FINAL

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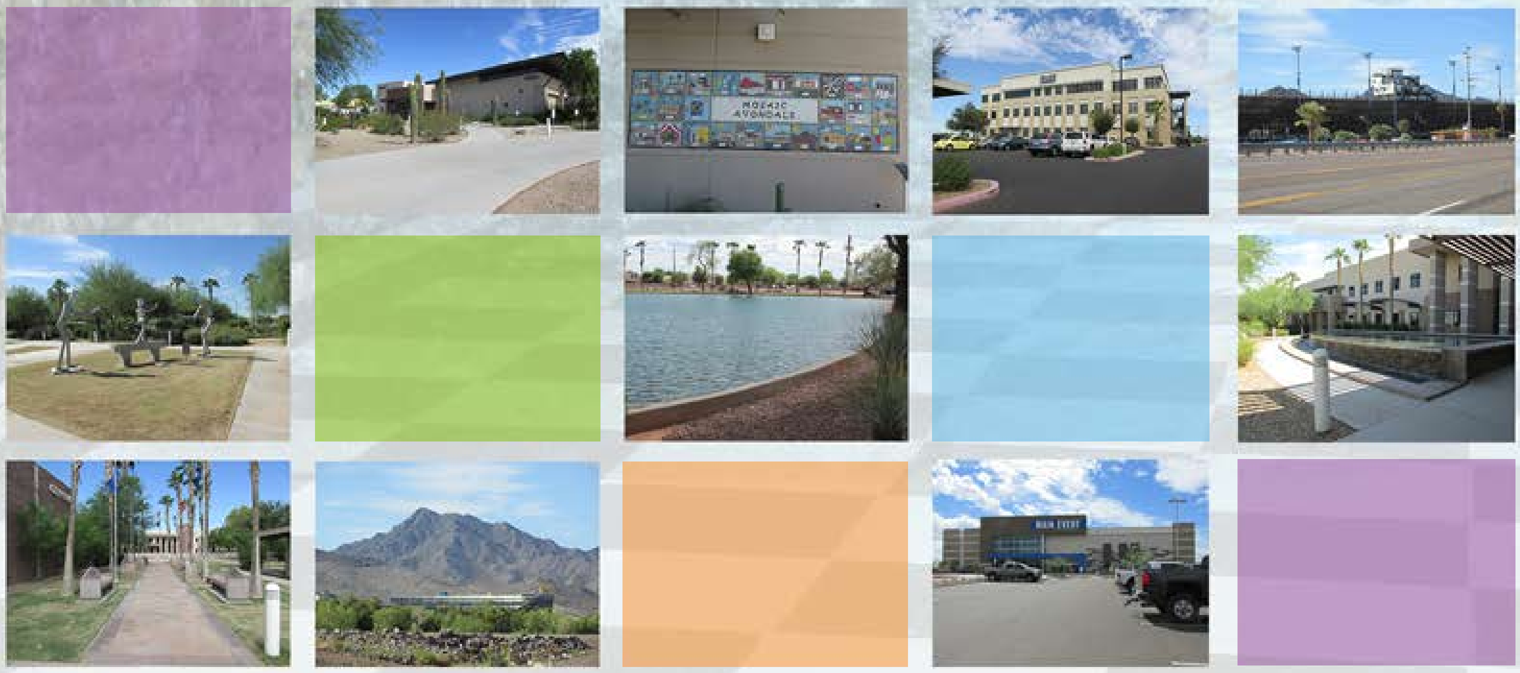
2018 INTEGRATED UTILITY MASTER PLAN



January 2018

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Executive Summary

2018 INTEGRATED UTILITY MASTER PLAN

January 2018

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Master Plan Vision

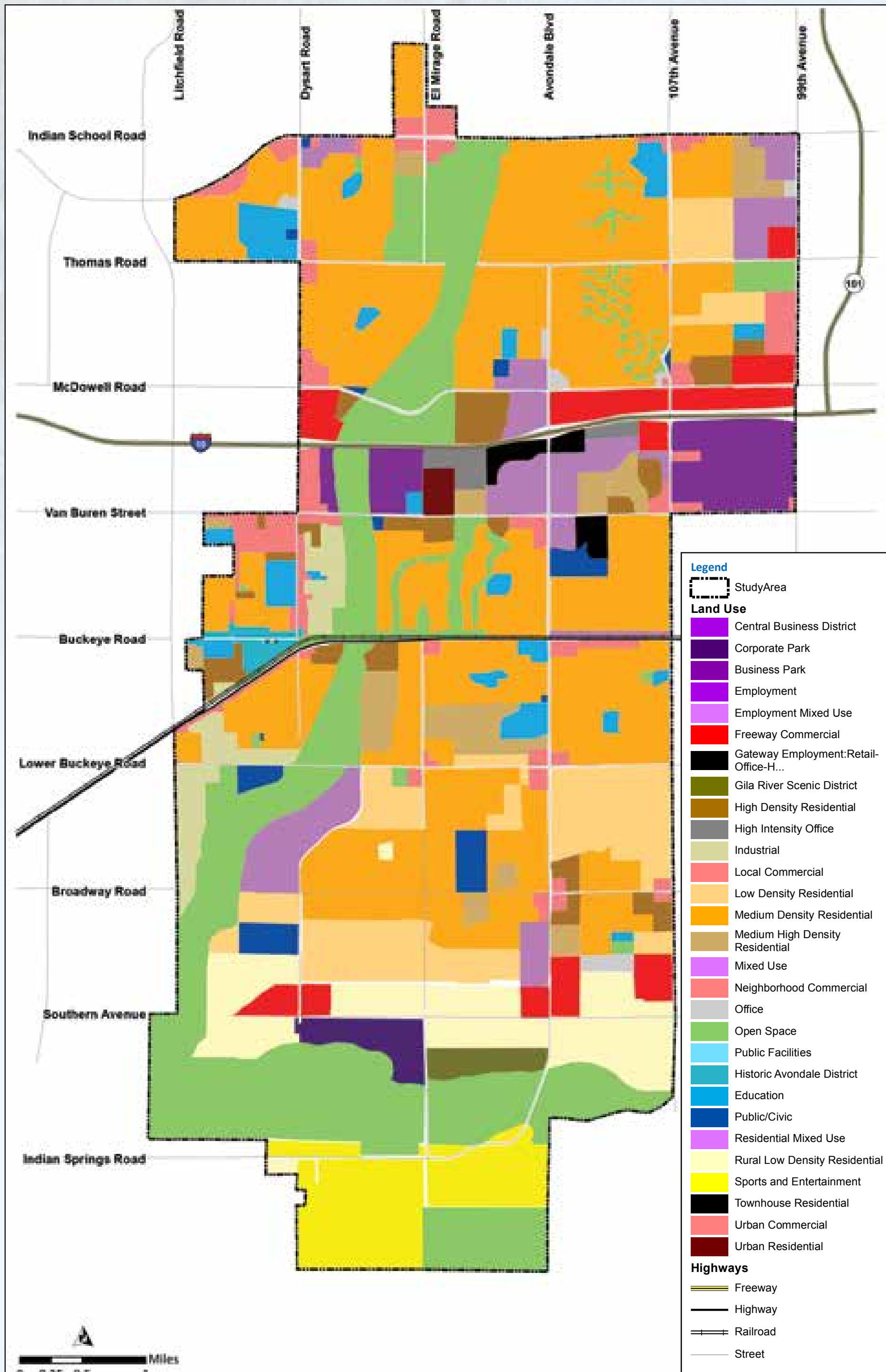
The 2018 Integrated Utility Master Plan (2018 IUMP) establishes the direction for the City of Avondale's water resources, water, wastewater, and reclaimed water infrastructure to assist the City in implementing its vision for the future as defined by the Avondale General Plan 2030.

Growth projections for the 2017 IUMP align with the projections in the transportation master plan and other planning documents being created concurrently by the City. The City benefits from a common set of assumptions for its plans by having the same growth projections for all infrastructure.

The IUMP validates the benefit of the City's previous water resource planning that has provided adequate water resources for lands north of the Estrella Mountains.

The plan also identifies the infrastructure that needs to be in place for planning years 2023, 2028, and buildout.

Flows were estimated using the General Plan 2030 Land Use.



Avondale's General Plan 2030 Land Use Plan.

Planning by the Numbers

The 2018 IUMP includes the projections for the City north of the Estrella Mountains. The population, residential dwelling units, and flows that the master plan is based upon are shown below.

Projections

	2017	2023	2028	Buildout
Population	82,309	88,250	93,200	154,700
Dwelling Units	28,207	29,967	31,434	57,700
Average Daily Water Demand (mgd)	12.7	13.5	14.2	26.1
Average Daily Wastewater Flow (mgd)*	5.8	6.2	6.5	12.0
Reclaimed Water Produced (mgd)	5.4	5.8	6.0	11.2

**WRF capacity is based on Max Month Average Flows (MMAF)*

Water Resources and Reclaimed Water

Avondale has a diverse portfolio of Salt River Project (SRP), Central Arizona Project (CAP), reclaimed water, and groundwater that is sufficient for lands north of the Estrella Mountains for normal water supply years. SRP water can only be used to supply on-project lands.

On Project Water Supply and Demand Balance - Normal Water Year

On Project	2017	2023	2028	Buildout
Water Supply (AF)	9,382	9,899	10,342	13,600
Demand (AF)	6,936	7,491	7,833	13,600
Surplus/(Deficit) (AF)	2,446	2,409	2,509	0

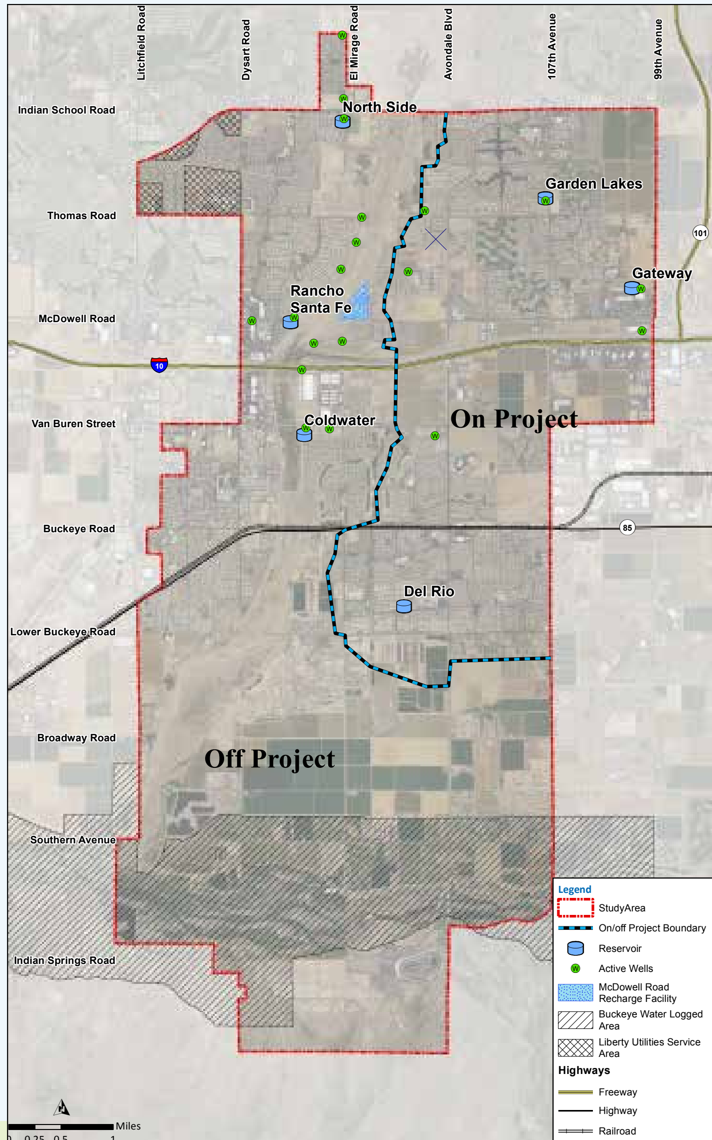
Reclaimed water and CAP water supplies are the main water resources that supply off-project lands.

Off Project Water Supply and Demand Balance - Normal Water Year

Off Project	2017	2023	2028	Buildout
Water Supply (AF)	12,962	13,378	13,763	20,001
Demand (AF)	7,280	7,602	8,095	15,680
Surplus/(Deficit) (AF)	5,682	5,777	5,667	4,321

Avondale is actively recharging water in the McDowell Road, NAUSP, Hieroglyphic Mountain, and Agua Fria facilities to replenish water pumped from wells.

Avondale service area north of the Estrella Mountains



Recommendations:

- Complete purchase of the White Mountain Apache Tribe CAP water lease.
- Finalize agreement with Phoenix to wheel water to Avondale's McDowell Road recharge facility.
- Optimize the McDowell Road Recharge Facility for continued groundwater replenishments near the City's wells.
- Continue current water conservation programs and seek opportunities to expand water conservation.

Wastewater Master Plan

Avondale operates and maintains a wastewater system that includes:

- A water reclamation facility with a capacity of 9 mgd
- 10 lift stations
- 235 miles of gravity sewer pipes
- 6.5 miles of sewer force mains

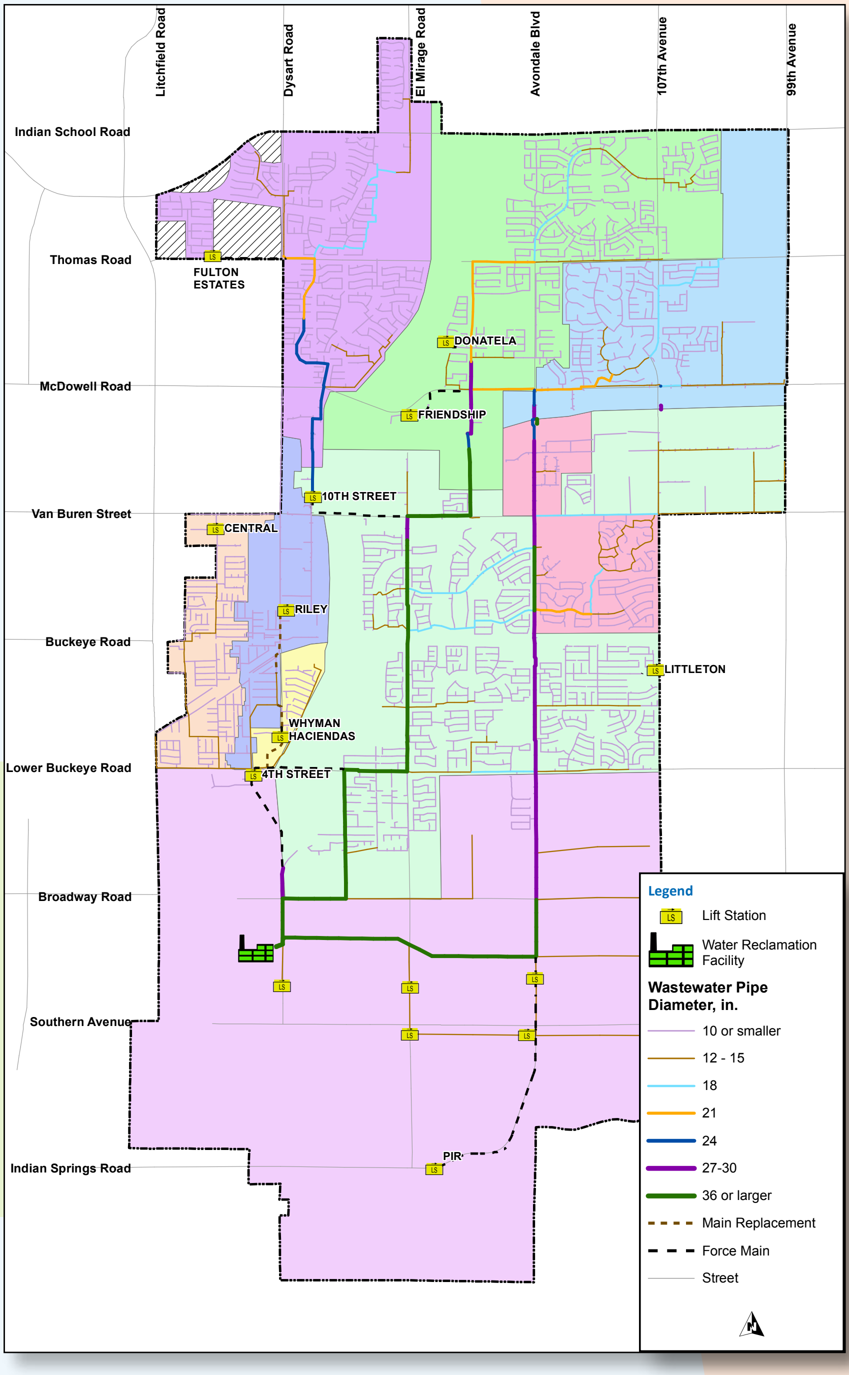
Collection system flow monitoring determined wastewater flows and evaluated the capacity of the collection system.

With the exception of a gravity main along Dysart between the Riley lift station and lower Buckeye Road, the collection system pipes are expected to have sufficient capacity through buildout.

Recommendations:

- Optimize lift station capacity as each station is rehabilitated in the future.
- Begin expanding the Wolf Water Resource Facility to 12 mgd by 2025.
- Replace the gravity main along Dysart Road from the Riley lift station to Lower Buckeye Road.
- Construct a back up force main for the 10th Street lift station.

Avondale Wastewater Collection System at Buildout



Wastewater Capital Project Recommendations

Planning Period	Project Name	Project Cost
FY 2018-2023	Construct a sewer main from Riley Drive to Lower Buckeye Road	$2,400,000
FY 2020-2028	Backup force main for 10th Street Lift Station	$2,200,000
FY 2024-2028	Expand the Wolf Water Reclamation Facility to 12 mgd	$63,070,000
FY 2029-Buildout	Expand the Wolf Water Reclamation Facility to 15 mgd	$23,170,000

Water Master Plan

Avondale operates and maintains a water system that includes:

- 15 potable wells producing up to 30 mgd
- 3 groundwater treatment facilities
- 6 booster pump stations with a capacity of 59 mgd
- 6 storage sites with a capacity of 8 mgd
- 321 miles of pipe

Multiple options to increase production were evaluated. Wheeling SRP and CAP water through Phoenix to the Garden Lakes facility is an attractive option because it minimizes water treatment costs by blending well water with surface water.

Additional wells will need to be constructed to deliver water to Garden Lakes, Coldwater, and Northside facilities.

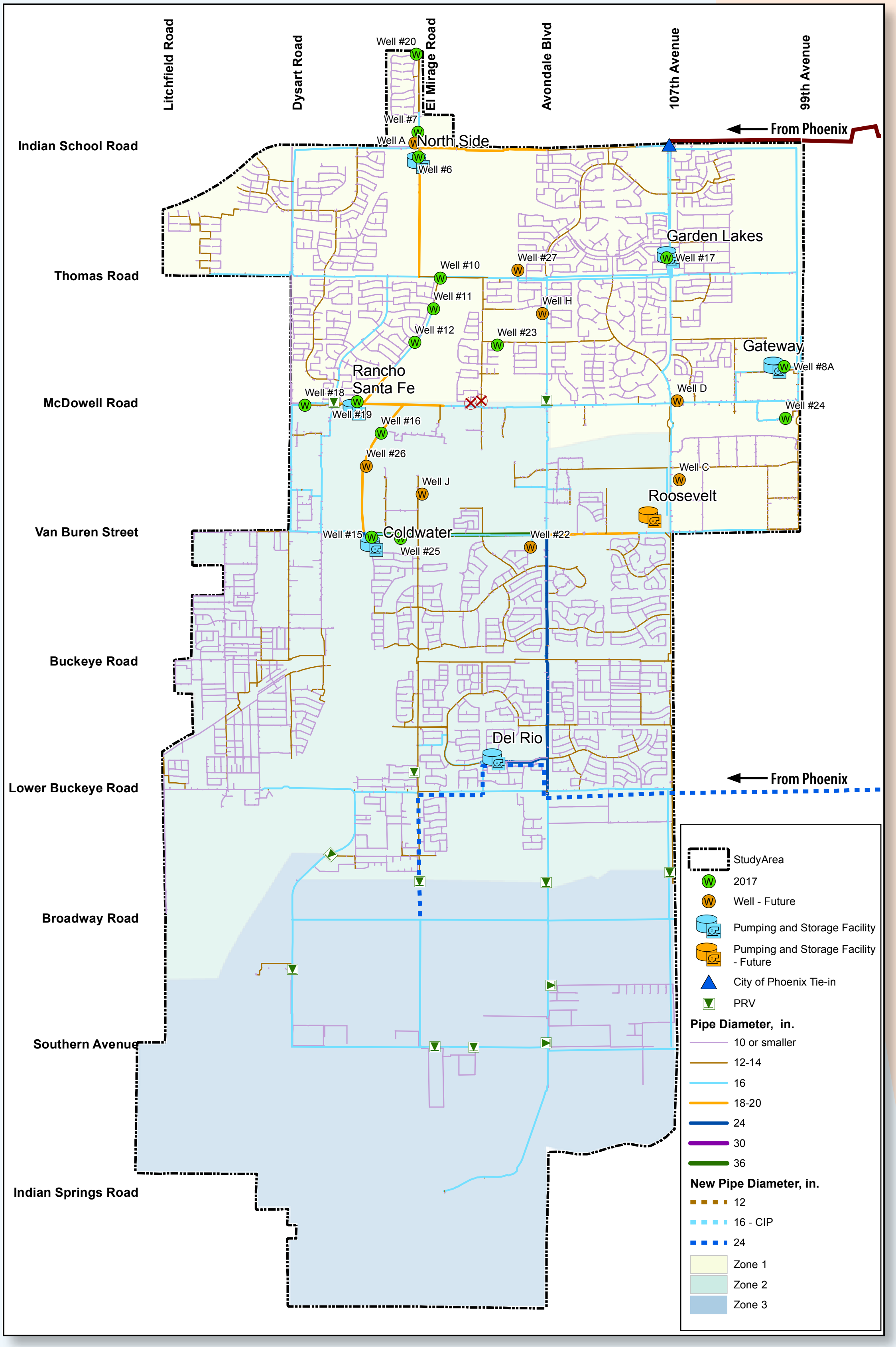
Recommendations:

- Construct the infrastructure needed to wheel water from Phoenix to the Garden Lakes facility for treatment and deliveries
- Implement the pressure zone boundary between Zones 1 and 2
- Drill, equip, and connect Well #27
- Replace the nitrate treatment equipment at the Gateway facility
- Expand storage pumping capacity at the Garden Lakes facility
- Construct a nitrate treatment facility at the Coldwater facility

Water Capital Project Recommendations

Project Name	Project Cost
Wheel water through Phoenix to Garden Lakes facility	$6,863,000
Northside well site land purchase & design	$75,000
Construct Well 27 and connect to Garden Lakes facility	$4,408,000
Separate Zone 1 and Zone 2	$1,727,000
McDowell Rd. Recharge facility improvements	$1,050,000
Replace nitrate treatment at the Gateway facility	$3,000,000
McDowell Rd. 16-inch waterline - 117th Ave. to Avondale Blvd.	$300,000
Rehabilitate Dysart Rd. 12-inch waterline - Whyman Rd. to Lower Buckeye Rd.	$400,000
Purchase land for future treatment site at 107th Ave. and Roosevelt St.	$600,000
Rehabilitate northside facility Arsenic treatment system	1,000,000
99th Ave. Waterline - Thomas Rd. to Encanto Blvd.	$710,000
Total From FY 2018 Through FY 2023	**$20,133,000**
Expand Garden Lakes storage and pumping	$8,358,000
Install 16-inch main on McDowell Rd. from 99th Ave. to 112th Ave.	$2,724,000
Construct future well	$2,940,000
Construct nitrate treatment facilities at Coldwater facility	$5,545,000
Construct future well	$2,900,000
Total From FY 2024 Through FY 2028	**$22,467,000**
Equip Well 22 and connect to the Coldwater facility	$1,817,000
Add Well J to Coldwater facility with expanded nitrate treatment	$2,900,000
Construct Well A and deliver to Northside facility	$2,900,000
Rehabilitate Del Rio facility	$2,002,000
Wheel water through Phoenix to Del Rio facility	$17,507,000
Construct a treatment, storage, and booster facility on 107th Ave. and Roosevelt St., add supply from Well C	$17,188,000
Add Well D to 107th Ave. and Roosevelt St., add supply from Well C	$8,916,000
Add storage and pumping capacity at Del Rio facility	$8,183,000
Construct future well	$2,940,000
Construct future well	$2,940,000
Total From FY 2029 Through Buildout	**$67,293,000**

Avondale Water System by Buildout



Acknowledgements

The project team wishes to extend appreciation and gratitude to all City staff who contributed their time, insight, and expertise to the success of this Integrated Utility Master Plan Project.

- City Managers Office
- Development and Engineering Department
- Finance and Budget Department
- Economic Development Department
- Public Works Department, including the following divisions:
  - Public Works Administration
  - Water Resources and Conservation
  - Water Production
  - Water Distribution
  - Wastewater Collection
  - Water Reclamation Facility

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Avondale

City of Avondale

2018 INTEGRATED UTILITY MASTER PLAN UPDATE

FINAL

Registered Professional Engineer (Civil)
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57843
LISA M.
FREESTONE
DATE SIGNED 1/8/18
ARIZONA, U.S.A.
EXPIRES 06-30-2020

Registered Professional Engineer (Civil)
CERTIFICATE NO.
51579
ERIC J.
MCLESKEY
DATE SIGNED 1/8/18
ARIZONA, U.S.A.
EXPIRES 12-31-2019

Registered Professional Engineer (Civil)
CERTIFICATE NO.
36578
RICHARD A.
HUMPHERYS
DATE SIGNED 1-8-2018
ARIZONA, U.S.A.
EXPIRES 09-30-2019

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Tables

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Abbreviations

%	percent
2018 IUMP	2018 Integrated Utility Master Plan
A.A.C.	Arizona Administrative Code
A.R.S.	Arizona Revised Statutes
AACE	Association for the Advancement of Cost Engineering
AADF	average annual daily flow
ac	acre
ADD	average daily demand
ADEQ	Arizona Department of Environmental Quality
ADMM	average day of the maximum month
ADWR	Arizona Department of Water Resources
AF	acre-feet
AF/ac	acre-feet per acre
AFY	acre-feet per year
AMAs	Active Management Areas
AS&R	annual storage and recovery
ASR	aquifer storage and recovery
AWBA	Arizona Water Bank Authority
AWS	Assured Water Supply
AWSA	Arizona Water Settlement Act
BWLA	Buckeye Waterlogged Area
CAGRD	Central Arizona Groundwater Replenishment District
CAP	Central Arizona Project
CAPSAM	Central Arizona Project Service Area Model
CAWCD	Central Arizona Water Conservation District
CAWS	Certificate of Assured Water Supply
CIP	Capital Improvement Program
City	City of Avondale
d/D	depth to diameter
DAWS	Designation of Assured Water Supply
DBPC	Butylated Hydroxytoluene

DU	dwelling unit
DU/ac	dwelling units per acre
ENR	Engineering News Record
FCDMC	Flood Control District of Maricopa County
fps	feet per second
ft	foot/feet
ft/sec	feet per second
FY	fiscal year
GAC	granular activated carbon
gal	gallon(s)
General Plan	Avondale General Plan 2030
GIS	Geographical Information System
GMA	1980 Groundwater Management Act
gpad	gallons per acre per day
gpd	gallons per day
gpd/DU	gallons per day per dwelling unit
gpm	gallons per minute
GSF	groundwater savings facilities
hp	horsepower
IFC	2012 International Fire Code
IGA	Inter-governmental Agreement
IGFR	irrigation grandfathered rights
IIP	Infrastructure Improvement Plan
in	inch/inches
kWh	kilowatt hour
LTSCs	long-term storage credits
M&I	Municipal and Industrial
MAF	million acre-feet
MAFY	million acre-feet per year
MAG	Maricopa Association of Governments
MD	maximum day
MD/AD	maximum day/average day
MG	million gallons

mgd	million gallons per day
MMADF	maximum month average daily flow
MSA	Member Service Area
N/A	not applicable
NAUSP	North Aqua Fria Underground Storage Project
NIA	Non-Indian Agriculture
No	number
O&M	operations and maintenance
PH/AD	peak hour/average day
PH/MD	peak hour/maximum day
PIR	Phoenix International Raceway
PRV	pressure reducing valve
psi	pounds per square inch
RUSRA	Recharge and Underground Storage and Recovery Act
SCADA	supervisory control and data acquisition
SPC	system pressure criteria
SRP	Salt River Project
TAZ	Traffic Analysis Zones
TDH	total dynamic head
TDS	total dissolved solids
TTHM	total trihalomethanes
US&R	underground storage and recovery
USBR	United States Bureau of Reclamation
USEPA	United States Environmental Protection Agency
USF	Underground Storage Facility
WDUA	Water Delivery and Use Agreement
WMAT	White Mountain Apache Tribe
WRF	water reclamation facility
WRF	Water Resource Facility
WS	Water Storage
WTP	Water treatment plant
WVWA	West Valley Water Association (formerly WESTCAPS)

Chapter 1

INTRODUCTION AND PROJECT SUMMARY

1.1 Background

The City of Avondale (City) is committed to providing reliable and safe water service to its customers, collecting and treating wastewater to provide sanitation, and beneficially reusing reclaimed water as a key part of its water resource portfolio. Avondale maintains a 100-year designation of assured water supply from the Arizona Department of Water Resources (ADWR) that demonstrates the City's ability to provide continuous availability of physical water resources and the legal right to use them to serve the City's customers.

The 2018 Integrated Utility Master Plan (2018 IUMP) presented here was initiated by Avondale to plan the City's water resources; and water, wastewater, and reclaimed water infrastructure using a common set of assumptions to develop a roadmap to guide the City as it continues to grow. One of the purposes of the 2018 IUMP is to make certain that planning is completed in a coordinated manner with the same set of assumptions as other master plans being undertaken by the City in addition to these water systems. City staff from the Water Resources, Planning, Engineering, Public Works, Water Operations, and Wastewater Operations worked together with Carollo Engineers, Inc. (Carollo) to develop the 2018 IUMP.

The previous water master plan was completed in 2013 and the previous wastewater master plan was completed in 2005. Other planning documents have also been prepared previously that address related topics including wellhead treatment, water resources, pressure zone boundary changes, and a water reclamation plant master plan. Therefore, it became important to update all the master plans concurrently to have a single plan going forward for the City's water system infrastructure.

1.2 Alignment with Avondale's General Plan

The Avondale General Plan 2030 (General Plan) contains the City's vision for growth through buildout and contains an approach to achieve this vision through established community goals, objectives, and policies. The planning framework for the 2018 IUMP was developed using the General Plan study area (excluding lands south of the Estrella Mountains that are not expected to develop for many years), land use plan, and growth assumptions to reach a buildout population of approximately 154,700 residents. Infrastructure recommendations with capital costs in the 2018 IUMP are for the FY 2023, FY 2028, and buildout planning periods. Concepts for how the City's water resources, water, wastewater, and reclaimed water systems develop over time are based on the assumption that the portion of the City in the study area will grow to a population of 154,700 at buildout.

1.3 Scope of Work

The scope of work for the 2018 IUMP was developed to provide the City with a plan to expand the water, wastewater, and reclaimed water systems over the next 5 and 10 year planning periods, and to provide an estimate of buildout requirements. The scope included updates to the City's water resources, water system, wastewater system, and reclaimed water system master plans.

The 2018 IUMP contains the following major activities that contributed to recommendations from the master plan:

- Previous studies were reviewed to determine which recommendations are still relevant for the City's infrastructure going forward
- Population projections were updated based on Maricopa Association of Government's (MAG) Traffic Analysis Zone (TAZ) data.
- Water demand projections were developed using the City's water production, customer billing, and TAZ data. Wastewater and reclaimed water flow projections were also based on TAZ data and flow information gathered from field test data.
- Avondale's water resources were evaluated against flow projections and were shown to be adequate for both on and off project areas.
- Hydraulic models were updated for the water and wastewater systems using the City's Geographic Information Service (GIS) data. The wastewater model was validated using data collected in the field.
- The water system hydraulic model was used to evaluate the capacity of the existing system, size future infrastructure, and make recommendations for capital improvements.
- The wastewater system hydraulic model was used to evaluate the capacity of the collection system, size future infrastructure, and make recommendations for capital improvements.

1.4 Report Organization

The report chapters include the following:

- Executive Summary Brochure – Summarizes the major findings and recommendations of the 2018 IUMP in a graphical format.
- Chapter 1 Introduction and Project Summary.
- Chapter 2 Water, Wastewater, and Reclaimed Water Projections, provides population, water demand, wastewater flow, and reclaimed water availability projections.
- Chapter 3 Water Resources and Reclaimed Water Master Plan, contains a description of Avondale's water resources and an analysis of the physical and legal availability of water to meet projected demands.
- Chapter 4 Water Infrastructure Master Plan Update, contains an evaluation of Avondale's water system infrastructure and recommendations for improvements needed to deliver potable water. Specific projects needed through year 2028 and buildout are identified.
- Chapter 5 Wastewater Infrastructure Master Plan Update, contains an evaluation of Avondale's wastewater system infrastructure and recommendations for improvements needed to collect and treat wastewater. Specific projects needed through years 2023, 2028 and buildout are identified.
- Chapter 6 Capital Improvement Program, contains the recommended capital improvement plan for water resources, water infrastructure, and wastewater infrastructure, including capital project costs.

The following sections summarize key aspects of each chapter.

1.5 Water, Wastewater, and Reclaimed Water Projections

This chapter presents the flow projections for Avondale. The flow projections were developed using the City's growth projections. These flow projections provide the foundation for the 2018 IUMP and will directly impact recommendations for system improvements and the required timing of future infrastructure expansions.

For the 2018 IUMP, MAG growth projections were used to estimate future populations. MAG establishes geographic areas called Traffic Analysis Zones (TAZ) with growth information to assist communities in planning growth within each zone. TAZ data includes dwelling unit, population, and employment estimates for years 2015 through 2040 were used for the City's Transportation Master Plan Update. These projections were applied in the 2018 IUMP to maintain consistency between the two planning efforts. Table 1.1 summarizes the population projections for the 2018 IUMP planning periods.

Table 1.1 2018 IUMP Population Projections

Planning Period	Total DU (1)	Total Population (2)
2017	28,207	82,309
2023	29,967	88,250
2028	31,434	93,200
Buildout	57,940	154,700

Notes:
(1) TAZ data provided by City of Avondale were interpolated to align with years 2017, 2023, and 2028. For buildout, the total number of dwelling units was based on acreages and densities from the City's General Plan 2030.
(2) Population estimates for years 2017 – 2028 from TAZ data. For buildout, population is based on 2.67 people per dwelling unit.

Current water demands were calculated using both land use and residential property parcel at 450 gpd/DU. Then future demands were estimated using the anticipated number of residential property parcels. Table 1.2 summarizes the water demand projections for each planning year through 2028 and buildout.

Table 1.2 2018 IUMP Water Demand Projections

Planning Period	Total DU (1)	Average Daily Demand (mgd) (2)	On Project Average Daily Demand (mgd) (3)	Off Project Average Daily Demand (3)
2017	28,207	12.7	6.2	6.5
2023	29,967	13.5	6.7	6.8
2028	31,434	14.2	7.0	7.2
Buildout	57,940	26.1	12.1	14.0
Buildout with Conservation (4)	57,940	20.9	9.6	11.3

Notes:
(1) TAZ data provided by the City of Avondale were interpolated to align with years 2017, 2023, and 2028. For the Buildout planning period, the total number of dwelling units was based on acreages and densities from the City's General Plan 2030.
(2) Calculated to be 450 gpd/DU.
(3) "On Project" areas refer to Salt River Project (SRP) member lands. "Off Project" areas are not SRP member lands.
(4) Assumes 360 gpd/DU based on estimates used by the West Valley Water Users Association.

Wastewater flows were developed by applying estimates of the wastewater generation rates for each land use type, calibrated to the flow monitoring data collected in the field. Then the wastewater flow generation rates were multiplied by the water demand projections for each planning year to obtain a projection of wastewater flows. Table 1.3 summarizes the wastewater flow projections.

Table 1.3 2018 IUMP Wastewater Flow Projections

Planning Period	Average Daily Water Demand (mgd)	Average Daily Wastewater Flow (mgd) (1)
2017	12.7	5.8
2023	13.5	6.2
2028	14.2	6.5
Buildout (2)	26.1	12.0
Buildout with Conservation (3)	20.9	9.6

Notes:
(1) Assumes a wastewater generation rate of 46% of water demand based on the ratio of water production to wastewater flows.
(2) Calculated to be 450 gpd/DU.
(3) Assumes 360 gpd/DU due to potential additional water conservation based on a study by the West Valley Water Users Association.
(4) The 46% overall wastewater generation rate was assumed, although this rate could increase if more outdoor than indoor conservation in achieved.

Reclaimed water flow projections are based on the assumption that 93 percent of the wastewater flow becomes reclaimed water. Table 1.4 summarizes the reclaimed water flow projections for each planning year.

Table 1.4 2018 IUMP Reclaimed Water Flow Projections

Planning Period	Wastewater Flow (mgd) (1)	Reclaimed Water Produced (mgd) (1)	Reclaimed Water Produced (AFY) (1)
2017	5.8	5.4	6,080
2023	6.2	5.8	6,400
2028	6.5	6.0	6,710
Buildout (2)	12.0	11.2	12,500
Buildout with Conservation (3)	9.6	8.9	10,000

Notes:
(1) Assumes a reclaimed water generation rate of 93% of wastewater flow based on typical reclaimed water to wastewater flows in Arizona.
(2) Based on a calculation of 450 gpd/DU.
(3) Assumes 360 gpd/DU due to conservation.
(4) The 46% wastewater generation rate was maintained although practically this could increase if more outdoor than indoor conservation in achieved.

1.6 Water Resources and Reclaimed Water Master Plan

The City has obtained a water resource portfolio over time that is managed to satisfy the City's water supply needs. The City's water resource portfolio includes SRP water that can be used only on land areas that funded the SRP Project, referred to as "On Project" lands. Other water resources consist of CAP water, groundwater, and reclaimed water that can be used on all lands within the City. Table 1.5 summarizes the water demands and water resources for On Project lands.

Table 1.6 summarizes water demands and water resources for Off Project lands. The tables show water resources relative to demands at current unit demand rates, and with additional conservation.

Table 1.5 On Project Water Supply and Demand Balance – Normal Water Year

On Project	2017	2023	2028	Buildout at 450 gpd/DU
Cut over acres (ac)	4,691	4,950	5,171	6,785
Surface Water Allocation (AF/ac)	2	2	2	2
Surface Water (AF)	9,382	9,899	10,342	13,570
Reclaimed Water (recovery wells) (AF)	0	0	0	30
Total (AF)	**9,382**	**9,899**	**10,342**	**13,600**
Demand (AF)	6,936	7,491	7,833	13,600
Surplus / (Deficit) (AF)	2,446	2,409	2,509	0

Table 1.6 Off Project Water Supply and Demand Balance – Normal Water Year

Off Project	2017	2023	2028	Buildout at 450 gpd/DU
CAP M&I (AF)	5,416	5,416	5,416	5,416
CAP WMAT (AF)	0	882	882	882
Reclaimed Water (Recovery Wells) (AF)	6,080	6,460	6,810	12,500
Phase-in Groundwater (AF) (1)	0	0	0	0
Incidental Recharge (AF) (2)	584	620	655	1,203
Total (AF)	**12,962**	**13,378**	**13,763**	**20,001**
Demand (AF)	7,280	7,602	8,095	15,680
Surplus / (Deficit) (AF)	5,682	5,777	5,667	4,321

Notes:
(1) Phase in groundwater is 578 AF per year but is not included in years when there is a surplus and the City is able to accrue LTSCs.
(2) Equals 4.11% of total demand.

Table 1.4 and Table 1.5 demonstrate that the City has enough water resources to serve development for lands in the 2018 IUMP study area for normal water supply years. To protect against future droughts or interruption to water supply, the City should take the following actions with respect to water resources planning:

1. Continue to work with the City of Phoenix to develop an inter-governmental Agreement (IGA) that would allow direct delivery of CAP and SRP supplies through a distribution system interconnect. This action provides redundancy to the City's wells, while potentially freeing up capacity in the City's McDowell Road Facility for reclaimed water recharge.
2. Avondale has formally expressed interest in the NIA priority water reallocation of 2021. By 2021 the City will need to submit an application and water management plan explaining how the City would use the water allocation by 2029 in a manner that satisfies ADWR's goals for the reallocation.
3. Explore opportunities to expand the City's recharge capabilities as a back up to the McDowell Road Facility. This may include piloting ASR or vadose zone wells as well as identifying a second recharge site for the City's reclaimed water, which could include a regional facility. This will enable the City to have reclaimed water recharge redundancy.
4. Establish policies for new developments to encourage water conservation in landscaping including turf requirements at individual homes and open spaces.
5. Water conservation enables Avondale water resources to go further and reduces the amount of groundwater pumping during times of drought. Efforts to reduce residential usage below 450 gpd per home, will help sustain the water resources the City currently has in its portfolio.

1.7 Water Infrastructure Master Plan

Avondale currently serves all of the land areas north of the Estrella Mountains with the exception of a small area in the northwest corner of Avondale that is served by Liberty Utilities, Inc. The water master plan identifies the water infrastructure improvements that are needed so the City can continue to provide a reliable water supply through buildout for the water service area.

One of the most critical issues that this master plan addresses is water supply infrastructure. Historically, Avondale has been a groundwater only system. Some of the wells in the northern part of the City produce water that meets water quality standards without treatment. Other wells produce water that requires arsenic, nitrate, or DBCP treatment. However, farther to the south near the Gila River, groundwater quality degrades and would require treatment for total dissolved solids (TDS), which is expensive due to brine disposal costs. To help manage costs and to provide increased water supply reliability, well water supply alternatives were compared with wheeling water through the City of Phoenix water distribution system and constructing a surface water treatment plant to treat and deliver Avondale's Salt River Project (SRP) and Central Arizona Project (CAP) water. This plan contains water supply, treatment, and infrastructure recommendations that address the City's water supply needs.

The City may choose one or more options to supplying water in addition to the monthly recharge and recovery methods that are used currently. The water supply options include:

- Continue monthly recharge and recovery
- Partner with the City of Goodyear on a surface water treatment plant (WTP).

- Construct a City of Avondale WTP
- Wheel the City's surface water allocation through the City of Phoenix distribution system

Avondale should proceed to develop an agreement with the City of Phoenix to wheel its water through the Phoenix water system for the following reasons:

- A surface water supply improves reliability because Avondale would have both a surface water and groundwater supply.
- The surface water supply is less expensive than the water treatment that would be required if Avondale used well water that requires treatment for salinity.
- Nitrate treatment at Garden Lakes could be reduced or eliminated.

The City will still need to continue developing wells in the near term. As a backup plan, the City should also purchase land for a surface water treatment plant while land is available in the event that conditions change in the future and a surface water plant is needed.

The City has plans to create a pressure zone to serve lands located primarily north of Interstate 10. This pressure zone is needed to provide adequate pressures in the northeast portion of Avondale. Creating this pressure zone is relatively inexpensive from a capital standpoint, but operating costs increase because wells that require treatment would be required to provide a greater portion of the water supply. In addition, the current water supplies that would serve this upper zone (Zone 1) are not sufficient to meet projected demands. By wheeling water through Phoenix to the Garden Lakes site, additional water supplied can be provided where they are needed.

The following water infrastructure improvements are recommended for each planning period. Most of these improvements are associated with providing additional water supplies:

2018 through 2023

1. Complete an agreement with Phoenix to deliver water to Avondale.
2. Construct the pipelines, pH adjustment, and TTHM treatment needed at Garden Lakes to provide water wheeled through the Phoenix system into the Avondale water distribution system.
3. Purchase land for Well A, that will deliver water to the Northside facility
4. Construct Well #27 and deliver the water to the Garden Lakes facility.
5. Implement the new pressure zone boundary to separate Zone 1 and Zone 2.
6. Construct improvements to the McDowell recharge facility diversion structure to improve water delivery.
7. Replace the original 1,300 gpm ion exchange media at the Gateway facility.
8. Construct a 16-inch waterline along McDowell Road from 117th Avenue to Avondale Boulevard to coordinate with development of adjacent property.
9. Construct a 12-inch waterline along Dysart Road from Whyman Road to Lower Buckeye Road to coordinate with Roadway extension project.
10. Purchase land for a treatment, storage, and booster station near Roosevelt St. and 107th Avenue for future supplies from Wells C and D.
11. Rehabilitate the arsenic treatment system at the Northside facility.
12. Construct a 16-inch pipeline along 99th Avenue from Thomas Road to Encanto Boulevard.

2024 through 2028

1. Increase the storage and pumping capacity at the Garden Lakes facility.
2. Construct a 16-inch main along McDowell Road in Zone 1 from Avondale Boulevard to 99th Avenue.
3. Construct future well 1.
4. Construct a nitrate removal facility at the Coldwater facility.
5. Construct future well 2.

2029 through Buildout

1. Equip Well #22 to deliver water to the Coldwater facility.
2. Construct Well J, connect to the Coldwater facility, and expand nitrate treatment.
3. Construct Well A and connect to the Northside facility.
4. Rehabilitate infrastructure at the Del Rio facility.
5. Construct the connection from the Phoenix water system to the Del Rio facility.
6. Expand pumping and storage capacity at the Del Rio facility.
7. Construct Well C and Well D and connect to a new treatment facility.

1.8 Wastewater System Evaluation

The City's water reclamation facility has sufficient capacity to treat current wastewater flows. Based on growth projections, the design for the next expansion to 12 mgd needs to start by 2025. If the City's growth projections begin to increase, staff will need to evaluate when to re-program the start of the expansion project. Table 1.7 presents the plant capacity relative to projected wastewater flows.

Table 1.7 Water Reclamation Facility Capacity vs. Wastewater Flows

	Existing Capacity (ADMM) (mgd)	Capacity/Flow (mgd)			
		2017	2023	2028	Buildout
Rated Capacity	9.0	9.0	9.0	9.0	15.0
80% Capacity Trigger for Design (based on MMADF)	7.2	7.2	7.2	7.2	12.0
Max Month Average Daily Flow		6.8	7.1	7.4	14.5

Abbreviation:
ADMM = average day of the maximum month

Sewer pipe capacity was evaluated for buildout flow conditions. With the exception of the pipe running primarily along Dysart Road between the Riley lift station and the 4th Street lift station, Avondale sewer pipes are predicted to have sufficient capacity through buildout.

The following improvements are recommended for the wastewater system:

1. The City's current lift stations have sufficient capacity to convey wastewater flows through buildout. However, the City should optimize the pumping capacity at each lift station as rehabilitation projects occur.
2. Replace the sewer main along Dysart Road from Riley Drive to Corral Street with a 12-inch main.
3. Replace the sewer main along Harrison Drive from 4th Street to Dysart Road.

4. A backup force main is recommended for the 10th Street Lift Station.
5. The Wolf Water Resource Facility will need to begin expansion design by 2025 to accommodate additional wastewater flows from growth. If population growth occurs faster than currently planned, City staff will need to adjust this schedule.

1.9 Capital Improvement Program

One of the primary purposes of the 2018 IUMP is to develop a capital improvement program to assist the City in planning for the capital improvements that are needed to serve the City's customers in the future. Projects to maintain and upgrade infrastructure are funded from the City's Capital Improvement Program (CIP). Other projects such as pipes within a development are funded or constructed entirely by the developer. In this master plan, projects funded through the IIP are a subset of the CIP and the City will make decisions about the IIP separate from the 2018 IUMP. Some projects that are anticipated to be paid for entirely by developers are listed separately.

