fourth of the pumped volume on the peak day. This pumped volume is based on modeled values with a safety factor of 2.0. Actual needed pump operation storage used can vary depending on demand and pump control set points. Zone 1 does not require any pump operation storage because the Centennial Pump Station pumps directly out of a JVWCD connection. A summary of existing pump operation storage requirements by pressure zone is included in Table IV-2.

BUILD-OUT STORAGE REQUIREMENTS

The storage volumes required at build-out are based on the same equalization, fire suppression, pump operation, and emergency storage requirements as were calculated for existing conditions. The City's future storage requirements at build-out are presented in Table IV-5.

TABLE IV-5
BUILD-OUT STORAGE REQUIREMENTS

ZONE	RECOMMENDED STORAGE REQUIREMENTS						EXISTING STORAGE	STORAGE DEFICIT (MG)
	ERCs	Equalization (MG) [1]	Pump Operation (MG) [2]	Fire Suppression (MG)	Emergency Storage [7] (MG)	Total (MG)	Total (MG)	
1	7,000	7.1	0.0 [3]	1.0 [4]	1.6	9.7	5.0	4.7
2	2,100	2.2	2.0	0.6 [5]	1.0	5.8	1.2	4.6
3	3,750	2.2	0.9	0.6 [6]	0.7	4.4	0.5	3.9
4	2,750	1.8	0.0	0.6 [6]	0.5	2.9	2.4	0.5
TOTAL	15,600	13.3	2.9	2.8	3.6	22.8	9.1	13.7

1. Half of the peak day demand shown in Table III-4.
2. 1/4 of the pumped peak day flow rate for the next higher zone.
3. No pump operation assumed for Zone 1 because Centennial Pump Station pumps directly out of a JVWCD connection.
4. Fire flow 4,000 gpm for 4 hours.
5. Fire flow 3,500 gpm for 3 hours.
6. Fire flow from the SunCrest Master Plan (3,500 gpm for 3 hours).
7. 20% of equalization + pump operation + fire suppression.

STORAGE RECOMMENDATIONS

Currently the City has 9.1 MG of storage and a calculated storage requirement of 7.9 MG. Currently Zone 2 is the only Zone with deficient storage to existing storage requirements. The following four storage projects are recommended.

Zone 1 Storage

Zone 1 currently has sufficient storage for existing conditions with storage in the Metro Tank at the Point of the Mountain Treatment Plant. For build-out, however, it is estimated that another 5 MG is needed. It is recommended that the City consider either building a 5 MG tank to serve new growth in Zone 1, or, if this is not feasible, simply accepting the additional peaking charges from use of JVWCD's storage facilities. Currently the peaking fee is low and does not justify the cost of a new storage reservoir. A Zone 1 storage feasibility study is warranted to assist the City in making this decision.

Zone 2 Storage

Zone 2 currently does not have sufficient storage for existing demands. It is recommended that the City build at least a 2 MG storage reservoir immediately. A site review is needed to determine the most appropriate location for the recommended Zone 2 storage. By build-out it is predicted that a total of 4.6 MG of new storage is needed in addition to the existing 1.2 MG tank.

Zone 3 Storage

Currently Tank 3 is just large enough for existing development if fire suppression storage is assumed to be provided by Tank 4a and 4b. Another 3.9 MG is predicted for build-out for Zone 3 if fire suppression storage is assumed in Zone 3. At least 2.0 MG should be built at the "Tank 3b" site next to Tank 3a. The remaining 2.0 MG should be split between other possible Zone 3 tank sites. Splitting up the location of the Zone 3 storage allows for smaller transmission lines in Zone 3 because peak day flow is the highest flow that needs to be transported to the remote Zone 3 tank sites instead of peak instantaneous or peak day plus fire flow.

Zone 4 Storage

Zone 4 currently has sufficient storage for existing conditions with Tank 4a and Tank 4b. For build-out, however, it is predicted that another 0.5 MG is needed. It is recommended that the City build a 0.5 MG tank to serve Zone 4. Other options include: limiting development in Zone 4 to 1,900 ERCs, assume no emergency storage in Zone 4, or build a 0.5 MG tank as part of a proposed future Zone 5 development.

CHAPTER V

DISTRIBUTION SYSTEM

EXISTING DISTRIBUTION SYSTEM

The distribution system consists of all pipelines, valves, fittings, and other appurtenances used to convey water from the water sources and storage tanks to the water users. The existing water system contains over 60 miles of distribution pipe ranging in size from 6 to 30 inch diameter. Four main pressure zones exist currently–Zone 1 is the lowest in elevation and Zone 4 is the highest. Several subzones exist that are separated from the tanks by PRVs. The existing distribution system is shown on Figure I-1.

EXISTING DISTRIBUTION SYSTEM REQUIREMENTS

DDW requires that the distribution system be able to maintain 20 psi at all points in the system under peak instantaneous conditions and under peak day plus fire flow conditions. The City further prefers that the distribution system maintain pressures between **50 and 150 psi** at all points in the system under normal operating conditions, including Peak Instantaneous, Peak Day, and Average Day.

Existing Peak Instantaneous Demand

Peak instantaneous demand is the highest demand on the peak day. The pipes in the distribution system must be large enough to convey the peak instantaneous demand while maintaining a pressure between 50 and 150 psi. The peaking factor from the peak day average flow to peak instantaneous flow was estimated to be 2.0 on the peak day of July 17, 2007 (see Figure III-4). Applying this peaking factor of 2.0 to the peak day demand gives a total existing peak instantaneous demand of **10,800 gpm**.

Existing Peak Day Plus Fire Flow Demand

In accordance with DDW regulations, the distribution system must be capable of delivering fire flow to a specified location within the system while supplying the peak day demand to the entire distribution system and maintaining 20 psi minimum pressure at all delivery points within the distribution system. After discussions with the Unified Fire Authority the City decided that **40 psi** would be used as the minimum pressure instead of 20 psi. A minimum fire flow demand of **2,000 gpm** or more is required for all demand nodes in the system. Larger fire flows are required at larger structures throughout the system based on the International Fire Code and recommendations from the Unified Fire Authority. The highest fire flow required in each zone is presented in Table IV-3. Existing peak day demand, which fire flow is run with, is discussed in Chapter III and existing peak day demand for each pressure zone is presented in Table III-3.

BUILD-OUT DISTRIBUTION SYSTEM REQUIREMENTS

The same requirements for the existing system are required for the projected build-out. DDW requires the distribution system be able to maintain 20 psi at all points in the system under first, peak instantaneous conditions and second, peak day plus fire flow. Again, the City further prefers that the distribution system maintain a pressure between 50 and 150 psi at all points in the system under peak instantaneous conditions and 40 psi during fire flow conditions.

Build-Out Peak Instantaneous Demand

Assuming the same peaking factor of 2.0 to the peak day demand gives a peak instantaneous demand at build-out of **36,600 gpm**.

Build-Out Peak Day Demand Plus Fire Flow

Peak day demand projected for build-out is discussed in Chapter III and presented by pressure zone in Table III-4. The same fire flow requirements for existing conditions were assumed for build-out.

COMPUTER MODEL

A computer model of the City's water distribution system was developed to analyze the performance of the existing and future distribution system and to prepare solutions for existing facilities that cannot meet the City's criteria for water system pressures. The software used for the model was WaterCAD by Bentley Systems, Inc. WaterCAD is a GIS based computer program that models the hydraulic behavior of piping networks. The pipe, tank, and valve data used to develop the model were obtained from the model prepared previously, and other updated information supplied by the City.

Computer models were developed for three phases of water system development. The first phase was the development of a model of the existing system (existing model). This model was used to calibrate the model and identify deficiencies in the existing system. A second model was developed which was used to identify those corrections necessary to improve existing system deficiencies (corrected existing model). The third phase was the development of a future model to indicate those improvements that will be necessary for the projected "build-out" condition (future model).

MODEL COMPONENTS

The two basic elements of the computer model are pipes and nodes. A pipe is described by its inside diameter, overall length, minor friction loss factors, and a roughness value associated with friction head losses. A pipe can include elbows, bends, valves, pumps, and other operational elements. Nodes are the end points of a pipe and they can be categorized as junction nodes or boundary nodes. A junction node is a point where two or more pipes meet, where a change in pipe diameter occurs, or where flow is put in or taken out of the system. A boundary node is a point where the hydraulic grade is known (a reservoir or PRV).

The computer model of the water distribution system is not an exact replica of the actual water system. Pipeline locations used in the model are approximate and every pipeline may not be included in the model, although efforts were made to make the model as complete and accurate as possible. It is not necessary to include all of the distribution system pipes in the model to accurately simulate its performance.

Pipe Network

As indicated previously, the pipe network layout was based upon the model previously prepared by others. Updates to the model were made from maps and drawings provided by the City. The elevation information used by the model is based upon contour mapping provided by the City.

Demands

Water demands were input into the water system model by flow in gallons per minute. Existing and Future water demand was assigned to nodes in the model which best represented the location of the demand. Demand data sets were created in the model for the appropriate demand conditions for each scenario. In the extended period model scenarios, the model runs for 24 hours or more and the demand changes over time. How the demand changes over a 24 hour period is referred to as a diurnal or daily demand curve. The demand curve for the peak day is the demand line in Figure III-4.

Sources and Storage Tanks

The sources of water in the model are the storage tanks and JVWCD connections. Depending on which combination of pump stations are on and what the system demands are, pumps stations and JVWCD connections can meet demands and fill tanks at the same time. The levels in the tanks are modeled in the extended period model scenario. The extended period model predicts the levels in the tanks as they fill from sources and as they empty to meet demand in the system.

MODEL CALIBRATION

A water system computer model should be calibrated before it may be relied on to accurately simulate the performance of the distribution system. Calibration is a comparison of the computer results, field tests, and actual system performance as recorded by the SCADA system. Field tests are accomplished by performing fire flow tests and pressure tests on the system. When the computer model does not match the field tests within an acceptable level of accuracy, the computer model is adjusted to match field conditions. Calibration of the model included a 24 hour time period simulating the peak day of July 17, 2007. Not only were actual flow and pressure tests matched, but also pumping on and off times, tank levels, and other system control data. When a pump turns on to fill a tank when the tank water elevation drops to a certain level in the real system, the model also turns the pump on at the same level. Appendix A has graphs of tank levels and source flows from the SCADA system and from the calibrated peak day extended period scenario for July 17, 2007 that show a comparison between the real system versus the model.

The model was calibrated successfully with the use of fire flow, pressure tests, and SCADA information. Fire flow test data is found in Appendix A. It is recommended that City staff continue to conduct fire flow tests on an ongoing basis and review SCADA information to refine the model calibration as system conditions change.

ANALYSIS METHODOLOGY

The WaterCAD model was used to analyze the performance of the water system for current and projected future demands under three main operating conditions: low flow (highest pressure) conditions, peak instantaneous conditions, and peak day plus fire flow conditions. Each of these conditions put the water system into a worst-case situation so the performance of the distribution system may be analyzed for compliance with DDW and the City's minimum requirements. The results of the model for each of the conditions are discussed below.

High Pressure Conditions

Low flow, or static conditions, are usually the worst case for high pressures in a water distribution system. In the wintertime, water demand during night time hours is very low, tanks are nearly full, and movement of water through the system is minimal. Under these conditions, the water system approaches a static condition and water pressure in the distribution system is dependent only upon the elevation differences and pressure regulating devices. Another condition similar to static condition that can also cause high pressures in the City's water system occurs in the summer when demand is low and pumps are on to fill storage tanks. During times of low demand, the pumps increase the pressure in the system high enough to reverse the flow coming from the tanks. The highest pressures are reached when pumps are on, tanks are almost full, and demand is low. Both of these high pressure conditions were simulated with the model. The City would like to see pressures not too much over 150 psi under this condition.

Peak Instantaneous Demand Conditions

Peak Instantaneous demand conditions can sometimes be the worst-case scenario for low pressures throughout a water distribution system. The water system reaches peak instantaneous demand conditions during the hottest days of the summer when both indoor and outdoor water use is the highest. The high demand creates high velocities in the distributions pipes which reduces pressure. DDW requires the pipes in the distribution system to be capable of delivering peak instantaneous demand to the entire service area and maintain a minimum pressure of 20 psi at any service connection within the distribution system. Usually, minimum pressures of 20 psi at peak instantaneous demand are too low for customer satisfaction, hence, the City prefers a minimum pressure of 50 psi under this condition.

Peak Day Demand Plus Fire Flow Conditions

Even though peak instantaneous conditions are the worst-case for the lowest pressure and highest demand for the entire system, the peak day plus fire flow is often the worst-case scenario for the lowest pressures for specific locations in the system. This condition occurs when fire hydrants are being used on a day of high water demand. The distribution system must be capable of delivering the required fire flow to the specified location within the system, while supplying the peak day demand to the entire distribution system. In accordance with the recommendations from the Unified Fire Authority, the required fire flow of at least 2,000 gpm must be delivered while maintaining 40 psi minimum residual pressure at the delivery point and to all service connections within the distribution system. In addition, specific locations in the water system must have higher fire flows due to the nature of the development in those areas. The highest fire flow applied in each pressure zone is in Table IV-3.

Identifying every pipe which is not capable of supplying the required fire flow is beyond the scope of this study. While the computer analysis is useful for providing general indications of the fire flow capacity, it does not calculate the capacity at every fire hydrant, nor does it identify every water line where fire flow capacity is inadequate. The computer analysis checks fire flow capacity at model junction nodes which are generally placed at the intersections of two or more pipes. Fire flow capacity at fire hydrants between model junction nodes could be less than the computer analysis indicates. For this reason, the computer analysis should not replace physical fire flow tests at fire hydrants as the primary method of determining fire flow capacity.

Peak Day Extended Period

The peak day extended period model was used to model the water system performance over time. An extended period model is actually a static model run several times for each time period, like a movie is made up of individual pictures put together. The peak day extended period model was used to set system conditions for the static models, calibrate zone to zone water transfers, analyze system controls and the performance of the system over time, analyze system recommendations for performance over time, and analyze the water system for system optimization recommendations. The peak day extended period model was run for 96 hours with the peak day repeating every 24 hours in order for the model to stabilize, which is indicated by the tanks filling and emptying in a consistent pattern without running empty. System recommendations for existing conditions and future conditions at build-out were checked with the extended period model to confirm adequacy.

CONTINUED USE OF THE COMPUTER PROGRAM

It is recommended that the City continue updating the model as the water system changes. Below is a list of ways in which the model could help the City with water system management.

The computer model can assist City staff in determining:

- Effect on the system if individual facilities are added or taken out of service
- Selection of pipe diameters and location of proposed water mains
- Capacity of the water system to provide fire flows in specific areas
- Water age for water quality monitoring

The computer model should be maintained for future use. Necessary data required for continued use of the program are:

- The location , length, diameter, pipe material, and ground elevation at each end of each new pipeline constructed
- Changes in water supply location and characteristics
- Location and demand for new large customers

RESULTS

Generally speaking, the computer model showed that the distribution system performs quite well in both existing and future scenarios. This is most likely due to fact that the water system is relatively new.

The model output primarily consists of the computed pressures at nodes and flow rates through pipes. The model also provides additional data related to pipeline flow velocity and head loss to help evaluate the performance of the various components of the distribution system. Results from the model are available on a CD in Appendix B. Due to the large number of pipes and nodes in the model, it is impractical to prepare a figure which illustrates pipe numbers and node numbers. The reader should refer to the CD to review model output.

Areas with fire flow delivery deficiencies were identified by the model. All nodes in the existing conditions model can provide 1,500 gpm at 20psi. There are 14 fire hydrants in four different developments that can not deliver 1,500 gpm at 40 psi and 67 fire hydrants in 8 different developments can not deliver 2,000 gpm at 40 psi. Also, a few new PRVs are recommended for subdivisions that have either too high of pressure, too low of pressure, or should have redundant fire protection. Fire flow deficiencies and recommended solutions are presented in Table V-1.

TABLE V-1
FIRE FLOW DEFICIENCIES

DEVELOPMENT	Number of Fire Hydrants that Cannot Provide 1,500 GPM at 40 psi	Number of Fire Hydrants that Cannot Provide 2,000 GPM at 40 psi	RECOMMENDED SOLUTION
Centennial Heights C	0	3	Field test indicates that hydrants can flow at 2,000 gpm at 40 psi. Reevaluate as growth continues.
Cranberry Hill	3	12	Replace dead-end 6-inch pipelines with 8-inch pipelines.
Deer Ridge I	0	1	Model indicates that hydrant can flow at 1,900 gpm at 40 psi. Test and monitor.
Eagle Crest I	2	14	Install PRV and loop system with new development
Eagle Crest III	0	8	Increase pressure setting of PRV and loop system with new development
Maple Hollow	1	19	Increase pressure setting of PRV
Oak Vista IV		1	Test and find solution if necessary
Stoneleigh Heights II	8	9	Install new PRV
TOTAL	**14**	**67**	

The existing 12-inch diameter waterline in Suncrest Drive past Eagle Stone Way has a capacity of about 1,250 ERCs. Currently there appears to about 150 active connections and over 350 parcels. Before more than 1,250 ERCs can be served past Eagle Stone Way a parallel line in Suncrest Drive or a looped line is required. A 16-inch diameter pipeline in addition to the existing 12-inch diameter pipeline is required for build-out.

