SURPRISE

ARIZONA

City of Surprise
Water Infrastructure Master Plan

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Acronyms and Abbreviations

AAC	Arizona Administrative Code
AAW	Arizona American Water
ADEQ	Arizona Department of Environmental Quality
ADF	Average Daily Flow
ADWR	Arizona Department of Water Resources
AWWA	American Water Works Association
CAGRD	Central Arizona Groundwater Replenishment District
CAP	Central Arizona Project
CAWCD	Central Arizona Water Conservation District
DU	Dwelling Units
Gal	Gallons
GPAD	Gallons Per Acre Per Day
GPCD	Gallons Per Capita Per Day
GPD	Gallons Per Day
GPM	Gallons Per Minute
LF	Linear Feet
MAG	Maricopa Association of Governments
MG	Million Gallons
MGD	Million Gallons Per Day
MPA	Municipal Planning Area
MWD	Maricopa Water District
PPH	Persons Per House
psi	Pounds Per Square Inch
SPA	Special Planning Area

Glossary of Terms

Acre-foot (AF) A volume of water equal to 325,851 gallons.

Active Management Area (AMA) An area designated by ADWR to meet specific groundwater management goals.

Average Day Demand The average demand over a specific time period over which the average is calculated. For example, the annual water consumption divided by 365 days in a year.

Aquifer A geologic formation or soils that is sufficiently saturated to transmit or yield economic quantities of water to wells or springs.

Drinking Water Water that meets or exceeds all applicable federal, state, county, city, and local requirements concerning safety. Drinking water is also called potable water.

Groundwater The water contained in the aquifer.

Incidental Recharge The irrigation of landscape or crops, which results in the secondary benefit of adding water to the aquifer.

Maximum Day Demand The maximum demand over a one-day period.

Numeric Model A computer program used to design and analyze water, reclaimed, or wastewater systems.

Peak Hour Demand The maximum demand over a one-hour period.

Recharge The application of water to the land surface for the specific purpose of adding water to the aquifer.

Reclaimed System Collectively, all property involved in the production, distribution, and treatment of reclaimed water, including land, water source, water lines, reservoirs, pumps, motors, hydraulic structures, and general properties.

Reclaimed Water Wastewater that has been treated and recovered for useful purposes.

Surface Water All water on the surface, as distinguished from subsurface water or groundwater.

Wastewater The used water from a community, customer, or individual.

Wastewater System Collectively, all property involved in the collection and treatment of wastewater, including land, sanitary sewer lines, treatment plants, pumps, motors, hydraulic structures, and general properties.

Water Provider A city, town, private water company, water co-operation, or public wholesaler responsible for the direct or indirect distribution of water to its customers.

Water System Collectively, all property involved in the production, distribution, and treatment of drinking water, including land, water source, water lines, reservoirs, pumps, motors, hydraulic structures, and general properties.

References

Arizona Department of Water Resources, February 13, 2001, *Arizona Water Providers*, CD-ROM.

Brown, P. W., December 2001, University of Arizona, *Turfgrass Consumptive Use Values for the Phoenix Area.*

Craftsman Book Company, *2003 Arizona Heavy Construction Costs,* http://www.get-a-quote.net, last accessed January 2003.

City of Phoenix, April 1994, Design Standards Manual.

City of Surprise, *City of Surprise General Plan 2020.*

Haestad Methods Inc., Waterbury, Connecticut, *WaterCAD Users Guide v5*.

International Code Council, *2000 International Fire Code*.

1.0 INTRODUCTION

1.1 Purpose of Study

The City of Surprise (City) is currently experiencing rapid population growth. Along with this rapid growth, comes an increased demand on the City's drinking water, wastewater, reclaimed water, and recharge (water) infrastructure. This Water Infrastructure Master Plan (Master Plan) will serve as a planning tool that will serve as a guide for the development of capital improvement programs and expansion of the City's water infrastructure. Two planning periods have been evaluated for this master plan. The planning periods include the present day (2002) demands, and the build-out demand conditions.

1.2 Scope of Work

RBF was contracted by the City to assist with the development of this Master Plan, which includes an evaluation of the City's existing infrastructure, as well as planning for the infrastructure needs of the future. This included evaluating the existing drinking water and wastewater systems, as well as evaluating the current population demands. The future population growth and distribution patterns utilized for this study were projected by the City's Planning Department and are described in the City's General Plan. The population projections and the associated demands provide the foundation for the development of the future drinking water, wastewater, reclaimed water, and recharge infrastructure. A drinking water system model, wastewater system model, and reclaimed water system model were created in order to analyze the existing infrastructure, as well as to serve as tools in determining an effective build-out system design.

Demand factors for both planning and design purposes have been developed and are presented in this report. Planning level cost estimates have been developed for the improvements to the City's water infrastructure. The build-out planning periods are conceptual, and should be reevaluated prior to undertaking any project.

1.3 Background Information

Background information was provided by the City's Water Services Department, Planning Department, GIS Department, and Engineering Department. Additional information was provided by Arizona American Water Company. Design criteria from the City of Phoenix, City of Peoria, and the City of Glendale were analyzed and are included in the Master Plan. The above and other background information is included in the appendix

1.4 Study Areas

The General Plan is divided into six (6) planning areas known as Special Planning Areas (SPA), which includes approximately 299 square miles. The Master Plan includes SPAs 1, 2, 3, 4, and 5; SPA 6 was not included in this Master Plan. The SPAs are shown in Figure 1 and are explained in greater detail in General Plan.

1.4.1 Drinking Water

Within the drinking water study area there are twelve (12) separate water companies (Figure 2). The City will serve the majority of the study area, however Arizona-American Water Company serves a large portion of SPA 1. The drinking water system was analyzed in two parts, which includes the existing condition within SPA 1 and the build-out of SPA 1-5.

1.4.2 Wastewater

The City currently provides wastewater service throughout the majority of SPA 1 (Figure 3 and 4). The wastewater system was analyzed in two parts, which includes the existing condition within SPA 1 and the build-out of SPA 1-5.

1.4.3 Reclaimed Water

The City currently provides reclaimed water service in SPA 1. The reclaimed water system was analyzed in two parts, which includes the existing condition within SPA 1 and the build-out of SPA 1-5.

2.0 LAND USE AND POPULATION PROJECTIONS

2.1 Land Use

In November 2000, the City completed the General Plan, which included 19 different land use categories (Figure 5). While it is important to understand that future growth may not always follow the land use plan, this plan provided an important piece of information in establishing a plan for the infrastructure growth within the City. The land use plan was utilized throughout the development of this master plan in order to identify the build-out population projections, as well as the spatial distribution of this future population.

2.2 Current Population

The current (2002) population within the City was utilized in developing the drinking water and wastewater models for the present day system. The City Planning Department estimates that the City's 2002 population is 54,416 people. For the purposes of this master plan, it was assumed that this population is contained within the SPA1.

Along with an accurate estimate of the existing population, it is also important to understand how this population is spatially distributed. The spatial distribution of the existing population was determined from the City's drinking water service connection map, as well as maps delineating the existing developments within the City and the associated number of homes that had been completed. This spatial population distribution was utilized in setting up the demands for the model.

2.3 Build-out Population

The build-out population was determined based on the City's land use plan (Figure 5). The different land use areas with their corresponding densities were used to calculate the build-out population. The build-out population utilized for this study is based on the mid range allowable densities.

Existing and proposed developments in SPA 1 were used to determine the build-out population. The densities and population for these developments, as well as existing developments were computed first. In areas where information regarding a proposed development was not provided, the General Plan land use plan and methodology was utilized to compute the build-out population. The SPA 1 build-out population utilized for this master plan is 171,750.

For SPA 2-5, the General Plan made the assumption that the land use type Proving Ground, would remain an undeveloped area. For the purposes of this master plan, it was assumed that this land use type would develop as the surrounding land use types. For SPA 3, the Proving Ground land use was treated as an Employment land use type, while in SPA 4, it was treated as a Rural Residential land use type. The SPA 2-5 build-out population utilized for this master plan is 345,857.

According to the General Plan, the City will have a build-out population of 509,378 people. The build-out population utilized for this study is 517,607, which varies slightly from the build-out population provided in the General Plan. It is important to note that the build-out population may change over time depending on the actual densities of the developments and their final developed land uses.

While understanding the total projected population for the City is important, it is also necessary to understand how the population is distributed. The population distribution was calculated at the square mile level. These population distributions served as the basis for distributing the demands when setting up the models. The build-out population for SPA 1 was computed from various population sources, which include the General Plan, a summary of development progress from the newsletter *Site Lines* (December 2002/January 2003), as well as aerial photos, and the Planning Department. The build-out population distribution for SPA 2-5 was computed from the General Plan Land Use Plan. Figure 6 and Figure 7 show the build-out populations for SPA 1 and SPA 2-5, respectively.

3.0 DRINKING WATER SYSTEM

3.1 Comparison of Design Criteria

In order to establish adequate design criteria for the development of this master plan drinking water design criteria from various water providers within the Phoenix metropolitan area were evaluated. The design parameters evaluated consisted of the identifying the design flows, peaking factors, and maximum and minimum allowable pressures, as well as the waterline sizing including the maximum velocities, valve spacing, and minimum allowable pipe diameters.

The design criteria for the City of Phoenix, Peoria, Glendale, and the Arizona American Water Company were evaluated. The water demand design values are shown in Table 2, while the waterline sizing criteria is shown in Table 3. Additionally, the fire flow requirements and fire hydrant spacing criteria were compared. The fire flow requirements are outlined in Table 4, while the fire hydrant spacing requirements are shown in Table 5.

3.2 Recommended Design Criteria

Based on an analysis of the design criteria of surrounding cities, the present day needs and anticipated growth within the City, a set of recommended design criteria have been developed.

A demand factor of 200 gallons per captia per day (gpcd) should be used when designing drinking water infrastructure. Table 6 outlines the drinking water demands that are recommended within the City, and the demands that are used throughout this master plan.

In order to adequately size the drinking water infrastructure, peaking factors were established for both Maximum Day and Peak Hour scenarios. The Maximum Day scenario represents the single day throughout the year where the greatest amount of water is used. The Peak Hour scenario represents the single hour throughout a year when the greatest demand is placed on the system. For the purposes of this study, and for future design purposes it was recommended that a Maximum Day peaking factor of 2.0 times the average day demand and a Peak Hour factor of 3.0 times the average day demand be utilized (Table 6).

The maximum pipe velocity, valve spacing, and minimum pipe sizes are summarized in Table 9.

One of the fundamental uses of the City's drinking water system is the ability to provide adequate fire protection. The fire flow protection requirements that were utilized in the development of this study, and that are recommended are those requirements outlined in the 2000 International Fire Code (IFC). The IFC contains fire flow requirements based on the building size, type of construction, and proposed building use. The IFC fire flows are based on maintaining a minimum residual pressure of 20 psi throughout the system.

For planning purposes, minimum fire flow requirements for different building types are summarized in Table 7. In addition to the recommended fire flow requirements within the City, the maximum fire hydrant spacing within Surprise is outlined in Table 8.

3.3 Projected Drinking Water Demands

In addition to the present day water demand, the future water demand was also studied. It is estimated that the projected per capita water demand will decrease over the next few years. Based on the City's 2001 Annual Water Report (Appendix B), the water demand is predicted to drop to 144 gpcd by 2008. Table 10 shows the projected annual demand for the years 2002 to 2011.

Based on an analysis of the drinking water demand design criteria, it was determined that a demand factor of 200 gpcd should be used when designing drinking water infrastructure.

3.4 Existing Drinking Water System

The City's drinking water system is comprised of wells, storage tanks, booster pumps, and distribution lines. The City's drinking water system follows an operation procedure, where wells pump water through raw water transmission mains to a water supply facility for disinfection, treatment, storage, and distribution. A schematic figure of the City's drinking water system operation can be seen in Figure 8.

The City currently several wells in service, with an additional well to be put back in service. In addition to the existing wells there are seven (7) wells under construction and five (5) additional wells in the planning or design stage. A summary of the existing wells and their design pump capacity, as well as the wells under construction and being planned are summarized in Table 11. It is anticipated that the design capacity for each of the wells under construction and being planned will be approximately 1,000 to 1,500 gpm.

The drinking water system currently consists of 4 reservoirs ranging in size from 200,000 to 3.5 million gallons. All of the reservoirs located within the City are above ground steel reservoirs. Each of the reservoirs is connected to a series of booster pumps that provide the design flows and pressures to the system. Table 12 provides a listing of the existing reservoirs.

The City is currently expanding their water system. Two additional reservoirs are in the design phase within the City's boundaries. A 1.2 million gallon reservoir and booster station upgrade is planned at the Mountain Vista Ranch water supply facility (WSF), and a 1.5 million gallon reservoir is planned at the Desert Oasis WSF.

Booster pumps provide flow and pressure throughout the system. Each water supply facility has between four and six booster pumps. An inventory of the booster pumps is provided in Table 13.

The drinking water distribution system is comprised of waterlines ranging in size from 6-inch to 16-inch in diameter. The pipelines consist of various materials such as ductile iron pipe (DIP), and Polyvinyl chloride (PVC).

3.5 Private Water Providers

There are three private water providers within the incorporated boundary of Surprise. The City of El Mirage provides water service to the original townsite, the Arizona American Water Company provides service to Sun City West and various other portions of the City, and the City provides service to the remaining locations throughout SPA 1.

Within SPA 2-5, ten (10) private water providers have rights to serve water. These companies include: Arizona American Water Company, Beardsley Water Company, Brooke Water Company, Chaparral Water Company, Morristown Water Company, Puesta Del Sol Water Company, Rio Verde Utilities, Saguaro Acres, Saguaro View and West End Water Company. The service area for each water company is shown in Figure 2.

For the purposes of this study, it was assumed that the water providers providing water service in SPA 1 would continue to provide water to their service areas throughout the duration of the study. In SPA 2-5 the area was modeled as if the entire planning area was to be served by the City.

3.6 Drinking Water Model

3.6.1 Hydraulic Model

As part of this master plan, WaterCAD was used to develop a hydraulic model of the existing drinking water system. A steady-state analysis of the drinking water system was done to look at how the drinking water system is functioning at a single instance in time. The model was used to evaluate the pressure and flow within the water system, and to identify areas that require improvements.

In setting up the water model, the main lines 8-inches and larger were included. In certain locations various 6-inch lines were also included where these lines are acting as the main looping lines.

The model was set up to provide a look at the system during two different build-out scenarios, and three different demand scenarios. The existing 2002 water system was modeled, and then the anticipated build-out system was also modeled. The improvements required for the build-out system were identified and included within the model. The recommendations developed based on this water model may change over time due to the actual growth patterns that occur within the City, as opposed to the planned growth patterns utilized in the development of this study.

An existing 2002 water system model was developed for SPA 1, and then a build-out system model was developed for both SPA 1 and SPA 2-5. For each of the demand scenarios modeled, pressure contour maps were produced. These pressure contour maps represent the pressures available in the water system during a specific instance in time and under specific demand conditions. The pressure contours therefore may not necessarily reflect the actual field conditions found on a given day.

3.6.2 Assumptions

The drinking water distribution system was modeled as a steady-state model. By nature of a steady state water model, all flow into the system is provided from the tanks in the model. Filling and draining of the reservoirs is not analyzed. The sizes and alignments shown in the model are considered to be the correct sizes and locations.

One of the key factors in setting up a water model is determining accurate demands. The demands were determined and distributed throughout the model based on the population distribution. The actual demand distribution may vary depending on the ultimate growth pattern and land use within the City of Surprise. The demands for the build-out scenario are based on the average development value outlined on the City's land use plan (Figure 5).

The pump curves, which were input into the model, also have a dramatic effect on the results of the model. Since no pump testing was performed for this study, actual pump performance data was not obtained. The pumping curves input into the model were based on information received from the pump manufacturers. Therefore the pumping performance shown in the model may differ from the actual pump performance. It is recommended that periodic pump testing be performed, to verify the field performance of the booster pumps and to improve the accuracy of the hydraulic model.

Pipe roughness values also have a large effect on the results of a hydraulic model. C-value testing was not performed as part of this study, and therefore the roughness values for the pipe were assumed. A C-value of 130 was typically assumed for the piping in the water model.

3.6.3 Scenarios Modeled

In performing the water system analysis, three scenarios were modeled for each time period studied. These three scenarios included the Average Day, Maximum Day with fire flow, and Peak Hour Scenarios. The Average Day scenario represents the average water demand for a single day over the year. The Maximum Day with fire flow simulates the available fire flow throughout the system on the single day where the greatest amount of water is used. The Peak Hour scenario represents the single hour throughout a year when the greatest demand is placed on the system.

In setting up this model, the existing system utilized an average day demand of 151gpcd. This is the average combined water use demand within Surprise. For all future demands,

the design demand factor of 200 gpcd was utilized. In addition, the maximum day and peak hour peaking factors were utilized.

3.6.4 Calibration

After the initial setup of the water model, the model was calibrated to evaluate how well the results of the model would represent actual field conditions. In order to calibrate the model various fire flow tests were performed throughout the water system. The fire flow tests provide a measurement of the pressures and flows available at a specific location. The results form these fire flow tests were used to calibrate the model.

On December 9, 2003, nine fire flow tests were conducted throughout the water system. Then on December 19, 2003 an additional fire flow test and static pressure readings were conducted. The results of these fire flow tests were used to calibrate the water model. The results of the fire flow tests can be seen in Table 14. The complete fire flow test results can be seen in Appendix C.

3.6.5 Existing System

The existing drinking water system was modeled to determine the performance and capabilities of the system. The system was required to maintain an acceptable pressure of at least 40 psi and not greater then 80 psi for each of the scenarios. The maximum day with fire flow scenario however, should maintain a residual pressure of 20 psi at all points throughout the system.

For each of the scenarios evaluated, the maximum and minimum pressure is provided, as well as the node number. A complete listing of the results for each of the nodes is provided in Appendix D-1.

At the present time, the existing system is operated as three standalone systems. The Mountain Vista Ranch subdivision, and Roseview subdivision are both isolated from the Ashton Ranch water supply facility. The model of the existing system was evaluated with each of these portions of the water system isolated from the other portions. At the present time, the Mountain Vista Ranch Subdivision is being served through a mutual aid interconnect with the Arizona-American Water Company.

The existing system was created to represent the system as it stands today, with no system improvements. The average day, maximum day, and peak hour scenarios were evaluated for this system, and the results can be seen in the contour maps provided as well as in the Appendix D-1. The pressure results exclude the values for nodes that are located between the reservoirs and tanks (pump-in nodes). Pressure contour maps of the results are provided in Figure 9 through Figure 11.

3.6.6 SPA 1 Build-out

The purpose of the build-out model is to identify locations and alignments of future infrastructure, as well as provide an initial sizing for the infrastructure. It is important to note that the build-out development patterns and densities may change over time, and therefore may not reflect what is shown in this master plan. In addition, a commercial demand of 2,500 gallons per acre per day was utilized in the development of the models.

SPA 1 was first evaluated to determine the infrastructure requirements for the build-out scenario. In order to set up this model, the planned water supply facilities at Mountain Vista Ranch and Rancho Gabriella were included in the model. In addition, the planned upgrades to the Ashton Ranch water supply facility were included. A summary of the improvements included in the development of SPA 1 water system build out model is provided below.

The storage capacity in the system was evaluated for the SPA 1 build-out water demands. It is recommended that sufficient water storage be supplied within the system such that the average day demand can be met utilizing storage only. In addition to the system storage, Surprise has a mutual aid interconnect with the Arizona-American Water Company, and is planning to construct a mutual aid interconnect with the City of El Mirage. The City can receive additional water supply through these interconnects if necessary. Based on this analysis, the storage required in SPA 1 is 15.1 million gallons. Currently the system has 10.1 million gallons of existing and planned storage. It is recommended that an additional 2.25 million gallons of storage be provided in the high pressure zone, and 2.75 million gallons in the low pressure zone.

As part of the water model analysis, it was determined that the water system should be separated into two pressure zones, a high pressure zone and a low pressure zone. The high pressure zone will serve the Mountain Vista Ranch, Ashton Ranch, Orchards, and Surprise Center Areas, while the remainder of the City's service area will be served through the low pressure zone. The pressure zones can be seen in Figure 12.

The results of the SPA 1 Water Build-out are provided in the Appendix D-2. In addition, pressure contour maps have been produced which show the average day, maximum day, and peak hour pressures. These exhibits can be seen in Figure 13, 14, and 15. The SPA 1 Build-out Average Day model has a high pressure node of 90 psi in the southeast corner of the City. When development in this area takes place, it may be necessary to include a pressure reducing valve (PRV) at the development located in the area.

In analyzing the peak hour scenario, it was necessary to activate all the existing and planned booster pumps at the Mountain Vista Ranch, Ashton Ranch, and Roseview water supply facilities. While this doesn't pose an immediate concern, it does indicate that additional booster pump capacity may be necessary at build-out.

In order to meet the Build-out water model demands, the following improvements should be implemented prior to build-out of SPA 1:

- 3.5 MG reservoir and booster pumps at Rancho Gabriela
- 1.2 MG reservoir and booster pumps at Mountain Vista Ranch
- 3.0 MG reservoir and booster pumps at Ashton Ranch
- 2.25 MG storage high pressure zone
- 2.75 MG storage low pressure zone
- Additional booster pump capacity at Roseview.

3.6.7 SPA 2 Build-out

This drinking water system was developed to provide an overview of the potential infrastructure required in the area if development occurs according to the General Plan. In areas where the mixed use was designated as the sole land use, the commercial generation factor was used, if the mixed use area had another land use designation, the additional designation was used. Additionally, while the land use plan identifies a few areas as potential resort locations, the designated land use in the area was utilized in computing the demands. In developing this drinking water model, the system was modeled at the square mile level, with the main waterlines aligned with the existing section lines, or existing major roads. This drinking water system was modeled to meet the same standards that were set for the existing drinking water system. Namely, a minimum pressure of 40 psi, and the ability to provide 2,000 gpm fire flow with a residual pressure of 20 psi in the system. A layout of the SPA 2-5 build-out water system can be seen in Figure 16.

In developing the build-out water model, the elevation contours played a large role in locating the pressure zone breaks, and reservoirs. Due to the large planning area, and the lack of readily available contour information, the USGS 20-foot contours were utilized in the area. It is important to note that the elevations provided may therefore be quite different from the actual elevations. Before undertaking any of the waterlines identified in this master plan, it is recommended that the engineer perform a detailed survey as part of their design.

In developing the SPA 2-5 build-out drinking water model, the area was divided into 10 pressure zones. The general rule for pressure zone breaks was at every 80 feet of elevation change. The pressure zones can be seen in Figure 17. The water service area was divided into pressure zones through the use of pressure reducing valves. Table 16 lists the pressure for each PRV identified in the SPA 2-5 build-out water system.

While developing the SPA 2-5 water build-out scenario, the reservoirs were located and sized such that in general, the average day demand in each pressure zone would be satisfied by the reservoirs located within that pressure zones. Additionally, the reservoirs that are located throughout this planning area have been selected such that they may be completed as development necessitates it. The reservoirs were sized such that they can supply the average day demand without depleting more than 80 percent of the supply. The water system for SPA 2-5 was designed to include a greater amount of storage than the system serving SPA 1, since no redundant water supply is planned for this area. The

reservoirs sized in this report provide planning level estimate as to the sizes and locations necessary. It is recommended that a detailed supply and demand analysis be performed for each area before undertaking construction on a new reservoir. A breakdown of the size of each reservoir is provided in Table 17.

The water model results can be seen in Table 15. The ids for each junction are shown in Figure 16. A detailed listing of the results is provided in Appendix D-3.

3.6.8 Fire Flow Analysis

One of the primary functions of a drinking water distribution system is to provide the users of that system with adequate fire flow protection. Adequate fire protection has been defined as providing the minimum required fire flow at a minimum residual pressure of 20 psi. The minimum required fire flow is provided using the 2000 International Fire Code.

In this fire flow analysis, the maximum fire flow possible was computed for each node in the system, excluding those nodes at the inlet side of a pump. The fire flow analysis was performed for the maximum day system for the existing system and build-out systems. The results of the fire flow analysis can be seen in Appendix D-4.

The existing system fire flow analysis, indicates that under the current conditions, the water system is capable of providing a minimum fire flow of 1,000 gpm to all of the residential areas in the model, except for the southern end of Ashton Ranch where 914 gpm is available. The fire flow in this area can be achieved by connecting this line to a main looping line. A minimum fire flow of 2,000 gpm is available at other sites within the model. The build-out system was designed to satisfy these fire flow constraints.

For the SPA 1 build-out systems, a minimum fire flow of 1,500 gpm is available throughout all residential subdivisions, except for the southern end of Ashton Ranch, and the one location in the Countryside subdivision. The fire flow at these locations is occurring at dead end lines and could be improved by looping the waterline. Throughout the remainder of the system 2,000 gpm is available. A detailed listing of the results of the fire flow analysis can be seen in Appendix D-4.

The SPA 2-5 build-out water system will provide a minimum fire flow of 2,000 gpm throughout the entire system.

3.7 Drinking Water Recommendations

Based on the water model analysis, a series of improvements are recommended in order for the to adequately meet the projected build-out water demands. These improvements are discussed in the following sections.

3.7.1 SPA 1 Drinking Water Improvements

In order to meet the build-out water demand requirements the following water supply facilities are recommended.

- 3.5 MG reservoir and booster pumps at Rancho Gabriela
- 1.2 MG reservoir and booster pumps at Mountain Vista Ranch
- 3.0 MG reservoir and booster pumps at Ashton Ranch
- 2.25 MG storage high pressure zone
- 2.75 MG storage low pressure zone

Additional booster pumping capacity could be included at the Mountain Vista Ranch, Ashton Ranch, and Roseview water supply facilities in order to provide added redundancy and an added factor of safety during the build-out peak hour demand scenario.

The actual sizing of these water supply facilities may vary depending on the actual development that occurs in the area.