This 2018 IUMP is being completed in the 2017-2018 fiscal year (FY). Projects in FY 2018 through 2023 are phased year by year so that the City has the detail needed for the five year CIP. Projects that are scheduled for FY 2024 through FY 2028 are not assigned a specific year due to the uncertainty associated with the timing of projects more than five years into the future. CIP projects in the buildout planning period are useful for long term planning of the City's infrastructure systems. If growth accelerates more rapidly than projected in this master plan, then the City will need to identify the CIP projects that need to be moved forward in time.

1.9.1 Water Supply Alternatives

Water supply alternatives were evaluated to determine the relative costs of different water supply options. Both capital and operations and maintenance (O&M) costs were included in the evaluation. Costs were compared on a present worth basis, which is useful to compare the relative costs of different alternatives. The present worth cost is expressed in terms of a cost per million gallons (MG) because the available water supply amounts differ by water supply. Costs include infrastructure from the water source to delivery into the distribution system, including the cost of expanding different water production sites to buildout.

The following alternatives were compared:

1. Construct a well that does not require treatment. This alternative was included to compare the relative cost of wells that the City currently has that do not need treatment, such as at Rancho Santa Fe. Wells that do not need treatment are not expected in Avondale going forward, so water supply costs will be going up as more wells require treatment. The relative cost of this supply is $900/MG.
2. Construct a well that requires arsenic treatment such as future Well A pumping to Northside. Arsenic treatment is less than nitrate treatment, so wells with only arsenic are preferred based on cost. The arsenic treatment costs are based on the assumption that 50 percent of the well water needs to be treated. Higher percentages will increase treatment costs. The relative cost of this supply is $1,200/MG.
3. Construct a well that requires nitrate treatment. This water supply cost will be typical of wells in the master plan that are planned. The relative cost of wells with nitrate treatment is $2,100/MG.

4. Wheel 5 mgd of surface water from Phoenix to the Garden Lakes facility and blend with 5 mgd of well water. This alternative is the third lowest cost, behind wells with no treatment and wells with nitrate treatment. The advantage of this alternative is that blending eliminates the need for nitrate treatment and total trihalomethanes (TTHM) treatment. However, granular activated carbon (GAC) contactors are included for redundancy in the event that a well is out of service. The relative cost of this alternative is $1,600/MG.
5. Wheel 10 mgd of surface water from Phoenix to Del Rio. This alternative would require pH and GAC treatment, and would not have any well blending. This alternative results in a higher cost because there is no blending to reduce treatment costs. The relative cost of this option is $2,400/MG.
6. Construct a surface water treatment plant in Avondale. Analysis currently indicates lower operating/treatment costs compared to wheeling surface water through neighboring cities. However, the City would need to finance approximately $87 M to do this alternative. The relative cost of this alternative is $1,800/MG.
7. Team with Goodyear as part owners in their surface water plant. This alternative will always be more expensive than a surface water treatment plant in Avondale because of the capital and pumping cost to deliver raw water to Goodyear and then pump treated water back to Avondale. The relative cost of this alternative is $2,400/MG.

Alternative 4, wheeling water through Phoenix to the Garden Lakes Facility and blending with well water is an attractive alternative because blending eliminates the need for well head treatment and significantly reduces the need for TTHM treatment for the level of reliability that is provided, so this alternative is being recommended.

Alternative 5, wheeling water through Phoenix to the Del Rio site is a viable option but the costs are relatively high in comparison with most of the other options.

1.10 Capital Project Summary

Table 1.8 presents a capital project summary developed for the 2018 IUMP.

Table 1.8 2018 IUMP Capital Project Summary

Project No.	Infrastructure Category	Project Cost ($)	FY 2018/2019 Project Cost ($)	FY 2019/2020 Project Cost ($)	FY 2020/2021 Project Cost ($)	FY 2021/2022 Project Cost ($)	FY 2022/2023 Project Cost ($)	FY2023/2024 to FY2027/2028 Project Costs ($)	Buildout Project Cost ($)
WA1285	White Mountain Apache Tribe water settlement	$2,300,000	$2,300,000						
	Water Infrastructure								
W1	Wheel water through Phoenix to Garden Lakes facility	$6,863,000	$1,357,000	$5,506,000					
W2	Northside well site (Well A) land purchase & Design Concept Report	$75,000	$75,000						
WA1131	Construct Well #27 and connect to Garden Lakes facility	$4,408,000	$800,000	$722,000	$2,886,000				
WA1344	Separate Zone 1 and Zone 2	$1,727,000		$368,000	$1,359,000				
W3	Recharge facility - replace diversion structure and piping improvements	$1,050,000	$300,000	$750,000					
W4	Replace Gateway nitrate treatment	$3,000,000		$500,000	$2,500,000				
WA1135	McDowell Road 16-inch waterline - 117th Avenue to Avondale Boulevard	$300,000			$300,000				
WA1231	Dysart Road 12-inch waterline from Whyman Road to Lower Buckeye Road	$400 ,000			$400,000				
W5	Purchase land for future treatment site at 107th Avenue and Roosevelt Street	$600,000				$600,000			
W6	Rehabilitate Northside arsenic treatment system	$1,000,000				$1,000,000			
WA1133	Construct 99th Avenue waterline from Thomas Road to Encanto Boulevard	$710,000					$710,000		
W7	Expand Garden Lakes storage and pumping	$8,358,000						$8,358,000	
W8	Install 16-inch main on McDowell Road from Avondale Boulevard to 99th Avenue	$2,724,000						$2,724,000	
WA1142	Construct Future Well 1	$2,940,000						$2,940,000	
WA1340	Construct nitrate removal system for Coldwater facility	$5,545,000						$5,545,000	
WA1214	Construct Future Well 2	$2,900,000						$2,900,000	
W9	Equip Well #22 to deliver water to Coldwater facility	$1,817,000							$1,817,000
W10	Add Well J to Coldwater	$2,900,000							$2,900,000
W11	Construct Well A and deliver to Northside facility	$2,900,000							$2,900,000
W12	Rehabilitate Del Rio facilities	$2,002,000							$2,002,000
W13	Wheel water through Phoenix to Del Rio facility	$17,507,000							$17,507,000
W14	Construct a treatment, storage, and booster facility on 107th Avenue and Roosevelt Street, add supply from Well C	$17,188,000							$17,188,000
W15	Add Well D to 107th Avenue and Roosevelt Street, add supply from Well C	$8,916,000							$8,916,000
W16	Add storage and pumping capacity at Del Rio facility	$8,183,000							$8,183,000
W17	Construct Future Well	$2,940,000							$2,940,000
W18	Construct Future Well	$2,940,000							$2,940,000
	Water Infrastructure Total	**$109,893,000**	**$2,532,000**	**$7,846,000**	**$7,445,000**	**$1,600,000**	**$710,000**	**$22,467,000**	**$67,293,000**
	Wastewater Infrastructure								
SW1389	Sewer main, Dysart Road from Riley Drive to Corral Street	$1,270,000	$260,000	$1.010,000					
SW1390	Sewer Main, Dysart Road from Harrison Dr. to Lower Buckeye Road	$1,130,000				$230,000	$900,000		
SW1108	Backup force main - 10th Street lift station to El Mirage Road	$2,200,000		$300,000				$1,900,000	
SW1237	Water Reclamation Facility Expansion Phase 2	$63,070,000						$63,070,000	
WW1	Water Reclamation Facility Expansion Phase 3	$23,170,000							$23,170,000
	Wastewater Infrastructure Total	**$90,840,000**	**$260,000**	**$1,310,000**	**$ –**	**$230,000**	**$900,000**	**$64,970,000**	**$23,170,000**
	CIP Projects Total	**$203,033,000**	**$5,092,000**	**$9,156,000**	**$7,445,000**	**$1,830,000**	**$1,610,000**	**$87,437,000**	**$90,463,000**

Chapter 2

WATER, WASTEWATER, AND RECLAIMED WATER PROJECTIONS

2.1 Planning Framework

This chapter presents the flow projections for the 2018 Integrated Utility Master Plan (2018 IUMP) Update. The flow projections were developed using the City's growth projections. These flow projections are an important part of the planning framework for the 2018 IUMP and will directly impact recommendations for system improvements and the required timing of future infrastructure expansions.

Growth projections are based on previous planning reports and data provided by the City of Avondale, including:

- Study area boundary
- Land use classifications per the land use plan included in the General Plan 2030
- Historical population growth trends
- Established population growth rates for Maricopa Association of Governments (MAG) Traffic Analysis Zones (TAZ) within Avondale

2.1.1 Study Area

The study area (Figure 2.1) for infrastructure planning in the 2018 IUMP includes the City's incorporated limits north of the Estrella Mountains. There are approximately 235 acres in northwest Avondale that receive water and sewer service from Liberty Utilities that are not included in the study area.

2.1.2 Planning Periods

The 2018 IUMP includes four planning periods: year 2017, year 2023, year 2028, and buildout. The buildout planning period is not associated with a specific year; it represents the conditions in which all land areas within the study area are developed. Population, water demand, wastewater flows, and reclaimed water flows were prepared for each planning year.

2.1.3 Land Use Categories

Land use provides a common framework for establishing growth trend patterns in undeveloped areas and can be used to develop water demand and wastewater flow projections. The City's Land Use Plan as presented in the General Plan 2030 was used to estimate growth potential for the study area, and target dwelling unit densities for each land use type were provided by the City. It is estimated that there will be approximately 57,940 dwelling units in the City's study area. Figure 2.2 presents the City's Land Use Plan and Table 2.1 summarizes acreage, target densities, and potential dwelling units at buildout by land use classification.

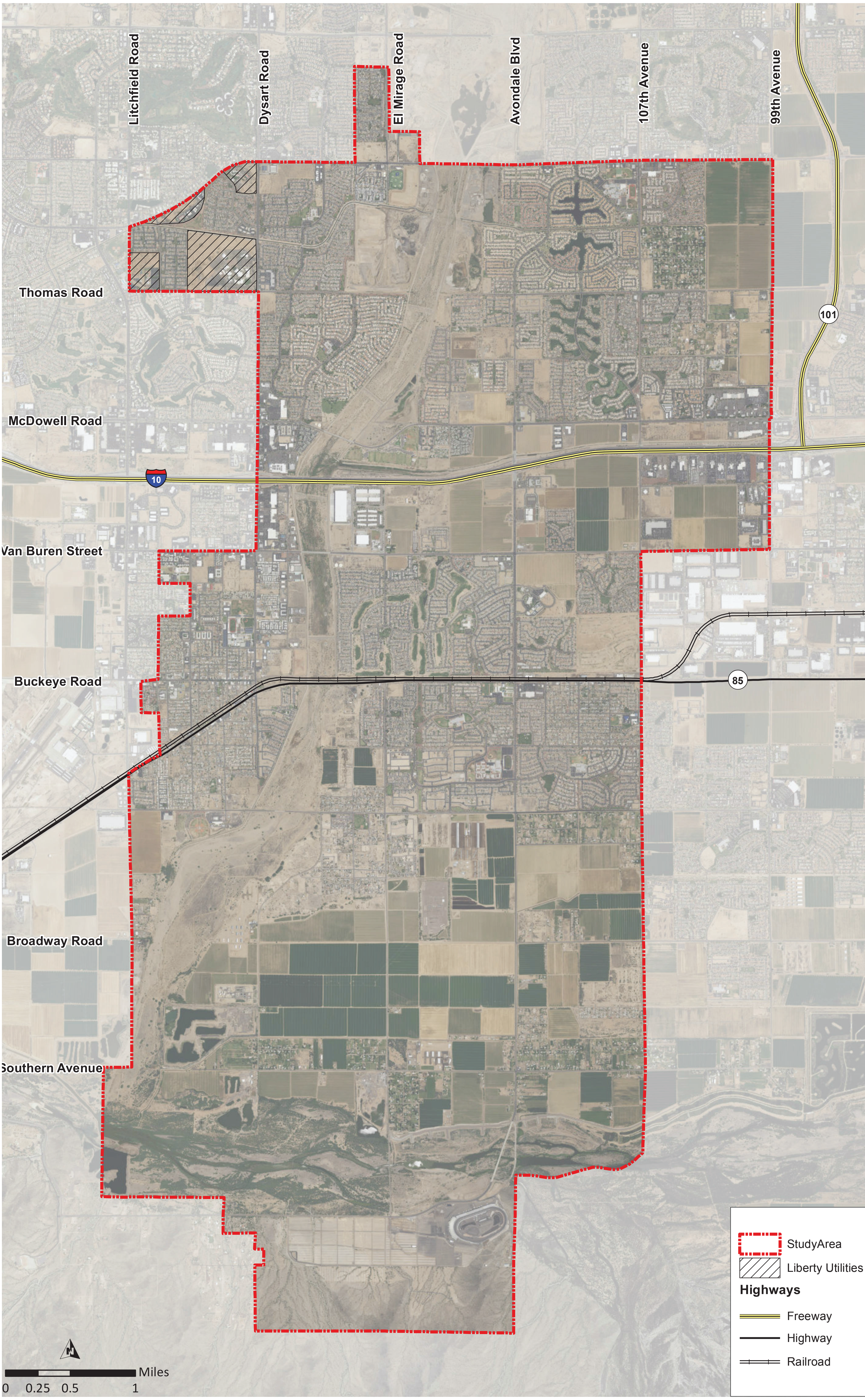

Figure 2.1 Study Area

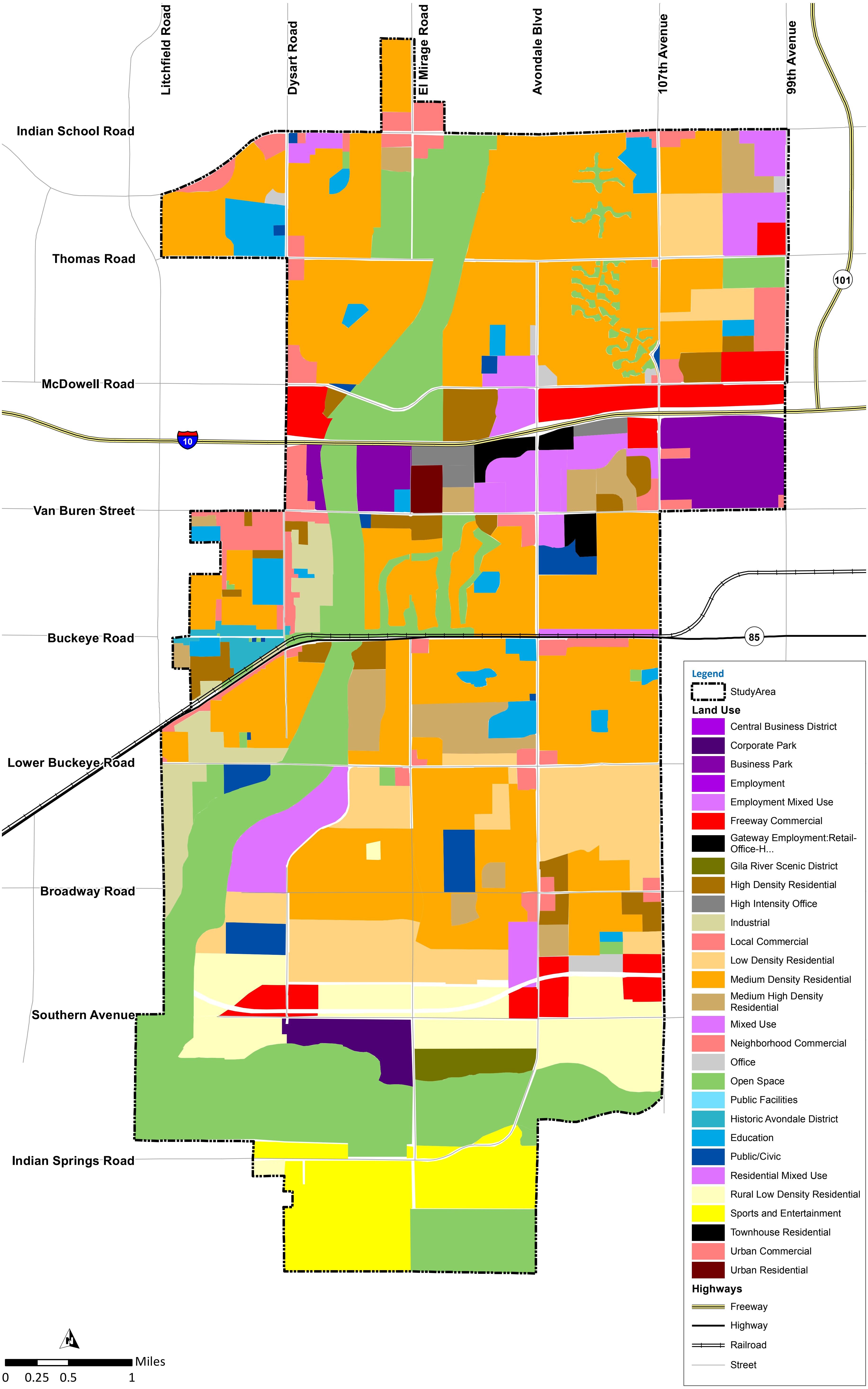

Figure 2.2 Land Use Plan

Table 2.1 Land Use Summary for the Study Area.

Land Use Category	Total Acres (ac)	Target Density (DU/ac) (1)	Estimated Dwelling Units (DU)
Rural Low Density Residential (2)	1,066	0.2	213
Estate/Low Density Residential (2)	1,499	1	1,499
Sports & Entertainment	935	2	1,871
Medium Density Residential (2)	6,719	2.5	16,797
City Center	386	7.5	2,900
Historic Avondale	85	8	683
Medium – High Density Residential (2)	655	4	2,621
High Density Residential (2)	542	20	10,849
Urban Commercial	131	20	2,620
Mixed Use (2)	804	20	16,072
Urban Residential	60	30	1,815
Local Commercial (2)	616	-	-
Open Space & Parks (2) (3)	4,075	-	-
Open Space – Irrigation (2) (3)	120	-	-
Freeway Commercial	711	-	-
Business Park	595	-	-
Education	398	-	-
Industrial	418	-	-
Public / Civic	285	-	-
Corporate Park	191	-	-
Gila River Scenic District	129	-	-
High Intensity Office	108	-	-
Office / Professional (2)	78	-	-
Total (4)	**20,606**	**NA**	**57,940**

Notes:

(1) General Plan 2030, Table 9.

(2) Acreage differences from Table 9 of the General Plan 2030 can be attributed to adjustments made to the City's land use GIS data layer since the General Plan 2030 was completed. The General Plan 2030, Table 9 acreages are: Rural Low Density Residential (1,056 ac), Estate/Low Density Residential (1,866 ac), Medium Density Residential (6,351 ac), Medium-High Density Residential (614 ac), High Density Residential (572 ac), Mixed Use (809), Local Commercial (755 ac), Open Space & Parks (4,208 ac), Office/Professional (80 ac).

(3) A visual inspection of the "Open Space & Parks" land use category using aerial photography and the GIS water meter database showed approximately 120 acres that are irrigated from the potable system. The remaining area appears to be natural open space (i.e., Agua Fria River, washes, open desert).

(4) Excludes land areas served by Liberty Utilities, Inc.

2.1.4 Historical Population and Growth Projections

The City of Avondale has grown from a population of approximately 37,000 in the year 2000 to an expected population of over 82,000 by the close of year 2017. Previous water planning studies, including the water master plan updates (years 2002, 2010, and 2013) and the City's 2014 Infrastructure Improvement Plan (IIP), include population growth estimates that vary widely (see Figure 2.3).

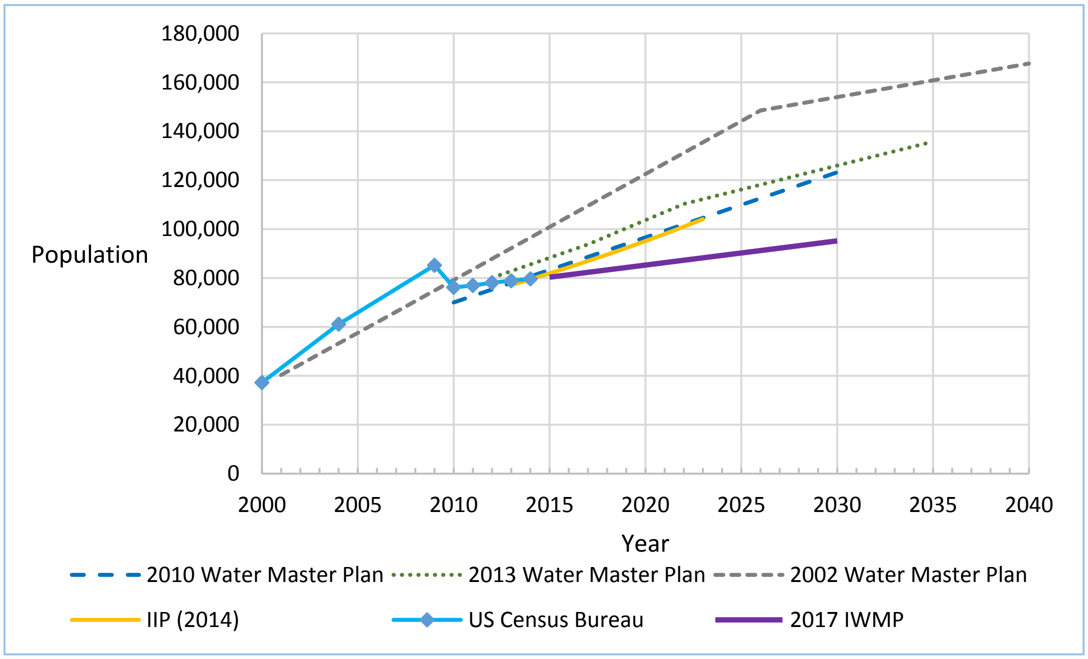

Figure 2.3 Population Projections from Previous Studies

For the 2018 IUMP, MAG growth projections were used to estimate future populations. MAG establishes geographic areas called Traffic Analysis Zones to assist communities in planning for specific regions. TAZ growth projections that included dwelling unit, population, estimates for years 2015 through 2040 were used for the City's Transportation Master Plan Update (in progress). These were carried forward to the 2018 IUMP to maintain consistency between the two planning efforts. Table 2.2 summarizes the population projections for the 2018 IUMP planning periods. See Appendix A for a summary of the dwelling unit and population projections for each TAZ shown in Figure 2.4.

Table 2.2 2018 IUMP Population Projections

Planning Period	Total DU (1)	Total Population (2)
2017	28,207	82,309
2023	29,967	88,250
2028	31,434	93,200
Buildout	57,940	154,700

Notes:

(1) TAZ data provided by City of Avondale were interpolated linearly to align with years 2017, 2023, and 2028. For buildout, the total number of dwelling units was based on acreages and densities from the City's General Plan 2030.

(2) Population estimates for years 2017 – 2028 from TAZ data. For buildout, population is based on 2.67 people per dwelling unit.

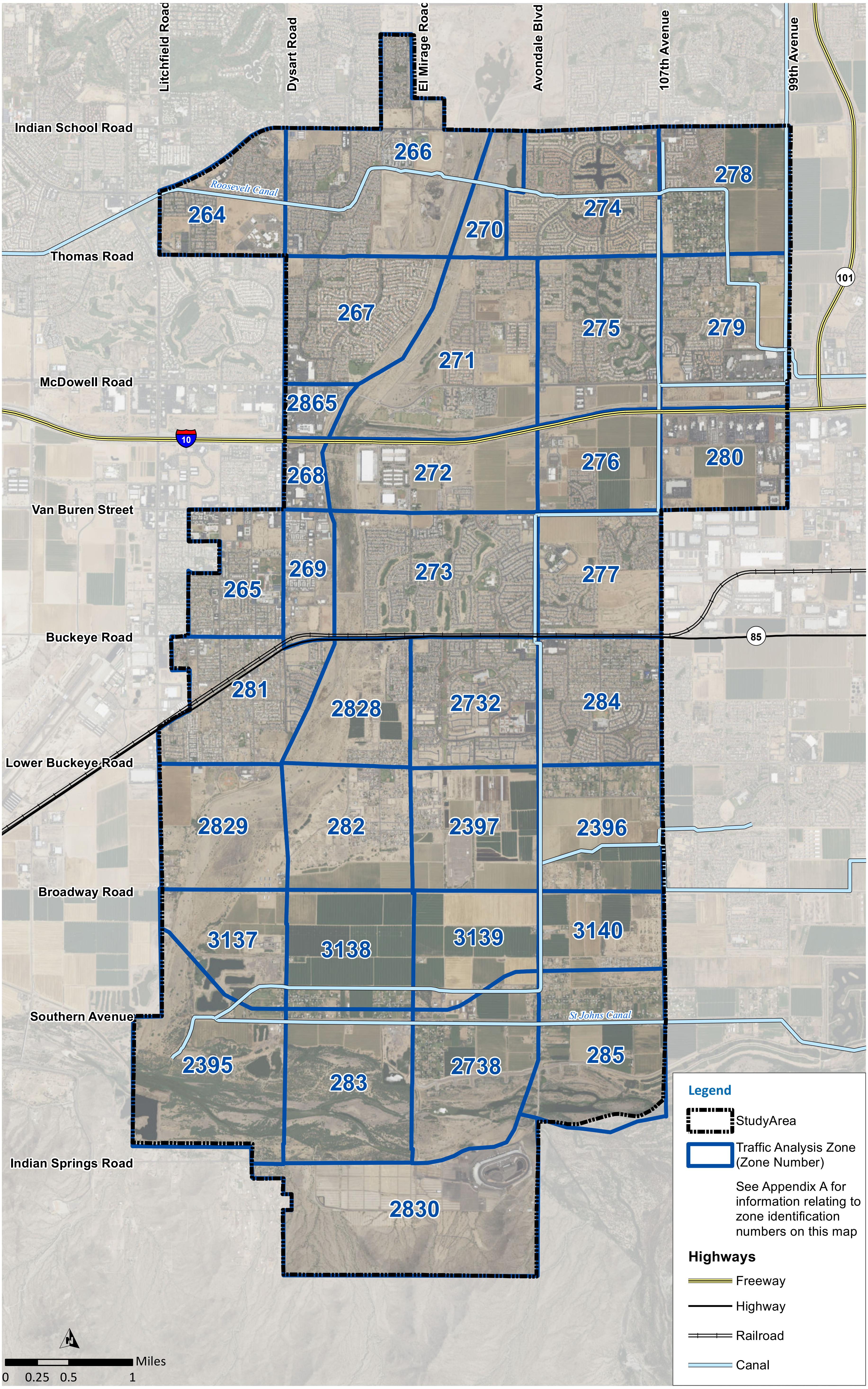

Figure 2.4 Traffic Analysis Zones

2.2 Water Demand Projections

2.2.1 Unit Water Demands

Unit water demands are an estimate of average annual water use expressed on a per-acre, dwelling unit, meter type, or other unit basis. Avondale's water customer billing data and water production records were used in conjunction with the City's Geographic Information System (GIS) land use data to develop unit water demands. These unit water demands were compared to the unit water rates by dwelling unit that the City provided to the West Valley Water Association for a regional water supply and demand study. The following sections summarize the methodology used to develop the unit water demands.

2.2.1.1 Customer Billing Database and Water Production Records

Avondale's water customer billing database includes over 24,500 individual accounts and provides a record of monthly water use by location. The City's water production records were compared to the water billing records to verify the completeness of the billing database. Table 2.3 is a summary of the average daily water produced and average daily water billed between 2012 and 2016. Avondale's non-revenue water (water produced less the water billed) ranges from 0.5 to 1.5 million gallons per day (mgd), which represents between 5 percent and 12 percent of the average daily water produced by the City each year. This range is typical of Arizona communities and a non-revenue water factor of 10 percent is a reasonable value to use for future water resources planning.

Table 2.3 Historical Water Produced and Billed

Year	Average Daily Water Produced (mgd) (1)	Average Daily Water Billed (mgd) (2)	Non-Revenue Water (mgd)	Non-Revenue Water (%) (3)
2012	12.6	11.1	1.5	12
2013	12.2	11.1	1.1	9
2014	11.6 (4)	11.1	0.5	5
2015	12.1	10.7	1.4	11
2016	12.6	11.3	1.2	10

Notes:
(1) Water production records.
(2) Water billing records.
(3) Defined as a percentage of water produced: (Water Produced – Water Billed) / Water Produced x 100.
(4) There were potential water production metering inaccuracies in year 2014.

The City's water use by customer classification was summarized for year 2016 to understand general water use trends by sector (see Table 2.4). Of the City's water meters, 88 percent are classified as Residential, which accounts for 57 percent of the City's annual average water use. The City's Landscape meters represent 2 percent of the total number of water meters, but account for nearly 25 percent of the City's annual average water use. Commercial water meters also represent 2 percent of the total number of water meters, and account for 10 percent of the City's annual average water use. The remaining 5 percent of water use is spread across the other account types shown in Table 2.4.

Table 2.4 2016 Water Use by Sector

Account Type	Number of Meters (No)	Percent of Total (%)	2016 Consumption (gpd)	Percent of Total (%)
Residential	21,582	88	6,444,937	57
Multi-Family/Apartment/Hotel	140	1	609,252	5
Commercial	534	2	1,180,512	10
Schools	59	0	182,868	2
Churches	42	0	12,296	0
Industrial	3	0	9,184	0
Laundromat	3	0	12,556	0
Mobile Home Park	19	0	155,074	1
Hydrant Meter	1	0	7,822	0
Car Wash	9	0	64,088	1
Sewer Only (1)	1	0	663	0
Landscape Meter	554	2	2,550,748	23
Unclassified	1,614	7	88,819	1
Total	**24,561**	**100**	**11,318,819**	**100**

Notes:
(1) Avondale has Account Type 13-Sewer Only, which is used to identify a group of 26 Goodyear homes on Los Robles Drive, north of Western Avenue that Avondale provides sewer service for and is paid as a single account by the Goodyear Water Department.

The account types shown in Table 2.4 do not necessarily correlate with the City's Land Use Plan categories. However, reviewing water use by account type is valuable because it identifies the sectors where the potential for water savings through conservation is the largest. For Avondale, the Landscape Meter account type is one of these sectors; it is recommended that the City study further the areas served by these meters to determine if there are irrigation efficiencies that could be gained to reduce water use. The Residential category should also be studied further to determine if indoor and outdoor use in homes can be reduced.

2.2.1.2 Land Use Unit Water Demands

The City has established unit water demands based on land use classification that were developed in 2009 and used in the 2010 and 2012 Water Master Plan Updates. These factors are based on a water use value of 361 gallons per day per dwelling unit (gpd/DU) for residential land uses, and between 1,000 and 2,300 gallons per acre per day (gpad) for non-residential land uses. Some land uses, including Sports & Entertainment, Urban Commercial, and Mixed Use, were assumed to have both residential and non-residential unit water demand components. Table 2.5 summarizes the City's unit water demands and the buildout (fully developed) acreages by land use type within the 2018 IUMP study area.

Table 2.5 Unit Water Demands and Target Densities within the Study Area

Land Use Category	Dwelling Units per Acre	Residential Unit Water Demand (gpd/DU) (1)	Non-Residential Unit Water Demand (gpad) (1)	Total Unit Water Demand (gpad) (2)
Rural Low Density Residential	0.2	361	-	72
Estate/Low Density Residential	1	361	-	361
Sports & Entertainment	2	361	2,230	1,476
Medium Density Residential	2.5	361	-	903
City Center (1)	7.5	361	-	2,712
Historic Avondale	8	361	-	2,888
Medium – High Density Residential	4	361	-	1,444
High Density Residential	20	361	-	7,220
Urban Commercial	20	361	1,850	4,535
Mixed Use	20	361	2,230	4,725
Urban Residential	30	361	-	10,830
Local Commercial	-	-	1,850	1,850
Open Space & Parks	-	-	-	-
Open Space – Irrigation	-	-	2,300	2,300
Freeway Commercial	-	-	1,300	1,300
Business Park	-	-	1,300	1,300
Education	-	-	1,100	1,100
Industrial	-	-	1,000	1,000
Public / Civic	-	-	1,100	1,100
Corporate Park	-	-	1,000	1,000
Gila River Scenic District	-	-	1,300	1,300
High Intensity Office	-	-	1,300	1,300
Office / Professional	-	-	1,000	1,000

Notes:

(1) From the City of Avondale's 2010 and 2013 Water Master Plan Update. Some Mixed Use areas include both a residential and non-residential water demand component (Sports & Entertainment, Urban Commercial, and Mixed Use).

(2) Based on housing densities from the General Plan 2030. For land use types with residential and non-residential components, the total unit demand assumes 50% residential and 50% non-residential (i.e., for Sports and Entertainment: 2 DU x 361 DU/ac * 50% + 2,230 gpad * 50% = 1,476 gpad).

2.2.1.3 Unit Water Demand for Total Dwelling Units

In 2016 there were approximately 27,913 dwelling units in Avondale, based on TAZ data from the City's Transportation Master Plan. Using the total production value from 2016, the composite unit water demand was 450 gpd/DU (12,600,000 gpd / 27,913 DU = 450 gpd/DU). This composite value includes both residential and non-residential demand components of the City's total water use (including non-revenue water). This approach assumes that the ratio of residential to non-residential growth remains constant, and that the ratio of residential to non-residential water use also remains constant.

Avondale recently participated in a water supply study led by the West Valley Water Association (WVWA, formerly WESTCAPS) that used a demand approach based on the number of anticipated dwelling units in each planning year. The baseline assumption for this study was that the City's 2016 unit water demand is 450 gpd/DU. The WVWA study assumed a year 2060 composite unit water demand in the range of 344 and 360 gpd/DU, which represents a 20 percent to 24 percent reduction in total water use for the City, presumably through water conservation.

To align the IUMP with recent studies completed by the City, the composite dwelling unit water demand approach was selected to allow the dwelling unit projections from the TAZ data to be used with the unit water demand values assumed in the WVWA study.

2.2.2 Current Water Demands

The unit water demands shown in Table 2.5 were used to calculate the 2016 average daily demand (ADD) using an estimate of currently developed acreage in the City's Land Use Plan. A 10 percent factor for non-revenue water was added to the land use predicted values in Table 2.6, and results in a prediction of 12.6 mgd, which is the same as the 2016 actual production value.

Table 2.6 shows that the Land Use Plan predicted a total of 27,381 dwelling units in the City. Extrapolating from the TAZ data, 27,913 dwelling units were estimated in the City for year 2016. These values are within 2 percent and indicate that the Land Use Plan dwelling unit predictions align with the TAZ data. Therefore, the City's plan provides a reasonable estimate of both dwelling units and water demand for year 2016 conditions and can be used to make future projections.

Table 2.6 Land Use Predicted Water Demands for Year 2016

Land Use Category	2016 Acreage	2016 Dwelling Units (DU) (1)	Unit Water Demand (gpad)	Total Water Demand (gpd)
Rural Low Density Residential	216	43	72	16,000
Estate/Low Density Residential	422	422	361	152,000
Sports & Entertainment	288	576	1,476	425,000
Medium Density Residential	4,957	12,392	903	4,473,000
City Center (1)	57	431	2,712	156,000
Historic Avondale	66	530	2,888	191,000
Medium – High Density Residential	257	1,027	1,444	371,000
High Density Residential	271	5,429	7,220	1,960,000
Urban Commercial	53	1,058	4,535	240,000
Mixed Use	274	5,473	4,725	1,293,000
Urban Residential	-	-	10,830	-
Local Commercial	263	-	1,850	487,000
Open Space & Parks	4,075	-	-	-
Open Space – Irrigation	70	-	2,300	161,000
Freeway Commercial	215	-	1,300	279,000
Business Park	330	-	1,300	430,000
Education	280	-	1,100	308,000
Industrial	164	-	1,000	164,000
Public / Civic	241	-	1,100	265,000
Corporate Park	-	-	1,000	-
Gila River Scenic District	32	-	1,300	42,000
High Intensity Office	-	-	1,300	-
Office / Professional	21	-	1,000	21,000
Total	**12,552**	**27,381**	**-**	**11,433,000**
Non-Revenue Water (10%)				1,143,000
Total Estimated 2016 Water Demand				**12,576,000**
2016 Water Demand (2)				12,600,000
Percent Difference				**-0.2%**

Notes:
(1) From Table 9 of the City of Avondale's General Plan 2030.
(2) From Avondale 2016 water production records

2.2.3 Water Demand Projections

The City's TAZ data was used to estimate the number of dwelling units for each of the 2018 IUMP planning years. The composite unit water demand developed from the 2016 water billing data (450 gpd/DU) was then used to estimate the average annual water demand in each planning year by multiplying the number of dwelling units per planning scenario by the composite unit water demand. For buildout, the total acreage from the City's Land Use Plan for the study area was used to estimate the potential dwelling units and water demand (see Table 2.7). The 450 gpd/DU value is based on the number of dwelling units, which is calculated using the residential land use categories, and the total annual average production. However, because it is a composite unit water demand it includes both the residential and non-residential component of water use (including non-revenue water).

Table 2.7 Land Use Predicted Water Demands for Buildout

Land Use Category	Total Acreage	Total Dwelling Units (1)	Unit Water Demand (gpd/DU)	Total Water Demand (gpd)
Rural Low Density Residential	1,066	213	450	95,973
Estate/Low Density Residential	1,499	1,499	450	674,495
Sports & Entertainment	935	1,871	450	841,927
Medium Density Residential	6,719	16,797	450	7,558,579
City Center (1)	386	2,900	450	1,305,000
Historic Avondale	85	683	450	307,137
Medium – High Density Residential	655	2,621	450	1,179,256
High Density Residential	542	10,849	450	4,881,936
Urban Commercial	131	2620	450	1,178,928
Mixed Use	804	16,072	450	7,232,209
Urban Residential	60	1,815	450	816,621
Local Commercial	616	-	-	-
Open Space & Parks	4,075	-		-
Open Space – Irrigation	120	-		-
Freeway Commercial	711	-	-	-
Business Park	595	-	-	-
Education	398	-	-	-
Industrial	418	-	-	-
Public / Civic	285	-	-	-
Corporate Park	191	-	-	-
Gila River Scenic District	129	-	-	-
High Intensity Office	108	-	-	-
Office / Professional	78	-	-	-
Total	**20,606**	**57,940**	**-**	**26,072,061**

Notes:
(1) From Table 9 of the City of Avondale's General Plan 2030.

At buildout, the City will have approximately 57,940 dwelling units in the study area that will generate 26.1 mgd of average annual water demand. The future average water demand is over 2 times larger than the City's current average demand.

Table 2.8 summarizes the number of dwelling units and water demand projections for each planning year through 2028 and buildout. On Project lands can use SRP water and Off Project lands cannot. The West Valley Water Users Association completed a study that included levels of water conservation and in this study, water conservation measures, when implemented, would result in a composite unit water demand of 360 gpd/DU so this value was used to estimate water demand in Table 2.8 with conservation.

Table 2.8 2018 IUMP Water Demand Projections

Planning Period	Total DU (1)	Average Daily Demand (mgd) (2)	On Project Average Daily Demand (mgd) (3)	Off Project Average Daily Demand (3)
2017	28,207	12.7	6.2	6.5
2023	29,967	13.5	6.7	6.8
2028	31,434	14.2	7.0	7.2
Buildout	57,940	26.1	12.1	14.0
Buildout with Conservation (4)	57,940	20.9	9.6	11.2

Notes:
(1) TAZ data provided by the City of Avondale were interpolated to align with years 2017, 2023, and 2028. For the Buildout planning period, the total number of dwelling units was based on acreages and densities from the City's General Plan 2030.
(2) Assumes composite unit water demand of 450 gpd/DU based on 2016 data.
(3) "On Project" areas refer to Salt River Project (SRP) member lands. "Off Project" areas are not SRP member lands.
(4) Assumes composite unit water demand 360 gpd/DU based on a West Valley Water Users Association study.

2.2.3.1 Peaking Factors

Since 2012, the City's maximum water production month (max month) has been June or July. The day with the highest water production was estimated using daily well reads provided by the City. Table 2.9 summarizes the average daily demand and maximum day (MD) water production values for the past 5 year and the associated MD/ADD peaking factors.

The highest observed maximum day to average day peaking factor over the past 5 years is 1.45 MD/ADD. For infrastructure planning purposes, the City uses 1.65 MD/ADD, which provides a conservative estimate of potential demands and accounts for uncertainties in future water use patterns and infrastructure redundancy. Accordingly, the City's maximum day water production at buildout is estimated to be 43.1 mgd.

Table 2.9 Historical Average Annual and Maximum Day Water Production

Year	Average Daily Demand (mgd)	Maximum Day Demand (mgd)	Maximum Production Day	MD/ADD Peaking Factor
2012	12.6	17.2	July 6	1.37
2013	12.2	17.1	June 24	1.40
2014	11.6	16.8	June 24	1.45
2015	12.1	16.2	July 7	1.34
2016	12.6	18.3	July 6	1.45

2.3 Wastewater Flow Projections

2.3.1 Unit Wastewater Flows

Unit wastewater flows are an estimate of the wastewater flow expressed on a per-acre, dwelling unit, meter type, or other unit basis. Because wastewater flows are not metered at customer connections, they must be estimated as a percentage of water demand. Flow monitoring data and flow records from the City's Wastewater Reclamation Facility (WRF) were used to estimate current flows, and the City's GIS data was used to estimate acreages for currently developed areas. The following sections summarize the methodology used to develop unit wastewater flows.

2.3.1.1 Historical Wastewater Flows

Between 2012 and 2016 the City's average annual wastewater flow ranged between 5.0 and 6.2 mgd, with the highest flow in 2014. During the same period, the maximum month flows ranged between 4.9 and 6.4 mgd, again with the highest flow in 2014. Table 2.10 summarizes the City's wastewater flows for the past 5 years. There was relatively little change in flows, with the exception of those recorded in 2014.

Wastewater generation rates have ranged between 42 percent and 53 percent of potable water flows over the past 5 years. The wastewater generation rates in 2015 and 2016 have been 46 percent and 44 percent, respectively. For the IUMP an overall wastewater generation rate of 46 percent of potable water production was used for planning year flow projections.

Table 2.10 Historical Average Annual and Maximum Month Wastewater Flows

Year	Average Annual Daily Flow (mgd)	Maximum Month Flow (mgd)	Maximum Month / Average Annual Daily Flow	Average Annual Water Production (mgd)	Average Annual Wastewater Flow as Percent of Water Production (%)
2012	5.3	5.7	1.06	12.6	42
2013	5.8	6.2	1.06	12.2	48
2014	6.2	6.4	1.04	11.6 (1)	53
2015	5.6	5.8	1.03	12.1	46
2016	5.6	5.8	1.02	12.6	44

Notes:
(1) There were potential water production metering inaccuracies in year 2014.

2.3.1.2 Flow Monitoring Field Test

A flow monitoring field test was conducted to collect the data necessary to develop unit wastewater loads and wastewater flow projections. Flow monitoring data was also used to calibrate the wastewater hydraulic model. The collected data included temporary flowmeters deployed in the collection system in April and May 2017, permanent flowmeters at the City's WRF, and temporary flowmeters deployed in 2016. After discussions with the City, the sites metered in April and May 2017 were selected with the intention to characterize system wastewater flows by collection basin. The 2016 flow monitoring locations were selected by City staff to meet the needs of individual projects. Although this data was collected prior to the IUMP, it is still useful in validating flows in areas that are essentially built out.

Figure 2.5 presents the flow monitoring locations and collection basins for the IUMP. Table 2.11 summarizes the flow monitoring results for the flowmeters placed for the IUMP in April and May 2017. Table 2.12 summarizes the flow monitoring results for the historical flow monitoring locations.

Flowmeter No. 9 was placed just upstream from the City's WRF, where it captures all influent flows to the facility. However, the average daily flows did not match those that were recorded by the WRF influent flowmeter during the same time period. It is suspected that there was a problem with the temporary flowmeter or recording setting on the data logger, which caused the discrepancy. For this reason, the City's flowmeter was used to establish the current total flow of the system. The data corresponding to the City's flowmeter is also shown in Table 2.11.

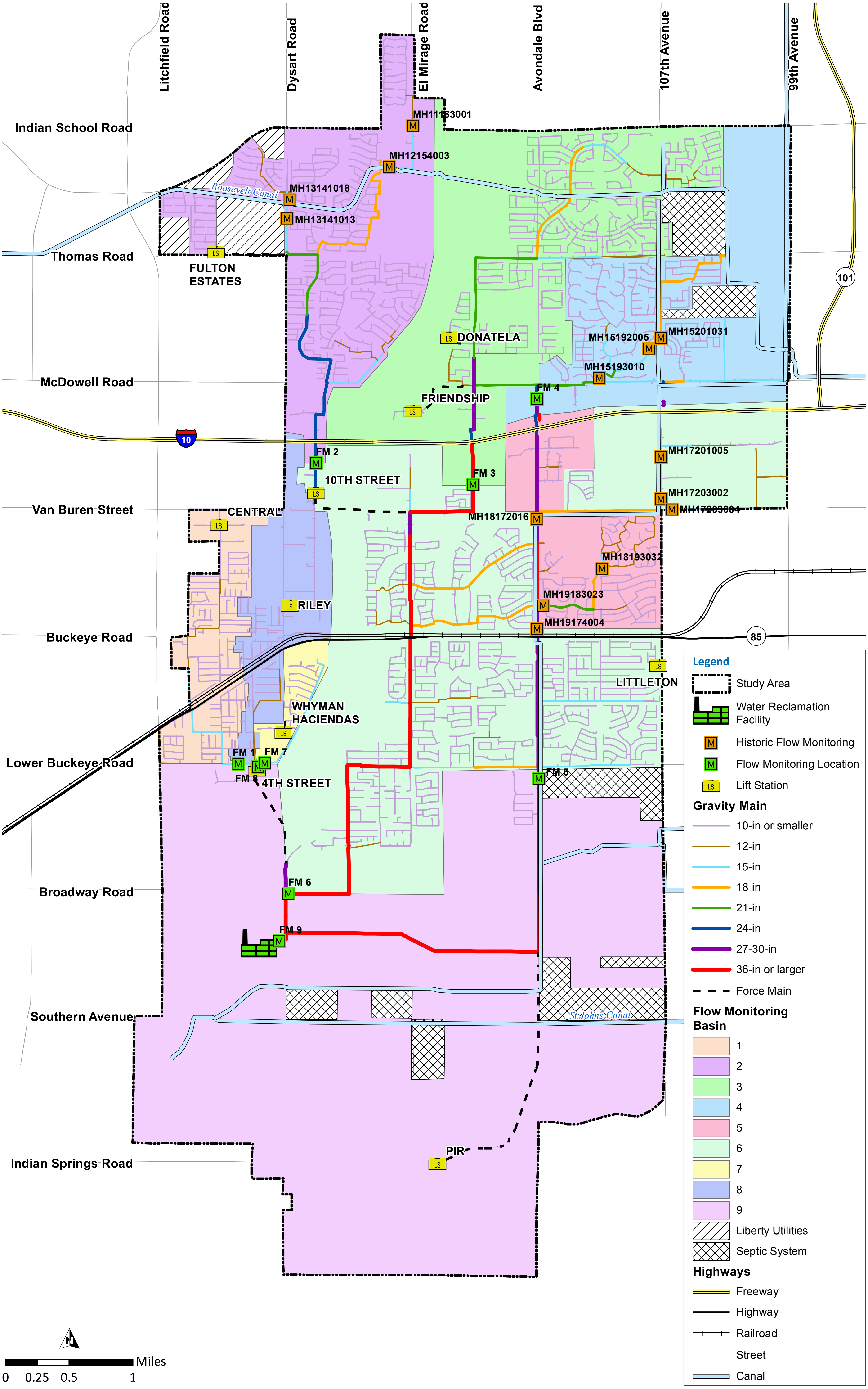

Figure 2.5 Flow Monitoring Basins and Meter Locations

Table 2.11 Flow Monitoring Results

Flowmeter	Start Date	End Date	Average Daily Flow (mgd)	Peak Hour Flow (mgd)	Peak Hour to Average Daily Flow
1	3/29/2017	5/18/2017	0.42	0.74	1.8
2 (1)	3/31/2017	5/22/2017	1.35	2.21	1.6
3	3/30/2017	5/17/2017	0.83	1.79	2.2
4	3/29/2017	5/19/2017	0.50	0.84	1.7
5	3/30/2017	5/18/2017	0.58	1.01	1.7
6	3/30/2017	5/11/2017	4.07	9.03	2.2
7	3/31/2017	5/16/2017	0.08	0.19	2.4
8	3/31/2017	5/17/2017	1.14	2.78	2.4
9 (2)	4/3/2017	5/16/2017	4.67	7.44	1.6
WRF	4/3/2017	5/16/2017	5.72	8.86	1.5

Notes:
(1) Flow meter data collected at this location has some unresolved anomalies and did not correlate well with the flow monitoring data collected by the City in 2016 at sites MH-11163001, MH-12154003, MH-13141018, and MH-13141013.
(2) Average daily flows recorded at flowmeter No. 9 did not correlate to the City's WRF influent flowmeter. It is suspected that an equipment problem with the temporary meter caused the discrepancy.