One of the current deficiencies of the water delivery system for Zones 2 through 4 is that once water is pumped to a higher water zone, there is currently no means of allowing water to flow back into the lower zone in case of emergency in the lower zone. A relatively low cost solution to this deficiency would be to add bypass piping at the zone breaks so that in the event of an outage in a lower zone, water service could be provided manually by opening up the bypass. Several new pipelines are needed in the Traverse Mountain Area and the Galena Park Boulevard and State Prison Area for future growth. Also, a new 24-inch diameter transmission pipeline is needed between the Centennial Pump Station and the new Zone 2 Tank parallel to the existing 16-inch diameter transmission pipeline. Recommendations for future pipelines, PRVs ,and solutions to correcting fire flow deficiencies are given below under Distribution System Recommendations.

DISTRIBUTION SYSTEM RECOMMENDATIONS

Distribution system recommendations are categorized as corrections to existing deficiencies and improvements to provide capacity for new growth. Specific projects to correct existing deficiencies are listed in Table V-1 with fire flow deficiencies listed separately in Table V-2. Projects to provide capacity for new growth are listed in Table V-3. Conceptual level costs for the proposed projects are presented in Chapter VI.

TABLE V-2
PROPOSED IMPROVEMENT PROJECTS TO CORRECT EXISTING DEFICIENCIES

RECOMMENDED PROJECT
Install a PRV at 2180 East Eagle Crest Drive to add fire flow redundancy from Zone 4 to Zone 3 and to improve fire flow at hydrants.
Stoneleigh Heights II has operating and fire flow pressures that are too low. Install a PRV at the intersection of Suncrest Drive and Haddington Road off the Zone 4 pipeline.
The Cranberry Hill subdivision has several dead-end 6-inch diameter pipelines that limit fire flow. Replace the 6-inch diameter pipelines in Mayberry Court, Cranberry Hill Court, and Honey Locust Court with 500 ft of 8-inch diameter pipeline for a total of 1,500 ft.

TABLE V-3
PROPOSED SYSTEM IMPROVEMENT PROJECTS FOR BUILD-OUT

RECOMMENDED PROJECT
Install 12,000 feet of 24-inch diameter transmission pipeline between the Centennial Pump Station and the new Zone 2 Tank.
Install 12,000 feet of 16-inch diameter pipeline parallel to the 12-inch diameter pipeline in Suncrest Drive or equivalent looped.
Install 5,200 feet of 14-inch diameter pipeline in Galena Park Boulevard from Cephus Road to Green Clover Road (500 West).
Install 1,400 feet of 14-inch diameter pipeline in Green Clover Road (500 West) from Galena Park Boulevard to 13490 South.
Install 2,500 feet of 14-inch diameter pipeline in 13490 South from Green Clover Road (500 West) to 200 West.
Install 2,500 feet of 14-inch diameter pipeline in Green Clover Road (500 West) from 13490 South to 13775 South.

TABLE V-3
PROPOSED SYSTEM IMPROVEMENT PROJECTS FOR BUILD-OUT
(Continued)

Install 2,200 feet of 12-inch diameter pipeline in 13775 South from Green Clover Road (500 West) to 200 West.
Install 3,200 feet of 16-inch diameter pipeline in Green Clover Road (500 West) from 13775 South to 14000 South.
Install 3,000 feet of 24-inch diameter pipeline in from Green Clover Road (500 West) and 14000 South to 14600 South and Pony Express Road.
Install 10,000 ft of 12-inch diameter pipeline from Suncrest drive to proposed Zone 4 development and 7,000 ft of a parallel 12-inch diameter pipeline from Suncrest Drive to a new Zone 3 Tank.
Install 2,000 ft of 16-inch diameter pipeline and 6,000 ft of 12-inch diameter pipeline from a new Zone 3 tank along East Loop Road.
Install 10,000 feet of 16-inch diameter pipeline at the end of Suncrest Drive.

CHAPTER VI

CAPITAL IMPROVEMENTS PLAN

Throughout the master planning process, the three main components of the City's water system (source, storage, and distribution) were analyzed to determine the system's ability to not only meet existing demands but also the anticipated future demands at build-out. Each of the system deficiencies identified in the master planning process and described previously in this report were presented in an alternatives workshop with City staff. Possible solutions were discussed for each of the identified system deficiencies as well as possible solutions for maintenance and other system needs not identified in the system analysis. After the workshop, HAL studied the feasability of the solution alternatives and developed conceptual costs. An implementation plan workshop was then held with City staff to select and prioritize the preferred solutions.

One important method of paying for system improvements is through impact fees. Impact fees are collected from new development and should only be used to pay for system improvements related to new development. For this reason it is important to identify which projects are related to resolving existing deficiencies, and which projects are related to providing anticipated future capacity for new development. It is assumed that all existing system improvement projects solve existing problems, so these project costs can not be paid for with impact fees. The future recommended system improvement projects are for future development and it is assumed that 100 percent of the costs are eligible to be paid for with impact fees.

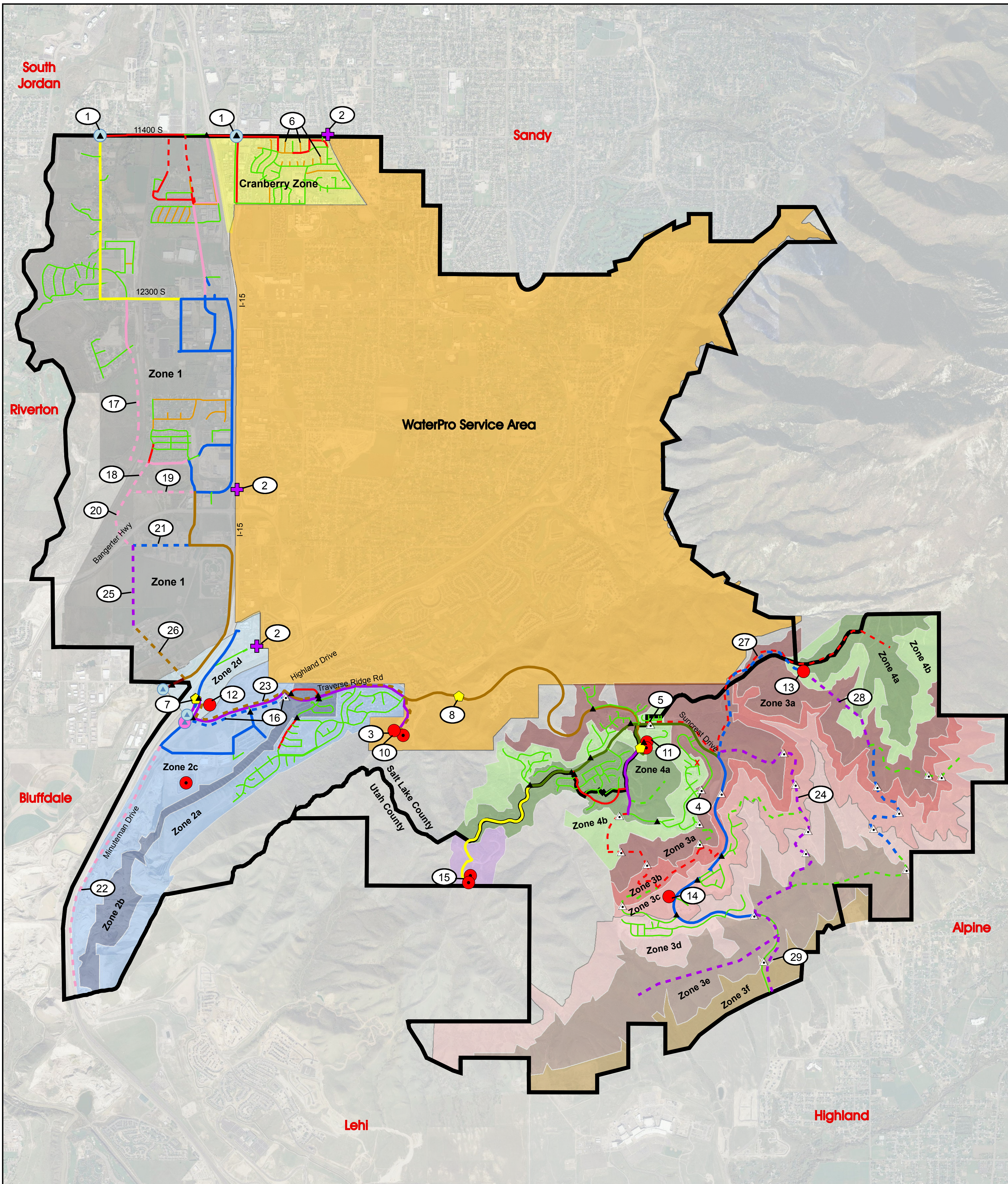
EXISTING SYSTEM IMPROVEMENT PROJECTS

As discussed in previous chapters, several existing source, storage and distribution system deficiencies were identified during the system analysis. Existing water system improvement recommendations are presented in Table VI-1 and shown in Figure VI-1. Each recommendation includes a conceptual cost estimate for construction.

Unit costs for the construction cost estimates are based on conceptual level engineering. Sources used to estimate construction costs include

- "Means Heavy Construction Cost Data, 2007"
- Price quotes from equipment suppliers
- Recent construction bids for similar work

All costs are presented in 2007 dollars. Recent price and economic trends indicate that future costs are difficult to predict with certainty. Engineering cost estimates provided in this study should be regarded as conceptual level for use as a planning guide. Only during final design can a definitive and more accurate estimate be provided for each project. A cost estimate calculation for each project is provided in Appendix C. All existing system improvement projects are recommended to be completed in 0 to 5 years.



Key

Pipe Diameter, Inches

- 4
- 6
- 8
- 10
- 12
- 14
- 16
- 18
- 20
- 24
- 30

- Existing Tank
- Future Tank
- Existing PRV
- Future PRV
- Existing JVWCD Connection
- Future JVWCD Connection
- Pump Station
- WaterPro Interconnection
- Draper City Boundary
- Closed Valve

Dashed Lines Represent Future Pipelines

0 0.5 1 Miles

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DRAPER CITY

DRINKING WATER SYSTEM MASTER PLAN

RECOMMENDED IMPROVEMENTS

FIGURE VI-1

TABLE VI-1
EXISTING SYSTEM IMPROVEMENT PROJECT COSTS

TYPE	MAP ID	RECOMMENDED PROJECT*	COST [1]
SOURCE	1	2 Peaking Flow Control Valves on 11400 S JVWCD Connections	$25,000
	2	3 WaterPro Interconnects	$405,000
		Back/alternative power for booster pump stations	$351,000
		New Water Source Feasibility Study	$135,000
STORAGE	3	1.5 MG of additional storage for Zone 2	$2,025,000
DISTRIBUTION	4	Install a PRV at 2180 East Eagle Crest Drive to add fire flow redundancy from Zone 4 to Zone 3 and to improve fire flow at hydrants.	$135,000
	5	Stoneleigh Heights II has operating and fire flow pressures that are too low. Install a PRV at the intersection of Suncrest Drive and Haddington Road off the Zone 4 pipeline.	$135,000
	6	The Cranberry Hill subdivision has several dead-end 6-inch diameter pipelines that limit fire flow. Replace the 6-inch diameter pipelines in Mayberry Court, Cranberry Hill Court, and Honey Locust Court with 8-inch diameter pipelines.	$247,000
TOTAL			**$3,458,000**

* See descriptions in the source, storage and distribution system recommendation summaries presented in previous chapters.

[1] All existing system improvement projects are recommended to be completed in the 0 to 5 years.

FUTURE RECOMMENDED SYSTEM IMPROVEMENT PROJECTS

A summary of the future recommended source, storage and distribution projects to improve the water system are presented on Table VI-2 along with the conceptual cost. The project recommended to be completed in the next 5 years is white. The projects recommended to be completed in 5 to 15 years are colored blue, and the projects recommended to be completed beyond 15 years are colored yellow. Table VI-3 is a summary of conceptual project costs by time frame.

TABLE VI-2
FUTURE RECOMMENDED PROJECT COSTS

TYPE	MAP ID	RECOMMENDED PROJECT*	COST
SOURCE	7	New Centennial 10,000 gpm Pump Station	$2,430,000 [2]
	8	4,500 gpm Upgrade for Pump Station 3	$810,000 [3]
	9	1,500 gpm Pump Station 4 Upgrade	$338,000 [3]
STORAGE	10	3.0 MG of Storage for Zone 2	$4,050,000 [2]
	11	2.0 MG Tank 3b	$2,700,000 [2]
	12	5.0 MG Zone 1 Storage	$6,750,000 [3]
	13	1.0 MG Tank 3c	$1,350,000 [3]
	14	1.0 MG Tank 3d	$1,350,000 [3]
	15	0.5 MG of Storage for Zone 4 or 5	$675,000 [3]
DISTRIBUTION	16	Install PRV at the intersection of Highland Drive and Traverse Ridge Road. Install 4,500 ft of 12-inch diameter pipeline in Highland Drive from Traverse Ridge Road to Minuteman Drive.	$1,058,000 [1]
	17	Install 12,000 feet of 24-inch diameter transmission pipeline between the Centennial Pump Station and the new Zone 2 Tank.	$4,682,000 [1]
	18	Install 5,200 feet of 14-inch diameter pipeline in Galena Park Boulevard from Cephus Road to Green Clover Road (500 West).	$1,121,000 [2]
	19	Install 1,400 feet of 14-inch diameter pipeline in Green Clover Road (500 West) from Galena Park Boulevard to 13490 South.	$314,000 [2]
	20	Install 2,500 feet of 14-inch diameter pipeline in 13490 South from Green Clover Road (500 West) to 200 West.	$560,000 [2]
	21	Install 2,500 feet of 14-inch diameter pipeline in Green Clover Road (500 West) from 13490 South to 13775 South.	$560,000 [2]
	22	Install 2,200 feet of 12-inch diameter pipeline in 13775 South from Green Clover Road (500 West) to 200 West.	$451,000 [2]
	23	Install 10,500 feet of 14-inch diameter pipeline in Minuteman Drive from Highland Drive south.	$2,353,000 [2]
	24	Install 12,000 feet of 16-inch diameter pipeline parallel to the 12-inch diameter pipeline in Suncrest Drive or equivalent looped.	$3,321,000 [3]
	25	Install 3,200 feet of 16-inch diameter pipeline in Green Clover Road (500 West) from 13775 South to 14000 South.	$886,000 [3]
	26	Install 3,000 feet of 24-inch diameter pipeline in from Green Clover Road (500 West) and 14000 South to 14600 South and Pony Express Road.	$1,170,000 [3]
	27	Install 10,000 ft of 12-inch diameter pipeline from Suncrest drive to proposed Zone 4 development and 7,000 ft of a parallel 12-inch diameter pipeline from Suncrest Drive to a new Zone 3 Tank.	$3,488,000 [3]
	28	Install 2,000 ft of 16-inch diameter pipeline and 6,000 ft of 12-inch diameter pipeline from a new Zone 3 tank along East Loop Road.	$1,785,000 [3]
	29	Install 10,00 feet of 16-inch diameter pipeline at the end of Suncrest Drive.	$2,768,000 [3]
TOTAL			**$44,970,000**

* See descriptions in source, storage and distribution system recommendations presented in previous chapters.
[1] 0 to 5 year time frame (white)
[2] 5 to 15 year time frame (blue)
[3] beyond 15 year time frame (yellow)

TABLE VI-3
RECOMMENDED PROJECT TIME LINE COST SUMMARY

TIME	TOTAL COST
0 to 5 Years	$11,628,000
5 to 15 Years	$12,109,000
More than 15 Years	$24,691,000
TOTAL	**$48,428,000**

FUNDING OPTIONS

Funding options for the recommended projects, in addition to water use fees, could include the following options: general obligation bonds, revenue bonds, State/Federal grants and loans, and impact fees. In reality, the City may need to consider a combination of these funding options. The following discussion describes each of these options.

General Obligation Bonds

This form of debt enables the City to issue general obligation bonds for capital improvements and replacement. General Obligation (G.O.) Bonds would be used for items not typically financed through the Water Revenue Bonds (for example, the purchase of water source to ensure a sufficient water supply for the City's in the future). G.O. bonds are debt instruments backed by the full faith and credit of the City which would be secured by an unconditional pledge of the City to levy assessments, charges or ad valorem taxes necessary to retire the bonds. G.O. bonds are the lowest-cost form of debt financing available to local governments and can be combined with other revenue sources such as specific fees, or special assessment charges to form a dual security through the City's revenue generating authority. These bonds are supported by the City as a whole, so the amount of debt issued for the water system is limited to a fixed percentage of the real market value for taxable property within the City.

Revenue Bonds

This form of debt financing is also available to the City for utility related capital improvements. Unlike G.O. bonds, revenue bonds are not backed by the City as a whole, but constitute a lien against the water service charge revenues of a Water Utility. Revenue bonds present a greater risk to the investor than do G.O. bonds, since repayment of debt depends on an adequate revenue stream, legally defensible rate structure /and sound fiscal management by the issuing jurisdiction. Due to this increased risk, revenue bonds generally require a higher interest rate than G.O. bonds, although currently interest rates are at historic lows. This type of debt also has very specific coverage requirements in the form of a reserve fund specifying an amount, usually expressed in terms of average or maximum debt service due in any future year. This debt service is required to be held as a cash reserve for annual debt service payment to the benefit of bondholders. Typically, voter approval is not required when issuing revenue bonds.

State/Federal Grants and Loans

Historically, both local and county governments have experienced significant infrastructure funding support from state and federal government agencies in the form of block grants, direct grants in aid, interagency loans, and general revenue sharing. Federal expenditure pressures and virtual elimination of federal revenue sharing dollars are clear indicators that local government may be left to its own devices regarding infrastructure finance in general. However, state/federal grants and loans should be further investigated as a possible funding source for needed water system improvements.