3.7.2 SPA 2-5 Drinking Water Improvements

In order to meet the build-out water demand requirements for the SPA 2-5 a series of improvements are shown in Figure 16. A summary of the required water supply facilities, listed by their model node number is provided in Table 17. The pressure reducing valves required are summarized in Table 16.

3.7.3 Drinking Water Model Updates

Due to the rapid growth that is occurring within the City, and the potential for the actual water use within the City to change, it is recommended that the City update the water model at on a yearly basis. An updated water model will provide the City with a tool that continues to accurately reflect the City's drinking water system. Updating the model should consist of including new developments that have occurred within the City's service area, including new infrastructure that has occurred, and recalibrating the model. By calibrating the model on a yearly basis, the City can be ensured that the model provides an accurate representation of the City's system.

3.7.4 Drinking Water Master Plan Update

Four out of the last five years, the City of Surprise has been ranked as one of the fastest growing Cities within Arizona. At the present time, Surprise is continuing to experience rapid growth. In order to ensure that this drinking water master plan continues to provide the most effective guidance to the City, it is recommended that this drinking water master plan be revised and updated every five years.

3.8 Cost Estimates

In order to assist in planning for the future, planning level cost estimates were developed for each of the improvements outlined. These cost estimates are meant to serve as a planning level guide only. Before beginning any project recommended in this master plan, it is recommended that a detailed cost analysis be performed for the project.

The costs were computed based on similar construction projects completed within the area, as well as from the 2003 Arizona Heavy Construction Costs Guide developed by Craftsman Book Company. All costs are provided as present day costs.

Three categories of improvements were analyzed. Waterline costs, water facility (tanks and booster stations), and pressure reducing valves. The water cost estimates are summarized in Table 18. Cost estimates have been developed for each recommended improvement and are listed by model id. These cost estimates are listed in detail in Table 19 through Table 24.

4.0 WASTEWATER SYSTEM

4.1 Comparison of Design Criteria

In order to establish adequate design criteria for the development of this master plan, the wastewater design criteria from various cities was evaluated. This section provides a summary of the design factors evaluated and utilized in the development of this master plan.

In analyzing the wastewater infrastructure, it was necessary to establish appropriate design criteria, which meets the City's present day needs. The sanitary sewer system design criteria for various communities located within the Phoenix metropolitan were evaluated. The design parameters evaluated consisted of the identifying the design flows, peaking factors, as well as the sanitary sewer line sizing criteria including the maximum and minimum velocities, minimum slopes, roughness factors, and sanitary sewer trunk line cover. The design criteria for the City of Phoenix, Peoria, Glendale, and the Arizona American Water Company were evaluated. The wastewater demand design values are shown in Table 25 and 26, while the sanitary sewer line sizing criteria is shown in Table 27 and 28.

4.2 Recommended Design Criteria

In order to establish adequate design criteria for the development of this master plan, the wastewater design criteria from various cities was evaluated. The recommend wastewater design criteria are summarized in Table 29. The recommended peaking factors to be used are outlined in Table 30. The additional recommended wastewater design factors are provided in Table 31 and 32.

4.3 Current Demand

In order to adequately design and plan for the City's sewer infrastructure, adequate wastewater generation factors must be determined. In order to estimate the current demand on the City's system, sewer monitoring was performed throughout the City. In addition to the sewer monitoring, the daily wastewater treatment plant (WWTP) effluent flows for the last year were analyzed. Based on the analysis of this information, it was determined that the 2002 average residential wastewater generation is 64 gpcd. A summary of the WWTP flows is provided in Appendix E-2. For the existing system, a wastewater generation factor of 1,000 gallons per acre was utilized for commercial demands.

In order to provide adequate capacity within the sewer collection system however, it was recommended that an average residential demand of 100 gpcd be utilized for design. Additionally, an average day commercial demand of 2,500 gallons per acre was used for this study.

In addition to determining the average wastewater generation within the City, the variability of the flow over the year was also studied. The total WWTP effluent flow was analyzed for a years time to determine the month when the peak flows in the system occur. The results of this analysis indicate that the peak flows occur during the month of March. Figure 18 shows the monthly peaking factors for the South WWTP.

When analyzing a wastewater collection system, the demand on the system will vary throughout the day. In general terms, a wastewater collection system will experience two peak demand times, a peak demand in the morning, and a peak demand in the evening. As part of this study, sewer monitoring was performed throughout the system at various locations. The sewer monitoring information was used to develop a diurnal curve for the City's residential demands. A diurnal curve shows the variation of the sewer flow over time. The residential diurnal curve for the City of Surprise is shown in Figure 19 and the factors are listed in Table 33.

4.4 Existing Wastewater Collection System

The wastewater system is primarily a gravity flow system; however there are currently two lift stations operated within the system. The City's system is comprised of sanitary sewer lines, two lift stations, and a treatment plant. The City's system currently collects 2.7 MGD of wastewater.

The majority of the City is serviced by the City's wastewater system. The Coyote Lakes development and various small pockets on Bell Road however, receive sanitary sewer service from the Arizona-American system. A map showing the City's wastewater service area is shown in Figure 3.

The sanitary sewer lines located within the City's system range in size from 4-inch to 30-inch. The wastewater flow is conveyed to the ultimate discharge point of the South

Wastewater Treatment Plant (WWTP). While the sanitary sewer system is primarily gravity fed, there are two lift stations operating in the system. A conceptual layout of the City's sewage system is shown in Figure 20.

Table 34 provides a summary of the characteristics of each of the lift stations within the system. At the present time, a new sanitary sewer interceptor in Litchfield Road is currently being designed. This new sanitary sewer line will bypass the Litchfield Road lift station, and provide conveyance of the wastewater through gravity flow. Once this line is in place, the Litchfield Road lift station will be abandoned.

The ultimate wastewater discharge for the City is the South Wastewater Treatment Plant. The South WWTP was designed to treat an average daily flow of 3.2 million gallons. The WWTP currently treats an average daily flow of 2.7 million gallons. The South WWTP is currently being expanded to treat an average daily flow of 7.2 million gallons per day.

4.5 Sanitary Sewer Hydraulic Model

A computer hydraulic model was developed for the existing sanitary sewer system. The sewer modeling system that was utilized for the analysis of the City's system was SewerCAD® developed by Haestad Methods Inc. The sewer model was used to perform a steady state analysis of the City's existing system, the SPA 1 build-out system, and for the SPA 2-5 build-out system. A steady state analysis provides an evaluation of the system at a single instance in time.

This sanitary sewer model was utilized to evaluate the capacity of the sewer lines located within the City's system and to identify areas where improvements are required. Additionally, the sewer model was used as a planning tool to size future infrastructure, and recommend alignments.

In setting up the sanitary sewer model, the main sanitary sewer interceptor lines were included in the model. Generally the sanitary sewer lines 10-inch and greater were included in the model. In select locations 8-inch lines were included where greater detail was required.

The water model was setup to provide a look at the system during two different planning periods. The existing 2002 sanitary sewer system was analyzed, and the anticipated build-out system was also modeled. The build-out system was modeled in two separate parts. SPA 1 was developed as a stand-alone model, and SPA 2-5 was developed as a separate build-out model. Based on the analysis performed in this study, it is anticipated that only a small portion of the sanitary sewer system in SPA 2-5 will be connected to the system served by SPA 1. The existing sanitary sewer system layout can be seen in Figure 20.

4.5.1 Assumptions

The sizes, alignments, and invert elevations shown in the model are considered to be correct. One area of the model believed to have invert elevation errors, is the connection between the line in Sunrise Boulevard and Bell Road. The GIS Department is currently researching this area to determine what is occurring.

One of the key assumptions in setting up the sanitary sewer model was the determination of wastewater generation factors. For the build-out sewer model, the design wastewater generation factors of 100 gpcd for residential demands, and 2,500 gallons per acre for commercial demands were utilized for all new development.

The demands were distributed throughout the model based on the computed population distribution. The actual demand distribution may vary depending on the ultimate growth pattern and land use within the City of Surprise. The demands for the build-out scenario were set up based on the average development value outlined on the City's land use plan (Figure 5).

As described earlier, the peak flow condition was modeled for each of the systems analyzed. For the purposes of this study, a single peaking factor of 2.5 was utilized for the analysis. Due to the existing and projected populations within the City, this peaking factor may provide a conservative look at the available capacity within the system, allowing a reduced peaking factor to be used.

4.5.2 Sanitary Sewer Monitoring

In order to help estimate the system demands and calibrate the model, sewer flow monitoring was performed. The flow monitoring was conducted by RDH Environmental and was performed at nine locations throughout the City, during the months of September and October 2002. The monitoring locations are shown in Figure 21. The monitoring was performed for a 2-week period, measuring the flow and velocity through the selected manholes. The results of the monitoring are provided in Appendix E-1.

In calibrating the model to the existing flow data, the average flow over the two week period was typically used. A few sites had questionable monitoring results. The results that may include some questionable data included the Dysart Rd 24-inch interceptor and the Greenway Rd site.

The Dysart Road 24-inch site had a large amount of sludge flowing through the pipe, which was affecting the monitoring results. RDH cleaned the pipe in the area of the flow and tried monitoring the site with both an area velocity meter and an ultrasonic meter. For many time periods, the area velocity meter could not get a good reading which would report zero flow. The quantity of flow measured by the ultrasonic meter seemed excessively high, and based on discussions with RDH staff, this could be caused by the sludge flowing into the pipe and affecting the level of water and the results. In analyzing the results, a 24-hour period of data seemed to provide reasonable results after the pipe in

the area was cleaned. This data was utilized in the calibration of the model and assumed to be correct. It is recommended that the lines in the area of the 24-inch site be cleaned and that the flow be verified.

The Greenway Road site had various increments where zero flow was reported. These zero flows occur regularly in the early morning hours, and may therefore reflect a correct reading.

4.5.3 Calibration

After the initial setup of the sewer model, the model was calibrated to evaluate how well the results of the model would represent the actual field conditions. The sanitary sewer monitoring results were used to calibrate the model. The model was analyzed to determine where discrepancies exist between the model and the monitored results.

4.5.4 Existing Sanitary Sewer System

The existing sanitary sewer system was modeled to determine the available capacity of each of the lines in the system and to evaluate system performance. The model was analyzed under a peak demand condition utilizing a peaking factor of 2.5. The system was analyzed to ensure that each of the lines in the system had adequate capacity to carry the present peak day flows, and also to ensure that no surcharging was occurring. The existing system was modeled to serve a population of 51,203 people.

An overview of the results for the existing system, are presented in Figure 22. Within the figure, the peak flow in select pipes is shown, along with the available additional capacity. While the majority of the system shows adequate capacity, a few select areas in the system indicated that further study should be conducted. These pipes show the existing capacity in red, or being over capacity. While the model indicates that these pipes currently exceed capacity, this could be caused by a variety of reasons. Such as the pipe inverts indicating that a pipe had been installed at no slope, or an adverse slope. The model indicates that these areas should be studied further.

In addition, Figure 23 shows the d/D ratio for each of the pipes in the system. The d/D ratio is the ratio of the depth of flow in a pipe compared to the diameter of the pipe multiplied by 100. If the d/D ratio is greater than 100, then this indicates that the pipe is flowing under pressure, or that surcharging may be occurring. While the capacity of each pipe looks at the quantity of flow that can be conveyed by a single reach of pipe, the d/D ratio evaluates the hydraulics of the system. Therefore, a pipe may show that it exceeds capacity, while the d/D is less than 100, or vice versa. The areas that show a d/D greater than 100 indicate that further study should be conducted. Detailed results of the existing system analysis are provided in Appendix F-1.

4.5.5 Sanitary Sewer System Build-out

The build-out sanitary sewer system was modeled in two separate parts, SPA 1 and SPA 2-5. The build-out systems were modeled to represent the peak flow values. In setting up the build-out models, the demands were distributed according to the General Plan. The wastewater generation factors outlined in Table 29 were used as well as a peaking factor of 2.5. For the build-out system, two wastewater generation factors were used, residential and commercial. In areas where the mixed use was designated as the sole land use, the commercial generation factor was used, if the mixed use area had another land use designation, the additional designation was used. Additionally, while the land use plan identifies a few areas as potential resort locations, the designated land use in the area was utilized in computing the demands.

The new sanitary sewer lines designed for the build-out systems were designed to ensure that a minimum full pipe velocity of 2 feet per second was maintained throughout the system. It is important to note that the actual ground contours were used in designing the system, therefore in various locations throughout the model velocities greater than 2 feet per second, and slopes greater than the minimum slope may exist. The build-out systems were analyzed to ensure that adequate capacity would exist within the sanitary sewer lines.

4.5.6 SPA 1 Sanitary Sewer System Build-out

In setting up the build-out model for SPA 1, the planned sewer infrastructure was first included, and then additional infrastructure was included to adequately meet the build-out demands. The City has the capacity to expand the South WWTP, so this served as the ultimate discharge point for this model. It was also assumed that the SPA 1 system would receive approximately 449,000 gallons per day from the SPA 2-5 system.

Similar to the existing system, a layout of the build-out system as well as a summary of the results is shown in Figure 24. In addition, an exhibit showing the d/D ratios for each of the pipes in the model is presented in Figure 25. The model indicates that the portions of the sanitary sewer lines in Reems Road from Bell to Greenway, from Dysart Rd to the South WWTP and from 136th Ave to the South WWTP, as well as a few other locations shown on the exhibits may have problems at build-out. The flow in these areas could be improved through rerouting the wastewater through a different path if possible, or installing a relief sewer line. While this doesn't pose an immediate concern, it does indicate that the capacity in these lines should be studied as growth occurs in the area. The results for the SPA 1 build-out analysis are provided in the Appendix F-2.

4.5.7 SPA 2-5 Sanitary Sewer System Build-out

For special planning areas 2 through 5, it is estimated that 56 MGD of wastewater will be produced on an average day. The SPA 2-5 build-out model was designed to serve the build-out population shown in Table 1 and approximately 10,592 acres of commercial. The design wastewater generation factors and peaking factors as described earlier in this

section were utilized in the development of this model. In areas where the mixed use was designated as the sole land use, the commercial generation factor was used, if the mixed use area had another land use designation, the additional designation was used. Additionally, while the land use plan identifies a few areas as potential resort locations, the designated land use in the area was utilized in computing the demands. The sanitary sewer lines included in the model were sized such that the d/D ratio remained below 80% for each pipe. In developing this sanitary sewer model, the system was modeled at the square mile level, with the main sanitary sewer lines aligned with the existing section lines, or existing major roads.

An important consideration for SPA 2-5 is that for the majority of these planning areas, the only available elevation data was the USGS 20-foot contours. In addition the design for SPA 2-5 also included minimizing wash crossing, canal crossings, and crossing Grand Avenue.

In order to address the design needs for this area, four sewer design scenarios were analyzed. An important consideration for SPA 2-5 is that for the majority of these planning areas, the only available elevation data was the USGS 20-foot contours. In addition the design for SPA 2-5 also included minimizing wash crossing, canal crossings, and crossing Grand Avenue. The scenario number corresponds to the number of treatment plants recommended at build-out. The four separate scenarios are described as follows:

- Scenario 1: WWTP in SPA3
- Scenario 2: WWTP in SPA3, SPA5
- Scenario 3: WWTP in SPA3, SPA4, SPA5
- Scenario 4: WWTP in SPA2, SPA3, SPA4, SPA5

Based on an evaluation of the four different treatment plant scenarios Scenario 4 was selected as the desired build-out scenario. Scenario 4 was selected as the most feasible development scenario in planning for long-range growth. Another advantage that led to the selection of Scenario 4 is that it will help to reduce the upfront costs of constructing the sanitary sewer system.

The sizing for these wastewater treatment plants is based on the design values of 100 gpcd for residential demand and 2,000 gallons per acre for commercial demand.

A layout of the SPA 2-5 build-out system, along with a summary of the results is presented in Figure 26 and 27. The results for each of these scenarios are provided in Appendix F-3.

4.6 Recommendations

It is important to note that these scenarios were designed based on the midrange density build-out of the General Plan land use map as well as the USGS 20-foot contours. Since the actual densities and build-out values will vary, the sewer line locations and sizing

provided in this report may or may not be adequate. It is therefore recommended that the designer perform a detailed sewer analysis before the design of a sewer project, and it is also recommended that the City update this master plan at a minimum on a five-year basis.

4.6.1 Sanitary Sewer Model Updates

Due to the rapid growth that is occurring within the City, it is recommended that the City update the sewer model on a yearly basis. An updated sewer model will provide the City with a tool that continues to accurately reflect the City's wastewater collection system. Updating the water model should consist of including new developments that have occurred within the City's service area and including new infrastructure that has occurred.

4.6.2 Wastewater Master Plan

Due to the rapid growth that Surprise is continuing to experience, and in order to ensure that this wastewater master plan continues to provide the most effective guidance to the City, it is recommended that the wastewater master plan be revised and updated at minimum every five years.

4.7 Cost Estimates

In order to assist in planning for the future, planning level cost estimates were developed for each of the improvements outlined. These cost estimates are meant to serve as a planning level guide only. Before beginning any project recommended in this master plan, it is recommended that a detailed cost analysis be performed for the project.

The costs were computed based on similar construction projects completed within the area, as well as from the 2003 Arizona Heavy Construction Costs Guide developed by Craftsman Book Company. All costs are provided as present day costs.

Planning level cost estimates were performed for each of the recommended improvements to the City's wastewater system. The cost estimates include sanitary sewer line costs and planning level costs. The cost estimates are summarized in Table 35. Cost estimates have been developed for each recommended improvement and are listed by model id. These cost estimates are listed in detail in Table 36 through 38.

5.0 RECLAIMED WATER SYSTEM

Presently, a reclaimed water plan has been implemented within SPA 1. It is anticipated that the use of reclaimed water will occur at more locations throughout SPA 1, and that the use of reclaimed water will be an important consideration for the development occurring within SPA 2-5. This section provides a conceptual outline of a potential system that will allow the beneficial use of reclaimed water.

5.1 Recommended Design Criteria

The reclaimed water system design criteria established for this report was based upon the water design criteria outlined within this report, the irrigation demands as determined by landscape architects, and discussions with staff.

In developing the reclaimed water master plan, it was assumed that the reclaimed water would be utilized provide water for open space, such as, turf, lakes, low water use landscape, and other related uses. The turf irrigation demand utilized for the peak demand conditions was 26.54 gpm per acre (0.000609259 gpm/ ft^2) based on a 6 day per week 9 hours per day watering schedule. This water demand was determined by PD/Saurey Associates, Inc., the landscape architects for the Sierra Verde development. The recommended reclaimed demand factors are summarized in Table 39.

In evaluating the turf irrigation demand, it is important to note that the demand can vary significantly depending on the time of year. According to the City of Phoenix Design Standards Manual the turf water demands can vary by a factor of 10 between the summer and winter demand conditions. During those times of the year when the reclaimed water cannot be utilized through direct reuse, it will be necessary for an alternative form of use. A recharge plan has been developed to use the reclaimed water when direct reuse through open space is not possible.

5.2 Potential Reclaimed Water Uses

The potential uses for reclaimed water vary depending on the class of effluent that is discharged from the City's WWTPs. Each class of reclaimed water may be used for its designated potential uses, and any potential uses for classes lower than itself. The potential uses for reclaimed water are as follows:

Class A reclaimed water is suitable for irrigation of food crops, recreational impoundments, residential landscape irrigation, school ground landscape irrigation, open access landscape irrigation, toilet and urinal flushing, fire protection systems, spray irrigation of an orchard or vineyard, commercial closed loop air conditioning systems, vehicle and equipment washing as well as those uses approved for Class B and Class C reclaimed water.

Class B reclaimed water is suitable for recharge, irrigation of an orchard, irrigation of golf courses, restricted access landscape irrigation, landscape impoundment, dust control, construction water, milking animal pasture irrigation and livestock watering, and street cleaning as well as those uses approved for Class C reclaimed water.

Class C reclaimed water can be used for pasture or livestock watering for non-dairy animals; irrigation of sod farms; irrigation of fiber, forage, seed or other similar crops and silviculture.

The recommendations outlined in this reclaimed water master plan are based on the assumption that all reclaimed water will meet or exceed Class A.

5.3 Infrastructure Requirements

The recommendations for the reclaimed water master plan are closely associated with the wastewater master plan. Potential reuse locations were identified within those special planning areas where wastewater treatment plants are located. Potential locations for reuse were identified within the study area.

The reclaimed water system infrastructure was designed to be capable of meeting the peak demands. During those times of the year when the peak demands are not required, the reclaimed water system will be used to distribute the reclaimed water to the City's recharge wells.

5.3.1 Assumptions

One of the key assumptions utilized in establishing this reclaimed water master plan, is determining the quantity of reclaimed water to be utilized for each square mile. Based on discussions with staff and the reuse plan developed for the Sierra Verde development, it was determined that a reclaimed water factor of 1,200 gpm per section would be utilized. Utilizing the peak demand factor this corresponds to approximately 45 irrigated acres per section.

A second assumption utilized in the development of this plan, is that Class A reclaimed water would be produced. Class A reclaimed water is required for unrestricted landscape irrigation and would be necessary in order to irrigate parks or other nonrestricted landscapes.

Another assumption in developing the reclaimed master plan is the quantity of reclaimed water that will be generated. For the wastewater master plan, a design factor of 100 gpcd was utilized. However, in estimating the quantity of reclaimed water that will be available the actual demand factor of 64 gpcd, which was determined to be the 2002 wastewater demand, was utilized. This value provides a conservative estimate of the quantity of reclaimed water that may be available. The quantity of reclaimed water projected to be available for recharge for the purposes of the reclaimed master plan is outlined in Table 40.

The storage reservoirs for the reclaimed water master plan were sized to provide one day of storage. Storage areas were also calculated at the wastewater treatment plants to provide one day of storage. If additional backup storage is required, it would be necessary to increase the size of the reservoirs.

The reclaimed infrastructure was designed as four separate and distinct systems, one for each of the planning areas described above. The infrastructure was designed to have a service pressure of at least 50 psi. This will allow the water to be used without requiring

onsite booster pumping facilities. At locations where the reclaimed system is connected to an anticipated storage reservoir, the pressure may be less than 50 psi. The onsite storage may be in the form of water features (i.e., lakes) or reservoirs. The layout for the reclaimed water system is shown in Figure 28.

5.3.2 Reclaimed Water System

The City is currently planning a reclaimed water system for the South WWTP. The main reclaimed water transmission line will be located in Litchfield Road, and will run from the WWTP to Litchfield Road north to Statler, and then west to the Surprise Center. It is anticipated that this line will be extended to Bell Road Lake in the future. A layout for this reclaimed water line is shown in Figure 28.

The reclaimed plan shown in SPA 1 is anticipated to utilize 4,450 gpm of reclaimed water per day during the peak demand period. It is also determined that 2.5 MG of storage would be required at the South WWTP in order to provide one day of storage for the reclaimed system. While this is only a fraction of the reclaimed water that will be produced by the South WWTP, it will be necessary to deliver the additional reclaimed water to recharge.

A proposed reclaimed water plan has been developed for SPA 2 and 3. The source of effluent for this planning area is the planned WWTP. The infrastructure for this area was designed to utilize the effluent produced by SPA 2 and 3. It is projected that 28.5 sections will be provided effluent at 1,200 gpm per section. The layout for this planning area can be seen in Figure 28.

The infrastructure for SPA 3, will require four storage sites for a total of 20.75 MG, in addition 18.5 MG of storage would be necessary at the WWTP. These storage sites may be in the form of water features such as lakes, or storage tanks. Additionally, a booster pumping station is necessary at each of the storage reservoirs as well as the WWTP. The design flow and pressure for each of the booster pump stations is shown in Figure 28.

A proposed reclaimed water plan has been developed for SPA 4. The source of reclaimed water for this planning area is the WWTP that has been planned. It is projected that 5 sections will be provided effluent at 1,200 gpm per section. A booster pumping station will be required at the WWTP at the design flow and pressure shown in Figure 28, along with 3.5 MG of storage.

A proposed reclaimed water plan has been developed for SPA 5. The source of effluent for this planning area is the WWTP that has been planned. It is projected that 5 sections will be provided effluent at 1,200 gpm per section. A booster pumping station will be required at the WWTP at the design flow and pressure shown in Figure 28, along with 4.0 MG of storage.

5.4 Recommendations

Based on the reclaimed water system analysis, a series of improvements are recommended in order to adequately meet the projected build-out reclaim demands. These improvements are discussed in the following sections. Planning level cost estimates have been developed for each of these projects, and are described in greater detail.

It is recommended that the design engineer perform a detailed analysis evaluating the reuse demands, pressures required, and infrastructure necessary before designing a reclaimed water system within the City.

In addition to the reclaimed water use sites identified for this master plan, it is also necessary to have a back up use method if the reclaimed water transmission infrastructure fails. For SPA 1 a transmission line is planned from the WWTP to the Agua Fria River as an alternative method. For SPA 3, it is recommended that the recharge basins within the McMicken Dam area be utilized as a backup. For SPA 4 and 5, a possible alternative disposal location for the effluent would be the Central Arizona Project (CAP) canal. It would be necessary to establish an agreement with the CAP to determine the parameters and feasibility of utilizing the canal as an effluent disposal site.

5.5 Cost Estimates

In order to assist in planning for the future, planning level cost estimates were developed for each of the improvements outlined. These cost estimates are meant to serve as a planning level guide only. Before beginning any project recommended in this master plan, it is recommended that a detailed cost analysis be performed for the project.

The costs were computed based on similar construction projects completed within the area, as well as from the 2003 Arizona Heavy Construction Costs Guide developed by Craftsman Book Company. All costs are provided as present day costs.

Two categories of cost estimates were performed for the reclaimed master plan, reclaimed supply facilities (storage and booster pump stations), and pipe lines.

6.0 RECHARGE SYSTEM

The reclaimed water system was designed to meet the peak demands for various turf facilities located throughout the City. The infrastructure was sized such that the total projected volume of reclaimed could be distributed throughout the City. While this plan utilizes the reclaimed water produced during a peak demand time, it is also necessary to address the use of the reclaimed water when it cannot be distributed for turf irrigation. Recharging reclaimed water is eligible for receiving recharge credits from the Arizona Department of Water Resources.