Table 2.12 Wastewater Flow Monitoring Data Collected in 2016

Manhole	Approximate Address	Flow Monitor Begin	Flow Monitor End	Average Daily Flow (gpm)	Peak Flow (gpm)	Peaking Factor
MH17201005	824 N 107th Ave.	4/15/2016	4/22/2016	35.4	238.5	6.7
MH17203002	386 N 107th Ave.	4/15/2016	4/22/2016	24.0	160.3	6.7
MH17203004	10609 W Van Buren St.	4/15/2016	4/22/2016	34.2	266.3	7.8
MH18172016	2900 N Avondale Blvd.	4/15/2016	4/22/2016	102.1	214.0	2.1
MH18193032	11060 W Jefferson St.	4/15/2016	4/22/2016	42.7	131.3	3.1
MH19183023	11434 W Maricopa St.	4/15/2016	4/22/2016	90.2	271.7	3.0
MH15193010	11027 W Almeria Rd.	9/22/2016	9/30/2016	233.6	415.2	1.8
MH15201031	1949 N 107th Ave.	9/22/2016	9/30/2016	114.2	216.7	1.9
MH15192005	Crystal Gardens Pkwy.	9/22/2016	9/30/2016	12.0	132.3	11.0
MH11163001 (1)	4127 N El Mirage Rd.	9/23/2016	9/30/2016	229.0	667.0	2.9
MH13141013 (1)	3121 N Dysart Rd.	9/23/2016	9/30/2016	47.0	81.4	1.7
MH12154003 (1)	3800 N El Mirage Rd.	9/23/2016	9/30/2016	28.8	113.0	3.9
MH13141018 (1)	13098 W Flower St.	9/23/2016	9/30/2016	9.0	37.3	4.1
MH19174004	1148 S Avondale Blvd.	9/23/2016	9/30/2016	562.8	916.5	1.6

Notes:
(1) Flow monitoring data collected at these locations in 2016 did not correlate well with the Basin 2 flow monitoring data collected for the 2018 IUMP.

2.3.1.3 Land Use Unit Wastewater Flows

Unit wastewater flows were developed using the results from the flow monitoring studies, the estimate of currently developed acreage from the land use plan, and the unit water demands described previously. The unit wastewater loads were calculated by estimating the wastewater generation rates (or "water to wastewater" factors) for each land use type. The percent water to wastewater values were adjusted to obtain unit loads that provided a reasonable prediction of the observed flow rates. The end result is a set of unit wastewater flows by land use type for the entire system.

Table 2.13 summarizes the unit wastewater flows by land use type. The acreages for each flow monitoring basin and a comparison of the land use predicted flows with the average daily flows from the flow monitoring field test are included in Appendix B.

Table 2.13 Unit Wastewater Flows by Land Use

Land Use Category	Unit Water Demand (gpad)	Wastewater Generation Rate (%)	Unit Wastewater Flow (gpad)
Rural Low Density Residential	72	35	25
Estate/Low Density Residential	361	35	126
Sports & Entertainment	1,476	45	664
Medium Density Residential	903	40	361
City Center (1)	2,712	60	1,627
Historic Avondale	2,888	50	1,444
Medium – High Density Residential	1,444	50	722
High Density Residential	7,220	60	4,332
Urban Commercial	4,535	60	2,721
Mixed Use	4,725	60	2,835
Urban Residential	10,830	0	0
Local Commercial	1,850	60	1,110
Open Space & Parks		-	-
Open Space – Irrigation	2,300	0	0
Freeway Commercial	1,300	75	975
Business Park	1,300	60	780
Education	1,100	60	660
Industrial	1,000	60	600
Public / Civic	1,100	60	660
Corporate Park	1,000	60	-
Gila River Scenic District	1,300	60	780
High Intensity Office	1,300	60	780
Office / Professional	1,000	60	600

2.3.2 Current Wastewater Flows

The unit wastewater flows shown in Table 2.13 were used to calculate the 2016 average annual daily flow (AADF) using an estimate of currently developed acreage in the City's Land Use Plan that contributes flow to the wastewater system. Areas served by septic systems have different acreages from the acreages used to compute the 2016 average annual water demand.

In flow monitoring basin No. 2, the Medium Density Residential unit factor developed for the system appears to have under predicted the observed flows. A review of the historical flow monitoring data for this basin collected prior to the IUMP by the City indicated that the Medium Density Residential unit wastewater flow could be as much as twice the value used for the entire system (361 gpad). An adjustment factor was applied to flow monitoring basin No. 2 for the purposes of computing a mass balance for the system. Table 2.14 summarizes the 2016 predicted wastewater flows by land use. Without the adjustment factor for flow monitoring basin No. 2, the predicted flows are 5 percent less than the 2016 actual flows. With the adjustment factor, the Land Use Plan-predicted flows are less than 3 percent different than the 2016 actual flows.

Table 2.14 Land Use Predicted Wastewater Loads for 2016

Land Use Category	Unit Wastewater Flow (gpad)	2016 Developed Acres [(1)]	Average Daily Wastewater Flow (gpd)
Rural Low Density Residential	25	-	-
Estate/Low Density Residential	126	88	11,000
Sports & Entertainment	664	-	-
Medium Density Residential	361	4,915	1,774,000
City Center	1,627	57	93,000
Historic Avondale	1,444	113	163,000
Medium – High Density Residential	722	228	165,000
High Density Residential	4,332	263	1,138,000
Urban Commercial	2,721	53	144,000
Mixed Use	2,835	124	351,000
Urban Residential	-	-	-
Local Commercial	1,110	309	343,000
Open Space & Parks	-	1,721	-
Open Space – Irrigation	-	70	-
Freeway Commercial	975	215	209,000
Business Park	780	337	263,000
Education	660	369	244,000
Industrial	600	106	63,000
Public / Civic	660	51	34,000
Corporate Park	-	-	-
Gila River Scenic District	780	-	-
High Intensity Office	780	-	166
Office / Professional	600	21	13,000
Total		**9,040**	**5,008,000**
Basin No. 2 Adjustment			432,000
Total Estimated 2016 Wastewater Flow			**5,440,000**
2016 Actual Average Daily Wastewater Flow at WRF			5,600,000
Percent Difference			**-3%**

Notes:
(1) Vary from "2016 acres" for water system because some areas in the City are served by septic systems.

2.3.3 Wastewater Flow Projections

Wastewater flow projections were developed by applying the wastewater generation rates in Table 2.13 for each land use category to the water demand projections for each planning year. Table 2.15 summarizes the wastewater flow projections.

Table 2.15 2018 IUMP Wastewater Flow Projections

Planning Period	Average Daily Water Demand (mgd)	Average Daily Wastewater Flow (mgd) [1]
2017	12.7	5.8
2023	13.5	6.2
2028	14.2	6.5
Buildout [2]	26.1	12.0
Buildout with Conservation [3]	20.9	9.6

Notes:
(1) Estimated wastewater generation rate is 46% of water demand.
(2) Calculated to be 450 gpd/DU.
(3) Assumes 360 gpd/DU due to conservation. The 46% wastewater generation rate was maintained although practically this rate could increase if more outdoor than indoor conservation in achieved.

2.4 Reclaimed Water Flow Projections

Reclaimed water flow estimates are calculated as a percentage of the wastewater flow that is generated. The City provided wastewater influent and effluent data from January 2013 through December 2016. The monthly average influent to effluent ratio was 0.93, meaning 93 percent of the wastewater influent is available as reclaimed water flow. The remaining 7 percent is accounted for as a loss in the solids handling process. The 12-month rolling average influent to effluent ratio was 0.92. Figure 2.6 illustrates the measured monthly reclaimed water generation values as a percentage of wastewater flow. Several months have values above 100 percent, which could be a result of meter inaccuracies.

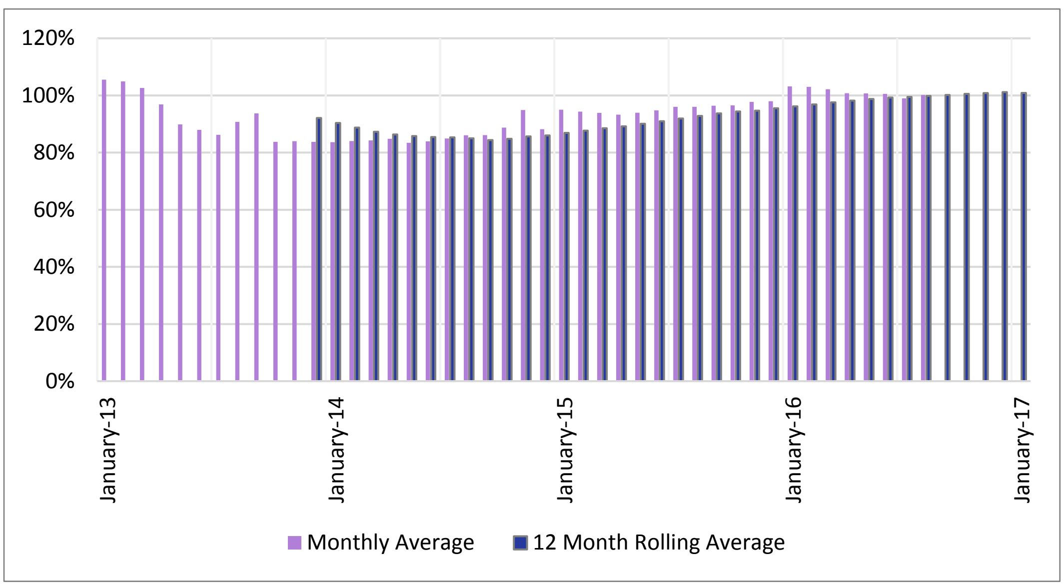

Figure 2.6 Avondale WRF Effluent as a Percentage of Influent

Table 2.16 summarizes the reclaimed water flow projections for each planning year.

Table 2.16 2018 IUMP Reclaimed Water Flow Projections

Planning Period	Wastewater Flow (mgd) (1)	Reclaimed Water Produced (mgd) (1)	Reclaimed Water Produced (AFY) (1)
2017	5.8	5.4	6,080
2023	6.2	5.8	6,400
2028	6.5	6.0	6,710
Buildout (2)	12.0	11.2	12,500
Buildout with Conservation (3)	9.6	8.9	10,000

Notes:
(1) Estimated reclaimed water generation rate is 93% of wastewater flow.
(2) Calculated to be 450 gpd/DU.
(3) Assumes 360 gpd/DU due to conservation. The 46% wastewater generation rate was maintained although practically this could increase if more outdoor than indoor conservation in achieved.

2.5 Reclaimed Water Uses

The majority of the reclaimed water generated at the Avondale WRF is recharge at the City's McDowell Road Recharge Facility. This facility is currently permitted to recharge 20,000 acre-feet per year (AFY), and can also accept Salt River Project (SRP) and Central Arizona Project (CAP) water. However, the City currently recharges only reclaimed and SRP water at this facility.

A relatively small amount of water (~460,000 gpd) is reused directly at the Avondale WRF for miscellaneous treatment processes. The majority of this water is recirculated through on-site pipes at the WRF. The Avondale WRF reclaimed water is class B+, which does not allow for residential landscape irrigation.

2.6 Buildout Reclaimed Water Generation Rates

The City's current reclaimed water generation rate is based on wastewater flows, which are a percentage of the total water demand. As the City continues to grow, it is expected that the amount of reclaimed water produced will also increase. Water conservation will have an impact on the percentage of water demand that becomes wastewater flow, and consequently reclaimed water that is produced. If future water conservation efforts target outdoor water use, the percentage of wastewater and reclaimed water generated as a unit of water demand will increase. Therefore, the values shown in Table 2.16 for reclaimed water generated at Buildout with Conservation are conservative in that they do not assume an increased water to wastewater generation percentage. If the City were to reduce water demands to 360 gpd/DU entirely through outdoor water conservation, the volume of reclaimed water generated at buildout would be the same as without conservation, or 11.2 mgd (12,500 AFY).

Chapter 3

WATER RESOURCES AND RECLAIMED WATER MASTER PLAN

3.1 Introduction

This chapter presents the water resources and reclaimed water master plans for the 2018 Integrated Utility Master Plan (2018 IUMP) Update. The City of Avondale actively manages its water supplies to provide its citizens with safe, reliable water service while promoting water conservation and long-term sustainability. The City has acquired a diverse portfolio of surface water, groundwater, and reclaimed water that provides a robust water supply during both normal and drought years. This water portfolio will enable Avondale to continue to grow and foster economic development throughout its service area in the future.

3.2 Regulatory and Institutional Framework

The State of Arizona water laws and regulations have been developed and enacted over the past several decades to achieve safe yield with respect to groundwater use, and to provide for and promote orderly utilization of the State's renewable water resources. The laws governing water rights and water utilization in the State of Arizona are complex, but necessary to protect and efficiently manage this valuable resource. There are a myriad of rules, regulations, court decisions, and other legal agreements that govern the quantity of water available to Avondale, how it can be conveyed to the City, and how and where it can be used. It is important to understand the legal and institutional issues that form the basis for water use in Avondale as the City looks to protect its current water supplies, and plan for acquisition of future water supplies to serve growth.

Arizona water law has a bifurcated system of water rights such that groundwater is managed under the 1980 Groundwater Management Act (GMA), and surface water rights are managed under the prior appropriation system. The following sections summarize and highlight some of the key components of several regulations and institutional constraints that are important to water resources planning for the City. Since these brief regulation summaries are interpretations, the City is encouraged to rely on official regulatory language and legal interpretation when implementing management strategies.

3.2.1 1980 Groundwater Management Act

Prior to 1980, many cities, private water companies, and other water users, that depended on groundwater supplies, observed declining groundwater levels. The Arizona State Legislature determined that the continued decline of groundwater levels threatened the economy and welfare of the State. To reverse this trend, the Legislature passed the GMA or Groundwater Code, which is intended to regulate the use of groundwater to maintain a balance between withdrawal and natural and artificial recharge. This balance is referred to as "Safe Yield."

The GMA created four initial "Active Management Areas" (AMAs) in locations that were experiencing severe groundwater overdraft, and were potentially at risk for continued declining groundwater levels with existing and projected urban growth. Avondale is within the Phoenix AMA. The primary management goal of the Phoenix AMA is to reach safe yield of groundwater use by 2025.

The GMA has five primary provisions that apply to Avondale and the Phoenix AMA:

1. Establishment of a program of groundwater rights and permits.
2. Preparation of five water management plans for each AMA that includes mandatory conservation requirements.
3. Development of a program that demonstrates an assured water supply for new growth.
4. Metering and measuring water pumped from all large wells.
5. Reports of annual water withdrawal and use.

The GMA established rights pertaining to groundwater pumping within an AMA. These rights included:

Service Area Rights – allowing water providers (Avondale) to withdraw and transport as much groundwater as required within their service area boundaries to serve the needs of their customers. Service area rights are unique in that they have the ability to be expanded, and they are the only groundwater right that can still be created within an AMA. There are specific procedures for expanding/extending existing service area rights, and for establishing new or "satellite" service areas.

Irrigation Grandfathered Rights (IGFR) – a right to use groundwater to irrigate specific land areas, which must have been irrigated between 1975 and 1980. Upon development by a City, the water right is converted to a Service Area Right.

Type 1 Non-Irrigation Grandfathered Right – a right to use groundwater for irrigation on lands permanently retired from farming and converted to non-irrigation use after January 1, 1965, but prior to the date of designation of the AMA. A Type 1 right has the right to withdraw 3 acre-feet (AF) of groundwater per acre per year. Unlike Type 2 Rights, Type 1 Rights cannot be transferred to other lands.

Type 2 Non-Irrigation Grandfathered Right – groundwater that was being legally withdrawn and used for non-irrigation purposes in any of the five years prior to the date of the AMA designation. The right is based on historical pumping of groundwater for a non-irrigation use and equals the maximum amount of water pumped in any one year between 1975 and 1980. Type 2 rights can be transferred for use on other tracts of land.

These groundwater right provisions are particularly important to Avondale as it extends its service area in the future.

3.2.2 Assured Water Supply (AWS)

The Assured Water Supply (AWS) program was instituted as part of the 1980 GMA, and was strengthened with the adoption of the AWS rules in 1995. Under these rules, persons wishing to develop lands within an AMA must demonstrate that sufficient renewable water supplies are available to meet the proposed new development's demands for 100 years. Only after a sufficient renewable supply is demonstrated can a developer record plats, subdivide land, or sell lots.

An AWS can be demonstrated through either a Designation of Assured Water Supply (DAWS) or through a Certificate of Assured Water Supply (CAWS). A DAWS is issued to and applies to a water provider with a defined service area. All residential subdivisions, commercial development, or new connections to the provider's water system within the service area are deemed to have an assured water supply when the water provider has a DAWS. A DAWS must be renewed every 15 years. However, it can be renewed at any time if a water provider wishes to amend its service area or update its water supply portfolio or demand projections.

A CAWS is issued to and applies to a single residential or commercial development with a legal description located in an area where the water provider does not have a DAWS. In these cases, developers must demonstrate directly to the Arizona Department of Water Resources (ADWR) that the requirements of an AWS have been met. It may be necessary for the development to enroll in the Central Arizona Groundwater Replenishment District (CAGRD) as a Member Land, to demonstrate consistency with the management goal of the AMA. If and when approved, ADWR then issues a CAWS for the development as platted. Any changes to development densities, lot counts, or irrigated areas would require a new CAWS. Once a CAWS is issued and the area is developed, the CAWS stands in perpetuity and does not need to be renewed.

Some of the requirements necessary to prove an Assured Water Supply for both the DAWS and CAWS programs include:

1. Sufficient water supplies must be physically, legally, and continuously available for a 100-year period.
2. The water provider must have financial capability to install the required facilities.
3. The quality of the water sources must meet Arizona Department of Environmental Quality (ADEQ) requirements.
4. Uses of the water must be consistent with the Management Goal of the AMA.
5. Uses of the water must be consistent with the water provider's conservation requirements of the Management Plan of the AMA.

Prior to 1995, a municipal water provider in an AMA needed only to demonstrate physical availability of water supplies to establish a service area right. The requirements to demonstrate legal and continuous availability of water supplies for 100 years as well as consistency with the management goals of the AMA were not in place until the AWS rules were adopted in 1995.

The City of Avondale has a DAWS and is therefore a “Designated” water provider. The City’s DAWS was most recently modified in 2008 and was approved on September 29, 2010.

The AWS Rules limit the amount of groundwater a municipal provider may withdraw "consistent with the management goal" of the AMA. The volume of groundwater a provider may withdraw is determined from several components and is recorded in the provider's "Groundwater Allowance Account." The initial, or "Phase-In," groundwater allowance is computed by multiplying 7.5 times the total volume of water provided by a DAWS applicant to its customers from any source during calendar year 1994 (Arizona Administrative Code [A.A.C.] R-12-15-724(2)). The amount of allowable groundwater use can be increased by an incidental recharge factor which is calculated as a percentage of water use and increases as water use increases. The groundwater allowance may be increased by credits obtained by the extinguishment of IGFR water rights. A provider may also increase its allowable groundwater pumping by becoming a member service area of the CAGRD.

3.2.3 Central Arizona Groundwater Replenishment District

In 1990, the State Legislature authorized legislation to establish Groundwater Replenishment Districts for the purpose of replenishing groundwater that is pumped in excess of safe yield. The CAGRD, which is a division of the Central Arizona Water Conservation District (CAWCD), was established in 1993 under different legislation with voluntary membership. The purpose of CAGRD is to provide a mechanism for landowners and water providers to demonstrate an AWS under the AWS rules. The CAGRD recharges unused Central Arizona Project (CAP) water, or other renewable water supplies, in order to offset groundwater pumping by its members. CAWCD owns and operates a number of underground water storage facilities including the Agua Fria, Hieroglyphic Mountains, Tonopah Desert, and Superstition Mountains projects in which CAGRD stores water.

The City of Avondale has enrolled in the CAGRD as a Member Service Area (MSA), but has not as yet had to rely on the CAGRD to replenish groundwater. As all of the City's wells are permitted as recovery wells, and as long as the City continues to recharge sufficient renewable supplies (i.e., surface water or reclaimed water) to offset the amount of groundwater pumped each calendar year, it will not be required to pay replenishment fees to the CAGRD. The City does not yet pay annual membership dues to the CAGRD because current projections do not show a need for CAGRD replenishment.

3.2.4 Underground Water Storage and Savings

In 1986, the State promulgated the Artificial Recharge and Underground Storage and Recovery Act (RUSRA) to regulate recharge, storage, and recovery of all classes of water. The RUSRA allows renewable supplies to be recharged and stored underground to meet future demands, and encourages the use of excess renewable supplies, such as CAP water and reclaimed water, that would otherwise remain unused.

Underground storage and recovery (US&R) projects are facilities where water is recharged with the expectation of recovering it for future use. Underground storage projects involve two types of permits, namely the Underground Storage Facility (USF) Permit and the Water Storage (WS) Permit. The USF permit regulates the "how" of underground storage, and the WS permit is issued for the purposes of accruing credits. The USF has two types of physical facilities, namely constructed and managed. Constructed facilities include facilities that are actually built such as spreading basins, infiltration trenches, injection wells, and vadose zone wells. The managed facility permit governs when water is discharged to a natural stream and water is allowed to infiltrate through natural processes.

The Act was amended in 1990 to include provisions for a third type of recharge identified as groundwater savings facilities (GSF). Using a GSF is an "indirect" method of recharging which allows a water provider to deliver reclaimed water or CAP water for use by another party such as an agricultural irrigation district in lieu of pumped groundwater. The water provider gains storage credits for the amount of water not pumped by the irrigation district. Initially, unlimited credits could be obtained. However, the law was modified to allow only that water used by agricultural irrigators in excess of their own CAP allocation to be counted as credits.

An amendment to the RUSRA was added which established "annual storage and recovery (AS&R)" accounts. This addition to the RUSRA allows for the use of recharge facilities and wells to store and recover water on an annual basis without having to construct costly treatment and conveyance facilities. Water stored on an AS&R basis must be recovered in the same calendar year as it was stored.

Water stored in these types of underground storage facilities requires a recovery well permit in order to recover the stored water credits. An existing well may be permitted as a recovery well provided that it is demonstrated that other wells in the vicinity will not be harmed by the recovery of the stored water. The water recovered from the well retains the identity of the water when it was stored.

Avondale currently recharges all of its reclaimed water at the City's McDowell Road Recharge Facility. This Facility is also used to store Salt River Project (SRP) water on a monthly basis. The City also owns recharge capacity in the New River Agua Fria River Underground Storage Project (NAUSP) and both the Hieroglyphic Mountain and Agua Fria Constructed recharge facilities operated by CAWCD.

3.3 Existing Water Supplies

The City of Avondale has a diverse water resources portfolio consisting of surface water supplies from the Salt and Verde Rivers within Arizona, and from the Colorado River. Avondale also owns and operates numerous potable groundwater production wells. Avondale utilizes 100 percent of its reclaimed water supply, primarily for recharge to offset groundwater pumping and accrue long-term storage credits for drought protection although the City does have some limited non-potable reuse at the Wolf WRF for process water.

The following water resources are the major components of Avondale's existing water resources portfolio, each of which is discussed in subsequent sections:

1. Salt River Project (SRP);
2. Colorado River Supplies consisting of the Central Arizona Project (CAP) Municipal and Industrial (M&I) allocation, and the White Mountain Apache Tribe (WMAT) lease;
3. Groundwater that can be legally pumped consisting of a "Phase-In" groundwater allowance, and an Incidental Recharge allowance as determined by the ADWR, and primarily annual recovery of same year SRP or CAP recharge (AS&R);
4. Reclaimed water consisting of direct, non-potable reuse, and recharge; and
5. Long-term storage credits derived from recharge of reclaimed water and CAP water.

The yield and delivery capability of each of Avondale's water resources is impacted by the following conditions:

1. Hydrologic/climatologic effects, i.e., drought impacts and climate change;
2. Institutional restrictions on the location of use;
3. Location of service area demand in relation to source delivery; and
4. Capacity of infrastructure to deliver the resource.

Figure 3.1 shows the water right jurisdictions within Avondale's planning area. The SRP area is referred to as "on-project" lands with SRP water supplies being appurtenant to those lands. A substantial portion of Avondale's planning area is not part of the SRP service area, and these lands are considered "off-project" lands and must be served with other water supplies such as CAP water or reclaimed water credits.

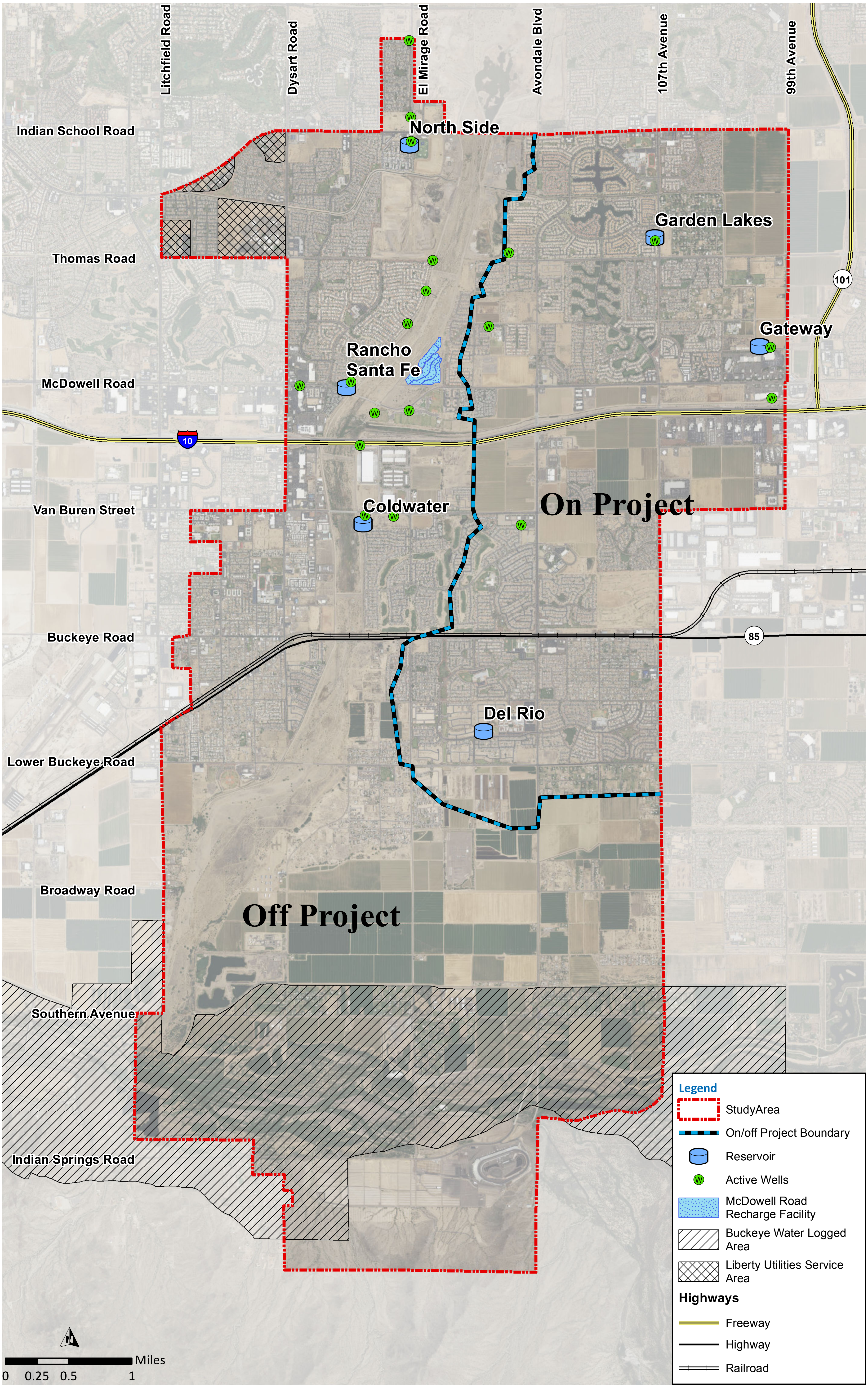

Figure 3.1 Water Rights Service Areas

3.3.1 Salt River Project

The SRP water supplies are delivered to the City of Avondale through the Arizona Canal, and are available for use only On-Project, or lands that were originally part of the Salt River Valley Water Users Association. Rights to SRP water are appurtenant to certain lands with the SRP District, and with few exceptions, the right stays with the lands, thus "On-Project."

The Water Delivery and Use Agreement (WDUA) between SRP and Avondale governs the municipality's access to water supplies controlled or stored by SRP. Based on the ADWR AWS requirements, the WDUA between Avondale and SRP is considered a long-term supply.

The SRP provides the following:

- Normal flow water
- Stored water
- Developed water
- Pump rights

SRP's water allocation is typically 3 acre-feet per acre (AF/ac), which is comprised of a mix of surface water and groundwater. The amount of eligible land "cut over" to Avondale also varies from year to year. However to assist with these estimates, SRP provides the municipalities with an annual Water Entitlement Report, which defines water availability under varying supply scenarios. SRP also announces the surface water/groundwater allocation mix each year for the following calendar year. SRP's 9/6/2017 Water Entitlement Report for Avondale shows that 6,785 acres are planned to be cut over to Avondale at buildout, 4,691 acres are cut over currently.

3.3.1.1 Normal Flow

Normal flow is water that would normally flow in the Salt and Verde Rivers and is distributed to Class A or normal flow only lands within the SRP service area. Normal flow is river water that would have been available to Class A member lands if there were no upstream dams and reservoirs. The normal flow assessment is based on historic flow records and is based upon the year that the lands entered into cultivation, and then calculated using a formula contained in the Kent Decree. According to the 9/6/2017 SRP report, Avondale is entitled to receive 3,109 acre-feet per year (AFY) of normal flow water from SRP during "normal" water year in 2017 and 5,045 AFY of normal flow water during a "normal" water year at buildout. During "dry" years, there is 554 AFY of normal flow water available to Avondale in 2017 and 1,150 AFY of normal flow available at buildout. Normal flow calculation is based upon the date the lands became eligible to receive water, which creates some uncertainty as to how much water is available from year to year. Due to this uncertainty, and to be conservative, normal flow water is not included in Avondale's water resource portfolio.

3.3.1.2 Stored Water

Stored water is surface water from the Salt and Verde watersheds that is stored in one of the six reservoirs operated by SRP and delivered through SRP's canal system. Stored water is distributed to SRP member lands on a per-acre basis. As of 2017, there are 4,691 acres of SRP member lands that have been "cut over" to Avondale, meaning these lands have been urbanized, and Avondale is delivering SRP water to the member land, rather than the individual landowners taking delivery and paying the assessments. The future potential cut over acreage at buildout is estimated at 6,785 acres, not including urban irrigation acres. However, because the SRP water must be used on-project, the water Avondale receives from SRP for the urbanized acreage must be distributed to these lands.

3.3.1.3 Developed Water

Developed water is groundwater pumped and delivered by SRP. This water is either directly delivered to Avondale's potable water system from SRP wells, or it is groundwater pumped into the Arizona Canal where it is commingled with stored water for delivery. Like stored water, developed water is distributed to SRP member lands on a per-acre basis.

An important point to note is that the SRP groundwater component of the total SRP allocation delivered to Avondale is reported to ADWR as groundwater pumped, which must be offset with renewable supplies. For this reason, Avondale avoids using developed water.

3.3.1.4 Pump Rights

Pump rights are similar to developed water in that it is groundwater pumped and delivered by SRP. As of 2017, Avondale is currently entitled to 4,846 AFY of pump rights, which is anticipated to increase to 7,544 AFY at buildout. Pump rights are reported to ADWR as pumped groundwater and must be offset with renewable supplies. Avondale participates in the Credit Recovery Program with SRP, which allows all water pumped from SRP wells to be offset with recharged water credits.

3.3.1.5 Operational Considerations

The standard allocation of stored and developed water to member lands, and the basis upon which assessments are paid, is 2 AF/ac. In a normal watershed year, SRP provides an additional 1 AF/ac of stored and developed water, for a total delivery of 3 AF/ac. In a high water year, SRP provides an additional 0.25 AF/ac beyond the normal year allocation, for a total delivery of 3.25 AF/ac. The amount of stored and developed water provided by SRP in all water years can vary from year to year. Although the City generally takes delivery of only the surface water portion of their SRP entitlement to avoid pumping groundwater and the consequent replenishment requirements, it is important to acknowledge the City's total water right with respect to meeting on-project demands.

For the purposes of this report, it is assumed SRP will provide 2 AF/ac of surface water in a normal water year, which can be delivered to member lands. It is estimated that the 2 AF/ac surface water supply is sufficient to meet on-project demands at buildout in normal water supply years.

Annually, SRP takes the Arizona Canal out of service for maintenance for one month during the winter, typically in January. Avondale's water supply portfolio and infrastructure must take SRP's canal dry-up into account. From time to time, the CAP Canal may also be taken out of service for routine maintenance during the winter. SRP and CAP coordinate so that the canal outages will not occur at the same time. This coordination could result in the shifting of the SRP dry-up month, but it still occurs in the winter months when water demand is reduced.

3.3.1.6 Drought Yield Implications

The recent prolonged drought conditions in the southwest have heightened awareness of drought impacts to surface water supplies. In 2003 and 2004, SRP reduced its annual shareholder allocation to a maximum of 2.0 AF/ac, with the majority of the allocation consisting of developed water (groundwater), rather than surface water.

During these shortage years, SRP purchased 100,000 AF of excess CAP water, which was used to support its 2.0 AF/ac allocation. However, as CAP subcontractors continue to increase their use of their CAP entitlement water, excess CAP supplies are not as readily available to supplement shortage conditions. It is uncertain how future shortage scenarios will be configured by SRP, but the supply delivered will most likely be met by a greater delivery of groundwater water and less delivery of surface water.

3.3.2 Central Arizona Project

The CAP is designed to deliver approximately 1.5 million acre-feet (MAF) of Colorado River water annually to central and southern Arizona. The estimated annual water supply available for delivery from the CAP in normal water years is 1.415 MAF. A total of 555,801 AF has been contracted by M&I entities, 462,801 AF are committed to Native American Communities, and 22,521 AF are under contract for agricultural purposes

Currently, Avondale has a subcontract for 5,416 AFY of M&I priority CAP water. In addition, Avondale has a pending lease with the WMAT for 882 AFY of CAP water (242 AF Indian priority, 640 AF Non-Indian Agriculture priority). These supplies may be used anywhere within the City's service area.

Presently, Avondale does not treat and directly deliver their CAP supplies. Use is either through annual storage and recovery or recharge for long term storage credits. Avondale is currently working with the City of Phoenix to develop an agreement that would enable Avondale's CAP water to be delivered and treated at a City of Phoenix water treatment plant and then delivered through an distribution system interconnect. Infrastructure alternatives for a City of Avondale/City of Phoenix interconnect will be presented in a later technical memorandum.

3.3.2.1 Operational Considerations

CAP water can be ordered year-round, although the CAWCD has a policy that limits a subcontractor to 11 percent of their total annual CAP supply delivered per month. Since the CAP is not operating at full capacity yet, this peak delivery rate has not been strictly enforced. While it is not known if and when the peak limit will be enforced, it is prudent for Avondale to assume that it will, and to plan accordingly.

The CAP system is an interruptible supply and outages are possible as a result of failures and outages for periodic maintenance. While shutdowns have not occurred, the CAP has indicated that in the future, short dry-ups are anticipated every two to three years for maintenance purposes. In those years when a CAP outage is scheduled, the CAP dry-ups would occur during the November to March time period, and would be coordinated with SRP so the outages would not occur at the same time. Outages occurring during other months would require additional well capacity/pumping and/or water use restrictions.

As the City of Avondale works with the City of Phoenix to develop an Inter-governmental Agreement (IGA) for CAP water deliveries, peak delivery rates and deliveries during scheduled CAP canal outages should be established within the agreement so that Avondale can make appropriate plans to deliver water to its customers consistently throughout the year.

3.3.2.2 Drought Yield Implications

Due to drought and over-allocation of the Colorado River resources, shortages to the CAP water supply are expected to occur in the future. Under normal year conditions, the CAP is expected to be able to deliver 1.5 million acre-feet per year (MAFY) to the subcontractors. During times of a moderate shortage (20 percent cut back with a 10 - 40 percent probability of occurrence), the CAP is expected to be able to deliver about 1.0 MAFY. However under a severe shortage condition (50 - 55 percent cut back, with a low probability of occurrence), the CAP is expected to be able to deliver only about 0.6 MAFY. The M&I subcontractor's water supply will not be affected until a shortage on the Colorado reaches 600,000 AFY.

Recent drought conditions have increased the awareness of the impact of future potential drought conditions on the long-term water supply availability to M&I users. However, a combination of reservoir operating guidelines, storage criteria agreements, and water banking arrangements may reduce the potential for severe shortage impacts to M&I users.

Based on studies by the United States Bureau of Reclamation (USBR) and CAWCD, Colorado River supply conditions should result in normal water supply yields for the near future. This expectation is based on modeling results of the Upper Colorado River Basin and demand patterns within Arizona. Shortage conditions that could occur in the next 10 - 20 years could potentially impact Avondale's water resources and infrastructure planning.

In 1996, the Arizona Water Bank Authority (AWBA) was created to store underground the unused portion of Arizona's share of the Colorado River water. The AWBA is in the process of storing unused CAP water for the following purposes:

- Firming a percentage of subcontracted amounts in times of shortages or disruption of the CAP system,
- Meeting the management plan objectives of the Arizona Groundwater Code,
- Assisting in the settlement of Native American water right claims, and
- Exchanging water supplies to assist Colorado River communities.

In January 2014, a draft report by the AWBA, ADWR, and the CAP was released entitled "Recovery of Water Stored by the Arizona Water Banking Authority". This report outlined strategies for firming M&I subcontractors, which included direct recovery, indirect recovery and credit exchange methods for providing the firming coverage. Shortage amounts and timing of these shortage conditions are also discussed based on recent Colorado River modeling studies. In general, the report stated that shortages to the Non-Indian Agriculture (NIA) water priority might impact users by about 2025. Also, the modeling suggested that shortages to the M&I contract might not occur until about 2035. For shortages to the M&I priority pool, the AWBA will distribute credits provided the following conditions exist:

- AWBA has credits available to firm the supply;
- CAP's recovery schedule is consistent with statutes, rules and policies;
- Credits will be used to benefit the county for which they were accrued; and
- The shortage to the M&I priority pool is less than 20 percent.

Water supply delivery strategies for Avondale are assessed under varying water supply yields resulting from various drought scenarios, including a moderate (30 percent cutback) and severe (50 percent cutback) drought conditions.

3.3.2.3 CAP Non-Indian Agriculture Water

NIA water priority subcontracts are the lowest priority or most junior water right associated with the CAP supplies. If a shortage is declared on the Colorado River, agricultural priority water will realize a 100 percent cut in supply before the municipal supplies would be affected. Because NIA water is the most susceptible to shortage, the Bureau of Reclamation has recommended to ADWR that about 70 percent of NIA water supply can be deemed firm in order to be used for AWS purposes. A portion of Avondale's 882 AFY WMAT lease is composed of NIA priority water. Of the total lease, 640 AFY is considered NIA priority water, and is assumed to be firmed by AWBA when a shortage condition occurs.

The Arizona Water Settlement Act (AWSA) resulted in 96,000 AF of CAP NIA water to be reallocated. ADWR currently has reallocated about half of this supply. ADWR is expected to proceed with reallocating the remaining NIA supply by 2021. It is recommended that Avondale apply for a portion of the remaining NIA water. In years when it is available, the City can recharge it for long-term storage credits or have it directly delivered to customers via the proposed City of Phoenix interconnect. Each of these options would reduce the City's reliance on groundwater and allow the City to extend its water resources portfolio.

3.3.3 Groundwater

The AWS rules adopted by ADWR require that for a groundwater resource to be considered physically available, it must not cause the water table to drop below 1,000 feet below land surface over a 100-year pumping period. On September 29, 2010, Avondale received its DAWS renewal effective until December 31, 2025.

Avondale's allowable groundwater pumping is limited by Arizona's 1980 GMA, which includes the volume of groundwater in Avondale's AWS Groundwater Allowance Account. The account includes groundwater in the following categories:

- Groundwater allowance,
- Accrued incidental recharge, and
- Annual and long-term storage credits (LTSCs).

Annual and long-term storage credits are accrued by recharging renewable supplies (CAP and reclaimed water), which can be used to offset groundwater pumping that exceeds Avondale's allowable limit. All of Avondale's production wells are permitted as both service area and recovery wells, allowing legal recovery of recharge water that does not have to be replenished.

3.3.3.1 Operational Considerations

Avondale has developed, and continues to develop a number of groundwater production wells throughout its service area. Groundwater pumping is not subject to canal delivery limitations, seasonal dry-ups, or drought impacts in the same manner as surface water supplies, making groundwater production wells ideal for purposes of meeting peaking, standby, drought, and emergency needs.

Groundwater pumping off-project is an important supply in addition to surface water resources. Wells are permitted according to ADWR rules and regulations, which include annual withdrawal rate/volume limitations. The quality of the groundwater resource is also of concern to Avondale, particularly with regard to nitrates and arsenic. These water quality issues are addressed on a case-by-case basis.

On-project groundwater resources are plentiful, but can only be used on SRP lands unless off-project water is exchanged.

3.3.3.2 Drought Yield Implications

Groundwater pumping is conceptually drought proof, and is an excellent physical source during periods of reduced surface water yields. However, Avondale has expressed concern over the sustainability of physical groundwater supplied in certain regions of the service area. Some of the City's wells do not currently require treatment for total dissolved solids (TDS), nitrates, or arsenic. However, recent studies performed and data collected by the City indicate that future well supplies are likely to require treatment for these constituents and potentially others.

3.3.4 Reclaimed Water

The City of Avondale's water reclamation facility (WRF) produces Class B+ reclaimed water, which is either recharged to provide storage credits to offset groundwater withdrawals or is directly re-used on a limited basis (primarily WRF process water). Avondale beneficially uses 100 percent of the reclaimed water produced.

The majority of Avondale's reclaimed water is delivered to the City's McDowell Road recharge facility, which is currently permitted to allow 20,000 AFY recharge. The City also uses this site to recharge SRP water for monthly storage and recovery operations whereby recovery wells On Project are pumped to meet On Project demands.

3.3.4.1 Operational Considerations

The City's current reclaimed water management strategy hinges on the operation and performance of the McDowell Road Recharge Facility. This facility is adequately sized for the City's current needs, but there is potential for the ADWR to reduce (or expand) the recharge capacity in the future. USF permits are issued for 20 years and can theoretically be renewed in perpetuity. However, if hydrogeologic conditions change and the facility fails to perform up to its operating capacity, the City may be faced with a reduction in recharge capacity and no alternative recharge site for reclaimed water.

As the City grows it is prudent to have more than one option for reclaimed water recharge. The City could explore recharge wells (either vadose zone or injection wells), partnering with neighboring water providers to develop a regional recharge project or projects, or developing a second recharge project within the City.

3.3.4.2 Drought Yield Implications

Reclaimed water is highly reliable and is generally not impacted by drought. During water shortages it is common for outdoor use to be curtailed (i.e., landscape irrigation) but indoor use often remains relatively constant. However, if Avondale were to enact water use restrictions in response to a long-term drought or short-term emergency, it could potentially impact the City's reclaimed water supply.

3.4 Future Water Resources Planning Considerations

The focus of the 2018 IUMP was on the portion of the City north of the Estrella Mountains. The water resources evaluation presented later in this chapter shows that the City has sufficient water supplies to meet projected demands at buildout for this northern service area. As the City develops south of the Estrella Mountains, additional water resources will be required. The City should continue to pursue opportunities to acquire additional water resources to broaden the City's water portfolio and prepare for growth in the south. The following sections describe water resources planning considerations for the City to consider as it moves forward into the future.

3.4.1 Potential Additional Supplies

Since the City's last water resources master plan update, opportunities for acquiring additional renewable supplies have decreased and competition for those that are available is fierce. The extended drought on the Colorado River and recent projections within the next 5 to 10 years have led many water providers in the Phoenix AMA to acquire renewable water supplies through tribal water leases, reclaimed water exchanges, and water importation projects.

The following sections outline some of the opportunities to acquire renewable supplies that are available to Avondale.

3.4.1.1 CAP Lease or NIA Acquisition

If available, the City could lease CAP water from an Indian community that holds an entitlement. This approach is common and many water providers in the Phoenix AMA have entered into 100-year lease agreements with various Indian communities, some as recently as 2016. However, the available of large blocks of water to lease is very limited.

The ADWR is expected to allocate a second block of NIA water as early as 2021. Avondale should initiate discussion immediately with the ADWR to determine what volumes may be available to the City and apply to be considered for it. Although delivery of NIA water is less firm than M&I, in years when it is available, the City can make use of it through recharge or directly delivery, if and when a wheeling agreement is established with the City of Phoenix.

3.4.1.2 SRP Surface Water

The City's total SRP allocation will increase as on-project acres urbanize and are cut over to the City. The surface water portion of the City's SRP allocation is variable from year to year but the entire entitlement is significant as it provides a sufficient physical and legal supply to serve the on-project areas in Avondale. In fact, it is likely that the City's on-project supplies will exceed the on-project demands at buildout.

Table 3.1 summarizes the City's total SRP water supply potential at buildout based on the September 2017 Water Entitlement Report. In a Low water year, the City's total entitlement is 22,264 AF (19.9 million gallons per day [mgd]) and in a High water year, the City's total entitlement is 42,768 AF (38.2 mgd).

3.4.1.3 Imported Supplies

Avondale could investigate developing water from the Harquahala groundwater sub-basin and transporting it to the City. This type of project would require well development, pumping, transmission, storage, water treatment, and delivery to the City. The costs for this type of water demand project would be significant. If the City were to pursue a project such as this, it may be beneficial to partner with another west valley water provider to share in costs.

Table 3.1 SRP Water Supplies for Avondale at Buildout

Water Supply Component	Volumes by Water Year (AFY) (1)		
	Low (2)	Normal (3)	High (4)
Stored and Developed (Assessment)	13,570	13,570	13,570
Stored and Developed (Additional) (5)	0	6,785	8,481
Normal Flow (6)	1,150	5,045	13,173
Pump Rights (7)	7,544	7,544	7,544
Total	**22,264**	**32,944**	**42,768**

Notes:
(1) Assumes 6,785 acres cut to the City at buildout. Assumes all active agricultural acreage is cut over to the City. Does not include urban irrigation acres.
(2) Lower quartile Normal Flow with no additional stored and developed water.
(3) Median Normal Flow with 1.0 AF/ac additional stored and developed water.
(4) Mean Normal Flow with 1.25 AF/ac additional stored and developed water.
(5) Additional stored and developed water for normal and high cases are based upon the historic allocations for the period 1950 – 2017.
(6) Estimates of future Normal Flow availability are based on the historic inflow for the period 1950 – 2017.
(7) Additional groundwater that is available to those lands for which SRP shareholders purchased pump rights (up to 2.0 AF/ac), pursuant to contracts offered in 1929 and 1948. Amounts available to the City are prorated by the percent of eligible and non-eligible pump right lands.