It is also important to assess likely trends regarding federal / state assistance in infrastructure financing. Future trends indicate that grants will be replaced by loans through a public works revolving fund. Local governments can expect to access these revolving funds or public works trust funds by demonstrating both the need for and the ability to repay the borrowed monies, with interest. As with the revenue bonds discussed earlier, the ability of infrastructure programs to wisely manage their own finances will be a key element in evaluating whether many secondary funding sources, such as federal/state loans, will be available to the City.

Impact Fees

Impact fees can be applied to water related facilities under the Utah Impact Fees Act. The Utah Impacts Fees Act is designed to provide a logical and clear framework for establishing new development assessments. It is also designed to establish the basis for the fee calculation which the City must follow in order to comply with the statute. However, the fundamental objective for the fee structure is the imposition on new development of only those costs associated with providing or expanding water infrastructure to meet the capacity needs created by that specific new development. Also, impact fees cannot be applied retroactively.

SUMMARY OF RECOMMENDATIONS

Several recommendations were made throughout the master plan report. The following is a summary of the recommendations.

1. It is recommended that the City continue to update the model as the water system changes and use the model as a tool for determining: the effect of changes to the system, verification of pipe diameters and location of proposed water mains, and capacity of the system to provide fire flows.

2. It is recommended that City staff continue to conduct fire flow tests on an ongoing basis and review SCADA information to refine the model calibration as system conditions change.

3. It is recommended that the Existing and Future Recommended Projects be completed.

4. It is recommended that the rated capacity of the pump stations be evaluated by assuming that the largest pump is out of service to account for redundancy. In addition to redundancy, it is recommended that the rated capacity be further reduced by a safety factor ranging between 1.25 and 2.0. This safety factor accounts for daily fluctuations in

demand verses how many hours the booster station should be expected to pump in a 24 hour period.

5. It is recommended that the City monitor the Average Yearly Demand to make sure the JVWCD contract is neither too high or too low to responsibly meet the needs of the City's drinking water system.

6. It is recommended that the City first weigh carefully the long term potential cost and benefits before proceeding with a groundwater development program. If the City decides to proceed, it is recommended that an initial study be conducted to investigate the feasibility of a groundwater development program including hydrogeologic, legal, and economic factors.

7. It is recommended that the City work towards the possibility of constructing backup water supply interconnections with existing water suppliers in addition to WaterPro.

8. It is recommended that an additional 20 percent of the sum of the other storage requirements be added as emergency storage. It is also recommended that tanks with booster stations pumping out of the pressure zone have pump operation storage equal to a fourth of the pumped volume on the peak day to allow storage volume to fluctuate as source is pumped into and out of the zone.

REFERENCES

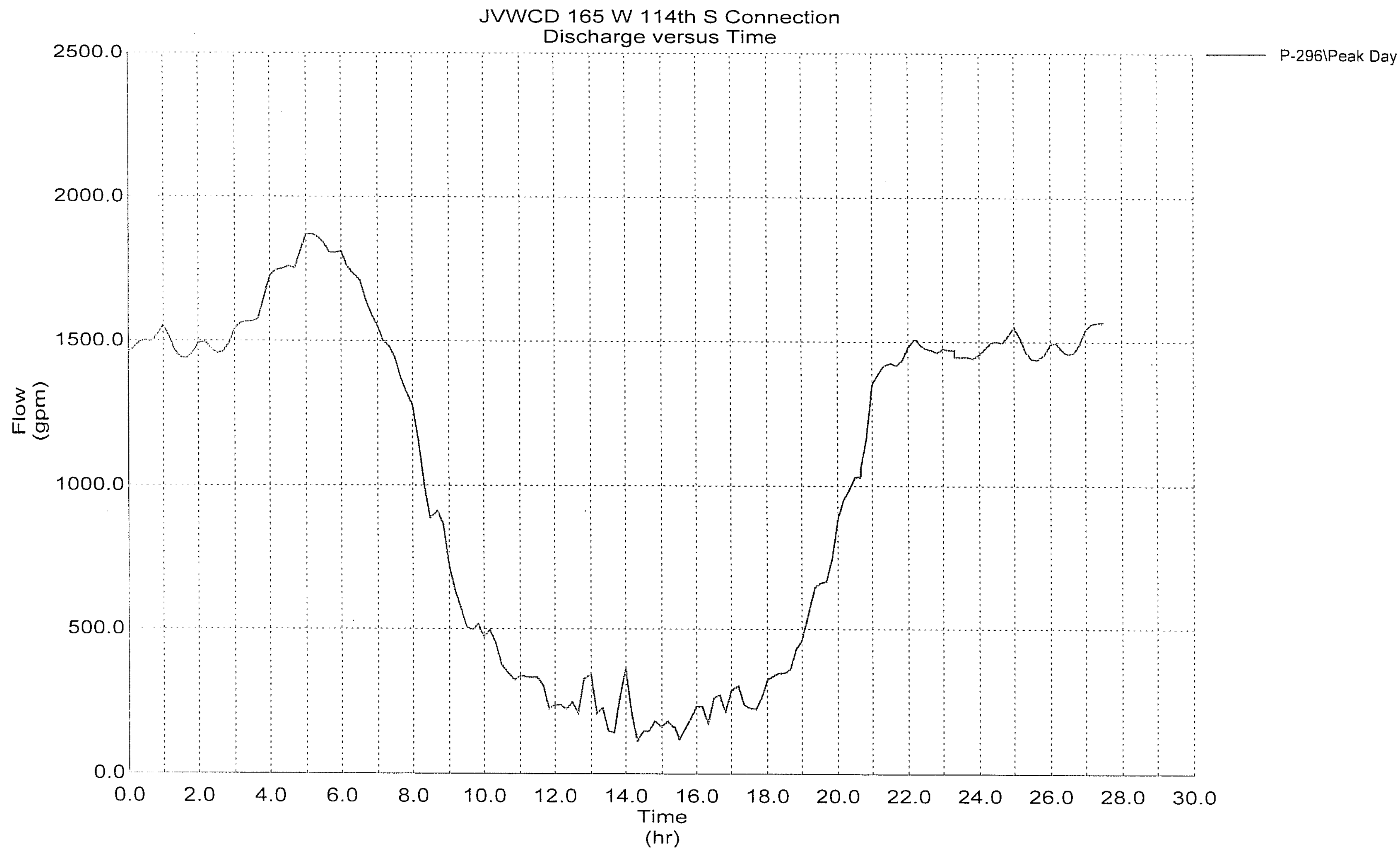
International Fire Code Institute, Uniform Fire Code, 1997.

Sanks, Robert L., Pumping Station Design, Butterworth Publishers,1989.

State of Utah, Utah Administrative Code.

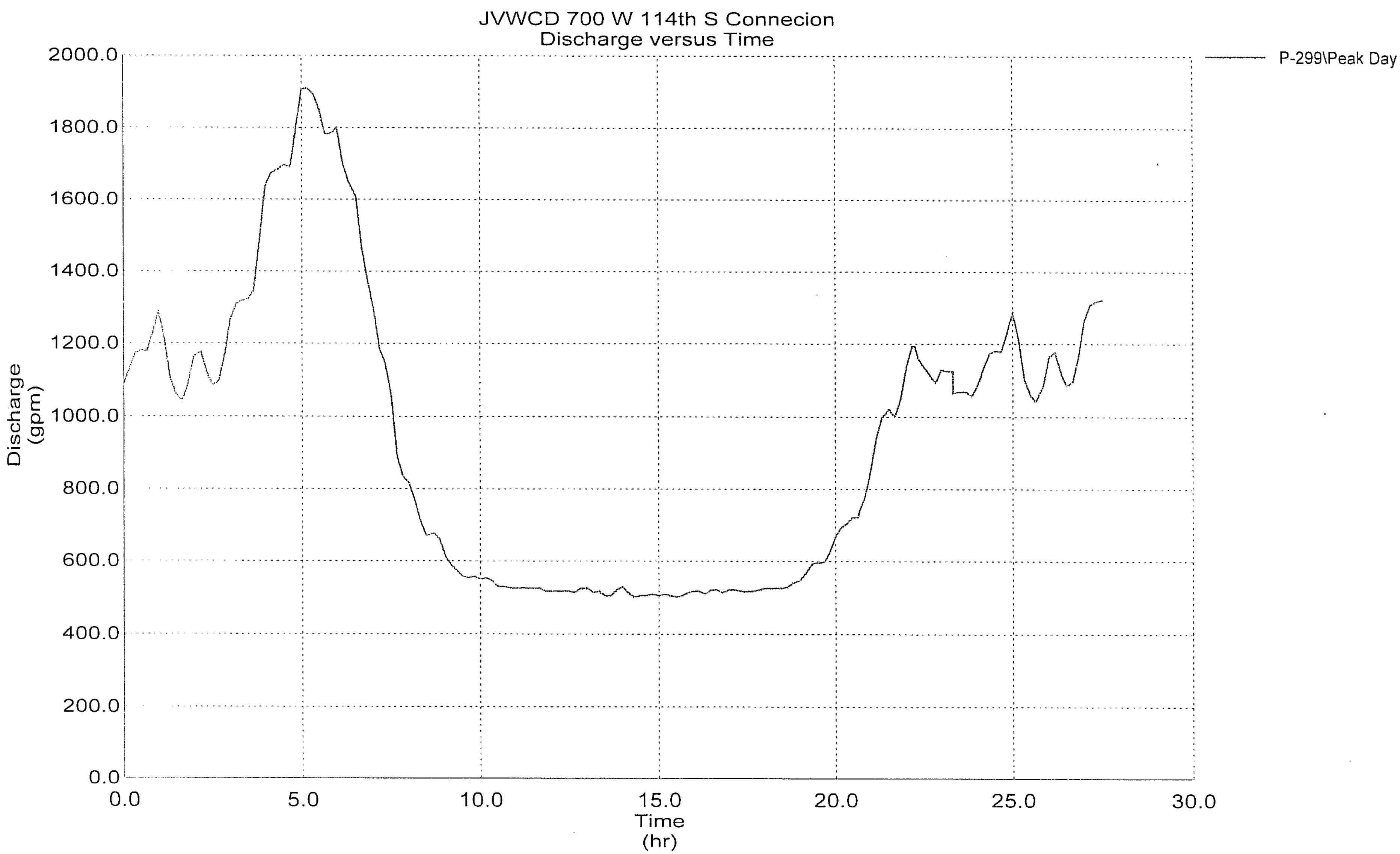
APPENDIX A
Calibration Data

Graph



JVWCD 165 W 114th S Connection
Discharge versus Time
P-296\Peak Day
Flow
(gpm)
2500.0
2000.0
1500.0
1000.0
500.0
0.0
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
16.0
18.0
20.0
22.0
24.0
26.0
28.0
30.0
Time
(hr)

Graph

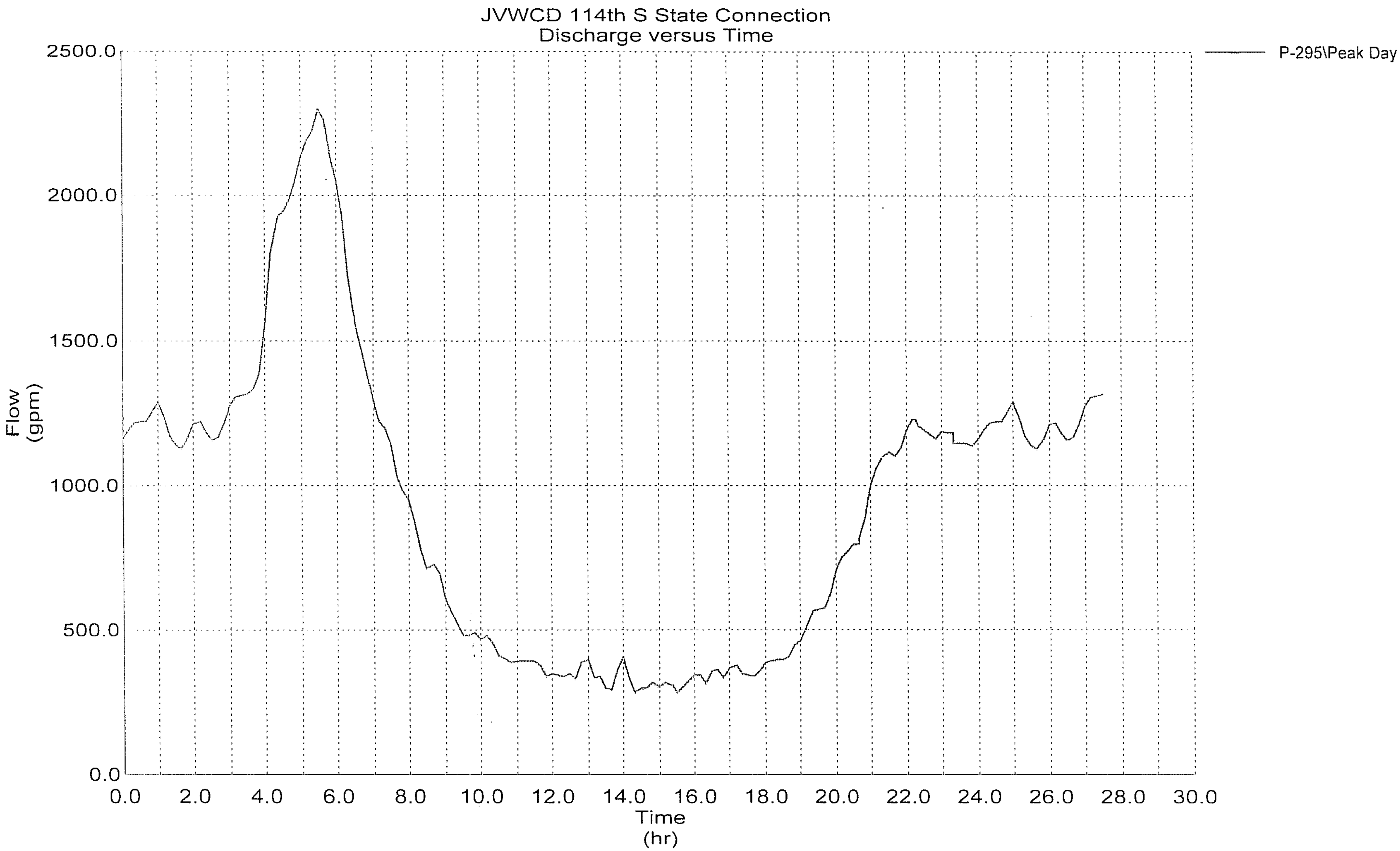


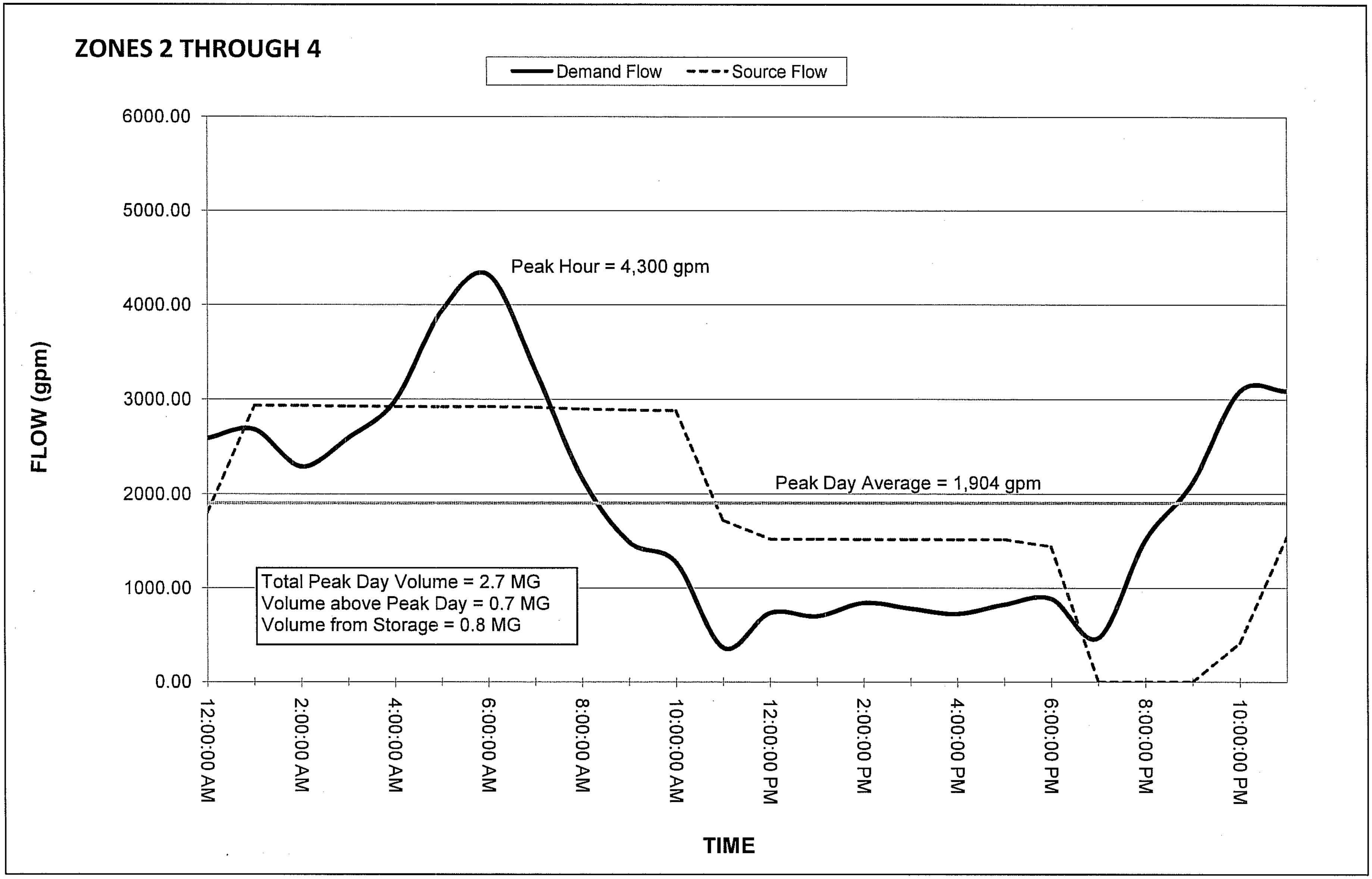
Title:
c:\...\model\2007 calibration model.wcd
09/05/07 12:10:21 PM