Before undertaking any recharge project within the City, it is recommended that a detailed study be performed identifying the quantity and quality of reclaimed water that will be produced, the quantity of reclaimed water that must be recharged, as well as the soil conditions for accepting recharge in each location.

6.1 Assumptions

In order to recharge reclaimed water, it is necessary to construct recharge wells. Many different designs of recharge wells may be available. Recharge wells require a site specific design that considers the soils, aquifer, effluent makeup, depth of well, and various other parameters. For the purposes of this recharge master plan, it was necessary to make various simplifying assumptions regarding the recharge well. These assumptions were made to provide an overview of what may be necessary in the area in terms of effluent recharge, and in no way are meant to serve as a recommendation on the ideal type of recharge system for the Surprise planning area. It is recommended that a site specific recharge study be performed before undertaking any recharge project in the area.

For the purposes of this master plan, it was assumed that the recharge wells would be designed and equipped similar to a potable water well, only the design and construction will be such that the effluent will be recharged into the ground rather than extracted. A simplifying assumption was that the recharge well could recharge 50 % what a groundwater well could extract. It was assumed, that the recharge wells could recharge 500 gpm. Due to the potential differences in soils throughout the special planning areas, it is important to note that the actual performance of any recharge well may differ considerably from the standard recharge well parameters assumed for this study. Therefore more or less recharge wells may be required.

This recharge master plan also assumes that the ground in the areas where the recharge wells will be located will be conducive to the recharge of effluent. The quantity of reclaimed water to be recharged is another area that must be considered.

It is also assumed that the recharge wells will operate during those times of the year when the reclaimed water cannot be utilized for open space.

6.2 Infrastructure Requirements

The reclaimed water infrastructure was designed such that the peak irrigation demand could be conveyed to each section projected to utilize reclaimed water. During those times of the year when reclaimed water will not be utilized, the reclaimed system will be utilized to convey water to the recharge wells.

A peak reclaimed water demand of 600 gpm per half section was utilized. The peak turf demand was calculated for a watering interval of 6 days a week for 9 hours a day. For the purposes of the recharge plan, it was assumed that the reclaimed water would be recharged over a 24-hour period, 7 days a week. This translates to a recharge requirement of 193 gpm per half section.

In addition, the City is planning on recharging their Central Arizona Project allocation of 7,373 ac-ft/yr. It is anticipated that the CAP water will be recharged within SPA 1.

6.3 Recommendations

Based on the analysis for this recharge master plan, a series of reclaimed wells are recommended to be constructed. The quantity of recharge wells estimated to be required for each SPA is summarized in Table 44. It is important to note that the recharge wells shown for SPA 3 are the quantity necessary to recharge the effluent from both SPA 2 and SPA 3.

It is also recommended that a detailed site specific study be performed to determine the best location for each recharge well along with the potential quantity of effluent that can be recharged in each location. It is recommended that a recharge program be pursued in order to take advantage of the City's reclaimed water as a potential water resource.

6.4 Cost Estimates

In order to assist in planning for the future, planning level cost estimates were developed for each of the improvements outlined. These cost estimates are meant to serve as a planning level guide only. Before beginning any project recommended in this master plan, it is recommended that a detailed cost analysis be performed for the project.

The costs were computed based on similar construction projects completed within the area, as well as from the 2003 Arizona Heavy Construction Costs Guide developed by Craftsman Book Company. All costs are provided as present day costs.

For the reclaimed master plan, the cost estimates are based on the cost to equip and construct an injection recharge well. For the purposes here, it was assumed that a recharge well would cost approximately double a potable water well. A value of $500,000 per recharge well was assumed. This value does not include the costs for additional piping to transfer the water from the transmission mains to the recharge site. The recharge costs are summarized in Table 45.

Table 1
Build-out Population Projections

Special Planning Area	Population	
	Master Plan	**General Plan**
SPA 1	171,750	171,684
SPA 2-5	345,857	337,694
Total	**517,607**	**509,378**

Table 2
Comparison of Water Demand Design Criteria

Water Provider	Demand			Peaking Factor		Pressure	
	Average Day (gpcd)	**Max Day (gpcd)**	**Peak Hour (gpcd)**	**Max Day**	**Peak Hour**	**Minimum (psi)**	**Maximum (psi)**
Arizona American Water	150	270	450	1.8	3.0	40	90
City of Glendale				1.65	2.64	50	90
City of Peoria	220	396	673	1.8	3.06	40	120
City of Phoenix	220	440	748	2.0	3.4	50	100

Table 3
Drinking Water Line Sizing Criteria

Water Provider	Maximum Velocity (feet/sec)	Minimum Pipe Size (inches)			Maximum Valve Spacing (feet)	
		Residential Street	**Collector Street**	**Major Arterials**		
Arizona American Water	10	N/A	N/A	N/A	Per ADEQ Bulletin #10	
City of Glendale	5	6	12	12	700	500
City of Peoria	5	8	8 or 12	16	800	500
City of Phoenix	5	6	8	12	800	600

Table 4
Comparison of Fire Flow Criteria

Water Provider	Description	Minimum Flow (gpm)
Arizona American Water	One and two-family dwellings less than or equal to 3,600 SF	1,500 for 2 hours
	One and two-family dwellings greater that 3,600 SF	per 1997 UFC
	All other development	3,000 for 3 hours
City of Peoria	Single Family Residence	1,000 for 2 hours
	Commercial, Industrial, Multi-Family	3,500 for 3 hours
City of Phoenix	Single Family Residence	1,000
	Multi-family Residence	1,500
	Commercial	3,000
	Industrial, Warehouse and Downtown areas	5,000

Table 5
Comparison of Fire Hydrant Spacing

Water Provider	Maximum Fire Hydrant Spacing (feet)			
	Single Family	Cul-de-sacs	Multi-family	Commercial & Industrial
Arizona American Water	Per UFC, AZ State Fire Code and/or local agency			
City of Glendale	500	N/A	300	300
City of Peoria	500	N/A	350	350
City of Phoenix	500	350	300	300

Table 6
Surprise Drinking Water Demand Design Factors

Demand Factors			Peaking Factors	
Average Day (gpcd)	Maximum Day (gpcd)	Peak Hour (gpcd)	Maximum Day	Peak Hour
200	400	600	2.0	3.0

Table 7
Surprise Planning Fire Flow Requirements

Description	Minimum Flow (gpm)
Single Family Residence, up to 3600 SF	1,000
Single Family Residence, 3601 SF and larger	1,750
Multi-family Residence	1,500
Commercial*	3,000
Industrial, Warehouse	3,500

Table 8
Surprise Maximum Fire Hydrant Spacing

Max Fire Hydrant Spacing (ft)			
Single Family	**Cul-de-Sacs**	**Multi-family**	**Commercial & Industrial**
500	350	300	300

Table 9
Surprise Waterline Sizing Criteria

Maximum Velocity (feet/sec)	Minimum Pipe Size (inches)			Maximum Valve Spacing (feet)	
	Residential Street	**Collector**	**Major Arterials or Section Line Streets**	**Single Family**	**Commercial & Multi-family**
10	8	12	16	800	500

Table 10
Annual Drinking Water Demand

Year	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Demand (GPCD)	152	148	147	146	145	145	144	144	144	144

Table 11
Well Inventory

Existing		Under Construction	Planned
Well ID	**Design Pump Capacity (gpm)**	**Well ID**	**Well ID**
Ashton Ranch 1		Rancho Gabriela 1	Ashton Ranch 2
Roseview 1	1,500	Rancho Gabriela 2	Mountain Vista Ranch 2
Mountain Vista Ranch 1A		Surprise Center 1	Litchfield Manor 1
		Orchards 1	Marley Park 1
		Desert Oasis 1	Mountain Gate 1
		Desert Oasis 2	
		Serria Verde 1	
		Royal Ranch 1	

Table 12
Reservoir Inventory

Reservoir	Diameter (feet)	Volume (gallons)
Ashton Ranch Water Supply Facility (WSF)	104	1,000,000
Mountain Vista Ranch WSF	46	200,000
Roseview WSF	115	1,200,000
Rancho Gabriela WSF	----	3,500,000
	Total Available Storage	**5,900,000**

Table 13
Water Supply Facility Booster Pump Inventory

Location	Booster Pump	Production (gpm)	HP	Type
Ashton Ranch WSF	1	400	25	Constant Speed
Ashton Ranch WSF	2	400	25	Constant Speed
Ashton Ranch WSF	3	400	25	Constant Speed
Ashton Ranch WSF	4	400	25	Constant Speed
Ashton Ranch WSF	5	1,500	75	Constant Speed
Ashton Ranch WSF	6	1,500	75	Constant Speed
Mountain Vista Ranch WSF	1	250	20	Constant Speed
Mountain Vista Ranch WSF	2	250	20	Constant Speed
Mountain Vista Ranch WSF	3	500	40	Constant Speed
Mountain Vista Ranch WSF	4	500	40	Constant Speed
Rancho Gabriela WSF	1	500	40	----
Rancho Gabriela WSF	2	1240	75	----
Rancho Gabriela WSF	3	1500	100	Variable Frequency Drive
Rancho Gabriela WSF	4	1500	100	Variable Frequency Drive
Rancho Gabriela WSF	5	1500	100	Variable Frequency Drive
Rancho Gabriela WSF	6	1500	100	Variable Frequency Drive
Rancho Gabriela WSF	7	1500	100	Variable Frequency Drive
Roseview WSF	1	1,500	100	Variable Frequency Drive
Roseview WSF	2	1,500	100	Variable Frequency Drive
Roseview WSF	3	1,500	100	Variable Frequency Drive
Roseview WSF	4	400	30	Constant Speed

Table 14
Fire Flow Tests

Test Location	Date	Time	Flow (gpm)	Static (psi)	Residual (psi)
Roseview Pressure Zone					
133rd & Thunderbird (1)	9-Dec	9:00am	1453.1	82	75
Mountain Vista Ranch Pressure Zone					
158th Ave & Smokey Dr	19-Dec	10:15am	2034.8	72	30
161st Ave & Mtn Vista Ranch Rd	19-Dec	9:55am		76	
Mtn Vista Blvd & Mtn Vista Ranch Rd	19-Dec	9:45am		80	
Ashton Ranch Pressure Zone					
140th Ave & Cactus (2)	9-Dec	8:40am	1433.6	93	80
Bullard & 1/2 Mile N of Greenway (3)	9-Dec	9:00am	1352.8	65	60
Reems & 1/2 Mile S of Greenway (4)	9-Dec	9:30am	1500.8	90	65
Yana St & 153rd (7)	9-Dec	12:30pm	1061.2	70	60
147th & 1block S of Young St (8)	9-Dec	12:50pm	1244.4	70	60
140th & Greenway (9)	9-Dec	1:00pm	1125.6	65	55
142nd By Court House (10)	9-Dec	2:00pm	1352.8	75	65

Table 15
SPA 2-5 Drinking Water Model Pressure Results

ID	Average Day Pressure (psi)	Max Day Pressure (psi)	Peak Hour Pressure (psi)
J-1	67.11	63.68	61.82
J-2	55.80	52.46	48.79
J-3	77.84	75.70	68.26
J-4	56.81	56.23	53.45
J-5	74.93	73.65	71.70
J-6	66.84	61.58	54.56
J-7	56.42	55.25	54.70
J-9	49.58	47.51	43.94
J-10	59.34	53.36	51.33
J-11	75.40	74.58	71.32
J-13	61.89	54.05	53.24
J-14	49.04	45.62	44.59
J-15	64.26	63.87	61.78
J-16	59.35	52.99	48.88
J-17	60.81	57.82	54.89
J-18	58.36	58.35	58.34
J-19	66.72	61.87	50.83
J-20	67.02	67.01	67.00
J-21	51.05	47.32	44.95
J-22	74.01	69.66	66.73
J-23	41.86	41.85	41.84
J-24	48.90	46.98	44.64
J-26	61.33	57.48	49.36
J-27	44.04	44.03	43.99
J-28	66.41	65.28	59.55
J-29	78.41	76.54	66.36
J-30	71.94	71.92	71.89
J-33	51.74	51.73	51.73
J-34	73.62	68.28	60.79
J-35	79.51	74.38	67.63
J-36	49.49	48.58	45.03
J-37	46.62	43.36	41.19
J-38	76.59	72.98	65.13
J-39	68.24	66.39	65.21
J-40	63.09	61.55	60.42
J-42	48.54	48.54	48.54
J-43	52.38	47.22	44.64
J-44	65.44	63.19	61.12
J-45	69.12	67.04	63.54

ID	Average Day Pressure (psi)	Max Day Pressure (psi)	Peak Hour Pressure (psi)
J-46	75.38	73.85	69.64
J-48	65.54	64.26	58.66
J-49	79.84	78.56	73.99
J-51	63.38	60.85	56.08
J-52	72.72	70.55	63.13
J-53	58.47	54.90	48.72
J-54	73.05	66.53	65.53
J-55	46.51	43.80	40.58
J-56	72.68	72.66	72.64
J-57	68.47	63.59	55.96
J-58	62.13	57.82	53.26
J-59	75.46	73.02	69.31
J-60	74.65	68.81	61.24
J-61	46.68	43.60	43.35
J-62	47.46	44.04	42.73
J-63	57.63	56.08	53.68
J-64	48.42	48.42	48.42
J-65	63.53	59.35	56.75
J-66	79.48	78.02	75.76
J-68	76.91	76.90	76.89
J-69	64.29	63.83	56.57
J-70	69.20	63.54	57.82
J-71	59.27	54.09	47.20
J-73	69.73	63.68	59.96
J-74	74.47	73.23	71.30
J-75	61.18	57.17	54.09
J-76	46.96	46.42	45.63
J-77	53.49	53.48	53.45
J-78	57.70	55.01	52.84
J-79	59.11	55.59	53.75
J-80	72.75	68.49	65.38
J-81	77.24	69.92	68.93
J-82	79.16	79.15	79.14
J-83	76.28	69.49	61.35
J-84	57.28	55.64	46.73
J-85	66.83	62.23	56.05
J-86	67.06	67.06	67.06
J-87	60.52	59.97	57.41
J-89	68.03	63.86	59.40
J-90	65.20	62.53	59.59
J-91	55.67	51.59	46.62

ID	Average Day Pressure (psi)	Max Day Pressure (psi)	Peak Hour Pressure (psi)
J-92	71.32	68.53	65.59
J-94	60.05	60.05	60.04
J-95	73.04	68.08	61.59
J-96	57.44	52.09	48.96
J-97	47.38	44.16	40.38
J-98	64.26	62.65	61.42
J-99	60.65	58.85	52.43
J-100	44.25	42.33	41.85
J-101	59.07	55.22	51.25
J-102	76.78	71.48	64.11
J-103	59.35	59.35	59.35
J-104	55.33	55.33	55.32
J-106	65.39	65.38	65.36
J-107	50.45	46.60	44.29
J-108	71.35	70.42	65.02
J-109	57.04	57.04	57.04
J-110	66.08	63.12	57.65
J-111	77.36	74.39	70.40
J-112	54.51	46.66	46.02
J-114	78.02	72.03	64.50
J-115	76.24	74.37	65.11
J-116	78.48	76.69	73.96
J-117	68.23	64.81	61.94
J-118	75.49	71.88	65.19
J-119	55.88	54.61	49.22
J-120	69.27	67.82	62.99
J-121	75.46	74.81	60.55
J-122	70.47	67.65	62.90
J-123	68.29	65.74	62.90
J-124	65.75	65.73	65.73
J-125	63.08	54.49	51.49
J-126	76.08	68.49	54.84
J-127	79.56	75.06	60.88
J-128	58.01	55.89	53.71
J-129	68.52	65.46	60.26
J-130	58.89	55.74	51.45
J-131	64.65	64.64	64.62
J-132	58.34	52.23	48.78
J-133	68.70	64.65	58.44
J-134	74.57	73.99	73.10
J-135	53.83	49.36	47.57

ID	Average Day Pressure (psi)	Max Day Pressure (psi)	Peak Hour Pressure (psi)
J-136	62.62	60.48	55.90
J-137	67.29	63.92	61.99
J-138	55.54	54.45	52.78
J-139	79.64	77.33	75.00
J-141	54.52	51.98	49.54
J-142	76.22	69.32	62.47
J-143	50.95	50.59	50.21
J-144	73.94	73.93	73.93
J-145	58.71	52.12	46.23
J-146	79.44	74.68	63.49
J-147	57.93	54.69	53.47
J-148	63.39	58.48	52.38
J-149	64.20	63.55	50.83
J-150	69.71	67.57	65.61
J-151	78.15	75.40	72.48
J-152	66.73	65.88	64.55
J-154	47.50	44.04	42.02
J-155	68.43	67.50	66.06
J-156	69.15	67.30	59.97
J-157	60.41	59.55	58.22
J-158	68.19	65.39	60.73
J-159	51.92	51.92	51.91
J-160	64.98	56.28	52.42
J-161	49.40	46.86	44.76
J-162	59.96	56.84	49.50
J-164	71.91	68.51	65.28
J-165	71.68	67.52	56.38
J-166	69.82	65.24	58.87
J-167	71.12	68.28	47.97
J-168	74.44	71.64	68.19
J-169	52.87	48.87	45.91
J-170	47.11	44.87	42.53
J-171	52.03	48.59	47.40
J-172	60.98	60.92	60.85
J-173	69.53	65.96	62.32
J-175	67.61	63.93	63.44
J-177	67.49	65.08	62.56
J-178	74.80	69.55	62.47
J-179	54.10	48.98	46.60
J-180	78.24	71.48	62.99
J-181	78.08	78.07	78.06

ID	Average Day Pressure (psi)	Max Day Pressure (psi)	Peak Hour Pressure (psi)
J-271	66.25	61.89	54.57
J-272	71.26	71.26	71.26
J-273	79.50	75.27	70.70
J-274	66.01	63.00	57.51
J-275	78.39	74.06	71.03
J-276	71.43	64.54	60.39
J-277	69.01	59.65	55.33
J-278	63.49	54.63	51.03
J-280	56.74	53.13	48.19
J-281	51.11	48.14	43.77
J-283	60.99	60.97	60.93
J-284	75.03	71.88	65.29
J-285	79.69	78.76	77.32
J-286	50.43	49.95	49.20
J-288	53.53	44.99	44.78
J-289	55.52	49.79	46.95
J-290	81.49	77.79	71.12
J-291	80.54	76.48	73.61
J-292	51.50	48.48	47.67
J-293	59.63	56.16	55.44
J-294	59.86	56.15	55.59
J-295	66.73	65.45	61.19
J-296	69.07	68.63	67.20
J-297	66.14	65.44	63.01
J-298	67.51	66.70	63.67
J-299	62.88	62.88	62.87
J-300	66.20	65.42	62.99
J-301	50.55	46.56	40.82

Table 16
SPA 2-5 PRV Pressure Settings

ID	Elevation (feet)	Pressure Setting (psi)	ID	Elevation (feet)	Pressure Setting (psi)	ID	Elevation (ft)	Pressure Setting (psi)
PRV-4	1,870	40	PRV-42	1,390	45	PRV-70	1,630	40
PRV-5	1,870	40	PRV-45	1,390	45	PRV-71	1,630	40
PRV-10	1,870	45	PRV-49	1,470	43	PRV-72	1,630	40
PRV-20	1,710	40	PRV-50	1,470	43	PRV-73	1,710	40
PRV-21	1,710	40	PRV-51	1,470	43	PRV-74	1,710	40
PRV-22	1,630	40	PRV-52	1,550	40	PRV-77	1,710	40
PRV-23	1,550	40	PRV-53	1,470	43	PRV-79	1,710	40
PRV-24	1,550	40	PRV-55	1,470	43	PRV-80	1,710	40
PRV-27	1,470	43	PRV-56	2,030	40	PRV-81	1,792	42
PRV-28	1,470	43	PRV-57	1,870	40	PRV-82	1,790	40
PRV-29	1,470	43	PRV-59	1,395	45	PRV-83	1,790	40
PRV-31	1,630	42	PRV-60	1,390	45	PRV-84	1,790	40
PRV-32	1,630	42	PRV-61	1,710	40	PRV-85	1,870	40
PRV-33	1,550	40	PRV-63	1,630	40	PRV-86	1,790	40
PRV-34	1,470	43	PRV-64	1,630	42	PRV-88	1,790	40
PRV-36	1,470	43	PRV-67	1,550	40	PRV-89	1,950	40
PRV-37	1,390	45	PRV-68	1,550	40	PRV-90	1,950	40
PRV-40	1,390	45	PRV-69	1,630	40	PRV-93	1,950	40

Table 17
SPA 2-5 Build-out of Drinking Water Reservoirs

Reservoir ID	Size (MG)	Hydraulic Grade (feet)	Pressure (psi)	Reservoir ID	Size (MG)	Hydraulic Grade (feet)	Pressure (psi)
R-5	3.0	1,730	60	R-29	6.5	1,815	78
R-6	1.5	2,060	57	R-31	6.0	1,525	66
R-8	1.75	1,815	59	R-32	6.5	1,525	67
R-12	4.5	1,735	44	R-34	6.5	1,580	54
R-13	5.5	1,665	42	R-35	1.5	2,060	74
R-16	7.0	1,525	58	R-36	4.5	1,660	79
R-17	5.0	1,660	65	R-37	1.0	1,895	63
R-18	3.75	1,580	55	R-38	1.5	1,815	48
R-20	1.5	2,170	52	R-39	4.0	1,740	52
R-21	7.0	1,660	61	R-43	1.2	1,975	67
R-22	11.1	1,660	61	R-45	1.50	2,145	71
R-24	8.0	1,580	73	R-47	4.0	1,580	77
R-26	2.1	1,895	49	R-49	8.25	1,580	72
R-27	7.0	1,740	65				

Table 18
Drinking Water System Cost Estimates

Special Planning Area	Pipe ($)	PRV ($)	Reservoir ($)	Total ($)
SPA 1	$4,106,440	$52,000	$7,700,000	$11,858,440
SPA 2-5	$60,745,295	$1,404,000	$59,950,000	$122,099,295
			Total	**$133,957,735**

Table 19
SPA 1 Waterline Cost Estimate

ID	Diameter (inches)	Length (feet)	Cost ($)	ID	Diameter (inches)	Length (feet)	Cost ($)
P-114	16	5,233	272,116	P-152	16	24	1,248
P-116	16	5,241	272,532	P-154	16	22	1,144
P-117	16	5,267	273,884	P-155	16	19	988
P-120	16	898	46,696	P-156	16	25	1,300
P-122	12	2,626	102,414	P-157	16	25	1,300
P-125	12	5,265	205,335	P-158	16	11	572
P-126	16	5,255	273,260	P-159	16	10	520
P-127	12	5,287	206,193	P-160	16	8	416
P-128	12	3,969	154,791	P-161	16	10	520
P-129	12	1,690	65,910	P-163	12	315	12,285
P-132	16	25	1,300	P-164	12	4,980	194,220
P-133	16	38	1,976	P-169	16	30	1,560
P-134	16	31	1,612	P-170	16	53	2,756
P-135	16	24	1,248	P-171	16	35	1,820
P-136	16	23	1,196	P-172	16	58	3,016
P-137	16	25	1,300	P-175	16	5,285	274,820
P-138	16	33	1,716	P-178	16	2,432	126,464
P-139	16	41	2,132	P-182	12	494	19,266
P-140	16	42	2,184	P-184	16	5,255	273,260
P-141	16	35	1,820	P-185	16	41	2,132
P-142	16	30	1,560	P-186	16	63	3,276
P-143	16	26	1,352	P-187	16	4,289	223,028
P-144	16	29	1,508	P-189	16	49	2,548
P-145	16	35	1,820	P-190	16	70	3,640
P-146	16	44	2,288	P-191	16	5,255	273,260
P-147	16	56	2,912	P-192	16	5,296	275,392
P-148	16	29	1,508	P-193	16	5,265	273,780
P-150	16	29	1,508	P-194	12	2,802	109,278
P-151	16	16	832	P-198	16	2,264	117,728
						Total	$4,106,440

Table 20
SPA 1 PRV Cost Estimates

ID	Cost ($)
PRV-2	26,000
PRV-4	26,000
Total	**$52,000**

Table 21
SPA 1 Drinking Water Reservoir and Booster Pump Cost Estimates

Water Supply Facility	Size (Million Gallons)	Cost ($)
Ashton Ranch Water Supply Facility (WSF)	2.0	1,500,000
Mountain Vista Ranch WSF	1.2	1,200,000
Additional Storage High Zone	2.25	2,250,000
Additional Storage Low Zone	2.75	2,750,000
Total	**8.2**	**$7,700,000**