3.4.1.4 Purchase Extinguishment Credits or Long Term Storage Credits

There are opportunities to purchase groundwater extinguishment credits on the open market, which can be used to meet legal replenishment requirements. Estimated rates to purchase extinguishment credits are approximately $50 - $100/AF. However, these credits can only be used once, and eventually there will be none remaining in the Phoenix AMA, therefore they do not provide a long-term solution for the City.

There are also opportunities to purchase LTSCs. As a designated water provider, the City is able to purchase CAP LTSCs from other water providers. In the near term, the cost to purchase CAP LTSCs may exceed the cost for the City to order and recharge an equal amount of CAP water that the City already has access to. The City should continue to monitor the market and opportunities to purchase LTSC in the Phoenix AMA in the future.

3.4.1.5 Buckeye Water Logged Area

The area community known as the Buckeye Waterlogged Area (BWLA) extends approximately 35 miles along the Gila River from the confluence of the Salt River to the Gillespie Dam. The BWLA was established in statute in 1988 (Arizona Revised Statutes [A.R.S.] 45-411.01), which includes the following provisions until December 31, 2024:

1. BWLA lands are exempt from irrigation duties,
2. BWLA lands are exempt from conservation requirements for the distribution of groundwater, and
3. Exemptions are granted for a portion of groundwater withdrawal fees within the BWLA.

The expiration of these exemptions corresponds with the end of the fifth management period of the Phoenix AMA. The ADWR is expected to issue recommendations on maintaining these exemptions beyond the fifth management period by December 15, 2019 after additional groundwater modeling is complete for the BWLA.

Avondale's service area right enables the City to pump, treat, and deliver this water to its customers without a replenishment requirement. However, the BWLA is highly saline and the cost to treat the water and dispose of the brine is much more expensive than the City's current groundwater production and treatment.

It is unclear how the ADWR will manage the BWLA sources long-term and if they will ever be able to be pledged to a 100-year AWS. The City should continue to monitor the ADWR's activities regarding the BWLA and stay abreast of current decisions that may impact the City's ability to use this resource.

Other west valley cities which have portions of their services areas in the BWLA, could be valuable partners with Avondale in developing water supplies in the BWLA. Coordinated regional efforts to develop pilot studies for treatment/brine disposal technologies and discussions with the ADWR on the fate of the BWLA could advance development of the water supplies in this area.

3.4.2 Underground Storage and Recovery

Underground water storage and recovery is an important part of the City's long-term water resources strategy. In addition to the City's McDowell Road Facility, the City has recharge capacity ownership in three CAWCD facilities, namely Hieroglyphic Mountain, Agua Fria Constructed, and Agua Fria Managed; and SRP's NAUSP facility. Table 3.2 summarizes the City's recharge capacity ownership in each of these facilities and water sources that have been approved for recharge in each.

Water from three sources is approved for recharge: SRP, CAP, and reclaimed water. The City's McDowell Road Facility is the only place where the City can recharge reclaimed water, therefore it is critical that it is managed to allow the City to continue to recharge all reclaimed water flows through buildout. A small portion of the City's SRP supplies can be recharged at NAUSP. However, 4,000 AFY of SRP water must be sent through the Crystal Gardens Lakes to maintain the wetlands, which is eventually conveyed to the McDowell Road Facility. The City's CAP supplies have the most flexibility and can be recharged at any of the facilities listed in Table 3.2.

Table 3.2 Recharge Facility Capacity Available to Avondale

Recharge Facility	City Recharge Capacity (AFY)	Approved Recharge Sources
McDowell Road Facility	20,000	Reclaimed, SRP, CAP
NAUSP (1)	2,400	SRP
Hieroglyphic Mountain	20,000	CAP
Agua Fria Constructed	20,000	CAP
Agua Fria Managed (2)	20,000	CAP

Notes:
(1) City owns 10% of facility capacity. Amount varies from year to year.
(2) Provides a maximum of 50% recharge credit (i.e., 1 AF recharged = 0.5 AF credit)

The capacities shows in Table 3.2 are not guaranteed. Each time the USF is renewed, the ADWR will review and may adjust capacities based on hydrogeological conditions at the time of renewal.

All SRP or CAP surface water supplies are currently delivered to customers through annual storage and recovery. All of the City's potable wells are permitted as recovery wells, thereby providing maximum flexibility in managing recharge and recovery. CAP surface water or reclaimed water that is recharged in excess of what must be recovered to meet customer demands, can accrue LTSCs. The City currently has approximately 75,000 AF of LTSC in its account with ADWR. This volume is equivalent to just over 5 years of the City's current annual demands (14,200 AFY).

Only the surface water portion of the City's SRP allocation can be recharged and all volumes must be recharged and recovered on an annual basis. In other words, SRP surface water recharge cannot be used to accrue LTSCs. The City manages SRP surface water deliveries and accounting on a monthly basis, consistent with the requirement that SRP supplies are only used on project.

The City is exploring a water delivery agreement with the City of Phoenix, whereby the City's CAP water would be treated at a City of Phoenix water treatment plant and delivered to Avondale through a distribution system interconnect. This would allow Avondale to directly deliver CAP water to their customers and reduce the need for underground storage and recovery. This CAP water wheeling agreement could also extend to the City's SRP water supplies, which would provide an alternative to the City's current practice of annual storage and recovery of SRP surface water and would provide more recharge capacity at the McDowell Road Facility for reclaimed water.

3.4.3 Central Arizona Groundwater Replenishment District

The City of Avondale enrolled in the CAGRD as a MSA on January 16, 1998. Membership in the CAGRD is voluntary but does enable the City to demonstrate consistency with the management goal of the Phoenix AMA in its DAWS renewals. Although the City does not need to rely on CAGRD for groundwater replenishment, maintaining CAGRD membership provides the City this option if needed in the future.

It is not anticipated that the City will need to rely on the CAGRD for groundwater replenishment in the Study Area for the 2018 IUMP. However, the water supplies to support growth in the southern service area (south of the Estrella Mountains) are less certain. Therefore it is recommended that the City maintain its membership in the CAGRD as one potential option for groundwater replenishment in the southern service area.

3.4.4 Water Conservation

Avondale takes a proactive approach to water conservation and has a number of programs and policies that offer financial incentives to its customers for saving water. Some of these include rebates for turf removal, installation of low flow water fixtures, smart irrigation controller rebates for non-residential customers, and free home owner assistance in setting up residential irrigation water budgets.

Most Maricopa County Cities are experiencing a decreasing trend in per capita water usage over the past 15 years as older plumbing fixtures are replaced with more efficient fixtures, landscaping water use declines, and personal habits change as the awareness of water conservation increases. In addition to allowing the City's water resources go further, increased conservation will also reduce energy use, equipment wear, and water treatment costs on a per customer basis – providing additional cost benefits to the City.

Water efficient clothes washers, dishwashers, toilets, and plumbing fixtures will reduce wastewater flows but may increase wastewater strength – leading to different treatment and capacity requirements at water reclamation facilities. Decreased wastewater flows will result in a decrease in available reclaimed water on a per capita basis, which needs to be considered in reclaimed water flow estimates.

As the City of Avondale continues to develop and attract economic growth, water conservation becomes increasingly important. Water conservation can significantly reduce the water resources requirements of Avondale, while reducing the cost of infrastructure, water treatment and the energy needed to provide water to customers. With this vision for water conservation, the City should encourage conservation practices for future developments that will provide permanent reductions in water use, which may include the following:

1. Enact development policies and regulations that limit the use of turf in yards and common spaces.
2. Design open spaces to capture and use storm water for desert landscaping. Storm water can be collected and used to provide the water needed for natural, desert landscaping. Use of storm water can enhance the beauty of Arizona's native plants to make attractive communities in the desert. Research has been completed at the University of Arizona to provide guidance on ways to use storm water retention in natural landscapes.
3. Continue the City's low flow fixture replacement and rebate programs.
4. Investigate the City's customer billing data to identify large water users, particularly those with landscape meters. Collectively the water use from the City's landscape meters is nearly 25 percent of the City's total water use (year 2016 data). There could be high potential to find water savings within this water use category, beginning with establishing water budgets for individual landscaped areas and comparing actual use to the estimated budget.

3.5 Reclaimed Water Management

Reclaimed water is an important component of the City's long-term water resources strategy. Beneficial reuse of reclaimed water can reduce potable demand for landscape irrigation, operations, and maintenance at the City's wastewater plant, and water for dust control for construction. Reclaimed water that is recharged in a permitted facility can be banked for LTSCs, and recovered through a recovery well if surface water shortages occur.

Reclaimed water should be considered as valuable as the City's CAP and SRP surface water supplies. Reclaimed water is reliable, essentially drought proof, and provides a legal and physical renewable supply that can be pledged in the City's DAWS.

3.5.1 Reclaimed Water Projections

A review of the Avondale WRF influent and effluent data (monthly and rolling average) from January 2013 through January 2017 show that approximately 92 - 93 percent of the wastewater entering the plant becomes reclaimed water. The remaining 7 - 8 percent is removed in the solids handling process. For the purposes of the 2018 IUMP, it was assumed that 93 percent of future wastewater flows would become reclaimed water.

Table 3.3 summarizes the reclaimed water flow projections for each planning year through buildout. Indoor water conservation reduces the volume of wastewater to the Avondale WRF and consequently the amount of reclaimed water that is available to the City. The reclaimed water projections in Table 3.3 assume that the ratio of indoor and outdoor water consumption is the same with or without conservation. However, if the majority of future water conservation occurs through reductions in outdoor use, the amount of reclaimed water available to the City at buildout would likely be more than is shown in the "Buildout with Conservation" line item in Table 3.3.

Table 3.3 Reclaimed Water Projections

Planning Year	Reclaimed Water Production	
	(mgd)	(AFY)
2017	5.4	6,080
2023	5.8	6,400
2028	6.0	6,710
Buildout (1)	11.2	12,500
Buildout with Conservation (2)	**8.9**	**10,000**

Notes:
(1) Calculated water demand of 450 gpd/DU
(2) Estimated water demand of 360 gpd/DU

3.5.2 Reclaimed Water Management Strategies

The City recharges the majority of its reclaimed water in the McDowell Road recharge facility. This facility is permitted for 20,000 AFY and the current permit is set to expire on December 31, 2023. Without another permitted recharge facility for reclaimed water, the McDowell Road Facility is critical for the City to be successful using 100 percent of its reclaimed water for beneficial uses, primarily recharge.

With the 4,000 AFY of SRP water that must be delivered through the Crystal Gardens Lakes to the McDowell Road Facility, there is sufficient capacity to recharge the City's projected buildout reclaimed water flow of 12,500, assuming the facility capacity is not de-rated in the future and the City establishes an agreement with the City of Phoenix to treat and deliver SRP water through the distribution system interconnects.

The City's current strategy of annual storage and recovery of SRP water cannot exceed the storage capacity of the facility, less the amount of reclaimed water to be recharged (20,000 AFY – 12,500 AFY = 7,500 AFY). The 7,500 AFY capacity available for monthly storage and recovery of SRP surface water is just over half of the estimated on project buildout demand of 14,000 AFY. If the City does not pursue an agreement with the City of Phoenix or build a water treatment plant in the City to treat and deliver SRP supplies, an additional recharge facility will be required to manage reclaimed water from the City's WRF.

It is possible the capacity of the McDowell Road Facility could increase the next time the USF is renewed. However, for redundancy, a prudent approach would be for the City to identify a secondary recharge site within the City for reclaimed water recharge either through spreading basins, aquifer storage and recovery (ASR) wells, or vadose zone wells. The City may consider expanding the facility to provide additional capacity and infrastructure (basins and/or wells).

3.6 Water Supply versus Demand Projections

The water demand projection approach adopted for the 2018 IUMP was based on unit water demands by dwelling unit, gpd/DU. This approach is consistent with the water supply and demand modeling performed for the Central Arizona Project Service Area Model (CAPSAM) study, which, for Avondale resulted in a range of unit factors between 342 gpd/DU to 450 gpd/DU over five different growth scenarios. Figure 3.2 illustrates the range of demand projections developed for Avondale in the CAPSAM study.

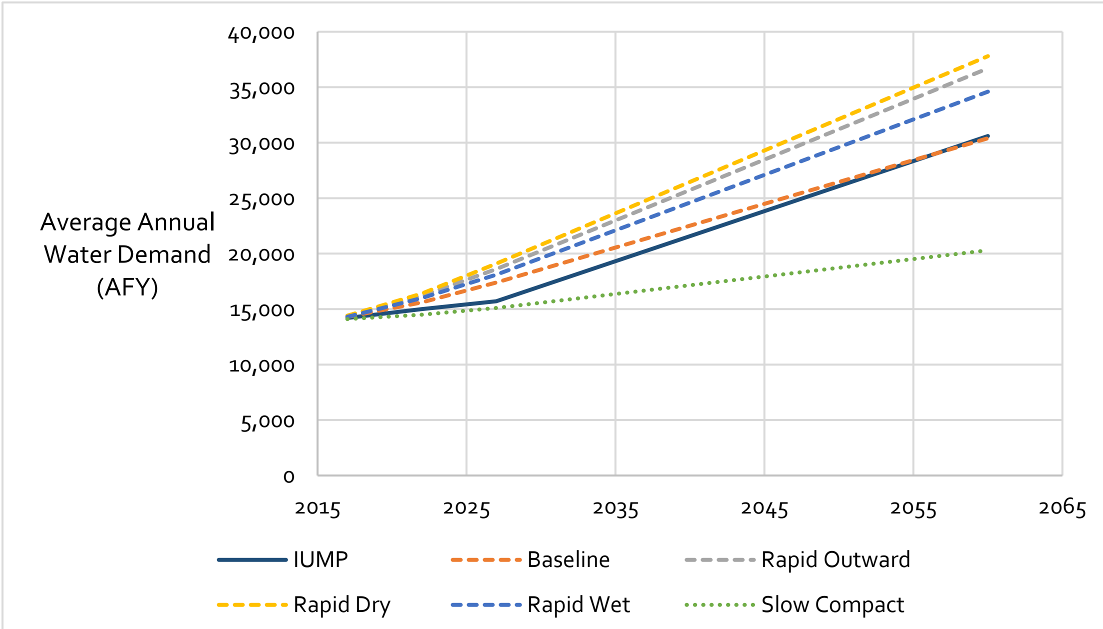

Figure 3.2 Water Demand Projections for Avondale from CAPSAM Study

The City's projected water demands shown in Table 2.8 were calculated for the On Project and Off Project lands within the Study Area to compare available supplies to estimated demands. Table 3.4 summarizes the water demands for each planning year for the 2018 IUMP and for buildout.

Table 3.4 Water Demand Projections for On/Off Project Areas

Planning Year	Average Daily Demand (AFY)		
	On Project	Off Project	Total
2017	6,936	7,280	14,216
2023	7,491	7,602	15,092
2028	7,833	8,095	15,928
Buildout (1)	13,600	15,680	29,280
Buildout (2)	10,750	12,540	23,290

Notes:
(1) Assumes 450 gpd/DU, which is representative of year 2017 water use rates
(2) Assumes 360 gpd/DU, which represents a potential water use rate assuming significant water conservation occurs.

3.6.1 On Project Supplies and Demands

The City's On Project supplies are plentiful and are estimated to be sufficient to meet projected demands through buildout. In 2008, SRP conducted an Assured Water Supply study to provide guidance to the ADWR regarding projected supplies and demands through year 2030 when determining AWS amounts for DAWS renewals. This study identifies 13,398 AFY of stored water available to Avondale, which is the amount the ADWR granted the City in its current DAWS. This value is consistent with the estimated buildout cutover acreages in Avondale's SRP water entitlement report with a 2.0 AF/ac allocation for stored water. Table 3.5 summarizes the On Project water supply and demand balance for each planning year through buildout assuming a Normal water year. For this analysis, it was assumed that only the renewable portion of the City's SRP allocation would be applied to meet projected demands. This does not include normal flow or developed water (groundwater). The stored water volumes are based on the estimated cut over acreages in each planning year, which were escalated at the same growth rate as the water demand projections.

For buildout, assuming no water conservation, 30 AF of groundwater (recovered reclaimed water) is required to meet demands. The City does have sufficient SRP groundwater to meet this additional demand. The City also has 3,105 AF of Normal Flow water that should be available in a Normal water year. Normal Flow was not included in the supply and demand balance in Table 3.5 but would be sufficient to not require groundwater pumping to support the On-Project service area. The surplus values shown in Table 3.5 are not available for other uses because both the Kent Decree and SRVWUA Articles are clear that member lands cannot take delivery of more water than is necessary On Project and prohibit moving SRP water Off Project.

Table 3.5 On Project Water Supply and Demand Balance – Normal Water Year

On Project	2017	2023	2028	Buildout (1)	Buildout (2)
Cut over acres (ac)	4,691	4,950	5,171	6,785	6,785
Surface Water Allocation (AF/ac)	2	2	2	2	2
Surface Water (AF)	9,382	9,899	10,342	13,570	13,570
Reclaimed Water (recovery wells) (AF)	0	0	0	30	0
Total Supply (AF)	**9,382**	**9,899**	**10,342**	**13,600**	**13,570**
Demand (AF)	6,936	7,491	7,833	13,600	10,750
Surplus / (Deficit) (AF)	2,446	2,409	2,509	0	2,820

Notes:
(1) Assumes 450 gpd/DU, which is representative of year 2017 water use rates.
(2) Assumes 360 gpd/DU, which represents a potential water use rate assuming significant water conservation occurs.

3.6.2 Off Project Supplies and Demands

The City's Off Project supplies are also sufficient to meet projected demands through buildout for a Normal water year. These supplies include CAP water (both the M&I sub-contract and future WMAT lease) and reclaimed water that is recovered through recovery wells (pumped groundwater). Table 3.6 summarizes the Off Project water supply and demand balance for each planning year through buildout.

Table 3.6 Off Project Water Supply and Demand Balance – Normal Water Year

Off Project	2017	2023	2028	Buildout (1)	Buildout (2)
CAP M&I (AF)	5,416	5,416	5,416	5,416	5,416
CAP WMAT (AF)	0	882	882	882	882
Reclaimed Water (Recovery Wells) (AF)	6,080	6,460	6,810	12,500	9,960
Phase-in Groundwater (AF) (3)	0	0	0	0	0
Incidental Recharge (AF) (4)	584	620	655	1,203	957
Total (AF)	**12,962**	**13,378**	**13,763**	**20,001**	**17,215**
Demand (AF)	7,280	7,602	8,095	15,680	12,540
Surplus / (Deficit) (AF)	5,682	5,777	5,667	4,321	4,675

Notes:
(1) Assumes 450 gpd/DU, which is representative of year 2017 water use rates.
(2) Assumes 360 gpd/DU, which represents a potential water use rate assuming significant water conservation.
(3) Phase in groundwater is 578 AF per year but is not included in years when there is a surplus and the City is able to accrue LTSCs.
(4) Equals 4.11% of total demand.

Over the next 10 years, the City is projected to have sufficient reclaimed water supplies to continue to accrue up to 5,100 AFY of long-term storage credits through recharge assuming Normal water years, with no shortages on both the SRP and CAP systems. This equates to over 50,000 AF of reclaimed water credits that can be gained over the next 10 years. This would be a substantial addition to the City's LTSC account, which is currently nearly 75,000 AF. With these projections, the City's LTSC account could be as high as 125,000 AF by year 2028. Figure 3.3 illustrates the City's Off Project water supplies and demands from 2017 through year 2028.

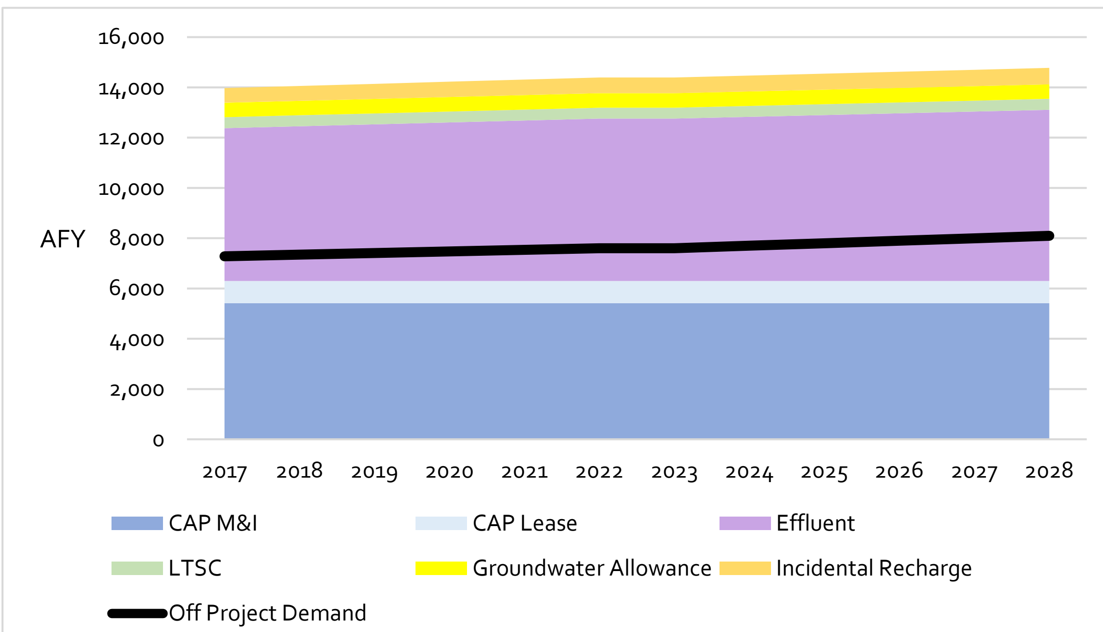

Figure 3.3 Off Project Supplies and Demands

In a Normal water year at buildout, the City is projected to have sufficient water resources to continue to store between 2,360 and 3,680 AF of reclaimed water each year for LTSCs.

3.6.3 Supply and Demand Balance for Dry Year Conditions

During drought years when SRP and/or CAP choose to reduce water deliveries, it is possible that the City's renewable supply sources will be reduced. To estimate the impacts of potential reductions of the City's SRP surface water and CAP allocations, a supply and demand balance was completed using the following assumptions:

1. SRP stored water (surface water) allocation would be 1.0 AF/ac.
2. CAP allocations would be reduced to 70 percent of the City's total M&I sub-contract entitlement and WMAT lease (Tier 3 shortage on Colorado River).
3. No water demand reductions were assumed (i.e., no curtailment policies instituted with customers).
4. Reclaimed water production would remain the same as in a Normal water year.

Table 3.7 summarizes the On-Project supply and demand balance for a Dry water year. Groundwater (recovered reclaimed water) is needed to meet projected demands in each planning year. Between 2,245 and 2,662 AF of groundwater would need to be pumped in a Dry water year between year 2017 and year 2028. At buildout, between 3,965 and 6,815 AF of groundwater would need to be pumped in a Dry water year.

Table 3.7 On Project Water Supply and Demand Balance – Dry Water Year

On Project	2017	2023	2028	Buildout (1)	Buildout (2)
Cut over acres (ac)	4,691	4,950	5,171	6,785	6,785
Surface Water Allocation (AF/ac)	1	1	1	1	1
Surface Water (AF)	4,691	4,950	5,171	6,785	6,785
Reclaimed water (recovery wells) (AF)	2,245	2,541	2,662	6,815	3,965
Total (AF)	**6,936**	**7,491**	**7,833**	**13,600**	**10,750**
Demand (AF)	6,936	7,491	7,833	13,600	10,750
Surplus / (Deficit) (AF)	0	0	0	0	0

Notes:
(1) Assumes 450 gpd/DU, which is representative of year 2017 water use rates.
(2) Assumes 360 gpd/DU, which represents a potential water use rate assuming significant water conservation.

Table 3.8 summarizes the Off-Project supply and demand balance for a Dry water year. For the next 10 years, the City's has sufficient water resources to meet projected demand and continue to accrue between 1,120 and 1,550 AF of reclaimed water LTSCs even in a Dry water year. However, at Buildout the City is projected to require between 596 and 3,780 AF of LTSC to offset groundwater pumped in a Dry water year. The City's Phase-in Groundwater allowance is only shown for the buildout year because it is a credit that is not needed in years when there is a surplus (i.e., when the City can accrue LTSCs).

Table 3.8 Off Project Water Supply and Demand Balance – Dry Water Year

Off Project	2017	2023	2028	Buildout (1)	Buildout (2)
CAP M&I (AF)	3,791	3,791	3,791	3,791	3,791
CAP WMAT (AF)	617	617	617	617	617
Reclaimed Water (Recovery Wells) (AF)	3,840	3,920	4,150	5,710	6,000
Phase-in Groundwater (AF) (3)	0	0	0	578	578
Incidental Recharge (AF) (4)	584	620	655	1,203	957
Total (AF)	**8,833**	**8,949**	**9,213**	**11,900**	**11,944**
Demand (AF)	7,280	7,602	8,095	15,680	12,540
Surplus / (Deficit) (AF)	1,553	1,347	1,118	(3,780)	(596)

Notes:
(1) Assumes 450 gpd/DU, which is representative of year 2017 water use rates.
(2) Assumes 360 gpd/DU, which represents a potential water use rate assuming significant water conservation.
(3) Phase in groundwater is 578 AF per year but is not included in years when there is a surplus and the City is able to accrue LTSCs.
(3) Equals 4.11% of total demand.

The City's current LTSC balance of nearly 75,000 AF is sufficient to make up the 3,780 AF per year deficit for 19 consecutive years based on the demand conditions analyzed in the 2018 IUMP. If a more severe drought condition occurred, more LTSCs would likely be required to make up the supply and demand deficit. However, there are other ways in which the City could get relief from additional groundwater pumping replenishment requirements including customer demand reductions, AWBA firming and drought exemptions by the ADWR explained previously.

3.6.4 South Service Area Demand Estimate

The portion of the City's planning area south of the Estrella Mountains is not part of the Study Area for the 2018 IUMP. However, a cursory water demand estimate and water resource supply/demand balance was conducted to provide a reference for the City moving forward.

The City's land use plan was used to estimate the acreage and the unit water demands developed for the Study Area as shown in Table 2.5 were applied to estimate potential demands. The water to wastewater and wastewater to reclaimed water percentages developed for the Study Area were used to estimate the reclaimed water that would be generated from development in the south. All reclaimed water generated was assumed to be recharged, thereby offsetting groundwater pumping required to deliver water to customers. Table 3.9 summarizes the water demand projections and water resources supplies required to serve the south planning area.

Table 3.9 South Service Area Water Demand Projections and Supply Requirements

Land Use	Acreage	Unit Water Demand (gpad)	Total Water Demand (mgd)	Estimated Reclaimed Water Available (mgd) (1)
Estate/Low Density Residential	28,430	361	10.3	4.3
Local Commercial	525	1,850	1.0	0.4
Open Space Parks	9,660	-	-	-
Total	**38,615**	**-**	**11.3**	**4.7**
Total (AFY)	**-**	**-**	**12,650**	**5,260**

Notes:
(1) reclaimed water = water demand * .45 = wastewater flow *.93 - reclaimed water flow
Abbreviation:
gpad = gallons per acre per day

Approximately 7,400 AFY of additional water resources will be needed to serve the southern planning area (12,650 AFY – 5,260 AFY = 7,390 AFY). The water demand projections from the 2010 Water Resources Master Plan Update were 7,802 AFY with 3,174 AFY of reclaimed water production, resulting in 4,628 AFY of additional water resources needed. The difference in the values from 2010 and 2017 is due to changes in the land use plan since 2010.

3.7 Recommendations

The City should take the following actions with respect to water resources planning:

1. Continue to work with the City of Phoenix to develop and IGA that would allow direct delivery of CAP and SRP supplies through a distribution system interconnect. This action provides redundancy to the City's wells, while potentially freeing up capacity in the City's McDowell Road Facility for reclaimed water recharge.
2. Avondale has formally expressed interest in the NIA priority water reallocation of 2021. By 2021 the City will need to submit an application and water management plan explaining how the City would use the water allocation by 2029 in a manner that satisfies ADWR's goals for the reallocation.
3. Explore opportunities to expand the City's recharge capabilities as a back up to the McDowell Road Facility. This may include piloting ASR or Vadose zone wells as well as identifying a second recharge site for the City's reclaimed water, which could include a regional facility. This will enable the City to have reclaimed water recharge redundancy.
4. Establish policies for new developments to encourage water conservation in landscaping including turf requirements at individual homes and open spaces.
5. Water conservation enables Avondale water resources to go further and reduces the amount of groundwater pumping during times of drought. Efforts to reduce residential usage below 450 gpd per home, will help sustain the water resources the City currently has in its portfolio.

Chapter 4

WATER INFRASTRUCTURE MASTER PLAN

4.1 Introduction

The water master plan identifies the water infrastructure improvements that are needed so the City of Avondale (City) can continue to provide a reliable water supply through buildout for the water service area.

The most critical issue that this master plan addresses is the water supply. Historically, Avondale has been a groundwater only system. Some of the wells in the northern part of the City produce water that meets water quality standards without treatment. Other wells produce water that requires arsenic, nitrate, or DBPC (Butylated Hydroxytoluene) treatment. However, farther to the south near the Gila River, groundwater quality degrades and would require treatment for total dissolved solids (TDS), which is expensive when brine disposal costs are included. To help manage costs and to provide increased water supply reliability, well water supply costs were compared with alternate water supplies including partnering with neighboring cities, wheeling water through the City of Phoenix water distribution system, teaming with Goodyear to construct a surface water treatment plant that treats water wheeled through the SRP canals, and constructing a surface water treatment plant to treat and deliver Avondale's Salt River Project (SRP) and Central Arizona Project (CAP) water. This plan contains water production, treatment, and infrastructure recommendations that address the City's water supply needs.

The City has plans to create a new pressure Zone 1 located primarily north of Interstate 10. This pressure zone is needed to provide adequate pressures in the northeast portion of Avondale. The water supplies that would serve Zone 1 are not sufficient to meet projected demands and maintain pressures, so different water supply approaches to Zone 1 were evaluated to reduce water supply costs and make the pressure zone split more practical.

In addition to water supplies, the City's water system will need additional wells, storage, pumping, and water mains to serve additional customers in the future. The infrastructure that will be needed is documented in this master plan chapter.

4.2 Previous Studies

The following studies were reviewed for insights and current relevance in establishing the water master plan. The capital projects recommended in these documents that have not been constructed yet and are still relevant for consideration in this master plan are as follows.

Pressure Zones Evaluation, August 2015

1. Implement a pressure zone boundary to create Zones 1 and 2 using two pressure reducing valve (PRV) stations and gate valves to construct the boundary.

Water Master Plan Update, May 2013 - needed to address declining water quality in some wells

1. Construct Wells #22 and #26.
2. Construct nitrate treatment at the Coldwater site to treat water from Well #22 and other wells.
3. Construct seven additional wells with well transmission mains to the respective sites.
4. Rehabilitate the Del Rio storage reservoir and place in service.
5. Construct an additional storage reservoir at the Coldwater site.
6. Construct additional 13 million gallons per day (mgd) of pumping capacity at Coldwater, Del Rio, and Northside sites.
7. Connect Well #16B to the Coldwater site.
8. Construct mains along section line streets in the vicinity of expected development.

Wellhead Treatment Study, December 2013

1. Construct a nitrate treatment facility at Coldwater.

Water Master Plan Update, 2010

1. Construct Well A and deliver water to Northside.
2. Increase pumping capacity at Rancho Santa Fe, Coldwater, and Garden Lakes.
3. Construct seven new wells with well transmission mains to the respective water delivery sites.
4. Construct a new distribution main along El Mirage Road from Van Buren Street to north of Broadway Road.
5. Construct mains along mile streets in the vicinity of expected development.

Water Resource Master Plan, May 2010

1. Continue the strategy of using wells as a water supply.
2. Reserve a site for a potential future surface water treatment plant.
3. Continue accruing long term storage credits for prolonged drought protection.
4. Acquire and recharge excess CAP supplies to add to the long term storage credit account, including Non-Indian Agricultural CAP water.

Surface Water Treatment: Opportunities and Analyses, April 2007

1. Construct up to 15 new wells with well transmission mains to wellhead treatment sites for 10 to 13 wells.
2. Obtain 7,500 acre-feet per year (AFY) of North Aqua Fria Underground Storage Project (NAUSP) recharge capacity.
3. Construct an additional nine wells, and six to nine wells may need wellhead treatment.

4. Expand the SRP lateral feeding the Crystal Gardens Wetlands as well as the conveyance pipe delivering water to the Avondale Recharge Facility.
5. Construct a 10 mgd surface water WTP that would be expanded to 15 mgd.

4.3 2017 City of Avondale Water System

Figure 4.1 presents the City's water system service area. Avondale currently serves all of the land areas north of the Estrella Mountains, with the exception of a small area in the northwest corner of Avondale that is served by Liberty Utilities, Inc. The following sections document the current water supply and distribution system.

4.3.1 Pressure Zones

Avondale currently operates two pressure zones: a main pressure zone that serves the most of the service area and a second pressure zone located to the south of the main zone. These two zones are separated by PRV stations located on Avondale Boulevard and Dysart Road. A new pressure zone is planned that would increase pressures in land areas north of Interstate 10 by splitting the main zone into two pressure zones. This new zone will be called Zone 1. The remaining portion of the existing main zone will be called Zone 2. Finally, the existing pressure zone located south of the main zone will be called Zone 3. The City also operates several sub-zones to protect developed areas with older infrastructure. These sub-zones can be eliminated as distribution lines are completed.

Figure 4.2 presents the future pressure zones of the Avondale water system and Table 4.1 presents the elevation ranges associated with each pressure zone.

Table 4.1 Pressure Zone Elevation Ranges

Pressure Zone	Low Elevation (ft)	High Elevation (ft)	Target HGL (ft)
1	975	1037	1177
2	943	1008	1139
3	926	977	1103

Table 4.2 presents the projected population in each pressure zone for each of the planning periods evaluated in this 2018 IUMP. These population projections provide an indication of where growth is expected to occur in each planning period. Water demand projections have been calculated for each pressure zone and planning period.

Table 4.2 2017 and Projected Populations by Planning Period and Pressure Zone

	2017	2023	2028	Buildout
Zone 1	34,000	36,000	39,000	52,000
Zone 2	47,000	50,000	53,000	121,000
Zone 3	1,000	1,000	1,000	9,000
Total	**82,000**	**87,000**	**93,000**	**182,000**

A portion of the City is located on SRP on-project lands, so the City calculates water resources for these areas separately to comply with SRP water resource regulations. Table 4.3, Table 4.4, and Table 4.5 present on-project, off-project, and total water demand projections for each pressure zone by planning scenario. Infrastructure is evaluated and sized in this master plan to satisfy these water demands.

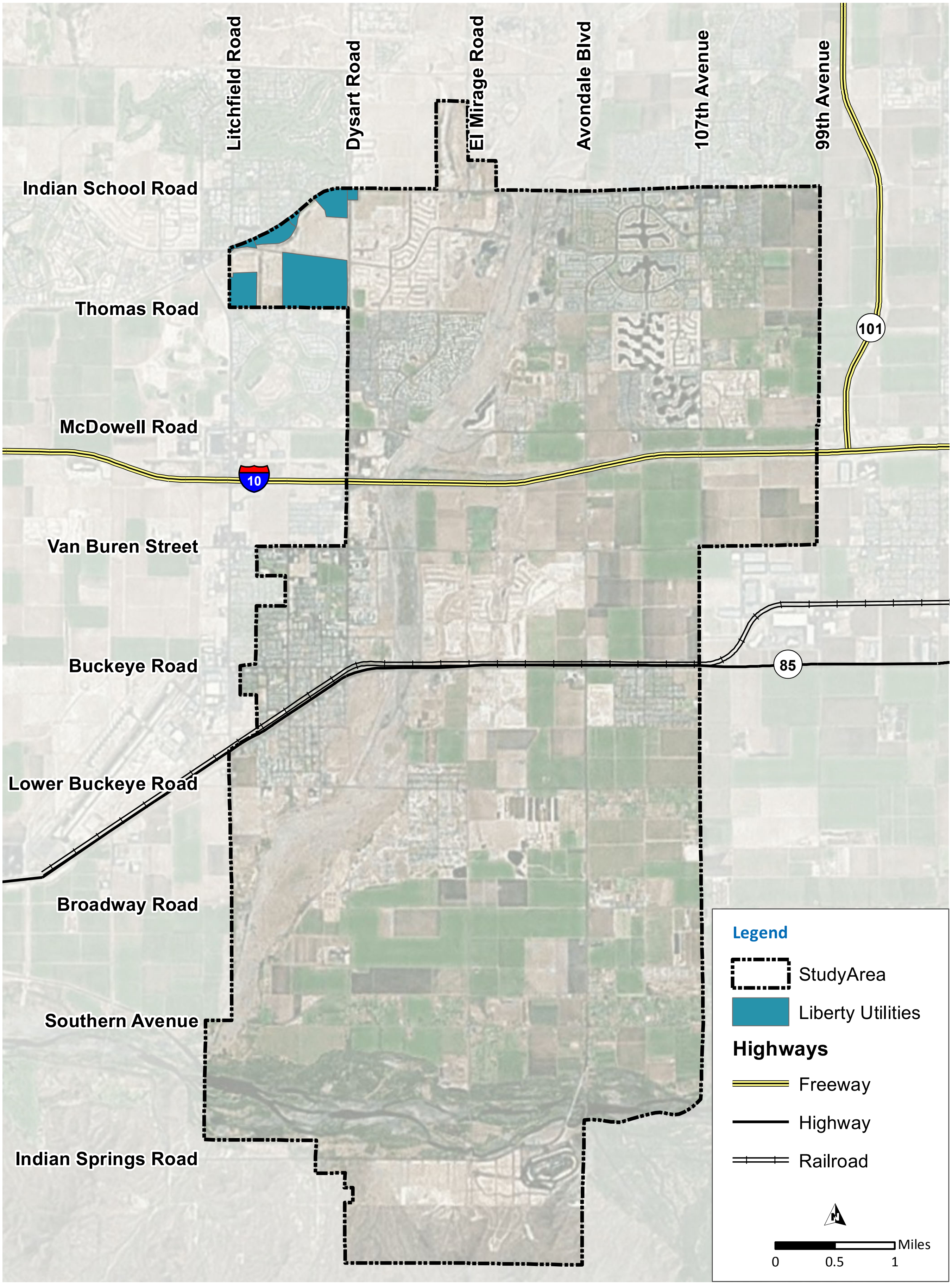

Figure 4.1 2017 Water System Service Area

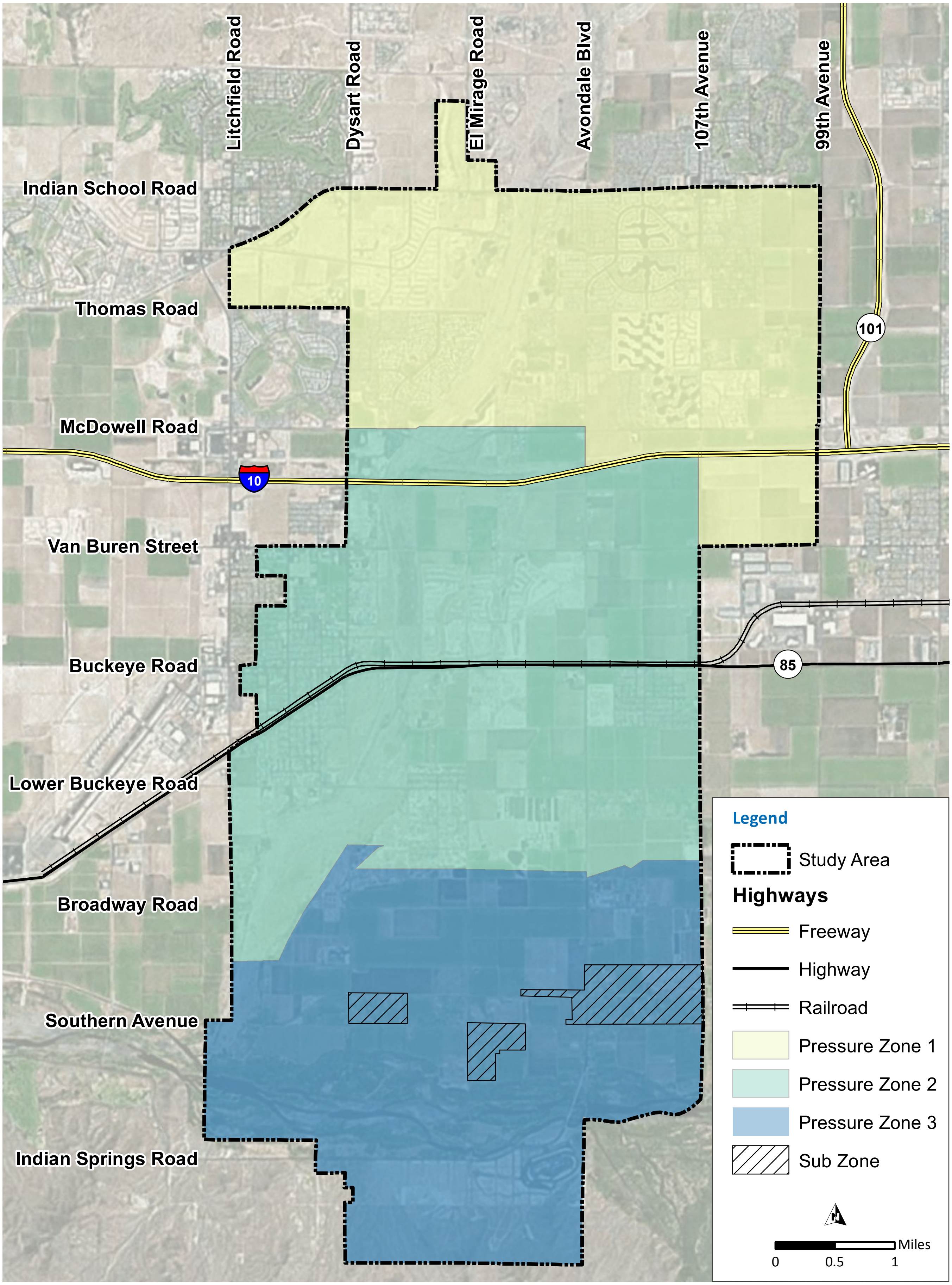

Figure 4.2 Pressure Zones

Table 4.3 Average Day Demands in 2017 and Future Planning Periods (mgd)

	2017			2023			2028			Buildout		
	On Project	Off Project	Zone Total	On Project	Off Project	Zone Total	On Project	Off Project	Zone Total	On Project	Off Project	Zone Total
Zone 1	3.0	2.5	5.5	3.3	2.6	5.9	3.5	2.8	6.3	5.1	2.2	7.3
Zone 2	3.2	3.6	6.8	3.3	3.8	7.1	3.5	3.9	7.4	7.0	6.8	13.8
Zone 3	0.0	0.3	0.3	0	0.4	0.4	0	0.5	0.5	0	5.0	5.0
Subtotal	**6.2**	**6.5**		**6.7**	**6.8**		**7.0**	**7.2**		**12.1**	**14.0**	
Total	**12.7**			**13.5**			**14.2**			**26.1**		

Table 4.4 Maximum Day Demands in 2017 and Future Planning Periods (mgd)

	2017			2023			2028			Buildout		
	On Project	Off Project	Zone Total	On Project	Off Project	Zone Total	On Project	Off Project	Zone Total	On Project	On Project	Zone Total
Zone 1	4.9	4.2	9.1	5.5	4.3	9.8	5.8	4.6	10.4	8.4	3.6	12.0
Zone 2	5.3	6.0	11.3	5.5	6.3	11.8	5.8	6.5	12.3	11.6	11.2	22.8
Zone 3	0	0.5	0.5	0	0.7	0.7	0	0.8	0.8	0	8.3	8.3
Subtotal	**10.2**	**10.7**		**11.0**	**11.2**		**11.5**	**11.9**		**21.0**	**23.1**	
Total	**20.9**			**22.2**			**23.5**			**43.1**		

Table 4.5 Peak Hour Demands in 2017 and Future Planning Periods (mgd)

	2017			2023			2028			Buildout		
	On Project	Off Project	Zone Total	On Project	Off Project	Zone Total	On Project	Off Project	Zone Total	On Project	On Project	Zone Total
Zone 1	7.7	6.6	14.3	8.7	6.7	15.4	9.1	7.3	16.3	13.2	5.7	18.9
Zone 2	8.3	9.4	17.7	8.7	9.8	18.5	9.0	10.2	19.2	18.2	17.6	35.9
Zone 3	0	0.8	0.8	0	1.0	1.0	0	1.3	1.3	0	13.0	13.0
Subtotal	**16.0**	**16.8**		**17.3**	**17.6**		**18.0**	**18.7**		**31.4**	**36.3**	
Total	**32.9**			**34.6**			**36.3**			**67.7**		

4.3.2 Water Sources

Avondale has a number of potable water production wells. Table 4.6 lists these wells. In addition to the potable wells, the City also operates Well #5 and Well #16b for non-potable irrigation only. Wells #21 and #28 can supply Del Rio but are not in use because of water quality issues. Figure 4.3 shows the City's current wells including the wells that are not used for potable water production. The annual recovery limit in the table is the amount that the well can legally withdraw based on the well permit with ADWR. The production capacity is the flowrate produced when the well is operating.

Table 4.6 Avondale Active Production Wells, 2017

Well Water Delivery Location	Supply Name	Annual Recovery Limit (AF)	Production Capacity (gpm)
Distribution System	Well #23	56	800
Coldwater	Well #15	970	600
	Well #16	1,225	1,950
	Well #25	1,935	1,150
Garden Lakes	Well #17	3,461	1,150
Gateway	Well #8A	2,258	2,000
	Well #24	2,300	750
Northside	Well #6	2,419	1,500
	Well #7	1,500	1,700
	Well #20	889	1,150
Rancho Santa Fe	Well #10	N/A	1,900
	Well #11	N/A	1,395
	Well #12	N/A	1,900
	Well #18	N/A	1,800
	Well #19	434	1,500
	Total	**17,447**	**21,245**
	Total (mgd)	**25.1**	**30.6**

Abbreviations:
AF = acre-feet; gpm = gallons per minute; N/A = not applicable
Note: Well #8a capacity will be increased to 3000 gpm. The existing recovery limit is still acceptable with the higher flowrate. The City also currently operates Wells and Well 16B However, both of these wells are used only for irrigation purposes.