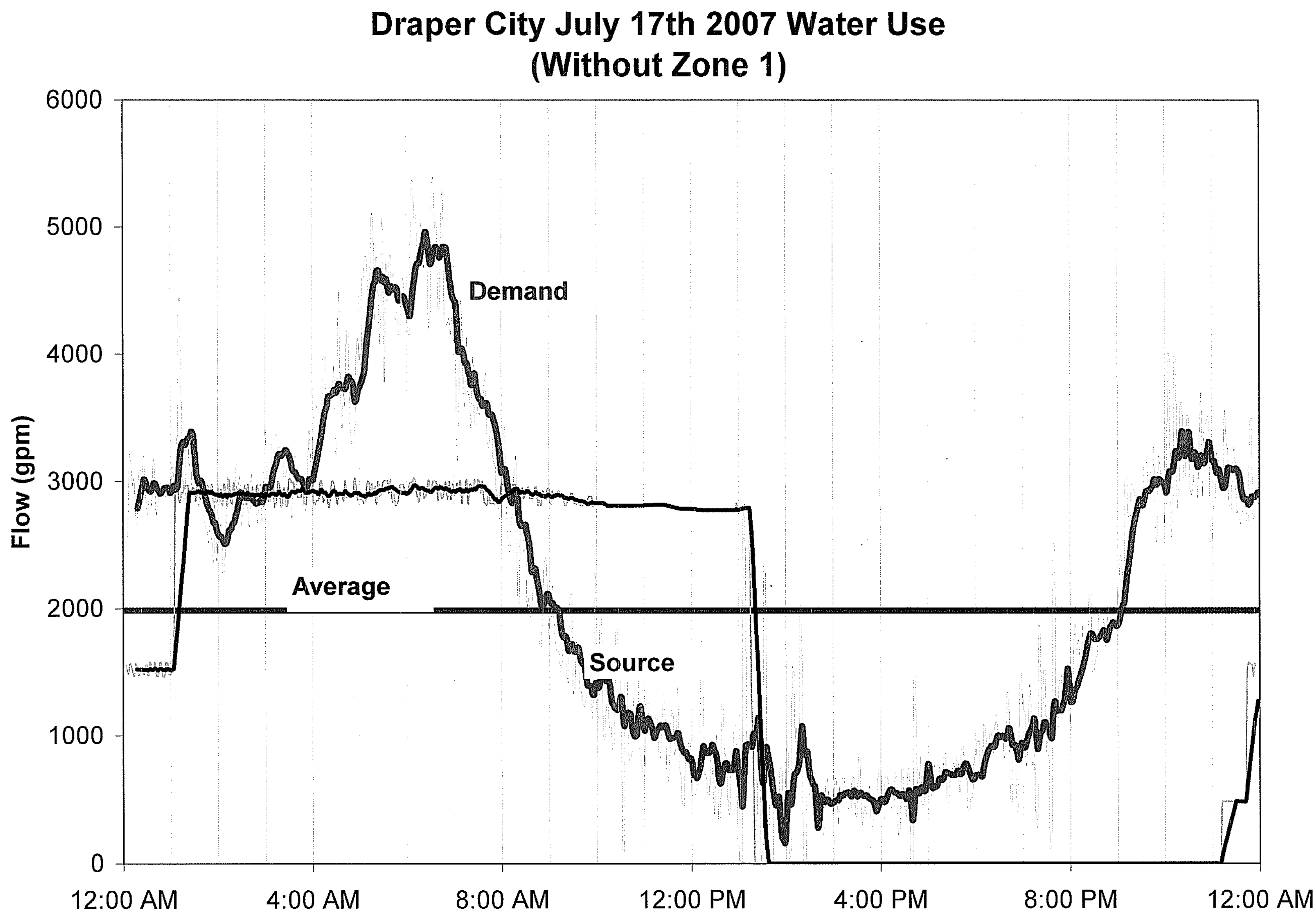
HAL
 Haestad Methods Solution Center Watertown, CT 06795 USA +1-203-755-1666

Project Engineer: Steven Jones
WaterCAD v7.0 [07.00.049.00]

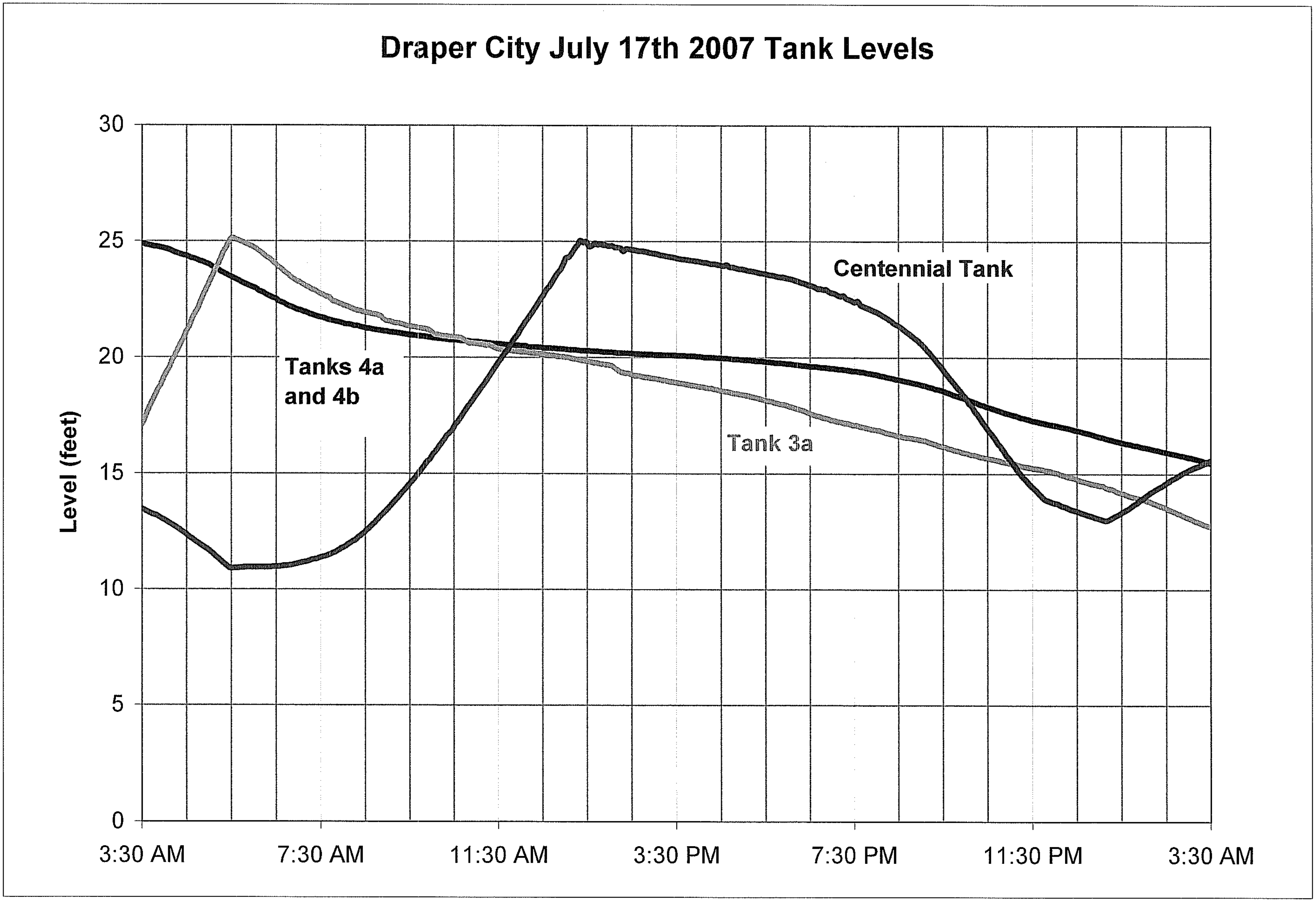
Graph

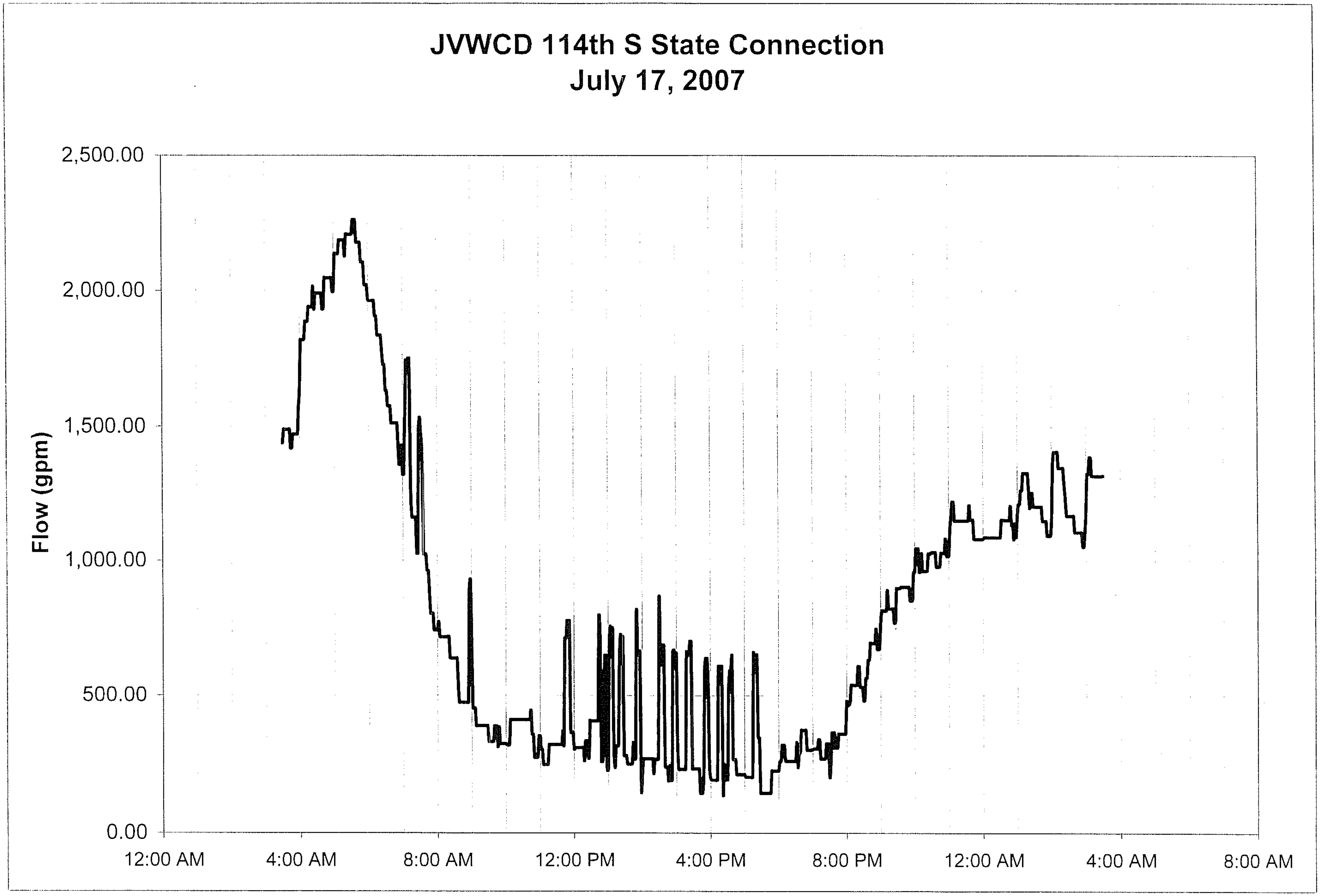

JVWCD 114th S State Connection
Discharge versus Time
P-295\Peak Day
Flow
(gpm)
2500.0
2000.0
1500.0
1000.0
500.0
0.0
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
16.0
18.0
20.0
22.0
24.0
26.0
28.0
30.0
Time
(hr)

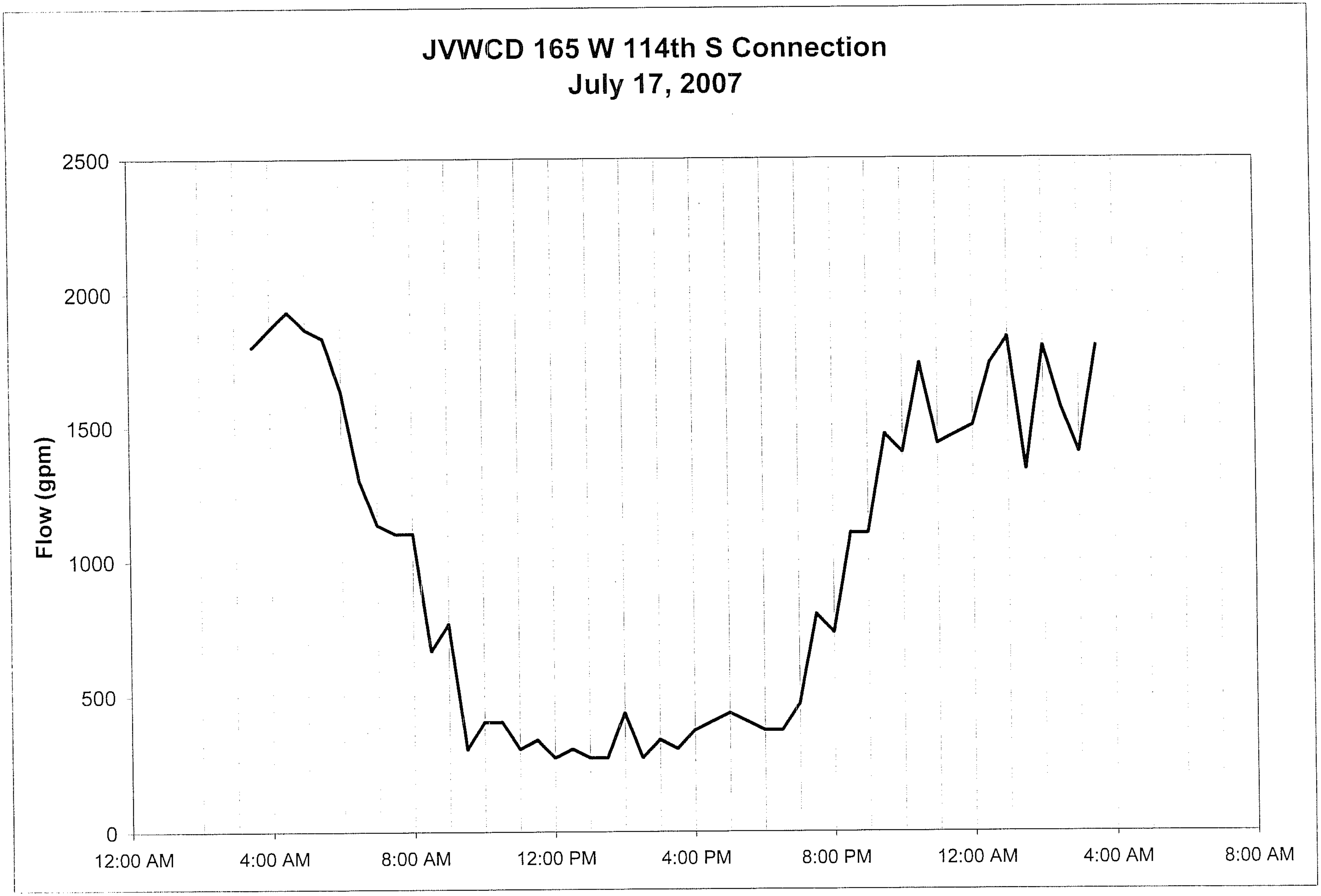

ZONES 2 THROUGH 4
Demand Flow
Source Flow
Peak Hour = 4,300 gpm
Peak Day Average = 1,904 gpm
Total Peak Day Volume = 2.7 MG
Volume above Peak Day = 0.7 MG
Volume from Storage = 0.8 MG
FLOW (gpm)
6000.00
5000.00
4000.00
3000.00
2000.00
1000.00
0.00
12:00:00 AM
2:00:00 AM
4:00:00 AM
6:00:00 AM
8:00:00 AM
10:00:00 AM
12:00:00 PM
2:00:00 PM
4:00:00 PM
6:00:00 PM
8:00:00 PM
10:00:00 PM
TIME