Table 22
SPA 2-5 Waterline Cost Estimates

Pipe ID	Diameter (inches)	Length (feet)	Cost ($)	Pipe ID	Diameter (inches)	Length (feet)	Cost ($)
P-1	16	5,271	274,092	P-81	16	1,529	79,508
P-7	12	5,092	198,588	P-82	16	4,375	227,500
P-9	16	5,271	274,092	P-83	16	1,717	89,284
P-14	12	5,166	201,474	P-84	12	5,300	206,700
P-17	12	5,240	204,360	P-85	12	5,271	205,569
P-18	12	5,271	205,569	P-87	12	5,272	205,608
P-19	12	5,242	204,438	P-88	12	5,299	206,661
P-22	16	5,239	272,428	P-91	12	5,306	206,934
P-23	12	5,239	204,321	P-93	16	5,184	269,568
P-24	12	5,387	210,093	P-95	12	5,242	204,438
P-25	12	5,313	207,207	P-98	12	5,271	205,569
P-29	12	5,314	207,246	P-102	16	1,107	57,564
P-30	12	5,239	204,321	P-103	16	4,649	241,748
P-32	12	5,239	204,321	P-104	16	5,313	276,276
P-34	16	5,242	272,584	P-105	16	4,649	241,748
P-36	12	5,300	206,700	P-106	16	4,132	214,864
P-38	12	5,314	207,246	P-107	12	3,717	144,963
P-40	12	5,314	207,246	P-109	12	5,240	204,360
P-41	12	5,239	204,321	P-110	12	5,314	207,246
P-45	12	5,240	204,360	P-111	12	5,314	207,246
P-46	12	5,314	207,246	P-112	16	5,239	272,428
P-47	12	5,313	207,207	P-113	16	4,576	237,952
P-48	12	5,240	204,360	P-114	16	1,061	55,172
P-49	12	5,314	207,246	P-115	16	4,253	221,156
P-50	12	5,313	207,207	P-117	16	5,267	273,884
P-51	12	5,239	204,321	P-119	16	5,314	276,328
P-52	12	4,451	173,589	P-120	16	4,319	224,588
P-58	16	4,651	241,852	P-121	16	5,272	274,144
P-59	12	5,271	205,569	P-127	16	5,257	273,364
P-61	16	5,338	277,576	P-128	16	5,258	273,416
P-62	16	5,392	280,384	P-130	12	5,271	205,569
P-63	16	5,313	276,276	P-133	12	5,242	204,438
P-65	16	5,149	267,748	P-135	12	5,345	208,455
P-66	16	5,156	268,112	P-136	12	5,269	205,491
P-67	16	5,243	272,636	P-137	12	5,244	204,516
P-68	16	10,328	537,056	P-138	12	5,226	203,814
P-73	16	5,387	280,124	P-139	12	5,387	210,093
P-74	16	5,166	268,632	P-140	12	5,314	207,246
P-141	12	5,240	204,360	P-213	16	5,239	272,428

Pipe ID	Diameter (inches)	Length (feet)	Cost ($)	Pipe ID	Diameter (inches)	Length (feet)	Cost ($)
P-142	12	4,061	158,379	P-215	24	5,240	408,720
P-143	12	1,923	74,997	P-219	24	5,239	408,642
P-144	12	3,676	143,364	P-220	16	5,387	280,124
P-145	16	5,365	278,980	P-221	16	5,314	276,328
P-146	16	5,188	269,776	P-223	16	5,126	266,552
P-147	20	5,239	340,535	P-224	16	5,241	272,532
P-148	16	5,240	272,480	P-226	16	5,431	282,412
P-150	12	5,337	208,143	P-227	16	5,461	283,972
P-151	12	5,261	205,179	P-228	16	5,240	272,480
P-152	12	5,108	199,212	P-231	16	5,315	276,380
P-157	16	4,278	222,456	P-232	16	5,339	277,628
P-158	16	924	48,048	P-234	16	7,517	390,884
P-159	16	5,286	274,872	P-235	16	5,240	272,480
P-161	16	4,450	231,400	P-236	16	1,084	56,368
P-162	16	5,339	277,628	P-237	16	2,235	116,220
P-163	16	5,033	261,716	P-238	16	3,341	173,732
P-164	16	4,452	231,504	P-241	16	5,166	268,632
P-165	16	5,338	277,576	P-242	16	2,186	113,672
P-166	16	5,314	276,328	P-244	12	1,078	42,042
P-169	16	5,174	269,048	P-245	16	5,205	270,660
P-170	16	5,032	261,664	P-246	16	5,092	264,784
P-172	16	4,796	249,392	P-247	16	5,244	272,688
P-178	12	5,338	208,182	P-248	16	5,165	268,580
P-180	12	5,295	206,505	P-250	16	5,338	277,576
P-182	16	4,301	223,652	P-251	16	3,853	200,356
P-183	16	865	44,980	P-252	16	5,277	274,404
P-184	16	5,202	270,504	P-253	16	5,320	276,640
P-187	20	5,239	340,535	P-255	16	5,235	272,220
P-188	16	5,166	268,632	P-256	16	4,729	245,908
P-190	20	5,387	350,155	P-257	16	1,097	57,044
P-192	16	5,165	268,580	P-258	16	4,216	219,232
P-193	16	5,313	276,276	P-259	16	1,344	69,888
P-195	16	5,240	272,480	P-261	16	5,296	275,392
P-197	16	5,313	276,276	P-265	12	5,305	206,895
P-199	20	5,240	340,600	P-266	12	5,273	205,647
P-200	20	5,209	338,585	P-267	12	5,269	205,491
P-203	20	5,204	338,260	P-268	12	5,264	205,296
P-207	16	5,313	276,276	P-269	16	5,313	276,276
P-208	16	5,166	268,632	P-270	16	5,315	276,380
P-209	12	5,166	201,474	P-273	20	5,197	337,805
P-212	16	5,387	280,124	P-274	16	4,395	228,540
P-275	20	992	64,480	P-408	16	4,121	214,292

Pipe ID	Diameter (inches)	Length (feet)	Cost ($)	Pipe ID	Diameter (inches)	Length (feet)	Cost ($)
P-276	20	5,293	344,045	P-413	16	69	3,588
P-277	16	3,532	183,664	P-416	16	42	2,184
P-279	16	3,293	171,236	P-421	16	51	2,652
P-324	12	1,561	60,879	P-430	16	1,167	60,684
P-325	12	3,700	144,300	P-431	16	1,424	74,048
P-326	16	1,518	78,936	P-432	16	2,887	150,124
P-327	16	3,757	195,364	P-433	16	2,258	117,416
P-331	12	5,240	204,360	P-434	16	1,661	86,372
P-345	16	838	43,576	P-435	16	3,412	177,424
P-346	16	4,434	230,568	P-438	16	63	3,276
P-366	12	4,527	176,553	P-442	12	988	38,532
P-367	12	593	23,127	P-443	12	4,328	168,792
P-368	16	3,750	195,000	P-447	16	46	2,392
P-369	16	1,499	77,948	P-448	16	5,239	272,428
P-370	12	5,313	207,207	P-449	16	5,360	278,720
P-371	12	4,331	168,909	P-450	16	5,113	265,876
P-372	12	2,320	90,480	P-451	16	39	2,028
P-373	12	2,994	116,766	P-452	16	5,257	273,364
P-374	16	1,327	69,004	P-453	16	913	47,476
P-375	16	2,830	147,160	P-454	16	4,498	233,896
P-376	16	2,967	154,284	P-456	16	68	3,536
P-377	16	1,639	85,228	P-457	12	5,035	196,365
P-379	12	5,238	204,282	P-458	16	5,310	276,120
P-384	16	1,403	72,956	P-459	16	49	2,548
P-385	16	3,984	207,168	P-460	16	4,771	248,092
P-386	16	1,842	95,784	P-461	16	5,233	272,116
P-387	16	3,325	172,900	P-489	16	655	34,060
P-388	16	2,497	129,844	P-490	16	4,658	242,216
P-389	16	2,817	146,484	P-506	12	2,084	81,276
P-394	16	3,552	184,704	P-507	12	3,225	125,775
P-395	16	1,762	91,624	P-510	12	5,271	205,569
P-396	12	1,975	77,025	P-511	12	3,494	136,266
P-397	12	3,257	127,023	P-512	12	1,777	69,303
P-398	16	718	37,336	P-524	16	5,032	261,664
P-399	16	2,410	125,320	P-525	16	4,956	257,712
P-400	16	2,959	153,868	P-526	16	5,032	261,664
P-401	16	2,281	118,612	P-527	16	3,207	166,764
P-404	16	4,576	237,952	P-528	16	685	35,620
P-405	16	3,239	168,428	P-529	16	4,652	241,904
P-406	16	2,074	107,848	P-530	16	1,825	94,900
P-407	16	1,119	58,188	P-537	16	5,204	270,608
P-538	16	5,303	275,756	P-597	12	5,314	207,246

Pipe ID	Diameter (inches)	Length (feet)	Cost ($)	Pipe ID	Diameter (inches)	Length (feet)	Cost ($)
P-539	16	5,245	272,740	P-598	12	5,240	204,360
P-540	12	5,299	206,661	P-599	12	3,643	142,077
P-541	12	5,069	197,691	P-600	12	1,749	68,211
P-543	16	5,124	266,448	P-601	12	3,725	145,275
P-544	16	5,245	272,740	P-602	12	1,588	61,932
P-545	16	5,303	275,756	P-607	12	593	23,127
P-546	16	5,084	264,368	P-608	12	4,795	187,005
P-547	16	5,175	269,100	P-609	16	5,303	275,756
P-549	16	5,245	272,740	P-612	16	2,367	123,084
P-551	16	3,510	182,520	P-613	16	2,821	146,692
P-552	16	1,851	96,252	P-614	12	860	33,540
P-559	16	5,156	268,112	P-615	12	4,413	172,107
P-560	16	3,486	181,272	P-617	12	5,271	205,569
P-561	16	1,877	97,604	P-618	12	4,707	183,573
P-564	16	5,210	270,920	P-619	12	592	23,088
P-565	16	5,252	273,104	P-622	12	4,685	182,715
P-576	20	5,241	340,665	P-623	12	559	21,801
P-578	16	2,036	105,872	P-624	12	3,583	139,737
P-579	16	3,277	170,404	P-625	12	1,776	69,264
P-580	16	3,434	178,568	P-628	12	1,980	77,220
P-581	16	1,953	101,556	P-629	12	3,340	130,260
P-582	12	5,247	204,633	P-632	12	562	21,918
P-583	12	5,315	207,285	P-633	12	4,757	185,523
P-584	12	5,314	207,246	P-634	12	2,083	81,237
P-585	12	677	26,403	P-635	12	3,188	124,332
P-586	12	1,980	77,220	P-636	12	2,545	99,255
P-587	12	3,990	155,610	P-637	12	2,772	108,108
P-588	12	1,278	49,842	P-638	12	6,147	239,733
P-589	12	1,361	53,079	P-640	16	1,906	99,112
P-590	12	3,952	154,128	P-641	16	3,340	173,680
P-591	12	2,059	80,301	P-642	12	1,489	58,071
P-592	12	3,181	124,059	P-643	12	3,783	147,537
P-593	12	2,006	78,234	P-645	12	5,283	206,037
P-594	12	3,307	128,973	P-646	12	5,255	204,945
P-595	12	5,314	207,246	P-648	16	2,574	133,848
P-596	12	5,313	207,207	P-655	16	2,706	140,712
						Total	**$60,745,295**

Table 23
SPA 2-5 PRV Cost Estimates

Quantity	Cost per PRV ($)	Total ($)
54	26,000	$1,404,000

Table 24
SPA 2-5 Drinking Water Reservoir and Booster Pump Cost Estimates

ID	Size (Million Gallons)	Cost ($)	ID	Size (Million Gallons)	Cost ($)
R-5	3	3,000,000	R-29	6.5	6,500,000
R-6	1.5	1,500,000	R-31	6	6,000,000
R-8	1.75	1,750,000	R-32	6.5	6,500,000
R-12	4.5	4,500,000	R-34	6.5	6,500,000
R-13	5.5	5,500,000	R-35	1.5	1,500,000
R-16	7	7,000,000	R-36	4.5	4,500,000
R-17	5	5,000,000	R-37	1	1,000,000
R-18	3.75	3,750,000	R-38	1.5	1,500,000
R-20	1.5	1,500,000	R-39	4	4,000,000
R-21	7	7,000,000	R-43	1.2	1,200,000
R-22	11.1	11,100,000	R-45	1.5	1,500,000
R-24	8	8,000,000	R-47	4	4,000,000
R-26	2.1	2,100,000	R-49	8.25	8,250,000
R-27	7	7,000,000		**Total**	**$121,650,000**

Table 25
Wastewater Generation Factors

Land Use	Average Flow				Units
	City of Phoenix	City of Peoria	City of Glendale	Arizona American Water	
Active Adult (1.9 persons/DU)	N/A			80	gpcpd
Low Density Res. (< 5 DU/ac, use 3.2 persons/DU)	100	100	80	80	gpcpd
Medium to High Density Res. (> 5 DU/ac, use 2.0 persons/DU)	100			80	gpcpd
Commercial	3000			1500	gpapd
Industrial / Warehouse	1000		1200	1500	gpapd
Industrial	50			N/A	gpcpd
Hotel/Motel	130	60		N/A	gprpd
Schools (no lunch, no showers)	50			N/A	gpcpd
Schools (with lunch & showers)	75			N/A	Gpcpd
Malls/Retail	0.5	0.1		N/A	gpd per SF

Table 26
Wastewater Peaking Factors

Pipe Size (inches)	Water Provider		
	City of Phoenix	City of Glendale	Arizona American Water
Less than 12	4	3	3
12 and Greater	2.5	2.5	3

Table 27
Wastewater Interceptor Design Factors

Water Provider	Velocity		Manning Coefficient	Minimum Depth of Cover (feet)
	Minimum (feet/sec)	Maximum (feet/sec)		
Arizona American Water	2.0	10.0	0.013	7.5
City of Glendale	2.0	9.0	0.013	6.0
City of Peoria	2.0	9.0	Per ADEQ Bulletin #11	6.0
City of Phoenix	2.0	9.0	0.013	7.0

Table 28
Wastewater Interceptor Minimum Slope Factors

Pipe Size (inches)	Wastewater Provider		
	City of Glendale	City of Peoria	City of Phoenix
6	0.01000	Per ADEQ Bulletin 11	0.01090
8	0.00340		0.00334
10	0.00240		0.00248
12	0.00200		0.00194
15	0.00160		0.00144
18	0.00120		0.00113
21	Slope shall allow for a velocity of 2.0 fps		0.00092
24			0.00077
27			0.00066
30			0.00057
33			0.00050
36			0.00045

Table 29
Surprise Wastewater Generation Factors

Land Use	Average Flow	Units
Active Adult (1.8 persons/DU)	100	gpcpd
Low Density Res. (< 5 DU/ac, use 3.2 persons/DU)	100	gpcpd
Medium to High Density Res. (> 5 DU/ac, use 2.0 persons/DU)	100	gpcpd
Commercial	2,500	gpapd
Industrial / Warehouse	1,000	gpapd
Industrial	50	gpcpd
Hotel/Motel	130	gprpd
Schools (no lunch, no showers)	15	gpcpd
Schools (with lunch & showers)	25	gpcpd
Malls/Retail	1	gpd per SF

Table 30
Surprise Wastewater Peaking Factors

Pipe Size (inches)	Peaking Factor
Less than 12	4.0
12 and Greater	2.5

Table 31
Surprise Sanitary Sewer Line Design Criteria

Velocity		Manning Coefficient	Minimum Depth of Cover for Trunklines
Minimum (feet/sec)	Maximum (feet/sec)		
2.0	9.0	0.013	7.0

Table 32
Surprise Sanitary Sewer Minimum Slopes

Pipe Size (inches)	Minimum Slope (feet/feet)	Pipe Size (inches)	Minimum Slope (feet/feet)
6	0.01090	21	0.00092
8	0.00334	24	0.00077
10	0.00248	27	0.00066
12	0.00194	30	0.00057
15	0.00144	33	0.00050
18	0.00113	36	0.00045

Table 33
Surprise Residential Diurnal Curve Factors

Time	Factor	Time	Factor	Time	Factor
12 AM	0.42	8 AM	1.83	4 PM	0.92
1 AM	0.19	9 AM	1.66	5 PM	1.24
2 AM	0.11	10 AM	1.52	6 PM	1.16
3 AM	0.09	11 AM	1.18	7 PM	1.42
4 AM	0.10	12 PM	1.11	8 PM	1.55
5 AM	0.30	1 PM	0.95	9 PM	1.55
6 AM	0.99	2 PM	0.77	10 PM	1.22
7 AM	1.92	3 PM	0.97	11 PM	0.83

Table 34
Lift Station Summary

Lift Station	Wet Well Size (ft)	Wet Well Depth (ft)	Capacity (gallons)	Pumps	
				Quantity	Horse Power (HP)
Greenway	9 x 12	5.4	4,362	3	35
Litchfield	9.5 x 9.5	4.5	3,037	2	5

Table 35
Wastewater System Costs

Special Planning Area (SPA)	Pipes ($)	Wastewater Treatment Plants ($)	Total ($)
1	9,259,509	----	9,259,509
2-5	69,282,851	380,051,604	449,334,455
		Total	$458,593,964

Table 36
Sanitary Sewer SPA 1 Cost Estimates

ID	Diameter (inches)	Length (feet)	Cost ($)	ID	Diameter (inches)	Length (feet)	Cost ($)
P-491	42	5,308	931,554	P-614	24	478	55,926
P-498	30	4,836	647,540	P-641	24	47	5,443
P-499	21	5,260	547,040	P-644	24	2,000	234,000
P-500	18	5,318	483,938	P-691	24	999	116,883
P-501	12	5,240	395,096	P-692	27	411	50,759
P-502	12	5,221	393,663	P-701	27	501	61,874
P-503	12	5,241	395,171	P-708	27	990	122,265
P-504	15	5,163	402,714	P-710	27	344	42,484
P-505	27	5,153	636,396	P-711	30	4,502	602,818
P-506	12	5,275	397,735	P-712	30	400	53,560
P-508	15	5,430	423,540	P-713	30	374	50,079
P-518	21	4,624	480,896	P-714	30	2,671	357,647
P-529	15	5,247	409,266	P-715	30	329	44,053
P-611	24	188	21,977	P-716	30	2,296	307,434
P-612	24	65	7,605	P-717	30	1,088	145,683
P-613	24	468	54,756	P-722	12	5,036	379,714
						Total	**$9,259,509**

Table 37
Sanitary Sewer SPA 2-5 Cost Estimates

ID	Diameter (inches)	Length (feet)	Cost ($)	ID	Diameter (inches)	Length (feet)	Cost ($)
P-1	18	5,239	476,749	P-118	12	3,717	280,262
P-4	27	4,796	592,306	P-119	10	5,247	286,486
P-5	27	5,240	647,140	P-120	8	5,092	244,925
P-6	27	5,314	656,279	P-121	8	5,240	252,044
P-9	8	5,166	248,485	P-122	10	5,314	290,144
P-11	18	4,870	443,170	P-123	12	5,313	400,600
P-12	8	5,338	256,758	P-124	10	5,239	286,049
P-13	8	5,032	242,039	P-125	12	4,156	313,362
P-14	12	4,803	362,146	P-126	27	6,700	827,450
P-15	12	5,338	402,485	P-128	15	4,253	331,734
P-17	8	5,032	242,039	P-129	15	1,061	82,758
P-18	12	5,032	379,413	P-130	8	5,267	253,343
P-19	27	5,235	646,523	P-131	12	4,132	311,553
P-20	27	3,186	393,471	P-132	15	1,107	86,346
P-21	36	3,374	517,572	P-133	8	5,268	253,391
P-22	12	1,594	120,188	P-134	8	5,315	255,652
P-23	8	5,108	245,695	P-135	30	999	133,766
P-24	12	5,032	379,413	P-136	30	1,251	167,509
P-25	18	5,146	468,286	P-137	30	3,341	447,360
P-26	27	971	119,919	P-138	10	4,451	243,025
P-27	27	4,315	532,903	P-139	8	4,004	192,592
P-28	27	924	114,114	P-140	24	1,309	153,153
P-29	8	5,072	243,963	P-141	15	5,254	409,812
P-30	8	5,174	248,869	P-143	8	5,331	256,421
P-31	18	961	87,451	P-145	12	5,271	397,433
P-33	10	5,338	291,455	P-148	15	5,271	411,138
P-37	10	5,166	282,064	P-149	15	5,357	417,846
P-38	12	5,313	400,600	P-150	18	5,242	477,022
P-39	21	5,387	560,248	P-158	10	3,676	200,710
P-40	24	5,314	621,738	P-159	18	5,120	465,920
P-41	36	5,166	792,464	P-162	27	5,314	656,279
P-42	36	5,240	803,816	P-163	27	5,387	665,295
P-43	42	5,239	919,445	P-164	36	5,314	815,168
P-44	48	5,313	1,001,501	P-165	36	4,061	622,957
P-45	48	5,354	1,009,229	P-166	48	1,923	362,486
P-47	8	5,240	252,044	P-167	8	5,271	253,535
P-52	42	5,635	988,943	P-168	8	5,214	250,793
P-53	8	5,240	252,044	P-171	8	5,300	254,930
P-54	12	5,241	395,171	P-172	10	5,271	287,797

ID	Diameter (inches)	Length (feet)	Cost ($)	ID	Diameter (inches)	Length (feet)	Cost ($)
P-55	15	5,313	414,414	P-177	8	5,274	253,679
P-56	12	5,092	383,937	P-178	8	5,319	255,844
P-57	12	5,387	406,180	P-179	8	5,274	253,679
P-58	18	5,335	485,485	P-180	10	5,232	285,667
P-60	12	5,239	395,021	P-182	10	5,343	291,728
P-61	18	5,313	483,483	P-183	8	2,186	105,147
P-64	18	5,314	483,574	P-184	8	5,271	253,535
P-65	15	4,651	362,778	P-186	10	5,309	289,871
P-68	15	4,649	362,622	P-188	15	2,586	201,708
P-69	21	5,387	560,248	P-189	24	2,473	289,341
P-70	27	5,166	638,001	P-190	27	2,888	356,668
P-71	15	4,576	356,928	P-192	15	2,518	196,404
P-72	21	5,461	567,944	P-195	15	1,194	93,132
P-73	24	5,165	604,305	P-196	10	5,240	286,104
P-75	12	5,339	402,561	P-197	12	5,320	401,128
P-76	15	5,253	409,734	P-198	12	5,249	395,775
P-78	8	4,596	221,068	P-201	12	7,482	564,143
P-79	8	1,215	58,442	P-202	12	7,495	565,123
P-80	8	4,213	202,645	P-203	15	7,434	579,852
P-81	12	5,241	395,171	P-204	24	1,529	178,893
P-82	10	5,166	282,064	P-205	24	4,375	511,875
P-83	8	5,271	253,535	P-206	24	1,717	200,889
P-84	10	5,271	287,797	P-212	24	6,653	778,401
P-85	12	5,300	399,620	P-215	21	2,891	300,664
P-86	12	5,238	394,945	P-216	21	2,274	236,496
P-87	12	5,314	400,676	P-217	27	2,796	345,306
P-88	15	5,239	408,642	P-218	42	2,340	410,670
P-89	15	5,314	414,492	P-219	24	1,600	187,200
P-90	15	5,313	414,414	P-222	36	4,452	682,937
P-91	18	5,314	483,574	P-223	54	7,517	1,612,397
P-92	18	5,313	483,483	P-227	54	7,307	1,567,352
P-93	18	5,314	483,574	P-228	24	5,184	606,528
P-94	18	5,272	479,752	P-229	12	2,213	166,860
P-96	8	5,300	254,930	P-230	48	3,081	580,769
P-97	8	5,271	253,535	P-231	36	3,058	469,097
P-98	8	5,283	254,112	P-232	27	1,549	191,302
P-99	10	5,240	286,104	P-234	18	5,240	476,840
P-100	8	5,242	252,140	P-235	10	4,938	269,615
P-101	8	5,255	252,766	P-236	12	4,514	340,356
P-102	10	5,313	290,090	P-237	48	3,832	722,332
P-103	10	5,240	286,104	P-238	48	1,272	239,772

ID	Diameter (inches)	Length (feet)	Cost ($)	ID	Diameter (inches)	Length (feet)	Cost ($)
P-104	8	5,313	255,555	P-239	12	5,174	390,120
P-105	8	5,271	253,535	P-240	12	5,278	397,961
P-106	10	5,314	290,144	P-241	12	2,360	177,944
P-107	10	5,387	294,130	P-242	8	5,303	255,074
P-108	10	5,239	286,049	P-243	10	5,249	286,595
P-109	8	4,331	208,321	P-244	12	5,249	395,775
P-110	8	5,314	255,603	P-245	12	5,256	396,302
P-111	10	5,239	286,049	P-246	12	5,261	396,679
P-114	15	4,319	336,882	P-247	18	5,237	476,567
P-117	12	2,658	200,413			**Total**	$69,282,851

Table 38
SPA 2-5 Wastewater Treatment Plant Cost Estimates

Special Planning Area	Capacity (MGD)	Wastewater Treatment Plant	Land	Total
3	40.50	230,935,969	7,290,000	$238,225,969
4	7.20	66,589,133	1,296,000	$67,885,133
5	8.10	72,482,502	1,458,000	$73,940,502
			Total	$380,051,604

Table 39
Reclaimed Water Demand Factors

Type	Peak Demand*	Units
Turf	26.54	gpm/ac

*Based on a 6 day per week, 9 hours per day watering schedule.