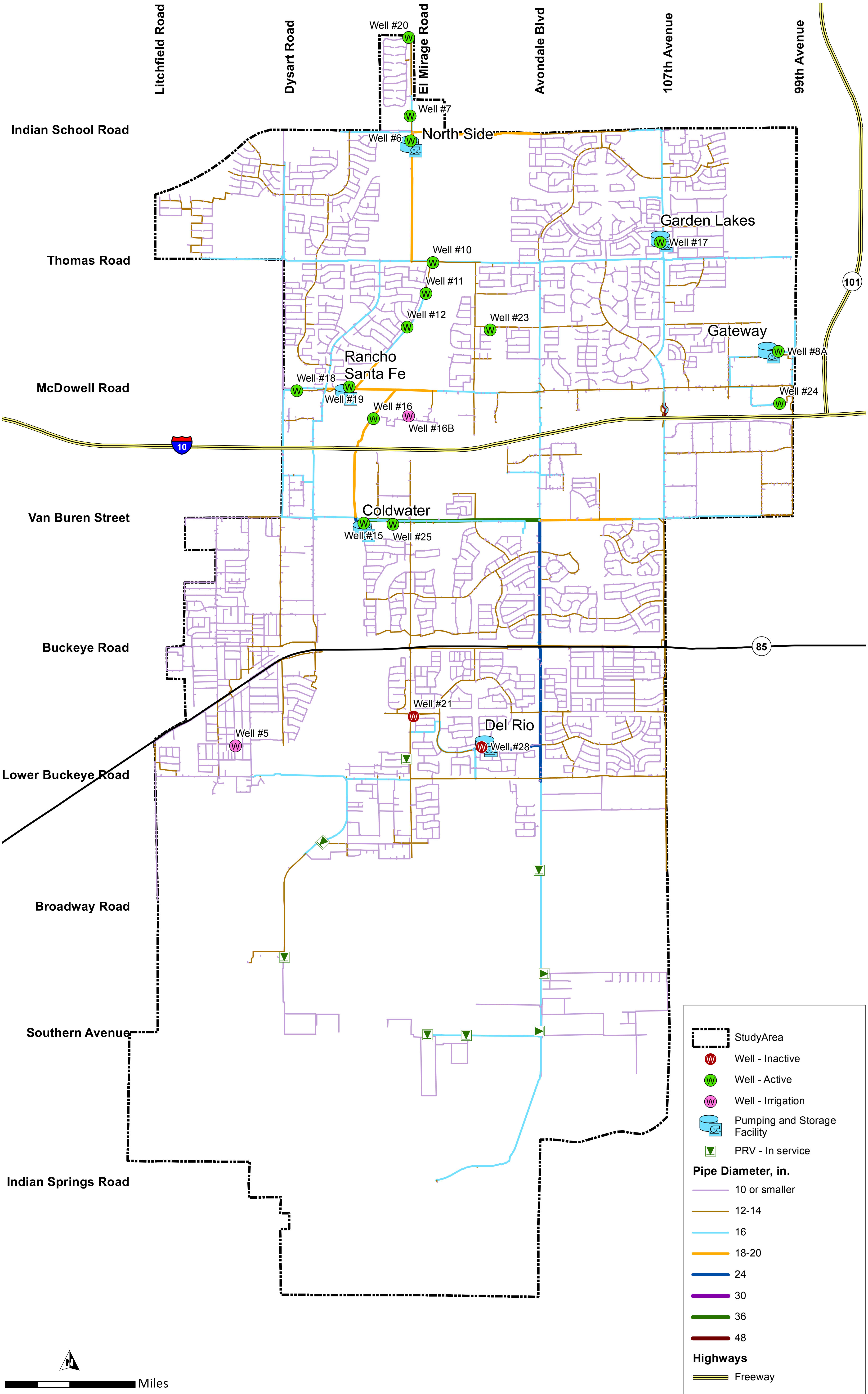

Figure 4.3 2017 City of Avondale Wells

4.3.3 Pump Stations

Avondale has five booster pump stations and one well that pumps directly into the distribution system, as shown in Table 4.7. The firm pumping capacity is the design flowrate with the largest well in the pump station out of service.

Table 4.7 Avondale Booster Pump Stations and Capacities, 2017

Facility	Number of Pumps	Total Pumping Capacity (gpm)	Firm Pumping Capacity (gpm)
Well 23	1	800	800
Rancho Santa Fe	4	8,400	6,200
Coldwater Springs	4	16,000	12,000
Northside	4	7,200	5,400
Gateway	4	8,000	6,000
Del Rio [(1)]	3	10,000	6,000
Garden Lakes	4	6,500	4,500
	Total	**56,900**	**40,900**
	Total (mgd)	**82**	**59**

Notes:
(1) Not currently in service and will require rehabilitation before being brought back into service.

4.3.4 Storage

Avondale's water system has five active reservoir sites and one inactive reservoir site in 2017. The Del Rio site is not currently active because of the poor water quality of the wells that supply water to this site. However, the Del Rio site will play a key role in future water deliveries for Zones 2 and 3. Table 4.8 presents the storage sites and capacities. The available water storage volume is set based on the minimum water levels in the tanks for pumps to operate. The Coldwater site requires a high minimum water level because the pipe supplying the pump station is taken out of the side of one tank at a level that prevents full utilization of both tanks as they are connected in parallel.

The City also has an existing reservoir at well #5. This reservoir is only used to supply the irrigation system at Festival Fields Park. The City anticipates that this reservoir will be removed in the next few years.

4.3.5 Pressure Reducing Valves

Table 4.9 summarizes the PRV stations in the water distribution system.

Table 4.8 Avondale Storage Reservoirs, 2017

Reservoir Name	Elevation (ft)	Tank Height (ft)	Minimum Water Level (ft)	Maximum Water Level (ft)	Tank Diameter (ft)	Number of Tanks	Total Volume (MG)	Available Volume (MG)
Northside	1012	16	0	14.5	80	2	1.2	1.1
Gateway	1021	20	2.5	17.9	92	1	1.0	0.8
Garden Lakes	1016	22	3	17.9	124	1	2.0	1.3
Rancho Santa Fe	982	16	2.7	14.5	123	2	2.8	2.1
Coldwater	971	20	5.2	18	146	2	5.0	3.2
Del Rio (Inactive)	984	32	3.2	29	136	1	3.5	0
						Total	**15.5**	**8.5**

Abbreviation:
MG = million gallons

Table 4.9 Avondale PRVs, 2017

Name	Location	Elevation (ft)	Setting (psi)	Pipe Diameter (in)	PRV Diameter (in)
Rio Vista	El Mirage North of Lower Buckeye Road	960	55	12	6
Subzone, Rigby PRV #1	Zone 3 to Rigby, Avondale Boulevard and Roeser Road	939.6	50	8	6 4
Subzone, Rigby PRV #2	Zone 3 to Rigby, Southern Avenue and Avondale Boulevard	940	50	8	4
Subzone, Rigby PRV #3	Zone 3 to Rigby, Southern Avenue and 119th Drive	938	50	8	2
Subzone, Rigby PRV #4	Zone 3 to Rigby, Southern Avenue and 122nd Avenue	939.6	50	8	2
Subzone, Dysart Road	Dysart Road at the Wolf Water Resource Facility	930	50	16	6
Zone 2 to Zone 3	Avondale Boulevard north of Broadway Road	952	65	16	4 8
Zone 2 to Zone 3	Vermeersch Road and Elwood Street	962	65	16	2 8

4.3.6 Pipelines

Avondale has a network of approximately 321 miles of pipes in their distribution system that range from 6 to 48 inches. Table 4.10 summarizes the pipe lengths by diameter for the Avondale water system. Figure 4.4 presents a map of the 2017 water system.

Table 4.10 Avondale Pipe Length Summary by Diameter

Diameter (in)	Length (miles)
6	48.2
8	170.5
10	3.3
12	57.7
16	31.5
18	0.1
20	5.1
24	2.7
30	0.1
36	1.3
48	0.1
Total	**320.8**

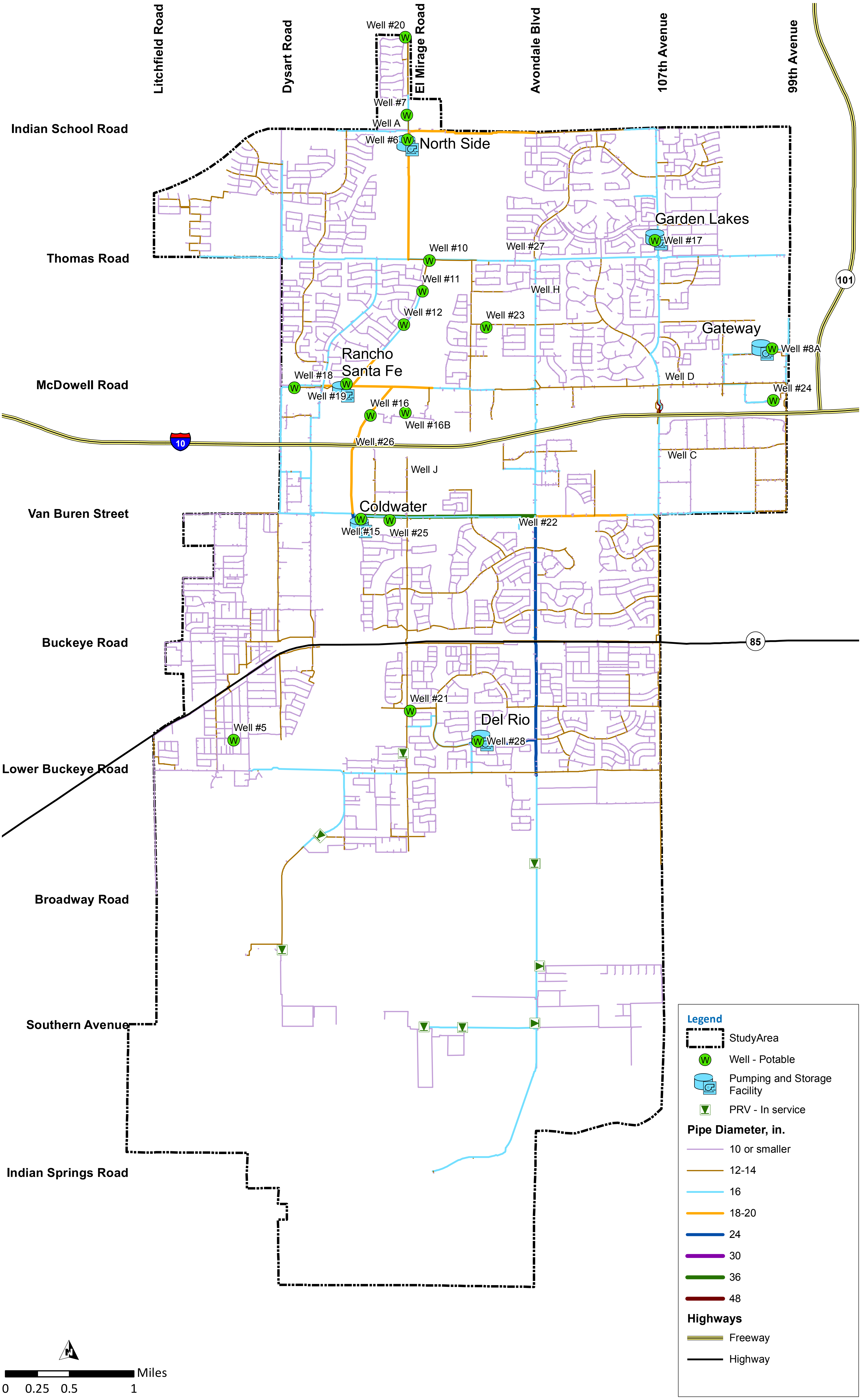

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Figure 4.4 2017 Water Distribution System

4.4 Performance Criteria

Performance criteria address water supply redundancy, water system reliability, and system operational requirements. Performance criteria are more general than design criteria, which provide specific requirements that must be incorporated into new infrastructure.

Performance criteria are based on legal requirements and engineering best practices. The water system performance criteria for the 2018 Integrated Utility Master Plan (IUMP) include standards from the Arizona Administrative Code (A.A.C.) Title 18, Engineering Bulletin No. 10 (issued by the Arizona Department of Health Services, May 1978), water industry best practices, and performance criteria established in the City's Engineering Design Standards.

4.4.1 Water Supply Redundancy

Water supply redundancy refers to the degree to which water can still be supplied to the City in the event that one or more of the water supply sources is unavailable. Decisions concerning the extent of redundancy are often policy decisions influenced by the price a utility is willing to pay for the redundancy compared with the risk of having to implement water use restrictions or provide a lower level of service to the customer. For Avondale, holding one or more production wells in reserve is a common practice to provide water supply redundancy. However, as noted later in the report, Avondale has several reservoir/booster sites that would be severely impacted by the loss of a single supply well.

4.4.2 Water System Reliability

The City's water system reliability is dependent on the reliability of all the components within the system as well as the reliability of support systems and services outside of the City's control. The level of reliability provided is usually based on historic operational experience and judgment, which results in confidence that the system can deliver water under a variety of normal and emergency conditions. Consequently, professional judgment must be used when specifying system components and the number and location of components needed to meet reliability criteria.

The overall level of reliability provided by the system is a function of the reliability of the major system components:

- Raw water sources
- Treatment processes and/or facilities
- Major transmission mains
- Power sources
- Booster stations
- Storage tanks

Reliability of the City's water system is provided by a combination of the following factors:

- Sufficient groundwater production to meet maximum-day demand.
- Reserve system storage to meet emergency conditions, in addition to fire and normal operational needs.
- Transmission capability to deliver water to the distribution system.
- Looped transmission and distribution system network to provide multiple pathways for water to reach customers.
- Sufficient booster pumping capabilities with a pump station or the largest pump in a station out of service.

4.4.3 Water System Operational Requirements

Water system operational requirements refer to the level of service provided by a utility to the customer. Levels of service include many parameters, such as minimum and maximum pressures, maximum flow velocities, storage, redundancy, and provisions for emergency conditions. Adequate pressure is usually defined in terms of a minimum pressure under certain demand conditions, such as peak hour or fire flow. Adequate fire protection refers to providing adequate storage volume and flow to meet firefighting demands. The water system is considered to be adequate when system demand conditions are satisfied while meeting system performance criteria, such as system pressure, velocity, and head loss.

4.4.4 Water Production Facilities

Production facilities for the water system should have sufficient capacity to meet the demands of the maximum day of the year. For systems served with groundwater wells, it is standard practice to evaluate production capabilities based on "firm" capacity, or the capacity with the largest well out of service in each pressure zone.

For Avondale, well blending requirements need to be considered in the reliability evaluation. When the well with the higher water quality is out of service, then the wells that depend on blending to produce acceptable water quality must also be taken out of service.

4.4.5 Fire Flow

The City of Avondale has adopted the 2012 Phoenix International Fire Code (IFC) with local amendments. Depending on the type of use, construction, fire area, the required fire flow and duration ranges from 1,500 gpm for 2 hours to 8,000 gpm for 4 hours as shown in IFC Appendix B, Table B105.1. The IFC allows reductions in fire flow requirements for structures with approved automatic sprinkler systems and installation practices, which can be granted at the discretion of Avondale's Fire Marshall.

For the purposes of the water system master plan system evaluations and future system planning, master planning fire flow requirements were developed that are general and based on land use. For single-family residential land uses the master planning fire flow requirement is 1,500 gpm for 2 hours. For commercial and industrial land uses the master planning fire flow requirement is 3,500 gpm for 4 hours.

The actual fire flow requirements for future, individual structures shall be determined in accordance with the IFC.

A major fire is assumed to not occur during the peak hour demand condition since the chance of this happening is small. Therefore, in the system evaluations, fire demand will be applied under maximum day demand conditions.

4.4.6 Pump Stations

Usually pumping stations are the most critical components in a distribution system with respect to meeting reliability/redundancy criteria, because these facilities are subject to disruption by the following conditions:

- Power outage
- Mechanical failure
- Line breaks

Table 4.11 summarizes these conditions and the criteria to be employed for reliability in this master plan update.

Table 4.11 Pump Station Reliability Criteria

Condition	Result	Mitigating Criteria
Power Outage	Creates loss of pumping capacity at one or more pumping facilities.	Provide emergency backup power supply generation or dual power feed to critical facilities.
Mechanical Failure	Creates loss of pumping capacity due to one or more pumps at a facility being out of service.	Provide sufficient pumping capacity at each booster pumping station to meet maximum day demands with any one pump or the largest pump out of service (referred to as "firm capacity" of the station). This allows for pumps to be out of service due to mechanical failure or unscheduled maintenance.
Line Break	Occurs at or near the booster station, creating a loss of all or a portion of the pumping capacity at the facility.	A line break at or near a booster station disrupting supply is usually mitigated through multiple pumping facilities, storage, and PRV facilities (where available).

For line breaks affecting critical pumping facilities, reliability/redundancy criteria are established so that average day demand conditions can be met for each pressure zone.

A pump station pumping to a closed system, with no other water sources or elevated storage, should be sized for the larger of peak hour demand or maximum day plus fire flow demand. Diurnal demands (peak hour) and fire demands will be met from ground storage, and the booster stations will need to be able to pump this flow from the reservoirs. Pump stations should be designed based on the capacity that can be consistently provided with the largest pump out of service (firm capacity). In addition, pump stations that deliver water into higher pressure zones must be sized to meet the demands of both zones, the parent and subordinate zones.

The following summarizes pump station criteria:

- When pumping to a closed system, the capacity equals the larger of peak hour demand or maximum day plus fire flow demand.
- Pump stations should be sized to meet demands with the largest pump out of service (firm capacity).
- When multiple booster stations supply a zone, average annual water demands should be supplied with the largest booster station out of service.

The firm capacity of booster stations that pump from reservoirs is often set so that half of the reservoir can be emptied in a six-hour period.

4.4.7 Transmission / Distribution Mains

Transmission and distribution mains are sized for the greater of the following two demand conditions:

- Maximum day demand plus fire flow, or
- Peak hour demand

The following pressure criteria are recommended to assess the adequacy of the water transmission/distribution system under the two demand conditions:

- **Peak Hour Demand:** Pressures must be greater than 40 pounds per square inch (psi) and less than or equal to 85 psi. Criteria are established to account for distribution system and backflow prevention facility head loss in order to achieve a minimum service pressure of 40 psi.
- **Maximum Day Demand plus Fire Flow Condition:** A minimum of 20 psi at the point of maximum fire draft.

The water velocity criteria under maximum day demand conditions are as follows:

- Velocity ≤ 5 feet per second (fps) for pipes < 36 inches diameter
- Velocity ≤ 6 fps for pipes ≥ 36 inches diameter

The water velocity criteria under peak hour demand condition is as follows:

- Velocity ≤ 7 fps

The water velocity criteria under fire demand condition is as follows:

- Velocity ≤ 10 fps

4.4.8 Storage Facilities

Since production facilities are typically designed to operate at a steady rate over an extended period of time, storage reservoirs are planned to accommodate fluctuating demands. The factors included in designing reservoir capacity are diurnal demand fluctuations, fire demand, and emergency reserve storage. In some situations, it may be prudent to have an additional storage volume to provide operational storage. Storage facilities should be designed and operated to meet these conditions, while achieving storage turnover to minimize water quality degradation.

The City's storage criteria are to satisfy the largest of the following four criteria:

1. Peak Hour Storage: Satisfy peak hour demand for 4 hours with 50 percent of storage capacity and 50 percent source capacity.
2. Fire Flow: Satisfy maximum day plus fire flow utilizing all sources and 80 percent of total storage.
3. Operating storage: Total storage should be equal to or greater than 20 percent of maximum day demand.
4. Emergency Supply: Satisfy average day demand with 80 percent of storage volume and 50 percent of well supply operated no more than 18 hours.

4.4.9 Performance Criteria Summary

Table 4.12 summarizes the City's water system performance criteria.

Using the City's criteria, water distribution system requirements can be calculated based on the demand in a zone. Table 4.13 lists the requirements for a range of flows.

Table 4.12 Water System Performance Criteria

Description	Criteria
Demand and Production Criteria	
Peaking Factors	
Maximum Day/Average Day (MD/AD)	1.65
Peak Hour/Maximum Day (PH/MD)	1.57
Peak Hour/Average Day (PH/AD)	2.59
Well Production	
Firm Supply	Supply Maximum Day Demand with the largest well out of service When wells are blended, if the well with good quality goes down, the blended well is also taken out of service
Reliable Supply	Supply Maximum Day Demand with wells operating no more than 18 hours/day. The acceptable water supply is the reliable supply applied to the firm supply
Note: Adjustments to this criteria will need to be made for well blending schemes	
Storage Criteria. Required criteria is the largest of the following: 1. Peak Hour Storage: Satisfy peak hour demand for 4 hours with 50% of storage capacity and 50 percent source capacity. 2. Fire Flow: Satisfy maximum day plus fire flow utilizing all sources and 80 percent of total storage. 3. Operating Storage: Total storage should be equal to or greater than 20% of maximum day demand. 4. Emergency Supply: Satisfy average day demand with 80% of storage volume and 50% of well supply operated no more than 18 hours.	
Transmission/Distribution	
Velocity Criteria	
Maximum Day	
Pipe < 36 inches	<5 fps
Pipe ≥ 36 inches	<7 fps
Peak Hour	≤7 fps
Fire Flow Condition	<10 fps, <20 psi
System pressure criteria (SPC)	40 psi ≤ SPC ≤ 80 psi
Size Criteria (Minimum Diameter, inches)	
Section Lines/Major Arterial	16
Minor Arterials	12
All Other Lines	8
Booster Pump Station Criteria	
Without Elevated Storage	The larger of Peak Hour Demand or Maximum Day plus Fire Flow of 3,500 gpm
Firm Capacity	Capacity with the largest pump out of service
Fire Demand Criteria	
Master Planning Fire Flow Requirements	Residential = 1,500 gpm for 2 hours
	Commercial/Industrial/Schools = 3,500 gpm for 4 hours

Table 4.13 Well, Storage, and Pumping Requirements

Maximum Day Demand (mgd)	Average Day Demand (mgd)	Peak Hour (mgd)	Required Well Capacity (mgd)	Pumping for Peak Hour (mgd)	Pumping for Max Day + Fire Flow (mgd)	Required Pumping Capacity (mgd)	Operating Storage (MG)	Fire Storage (MG)	Peak Hour Storage (MG)	Emergency Storage (MG)	Required Storage (MG)
2.0	1.2	3	3	3	6	6	0.4	0.7	0.6	0.2	1.0
3.0	1.8	5	4	5	7	7	0.6	0.6	0.9	0.3	1.0
4.0	2.4	6	6	6	8	8	0.8	0.5	1.1	0.3	1.5
6.0	3.6	9	9	9	12	12	1.2	0.4	1.7	0.5	2.0
8.0	4.8	13	11	13	14	14	1.6	0.2	2.3	0.7	2.5
10.0	6.1	16	14	16	17	17	2	0.0	2.8	0.9	3.0
12.0	7.3	19	17	19	19	19	2.4	0.0	3.4	1.0	3.5
16.0	9.7	25	23	25	23	25	3.2	0.0	4.5	1.4	5.0
20.0	12.1	31	29	31	27	31	4	0.0	5.7	1.7	6.0
24.0	14.5	38	34	38	31	38	4.8	0.0	6.8	2.1	7.0

Notes:

(1) Average Day = Max Day/1.65
(2) Peak Hour = Average Day*2.59
(3) Required Well Capacity = Max Day/0.75 + 10%(1 well minimum)
(4) Pumping Capacity = larger of Peak Hour or Max Day + Fire Flow for:
    a. 2-4 mgd Max Day, 3,000 gpm
    b. 6-8 mgd Max Day, 4,000 gpm
    c. 10-16 mgd Max Day, 5,000 gpm
(5) Operating: 20% Max Day Demand
(6) Fire: (Max Day Demand+ Fire flow) x 4 hours = 100% Well Supply + 80% Storage Volume
(7) Peak Hour: Peak Hour x 4 hours = 50% Storage Volume + 50% Well Supply
(8) Required storage is the largest of operating, Fire, Peak Hour, or Emergency storage, rounded up to the nearest 0.5 MG

4.5 Water Supply Evaluation

4.5.1 Water Supply Alternatives

The City may choose one or more options to supplying water in addition to the monthly recharge and recovery methods that are used currently. The water supply options include:

- Continue monthly recharge and recovery
- Partner with the City of Goodyear on a surface water treatment plant (WTP).
- Construct a City of Avondale WTP
- Wheel the City's surface water allocation through the City of Phoenix distribution system

The City previously considered similar water supply options and developed a matrix of the advantages and disadvantages of each water delivery method as documented in the report, *Surface Water Treatment: Opportunities and Analyses, April 2007*. A similar matrix was completed for this master plan by City staff on the 2018 IUMP team. Table 4.14 is the matrix of alternatives with a qualitative ranking of the different challenges and opportunities of each alternative based on qualitative criteria. This matrix is not intended to provide a final recommendation on water supply alternatives, but is presented as a way to consider the different qualitative issues that are relevant in a decision. In this table, out of a total of 55 points, wheeling water from Phoenix received the highest ranking (47), partnering with Goodyear received the lowest ranking (36); and aquifer storage and recovery had the same ranking as constructing an Avondale WTP (40).

Table 4.14 Water Supply Alternatives Scoring Matrix

Water Supply Alternatives Prioritization Scoring: 5-is the most favorable, 1- is the least favorable

Criteria	Continue Recharge and Recovery		Partner with Goodyear on a WTP		Wheel water from Phoenix		Construct a City WTP	
	Attributes	Score	Attributes	Score	Attributes	Score	Attributes	Score
Delivered Water Quality	No new delivery impacts Minimum water age - closest to customers	5	Increased water age for largest point source Higher water temperatures Potential groundwater/surface water blending impacts	2	Potential for longest water age for large point source Dependent on Phoenix distribution system quality Potential groundwater/surface water blending impacts	3	Increased water age for largest point source Higher water temperatures Potential groundwater/surface water blending impacts	4
Water Quality Management	Susceptible to groundwater contaminants Can treat groundwater to quality desired Flexibility of multiple sources Opportunities for blending Poor quality to the south	3	Grand Canal water quality concerns Ability to control plant influent quality Ability to choose and control treatment process Up to 14 mgd of blending water	2	No ability to choose and control treatment process Susceptible to groundwater in Phoenix distribution system	3	Grand Canal water quality concerns Ability to control plant influent quality Ability to choose and control treatment process Up to 14 mgd of blending water	4
Drought Resistance	Groundwater has greatest resistance to drought	5	14 mgd susceptible to drought impacts	3	11 mgd susceptible to drought impacts Phoenix customers have higher priority	5	14 mgd susceptible to drought impacts	3
Financial Capacity	Facilities are in CIP Capital is distributed over time, phased	3	Large capital impact	2	Low capital impact Potential for high water unit cost Time available for CIP planning	5	Large capital impact Time available for CIP planning	1
Operations and Maintenance	Greatest number of facilities to be maintained Groundwater treatment facilities are complex, will require training	2	Must have WTP and well head treatment staffs Will add more organization complexity Groundwater treatment facilities are complex, will require training	4	Least number of facilities to be maintained	5	Must have WTP and well head treatment staffs Will add more organization complexity Groundwater treatment facilities are complex, will require training	1
Institutional/ Legal Complexity	Least complex, status quo Greatest number of wells to permit	5	SRP concerns with Grand Canal water quality Extra water exchanges not required, status quo for water delivery	2	Dependent on availability of Phoenix supplies Plan for City WTP gives option to leave agreement	4	SRP concerns with Grand Canal water quality Extra water exchanges not required, status quo for water delivery	3
Jurisdictional Control	Greatest control of facilities and operations Greatest control of water quality	5	Greatest control of facilities and operations Greatest control of water quality	2	Least control of facilities and future costs Least control of operations and water quality	2	Greatest control of facilities and operations Greatest control of water quality	5
Risk of limited capacity at the Avondale recharge facility	Recharge capacity is required to withdraw water	3	Not a constraint	5	Not a constraint	5	Not a constraint	5
Groundwater annual withdrawal limits	Changes to the allowable withdrawal limit could reduce allowed pumping	4	Not a constraint	5	Not a constraint	5	Not a constraint	5
Groundwater quality	Some portions of the aquifer under Avondale produce poor quality water	3		5		5		5
Reliability, Redundancy	Redundancy may be provided by the number of wells but not the type of supply	2	Redundancy provided by surface and ground water	4	Redundancy provided by surface and ground water	5	Redundancy provided by surface and ground water	4
Totals		**40**		**36**		**47**		**40**

The issues that are relevant for each water supply method are discussed below:

Continue Monthly Recharge and Recovery

The City's current method of recharge and recovery has worked well up to this point. The City has been fortunate to have a portion of its wells produce water with a water quality that does not require treatment. The City delivers reclaimed water as well as a portion of its SRP water allocation to the City's recharge facility located along the Aqua Fria River north of McDowell Road. This recharge facility has a current permitted recharge limit of 20,000 AFY. There is land located immediately to the south of the existing basins on land owned by the Flood Control District of Maricopa County (FCDMC). If more recharge basins were needed for additional reclaimed water or to provide additional capacity in the event that the recharge rates of the current basins decreased, recharge basins could be constructed on this land. Although the recharge facility is working very well now, recharge facility permits need to be renewed every 20 years, and Arizona Department of Water Resources (ADWR) could reduce the permitted recharge amount if groundwater levels were too high as a result of all the recharge that is occurring in the West Salt River Valley Groundwater Sub-basin. The permit for the McDowell recharge facility expires in 2023.

Groundwater quality in the northern part of the City is reasonably good near the Aqua Fria River. The City's 2010 and 2013 water master plans include a map (see Figure ES-4, 2010 and 2013 Water Master Plan) that identifies favorable areas for additional wells. However, previous studies have recommended up to 15 additional wells may be needed (Surface Water Treatment: Opportunities and Analyses, April 2007.) It may not be feasible to locate this many wells in the portion of the aquifer where water quality is the best. The City has also noticed that nitrate levels in some of the wells are increasing and if this trend continues, some blending strategies may become less effective and additional treatment will be required. Therefore, if the City continues a groundwater only strategy, capital and operating expenses will increase as more wells require treatment.

In addition, there are two superfund sites west of the Goodyear Airport where groundwater quality is compromised. Although cleanup efforts have been underway for some time, the City would not want to construct wells in areas that could be affected by the contaminant plume.

Groundwater quality farther south in Avondale appears to be poor. Wells #21 and #28 near the Del Rio site have poor quality due to high iron, nitrate, and TDS levels. Due to the cost of treating water from these wells, this master plan does not include a recommendation to add treatment and brine disposal at this site because there are lower cost alternatives to supply water.

Therefore, although monthly recharge and recovery has served the City well, the cost of well treatment will increase, and the City's reliance on a single recharge facility poses some risk.

Partner with the City of Goodyear on a Surface Water Treatment Plant

Partnering with another community to build and operate a surface water treatment plant may provide an opportunity for lower operating costs with economies of scale. However, in comparing the cost of treating Avondale water at the future Goodyear WTP, the cost for Avondale would be higher than the cost of a treatment plant in Avondale because of the capital cost of building a pipeline to Goodyear to deliver raw water, and the capital cost of constructing another pipeline back to Avondale to deliver treated water. Operating costs would be higher by the energy cost of pumping.

Teaming with another community on a treatment facility also poses risks. Some of the teaming arrangements between communities in Arizona work very well. Other teaming arrangements have been more difficult when the priorities of teaming partners do not align well.

Construct a City of Avondale WTP

Avondale can take SRP and CAP water from canals, laterals, and pipelines located in Avondale. The City's water can be wheeled through the SRP system so that a WTP in Avondale can be productively used for both CAP and SRP water. In the study: *Surface Water Treatment: Opportunities and Analyses, April 2007*, several sites were considered for a surface WTP. One location was the land immediately south of the Avondale recharge facility. Water could be delivered to the site through the Crystal Gardens ponds, although improvements would need to be made to provide sufficient capacity to the ponds and the pipeline(s) from the ponds. However, this space may be better used as a site for additional recharge capacity if the City was able to purchase the land.

SRP indicated that a site north of Interstate 10 would be better based on SRP's canal or pipeline conveyance capacity. However, water could be conveyed down 99th Avenue to sites just south of Interstate 10. There is undeveloped land with space for a WTP south of Interstate 10. Avondale has sufficient water supplies north of Interstate 10, but most of Avondale's future growth will be south of Interstate 10. Constructing a treatment plant south of Interstate 10 would make it easier to serve customers to the south.

Constructing a surface water treatment plant will require substantial capital costs; so, a surface water WTP will not be recommended in this master plan. However, the City should consider purchasing land at a suitable location for a surface water treatment plant in case the agreement with Phoenix does not work out at some future time, so the City would have a backup plan.

Wheel Water through the City of Phoenix Water System

One key benefit to Avondale for taking surface water through the City of Phoenix distribution system is that it provides another way to obtain potable water, which increases water system reliability. Avondale will have 14 mgd of annual average surface water that can be delivered through the Phoenix system by buildout, after commitments to the Crystal Gardens Lakes have been satisfied. Avondale would not have to rely solely on its recharge facility as a key to its water supply strategy.

The City of Phoenix can take delivery of Avondale's CAP and SRP water, treat the water at one of the Phoenix water treatment plants, then deliver it to Avondale through a distribution system interconnect. There is an existing City of Phoenix 24-inch transmission main located on the northern boundary of Avondale on Indian School Road. Another transmission main in the Phoenix system can deliver water to the central part of Avondale, although a 24-inch main approximately three miles long would be required to deliver the water. Phoenix has excess capacity in its infrastructure to treat and deliver Avondale water. Benefits to Phoenix include being able to recover costs of their infrastructure investment and increasing flows in the southwest portion of their water system to reduce total trihalomethane (TTHM) formation. Phoenix also has an interest in partnering with Avondale to store a portion of their water in Avondale's recharge facility. The cost of treatment and delivery of this water has not yet been negotiated, but is expected to be near $2.26/1,000 gal.

Avondale would deliver the water from Phoenix to the Garden Lakes Reservoir in Zone 1 where additional treatment to adjust pH or reduce TTHMs would take place before pumping into the distribution system. The water from Phoenix could also be used for blending to eliminate the need for nitrate treatment at this site. Water can also be delivered to the Del Rio site where similar treatment could take place. The Del Rio site has two wells that are not used due to water quality issues. Therefore the site is not currently in service, so delivering water to Del Rio provides a way to use this site, which has the largest storage reservoir in the Avondale water system. Further investigations would need to be undertaken to determine if these wells could be used if the water was blended with water from Phoenix. A third connection to the Phoenix water system was considered at the Gateway site. However, for this site to be viable, the Gateway site would need to be expanded, and Avondale would be dependent on Phoenix to construct a pipeline across the Loop 101 at approximately the Encanto alignment.

Avondale will need to manage relationships with other teaming partners that provide water supplies. However, similar regional collaborations, including those the City of Phoenix has made with the Cities of Tolleson and Anthem, have reportedly been going well.

4.5.2 Water Supply Recommendation

Avondale should proceed to develop an agreement with the City of Phoenix to wheel its water through the Phoenix water system for the following reasons:

- A surface water supply improves reliability because Avondale would have both a surface water and groundwater supply.
- The surface water supply is less expensive than the water treatment that would be required if Avondale relied completely on well water.
- Nitrate treatment at Garden Lakes would no longer be needed

Avondale will still need to continue developing wells in the near term. Avondale should also purchase land for a surface water treatment plant while land is available in the event that conditions change in the future and a surface water plant is needed.

The remainder of this 2018 IUMP water master plan is based on the assumption that the City successfully partners with Phoenix to wheel surface water and deliver it through distribution system interconnects.

4.5.3 Water Treatment Evaluation

A separate study was conducted to evaluate water quality at the Garden Lakes and Gateway sites when water from Phoenix is delivered to the sites. The results of this analysis are contained in Appendix C. A summary of the recommendations from this study are as follows:

- A 50:50 Phoenix water/groundwater blend ratio can be used to avoid both nitrate treatment and TTHM treatment. Using blending only, Wells #17, #27, and H need to deliver water to Garden Lakes to fully use 5 mgd of Phoenix water. Alternatively, the GAC contactors could be used to reduce the need for blending Phoenix water so that the Phoenix water supply could be fully used even if a well was out of service.
- A blend ratio of 50 percent Phoenix water, 10 percent Avondale well water, and 40 percent SRP well water can also be used to avoid nitrate and TTHM treatment.
- pH adjustment is needed to avoid corrosive water after blending in case the water pH is lower than 7.

- Assuming 10 mgd maximum discharge flowrate (5 mgd groundwater, 5 mgd Phoenix water) from the Garden Lakes site:
  - Two caustic soda storage tanks (10-foot high by 10-foot diameter) will be required for pH adjustment for one month storage capacity.
  - Four granular activated carbon (GAC) contactors (10-foot diameter, 10-foot media depth, and 0.6 mgd capacity, each) will be required to treat 40 percent (2 mgd) of Phoenix water. This allows full utilization of 5 mgd of Phoenix water even if Avondale wells are out of service.
- Assuming 10 mgd Phoenix water from Del Rio:
  - Two caustic soda storage tanks (10-foot height by 12-foot diameter) will be required for pH adjustment for one month storage capacity.
  - Six GAC contactors (12-foot diameter, 10-foot media depth, and 0.8 mgd capacity, each) will be required to treat 40 percent (4 mgd) of Phoenix water. This allows full utilization of 10 mgd of Phoenix water even if Avondale wells are out of service.

4.5.4 2018 Water Supply

Current water supplies are compared with the firm water supply for 2018 before the pressure zone boundary is created. Table 4.15 shows that the firm water supply is 18.6 mgd which is 2.3 mgd less than the maximum daily demand of 20.9 mgd. Therefore maximum day demands are currently being supplied by running wells more than 18 hours per day and running all the wells on a daily basis. To operate the wells at this rate operations staff have needed to make sure that wells are well maintained to avoid outages during summer months. Over the past ten years a major recession has forced many cities to avoid rate increases to pay for expanding infrastructure, so growth during this time period has stretched existing water supplies. Avondale has found itself in a similar situation, and now needs to catch up to construct water supplies that provide a sufficient level of redundancy.

4.5.5 Water Supply by Pressure Zone

Water supplies were evaluated to determine supply adequacy for each pressure zone. The water supply criterion for the Avondale water system requires a unique approach because of the different combinations of wells or Phoenix water supplies that could be out of service. Judgement is required to establish a reasonable level of performance that appropriately balances the cost of redundancy with the risk of a water supply interruption if one or more water supplies are out of service. In an emergency, water can be delivered from Zone 1 to Zone 2. In an emergency staff could allow water from Zone 2 to supply Zone 1, but with reduced pressures. Accordingly, water delivery across this zone boundary is considered in the evaluation.

For Zone 1, the following approach is taken for each water production site.

- **Northside**: The firm supply is with the largest well out of service, which is well 7C at 1700 gpm.
- **Gateway**: If Well 8A goes down, then the entire Gateway site is out of service, and Zone 1 will be supplied by other sites.
- **Garden Lakes**: If the site does not have GAC treatment, then the loss of a well supply will require a corresponding loss of surface water from Phoenix because the well to surface water blending ratio is 50:50. If the site does have GAC treatment, then the firm capacity is equal to the portion of surface water treated with GAC plus two times the well supply up to a maximum of five mgd plus 5 mgd from Phoenix.

Table 4.15 Water Production Capacity on 2018 for the Entire Avondale Water System

Water Supply Location	Supply Name	2017 Production Capacity (gpm)	2018 Production (mgd)
Distribution System	Well #23	800	1.2
Garden Lakes	Well #17	1,200	1.7
Gateway	Well #8A	2,000	2.9
	Well #24	750	1.1
Northside	Well #6	1,500	2.2
	Well #7	1,700	2.4
	Well #20	1,150	1.7
Coldwater	Well #15	600	0.9
	Well #16	1,950	2.8
	Well #25	1,150	1.6
Rancho Santa Fe	Well #10	1,900	2.7
	Well #11	1,395	2.0
	Well #12	1,900	2.7
	Well #19	1,500	2.2
	Well #18	1,800	2.6
Total Production Capacity		**21,295**	**30.6**
		Resilient Supply (18 hours/day)	23.0
		Firm Supply	17.7
		Maximum Day Demand	20.9
		Total City Surplus/(Deficit)	**(3.2)**

Note:
If Well #16 is out, then Well #15 and Well #25 will also be out of service due to blending requirements. The firm supply represents the supply with all of the Coldwater wells out of service.

For Zone 2, the following approach is taken for each water production site.

- **Rancho Santa Fe:** The firm supply is with Well #10 or Well #12 out of service.
- **Coldwater:** Before nitrate treatment is constructed at this site, if Well #16 is out of service, then the entire site is out of service. With nitrate treatment at this site, the firm capacity is the capacity with Well #16 out of service.
- **Del Rio:** If the water supply from Phoenix is interrupted, then maximum day demands would be supplied by the other wells.
- **New Roosevelt well treatment site:** The Roosevelt site is a proposed future facility that is intended to treat water from future Wells D and C and would be located near the intersection of 107th Avenue and Roosevelt, depending on where the City is able to purchase land. The firm capacity is the capacity with either Well D or Well C out of service.

It would be overly conservative to assume that only the firm supply at each site would be provided on a maximum demand day, so the worst case among each of the sites within a zone was considered in the water supply capacity analysis. Table 4.16 and Table 4.17 show the wells or surface water supplies that are needed for each zone through buildout, including redundancy. By Buildout, two additional wells are needed, and the location of these wells has not been identified. These wells would preferably be located in Zone 2 because additional water supply is needed in Zones 2 and 3 although it would be possible to locate additional wells in Zone 1. For planning purposes, these two additional wells are located near the Del Rio Facility and may or may not be the existing wells that are not currently in production.

4.6 Water Distribution System Evaluation

4.6.1 Water System Hydraulic Model

The City's water distribution model was recently updated and calibrated prior to the 2018 IUMP, Water demands in the model were adjusted to the future demand conditions as documented in Chapter 2. Scenarios were set up in the model for 2023, 2028, and buildout demand conditions.

The water distribution system was evaluated based on supply, storage, pumping, and pipe velocity criteria as described in Section 4.3. The model was also used to evaluate the ability of the system to deliver peak hour flow and fire flows.

4.6.2 Pressure Zones

The previously completed study *Pressure Zones Evaluation, August 2015,* includes a recommendation for a new pressure zone boundary to create a Zone 1 located primarily north of Interstate 10. The purpose for adding a pressure zone is to improve pressures in the northern part of Avondale, particularly in the northeast corner of the City. A preferred alternative was recommended in the document. However, City staff have two operational concerns associated with the pressure zone change: 1. The Gateway and Garden Lakes sites do not have sufficient water supplies to operate throughout the day to maintain pressures; and 2. The Rancho Santa Fe site, which has the lowest operating cost because treatment is not required for wells that deliver to that site will be used less while the Garden Lakes and Gateway site will be used more, significantly increasing annual operating costs.

Several changes are recommended to the pressure zone boundary that was proposed in the *2015 Pressure Zones Evaluation*, as follows:

1. The pressure zone boundary between Avondale Boulevard and 107th Avenue should be along Interstate 10 instead of McDowell Road because the land area north of Interstate 10 can be more easily served from Zone 1.
2. To maintain looping, connections should be made to the 16-inch mains at the intersection of 107th Avenue and Van Buren Street; and 119th Avenue and McDowell Road.
3. An additional closed valve will be needed on 119th Lane just north of McDowell Road.

The recommended pressure zone boundary is shown in Figure 4.2. The specific PRV stations, closed valves, and connecting pipes required to separate the zones are shown in Figure 4.5.

Table 4.16 Pressure Zone 1 Production Capacity

Water Supply Location	Supply Name	2017 Production Capacity (gpm)	2023 Production (mgd)	2028 Production (mgd)	Buildout Production (mgd)
Distribution System	Well #23	800	1.2	1.2	1.2
Garden Lakes	Well #17	1,200	1.7	1.7	1.7
	Well #27	1,200	1.7	1.7	1.7
	Phoenix Tie-in 1	3472	5.0	5.0	5.0
	New Well	1,200		1.7	1.7
Gateway	Well #8A	2,000	4.3	4.3	4.3
	Well #24	750	1.1	1.1	1.1
Northside	Well #6	1,500	2.2	2.2	2.2
	Well #7	1,700	2.4	2.4	2.4
	Well #20	1,150	1.7	1.7	1.7
	New Well A	1,200			1.7
	Total Production Capacity	**17,100**	**21.2**	**22.9**	**24.7**
		Reliable Supply (wells: 18 hours/day)	17.2	18.4	19.8
		Firm Supply	11.8	13.1	14.4
		Maximum Day Demand	9.8	10.4	12.0
		Surplus available to Zones 2, 3/(Deficit)	**2.0**	**2.7**	**2.3**

Abbreviation:
gpd/DU = gallons per day per dwelling unit

Table 4.17 Pressure Zone 2 and 3 Production Capacity

Water Supply Location	Supply Name	2017 Production Capacity (gpm)	2023 Production (mgd)	2028 Production (mgd)	Buildout Production (mgd)
Coldwater	Well #15	600	0.9	0.9	0.9
	Well #16	1,950	2.8	2.8	2.8
	Well #25	1,150	1.7	1.7	1.7
	Well #26	1,600	2.3	2.3	2.3
	Well #22	1,200			1.7
	New Well J	1,200			1.7
Rancho Santa Fe	Well #10	1,900	2.7	2.7	2.7
	Well #11	1,395	2.0	2.0	2.0
	Well #12	1,900	2.7	2.7	2.7
	Well #19	1,500	2.2	2.2	2.2
	Well #18	1,800	2.6	2.6	2.6
Del Rio	Phoenix Tie-in 2	2,800		9.0	9.0
New Roosevelt Treatment Site	New Well D	1,200			1.7
	New Well C	1,200			1.7
	New Well	1,200			1.7
	New Well	1,200			1.7
	Total Production Capacity	**18,995**	**19.9**	**19.9**	**39.2**
		Reliable Supply (18 hours/day)	14.9	14.9	31.6
		Firm Supply	10.9	10.9	28.8
		Maximum Day Demand	12.4	13.1	31.1
		Zone 1 Surplus/(Deficit)	**2.0**	**2.7**	**2.3**
		Total City Surplus/(Deficit)	**0.5**	**0.5**	**0.1**

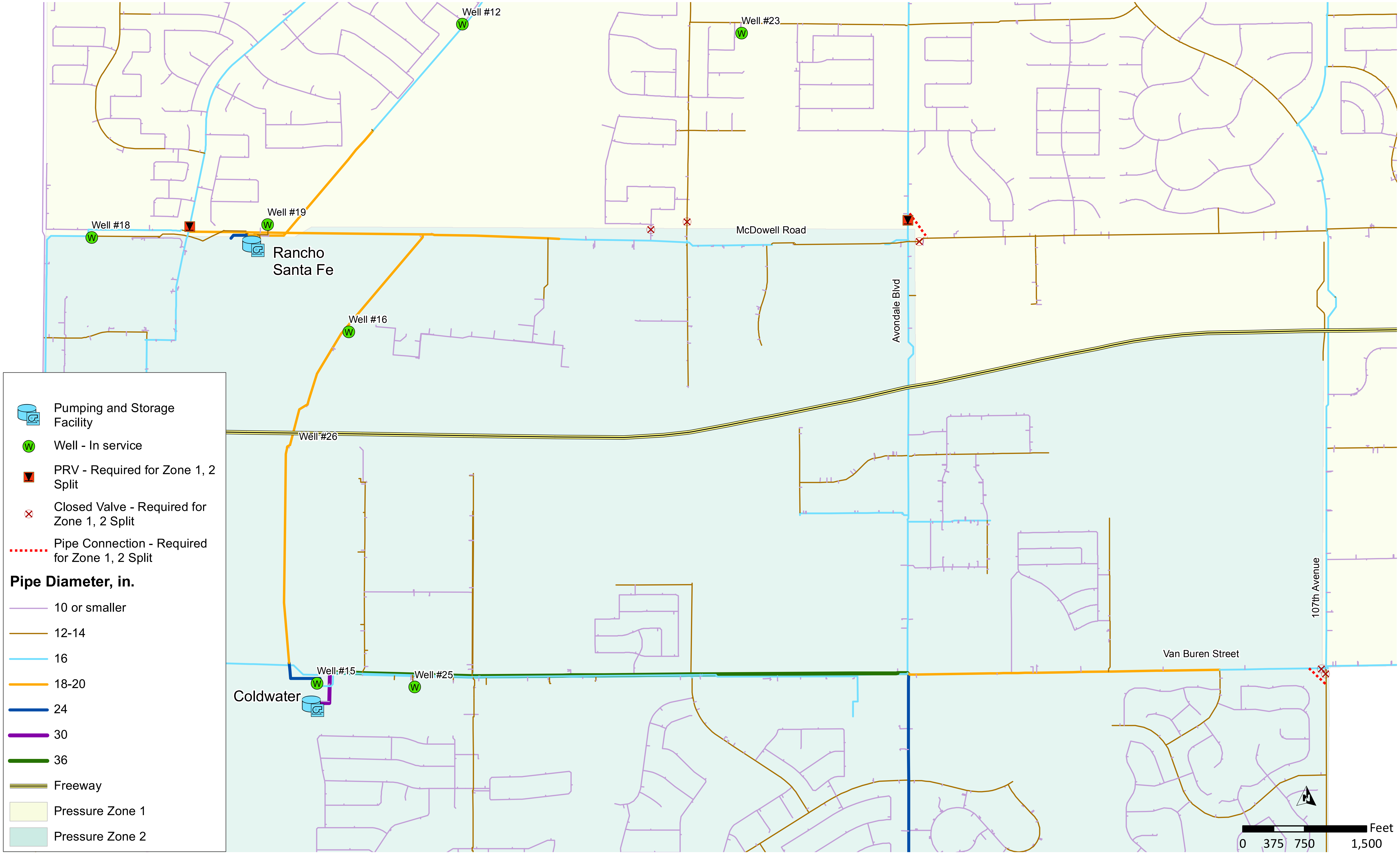

Figure 4.5 2023 PRV Stations, Closed Valves, and Connecting Pipes Required to Separate Zones 1 and 2

4.6.3 Storage

Water storage requirements are calculated for each pressure zone. Table 4.18 and Table 4.19 show the storage needs for the pressure zones for each planning period based on the City's storage criteria. In Table 4.19, the storage volume for Del Rio is combined for Zones 2 and 3, which share the storage volume at this site. The planning period when each new storage reservoir is needed is shown in the table. This storage evaluation shows that additional storage will be needed at Garden Lakes, Coldwater, the proposed well treatment site called Roosevelt, and Del Rio by buildout. The reservoir sizes for Garden Lakes, Coldwater, and Del Rio are master planned into the sites of these facilities.