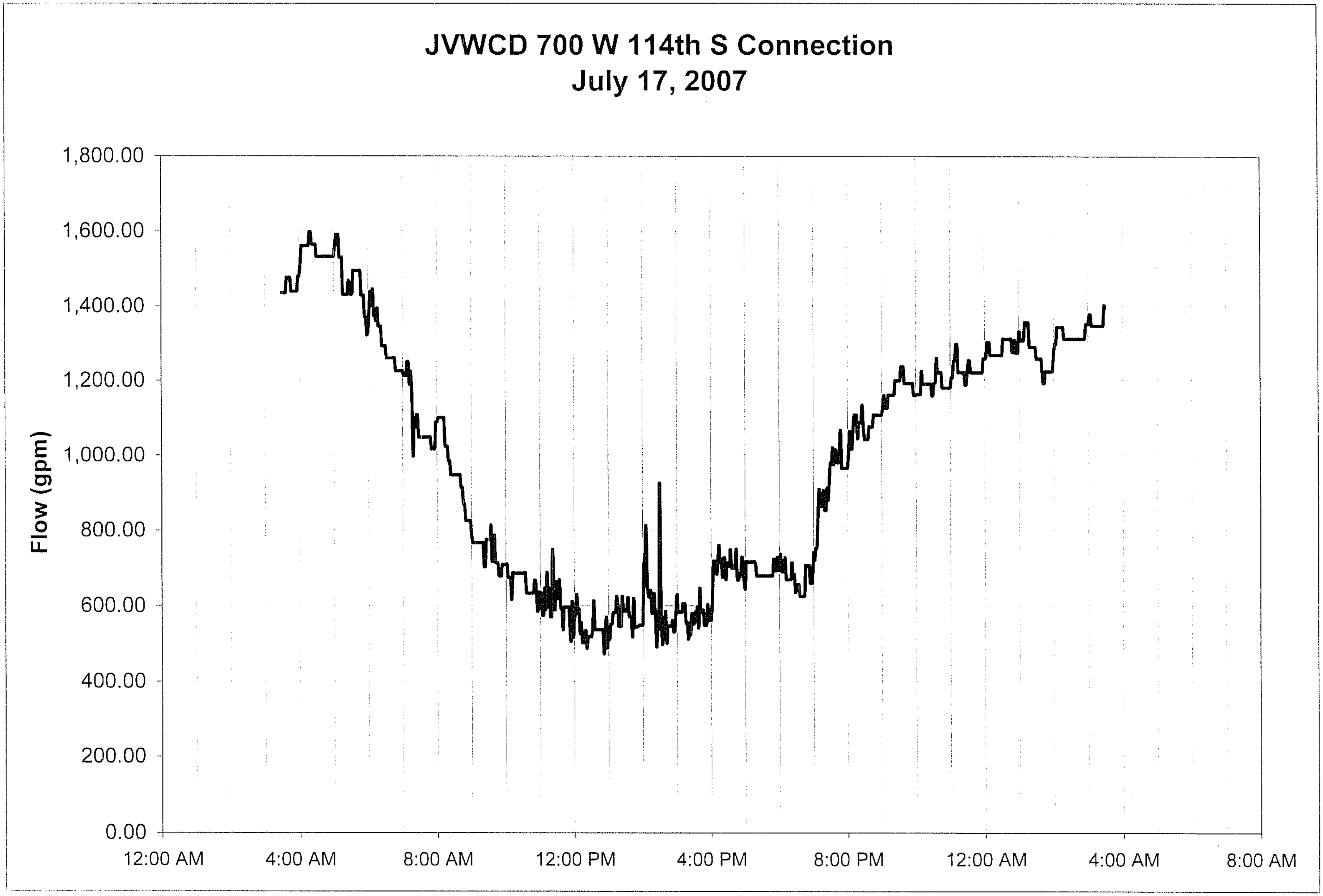
HANSEN ALLEN & LUCE inc ENGINEERS

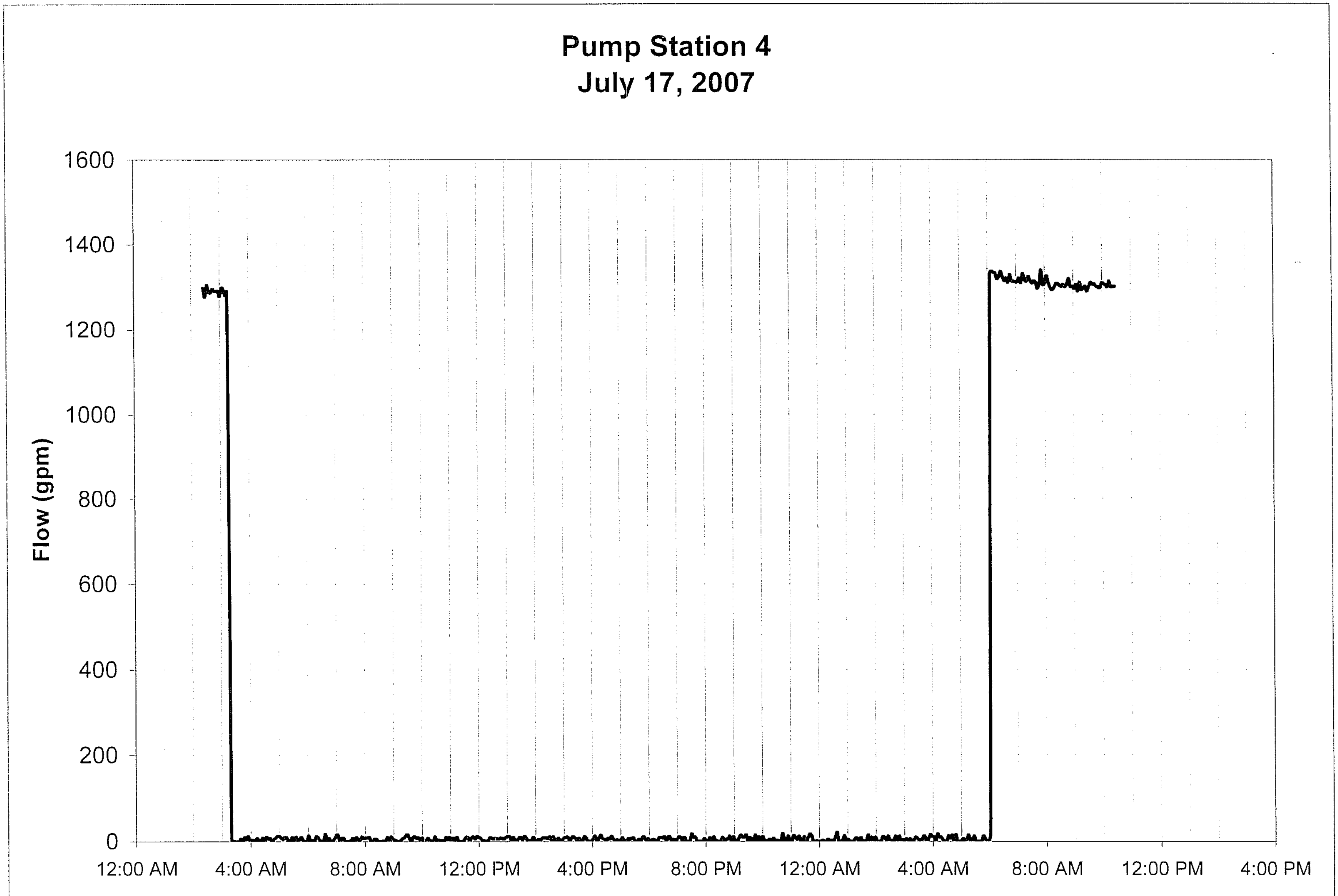

Draper City July 17th 2007 Tank Levels
Level (feet)
30
25
20
15
10
5
0
3:30 AM
7:30 AM
11:30 AM
3:30 PM
7:30 PM
11:30 PM
3:30 AM
Centennial Tank
Tanks 4a
and 4b
Tank 3a

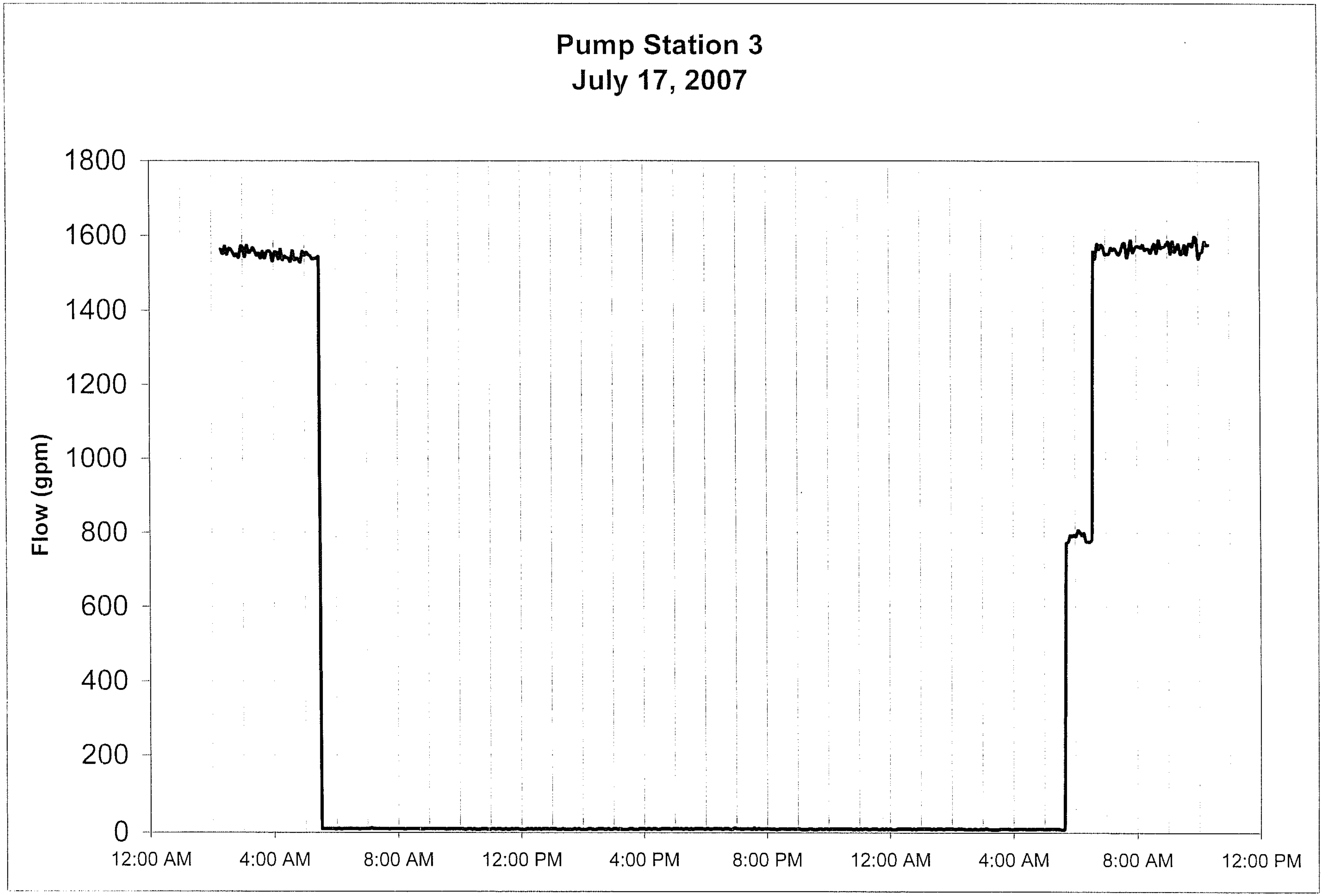

JVWCD 114th S State Connection
July 17, 2007
Flow (gpm)
2,500.00
2,000.00
1,500.00
1,000.00
500.00
0.00
12:00 AM
4:00 AM
8:00 AM
12:00 PM
4:00 PM
8:00 PM
12:00 AM
4:00 AM
8:00 AM

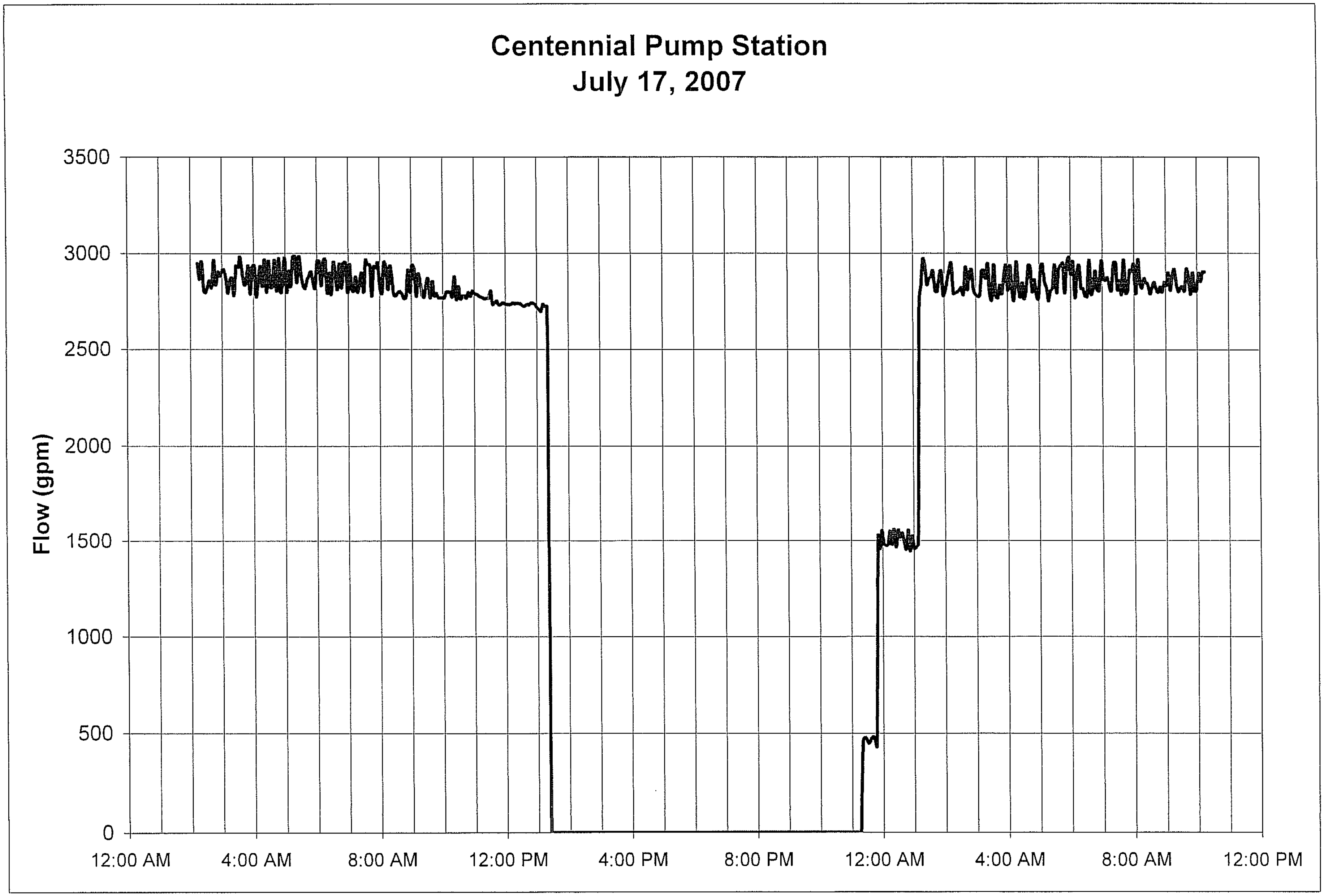


JVWCD 165 W 114th S Connection
July 17, 2007
Flow (gpm)
2500
2000
1500
1000
500
0
12:00 AM
4:00 AM
8:00 AM
12:00 PM
4:00 PM
8:00 PM
12:00 AM
4:00 AM
8:00 AM


JVWCD 700 W 114th S Connection
July 17, 2007
Flow (gpm)
1,800.00
1,600.00
1,400.00
1,200.00
1,000.00
800.00
600.00
400.00
200.00
0.00
12:00 AM
4:00 AM
8:00 AM
12:00 PM
4:00 PM
8:00 PM
12:00 AM
4:00 AM
8:00 AM


Pump Station 4
July 17, 2007
Flow (gpm)
1600
1400
1200
1000
800
600
400
200
0
12:00 AM
4:00 AM
8:00 AM
12:00 PM
4:00 PM
8:00 PM
12:00 AM
4:00 AM
8:00 AM
12:00 PM
4:00 PM


Pump Station 3
July 17, 2007
Flow (gpm)
1800
1600
1400
1200
1000
800
600
400
200
0
12:00 AM
4:00 AM
8:00 AM
12:00 PM
4:00 PM
8:00 PM
12:00 AM
4:00 AM
8:00 AM
12:00 PM