Table 40
Projected Effluent Production

Special Planning Area	Effluent (acre feet)
1	12,315
2	5,084
3	12,550
4	3,084
5	3,754
Total	**36,787**

Table 41
Reclaimed Water Cost Estimate

Special Planning Area	Reservoirs ($)	Pipes ($)	Total ($)
1	2,500,000	2,318,200	4,818,200
3	39,250,000	6,322,836	45,572,836
4	3,500,000	597,428	4,097,428
5	4,000,000	624,988	4,624,988
		Total	**$59,113,452**

Table 42
Reclaimed Water Pipe Line Cost Estimates

ID	Diameter (inches)	Length (feet)	Cost ($)	ID	Diameter (inches)	Length (feet)	Cost ($)
P-42	12	1,422	55,458	P-218	24	5,339	416,442
P-76	12	722	28,158	P-219	24	100	7,800
P-104	12	1,626	63,414	P-220	24	4,955	386,490
P-105	12	186	7,254	P-221	20	5,012	325,780
P-140	30	1,316	128,310	P-222	24	100	7,800
P-141	30	2,289	223,178	P-223	20	594	38,610
P-143	30	560	54,600	P-224	24	100	7,800
P-145	16	1,354	70,408	P-225	12	564	21,996
P-146	30	4,047	394,583	P-226	16	4,998	259,896
P-187	24	5,239	408,642	P-230	16	5,233	272,116
P-195	20	5,240	340,600	P-231	20	5,315	345,475
P-196	16	2,609	135,668	P-242	20	5,240	340,600
P-197	16	2,595	134,940	P-251	16	3,853	200,356
P-199	12	5,240	204,360	P-257	16	1,097	57,044
P-200	12	4,693	183,027	P-258	16	4,216	219,232
P-202	12	2,728	106,392	P-259	16	1,344	69,888
P-203	24	2,638	205,764	P-260	16	5,166	268,632
P-204	24	2,717	211,926	P-261	20	5,296	344,240
P-205	12	2,303	89,817	P-280	30	4,778	465,855
P-208	16	1,479	76,908	P-290	16	5,240	272,480
P-209	16	4,200	218,400	P-291	12	5,149	200,811
P-210	12	2,898	113,022	P-388	24	4,068	317,304
P-215	20	5,396	350,740	P-389	16	5,387	280,124
P-216	24	100	7,800	P-564	16	5,383	279,916
P-217	20	4,928	320,320	P-567	24	4,142	323,076
						Total	**$9,863,452**

Table 43
Reclaimed Water Supply Facility Cost Estimates

Special Planning Area	Size (Million Gallons)	Cost ($)
1	2.5	2,500,000
3	18.5	18,500,000
	7.5	7,500,000
	5.5	5,500,000
	5.0	5,000,000
	2.75	2,750,000
4	3.5	3,500,000
5	4.0	4,000,000
	Total	**$49,250,000**

Table 44
Estimated Required Recharge Wells

Special Planning Area	Effluent (gpm)	CAP (gpm)	Recharge Wells
1	7,635	611	25
3	10,932		22
4	1,912		4
5	2,328		5
Total	**22807**	**611**	**56**

Table 45
Recharge Well Cost Summary

Special Planning Area	Recharge Wells	Cost
1	25	12,500,000
3	22	11,000,000
4	4	2,000,000
5	5	2,500,000
Total	**56**	**$28,000,000**

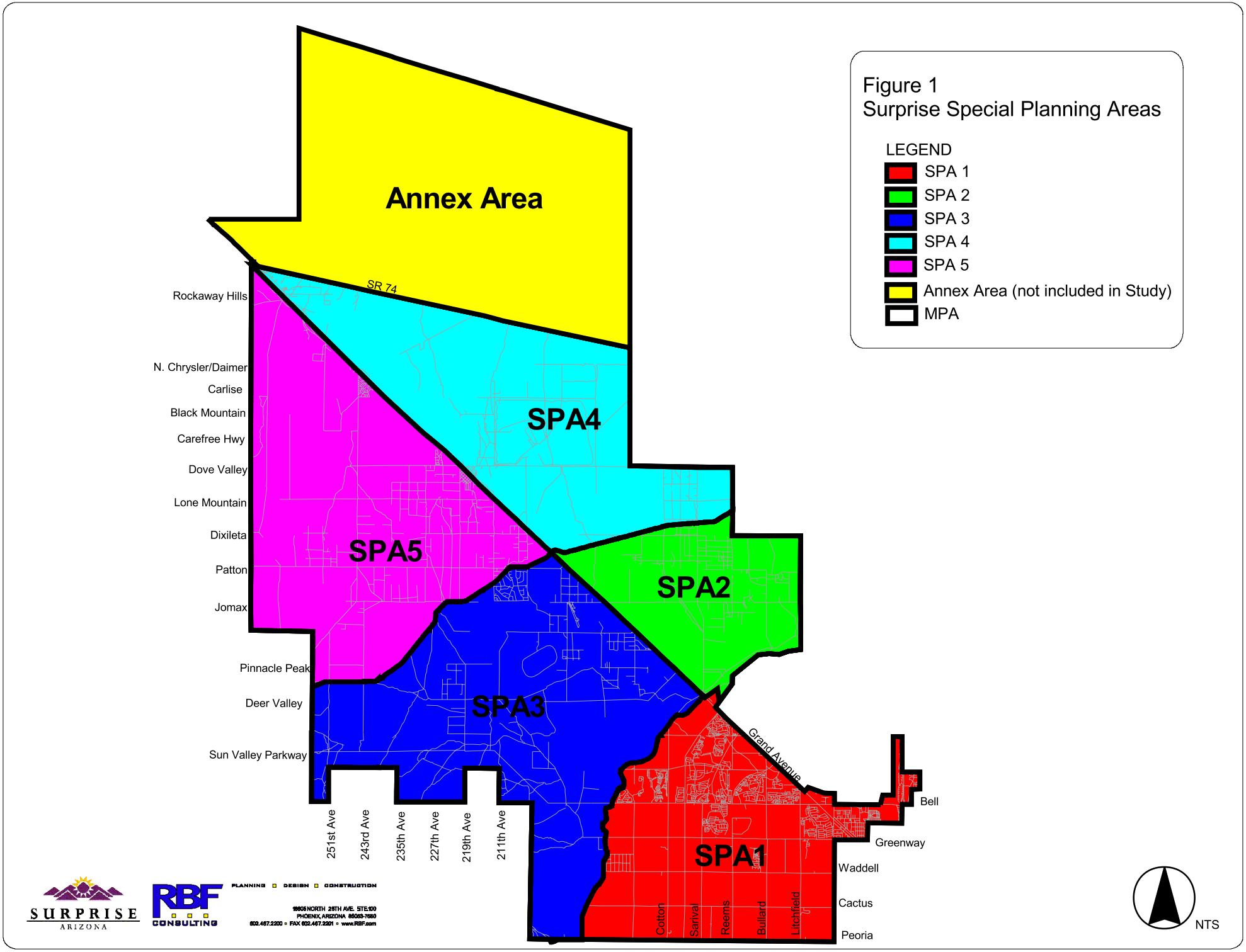
Figure 1
Surprise Special Planning Areas
LEGEND
SPA 1
SPA 2
SPA 3
SPA 4
SPA 5
Annex Area (not included in Study)
MPA
Annex Area
SPA4
SPA5
SPA2
SPA3
SPA1
SR 74
Rockaway Hills
N. Chrysler/Daimer
Carlise
Black Mountain
Carefree Hwy
Dove Valley
Lone Mountain
Dixileta
Patton
Jomax
Pinnacle Peak
Deer Valley
Sun Valley Parkway
251st Ave
243rd Ave
235th Ave
227th Ave
219th Ave
211th Ave
Grand Avenue
Bell
Greenway
Waddell
Cactus
Peoria
Cotton
Sarival
Reems
Bullard
Litchfield
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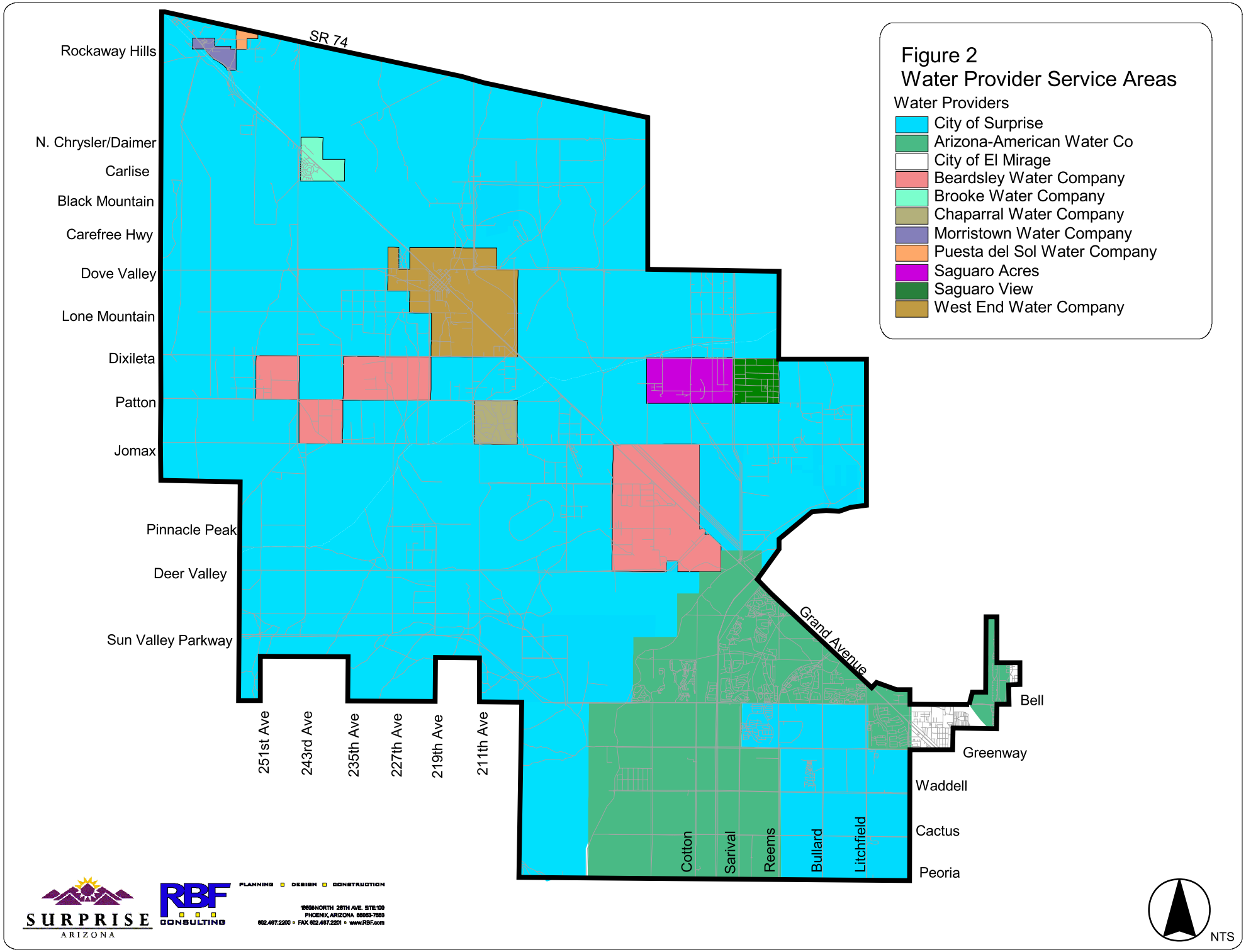
Figure 2
Water Provider Service Areas
Water Providers
City of Surprise
Arizona-American Water Co
City of El Mirage
Beardsley Water Company
Brooke Water Company
Chaparral Water Company
Morristown Water Company
Puesta del Sol Water Company
Saguaro Acres
Saguaro View
West End Water Company
SR 74
Rockaway Hills
N. Chrysler/Daimer
Carlise
Black Mountain
Carefree Hwy
Dove Valley
Lone Mountain
Dixileta
Patton
Jomax
Pinnacle Peak
Deer Valley
Sun Valley Parkway
Grand Avenue
251st Ave
243rd Ave
235th Ave
227th Ave
219th Ave
211th Ave
Bell
Greenway
Waddell
Cactus
Peoria
Cotton
Sarival
Reems
Bullard
Litchfield
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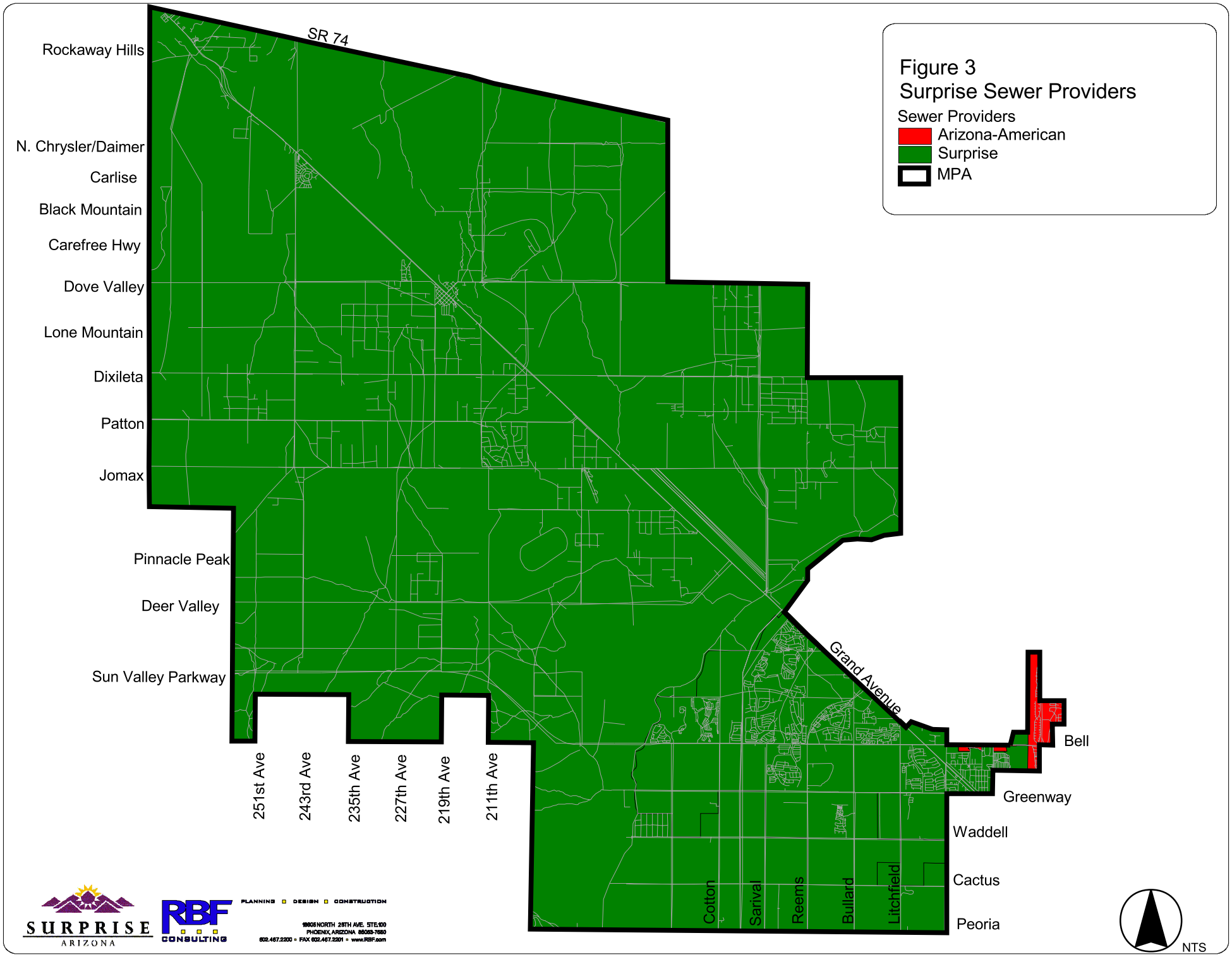
Figure 3
Surprise Sewer Providers
Sewer Providers
Arizona-American
Surprise
MPA
SR 74
Rockaway Hills
N. Chrysler/Daimer
Carlise
Black Mountain
Carefree Hwy
Dove Valley
Lone Mountain
Dixileta
Patton
Jomax
Pinnacle Peak
Deer Valley
Sun Valley Parkway
251st Ave
243rd Ave
235th Ave
227th Ave
219th Ave
211th Ave
Grand Avenue
Bell
Greenway
Waddell
Cactus
Peoria
Cotton
Sarival
Reems
Bullard
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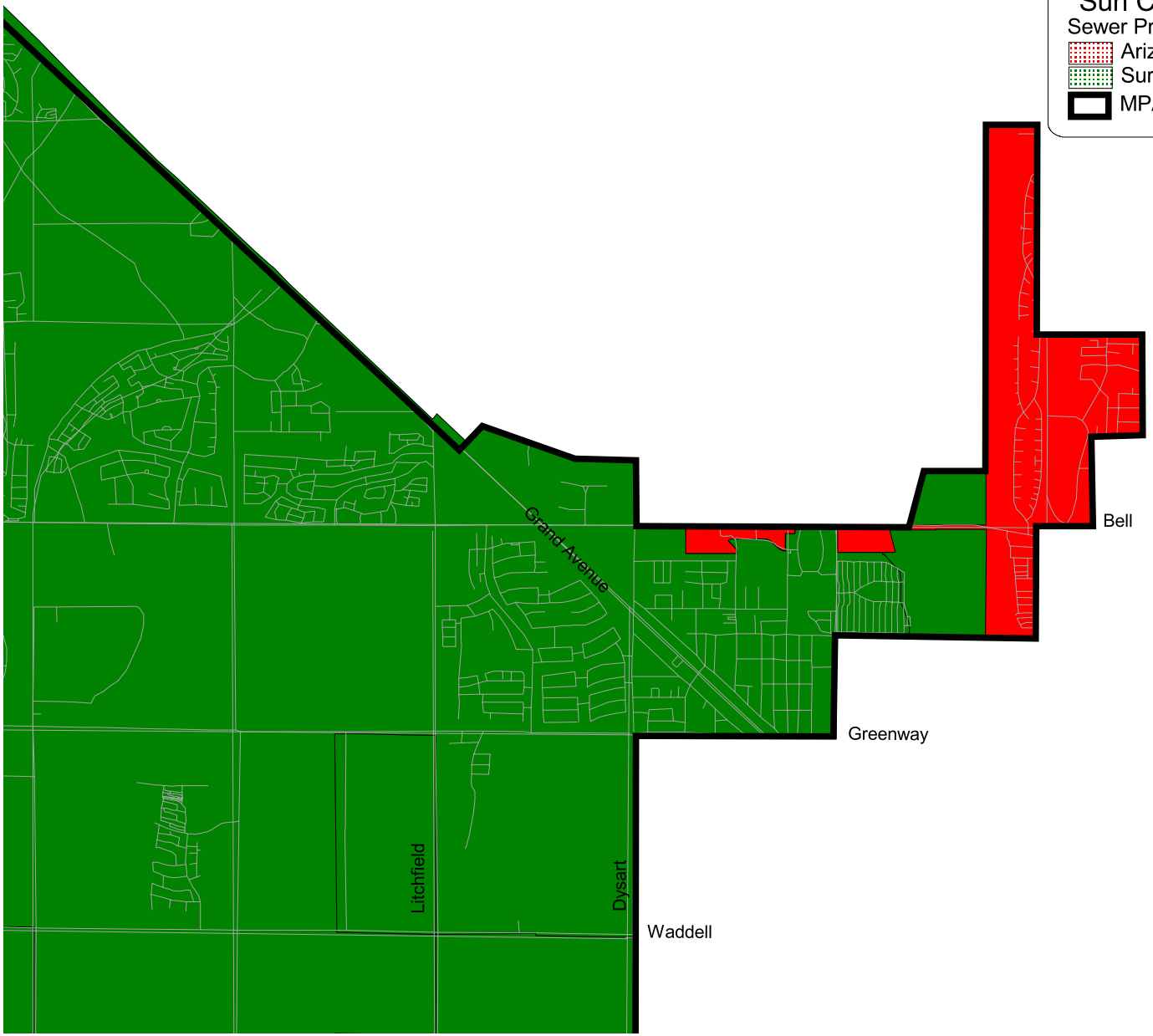

Figure 4
Surprise Sewer Providers
Sun City Area Blowup

Sewer Providers
- Arizona-American
- Surprise
- MPA

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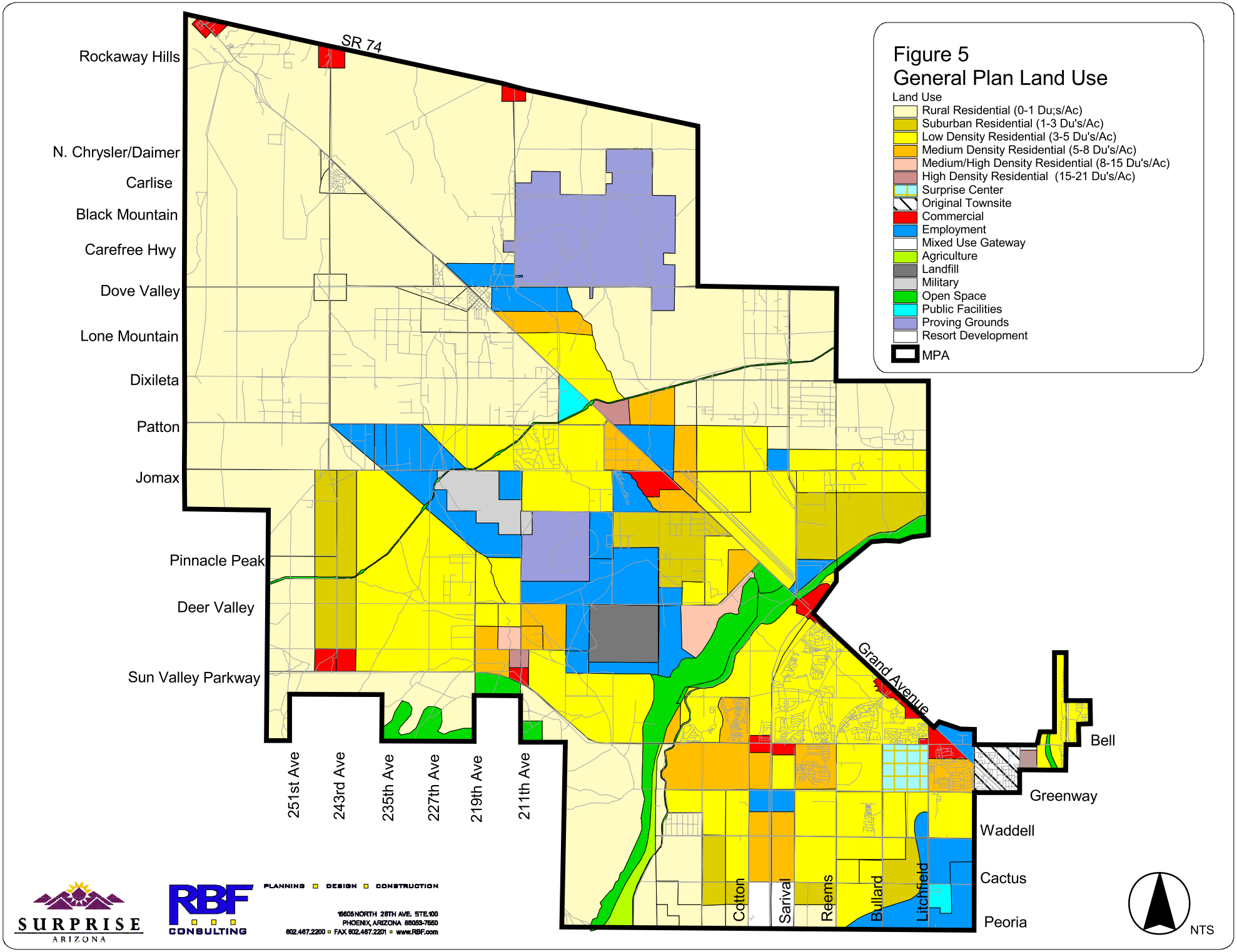
Figure 5
General Plan Land Use
Land Use
Rural Residential (0-1 Du;s/Ac)
Suburban Residential (1-3 Du's/Ac)
Low Density Residential (3-5 Du's/Ac)
Medium Density Residential (5-8 Du's/Ac)
Medium/High Density Residential (8-15 Du's/Ac)
High Density Residential (15-21 Du's/Ac)
Surprise Center
Original Townsite
Commercial
Employment
Mixed Use Gateway
Agriculture
Landfill
Military
Open Space
Public Facilities
Proving Grounds
Resort Development
MPA
SR 74
Rockaway Hills
N. Chrysler/Daimer
Carlise
Black Mountain
Carefree Hwy
Dove Valley
Lone Mountain
Dixileta
Patton
Jomax
Pinnacle Peak
Deer Valley
Sun Valley Parkway
251st Ave
243rd Ave
235th Ave
227th Ave
219th Ave
211th Ave
Grand Avenue
Bell
Greenway
Waddell
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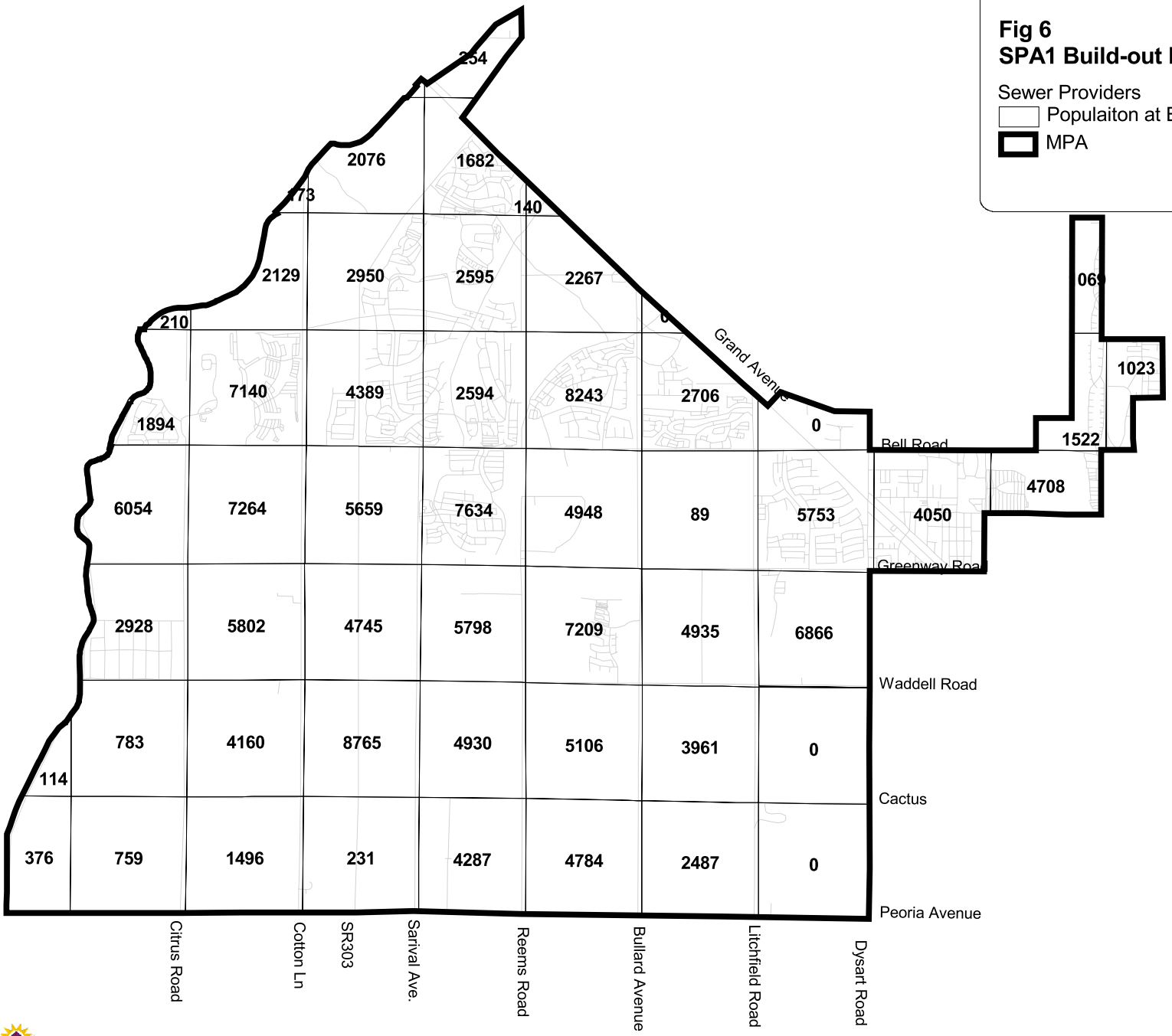