Table 4.18 Pressure Zone 1 Storage Capacity Analysis

Reservoir Name	2017 Storage (MG)	2023 Storage (MG)	2028 Storage (MG)	Buildout Storage (MG)
Northside	1.1	1.1	1.1	1.1
Gateway	0.8	0.8	0.8	0.8
Garden Lakes	1.3	1.3	2.8	2.8
Total	**3.2**	**3.2**	**4.7**	**4.7**
Max Day Demand	9.1	9.8	10.4	12.0
Production Capacity	9.8	11.8	15.5	18.1
Operating Storage	**1.8**	**2.0**	**2.1**	**2.4**
Fire Storage	**0.9**	**0.6**	**0.0**	**0.0**
Peak Hour Storage	**3.1**	**3.2**	**2.9**	**3.3**
Emergency Storage	**2.3**	**1.9**	**0.6**	**0.6**
Storage Requirement	**3.1**	**3.2**	**2.9**	**3.3**
Surplus/(Deficit)	**0.1**	**0.0**	**1.8**	**1.4**

Table 4.19 Pressure Zone 2 and Zone 3 Storage Capacity Analysis

Reservoir Name	2017 Storage (MG)	2023 Storage (MG)	2028 Storage (MG)	Buildout Storage (MG)
Rancho Santa Fe	2.1	2.1	2.1	2.1
Coldwater	3.2	3.2	3.2	4.8
Del Rio	0	0	0	7.0
New Roosevelt Facility to Zone 2	0.0	0.0	0.0	2.0
Total	**5.3**	**5.3**	**5.3**	**16.0**
Max Day Demand	11.8	12.5	13.1	31.1
Production Capacity	13.2	14.9	14.9	26.8
Operating Storage	**2.4**	**2.5**	**2.6**	**6.2**
Fire Storage	**0.8**	**0.6**	**0.7**	**1.9**
Peak Hour Storage	**4.0**	**4.1**	**4.4**	**11.8**
Emergency Storage	**2.8**	**2.5**	**2.9**	**11.0**
Maximum Storage Requirement	**4.0**	**4.1**	**4.4**	**11.8**
Surplus/(Deficit)	**1.3**	**1.2**	**0.9**	**4.2**

4.6.4 Pumping

Pumping requirements were calculated for each pressure zone. Pumping capacity requirements are shown in Table 4.20, Table 4.21, and Table 4.22. By buildout, additional pumping capacity will be required at Garden Lakes, a new facility serving Zone 2, and an additional pump station serving Zone 3 at the Del Rio site.

4.6.5 Pipelines

Additional pipelines were added to the model of the distribution system for the 2023, 2028, and buildout planning periods to provide service to growth areas. Figure 4.6, Figure 4.7, and Figure 4.8 present the new pipelines that are recommended for each planning period.

The water pipe velocities are acceptable through buildout without increasing the pipe capacity.

Table 4.20 Pressure Zone 1 Pumping Capacity

Pump Station	2017 Total Pumping Capacity (mgd)	2017 Firm Pumping Capacity (mgd)	2023 Firm Pumping Capacity (mgd)	2028 Firm Pumping Capacity (mgd)	Buildout Firm Pumping Capacity (mgd)
Well 23	1.2	1.2	1.2	1.2	1.2
Garden Lakes	9.4	6.5	9.4	15.0	15.0
Gateway	11.5	8.6	8.6	8.6	8.6
Northside	10.4	7.8	7.8	7.8	7.8
Total	**32.4**	**24.0**	**27.0**	**32.6**	**32.6**
Peak Hour Demand		14.3	15.4	16.3	18.9
Surplus available to Zones 2, 3/(Deficit)		**9.7**	**11.6**	**16.3**	**13.7**

Table 4.21 Pressure Zone 2 Pumping Capacity

Pump Station	2017 Total Pumping Capacity (mgd)	2017 Firm Pumping Capacity (mgd)	2023 Firm Pumping Capacity (mgd)	2028 Firm Pumping Capacity mgd)	Buildout Firm Pumping Capacity (mgd)
Coldwater	23.0	17.3	17.3	17.3	17.3
Rancho Santa Fe	12.1	8.9	8.9	8.9	8.9
Del Rio Zone 2	14.4	0	0	8.6	8.6
New Roosevelt Facility	0.0	0	0	0.0	8.0
Total	**49.5**	**26.2**	**26.2**	**26.2**	**42.8**
Peak Hour Demand		17.7	18.5	19.2	35.9
Zone 1 Surplus		**9.7**	**11.6**	**16.3**	**13.7**
Surplus available to Zone 3/(Deficit)		**18.2**	**19.3**	**23.2**	**20.7**

Table 4.22 Pressure Zone 3 Pumping Capacity

Pump Station	2017 Total Pumping Capacity (mgd)	2017 Firm Pumping Capacity (mgd)	2023 Firm Pumping Capacity (mgd)	2028 Firm Pumping Capacity (mgd)	Buildout Firm Pumping Capacity (mgd)
Del Rio Zone 3	0.0	0.0	0.0	2.0	8.0
Total	**0.0**	**0.0**	**0.0**	**2.0**	**8.0**
Peak Hour Demand		0.8	1.0	1.3	13.0
Zone 2 Surplus Through 2 PRVs		**18.2**	**19.3**	**23.2**	**10.0**
Surplus/(Deficit)		**17.4**	**18.3**	**21.9**	**5.1**

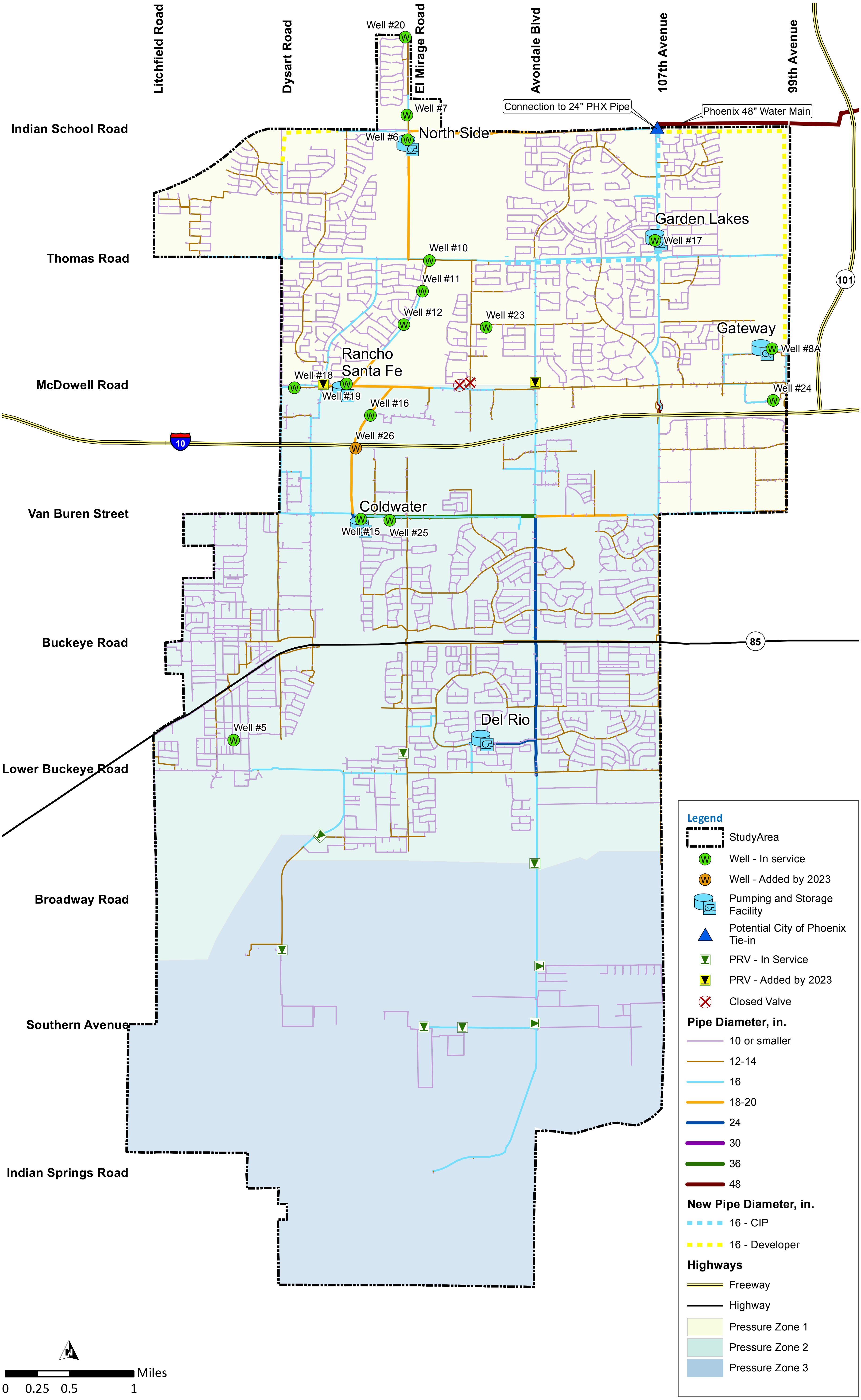

Figure 4.6 2023 Water System Infrastructure

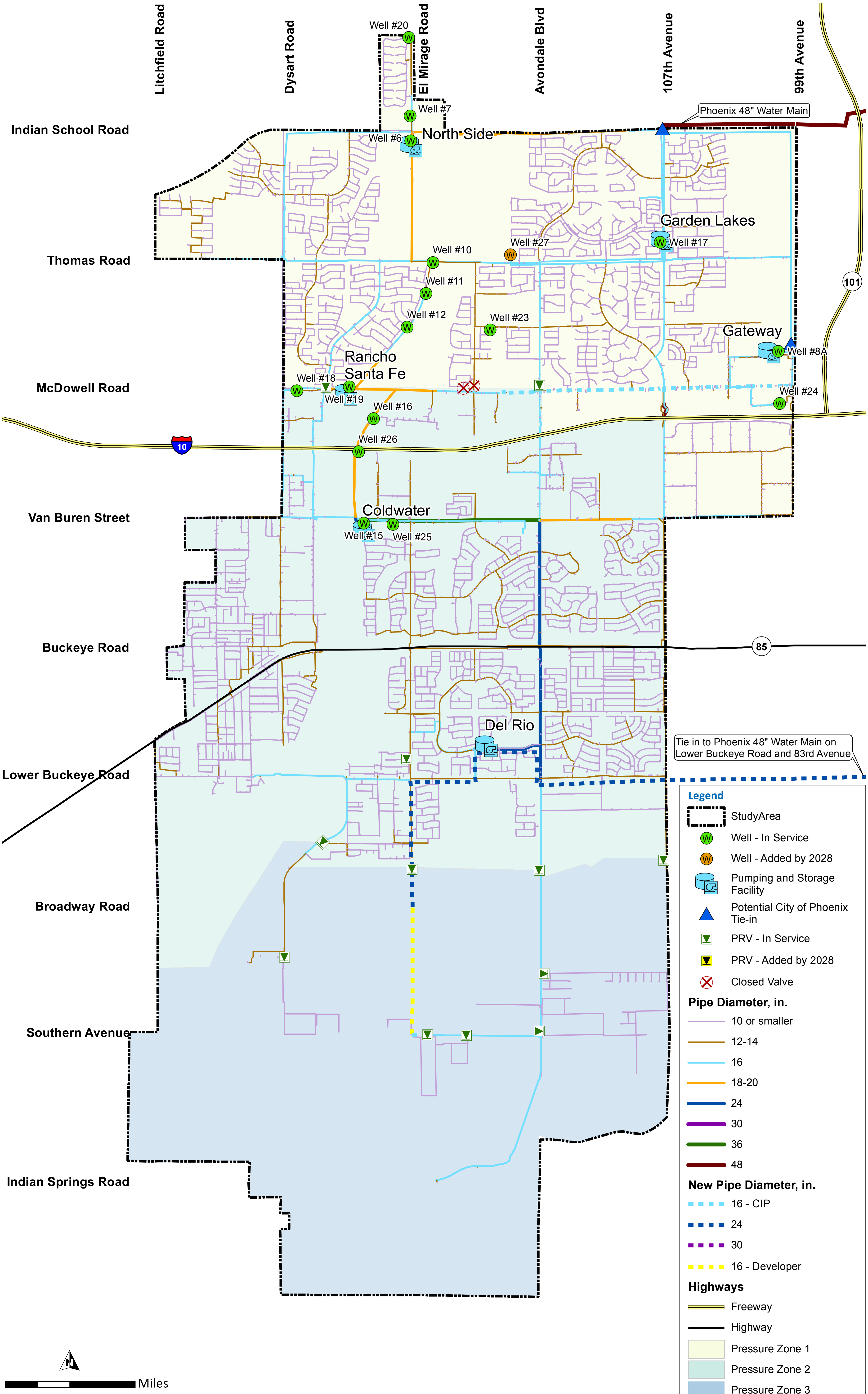

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Figure 4.7 2028 Water System Infrastructure

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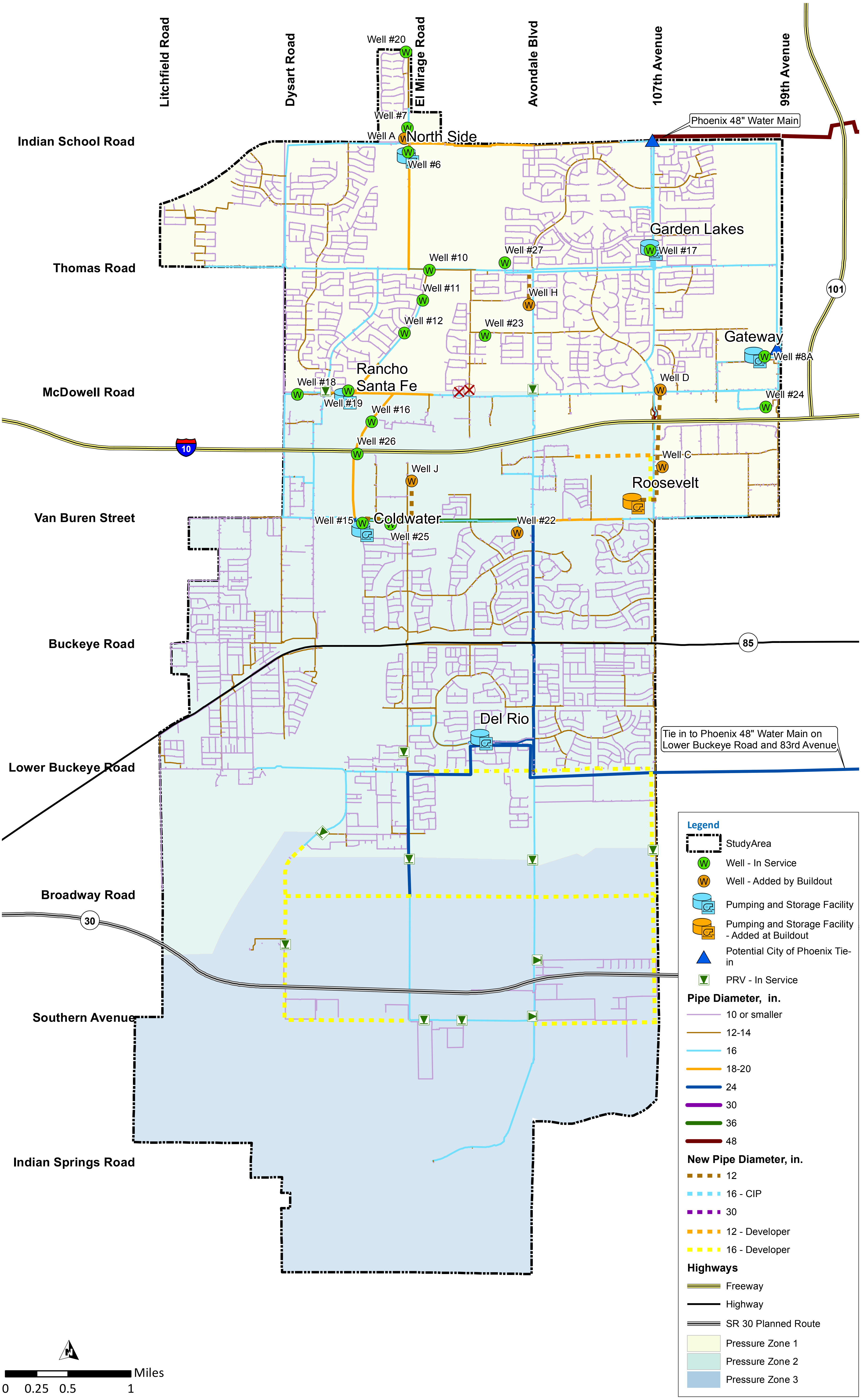

Figure 4.8 Buildout Water System Infrastructure

4.6.6 Pipeline Velocities

The water system was evaluated to determine if pipeline velocities at buildout, peak hour conditions resulted in flows that are 7 feet per second (ft/sec) or less. This criteria was satisfied for all pipes in the distribution system without requiring mains to be upsized. Figure 4.9 presents the peak hourly water velocities at buildout.

4.6.7 Fire Flows

The hydraulic model was used to evaluate fire flows in the water distribution system by buildout. Fire flows were set to residential flows of 1,500 gpm or commercial flows of 3,500 gpm based on the land use plan. Figure 4.10 presents the results of the fire flow analysis. The water distribution system appears to be able to provide fire flows, with the exception of several hydrants located primarily on dead end mains.

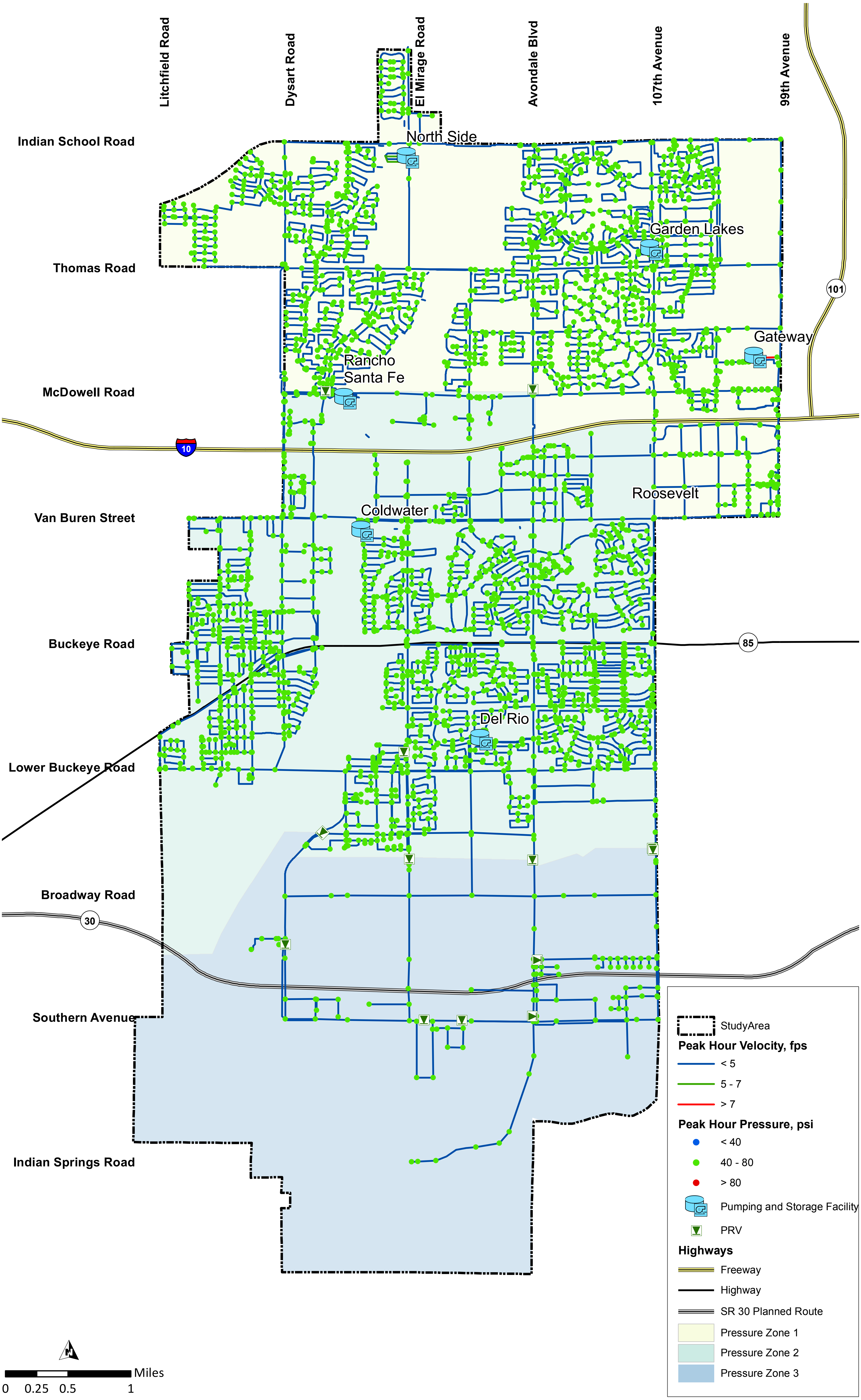

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Figure 4.9 Peak Hour Pressures and Velocities at Buildout with Proposed Infrastructure

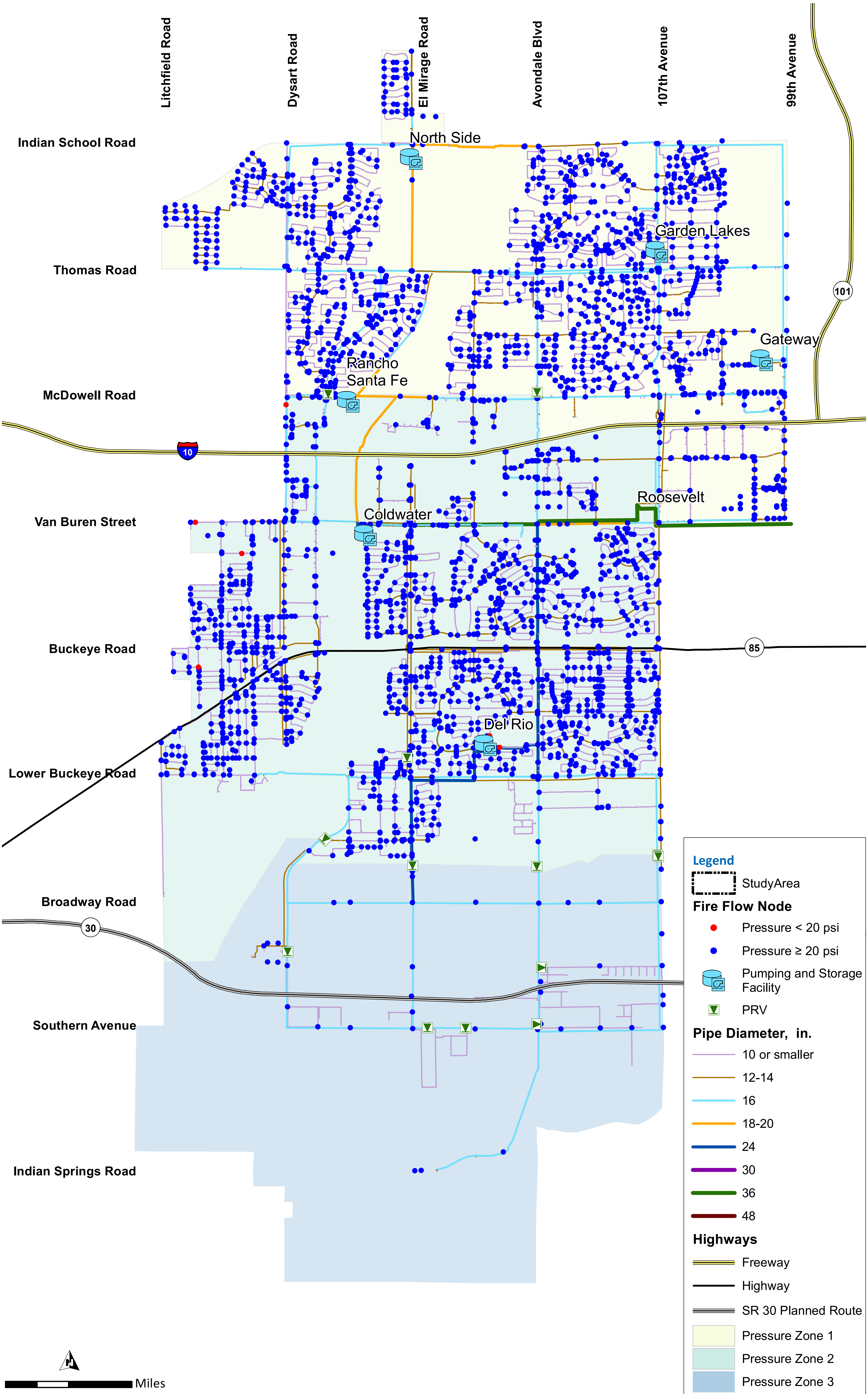

Figure 4.10 Fire Flow Results at Buildout

4.7 Recommendation Summary

The following improvements are recommended for each planning period:

2018 through 2023

1. Complete an agreement with Phoenix to deliver water to Avondale via the Garden Lakes and Del Rio connections.
2. Construct the pipelines, pH adjustment, and TTHM treatment at Garden Lakes needed to provide water wheeled through the Phoenix system into the Avondale water distribution system.
3. Purchase land for Well A near the Northside facility.
4. Construct Well #27 and deliver the water to the Garden Lakes site.
5. Implement the new pressure zone boundary to have a separate Zone 1 and Zone 2.
6. Construct improvements to the McDowell Road recharge facility diversion structure and pipelines to improve water delivery.
7. Replace the nitrate treatment system at the Gateway facility.
8. Construct a 16-inch water line along McDowell Road from 117th Avenue to Avondale Boulevard.
9. Construct a 12-inch water line along Dysart Road from Whyman Road to Lower Buckeye Road.
10. Purchase land for a future water treatment site near 107th Avenue and Roosevelt Street.
11. Rehabilitate the Northside arsenic treatment system.
12. Construct a 16-inch water line along 99th Avenue from Thomas Road to Encanto Boulevard.

2024 through 2028

1. Increase the storage and pumping capacity at the Garden Lakes facility.
2. Construct a 16-inch main along McDowell Road in Zone 1 from Avondale Boulevard to 99th Avenue.
3. Construct future well.
4. Construct a nitrate removal facility at the Coldwater facility.
5. Construct future well.

2029 through Buildout

1. Equip Well #22 to deliver water to the Coldwater facility.
2. Construct Well J, connect to the Coldwater facility, and expand nitrate treatment.
3. Construct Well A and connect to the Northside facility.
4. Rehabilitate infrastructure at the Del Rio facility.
5. Construct the connection from the Phoenix water system to the Del Rio facility.
6. Construct Well C and Well D and connect to a new treatment facility.
7. Expand pumping and storage capacity at the Del Rio facility.
8. Construct future well
9. Construct future well

Chapter 5

WASTEWATER INFRASTRUCTURE MASTER PLAN

5.1 Introduction

This report chapter is the wastewater portion of the City's 2018 Integrated Utility Master Plan (2018 IUMP). The larger interceptors in the wastewater system are mostly in place, but the purpose of this plan is to verify pipe sizes through buildout, establish timing for the Wolf Water Resource Facility (WRF) expansion, and identify any major interceptors that may still be required. This plan was prepared using updated wastewater flows that were developed from measured wastewater flows gathered during a field test as well as recent studies where the City gathered wastewater flows.

This plan includes the following sections:

1. The wastewater system description summarizing the existing collection system service area and infrastructure.
2. The wastewater system performance criterion defining the measure of acceptability against which the collection system is evaluated.
3. The model development section describing how the model was created and calibrated for use in the 2018 IUMP.
4. The collection system capacity evaluation containing results of analyses to determine collection system capacity, and to identify where additional mains will be needed to serve future growth.
5. Conclusions and recommendations summarizing the findings of the wastewater system analysis.

5.2 Wastewater System Description

5.2.1 Study Area

The wastewater service area comprises the entirety of the northern municipal planning area down to the Estrella Mountains. The southern planning area that includes part of the Estrella Mountains and goes down into Rainbow Valley is not included in this analysis. The service area includes several areas served by septic systems where the homes were constructed before the City provided sewer service to these areas. This plan is based on the assumption that these areas convert over to City sewer service by buildout, although the City is not making any efforts to convert these areas at the present time. Liberty Utilities also provides service to several small areas in the northwest part of Avondale. Figure 5.1 shows Avondale's current wastewater service area, septic areas, and floodplains.

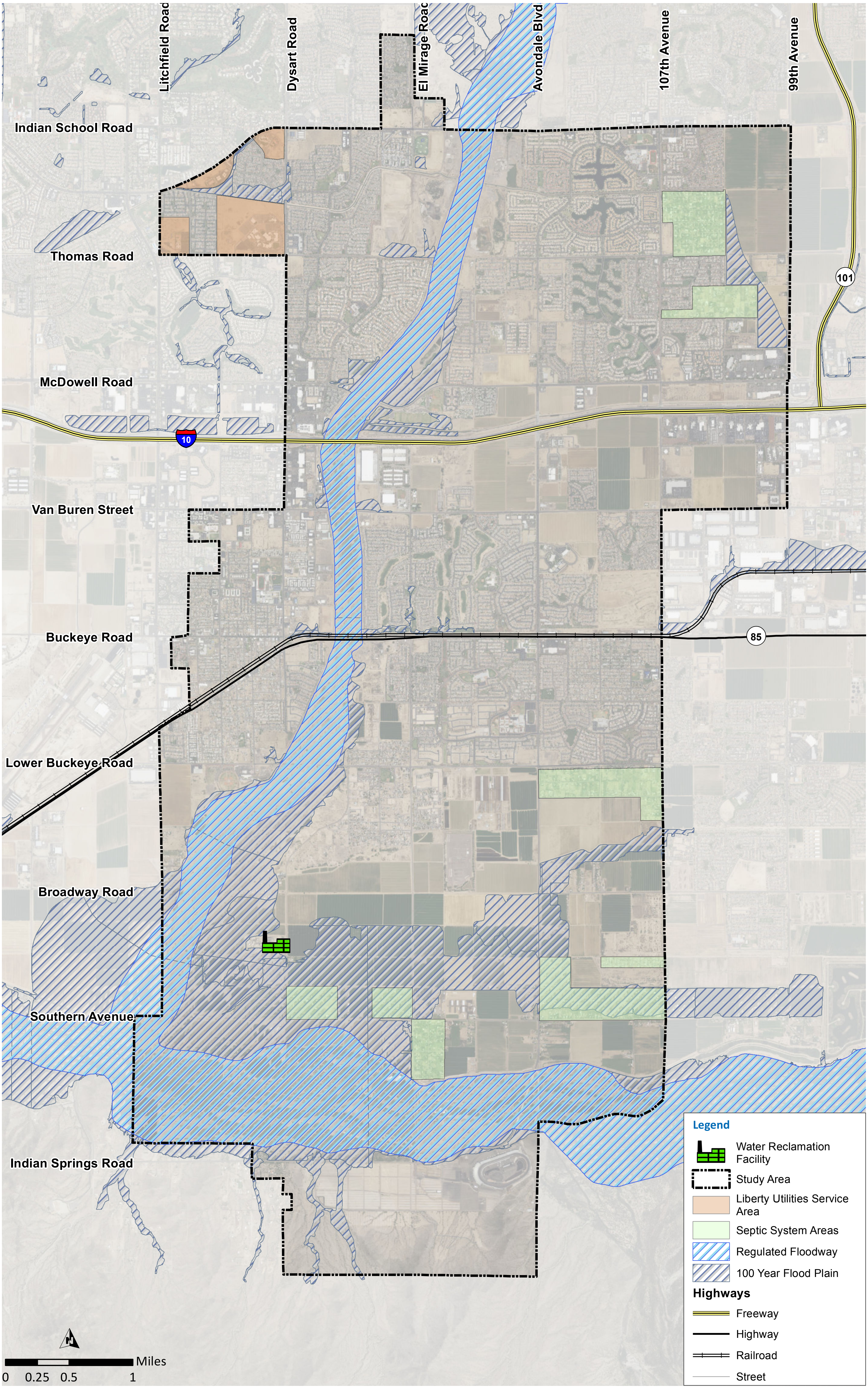

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Figure 5.1 Wastewater Collection System Service Area

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5.2.2 Water Reclamation Facility

The Avondale Water Reclamation Facility (WRF) is named the Charles M. Wolf Water Resource Center, and is located on Dysart Road south of Broadway Road alignment. Wastewater in conveyed to the facility through two interceptors (36-inch and 48-inch) that enter the facility from the east. The current treatment capacity is a maximum month average daily flow (MMADF) of 9.0 million gallons per day (mgd). The 2016 average annual daily flow to the Avondale WRF is 5.6 mgd. The City is currently completing an operational improvement project at the WRF, which will not increase plant capacity. The Phase 2 expansion of the plant is planned to bring the capacity up to 12 mgd. The design for the Phase 2 expansion will be triggered when the MMADF reaches 7.2 mgd. The final Phase 3 expansion is planned to bring the final plant capacity up to 15 mgd. Reclaimed water generated at the WRF is pumped to the City's McDowell Road recharge facility located north of McDowell Road and east of the Aqua Fria River. A master plan for this WRF was completed in January 2015.

5.2.3 Lift Stations and Force Mains

The City currently has 10 lift stations. There are nearly 6.5 miles of force mains associated with the City's lift stations, which range in size from 2 to 16 inches in diameter. A summary of the lift stations including a description of equipment, design flows, and operational set points is presented in Table 5.1.

5.2.4 Gravity Sewer Pipes

The City's sewer collection system contains over 235 miles of gravity sewer pipes, ranging in size from 4 to 48 inches in diameter. Figure 5.2 presents the wastewater collection system pipes.

Table 5.1 Avondale Lift Stations

Lift Station	Address	Firm Capacity (gpm)	Wet Well Depth (ft)	Wet Well Diameter (ft)	Pump #	Pump hp	Capacity (gpm)	TDH (ft)	Lead On (ft)	Lead Off (ft)	Lag 1 On (ft)	Lag 1 Off (ft)	Lag 2 On (ft)	Lag 2 Off (ft)
4th Street	399 East Lower Buckeye Road	3,200	21	7 x 25	1	5	Wet Well Drain		3.25	3.00	3.75	3.00	4.25	3.00
				(rectangular)	2	20	1,600	34						
					3	20	1,600	34						
					4	20	1,600	34						
10th Street	1477 N. Eliseo Felix Jr. Way	1,150	26	10	1	15	575	45	6.50	5.00	7.00	5.20	7.50	5.00
					2	15	575	45						
					3	20	1,600	32						
Central	1410 N. Central Avenue	200	27	8	1	5	200	24	4.20	2.50	5.30	3.00	-	-
					2	5	200	24						
Donatela	2100 N. 120th Drive	350	21	8	1	5	350	25	4.50	3.00	5.00	3.00	-	-
					2	5	350	25						
Friendship Park	12325 W. McDowell Road	140	16.9	6	1	5	140	30	Float 2	Float 1	Float 3	Float 1	-	-
					2	5	140	30						
Fulton	13501 W. Verde Lane	210	25	8	1	7.5	210	48	5.50	3.70	6.00	4.00	-	-
					2	7.5	210	48						
Littleton	1431 S. 107th Drive	30	22	8	1	2.7	30	40	3.50	3.00	4.50	3.50	-	-
					2	2.7	30	40						
PIR	12121 W. Indian Springs Road	2,200	31.6	11.5 x 10.5	1	140	2,200	160	10.20	8.00	-	-	-	-
				(rectangular)	2	140	2,200	160						
Riley	809 E. Riley Road	200	18.5	8	1	5	200	24	3.50	2.50	4.00	2.50	-	-
					2	5	200	24						
Whyman	1010 S. Dysart Road	200	22	6	1	5	200	34	8.00	4.50	9.00	4.50	-	-
					2	5	200	34						

Abbreviations:
gpm = gallons per minute; ft = foot/feet; hp = horsepower; TDH = total dynamic head; PIR = Phoenix International Raceway

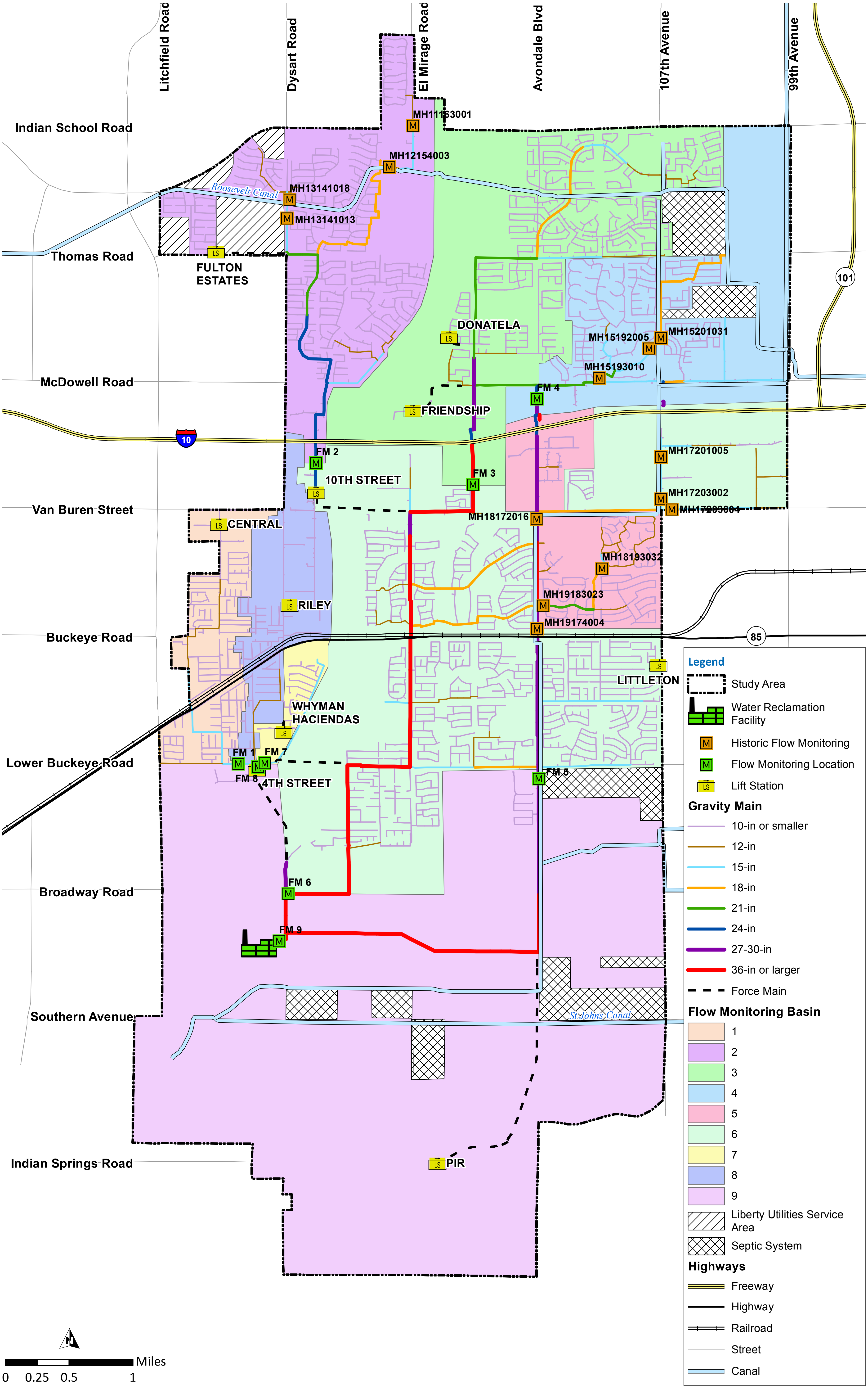

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Figure 5.2 Wastewater Collection System

5.3 Wastewater System Performance Criteria

This section describes the "standards of measurement" that were used to evaluate the performance of the existing wastewater system, as well as define the capacity requirements of future improvements. The City previously prepared a General Engineering Requirements Manual that includes capacity requirements for the wastewater collection system. The criterion in this manual was prepared to comply with requirements from the United States Environmental Protection Agency (USEPA) the Arizona Administrative Code (A.A.C.), City design standards, and common engineering practices. The performance criteria in this master plan comply with the City's General Engineering Requirements manual.

5.3.1 Gravity Sewer Pipes

Sewer capacities are dependent on several factors including pipe roughness, maximum allowable flow depth, and pipe slope. Manning's Equation is used to calculate energy losses in pipes. The Manning's coefficient 'n' is a friction coefficient that influences energy losses and is an indication of pipe roughness, that varies with pipe material, diameter, smoothness of joints, root intrusion, and other factors. For gravity sewers, the Manning's coefficient ranges between 0.011 and 0.017. For planning purposes, an 'n' value of 0.013 was used for this project. Arizona Department of Environmental Quality (ADEQ), requires an "n" of 0.013 for the design of all new construction, as documented in A.A.C. R18-9-E301-D.

Sewer capacity criterion is expressed as a ratio of maximum depth of dry weather flow to pipe diameter (d/D). The flow depth criterion for new mains with diameters less than 12 inches is 0.5. The d/D criteria for the design of new pipes with diameters 12 inches and greater is 0.75. However, existing mains are evaluated based on a d/D of 0.9 because there is no need to replace an existing pipe until flows are close to the pipe capacity. This approach avoids the problem of replacing or upgrading existing mains prematurely.

The following applies to sewer gravity main design:

- Gravity sewers should be designed and constructed to have a minimum of 5 feet of cover and sufficient depth to serve the ultimate drainage area.
- Gravity sewers and force mains should have a minimum separation of 6 feet from potable water mains unless they are encased in concrete as per ADEQ requirements.
- Manholes with sewers intersecting at greater than or equal to 90-degree angles should provide 0.2 foot of invert drop across the manhole.

5.3.2 Manholes

Manholes should be spaced according to the maximum allowable manhole spacing shown in Table 5.2.

Table 5.2 Recommended Maximum Manhole Spacing

Pipe Size (inches)	Maximum Spacing (feet)
8 to 10	400
12 to 21	500
24 and larger	600

5.3.3 Minimum Pipe Slopes

A minimum velocity of 2 feet per second (fps) is recommended when the pipe is flowing half full to provide sufficient scour velocity to prevent solids from settling. At this velocity, sewer flows will typically provide self-cleaning for the pipe. Due to the hydraulics of a circular pipe, the velocity for half pipe flow approaches the velocity of nearly full pipe flow. Table 5.3 lists the minimum slopes for maintaining self-cleaning velocities with d/D = 0.5 or 1.0. The minimum slope listed in Table 5.3 is 0.0008 ft/ft, which is the minimum practical slope for gravity sewer construction. Greater slopes are desirable where possible.

ADEQ regulations require velocities not to exceed 10 fps in gravity sewer mains (A.A.C. R18-9-E301-D).

When laying out new pipe and a smaller sewer joins a larger sewer, the invert of the larger sewer will be lowered sufficiently to maintain the same energy gradient. For master planning purposes, proposed sewer inverts were matched at manholes when smaller sewers joined a larger sewer and the minimum velocity criteria cited above was used when sizing pipes.

5.3.4 Lift Stations

Lift stations should have sufficient firm capacity to deliver peak hour flows plus expected inflow and infiltration when the collection basin served by the lift station is fully developed.

The wet well fill time, based on average flows, is used to size the lift station wet well. The effective volume of the wet well shall provide a holding period not to exceed thirty minutes for the design average flow. When selecting the minimum cycle time, the pump manufacturer's duty cycle recommendations shall be utilized. Start and stop times higher than seven (7) times an hour for any one pump are not recommended.

Lift stations should have backup power generation to prevent spills and overflows during power outages when flows could overflow wet wells or nearby manholes.

5.3.5 Force Mains

Force mains should be sized to have water velocities between 3 and 7 fps to provide a scour velocity high enough to prevent solids from settling in the force main.

Manholes where force mains discharge into should be constructed with corrosion resistant materials to prevent damage from hydrogen sulfide gas. Force mains should discharge into manholes in a manner that prevents raw sewage from splashing against the manhole walls and releasing odors.

5.3.6 Wet Weather Peak Factors

The Arizona Administrative Code requires that a sewer system be able to convey the peak wet weather flow. One way to accomplish this is by adding a wet weather infiltration and inflow peaking factor rate based on a percentage of dry weather flow on top of base design flows. Avondale is in an arid area that does not have frequent rainfall, so the exact inflow and infiltration rate is unknown. A wet weather peaking factor of 1.4 was applied in this study as a conservative estimate.

5.3.7 Water Reclamation Facilities

Maricopa County has the responsibility to enforce state regulations on water quality, and these regulations require that for the Avondale WRF, design for a capacity expansion must occur the average daily maximum month flow reaches 80 percent of the rated design capacity. Construction of the expansion needs to have commenced once the average daily maximum month flow reaches 90 percent of the rated design capacity. The Avondale WRF is currently rated at 9 mgd. Accordingly the next expansion needs to be under design when the MMADF flows reach 7.2 mgd and construction needs to be started before flows reach 8.1 mgd.

5.3.8 Criteria Summary

Table 5.3 summarizes the collection system performance criteria used in this master plan.