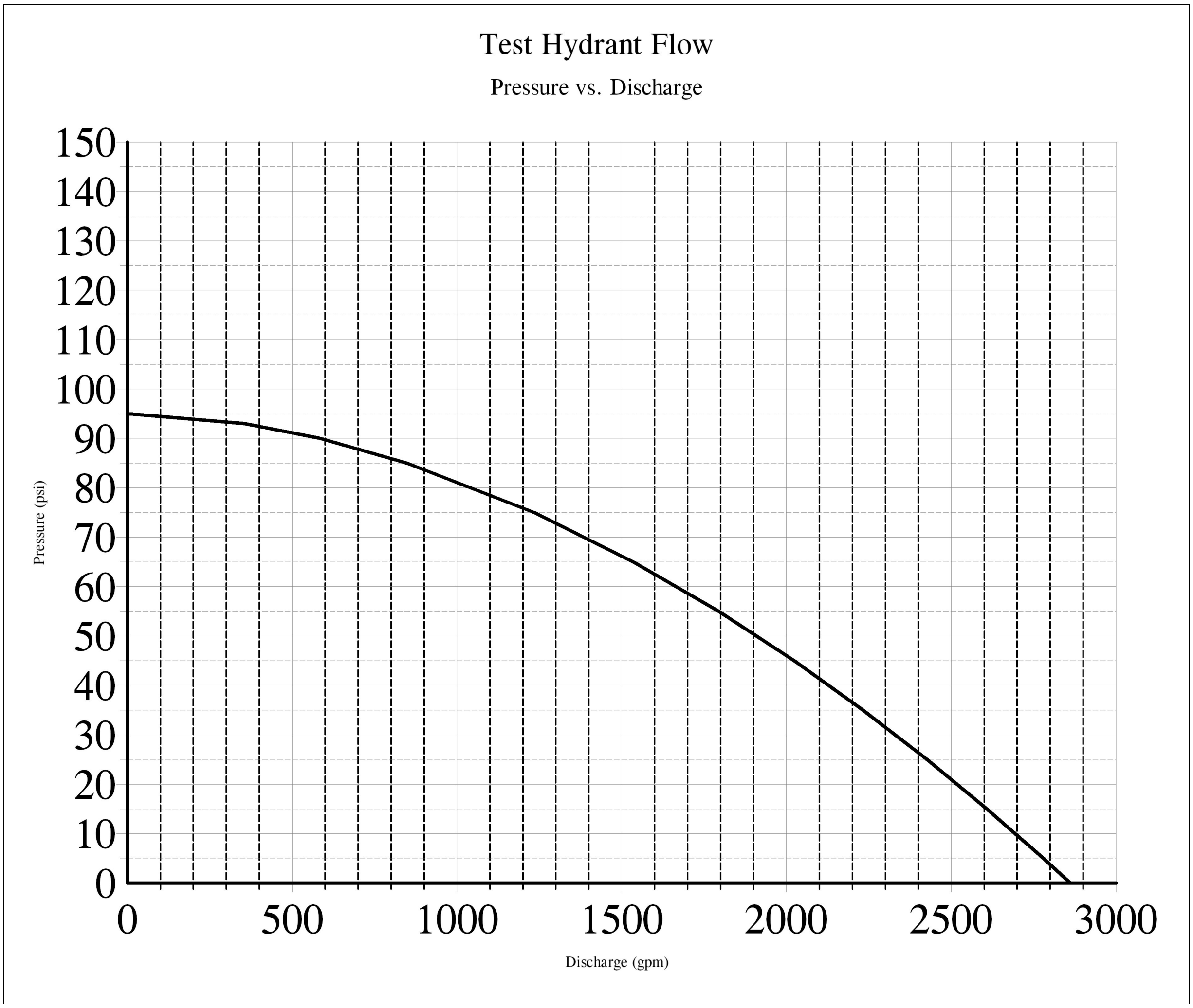
Centennial Pump Station
July 17, 2007
Flow (gpm)
3500
3000
2500
2000
1500
1000
500
0
12:00 AM
4:00 AM
8:00 AM
12:00 PM
4:00 PM
8:00 PM
12:00 AM
4:00 AM
8:00 AM
12:00 PM

TEST NUMBER	TEST HYDRANT				FLOW HYDRANT		ENGINEER	NOTES
	Static Pressure		Residual Pressure		Pitot Pressure			
	System	Model	System	Model	System	Model		
1	140	140	127	127	78	101	VB&F	
2	120	120	60	70	45	64	VB&F	rock in hydrant
3	95	95	78	77	63	65	HAL	
4	90	90	82	82	53	79	HAL	
5	157	157	126	126	106	119	?	PRV Open
6	69	69	69	65	61	75	HAL	
7	100	100	97	97	97	97	HAL	
8	60	60	46	46	37	37	HAL	
9	66	66	53	53	50	50	HAL	closed pipe. PRV set at 35
10	45	45					HAL	Pressure test
11	126	126					HAL	Pressure test

Client: Draper City
Project: Water Master Plan
Feature: Fire Flow Test 3
Date: 27 Aug 2007 Time: 09:45 AM

DIFFUSER TEST

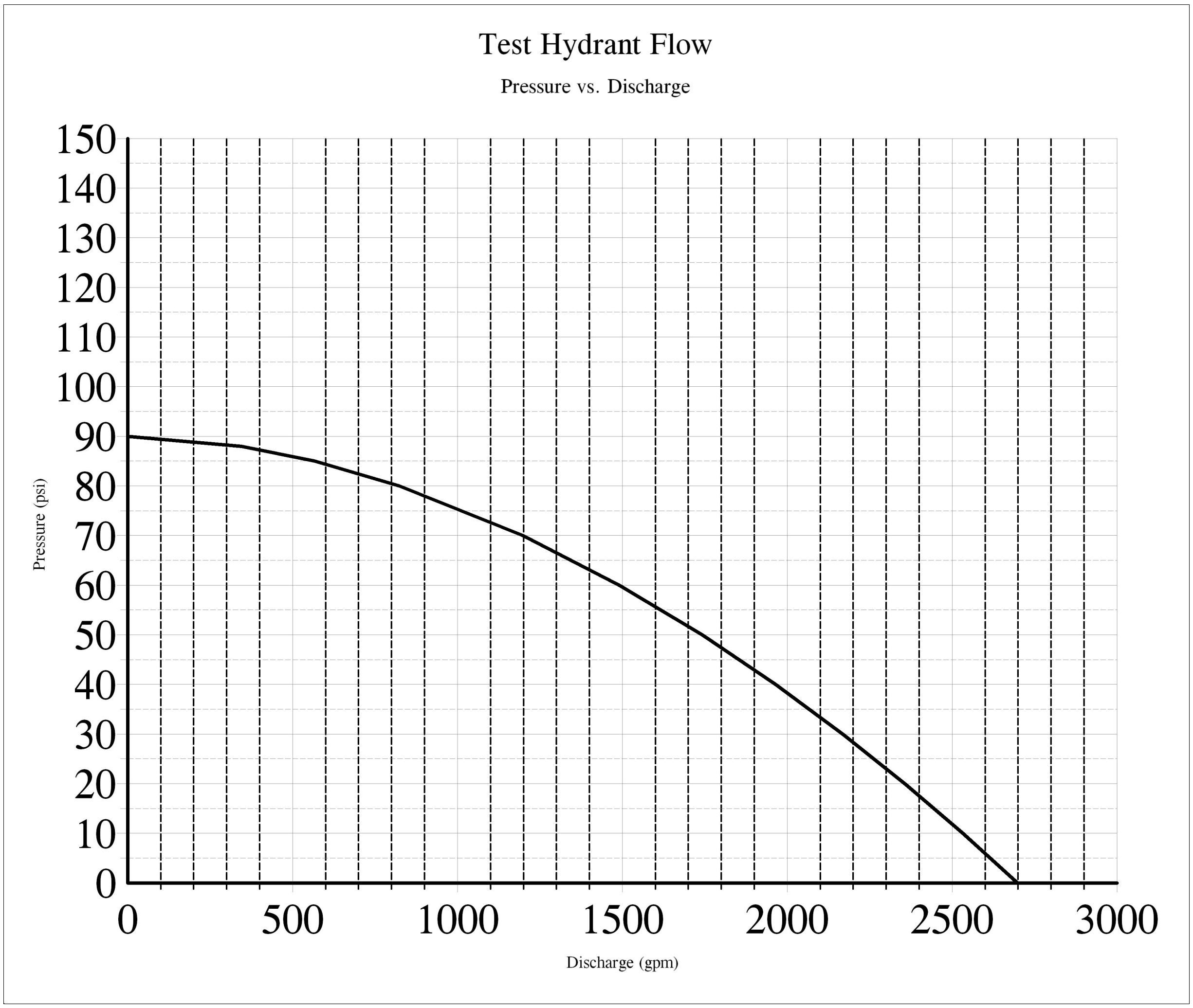
FLOW HYDRANT	15221 Steep Mountain Drive		TEST HYDRANT	15279 Steep Mountain Drive	
Pitot Pressure	63.0	psi (velocity head)	Static Pressure	95	psi
Discharge Coef., C	0.9		Residual Pressure	78	psi
Diffuser Throat ID	2.469	inches	Residual Flow at 20 psi	2518	gpm
Flowrate, Q	1130	gpm			
Static Pressure	NA	psi			



Client: Draper City
Project: Water Master Plan
Feature: Fire Flow Test 4
Date: 8 Aug 2004 Time: 10:05 AM

DIFFUSER TEST

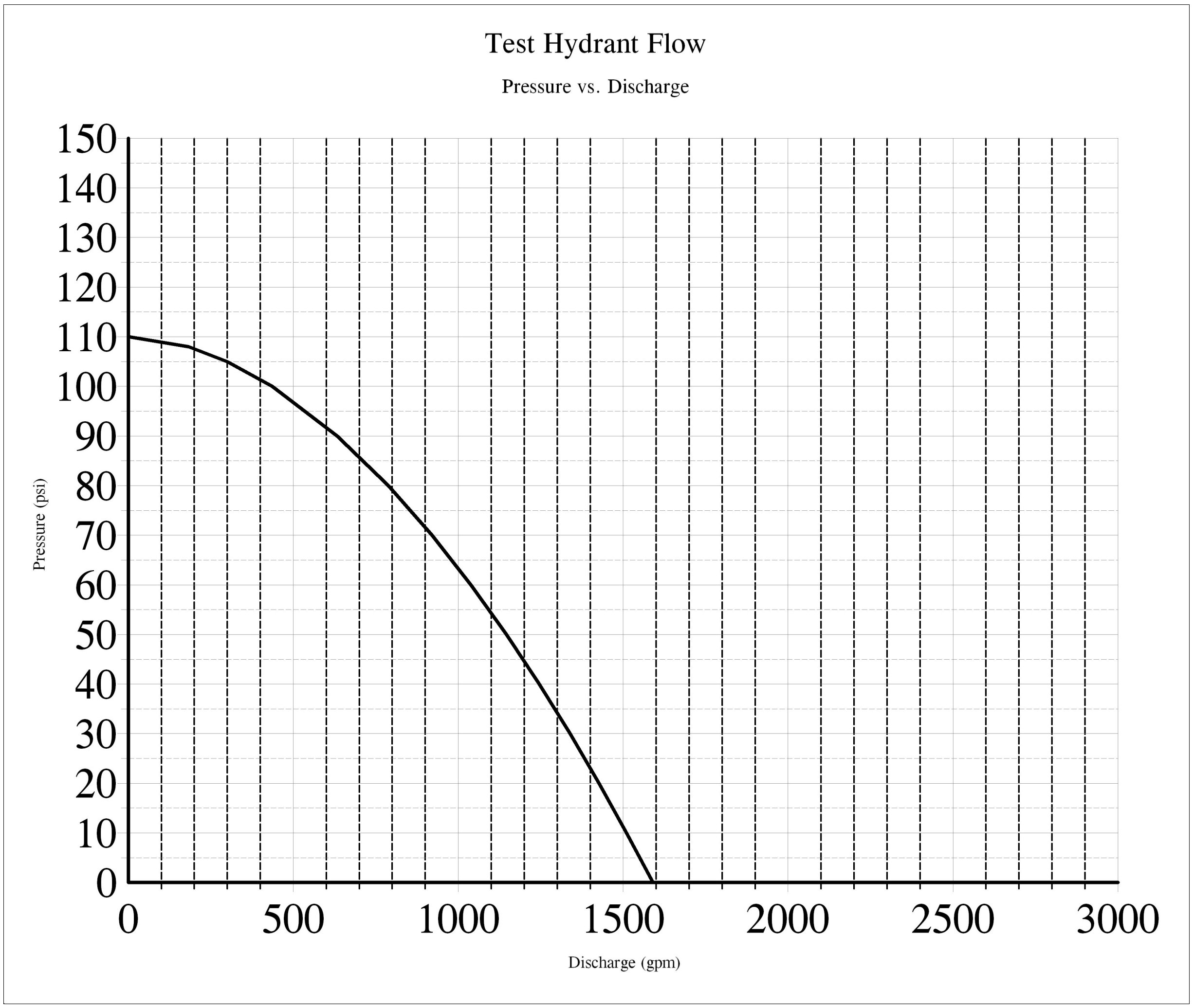
FLOW HYDRANT	428 Steep Mountain Drive		TEST HYDRANT	492 Steep Mountain Drive	
Pitot Pressure	53.0	psi (velocity head)	Static Pressure	90	psi
Discharge Coef., C	0.9		Residual Pressure	74	psi
Diffuser Throat ID	2.469	inches	Residual Flow at 20 psi	2356	gpm
Flowrate, Q	1062	gpm			
Static Pressure	NA	psi			



Client: Springville City
Project: Water Master Plan
Feature: Fire Flow Test 5
Date: 25 May 2004 Time: 09:40 AM

DIFFUSER TEST

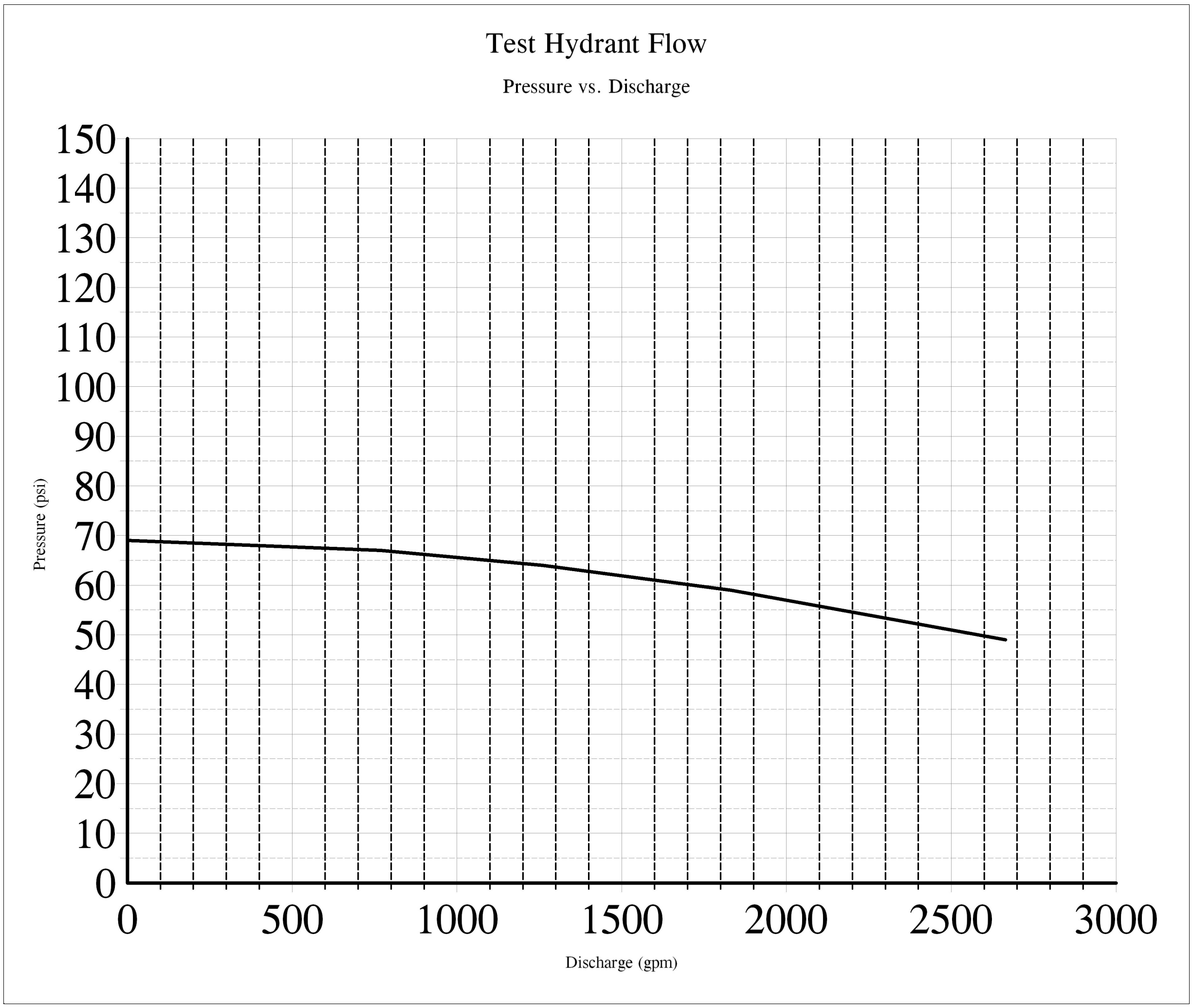
FLOW HYDRANT	671 E 1150 N		TEST HYDRANT	793 E 1150 N	
Pitot Pressure	50.0	psi (velocity head)	Static Pressure	110	psi
Discharge Coef., C	0.9		Residual Pressure	60	psi
Diffuser Throat ID	2.469	inches	Residual Flow at 20 psi	1427	gpm
Flowrate, Q	1039	gpm			
Static Pressure	135	psi			



Client: Draper City
Project: Water Master Plan
Feature: Fire Flow Test 6
Date: 27 Aug 2007 Time: 10:30 AM