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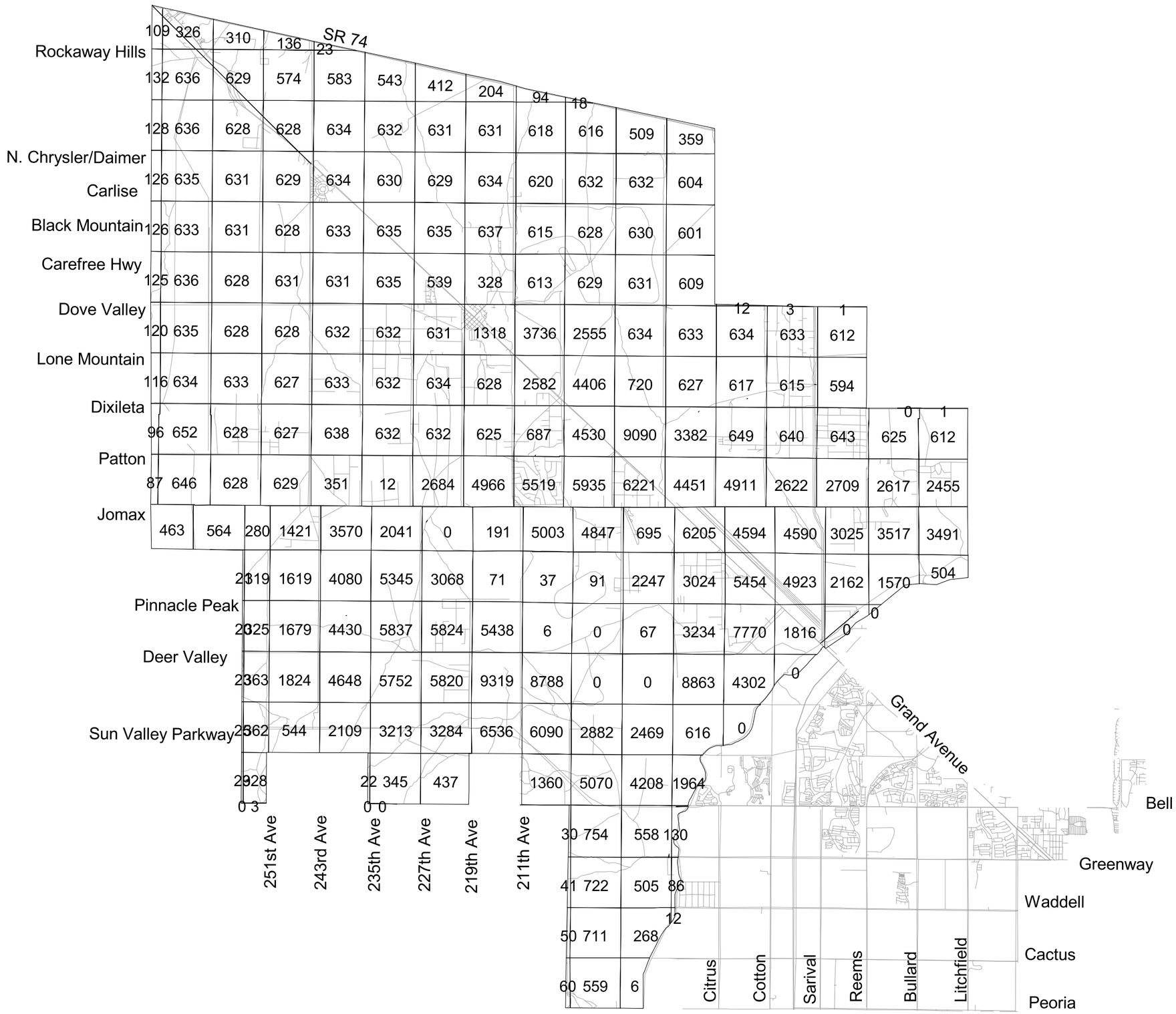
Figure 7
SPA2-5 Build-out Population



Legend

500 Population

1 0 1 2 Miles

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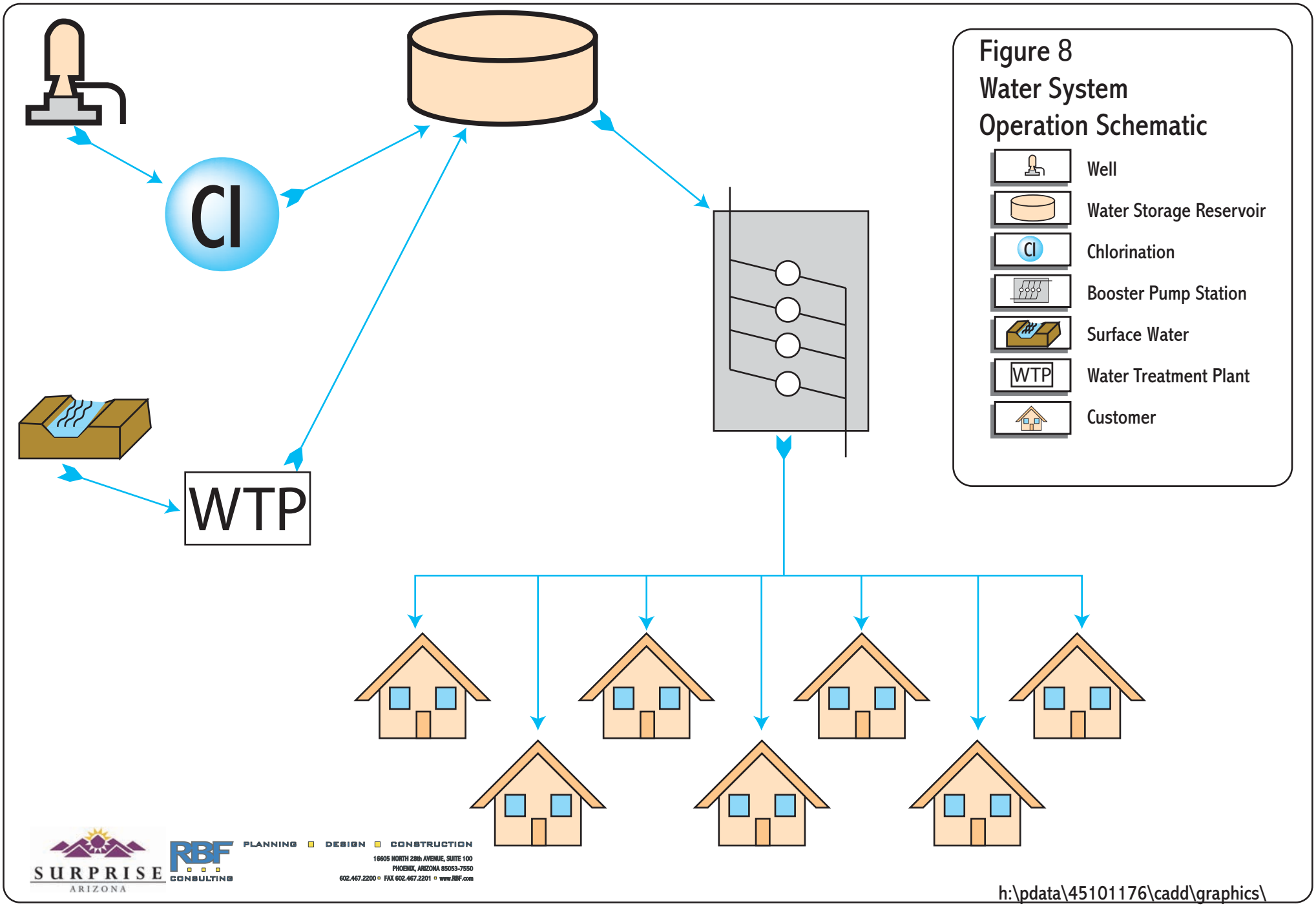
Figure 8
Water System
Operation Schematic
Well
Water Storage Reservoir
Chlorination
Booster Pump Station
Surface Water
Water Treatment Plant
Customer
CI
WTP
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Figure 9
Existing System Avg Pressure Contours

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Pressure Contours

40 PSI

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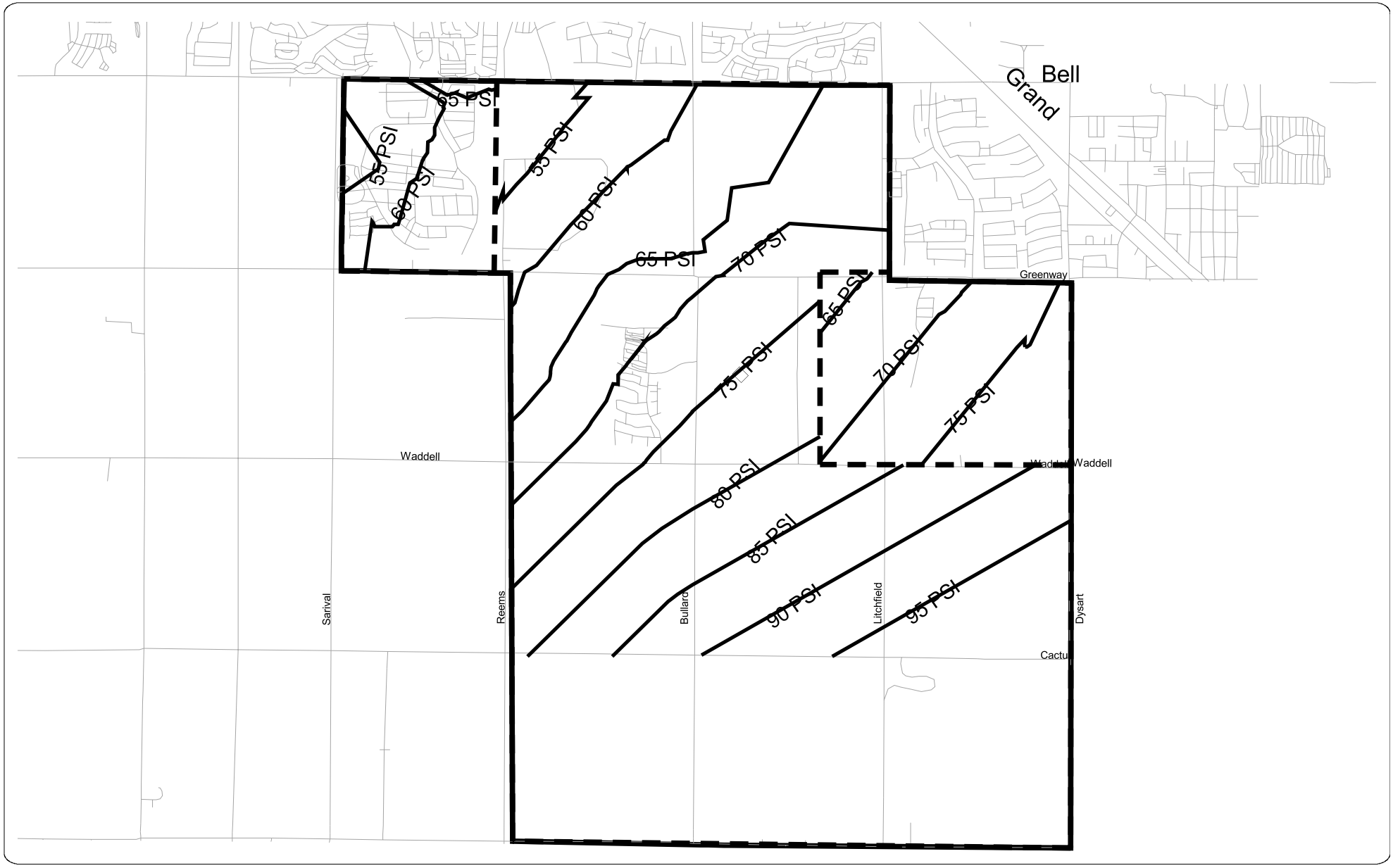

Figure 10
Existing System Max Day Press Contours

Pressure Contours

40 PSI

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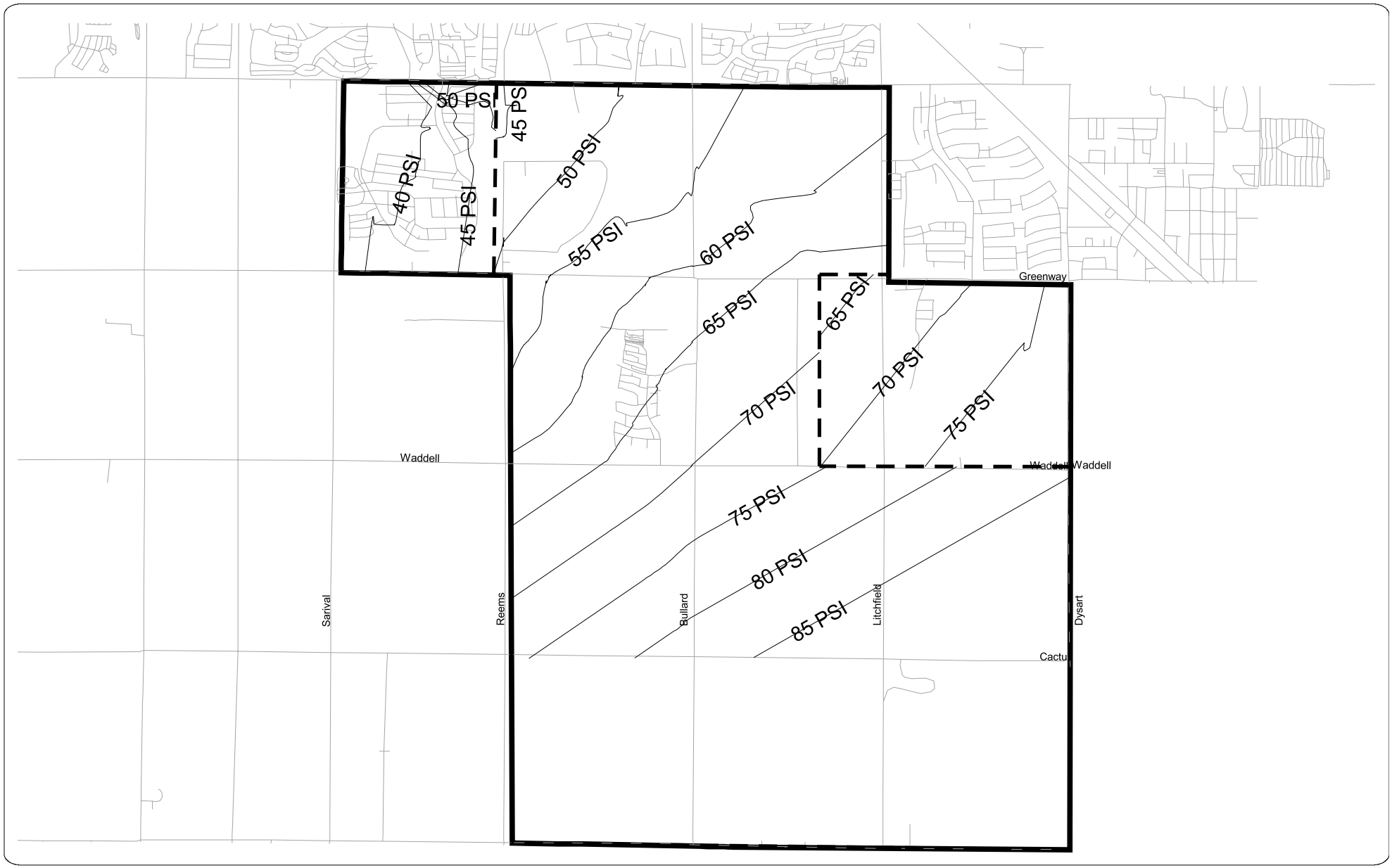

Figure 11
Existing System Peak Hour Contours

Pressure Contours

40 PSI

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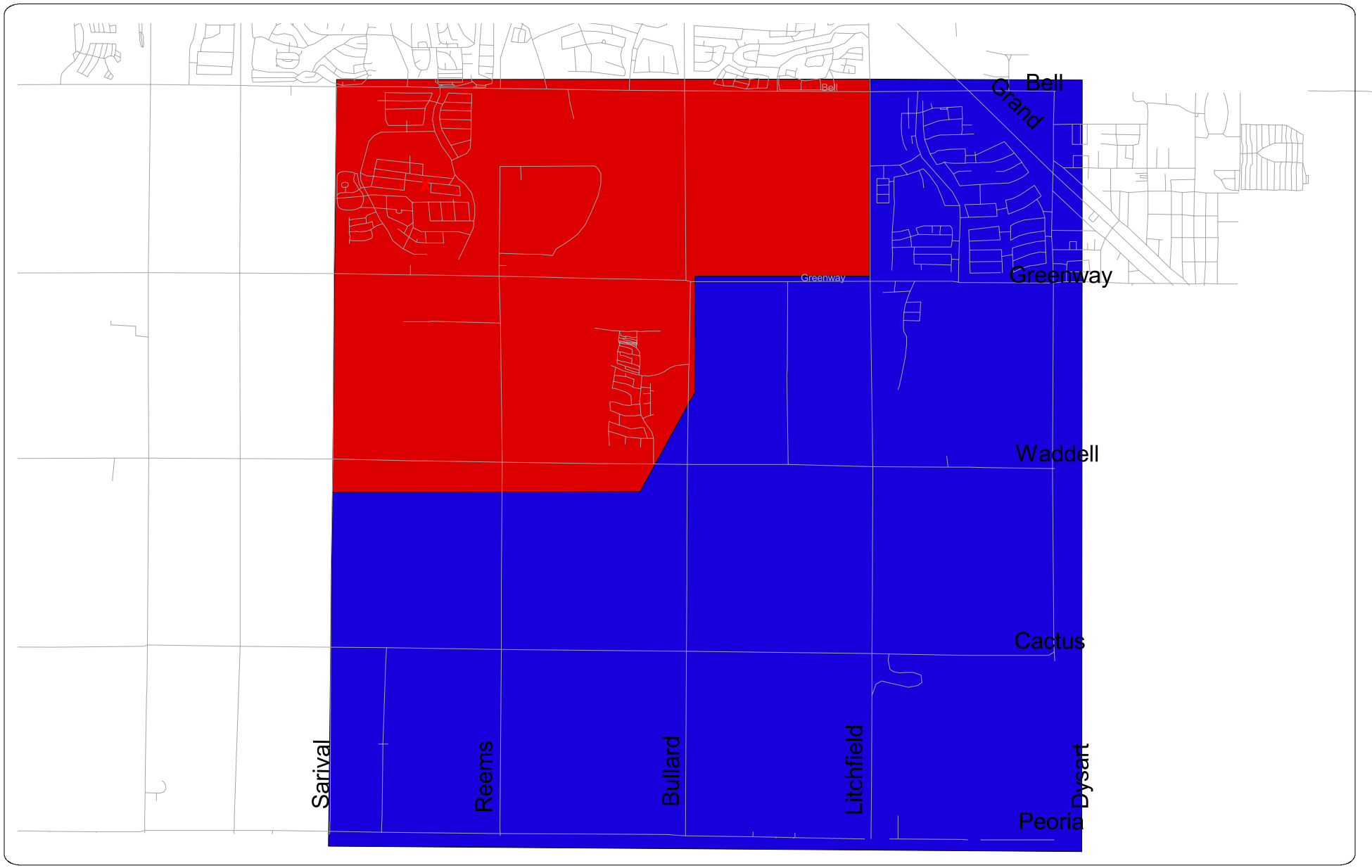

Figure 12
SPA1 Water Build-out Pressure Zones

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Pressure Zones
- High
- Low

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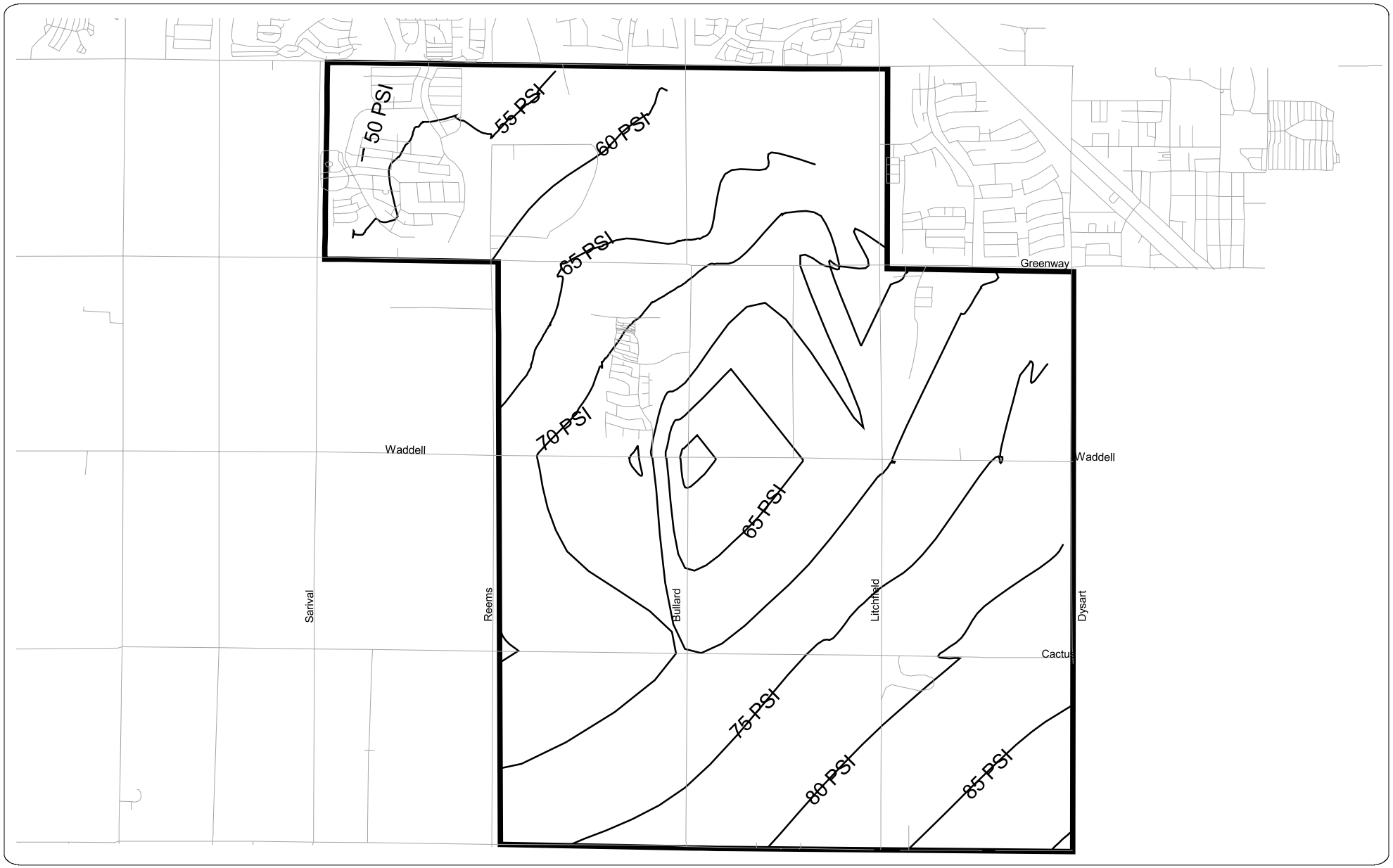