Table 5.3 Wastewater System Performance Criteria Summary

Pipe Size (inches)	Minimum Slope[1] (ft/ft)	Pipe Capacity[2]	
		(mgd)	(gpm)
8	0.0040	0.45	313
10	0.0025	0.70	486
12	0.0020	1.02	708
15	0.0015	1.59	1,104
18	0.0012	2.28	1,583
21	0.0010	3.11	2,160
>=24	0.0008	4.06	2,819

Notes:
(1) Mains larger than 24 inches should still have a slope no less than 0.0008
(2) Pipe Capacity based on full pipe flow or d/D = 1.0.
(3) Table assumes Manning's n coefficient of 0.013

Flow Velocity	
Gravity Pipes	2 fps ≤ V ≤ 10 fps
Force Mains	3 fps ≤ V ≤ 7 fps
Flow Depth, d/D	
d/D for New Sewer Pipes - Peak Dry Weather Flow (< 12 inches)	= 0.50
d/D for New Sewer Pipes - Peak Dry Weather Flow (≥ 12 inches)	= 0.75
d/D for Evaluating Existing Mains - Peak Dry Weather Flow	= 0.90
Wet Weather Peaking Factor	1.4
Pipe Head Loss	
Gravity Pipes	Manning's n = 0.013
Pressure Pipes	Hazen William's C = 120
Changes in Pipe Size	
When a smaller sewer joins a larger one	Sewer crowns will be matched
Elevation Drop in Manholes	
Manholes with pipelines intersecting at 90 degrees or greater	Provide 0.2' Invert Drop

5.4 Model Development

A new wastewater system hydraulic model was created for the 2018 IUMP. The collection system hydraulic model uses the InfoSewer software by Innovyze. The following sections describe how the model was created and validated.

Several data sources were provided by the City and were used to create the wastewater model. A description of each data source that was used is listed below:

- Geographic Information System (GIS) Data - Pipe attributes and topology information came from GIS data layers. Manhole locations, ground elevation contours, and lift station locations also came from the GIS.
- Lift Station Data - the attribute data for each lift station including the number and size of pumps, pump controls, wet well dimensions, and force main diameters was obtained from the City's wastewater operations personnel.
- Operations Data - wastewater collection system flow data came from supervisory control and data acquisition (SCADA) data and flow monitoring data from field tests.

The wastewater model represents all sewer pipes in the GIS and all lift stations and force mains. The model is an "all pipes" model, meaning that all system pipes (excluding service connections) are represented. A quality review of the GIS data was performed using tools in the modeling software to verify pipe connectivity, topology, and collection basin boundaries.

5.4.1 Pipe Invert Elevations

Pipe invert elevations were taken from the City's GIS data and reviewed in the model using network review tools in the software. These tools identify pipes with adverse or flat pipe slopes and missing connectivity between manholes and pipes. Elevation discrepancies were noted along major interceptors and the City completed updates to manhole invert elevations along these interceptors. Adjustments to manhole inverts were made to smaller collectors to align with adjustments made to the interceptors.

5.4.2 Future Facilities

Model scenarios were created for planning years 2017 (current), 2023, 2028, and buildout. The locations of future facilities, including new collection mains or lift stations, correlated with the 5- and 10-year growth areas used in this 2018 IUMP. Growth over the first 5-year planning period is expected to be primarily infill and development north of Interstate 10. Growth over the next 5-year period is expected to be the land areas to the south of existing development, including Lakin Ranch. Growth to buildout includes the land areas on either side of the proposed Highway 30.

5.4.3 Wastewater Flows

Current average annual daily wastewater flows (AADF) were calculated based on the ratio of the City's annual average water demand from billing records to the annual average wastewater flow. Adjustments to the water to wastewater ratio were then made for each land use type based on the indoor/outdoor water use characteristics of each land use type. Wastewater flows were then calculated for each water customer meter.

Wastewater flows were allocated in the model by geographically referencing the City's water meter locations to the nearest manhole. Further refinements to the wastewater unit flows were made in the model calibration process. This method of distributing wastewater flows provides the accuracy needed to evaluate pipe capacity.

Future wastewater flows were developed using the aggregated unit wastewater flow of 203 gal/parcel/day for undeveloped lands. This value is based on the water demand value of 450 gallons per day per dwelling unit (gpd/DU) and the water to wastewater percentage of 45 percent as presented in Chapter 2. Buildout flows were allocated based on the unit loads also discussed in Chapter 2. These flows were allocated using the geographical location of future development in the 5- and 10-year planning periods. These flows were added to the existing customer flows in the model.

Diurnal peaking factors were applied using data from the flow monitoring field test conducted for the 2018 IUMP to estimate dry weather peaking factors. A wet weather peaking factor of 1.4 was applied system wide to evaluate potential impacts from storm events.

5.4.3.1 Flow Monitoring

Wastewater flow monitoring was conducted to obtain flow data to calibrate the model and to establish flows in the model. Section 2.3.1.2 in Chapter 2 contains a discussion of flow monitoring.

5.4.3.2 Model Calibration

Model calibration is an iterative process whereby adjustments are made to model inputs until the flow rate, flow depth, and velocity at the flow monitoring locations those observed during the flow monitoring field studies.

Flows in the model were adjusted in each flow monitoring basin to match the average flows observed during the field tests. Flows were also adjusted in upstream basins to improve the correlation between field test data and model results in downstream basins. Diurnal patterns were also adjusted to help match the timing of the modeled flow peaks with the observed flow peaks for the calibration day. Figure 5.3 presents an example of flow, depth, and velocity calibration graphs for flow monitoring basin 1.

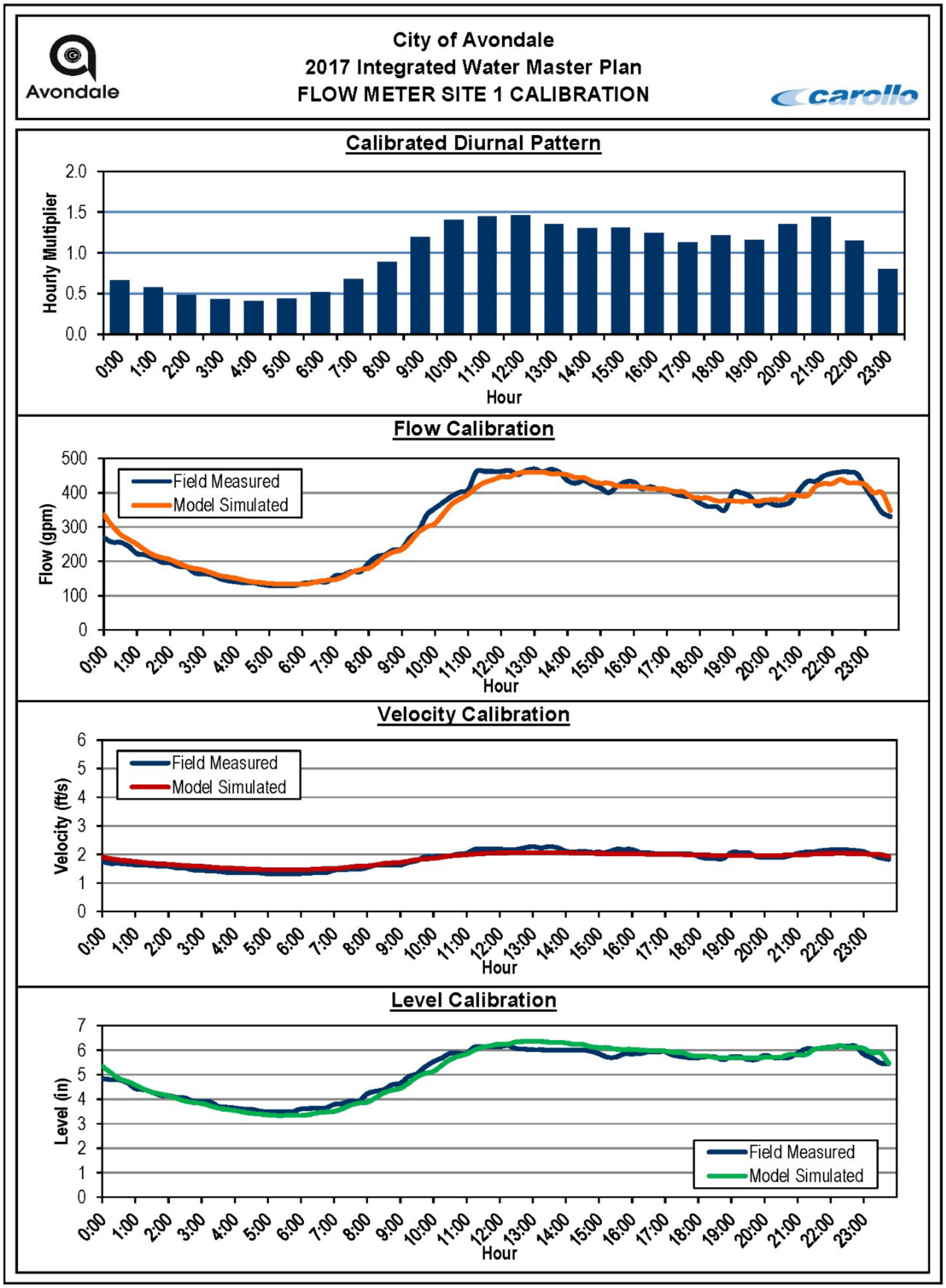

Figure 5.3 Example Model Calibration Graph

Table 5.4 shows the average flows observed during the flow monitoring compared to the average flow calculated in the model for each flow monitoring basin.

Table 5.4 Calibration Results

Flow Basin	Average Flow (gpm)		Difference		Peak Flow		Difference	
	Field	Model	(gpm)	(%)	Field	Model	(gpm)	(%)
1	293	319.1	26	9%	464.7	457.6	-7	-2%
2	1,002	1,003.5	2	0%	1,445.5	1,391.5	-54	-4%
3	674	673.3	-1	0%	1,062.3	998.4	-64	-6%
4	381	362.5	-19	-5%	558.6	509.4	-49	-9%
5	428	476.3	49	11%	636.6	681.3	45	7%
6	2,689	2,845.7	157	6%	4,523.5	4,182.3	-341	-8%
7	64	64.5	0	0%	104	100.9	-3	-3%
8	834	819.8	-14	-2%	1193.9	1,129.8	-64	-5%
9	4,151	4,166.7	15	0%	5,902.8	5,933.1	30	1%

Adjustments were used to bring the modeled average daily flows to the goal of within ±10 percent of observed flows. Adjustments to diurnal patterns were made to match the modeled peak flows to the observed flows. For eight of the flow basins, the modeled peak flows were within 10 percent of the observed peak flows. The flow monitoring site outside the WRF predicted flows that were too low, so the WRF flowmeter was used for calibration, as discussed in Chapter 2. As shown in Table 5.4 and Appendix D, the model provides a reasonable representation of Avondale's existing wastewater system and is appropriate for use in master planning analyses including evaluating system capacity and planning new infrastructure.

5.5 Wastewater System Capacity Evaluation

This section describes the evaluation of Avondale's wastewater collection system under current and future flow conditions using the hydraulic model. It also provides a capacity analysis of lift station and water reclamation facility. Infrastructure deficiencies are described and capital improvements are identified later in the report.

5.5.1 Water Reclamation Facility

The City's water reclamation facility has sufficient capacity to treat current wastewater flows. Based on growth projections, the design for the next expansion to 12 mgd needs to start by 2025. If the City's growth projections begin to increase, staff will need to evaluate when to re-program the start of the expansion project.

Buildout flows are projected to reach 14.5 mgd. This flow is below the treatment plant capacity, but above triggers for the next plant capacity. In discussions with Maricopa County, it will likely require that expansions be planned at the 80 percent trigger, but may not be constructed if the plant does not end up passing the 90 percent construction trigger. As the City grows and approaches this buildout flow, additional planning will be needed to ensure that the City has sufficient capacity.

Table 5.5 summarizes the current capacity of the City's WRF and the estimated flows for each planning year.

Table 5.5 Water Reclamation Facility Capacity vs. Wastewater Flows

	Existing Capacity (ADMM) (mgd)	Capacity/Flow (mgd)			
		2017	2023	2028	Buildout
Rated Capacity	9.0	9.0	9.0	9.0	15.0
80% Capacity Trigger for Design (based on MMADF)	7.2	7.2	7.2	7.2	12.0
Max Month Average Daily Flow		6.8	7.1	7.4	14.5

Abbreviation:
ADMM = average day of the maximum month

5.5.2 Collection System Capacity

The collection system capacity assessment was completed using the calibrated hydraulic model. The evaluation was based on the peak dry weather flows using the performance criteria summarized in Table 5.4. Then the pipe capacity was checked with wet weather flows. With the exception of the pipe running primarily along Dysart Road between the Riley lift station and the 4th Street lift station, Avondale sewer pipes are predicted to have sufficient capacity. The pipes with insufficient capacity are shown in Figure 5.4 (2017 flows) and Figure 5.5 (buildout flows).

Hydraulic modeling scenarios for the years 2023 and 2027 indicated the same capacity limitation as the year 2017 scenarios. A wet weather simulation was completed using buildout flows to determine that the collection system has sufficient capacity following storm events.

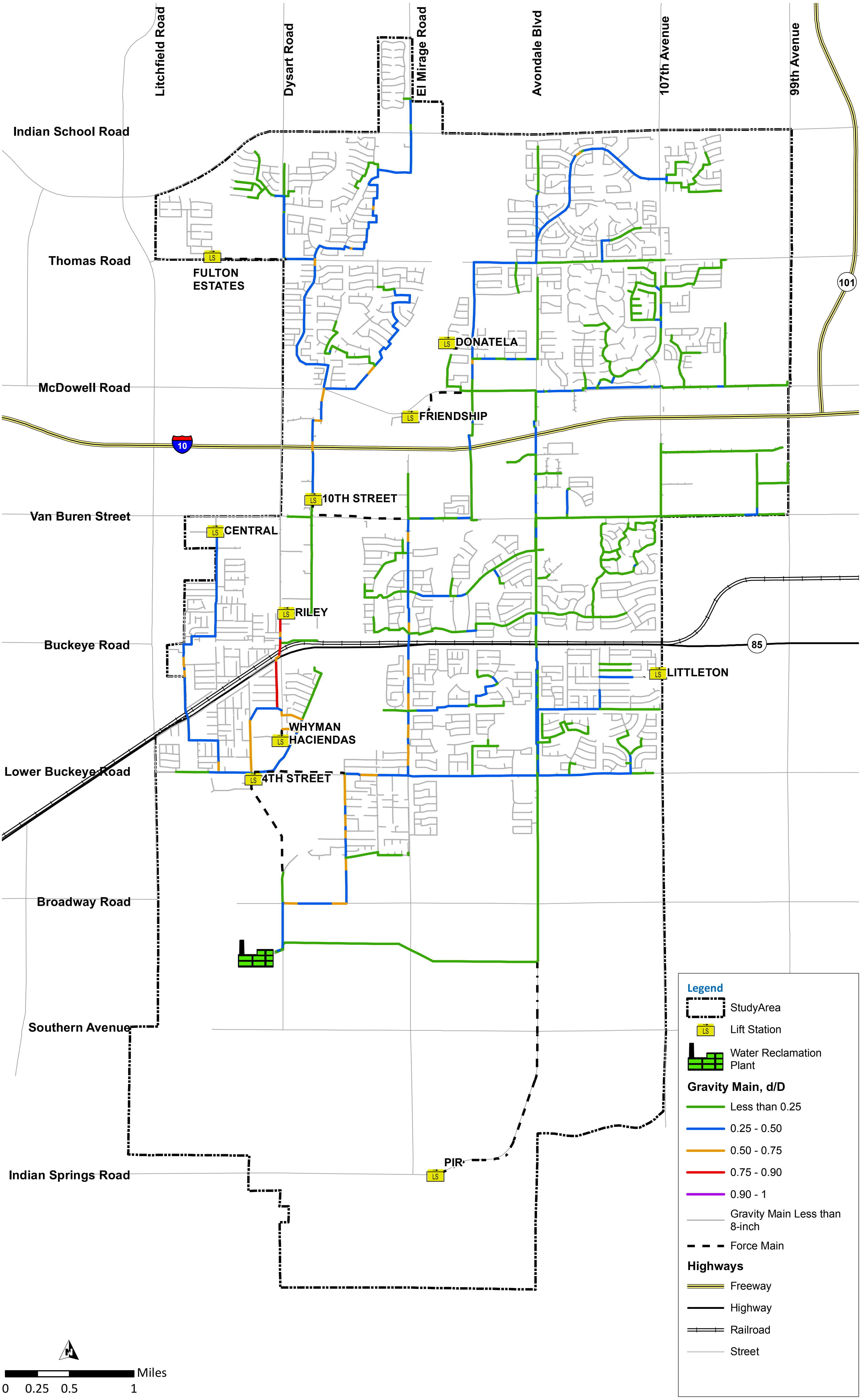

Figure 5.4 2017 Collection System Capacity - Dry Weather Flow

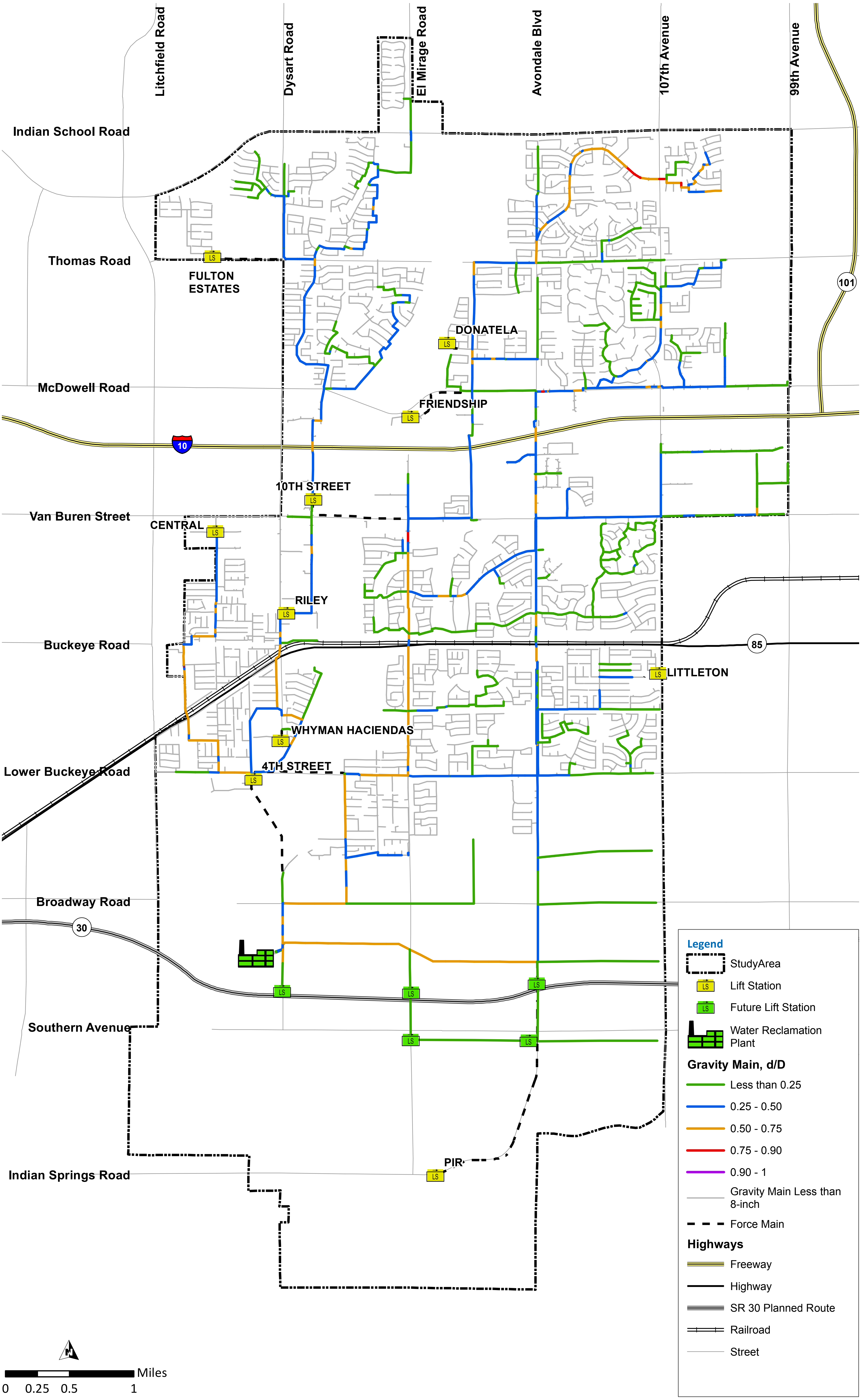

Figure 5.5 Buildout Collection System Capacity - Dry Weather Flow

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The lift stations were evaluated based on their firm pumping capacity and the estimated upstream, dry weather peak flow from the hydraulic model. All of the lift stations have sufficient capacity as shown in Table 5.6. The 10th Street Lift Station would be at capacity during wet weather flows by buildout. As development upstream from the 10th Street Lift Station approaches buildout, wet weather flows should be checked to determine if an increase in the capacity of this lift station is warranted. A second force main from the 10th Street lift station would provide important redundancy for the flows that pass through this lift station. City staff should consider evaluating the pump capacity at each lift station when the sites are rehabilitated to look for operational efficiencies.

Figure 5.6 shows the drainage basin of each lift station.

Table 5.6 Lift Station Capacity Analysis

Lift Station	Firm Capacity (gpm)	Peak Dry Weather Flows by Planning Year (gpm)			Upsize Required
		2017	2022	2027	
4th Street	3,200	818	830	850	No
10th Street	1,150	980	1,010	1,060	No
Central	200	39	39	39	No
Donatela	350	30	30	30	No
Friendship Park	140	Park Flows			No
Fulton	210	67	67	67	No
Littleton	30	15	15	15	No
PIR	2,200	Special Event Flows			No
Riley	200	28	59	65	No
Whyman	200	6	6	6	No

5.5.3 Future Sewer Mains

Table 5.7 lists the future sewer mains required as well as the other wastewater infrastructure required by planning period.

Additional sewer mains will be needed in each of the planning years to convey flows generated by new growth. Figure 5.7 through Figure 5.9 show the locations where new sewers will need to be constructed as development occurs. These pipe sizes will be sufficient through buildout without oversizing.

Table 5.7 Future Wastewater Infrastructure

Project Number	Project Description	Infrastructure Required	Diameter (in)	Length (ft)	Funded By
Wastewater System Infrastructure Recommended for FY 2018/2019 to FY 2022/2023					
SW1389	Sewer Main, Dysart Rd from Riley Dr. to Western Ave	Gravity Main	12	1,580	City
SW1390	Sewer Main, Dysart Rd from Western Ave to Lower Buckeye Rd	Gravity Main	12	6,620	City
WWD1	New Pipe, south of I-10, east of Avondale Blvd, connecting to Hilton Ave	Gravity Main	8	3,660	Developer
WWD2	New Pipe, 111th Ave, north of Van Buren St	Gravity Main	8	1,680	Developer
WWD3	New Pipe, north of Van Buren St, west of 107th Ave	Gravity Main	8	1,560	Developer
WWD4	New Pipe, south of I-10, west of 107th Ave	Gravity Main	8	2,480	Developer
WWD5	New Pipe, 104th Ave, north of Van Buren St	Gravity Main	8	1,100	Developer
WWD6	New Pipe, Encanto Blvd from 101st Ave to 103rd Ave	Gravity Main	12	1,340	Developer
Wastewater System Infrastructure Recommended for FY 2023/2024 to FY 2027/2028					
SW1237	WRF Expansion Phase 2 (12 mgd MMADF Capacity) tertiary filters	WRF	-	-	City
WWD7	New Pipe, Broadway Rd from 119th Ave to 127th Ave	Gravity Main	15	5,240	Developer
WWD8	New Pipe, 119th Ave from Elwood St to Broadway Rd	Gravity Main	15	2,640	Developer
WWD9	New Pipe, Raymond St from 107th Ave to Avondale Blvd	Gravity Main	12	5,000	Developer
WWD10	New Pipe, Broadway Rd from 107th Ave to Avondale Blvd	Gravity Main	12	5,000	Developer
WWD11	New Pipe, Rosner Rd from 107th Ave to Avondale Blvd	Gravity Main	12	5,000	Developer

Table 5.7 Future Wastewater Infrastructure (continued)

Project Number	Project Description	Infrastructure Required	Diameter (in)	Length (ft)	Funded By
Wastewater System Infrastructure Recommended Through Buildout					
WW1	WRF Expansion Phase 3 (15 mgd MMADF Capacity)	WRF	-	-	City
WWD12	New Pipe, Dysart Rd from Southern Ave to Roeser Rd	Gravity Main	15	2,600	Developer
WWD13	New Pipe, Southern Ave from El Mirage Rd to Dysart Rd and west of Dysart Rd to Dysart Rd	Gravity Main	15	7,100	Developer
WWD14	New Pipe, El Mirage Rd from Southern Ave to Roeser Rd	Gravity Main	15	3,310	Developer
WWD15	New Pipe, Southern Ave from Avondale Blvd to El Mirage Rd	Gravity Main	15	5,100	Developer
WWD16	New Pipe, Avondale Blvd from Southern Ave to Roeser Rd	Gravity Main	15	2,840	Developer
WWD17	New Pipe, Southern Ave from 107th Ave to Avondale Blvd	Gravity Main	15	5,100	Developer
WWD18	New Lift Station at Roeser Rd and Dysart Rd	Lift Station	0.2	-	Developer
	New Force Main at Roeser Rd and Dysart Rd	Force Main	8	600	
WWD19	New Lift Station at Roeser Rd and El Mirage Rd	Lift Station	0.2	-	Developer
	New Force Main at Roeser Rd and El Mirage Rd	Force Main	8	500	
WWD20	New Lift Station at Roeser Rd and Avondale Blvd	Lift Station	0.2	-	Developer
	New Force Main at Roeser Rd and Avondale Blvd	Force Main	8	200	
WWD21	New Lift Station at Southern Rd and Dysart Rd	Lift Station	0.2	-	Developer
	New Force Main	Force Main	8	300	
WWD22	New Lift Station at Southern Rd and El Mirage Rd	Lift Station	0.2	-	Developer
	New Force Main	Force Main	8	300	
WWD23	New Lift Station at Southern Rd and Avondale Blvd	Lift Station	0.2	-	Developer
	New Force Main	Force Main	8	300	

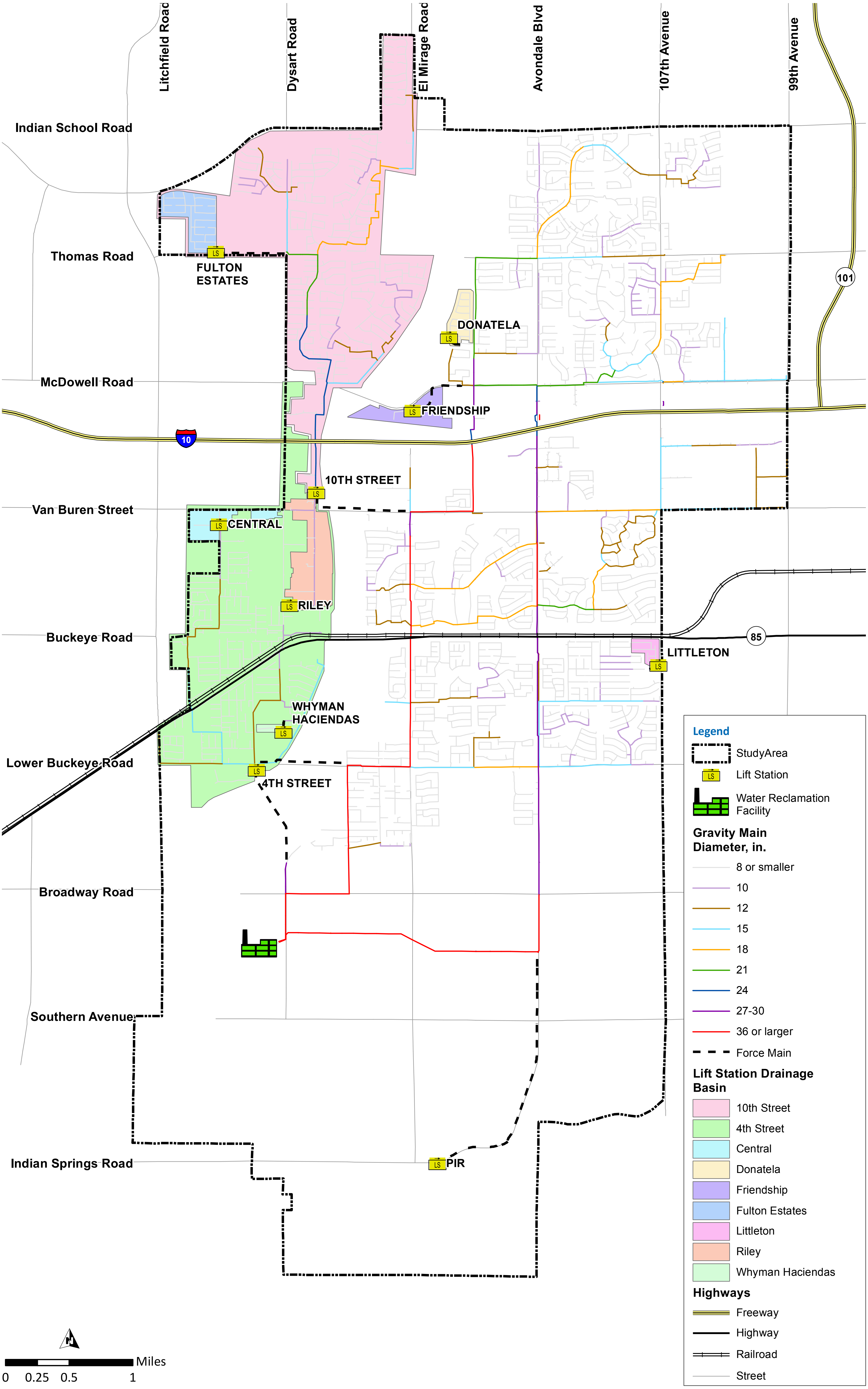

Figure 5.6 Lift Station Drainage Basins

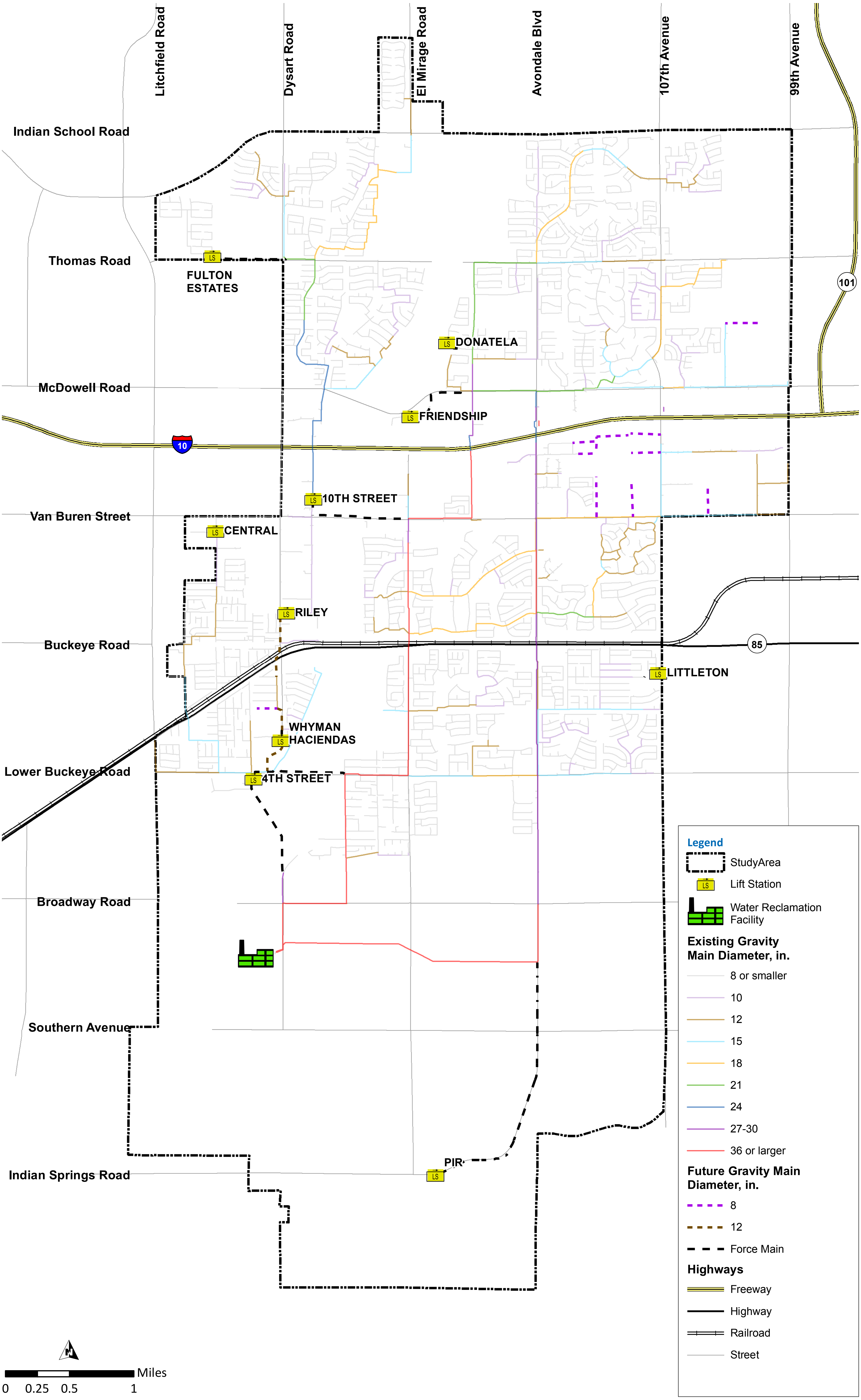

Figure 5.7 Wastewater Collection System by 2023

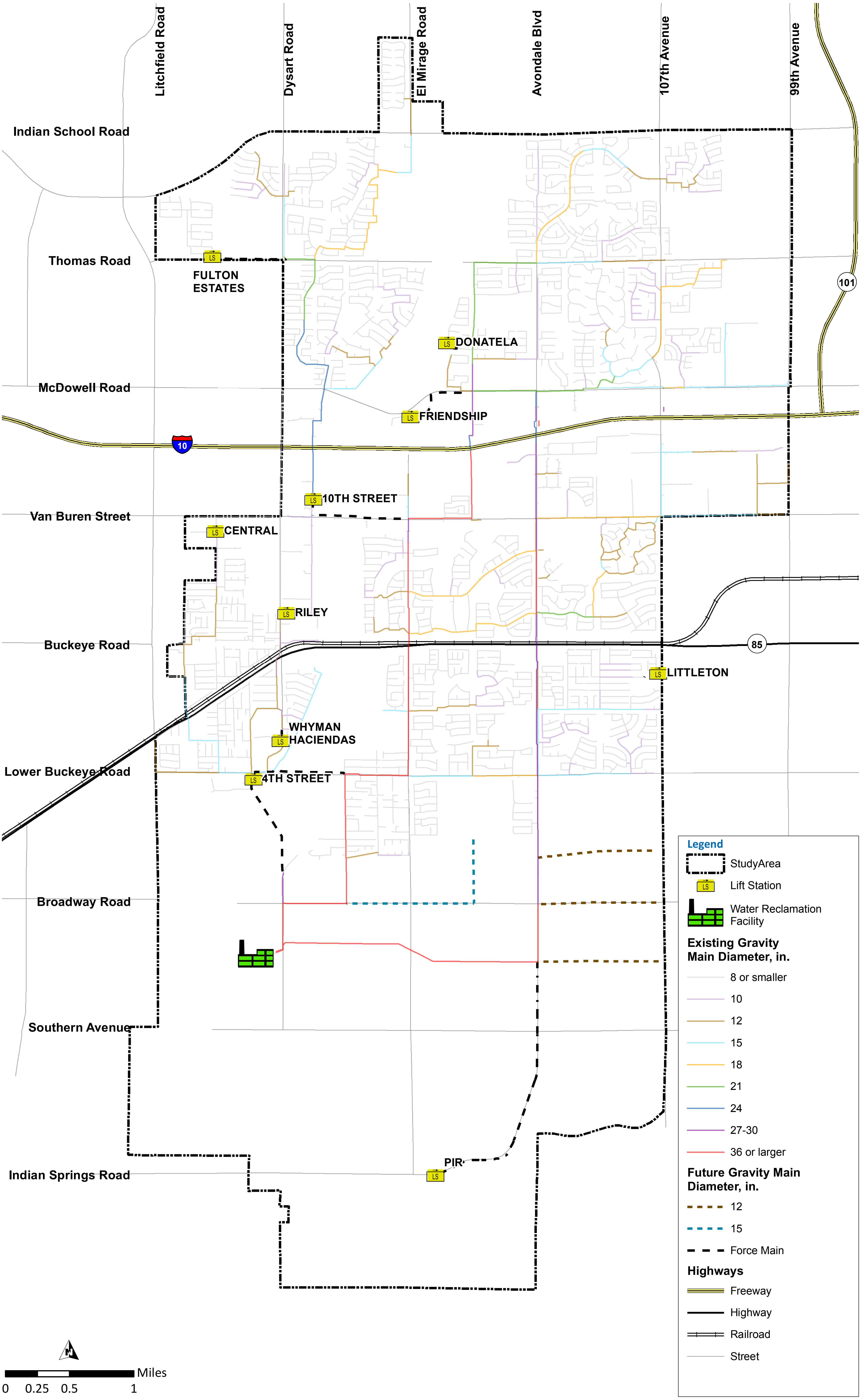

Figure 5.8 Wastewater Collection System by 2028

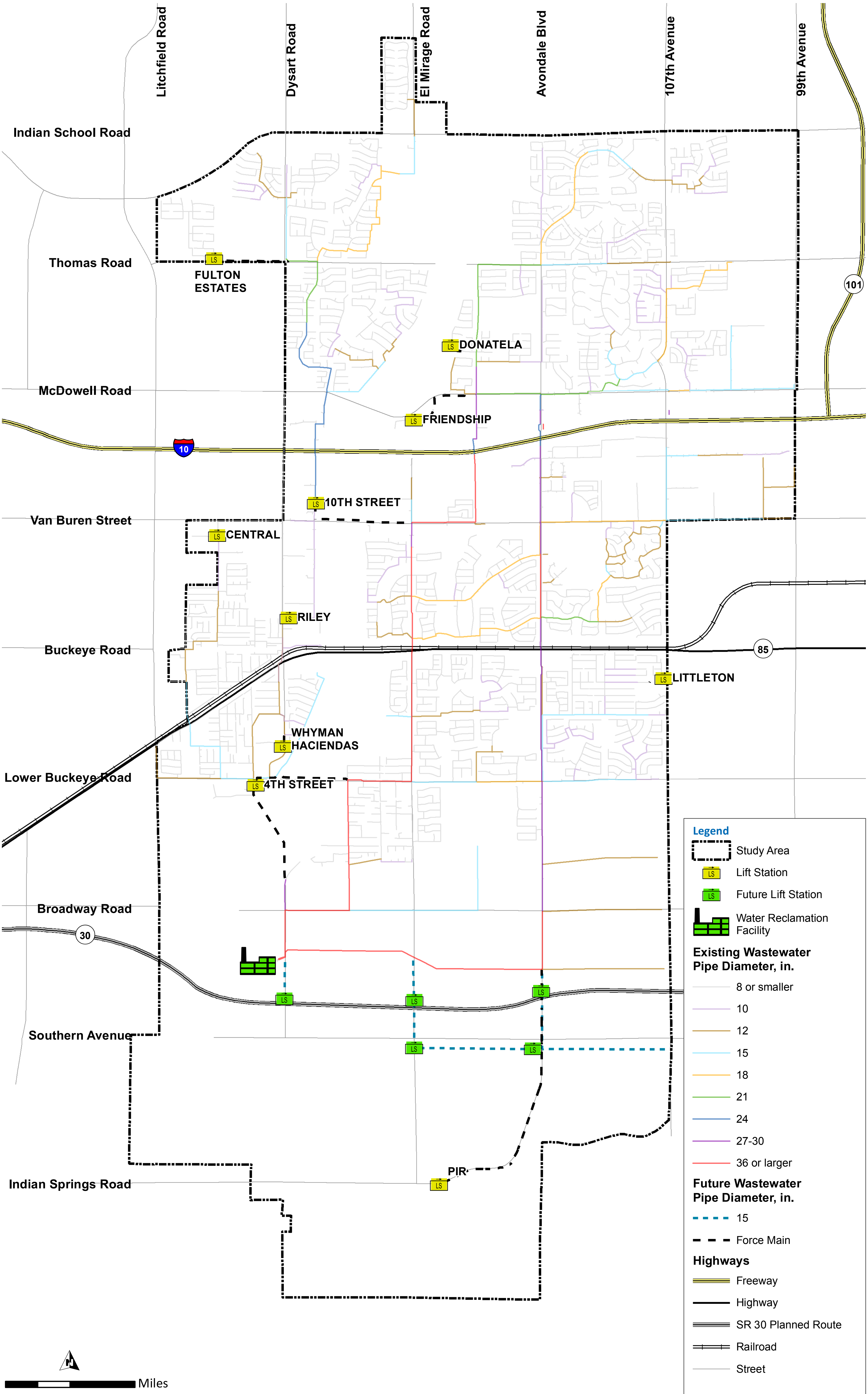

Figure 5.9 Wastewater Collection System by Buildout

5.6 Conclusions and Recommendations

The following conclusions and recommendations have been drawn from this study:

1. The City's current lift stations have sufficient capacity to convey wastewater flows through buildout. However, the City should optimize the pumping capacity at each lift station as rehabilitation projects occur.
2. Replace the sewer main along Dysart Road from Riley Drive to Corral Street with a 12-inch main.
3. Replace the sewer main along Harrison Drive from 4th Street to Dysart Road with a 12-inch main.
4. A 12-inch diameter backup force main is recommended for the 10th Street Lift Station.
5. The Wolf Water Resource Facility will need to begin expansion design by 2025 to accommodate additional wastewater flows from growth. If population growth occurs faster than currently planned, City staff will need to adjust this schedule.

Chapter 6

CAPITAL IMPROVEMENT PROGRAM

6.1 Introduction

One of the primary purposes of the 2018 Integrated Utility Master Plan (2018 IUMP) is to develop a capital improvement program to assist the City in planning for the capital improvements that are needed to serve the City's customers in the future. Projects to maintain and upgrade infrastructure are funded from the City's Capital Improvement Program (CIP) and recovered through rates. Projects required for growth are funded through the Infrastructure Improvement Program (IIP) and are paid for by impact fees. Impact fees are collected from developers for projects where design and construction needs to start in the next fifteen years. If the project does not commence in the fifteen year period, then the City may have to refund the impact fees that are collected. In this master plan, projects funded through the IIP are a subset of the CIP. Projects that are anticipated to be paid for or constructed by developers are listed separately.

This 2018 IUMP is being completed in the 2017-2018 fiscal year (FY). Projects in FY 2018 through 2023 are phased year by year so that the City has the full detail needed for the five year CIP. Projects that are scheduled for FY 2024 through FY 2028 are not assigned a specific year due to the uncertainty associated with the timing of projects more than five years into the future. Where appropriate, these projects are included in the City's IIP. CIP projects in the buildout planning period are useful for long term planning of the City's infrastructure systems. If growth accelerates more rapidly than projected in this master plan, then the City can identify the CIP projects that need to be moved forward in time.

6.2 Planning Level Cost Accuracy

Unit costs have been developed for the capital improvements for each project recommended herein. Cost estimates were prepared in accordance with the guidelines of the Association for the Advancement of Cost Engineering (AACE) International for a Class 4 estimate. Table 6.1 summarizes the AACE International cost estimate classification system, the level of project definition (percent of design), uses, cost estimating methodologies, and expected accuracy of Class 1 through 5 estimates. Design work would need to be undertaken to obtain more precise cost estimates.

Table 6.1 Cost Estimate Accuracy provided by the AACE

Estimate Class	Maturity Level of Project Definition Deliverables - (Level of Engineering Design)	End Use	Typical Cost Estimating Methodology Used	Expected Accuracy Range (Low/High)
Class 5	0% to 2%	Conceptual screening	Capacity factored, parametric models, judgment or analogy	L: -20% to -50% H: +30% to +100%
Class 4	1% to 15%	Study or feasibility	Equipment factored or parametric models	L: -15% to -30% H: +20% to +50%
Class 3	10% to 40%	Budget authorization or control	Semi-detailed unit costs with assembly level line items	L: -10% to -20% H: +10% to +30%
Class 2	30% to 75%	Control or bid/tender	Detailed unit cost with forced detailed take-off	L: -5% to -10% H: +5% to +20%
Class 1	65% to 100%	Check estimate or bid/tender	Detailed unit cost with detailed take-off	L: -3% to -10% H: +3% to +15%

6.2.1 Project Cost Development Methodology

To develop project costs for each capital improvement project, unit costs for infrastructure are developed based on information from R.S. Means and other unit cost sources including bid tabs. Unit costs then have multipliers for overhead, construction profit, sales tax, construction contingency, and general conditions. Appendix A contains the unit costs for pipelines, storage, pump stations, and other infrastructure. When multiplied by the capacity or size of the infrastructure, the unit construction cost is the cost that the City should expect to pay a contractor to construct the facility. The City will have other expenses including design, inspection, contingency, and project management that are included in the overall project cost. The project cost is obtained by multiplying the construction cost by a factor of 1.4.

6.3 Water Resources Capital Program

The City needs to take advantage of opportunities to expand its water resource portfolio, so the City plans to apply for Colorado River Non-Indian Agriculture (NIA) water supplies that can be recharged and used when needed.

Table 6.2 shows one water resources CIP item that is recommended. The timing of the CAP WMAT lease is budgeted for the FY 2018 - 2023 planning period but the timing of this CIP item is not set and may occur at a later time.

Table 6.2 Water Resources Capital Budget Items

Project No.	Project Description	Infrastructure Required	FY 2018 - 2019 Project Cost ($)
WA1285	Water Resources	CAP WMAT lease	$2,300,000

6.4 Water Infrastructure Program

6.4.1 Water Supply Alternatives Cost Comparison

Water supply alternatives were evaluated to determine the relative costs of different water supply options. Both capital and operations and maintenance (O&M) costs were included in the evaluation. Costs were compared on a present worth basis, which is useful to compare the relative costs of different alternatives. The present worth cost is expressed in terms of a cost per million gallons (MG) because the available water supply amounts differ by water supply. Costs include infrastructure from the water source to delivery into the distribution system, including the cost of expanding different water production sites to buildout.

The following alternatives were compared:

1. Construct a well that does not require treatment. This alternative was included to compare the relative cost of wells that the City currently has that do not need treatment, such as at Rancho Santa Fe. Wells that do not need treatment are not expected in Avondale going forward, so water supply costs will be going up as more wells require treatment. The relative cost of this supply is $900/MG.
2. Construct a well that requires arsenic treatment such as future Well A pumping to Northside. Arsenic treatment is less than nitrate treatment, so wells with only arsenic are preferred based on cost. The arsenic treatment costs are based on the assumption that 50 percent of the well water needs to be treated. Higher percentages will increase treatment costs. The relative cost of this supply is $1,200/MG.
3. Construct a well that requires nitrate treatment. This water supply cost will be typical of wells in the master plan that are planned. The relative cost of wells with nitrate treatment is $2,100/MG.
4. Wheel 5 mgd of surface water from Phoenix to the Garden Lakes facility and blend with 5 mgd of well water. This alternative is the third lowest cost, behind wells with no treatment and wells with nitrate treatment. The advantage of this alternative is that blending eliminates the need for nitrate treatment and total trihalomethanes (TTHM) treatment. However, granular activated carbon (GAC) contactors are included for redundancy in the event that a well is out of service. The relative cost of this alternative is $1,600/MG.
5. Wheel 10 mgd of surface water from Phoenix to Del Rio. This alternative would require pH and GAC treatment, and would not have any well blending. This alternative results in a higher cost because there is no blending to reduce treatment costs. The relative cost of this option is $2,400/MG.
6. Construct a surface water treatment plant in Avondale. Analysis currently indicates lower operating/treatment costs compared to wheeling surface water through neighboring cities. However, the City would need to finance approximately $80 M to do this alternative. The relative cost of this alternative is $1,800/MG.
7. Team with Goodyear as part owners in their surface water plant. This alternative will always be more expensive than a surface water treatment plant in Avondale because of the capital and pumping cost to deliver raw water to Goodyear and then pump treated water back to Avondale. The relative cost of this alternative is $2,400/MG.