DIFFUSER TEST

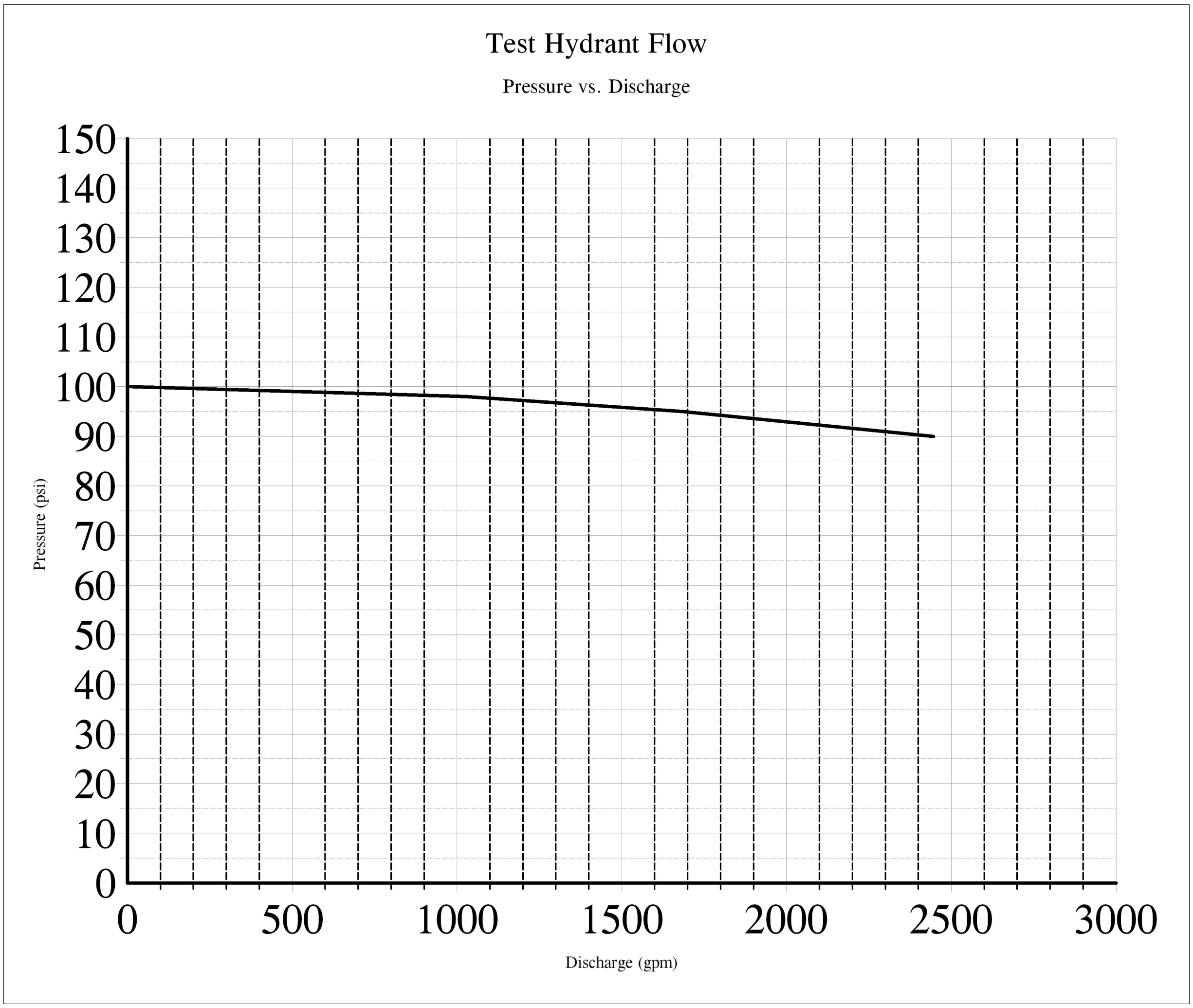
FLOW HYDRANT	14632 Woods Landing Ct		TEST HYDRANT	14678 Woods Landing Ct	
Pitot Pressure	61.0	psi (velocity head)	Static Pressure	69	psi.
Discharge Coef., C	0.9		Residual Pressure	65	psi
Diffuser Throat ID	2.469	inches	Residual Flow at 20 psi	4323	gpm
Flowrate, Q	1117	gpm			
Static Pressure	60	psi.			



Client:	Draper City
Project:	Water Master Plan
Feature:	Fire Flow Test 7
Date:	27 Aug 2007 Time: 11:20 AM

DIFFUSER TEST

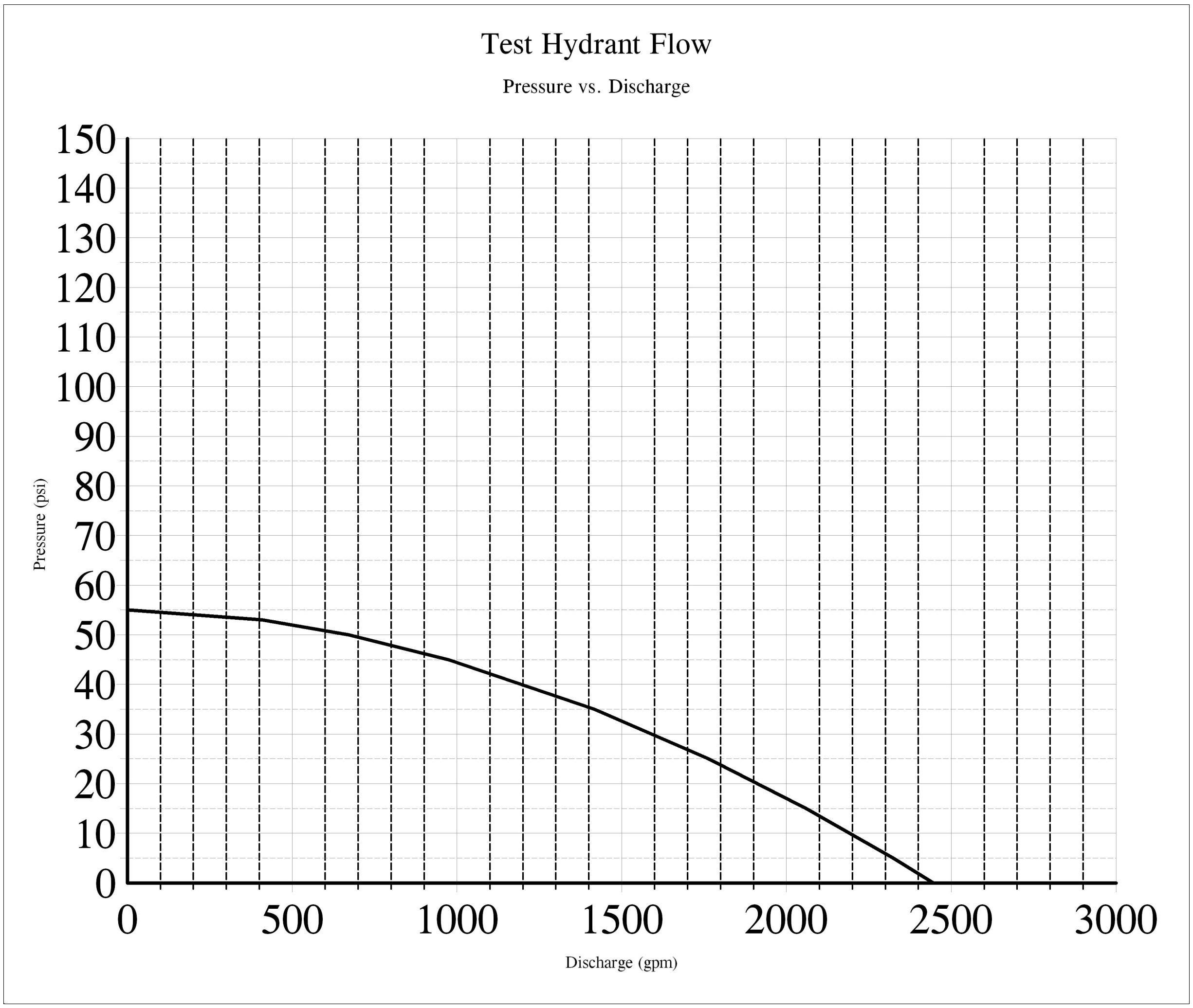
FLOW HYDRANT	1925 E EAGLE CREST DR		TEST HYDRANT	Traverse Rdge Rd	
Pitot Pressure	97.0	psi (velocity head)	Static Pressure	100	psi.
Discharge Coef., C	0.9		Residual Pressure	97	psi
Diffuser Throat ID	2.469	inches	Residual Flow at 20 psi	7519	gpm
Flowrate, Q	1277	gpm			
Static Pressure	NA	psi.			



Client:	Draper City
Project:	Water Master Plan
Feature:	Fire Flow Test 8
Date:	27 Aug 2007 Time: 11:55 AM

DIFFUSER TEST

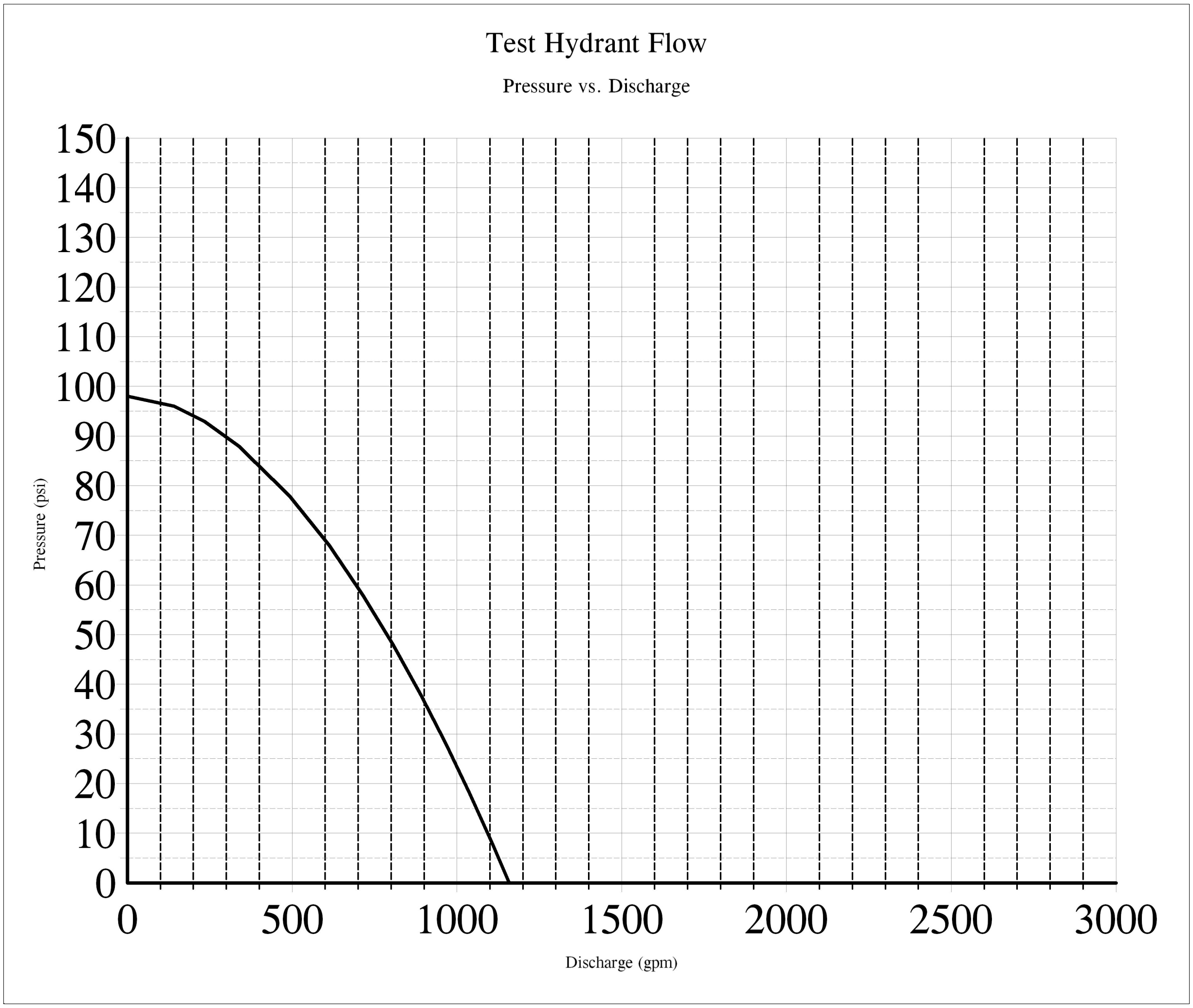
FLOW HYDRANT	2192 Eagle Crest Dr		TEST HYDRANT	15176 Eagle Crest Dr	
Pitot Pressure	37.0	psi (velocity head)	Static Pressure	55	psi.
Discharge Coef., C	0.9		Residual Pressure	46	psi
Diffuser Throat ID	2.469	inches	Residual Flow at 20 psi	1917	gpm
Flowrate, Q	920	gpm			
Static Pressure	100	psi.			



Client: Draper City
Project: Water Master Plan
Feature: Fire Flow Test 9
Date: 27 Aug 2007 Time: 12:10 AM

DIFFUSER TEST

FLOW HYDRANT	1982 Fielding Hill Ln		TEST HYDRANT	2008 Fielding Hill Ln	
Pitot Pressure	50.0	psi (velocity head)	Static Pressure	98	psi.
Discharge Coef., C	0.9		Residual Pressure	18	psi
Diffuser Throat ID	2.469	inches	Residual Flow at 20 psi	1025	gpm
Flowrate, Q	1039	gpm			
Static Pressure	110	psi.			



APPENDIX B
Computer Model Output

SEE DISK

APPENDIX C
Cost Estimate Calculations

MAP ID	PROJECT DESCRIPTION	UNIT	UNIT TYPE	UNIT COST	COST	Contengency (20%) and Engineering (15%)	TOTAL COST
1	2 Peaking Flow Control Valaves on 11400 S JVWCD Connections	2	Each	9400	$18,800	$6,580	$25,000
2	3 WaterPro Interconnects	3	Each	100000	$300,000	$105,000	$405,000
	Back/alternative power for booster pump stations	1	Each	260000	$260,000	$91,000	$351,000
	New Water Source Feasibility Study	1	Each	$100,000	$100,000	$35,000	$135,000
3	1.5 MG of additional storage for Zone 2	1.5	MG	$1,000,000	$1,500,000	$525,000	$2,025,000
4	Install a PRV at 2180 East Eagle Crest Drive to add fire flow redunndancy from Zone 4 to Zone 3 and to improve fire flow at hydrants.	1	each	$100,000	$100,000	$35,000	$135,000
5	Stoneleigh Heights II has operating and fire flow pressures that are too low. Install a PRV at the intersection of Suncrest Drive and Haddington Road off the Zone 4 pipeline.	1	each	$100,000	$100,000	$35,000	$135,000
6	The Cranberry Hill subdivision has several deadend 6-inch diameter pipelines that limit fire flow. Replace the 6-inch diameter pipelines in Mayberry Court (500 ft), Cranberry Hill Court (500 ft), and Honey Locust Court (500 ft) with 8-inch diameter pipelines.	1500	foot	$122	$183,000	$64,050	$247,000
TOTAL EXISTING WATER SYSTEM IMPROVEMENT PROJECT COSTS							**$3,458,000**
7	New Centennial 10,000 gpm Pump Station	1	Each	$1,800,000	$1,800,000	$630,000	$2,430,000
8	9,000 gpm Upgrade for Pump Station 3	1	Each	$600,000	$600,000	$210,000	$810,000
9	1,500 gpm Pump Station 4 Upgrade	1	Each	$250,000	$250,000	$87,500	$338,000
10	3.0 MG of Storage for Zone 2	3	MG	$1,000,000	$3,000,000	$1,050,000	$4,050,000
11	2.0 MG Tank 3b	2	MG	$1,000,000	$2,000,000	$700,000	$2,700,000
12	5.0 MG Zone 1 Storage	5	MG	$1,000,000	$5,000,000	$1,750,000	$6,750,000
13	1.0 MG Tank 3c	1	MG	$1,000,000	$1,000,000	$350,000	$1,350,000
14	1.0 MG Tank 3d	1	MG	$1,000,000	$1,000,000	$350,000	$1,350,000
15	0.5 MG of Storage for Zone 4 or 5	0.5	MG	$1,000,000	$500,000	$175,000	$675,000
16	Install PRV at the intersection of Highland Drive and Traverse Ridge Road. Install 4,500 ft of 12-inch diameter pipeline in Highland Drive from Traverse Ridge Road to Minuteman Drive.	4500	foot	$152	$684,000	$239,400	$1,058,000
17	Install 12,000 feet of 24-inch diameter transmission pipeline between the Centiennial Pump Station and the new Zone 2 Tank.	12000	foot	$289	$3,468,000	$1,213,800	$4,682,000
18	Install 5,000 feet of 14-inch diameter pipeline in Galena Park Boulevard from Cephus Road to Green Clover Road (500 West)	5000	foot	$166	$830,000	$290,500	$1,121,000
19	Install 1,400 feet of 14-inch diameter pipeline in Green Clover Road (500 West) from Galena Park Boulevard to 13490 South.	1400	foot	$166	$232,400	$81,340	$314,000
20	Install 2,500 feet of 14-inch diameter pipeline in 13490 South from Green Clover Road (500 West) to 200 West.	2500	foot	$166	$415,000	$145,250	$560,000
21	Install 2,500 feet of 14-inch diameter pipeline in Green Clover Road (500 West) to 200 West from 13490 South to 13775 South.	2500	foot	$166	$415,000	$145,250	$560,000
22	Install 2,200 feet of 12-inch diameter pipeline in 13775 South from Green Clover Road (500 West) to 200 West	2200	foot	$152	$334,400	$117,040	$451,000
23	Install 10,500 ft of 14-inch diameter pipeline from Highland Drive south in Minuteman Dr.	10500	foot	$166	$1,743,000	$610,050	$2,353,000
24	Install 12,000 feet of 16-inch diameter pipeline parallel to the 12-inch diameter pipeline in Suncrest Drive or equivalent looped.	12000	foot	$205	$2,460,000	$861,000	$3,321,000
25	Install 3,200 feet of 16-inch diameter pipeline in Green Clover Road (500 West) from 13775 South to 14000 South	3200	foot	$205	$656,000	$229,600	$886,000
26	Install 3,000 feet of 24-inch diameter pipeline in from Green Clover Road (500 West) and 14000 South to 14600 South and Pony Express Road.	3000	foot	$289	$867,000	$303,450	$1,170,000
27	Install 10,000 ft of 12-inch diameter pipeline from Suncrest Drive to proposed Zone 4 development and 7,000 ft of a parallel 12-inch diameter pipeline from Suncrest Drive to a new Zone 3 Tank.	10000	foot	$152	$1,520,000	$532,000	$2,052,000
		7000	foot	$152	$1,064,000	$372,400	$1,436,000
28	Install 2,000 ft of 16-inch diameter pipeline and 6,000 ft of 12-inch diameter pipeline from a new Zone 3 tank along East Loop Road.	2000	foot	$205	$410,000	$143,500	$554,000
		6000	foot	$152	$912,000	$319,200	$1,231,000
29	Install 10,000 ft of 16-inch diameter pipeline at the end of Suncrest Drive.	10000	foot	$205	$2,050,000	$717,500	$2,768,000
TOTAL FUTURE RECOMMENDED PROJECT COSTS							**$44,970,000**