Figure 13
Existing System Average Day Contours

Pressure Contours

40 PSI

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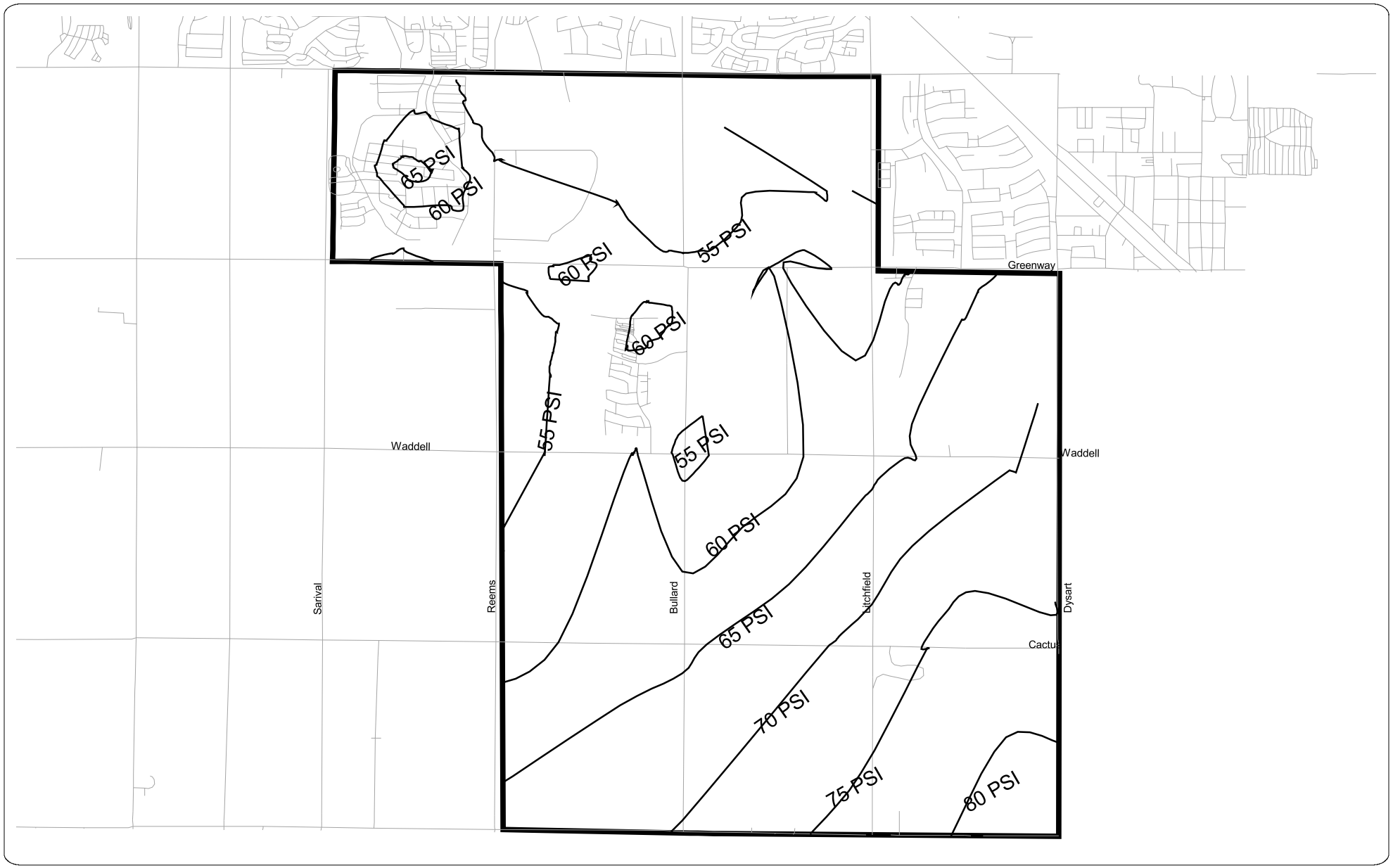

Figure 14
Existing System Max Day Contours

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Pressure Contours

40 PSI

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Figure 15
Existing System Peak Hour Contours

Pressure Contours

40 PSI

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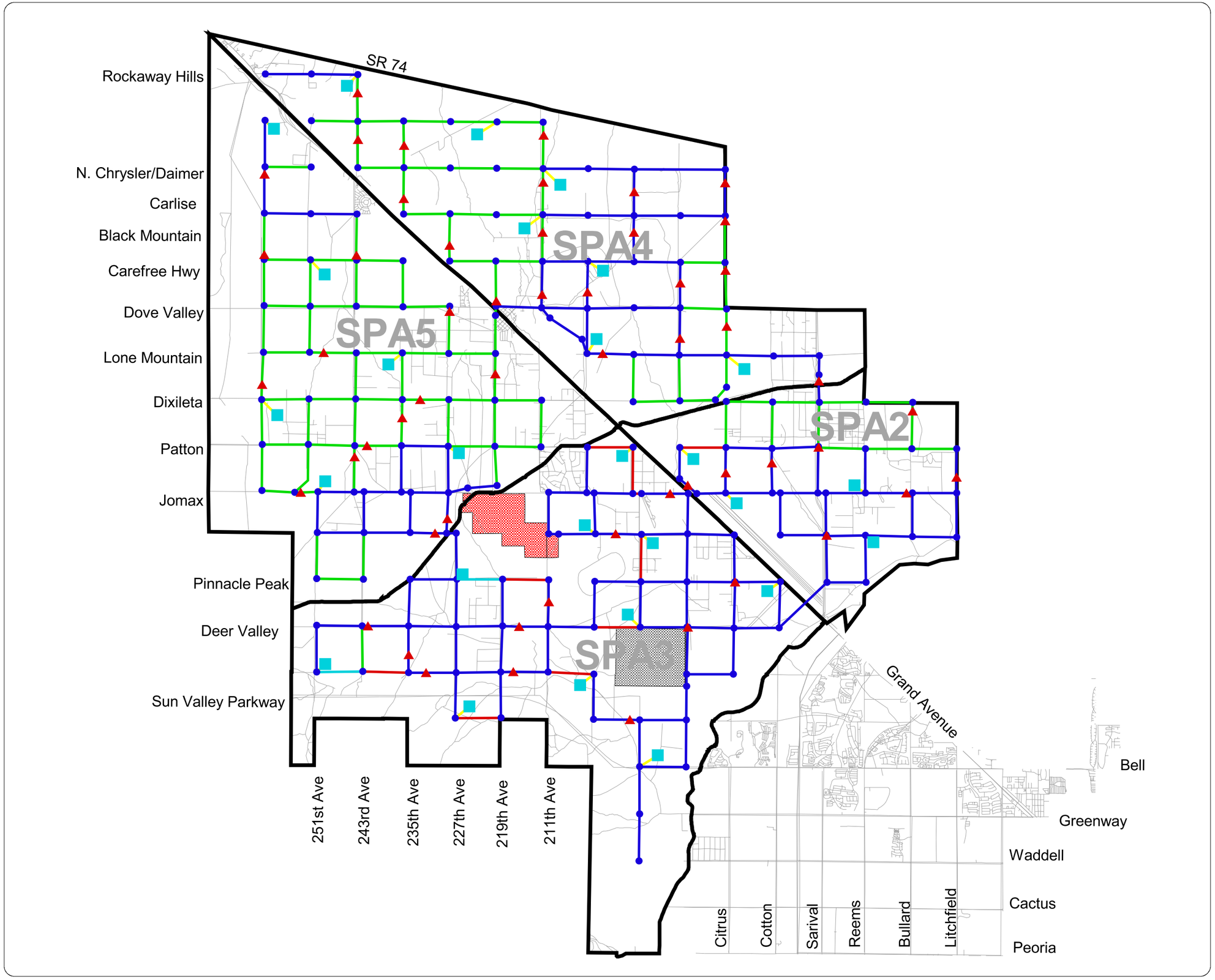

Figure 16
SPA2-5 Water Buildout

Legend

- Reservoir
- 1.0 Size (MG)
- PRV
- Pressure Node

Pipe Diameter

- 12
- 16
- 20
- 48
- Roads

No Service Areas

- Landfill
- Military

1 0 1 2
Miles

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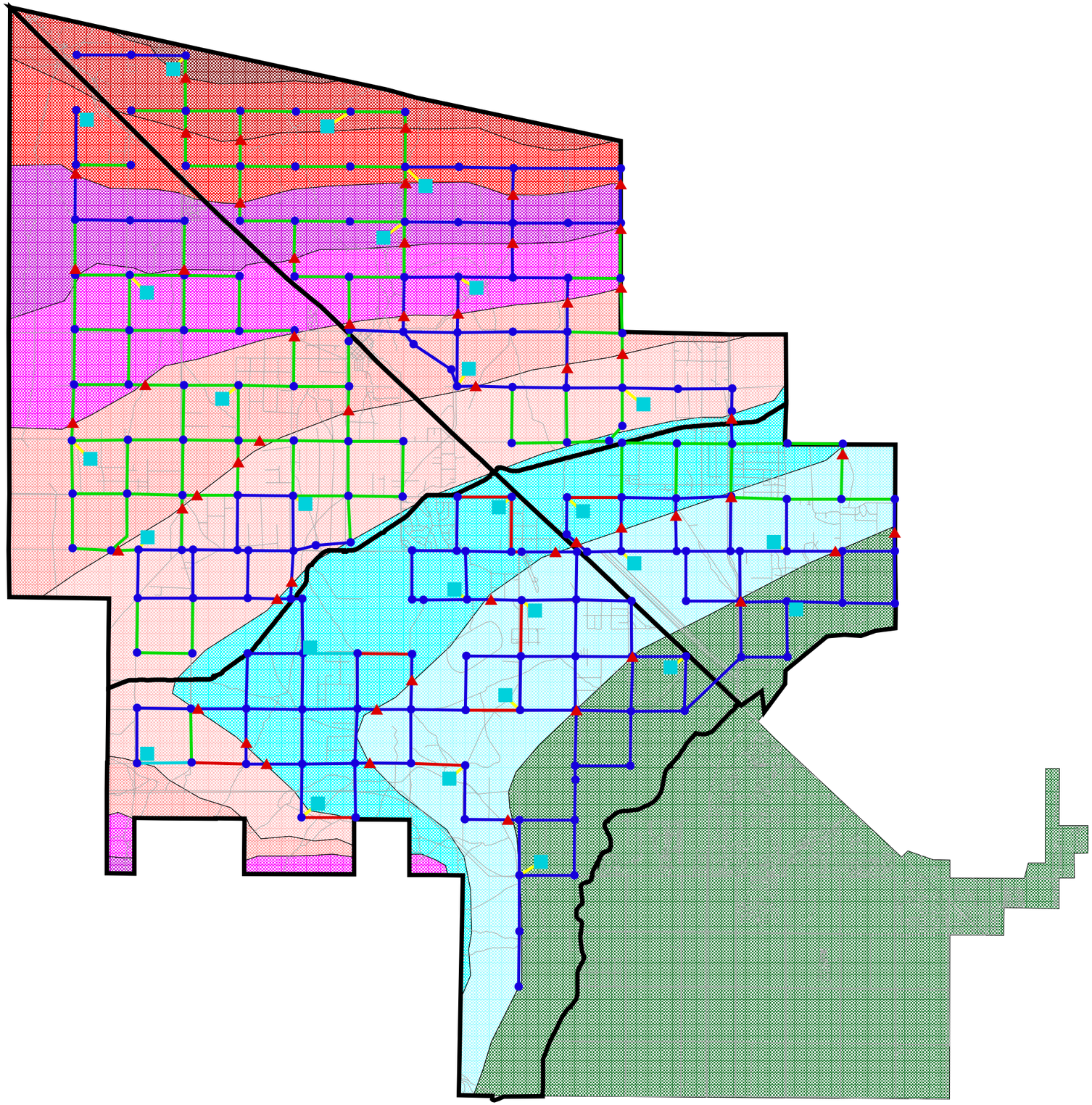

Figure 17
SPA2-5 Water Buildout Pressure Zones

Legend
- Reservoir
- PRV
- Pressure Node

Pipe Diameter
- 12
- 16
- 20
- 24
- 36
- MPA Boundary
- Roads

Pressure Zones
- Zone 5
- Zone 6
- Zone 7
- Zone 8
- Zone 9
- Zone 10
- Zone 11
- Zone 12
- Zone 13
- Zone 14

1 0 1 2
Miles

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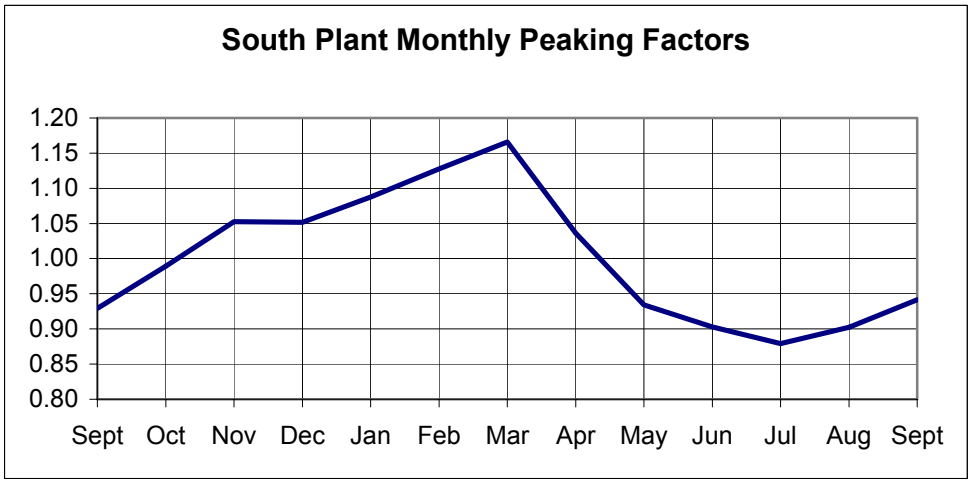

Figure 18 Monthly Peaking Factors

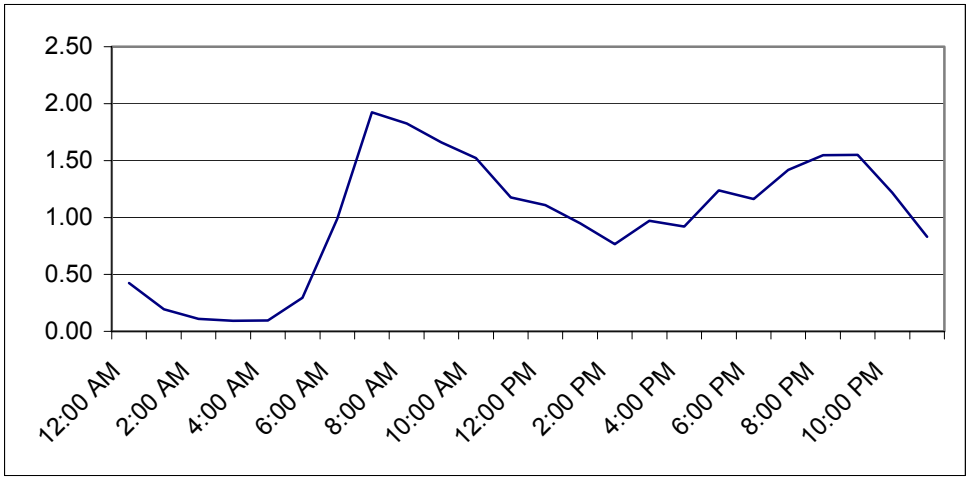

Figure 19 Residential Wastewater Diurnal Curve

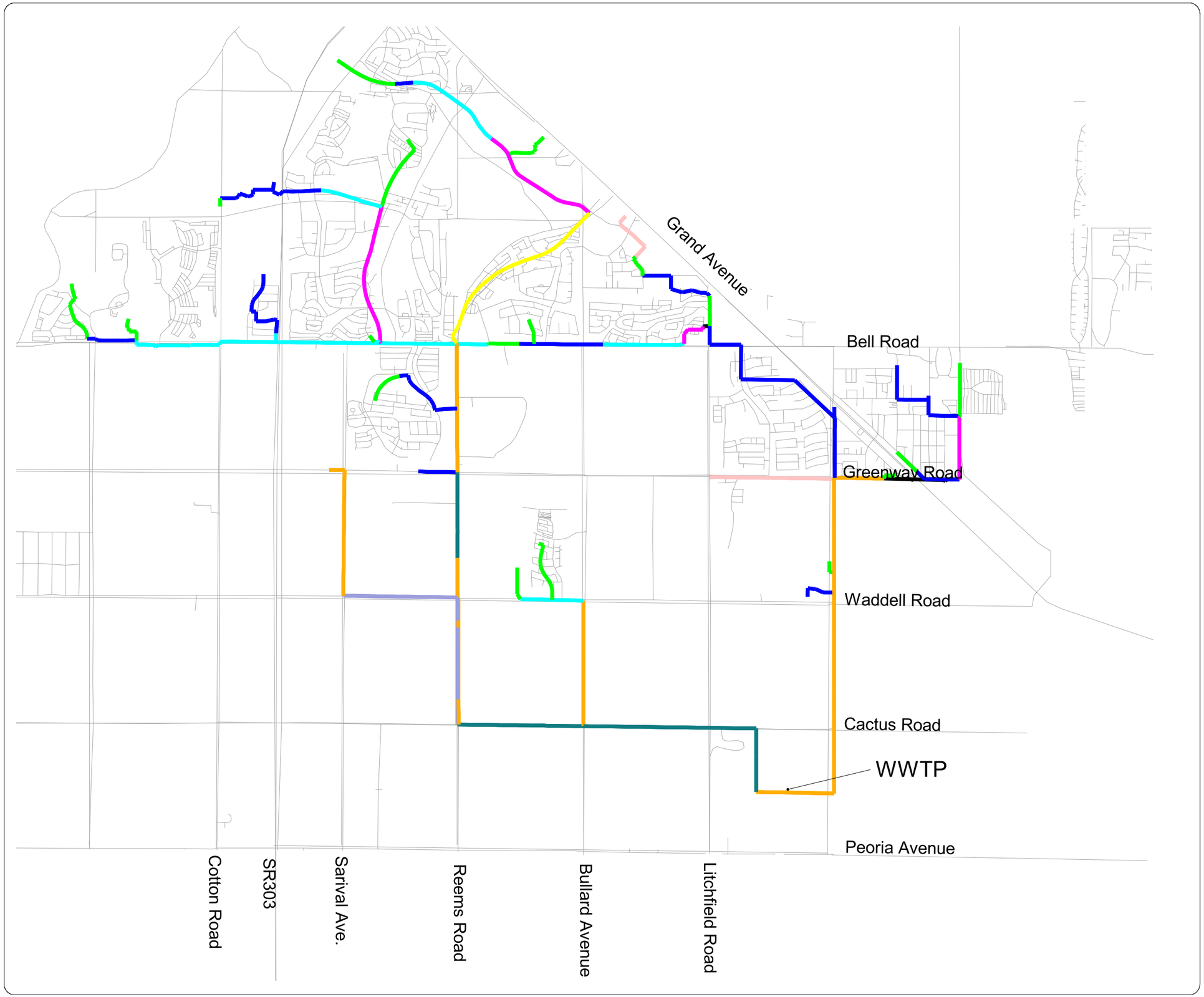

Figure 20
Existing Sanitary Sewer System

Pipe Size

- 8 inch
- 10 inch
- 12 inch
- 15 inch
- 18 inch
- 21 inch
- 24 inch
- 27 inch
- 30 inch
- Force Main

1 0 1 Miles

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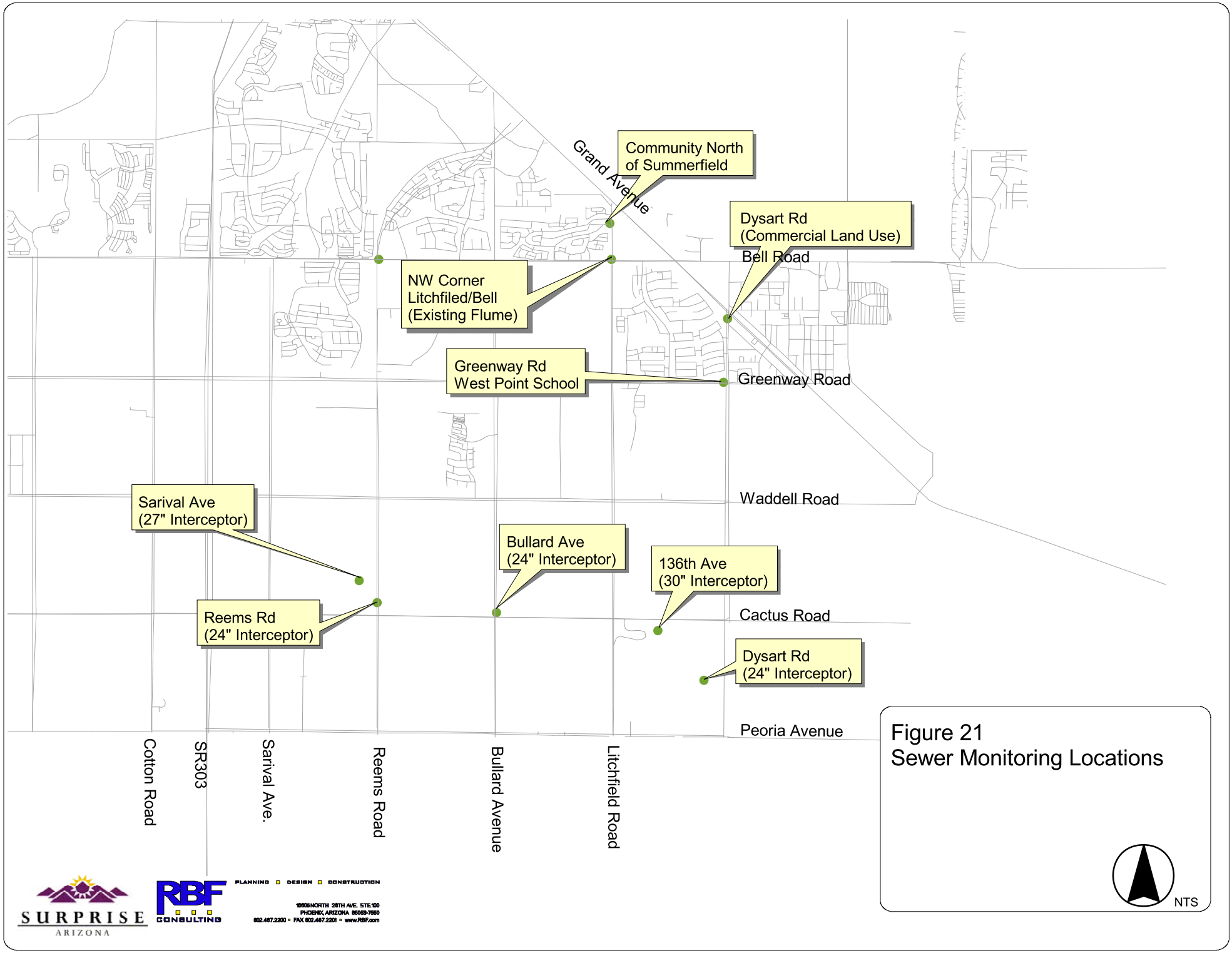
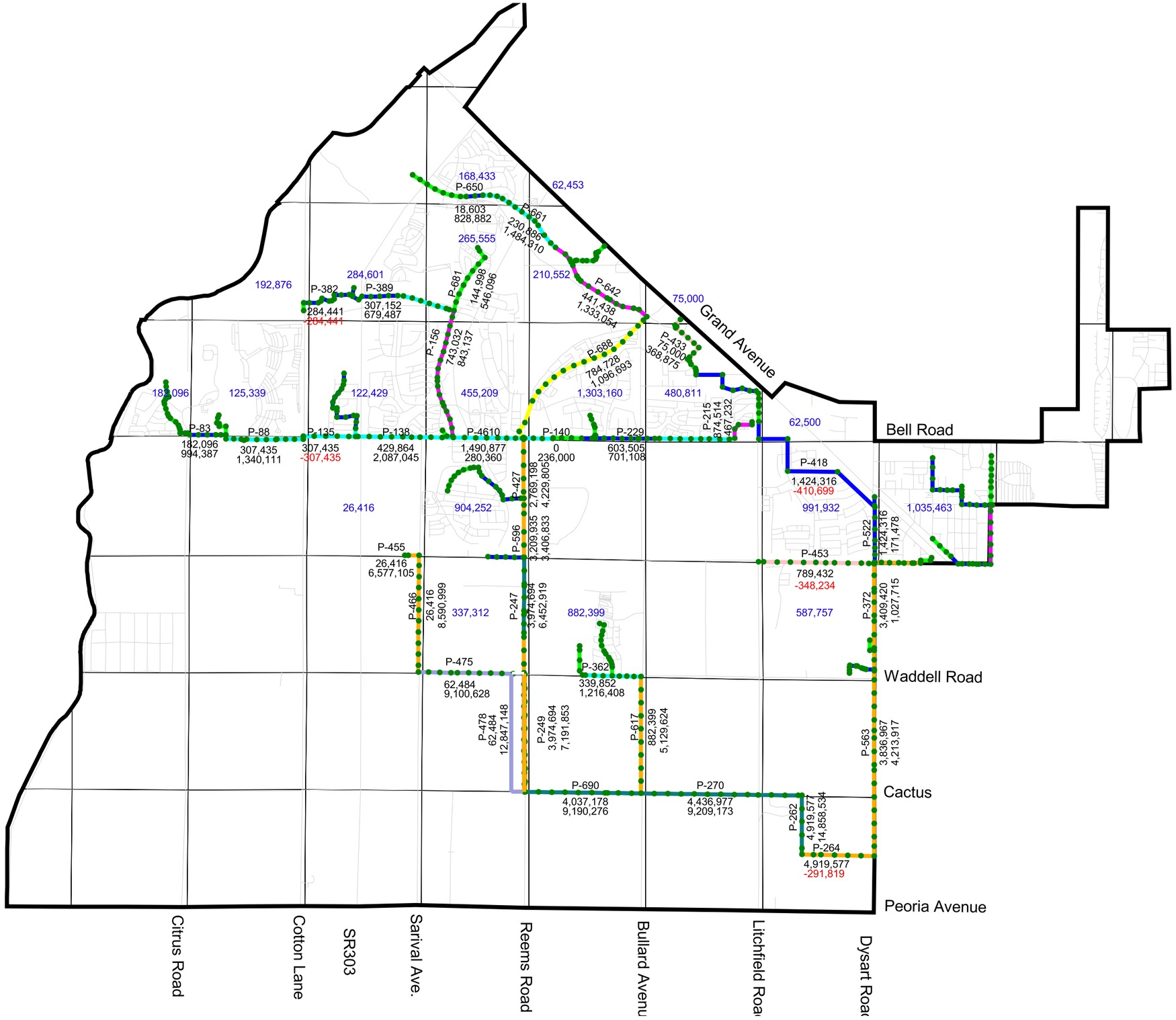


Figure 21
Sewer Monitoring Locations

Figure 22 SPA1 Existing Sewer System Results



Man Hole

Pipe
- 8 inch
- 10 inch
- 12 inch
- 15 inch
- 18 inch
- 21 inch
- 24 inch
- 27 inch
- 30 inch

Man Hole Legend

Wastewater Generation (gpd)

Pipe Legend

Pipe ID
Total Flow (gal)
Excess Capacity (gal)