AVERAGE WATER PIPE COST PER FOOT

Diameter (in)	Diameter (ft)	Outside Diameter (ft)	Pipe Material & Installation (1)	Excavation	Imported Bedding Installed	Hauling Excess Native Mat'l	Trench Backfill Installed (3)	Trench Box per Day (2)	Average Daily Output	Trench Box Cost	Top Trench Width (ft)	Road Repair Width (ft)	Asphalt Cost	Service Lateral Cost	Fire Hydrant Cost	Valves & Fittings Cost	Pipeline Connection Costs	Conflicts (8)	Trench Dewatering (4)	Total Cost per Foot of Pipe	Cost Out of Street (3)
4	0.3	0.39	16.90	2.54	10.15	4.96	5.17	202.65	190	1.07	3.79	7.79	29.17	8.50	12.00	2.78	5	0.00	0.00	98	68
6	0.5	0.58	21.00	2.81	11.63	5.50	5.46	202.65	130	1.56	3.98	7.98	29.78	8.50	12.00	3.35	5.5	0.00	0.00	107	75
8	0.7	0.78	31.50	3.10	13.13	6.05	5.75	202.65	115	1.76	4.18	8.18	30.39	8.50	12.00	4.02	6	0.00	0.00	122	89
10	0.8	0.97	40.50	3.40	14.67	6.64	6.04	202.65	100	2.03	4.37	8.37	31.00	8.50	12.00	6.82	8.5	0.00	0.00	140	101
12	1.0	1.17	43.50	3.71	16.22	7.25	6.33	202.65	94	2.16	4.57	8.57	31.61	8.50	12.00	9.82	11	0.00	0.00	152	108
14	1.2	1.36	49.50	4.04	17.81	7.90	6.62	202.65	88	2.30	4.76	8.76	32.22	8.50	12.00	13.10	12.1	0.00	0.00	166	117
16	1.3	1.56	70.50	4.38	19.42	8.57	6.91	202.65	88	2.30	4.96	8.96	32.83	8.50	12.00	16.23	13.2	9.74	0.00	205	151
18	1.5	1.75	79.00	4.74	21.05	9.26	7.20	202.65	72	2.81	5.15	9.15	33.44	8.50	12.00	23.91	14.3	10.81	0.00	227	164
20	1.7	1.94	87.50	5.11	22.72	9.99	7.49	202.65	72	2.81	5.34	9.34	34.05	8.50	12.00	30.00	15.4	11.78	0.00	247	177
24	2.0	2.33	113.00	5.89	26.12	11.52	8.06	202.65	64	3.17	5.73	9.73	35.27	8.50	12.00	34.25	17.7	13.77	0.00	289	212
30	2.5	2.92	N/A	7.18	31.42	14.02	8.93	202.65	56	3.62	6.32	10.32	37.10	8.50	12.00	53.00	21	N/A	0.00	N/A	N/A
36	3.0	3.50	N/A	8.59	36.96	16.78	9.80	202.65	48	4.22	6.90	10.90	38.93	8.50	12.00	100.00	24.3	N/A	0.00	N/A	N/A

Reference: 2008 RS Means Heavy Construction Cost Data

Assumptions:

- **Y** **Total Import Trench Backfill? (Y/N)**
- **N** **Dewatering? (Y/N)**
- **DIP** **Pipe Material (PVC/DIP/HDPE) - Note 1**
- 10 v :1h trench side slope (use trench boxes)
- 3 ' average depth to top of pipe
- 0.33 ' thick asphalt road covering
- 0.75 ' thick untreated base course
- 3 ft + Outside Diameter = Bottom trench width
- 1 ft bedding over pipe
- 0.5 ft bedding under pipe
- 5 # of service laterals per 1000 ft
- 2 # of fire hydrants per 1000 ft
- 2 # of valves per 1000 ft
- 3 # of fittings per 1000 ft
- 1 # pipeline connections per 1000 ft

Costs:

- $ 43.62 /CY Import Trench Backfill - use Imported Select Fill
- $ 43.62 /CY Imported Select Fill - pg 224-225: Sand, dead or bank w/ hauling (20 CY, 5 mi) and compaction. ($21.00/LCY + $7.10/LCY)*1.39 LCY/ECY + $4.56/ECY
- $ 5.05 /CY Excavation - pg 210 (Item 1375): 10-14 ft deep, 1 CY excavator, Trench Box.
- $ 28.21 /SY 4" Asphalt Pavement - pg 259-260,225: 9" Bank Run GravelBase Course ($9.15/SY), 2" Binder ($7.30/SY), 2" Wear ($8.20/SY [4"=$15.65/SY]) and Hauling ($7.10/LCY * 1.39LCY/ECY * 0.361CY/SY)
- $ 2.38 /LF 4" Asphalt cutting - pg 36: Saw cutting asphalt up to 3" deep ($1.60/LF), each additional inch of depth ($0.78/LF)
- $ 1,700.00 /EA Service Lateral Switched Over from old pipe to new pipe (see Note 7)
- $ 6,000.00 /EA Fire hydrant assembly including excavation and backfill (see Note 8)
- $ 9.87 /CY Hauling - pg 225: 20 CY dump truck, 5 mile round trip and conversion from loose to compacted volume. $7.10/LCY * 1.39 LCY/ECY
- $ 202.65 /day Trench Box (7' deep, 16' x 8', pg 245)
- $ 73.50 /CY Stabilization Gravel - pg 224-225: Bank Run Gravel ($42.50/LCY * 1.39 LCY/ECY) plus compaction ($4.56/ECY) and hauling ($7.10/LCY * 1.39 LCY/ECY)
- $ 880.00 /day Dewatering - pg 221: 4" diaphram pump, 8 hrs attended ($770/day). Second pump ($110/day)

NOTES:

(1) Assumes: class 50, 18' lengths, tyton push-on joint for DIP (Pg 296-297); Pressure Pipe class 150, SDR 18, AWWA C905 for PVC <14" & AWWA C905, PR 100, DR 41 for 14" and larger (Pg 298); butt fusion joints SDR 21, 40' lengths for HDPE (Pg 299).
DIP and HDPE costs only go up to 24". PVC costs only go up to 48". All costs for pipe larger than 48" are Prestressed Concrete pipe (PCCP), 150 psi, 24' length (Pg 296).

(2) 7' deep trench box (16' x 8') - on page 245

(3) Backfill Material & Installation assumes in street. For out of street unit costs, the backfill material cost has been added in place of base course and asphalt.

(4) Dewatering assumes 1' stabilization gravel at the bottom of the trench plus dewatering pumps

(5) Conversion from loose to compacted volumes assumes 125 PCF for compacted density and 90 PCF for loose density. Or (125 PCF/ECY)/(90 PCF/LCY) = 1.39 LCY/ECY

(6) Conversion from cubic yards to square yards for hauling of asphalt paving assumed a total thickness of 13". 3 ft x 3 ft x (13 in)/(12 in/ft) = 0.361 CY/SY

(7) Service Lateral costs are based on Springville 2006 Water Projects to Switch over Water Service Connections to the new pipeline. $1400 to $1600 in January 2007. Use $1700 for 2008. DOES NOT INCLUDE THE METER ASSEMBLY!

(8) Fire Hydrant assembly costs are based on Springville 2006 Water Projects . $5,500 in January 2007. Use $6000 for 2008.

(9) Conflicts ammounted to be 2% of the cost on the Springville 400 South Pipeline project. Use 5% of total cost per ft.

Abbreviations:

VLF	vertical lineal foot
PCF	pounds per cubic foot
LCY	loose cubic yard
ECY	embankment cubic yard

APPENDIX D
Rate Evaluation

Rate Evaluation

Introduction

As part of the overall Master Plan effort, Draper City requested a brief water rate evaluation. The specific tasks that were included in the scope of work are as follows:

- Review water system revenues, expenditures and water fees. Determine whether or not the Water Fund is self supporting or if it is being subsidized by the General Fund.

- Compare the existing fee structure to the fee structure of similar local water systems to determine if the water fees currently charged are in the same range as other systems.

- Prepare a summary of findings and recommendations.

This rate evaluation is not intended to be a comprehensive water rate study with recommendations on future water rates for the City. It is rather intended to be an evaluation of the general trends of the City's water fund and a comparison of the City's water rates with other similar municipalities.

Water Fund Trends

A review of the City's water fund was conducted to look at general trends from 2005 to 2008, including 2009 projected values. This review included both the operating fund and the capital fund.

In the evaluation, the operating fund as reported by the City was modified by removing all non-operating line items in order to perform a comparison of operating revenues and expenses before depreciation. Line items removed from the operating fund included the following:

- 51-30-0006 Contributions From Developers
- 51-39-9541 Transfer from CIP Fund
- 51-40-7090 Depreciation

The evaluation shows that the net operating profit has an overall declining trend. Reasons for this trend could include: rising water purchase costs from Jordan Valley Water Conservancy District, rising costs for power, fuel, and City personnel salary adjustments.

A summary of the evaluation is presented in Table A1.

TABLE A1
WATER OPERATING FUND TRENDS [1]

	2005	2006	2007	2008	2009 (projected)
Net Operating Fund Profit/Loss	$ 662,000	$ 883,000	$ 679,000	$ 310,000	$ 114,000

1. Non-operating revenues and expenditures were removed from City Water Fund reported values

A similar evaluation was prepared for the Capital Improvements Fund. This fund is also showing a declining trend in fund balances, as presented in Table A2. The declines in the Capital Improvements Fund appear to be due to large capital expenditures for water system capital improvements projects.

TABLE A2
WATER CAPITAL IMPROVEMENTS FUND TRENDS

	2005	2006	2007	2008	2009 (projected)
Capital Improvements Fund End Balance	$ 666,000	$ 1,084,000	($ 2,325,000)	($ 3,513,000)	($ 3,438,000)

A summary of the combined operating and capital funds is presented in Table A3. The total water fund balance declines an average of about $ 675,000 per year, assuming a straight line between 2005 actual and 2009 projected values.

TABLE A3
TOTAL WATER FUND BALANCE TRENDS [1]

	2005	2006	2007	2008	2009 (projected)
Total Ending Fund Balance, millions	$ 2.2	$ 4.1 [2]	$1.3	$ (0.2)	$ (0.5)

1. Includes both operation and capital funds
2. Includes a $ 1.3 M contribution from developers. Without this contribution, the value would have been $ 2.8 M.

The City's water fund accounting information provided by the City did not show any evidence that the City's general fund was contributing to or subsidizing the water fund.

User Rates Comparison

A comparison was made between Draper City water rates and other nearby municipalities and water providers. A summary of the comparison is shown in Table A4.

TABLE A4
WATER RATES COMPARISON

	Sandy City	Herriman	South Jordan	Water Pro	Draper
Base Water User Monthly Charge	$20.52	$21.00	$31.19	$18.00	$21.88 to $28.18
Water Allowance, 1,000 gallons	8,000	0	0	0	5,000
Overage Charge per 1,000 gallons	$2.16	$1.30 to $2.58	$1.31 to $2.58	$1.23 to $3.88	$1.63 to $2.89
Charge for Peak Month Demand (1)	$102.04	$86.19	$104.58	$92.57	$88.29
Impact Fee	$1,720	$3,528 to $4,156	$3,194	$2,963 to $7,763	$1,853
Commercial	Same as residential	Base rate x ERC	Base rate = $66.14	Base rate x ERC	Same as residential

1. For 45,752 gallons, which is Draper City average residential usage on peak month.

Although Draper's base monthly charge appears to be about the same as the others, the peak month total water bill is second to the lowest.

Rate Increase Effect on Water Fund

A water rate increase would help to stabilize the current yearly declining fund balance. A projection of different rate increase scenarios was made to determine the magnitude of rate increase which might be needed to generate the revenue needed to maintain a steady year end fund balance. A summary of this projection is presented in Table A5, which is included at the end of this section.

The projection for 2009 shows that the base rate could be raised by $ 7.38 per month, or the overage could be increased by about $ 0.40 per 1,000 gallons in order to maintain a steady fund balance. If the City wanted to generate an additional $ 250,000 per year, the base rate would have to be raised by $ 12.24, or overage raised by about $ 0.65. A third scenario looks at generating an additional $ 1,417,000 per year, which is the amount needed to fund a

$ 3.5 Million capital improvements program over three years. With this scenario, the base rate would have to be raised by $ 35.96, or the overage raised by significantly more than $ 0.70. Similar projections were made for 2010, including inflation values as noted.

It is important to note that these projections assume that all present water fund budgets will remain as they are currently budgeted, with inflation as noted. The projection does not include impact fee increases (which are recommended based on the recommended Capital Improvements Program), or analyses of rate increases for different water service pressure zones within the City. Therefore, the value of this projection is limited to estimating the order of magnitude that may be needed for a water rate increase.

Recommendations

The following recommendations are made to the City with respect to water rates.

1. The City should consider a rate increase that will effectively balance revenues and expenses.

2. The rate increase should include the necessary revenues to support near term (0-5 years) capital improvements projects, including the specific funding mechanism that the City selects for these projects.

3. The City should adjust Impact Fees based on the recommended Master Plan Capital Improvements Projects that will be needed to support anticipated future growth. Impact fees adjustments will greatly assist the City in bringing in the revenues to help fund the needed future projects.

4. The City may need to consider bond issues for capital improvements projects, depending on many issues such as project timing, capital funds currently on hand, impact fees revenue expectations, etc.

TABLE A5
RATE INCREASE EFFECTS

				MONTHLY BASE RATE INCREASE IF OVERAGE IS INCREASED BY							
				$0.00 per 1000 gal	$0.10 per 1000 gal	$0.20 per 1000 gal	$0.30 per 1000 gal	$0.40 per 1000 gal	$0.50 per 1000 gal	$0.60 per 1000 gal	$0.70 per 1000 gal
2009 Projected (1)	Projected	Expenses	$2,894,728								
		Revenues	$2,515,000								
		Net Income/Loss	-$379,728								
	Break Even	Revenues	$2,894,728	$7.38	$5.50	$3.61	$1.73	-$0.16	-$2.04	-$3.92	-$5.81
		Net Income/Loss	$0								
	+$250,000	Revenues	$3,144,728	$12.24	$10.36	$8.47	$6.59	$4.70	$2.82	$0.94	-$0.95
		Net Income/Loss	$250,000								
	+$1,417,000 (3)	Revenues	$4,364,728	$35.96	$34.07	$32.19	$30.30	$28.42	$26.54	$24.65	$22.77
		Net Income/Loss	$1,470,000								
2010 Projected (2)	Projected	Expenses	$2,998,301								
		Revenues	$2,515,000								
		Net Income/Loss	-$483,301								
	Break Even	Revenues	$2,998,301	$9.39	$7.51	$5.63	$3.74	$1.86	-$0.03	-$1.91	-$3.79
		Net Income/Loss	$0								
	+$250,000	Revenues	$3,248,301	$14.25	$12.37	$10.49	$8.60	$6.72	$4.83	$2.95	$1.06
		Net Income/Loss	$250,000								
	+$1,417,000 (3)	Revenues	$4,415,301	$36.94	$35.06	$33.17	$31.29	$29.40	$27.52	$25.63	$23.75
		Net Income/Loss	$1,417,000								

(1) Expenses and revenues are taken from City projections
(2) Expenses and revenues are inflated from 2009 as follows:
- JVWCD water costs + 5%
- Power costs + 5%
- All other expenses + 2%

(3) $3.5M Generated over 3 years plus $250,000