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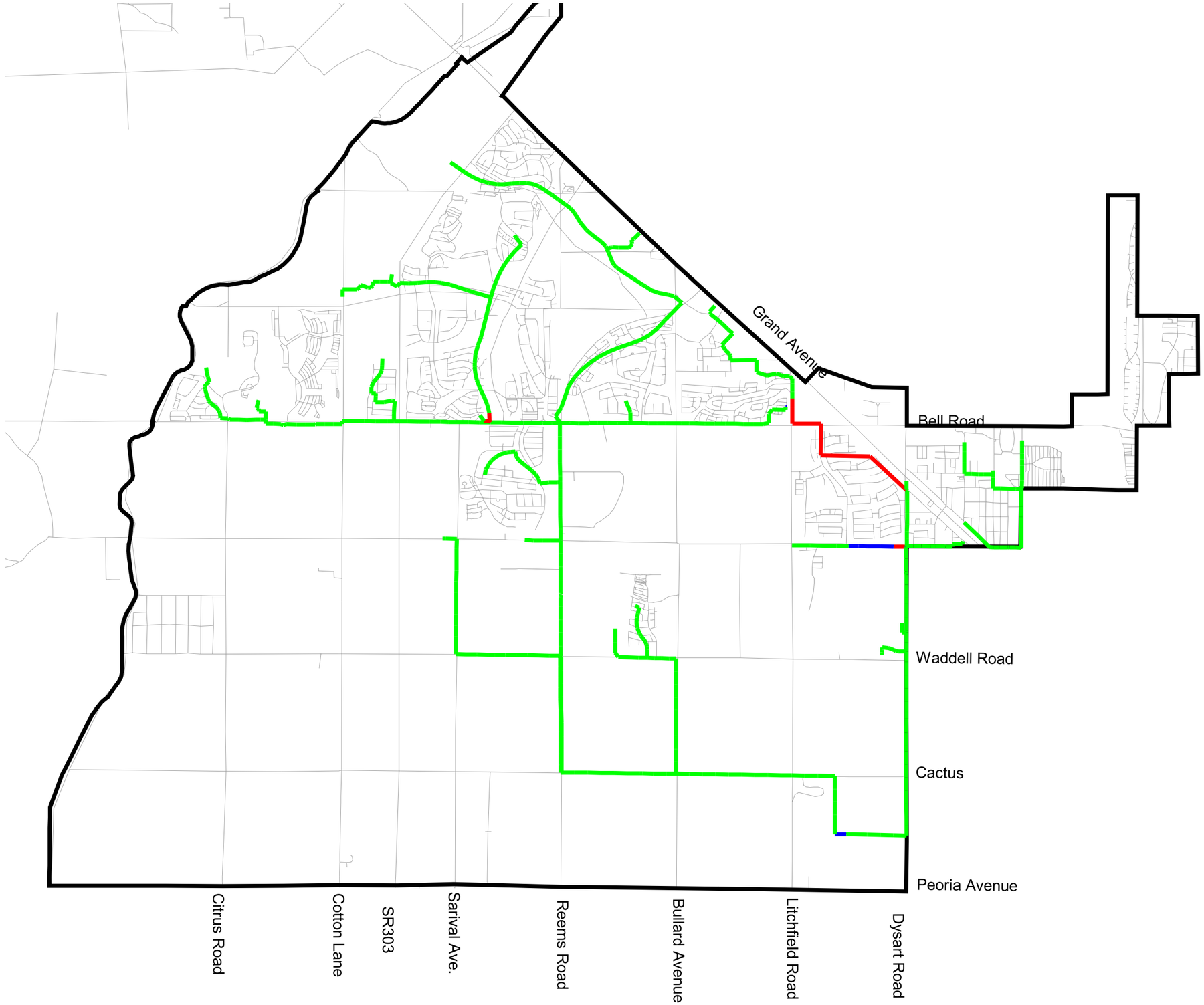

Figure 23
Existing Sewer System
d/D Ratio

- Man Hole

Pipe
- < 80%
- 80%-100%
- > 100%

1 0 1 Miles

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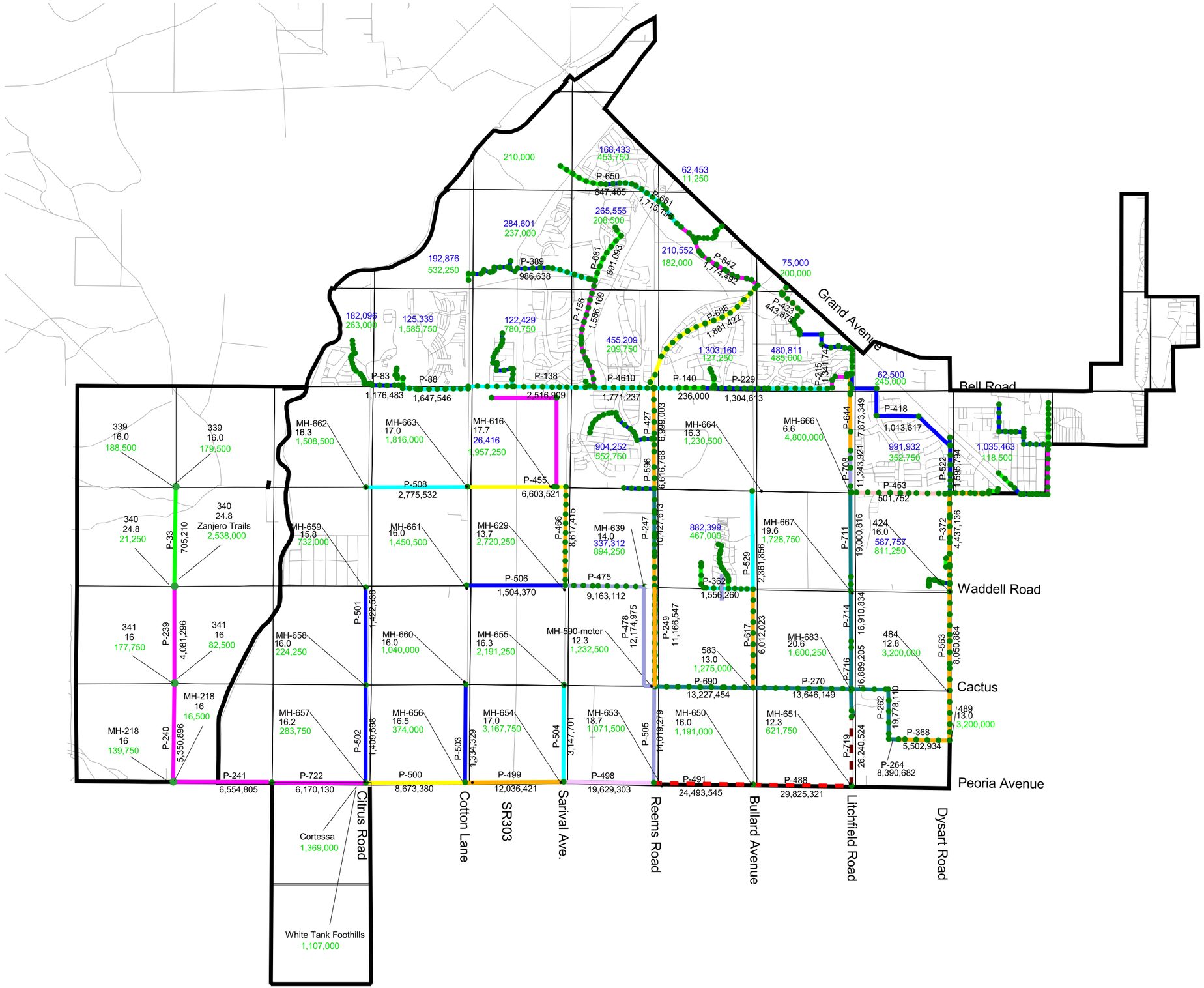
5/22/2003

Figure 24
SPA1 Build-out Sewer System



Man Hole

Pipe
- 8 inch
- 10 inch
- 12 inch
- 15 inch
- 18 inch
- 21 inch
- 24 inch
- 27 inch
- 30 inch
- 33 inch
- 36 inch
- 42 inch
- 48 inch
- 54 inch

Man Hole Legend

Man Hole ID
Invert Depth (ft)
Existing Peak Demand (gpd)
Projected Peak Flow (gpd)

Pipe Legend

Pipe ID
Full Flow Capacity (gal)

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1 0 1 Miles

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Disclaimer:
The data presented in this layout is derived from the build-out sewer system model for the City of Surprise. This data is presented for informational purposes only. The engineer is responsible for verifying the invert depths, locations, pipe sizes, capacities, and available capacity, before undertaking a design project.

4/23/2004

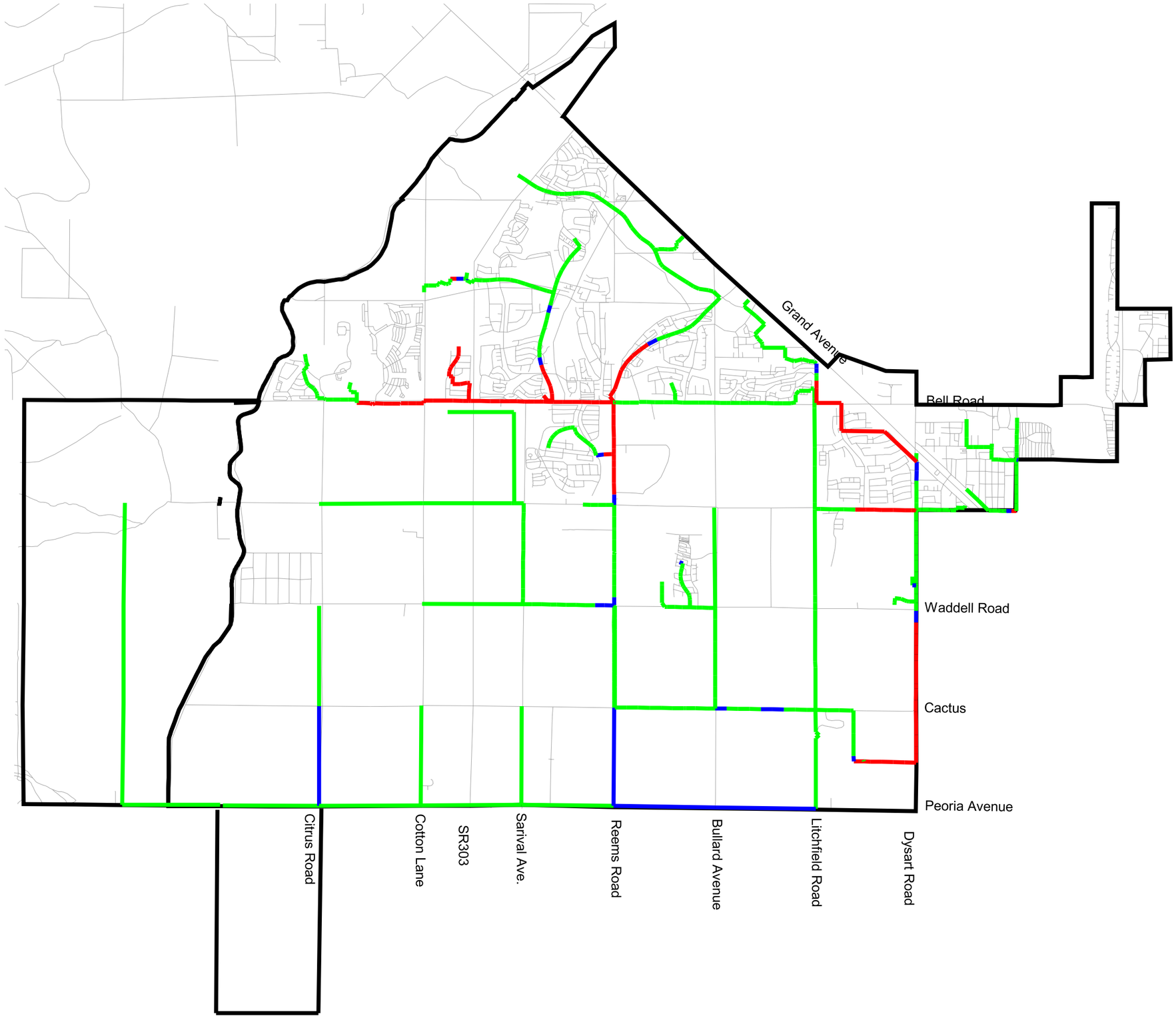

Figure 25
Build-out Sewer System d/D Ratio

Man Hole

Pipe

< 80%

80%-100%

> 100%

1 0 1 Miles

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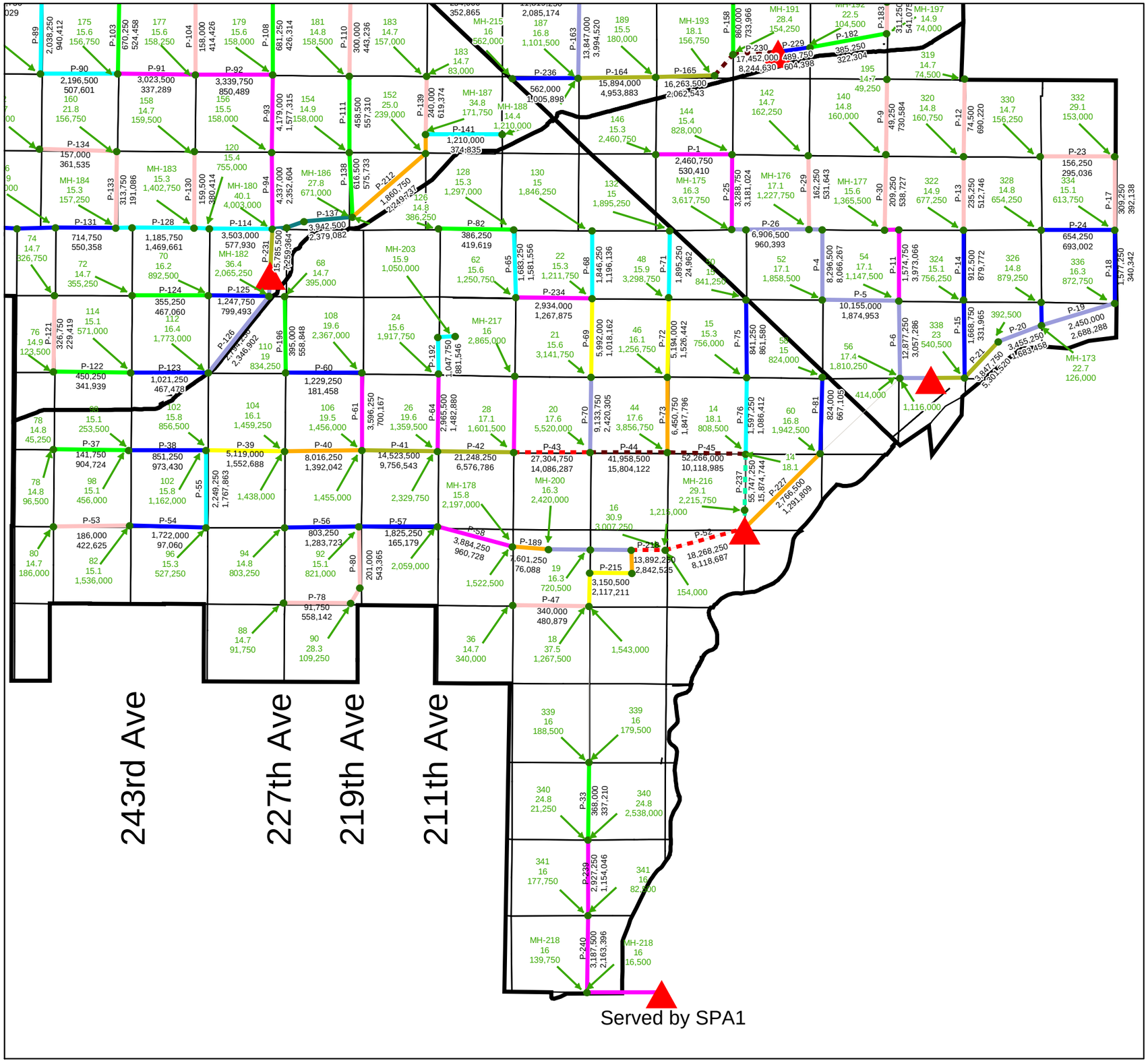

Figure 26 SPA2-3 Build-out Sewer Results

- WWTP
- Man Hole
- 8 inch
- 10 inch
- 12 inch
- 15 inch
- 18 inch
- 21 inch
- 24 inch
- 27 inch
- 30 inch
- 36 inch
- 42 inch
- 48 inch
- 54 inch

Unserved Areas

- Landfill
- Military

- Roads
- Section Line

Man Hole Legend

Man Hole ID
Depth (ft)
Peak Flow (gpd)

Pipe Legend

Pipe ID
Total Peak Flow (gpd)
Excess Capacity (gpd)

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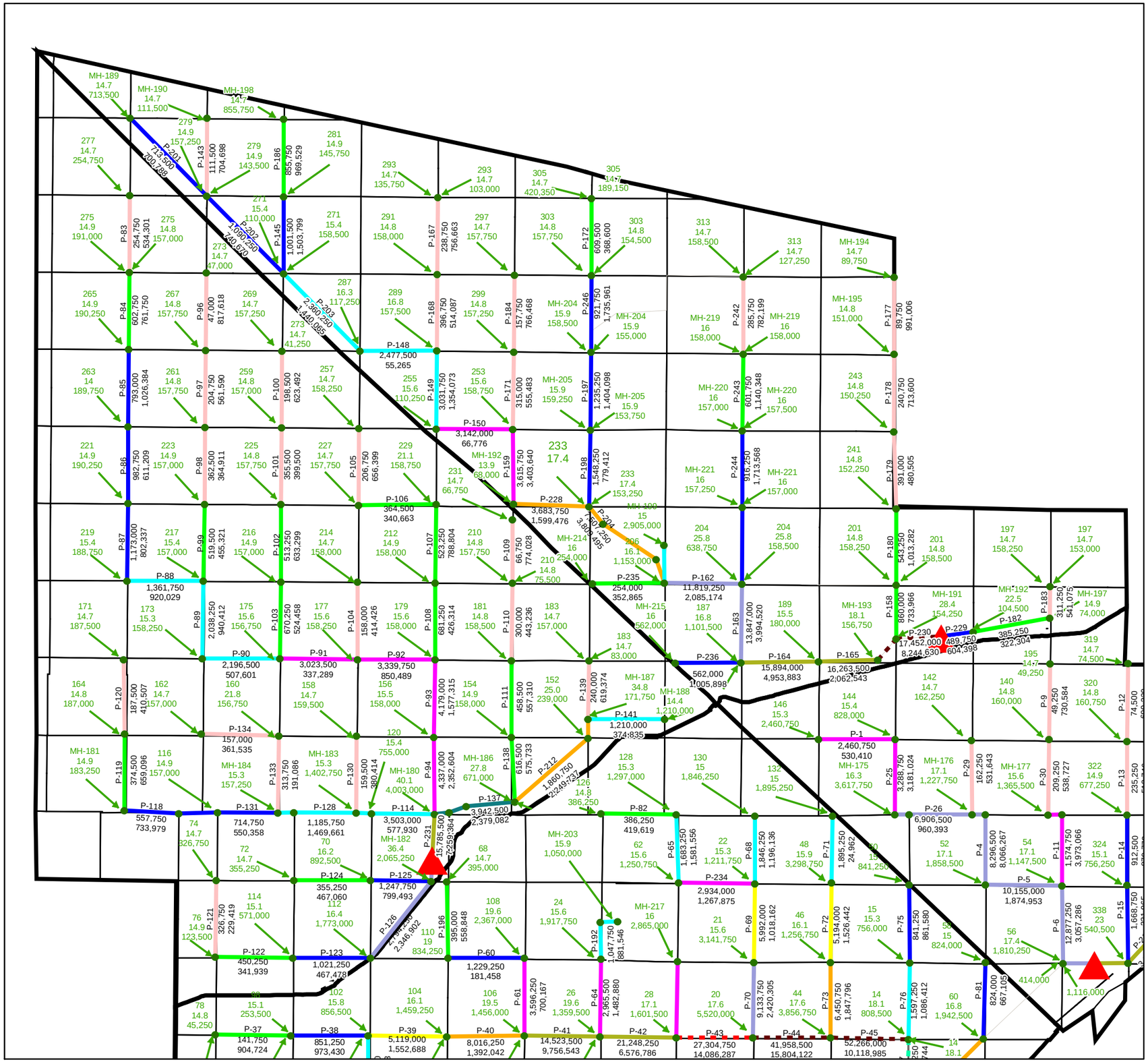

Figure 27 SPA4-5 Build-out Sewer Results

- WWTP
- Man Hole
- 8 inch
- 10 inch
- 12 inch
- 15 inch
- 18 inch
- 21 inch
- 24 inch
- 27 inch
- 30 inch
- 36 inch
- 42 inch
- 48 inch
- 54 inch

Unserved Areas

- Landfill
- Military

- Roads
- Section Line

Man Hole Legend

Man Hole ID
Depth (ft)
Peak Flow (gpd)

Pipe Legend

Pipe ID
Total Peak Flow (gpd)
Excess Capacity (gpd)

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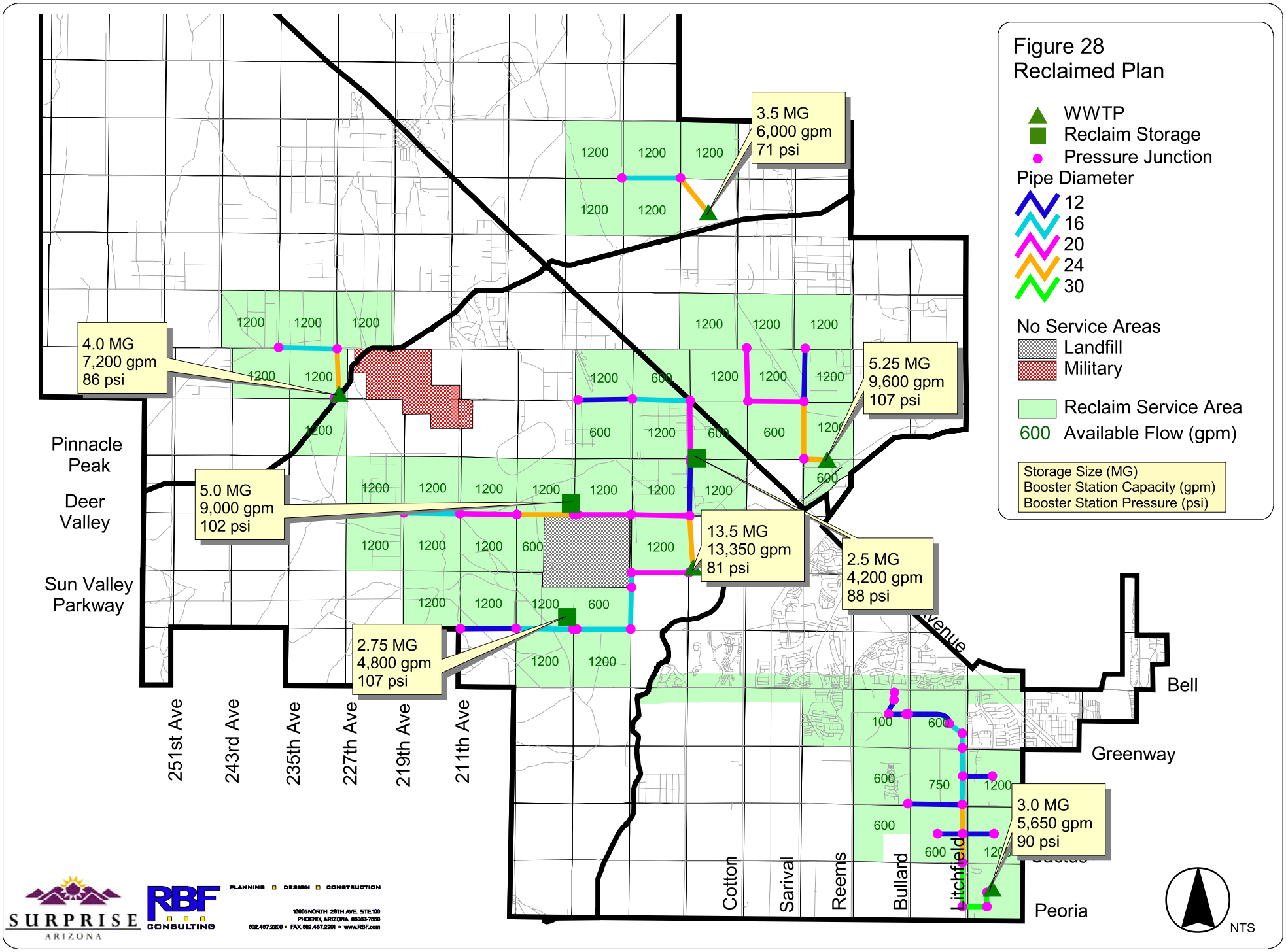
Figure 28
Reclaimed Plan
WWTP
Reclaim Storage
Pressure Junction
Pipe Diameter
12
16
20
24
30
No Service Areas
Landfill
Military
Reclaim Service Area
600 Available Flow (gpm)
Storage Size (MG)
Booster Station Capacity (gpm)
Booster Station Pressure (psi)
3.5 MG
6,000 gpm
71 psi
4.0 MG
7,200 gpm
86 psi
5.25 MG
9,600 gpm
107 psi
5.0 MG
9,000 gpm
102 psi
13.5 MG
13,350 gpm
81 psi
2.5 MG
4,200 gpm
88 psi
2.75 MG
4,800 gpm
107 psi
3.0 MG
5,650 gpm
90 psi
Pinnacle Peak
Deer Valley
Sun Valley Parkway
251st Ave
243rd Ave
235th Ave
227th Ave
219th Ave
211th Ave
Cotton
Sarival
Reems
Bullard
Litchfield
Bell
Greenway
Peoria
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