Table 6.3 presents the details of this comparison.

Table 6.3 Present Worth Costs for Water Supply Options

Description	Supply (mgd)	Utilization	Cost Item	Diameter/Size (in, mgd, kWh, acre)	Length (ft or number)	Unit Construction, Energy, or O&M Cost ($)	Construction Cost ($)	Project Cost ($)	Annual O&M Cost ($)	Present Worth ($)	Cost per MG ($)
1. Well with no treatment required	1.7	75%	Pipeline to storage/booster station	16 in	6,600 ft	$179	$1,184,000	$1,658,000			
			Drill and Equip Well	1.7 mgd		$1,941,000	$1,941,000	$2,717,000			
			Chlorine disinfection - capital			$300,000	$300,000	$420,000			
			Chlorine disinfection - O&M	1.3 mgd		$30			$14,000		
			Power cost - well to storage	105 kWh		$0.16			$147,000		
			Power cost - storage to distribution	41 kWh		$0.16			$57,000		
						Subtotal	**$3,425,000**	**$4,795,000**	**$218,000**	**$8,790,000**	**$900**
2. Well with arsenic treatment - Well A pumping to Northside	1.7	75%	Pipeline to storage/booster station	12 in	1,000 ft	$154	$154,000	$216,000			
			Drill and Equip Well	1.7 mgd		$1,941,000	$1,941,000	$2,717,000			
			Arsenic treatment - capital	0.85 mgd		$2.10	$1,785,000	$2,499,000			
			Arsenic treatment - O&M	0.6 mgd		$700			$122,000		
			Power cost - well	105 kWh		$0.16			$147,000		
			Power cost - distribution	41 kWh		$0.16			$57,000		
						Subtotal	**$3,880,000**	**$5,432,000**	**$326,000**	**$11,400,000**	**$1,200**
3. New well with nitrate treatment	1.7	75%	Pipeline to storage/booster station	16 in	6,600 ft	$179	$1,184,000	$1,658,000			
			Drill and Equip Well	1.7 mgd		$1,941,000	$1,941,000	$2,717,000			
			Nitrate treatment - capital	0.9 mgd		$2.70	$2,295,000	$3,213,000			
			Nitrate treatment - O&M	0.6 mgd		$1,900			$442,000		
			Power cost - well to storage	105 kWh		$0.16			$147,000		
			Power cost - well to distribution	41 kWh		$0.16			$57,000		
						Subtotal	**$5,420,000**	**$7,588,000**	**$646,000**	**$19,410,000**	**$2,100**
4. Wheel 5 mgd of surface water from Phoenix and blend with 5 mgd of well water at Garden Lakes	10.0	100%	Connection to Phoenix main			$335,000	$335,000	$469,000			
			Pipe from Phoenix 24" main to Garden Lakes	24 in	4,400 ft	$266	$1,170,000	$1,638,000			
			Distribution pipe from Garden Lakes to McDowell Road	16 in	1,200 ft	$179	$215,000	$301,000			
			Pipeline from Wells #27 and H to Garden Lakes	16 in	6,600 ft	$179	$1,184,000	$1,658,000			
			Drill and Equip Well #27	1.7 mgd		$1,941,000	$1,941,000	$2,717,000			
			Drill and Equip Well H	1.7 mgd		$1,941,000	$1,941,000	$2,717,000			
			Expand Garden Lakes pump station	6 mgd		$951,000	$951,000	$1,331,000			
			Second storage reservoir	2 MG		$2,744,000	$2,744,000	$3,842,000			
			pH treatment - capital	5 mgd		$0.15	$750,000	$1,050,000			
			TTHM treatment (GAC contactors)	2 mgd		$1.00	$2,000,000	$2,800,000			
			pH treatment - O&M	5 mgd		$66			$120,000		
			TTHM (GAC) O&M	2 mgd		$100			$73,000		
			Power cost - 3 wells to storage	410 kWh		$0.16			$575,000		
			Power cost - storage to distribution	320 kWh		$0.16			$449,000		
			Phoenix Water Wheeling Rate	5 mgd		$2,260			$4,125,000		
						Subtotal	**$13,231,000**	**$18,523,000**	**$5,342,000**	**$116,330,000**	**$1,600**

Table 6.3 Present Worth Costs for Water Supply Options (continued)

Description	Supply (mgd)	Utilization	Cost Item	Diameter/Size (in, mgd, kWh, acre)	Length (ft or number)	Unit Construction, Energy, or O&M Cost ($)	Construction Cost ($)	Project Cost ($)	Annual O&M Cost ($)	Present Worth ($)	Cost per MG ($)
5. Wheel 10 mgd of surface water from Phoenix to Del Rio with pH and GAC treatment, no blending	10.0	100%	Pipe from Phoenix tie-in to Del Rio	30 in	21,900 ft	$352	$7,713,000	$10,798,000			
			Connection to Phoenix main			$427,000	$427,000	$598,000			
			Expand Del Rio pump station to Zone 2	8 mgd		$1,121,000	$1,121,000	$1,569,000			
			Del Rio Zone 3 pump station	4 mgd		$564,000	$564,000	$790,000			
			Second storage reservoir at Del Rio	3.5 MG		$4,147,000	$4,147,000	$5,806,000			
			TTHM treatment (GAC contactors)	4 mgd		$1.00	$4,000,000	$5,600,000			
			pH treatment using caustic soda - capital	10 mgd		$0.15	$1,500,000	$2,100,000			
			pH treatment using caustic soda - O&M	10 mgd		$66			$241,000		
			TTHM (GAC) treatment	4 mgd		$100			$146,000		
			Power cost - storage to distribution	320 kWh		$0.16			$449,000		
			Phoenix Water Wheeling Rate	10 mgd		$2,260			$8,249,000		
						Subtotal	**$19,472,000**	**$27,261,000**	**$9,085,000**	**$174,010,000**	**$2,400**
6. Surface water treatment plant in Avondale	10.0	100%	Pipe from canal to treatment plant	36 in	8,000 ft	$437	$3,497,000	$4,896,000			
			Pipe from treatment plant to distribution	36 in	8,000 ft	$437	$3,497,000	$4,896,000			
			Land acquisition	30 acres		$150,000	$4,500,000	$4,500,000			
			Diversion structure from canal			$1,000,000	$1,000,000	$1,400,000			
			Storage reservoir	2.5 MG	2	$3,234,000	$6,468,000	$9,055,000			
			Treatment Plant	10 mgd		$5.06	$50,600,000	$55,660,000	$2,004,000		
			Booster pump station to Zone 2	12 mgd		$4,203,000	$4,203,000	$5,884,000			
			Del Rio Zone 3 pump station expansion	4 mgd		$564,000	$564,000	$790,000			
			Power cost - storage to distribution	320 kWh		$0.16			$449,000		
						Subtotal	**$74,329,000**	**$87,081,000**	**$2,453,000**	**$131,990,000**	**$1,800**
7. Team with Goodyear on a surface water plant	8.0	100%	Pipe from canal to treatment plant	36 in		$437		$12,000,000			
			Pipe from Goodyear WTP to Del Rio site	30 in	36,960 ft	$352	$13,016,000	$18,222,000			
			Land acquisition	20 acres		$150,000	$3,000,000	$3,000,000			
			Diversion structure from canal			$1,000,000	$1,000,000	$1,400,000			
			Storage reservoir	3.5 MG		$4,147,000	$4,147,000	$5,806,000			
			Del Rio Zone 2 pump station rehabilitation	8 mgd		$1,121,000	$1,121,000	$1,569,000			
			Del Rio Zone 3 pump station expansion	4 mgd		$564,000	$564,000	$790,000			
			Pump station for transmission to Del Rio	12 mgd		$4,203,000	$4,203,000	$5,884,000			
			Treatment	8 mgd		$5.06	$40,480,000	$44,528,000	$1,781,000		
			Power cost - surface water plant to storage	288 kWh		$0.16			$404,000		
			Power cost - storage to distribution	256 kWh		$0.16			$359,000		
						Subtotal	**$67,531,000**	**$93,199,000**	**$2,544,000**	**$139,770,000**	**$2,400**

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Notes:

(1) Discount Rate (based on data from NRCS for water resources projects) 2.875% https://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/cntsc/?&cid=nrcs143_009685

(2) Inflation (based on data from Federal Reserve) 2.000% https://www.federalreserve.gov/newsevents/press/monetary/20170201a.htm

(3) Useful life for treatment, storage, and pumping facilities: 20. years

(4) Useful life for pipelines and appurtenances: 50. years

(5) Effective rate for Present worth calculations: 0.86%

6.4.2 Capital Program

Water Capital Improvement Projects are grouped by planning year. Table 6.4 presents the capital projects for FY 2018 through FY 2023. Table 6.5 presents the capital projects for FY 2024 through FY 2028, and Table 6.6 presents the additional capital projects through Buildout. Table 6.7 presents the planning level costs for a surface water treatment plant in the event that the City of Phoenix connection ends, and Table 6.8 presents the infrastructure projects that are anticipated to be paid or constructed by developers.

Table 6.4 Water Capital Projects for Fiscal Years 2018 through 2023

Project No.	Project Description	Infrastructure Required	Diameter/Size (in, mgd, acre, MG)	Length (ft or number)	Unit Construction Cost ($)	Construction Cost ($)	Project Cost ($)	FY 2018/2019 Project Cost ($)	FY 2019/2020 Project Cost ($)	FY 2020/2021 Project Cost ($)	FY 2021/2022 Project Cost ($)	FY 2022/2023 Project Cost ($)
W1	Wheel water through Phoenix to Garden Lakes facility	Transmission main from Phoenix 24" main on Indian School Road to Garden Lakes site to Thomas Road	24 in	5,280 ft	$266	$1,404,000	$1,966,000	$394,000	$1,572,000			
		Make Phoenix pipe connection	24 in		$335,000	$335,000	$469,000	$94,000	$375,000			
		On-site piping	24 in	200 ft	$266	$53,000	$74,000	$15,000	$59,000			
		Add one pump	2000 gpm			$60,000	$84,000		$84,000			
		Chlorine disinfection	10 mgd		$300,000	$300,000	$420,000	$84,000	$336,000			
		pH, Corrosion treatment (caustic soda injection)	5 mgd		$0.15	$750,000	$1,050,000	$210,000	$840,000			
		TTHM treatment (GAC contactors)	2 mgd		$1.00	$2,000,000	$2,800,000	$560,000	$2,240,000			
					Subtotal	**$4,902,000**	**$6,863,000**	**$1,357,000**	**$5,506,000**			
W2	Well A land purchase & Design Concept Report	Purchase land	1 acre			$75,000	$75,000	$75,000				
WA1131	Construct Well #27 and deliver water to Garden Lakes	Drill well	1.7 mgd		$570,000	$570,000	$800,000	$800,000				
		Equip well	1.7 mgd		$1,293,000	$1,293,000	$1,810,000		$362,000	$1,448,000		
		Connection into Garden Lakes	16 in		$100,000	$100,000	$140,000		$28,000	$112,000		
		Pipeline from Well #27 to Garden Lakes	16 in	6,600 ft	$179	$1,184,000	$1,658,000		$332,000	$1,326,000		
					Subtotal	**$3,147,000**	**$4,408,000**	$800,000	**$722,000**	**$2,886,000**		
WA1344	Separate Zone 1 and Zone 2	Pressure reducing/sustaining station with SCADA	10 mgd	2	$220,000	$440,000	$616,000			$123,000	$493,000	
		Connect pipes at the intersection of Avondale/McDowell and 107th/Van Buren	16 in	50 ft	$179	$8,950	$13,000			$3,000	$10,000	
		Well 23 Improvements - add a pump bowl	1,200 gpm		$20,000	$20,000	$28,000			$28,000		
		Pipeline along 107th Avenue	16 in	3,550 ft	$179	$635,450	$891,000			$178,000	$712,000	
		Gate valves	16 in	4	$32,000	$128,000	$179,000			$36,000	$143,000	
					Subtotal	**$1,234,000**	**$1,727,000**			**$368,000**	**$1,359,000**	
W3	Recharge facility Improvements	Replace diversion structure and make piping Improvements					$1,050,000	$300,000	$750,000			
W4	Gateway Nitrate Treatment Facility	Replace nitrate treatment facility	1.9 mgd		$1.13	$2,147,000	$3,000,000		$500,000	$2,500,000		
WA1135	Construct 16-inch main on McDowell Road	McDowell Road 16-inch waterline - 117th Avenue to Avondale Boulevard	16 in				$300,000			$300,000		
WA1231	Construct 12-inch water line	Construct 12-inch water line on Dysart Road from Whyman Avenue to Lower Buckeye Road	12 in				$400,000			$400,000		

Table 6.4 Water Capital Projects for Fiscal Years 2018 through 2023 (continued)

Project No.	Project Description	Infrastructure Required	Diameter/Size (in, mgd, acre, MG)	Length (ft or number)	Unit Construction Cost ($)	Construction Cost ($)	Project Cost ($)	FY 2018/ 2019 Project Cost ($)	FY 2019/ 2020 Project Cost ($)	FY 2020/ 2021 Project Cost ($)	FY 2021/ 2022 Project Cost ($)	FY 2022/ 2023 Project Cost ($)
W5	Land for future treatment site at 107th Avenue and Roosevelt St.	Purchase land	4 acres			$600,000	$600,000				$600,000	
W6	Rehabilitate Northside facility arsenic treatment	Rehabilitate arsenic treatment equipment					$1,000,000				$1,000,000	
WA1133	Construct a 16-inch water line along 99th Avenue	16-inch water line along 99th Avenue from Thomas Road to Encanto Boulevard					$710,000					$710,000
					Total	**$14,350,000**	**$20,133,000**	**$2,532,000**	**$7,846,000**	**$7,445,000**	**$1,600,000**	**$710,000**
											Five Year Project Total	**$20,133,000**

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Abbreviations:
mgd = million gallons per day; ENR = Engineering News Record; GAC = granular activated carbon; SCADA = supervisory control and data acquisition

Table 6.5 Water Capital Projects for Fiscal Years 2024 through 2028

Project No.	Project Description	Infrastructure Description	Diameter/Size (in, mgd, acre, MG)	Length (ft or number)	Unit Construction Cost ($)	FY2023/2024 to FY2027/2028 Costs	
						Construction Cost ($)	Project Cost ($)
W7	Garden Lakes site improvements	Construct second storage reservoir	2 MG		$3,411,000	$3,411,000	$4,775,000
		Rehab and expand pump station	6 mgd		$2,559,000	$2,559,000	$3,583,000
					Subtotal	**$5,970,000**	**$8,358,000**
W8	Install 16-inch main on McDowell Road	Pipeline along McDowell Road from 99th Avenue to Avondale Boulevard	16 in	10,850 ft	$179	$1,946,000	$2,724,000
WA1412	Construct future well	Drill and equip a well, construct a 1200 ft. 12-inch pipe to a storage reservoir	1.7 mgd	1200	$2,100,000	$2,100,000	$2,940,000
WA1340	Nitrate treatment facilities at Coldwater	Construct nitrate treatment facilities at Coldwater	1.7 mgd		$2.33	$3,961,000	$5,545,000
WA1214	Construct future well	Drill and equip a well, construct a 1200 ft. 12-inch pipe to a storage reservoir	1.7 mgd	1200	$2,100,000	$2,100,000	$2,940,000
					2024 - 2028 Total	**$16,077,000**	**$22,507,000**

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Table 6.6 Water Capital Projects through Buildout

Project No.	Project Description	Infrastructure Required	Diameter/Size (in, mgd, acre, MG)	Length (ft or number)	Unit Construction Cost ($)	Buildout Costs	
						Construction Cost ($)	Project Cost ($)
W9	Equip Well #22 and deliver water to the Coldwater facility	Equip Well #22			$1,298,000	$1,298,000	$1,817,000
W10	Construct and equip Well J	Drill Well J	1.7 mgd		$670,000	$670,000	$938,000
		Equip Well J	1.7 mgd		$1,400,000	$1,400,000	$1,960,000
					Subtotal	**$2,070,000**	**$2,900,000**
W11	Add water to Northside from Well A	Pipeline from Well A to Northside	12 in	1,000	$154	$154,000	$216,000
		Drill Well A		1	$570,000	$570,000	$798,000
		Equip Well A		1	$1,298,000	$1,298,000	$1,817,000
					Subtotal	**$2,105,000**	**$2,900,000**
W12	Rehabilitate Del Rio facilities	Rehabilitation			$1,430,000	$1,430,000	$2,002,000
W13	Wheel water through Phoenix to Del Rio	Transmission main from Phoenix connection on 99th Avenue and Lower Buckeye Road to Del Rio site	30 in	18,480 ft	$352	$6,508,000	$9,111,000
		Connection to Phoenix pipe	30 in		$427,000	$427,000	$598,000
		Chlorine Disinfection	10 mgd		$570,000	$570,000	$798,000
		pH treatment (caustic soda injection)	10 mgd		$0.15	$1,000,000	$1,400,000
		TTHM treatment (GAC Contactors)	4 mgd		$1.00	$4,000,000	$5,600,000
					Subtotal	**$12,505,000**	**$17,507,000**
W14	Construct a treatment, storage, and booster facility on 107th Avenue and Roosevelt Street, add supply from Well C	Pipeline from Well C to new facility	16 in	2,000	$154	$359,000	$503,000
		Pump station	8 mgd	1	$3,345,000	$3,345,000	$4,683,000
		Storage Tank	2 MG	1	$2,744,000	$2,744,000	$3,842,000
		Drill Well C		1	$570,000	$570,000	$798,000
		Equip Well C	1.7 mgd	1	$1,298,000	$1,298,000	$1,817,000
		Nitrate treatment	1.7 mgd	1	$2.3	$3,961,000	$5,545,000
					Subtotal	**$12,277,000**	**$17,188,000**
W15	Add Well D to 107th Avenue and Roosevelt treatment facility	Pipeline from Well D to new treatment facility	12 in	3,500	$154	$540,000	$756,000
		Drill Well D	1.7 mgd	1	$570,000	$570,000	$798,000
		Equip Well D	1.7 mgd	1	$1,298,000	$1,298,000	$1,817,000
		Ion exchange nitrate treatment	1.7 mgd	1	$2.3	$3,961,000	$5,545,000
					Subtotal	**$6,369,000**	**$8,916,000**
W16	Add storage and pumping capacity at Del Rio	Pump station expansion	4 mgd	1	$1,698,400	$1,698,000	$2,377,000
		Storage reservoir	3.5 MG	1	$4,147,000	$4,147,000	$5,806,000
					Subtotal	**$5,845,000**	**$8,183,000**
W17	Construct Future Well	Drill and equip a well, construct a 1,200-ft 12-inch pipe to a storage reservoir	1.7 mgd	1,200	$2,100,000	$2,100,000	$2,940,000
W18	Construct Future Well	Drill and equip a well, construct a 1,200-ft 12-inch pipe to a storage reservoir	1.7 mgd	1,200	$2,100,000	$2,100,000	$2,940,000
					Total	**$48,099,000**	**$67,293,000**

ENR = 10678

Table 6.7 Planning Level Capital Costs for an 8 mgd Phase 1 Surface Water Treatment Plant

Project No.	Project Description	Infrastructure Required	Diameter/Size (in, mgd, acre, MG)	Length (ft or number)	Unit Construction Cost ($)	Buildout Costs	
						Construction Cost ($)	Project Cost ($)
W17	Surface Water Treatment Plant	Purchase land	30 acres		$150,000		$4,500,000
		Connection to Salt River Project (SRP) pipeline	36 in		$500,000	$500,000	$700,000
		Pipeline to treatment plant	36 in	8,000 ft	$437	$3,496,000	$4,894,000
		Water Treatment	8 mgd		$5.06	$40,408,000	$44,528,000
		Pump station	14 mgd		$4,700,000	$4,700,000	$6,580,000
		Storage reservoir	2.5 MG	2	$3,234,000	$6,468,000	$9,055,000
		Pipeline to Zone 2 transmission mains	36 in	8,000 ft	$437.00	$3,496,000	$4,894,000
		Low Head pipeline to Del Rio reservoir	16 in	18,500 ft	$179	$3,311,500	$4,636,000
					Capital Cost for a Surface Water Plant and Associated Infrastructure	**$62,452,000**	**$79,787,000**

Table 6.8 Water Pipeline Infrastructure that may be Paid for or Constructed by Developers

Project No.	Project Description	Infrastructure Required	Diameter/Size (in, mgd, acre, MG)	Length (ft or number)	Unit Construction Cost ($)	Buildout Costs	
						Construction Cost ($)	Project Cost ($)
DEV	Water distribution mains in Zone 2	Distribution main on Lower Buckeye Road from El Mirage Road to 107th Avenue	16 in	10,600 ft	$179	$1,897,000	$2,656,000
DEV	Water distribution mains in Zone 3	Distribution main on Dysart Road between Broadway Road and Southern Avenue	16 in	7,900 ft	$179	$1,414,000	$1,980,000
DEV	Water distribution mains in Zone 3	Distribution main on 107th Avenue between Lower Buckeye Road and Southern Avenue	16 in	10,600 ft	$179	$1,897,000	$2,656,000
DEV	Water distribution mains in Zone 3	Distribution main on Southern Avenue between Dysart Road and 107th Avenue	16 in	10,600 ft	$179	$1,897,000	$2,656,000
DEV	Water distribution mains in Zone 3	Distribution main in Vermeersch from the PRV to Broadway Road/Dysart Road	16 in	2,600 ft	$180	$468,000	$655,000
DEV	Water distribution mains in Zone 3	Distribution main on Broadway Road between Dysart Road and 107th Avenue	16 in	15,900 ft	$179	$2,846,000	$3,984,000
DEV	Water distribution mains in Zone 3	Distribution main on El Mirage Road between Broadway Road and Southern Avenue	16 in	5,300 ft	$179	$949,000	$1,329,000
DEV	Water distribution mains in Zone 1	99th Avenue from Indian School Road to Thomas Road	16 in	5,300 ft	$180	$954,000	$1,336,000
DEV	Water distribution mains in Zone 2	99th Avenue from Thomas Road to McDowell Road	16 in	5,300 ft	$180	$954,000	$1,336,000
DEV	Water distribution mains in Zone 1	Indian School Road from 99th Avenue to 107th Avenue	16 in	5,300 ft	$180	$954,000	$1,336,000
DEV	Water distribution mains in Zone 1	Intersection of Dysart Road and Indian School Road	16 in	3,975 ft	$180	716,000	$1,002,000

6.5 Wastewater Capital Program

Wastewater Capital Improvement Projects are grouped by planning year. Table 6.9 presents the capital projects for FY 2018 through FY 2023. Table 6.10 presents the capital projects for FY 2024 through FY 2028, and Table 6.11 presents the additional capital projects through buildout. Table 6.12 presents the infrastructure projects that may be constructed or paid for by developers.

6.6 Capital Project Summary

The overall capital project summary including IIP projects for water resources, water, and wastewater are presented in Table 6.13. Table 6.13 does not include project costs for infrastructure that may be constructed by developers.

Table 6.9 Wastewater Capital Projects for 2018 through 2023

Project Number	Project Description	Infrastructure Required	Diameter (in)	Length (ft)	Unit Construction Cost ($)	Construction Cost ($)	Project Cost ($)	FY 2018/2019 Project Cost ($)	FY 2019/2020 Project Cost ($)	FY 2020/2021 Project Cost ($)	FY 2021/2022 Project Cost ($)	FY 2022/2023 Project Cost ($)
SW1389	Sewer Main, Dysart Road from Riley Drive to Corral Street	Gravity main	12	3,035	$296	$900,000	$1,260,000	$260,000	$1,010,000			
SW1390	Sewer main, Harrison Drive from 4th Street to Dysart Road	Gravity main	8	1,100	$139	$160,000	$224,000				$50,000	$180,000
	Sewer Main, Dysart Road from Western Avenue to Lower Buckeye Road	Gravity main	12	3,220	$198	$640,000	$896,000				$180,000	$720,000
SW1108	Backup force main from 10th Street lift station to El Mirage Road Part 1	Force main	12				$300,000		$300,000			
						Total		**$260,000**	**$1,310,000**	**$ –**	**$230,000**	**$900,000**

ENR = 10678

Table 6.10 Wastewater Capital Projects for 2024 through 2028

Project Number	Project Description	Infrastructure Required	Diameter (in)	Length (ft)	Unit Construction Cost ($)	Construction Cost ($)	Project Cost ($)
SW1108	Backup force main from 10th Street lift station to El Mirage Road Part 2	Construct 12-inch force main across the Aqua Fria River	12				$1,900,000
SW1237	WRF Expansion Phase 2 (12 mgd MMADF capacity) tertiary filters	WRF	–	–	–	$45,770,000	$63,070,000
						Total	**$64,970,000**

ENR= 10678
Abbreviations:
WRF = wastewater reclamation facility; MMADF = maximum month average day flow

Table 6.11 Wastewater Capital Projects through Buildout

Project Number	Project Description	Infrastructure Required	Diameter/Size (in, mgd)	Length (ft)	Unit Construction Cost ($)	Construction Cost ($)	Project Cost ($)
WW1	WRF Expansion Phase 3 (15 mgd MMADF capacity)	WRF	–	–	–	$18,960,000	$23,170,000
						Total	**$23,170,000**

ENR= 10678

Table 6.12 Wastewater Infrastructure Provided by Developers

Project Number	Project Description	Infrastructure Required	Diameter (in) or Flow (mgd)	Length (ft)	Unit Construction Cost ($)	Construction Cost ($)	Project Cost ($)
Developer paid Wastewater System Infrastructure for FY 2018/2019 to FY 2022/2023							
WWD1	New Pipe, south of I-10, east of Avondale Boulevard, connecting to Hilton Avenue	Gravity Main	8 in	3,660	$172	$630,000	$890,000
WWD2	New Pipe, 111th Avenue, north of Van Buren Street	Gravity Main	8 in	1,680	$172	$290,000	$410,000
WWD3	New Pipe, north of Van Buren Street, west of 107th Avenue	Gravity Main	8 in	1,560	$172	$270,000	$380,000
WWD4	New Pipe, south of I-10, west of 107th Avenue	Gravity Main	8 in	2,480	$172	$430,000	$610,000
WWD5	New Pipe, 104th Avenue, north of Van Buren Street	Gravity Main	8 in	1,100	$172	$190,000	$270,000
WWD6	New Pipe, Encanto Boulevard from 101st Avenue to 103rd Avenue	Gravity Main	12 in	1,340	$198	$270,000	$380,000
						Total	**$2,940,000**
Wastewater System Infrastructure Recommended for FY 2023/2024 to FY 2027/2028							
WWD7	`	Gravity Main	15 in	5,240	$213	$1,120,000	$1,570,000
WWD8	New Pipe, 119th Avenue from Elwood Street to Broadway Road	Gravity Main	15 in	2,640	$213	$570,000	$800,000
WWD9	New Pipe, Raymond Street from 107th Avenue to Avondale Boulevard	Gravity Main	12 in	5,000	$198	$990,000	$1,390,000
WWD10	New Pipe, Broadway Road from 107th Avenue to Avondale Boulevard	Gravity Main	12 in	5,000	$198	$990,000	$1,390,000
WWD11	New Pipe, Roeser Road from 107th Avenue to Avondale Boulevard	Gravity Main	12 in	5,000	$198	$990,000	$1,390,000
						Total	**$6,540,000**
Wastewater System Infrastructure Recommended Through Buildout							
WWD12	New Pipe, Dysart Road from Southern Avenue to Roeser Road	Gravity Main	15 in	2,600	$213	$560,000	$790,000
WWD13	New Pipe, Southern Avenue from El Mirage Road to 1/2 mile west of Dysart Road	Gravity Main	15 in	7,100	$213	$1,520,000	$2,130,000
WWD14	New Pipe, El Mirage Road from Southern Avenue to Roeser Road	Gravity Main	15 in	3,310	$213	$710,000	$1,000,000
WWD15	New Pipe, Southern Avenue from Avondale Boulevard to El Mirage Road	Gravity Main	15 in	5,100	$213	$1,090,000	$1,530,000
WWD16	New Pipe, Avondale Boulevard from Southern Avenue to Roeser Road	Gravity Main	15 in	2,840	$213	$610,000	$860,000
WWD17	New Pipe, Southern Avenue from 107th Avenue to Avondale Boulevard	Gravity Main	15 in	5,100	$213	$1,090,000	$1,530,000
WWD18	New Lift Station at Roeser Road and Dysart Road	Lift Station	0.2 mgd	-	$584,000	$584,000	$820,000
	New Force Main at Roeser Road and Dysart Road	Force Main	8 in	600	$139	$90,000	$130,000
WWD19	New Lift Station at Roeser Road and El Mirage Road	Lift Station	0.2 mgd	-	$584,000	$584,000	$820,000
	New Force Main at Roeser Road and El Mirage Road	Force Main	8 in	500	$139	$70,000	$100,000
WWD20	New Lift Station at Roeser Road and Avondale Boulevard	Lift Station	0.2 mgd	-	$584,000	$584,000	$820,000
	New Force Main at Roeser Road and Avondale Boulevard	Force Main	8 in	200	$139	$30,000	$50,000
						Total	**$10,580,000**

ENR = 10678

Table 6.13 City of Avondale Water Resources, Water, and Wastewater Capital Project Summary

Project No.	Infrastructure Category	Project Cost ($)	FY 2018/2019 Project Cost ($)	FY 2019/2020 Project Cost ($)	FY 2020/2021 Project Cost ($)	FY 2021/2022 Project Cost ($)	FY 2022/2023 Project Cost ($)	FY2023/2024 to FY2027/2028 Project Costs ($)	Buildout Project Cost ($)
WA1285	White Mountain Apache Tribe water settlement	$2,300,000	$2,300,000						
	Water Infrastructure								
W1	Wheel water through Phoenix to Garden Lakes facility	$6,863,000	$1,357,000	$5,506,000					
W2	Northside well site (Well A) land purchase & Design Concept Report	$75,000	$75,000						
WA1131	Construct Well #27 and connect to Garden Lakes facility	$4,408,000	$800,000	$722,000	$2,886,000				
WA1344	Separate Zone 1 and Zone 2	$1,727,000		$368,000	$1,359,000				
W3	Recharge facility - replace diversion structure and piping improvements	$1,050,000	$300,000	$750,000					
W4	Replace Gateway nitrate treatment	$3,000,000		$500,000	$2,500,000				
WA1135	McDowell Road 16-inch waterline - 117th Avenue to Avondale Boulevard	$300,000			$300,000				
WA1231	Dysart Road 12-inch waterline from Whyman Road to Lower Buckeye Road	$400 ,000			$400,000				
W5	Purchase land for future treatment site at 107th Avenue and Roosevelt Street	$600,000				$600,000			
W6	Rehabilitate Northside arsenic treatment system	$1,000,000				$1,000,000			
WA1133	Construct 99th Avenue waterline from Thomas Road to Encanto Boulevard	$710,000					$710,000		
W7	Expand Garden Lakes storage and pumping	$8,358,000						$8,358,000	
W8	Install 16-inch main on McDowell Road from Avondale Boulevard to 99th Avenue	$2,724,000						$2,724,000	
WA1142	Construct Future Well	$2,940,000						$2,940,000	
WA1340	Construct nitrate removal system for Coldwater facility	$5,545,000						$5,545,000	
WA1214	Construct Future Well	$2,900,000						$2,900,000	
W9	Equip Well #22 to deliver water to Coldwater facility	$1,817,000							$1,817,000
W10	Add Well J to Coldwater	$2,900,000							$2,900,000
W11	Construct Well A and deliver to Northside facility	$2,900,000							$2,900,000
W12	Rehabilitate Del Rio facilities	$2,002,000							$2,002,000
W13	Wheel water through Phoenix to Del Rio facility	$17,507,000							$17,507,000
W14	Construct a treatment, storage, and booster facility on 107th Avenue and Roosevelt Street, add supply from Well C	$17,188,000							$17,188,000
W15	Add Well D to 107th Avenue and Roosevelt Street, add supply from Well C	$8,916,000							$8,916,000
W16	Add storage and pumping capacity at Del Rio facility	$8,183,000							$8,183,000
W17	Construct Future Well	$2,940,000							$2,940,000
W18	Construct Future Well	$2,940,000							$2,940,000
	Water Infrastructure Total	**$109,893,000**	**$2,532,000**	**$7,846,000**	**$7,445,000**	**$1,600,000**	**$710,000**	**$22,467,000**	**$67,293,000**
	Wastewater Infrastructure								
SW1389	Sewer main, Dysart Road from Riley Drive to Corral Street	$1,270,000	$260,000	$1.010,000					
SW1390	Sewer Main, Dysart Road from Harrison Dr. to Lower Buckeye Road	$1,130,000				$230,000	$900,000		
SW1108	Backup force main - 10th Street lift station to El Mirage Road	$2,200,000		$300,000				$1,900,000	
SW1237	Water Reclamation Facility Expansion Phase 2	$63,070,000						$63,070,000	
WW1	Water Reclamation Facility Expansion Phase 3	$23,170,000							$23,170,000
	Wastewater Infrastructure Total	**$90,840,000**	**$260,000**	**$1,310,000**	**$ –**	**$230,000**	**$900,000**	**$64,970,000**	**$23,170,000**
	CIP Projects Total	**$203,033,000**	**$5,092,000**	**$9,156,000**	**$7,445,000**	**$1,830,000**	**$1,610,000**	**$87,437,000**	**$90,383,000**

Appendix A

MARICOPA ASSOCIATION OF GOVERNMENT'S TRAFFIC ANALYSIS ZONE DATA FOR CITY OF AVONDALE

Appendix A
Traffic Analysis Zone (TAZ) Data for City of Avondale

	Residential Population 2015	Total Employment 2015	Total Dwelling Unit 2015	Single Family Household 2015	Multi-family Household 2015	Residential Population 2030	Total Employment 2030	Total Dwelling Unit 2030	Single Family Household 2030	Multi-family Household 2030	2015 to 2030 Population Increase	2017 Estimated Population	2022 Estimated Population	2027 Estimated Population
264.00	1814.00	578.00	579.00	519.00	0.00	1814.00	705.00	579.00	555.00	0.00	0.00	1814.00	1814.00	1814.00
265.00	4142.00	1419.00	1393.00	811.00	376.00	4512.00	2089.00	1407.00	839.00	491.00	370.00	4191.33	4314.67	4438.00
266.00	6120.00	493.00	2539.00	1738.00	263.00	7162.00	645.00	2793.00	1996.00	367.00	1042.00	6258.93	6606.27	6953.60
267.00	5915.00	658.00	1999.00	1908.00	0.00	5915.00	784.00	1999.00	1985.00	0.00	0.00	5915.00	5915.00	5915.00
268.00	0.00	970.00	0.00	0.00	0.00	0.00	1020.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
269.00	1576.00	412.00	558.00	312.00	246.00	1576.00	603.00	558.00	312.00	246.00	0.00	1576.00	1576.00	1576.00
270.00	0.00	51.00	0.00	0.00	0.00	0.00	51.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
271.00	4224.00	106.00	1734.00	964.00	481.00	5061.00	177.00	2014.00	926.00	858.00	837.00	4335.60	4614.60	4893.60
272.00	261.00	102.00	94.00	88.00	0.00	812.00	259.00	290.00	287.00	0.00	551.00	334.47	518.13	701.80
273.00	8448.00	334.00	2906.00	2205.00	463.00	9573.00	472.00	3106.00	2500.00	562.00	1125.00	8598.00	8973.00	9348.00
274.00	6329.00	504.00	2216.00	2113.00	0.00	6583.00	576.00	2227.00	2212.00	0.00	254.00	6362.87	6447.53	6532.20
275.00	5628.00	555.00	1849.00	1720.00	0.00	6127.00	807.00	1927.00	1901.00	0.00	499.00	5694.53	5860.87	6027.20
276.00	1347.00	316.00	554.00	218.00	240.00	1604.00	971.00	567.00	218.00	337.00	257.00	1381.27	1466.93	1552.60
277.00	2816.00	628.00	875.00	809.00	0.00	3546.00	723.00	1128.00	1087.00	0.00	730.00	2913.33	3156.67	3400.00
278.00	2138.00	384.00	694.00	656.00	0.00	4303.00	540.00	1359.00	1346.00	0.00	2165.00	2426.67	3148.33	3870.00
279.00	4126.00	1645.00	1565.00	886.00	534.00	6388.00	3734.00	2265.00	1316.00	887.00	2262.00	4427.60	5181.60	5935.60
280.00	0.00	1587.00	0.00	0.00	0.00	0.00	2213.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
281.00	7765.00	465.00	2633.00	1623.00	622.00	8495.00	781.00	2742.00	1728.00	817.00	730.00	7862.33	8105.67	8349.00
282.00	1317.00	29.00	351.00	335.00	0.00	1822.00	34.00	551.00	473.00	61.00	505.00	1384.33	1552.67	1721.00
283.00	88.00	0.00	25.00	25.00	0.00	88.00	0.00	25.00	25.00	0.00	0.00	88.00	88.00	88.00
284.00	7595.00	771.00	2320.00	2026.00	72.00	7595.00	873.00	2336.00	2205.00	97.00	0.00	7595.00	7595.00	7595.00
285.00	450.00	12.00	139.00	128.00	0.00	450.00	12.00	139.00	77.00	0.00	0.00	450.00	450.00	450.00
2395.00	9.00	2.00	5.00	4.00	0.00	9.00	18.00	5.00	4.00	0.00	0.00	9.00	9.00	9.00
2396.00	400.00	0.00	128.00	116.00	0.00	438.00	6.00	176.00	152.00	0.00	38.00	405.07	417.73	430.40
2397.00	442.00	31.00	135.00	124.00	0.00	2058.00	38.00	657.00	621.00	0.00	1616.00	657.47	1196.13	1734.80
2732.00	4533.00	401.00	1346.00	1220.00	0.00	5142.00	493.00	1607.00	1570.00	0.00	609.00	4614.20	4817.20	5020.20
2738.00	267.00	0.00	79.00	70.00	0.00	267.00	0.00	79.00	72.00	0.00	0.00	267.00	267.00	267.00
2828.00	1459.00	26.00	391.00	360.00	0.00	2009.00	25.00	591.00	587.00	0.00	550.00	1532.33	1715.67	1899.00
2829.00	45.00	180.00	15.00	15.00	0.00	45.00	187.00	15.00	15.00	0.00	0.00	45.00	45.00	45.00
2830.00	4.00	35.00	2.00	2.00	0.00	4.00	165.00	2.00	2.00	0.00	0.00	4.00	4.00	4.00
2865.00	592.00	1415.00	336.00	0.00	224.00	592.00	1582.00	336.00	0.00	327.00	0.00	592.00	592.00	592.00
3137.00	2.00	48.00	6.00	2.00	0.00	2.00	46.00	6.00	6.00	0.00	0.00	2.00	2.00	2.00
3138.00	149.00	3.00	48.00	43.00	0.00	149.00	3.00	48.00	43.00	0.00	0.00	149.00	149.00	149.00
3139.00	24.00	14.00	7.00	7.00	0.00	24.00	15.00	7.00	7.00	0.00	0.00	24.00	24.00	24.00
3140.00	304.00	11.00	99.00	91.00	0.00	1012.00	18.00	480.00	353.00	0.00	708.00	398.40	634.40	870.40
3178.00	0.00	0.00	0.00	0.00	0.00	0.00	7.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	**80329.00**	**14185.00**	**27620.00**	**21138.00**	**3521.00**	**95177.00**	**20672.00**	**32021.00**	**25420.00**	**5050.00**	**14848.00**	**82308.73**	**87258.07**	**92207.40**

Appendix A
Traffic Analysis Zone (TAZ) Data for City of Avondale

	2015 to 2030 Job Increase	2017 Estimated Job	2022 Estimated Job	2027 Estimated Job	2015 to 2030 Dwelling Unit Increase	2017 Estimated Dwelling Units	2022 Estimated Dwelling Units	2027 Estimated Dwelling Units	2017 Estimated Demand (gpd)	2022 Estimated Demand (gpd)	2027 Estimated Demand (gpd)
264.00	127.00	594.93	637.27	679.60	0.00	579.00	579.00	579.00	260550.00	260550.00	260550.00
265.00	670.00	1508.33	1731.67	1955.00	14.00	1394.87	1399.53	1404.20	627690.00	629790.00	631890.00
266.00	152.00	513.27	563.93	614.60	254.00	2572.87	2657.53	2742.20	1157790.00	1195890.00	1233990.00
267.00	126.00	674.80	716.80	758.80	0.00	1999.00	1999.00	1999.00	899550.00	899550.00	899550.00
268.00	50.00	976.67	993.33	1010.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
269.00	191.00	437.47	501.13	564.80	0.00	558.00	558.00	558.00	251100.00	251100.00	251100.00
270.00	0.00	51.00	51.00	51.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
271.00	71.00	115.47	139.13	162.80	280.00	1771.33	1864.67	1958.00	797100.00	839100.00	881100.00
272.00	157.00	122.93	175.27	227.60	196.00	120.13	185.47	250.80	54060.00	83460.00	112860.00
273.00	138.00	352.40	398.40	444.40	200.00	2932.67	2999.33	3066.00	1319700.00	1349700.00	1379700.00
274.00	72.00	513.60	537.60	561.60	11.00	2217.47	2221.13	2224.80	997860.00	999510.00	1001160.00
275.00	252.00	588.60	672.60	756.60	78.00	1859.40	1885.40	1911.40	836730.00	848430.00	860130.00
276.00	655.00	403.33	621.67	840.00	13.00	555.73	560.07	564.40	250080.00	252030.00	253980.00
277.00	95.00	640.67	672.33	704.00	253.00	908.73	993.07	1077.40	408930.00	446880.00	484830.00
278.00	156.00	404.80	456.80	508.80	665.00	782.67	1004.33	1226.00	352200.00	451950.00	551700.00
279.00	2089.00	1923.53	2619.87	3316.20	700.00	1658.33	1891.67	2125.00	746250.00	851250.00	956250.00
280.00	626.00	1670.47	1879.13	2087.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00
281.00	316.00	507.13	612.47	717.80	109.00	2647.53	2683.87	2720.20	1191390.00	1207740.00	1224090.00
282.00	5.00	29.67	31.33	33.00	200.00	377.67	444.33	511.00	169950.00	199950.00	229950.00
283.00	0.00	0.00	0.00	0.00	0.00	25.00	25.00	25.00	11250.00	11250.00	11250.00
284.00	102.00	784.60	818.60	852.60	16.00	2322.13	2327.47	2332.80	1044960.00	1047360.00	1049760.00
285.00	0.00	12.00	12.00	12.00	0.00	139.00	139.00	139.00	62550.00	62550.00	62550.00
2395.00	16.00	4.13	9.47	14.80	0.00	5.00	5.00	5.00	2250.00	2250.00	2250.00
2396.00	6.00	0.80	2.80	4.80	48.00	134.40	150.40	166.40	60480.00	67680.00	74880.00
2397.00	7.00	31.93	34.27	36.60	522.00	204.60	378.60	552.60	92070.00	170370.00	248670.00
2732.00	92.00	413.27	443.93	474.60	261.00	1380.80	1467.80	1554.80	621360.00	660510.00	699660.00
2738.00	0.00	0.00	0.00	0.00	0.00	79.00	79.00	79.00	35550.00	35550.00	35550.00
2828.00	-1.00	25.87	25.53	25.20	200.00	417.67	484.33	551.00	187950.00	217950.00	247950.00
2829.00	7.00	180.93	183.27	185.60	0.00	15.00	15.00	15.00	6750.00	6750.00	6750.00
2830.00	130.00	52.33	95.67	139.00	0.00	2.00	2.00	2.00	900.00	900.00	900.00
2865.00	167.00	1437.27	1492.93	1548.60	0.00	336.00	336.00	336.00	151200.00	151200.00	151200.00
3137.00	-2.00	47.73	47.07	46.40	0.00	6.00	6.00	6.00	2700.00	2700.00	2700.00
3138.00	0.00	3.00	3.00	3.00	0.00	48.00	48.00	48.00	21600.00	21600.00	21600.00
3139.00	1.00	14.13	14.47	14.80	0.00	7.00	7.00	7.00	3150.00	3150.00	3150.00
3140.00	7.00	11.93	14.27	16.60	381.00	149.80	276.80	403.80	67410.00	124560.00	181710.00
3178.00	7.00	0.93	3.27	5.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	**6487.00**	**15049.93**	**17212.27**	**19374.60**	**4401.00**	**28206.80**	**29673.80**	**31140.80**	**12693060.00**	**13353210.00**	**14013360.00**

Appendix B

WASTEWATER UNIT FLOWS

Appendix B

Wastewater Unit Loads

City of Avondale

Land Use	Flowmeter 1			Flowmeter 2			Flowmeter 3			Flowmeter 4			Flowmeter 5		
	Unit Load (gpad)	Acreage	Load (gpm)	Unit Load (gpad)	Acreage	Load (gpm)	Unit Load (gpad)	Acreage	Load (gpm)	Unit Load (gpad)	Acreage	Load (gpm)	Unit Load (gpad)	Acreage	Load (gpm)
Rural Low Density Residential	25	0	0.0	25	0	0.0	25	0	0.0	25	0	0.0	25	0	0.0
Estate/Low Density Residential	126	0	0.0	126	0	0.0	126	15	1.3	126	1	0.1	126	0	0.0
Sports & Entertainment	664	0	0.0	664	0	0.0	664	0	0.0	664	0	0.0	664	0	0.0
Medium Density Residential	361	270	67.7	361	1196	299.8	361	1024	256.8	361	487	122.1	361	275	68.9
City Center*	1627	0	0.0	1627	0	0.0	1627	0	0.0	1627	0	0.0	1627	43	49.1
Historic Avondale	1444	82	81.8	1444	0	0.0	1444	0	0.0	1444	0	0.0	1444	0	0.0
Medium/High Density Residential	1444	27	27.1	1444	0	0.0	1444	0	0.0	1444	0	0.0	1444	0	0.5
High Density Residential****	4332	11	31.8	4332	44	131.3	4332	60	181.5	4332	49	146.0	4332	0	0.0
Urban Commercial	2721	0	0.0	2721	1	2.1	2721	0	0.0	2721	0	0.0	2721	0	0.0
Mixed Use	2835	0	0.0	2835	0	0.0	2835	6	10.9	2835	0	0.0	2835	0	0.0
Urban Residential	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Local Commercial	1110	54	41.6	1110	92	70.5	1110	31	23.5	1110	4	3.1	1110	0	0.0
Open Space & Parks	0	0	0.0	0	222	0.0	0	704	0.0	0	72	0.0	0	0	0.0
Open Space - Irrigation	0	6	0.0	0	0	0.0	0	0	0.0	0	37	0.0	0	0	0.0
Freeway Commercial	975	0	0.0	975	78	53.1	975	1	0.8	975	128	87.0	975	3	2.0
Business Park	780	0	0.0	780	12	6.5	780	4	2.4	780	0	0.0	780	0	0.0
Education	660	39	18.0	660	30	13.8	660	71	32.5	660	10	4.6	660	0	0.0
Industrial	600	5	2.1	600	0	0.0	600	0	0.0	600	0	0.0	600	0	0.0
Public/Civic	660	0	0.0	660	8	3.5	660	0	0.2	660	4	1.6	660	29	13.3
Corporate Park	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Gila River Scenic District	780	0	0.0	780	0	0.0	780	0	0.0	780	0	0.0	780	0	0.0
High Intensity Office	780	0	0.0	780	0	0.0	780	0	0.1	780	0	0.0	780	0	0.0
Office/Professional	600	0	0.0	600	9	4.0	600	0	0.0	600	11	4.7	600	0	0.0
Total Total (gpm)		494	270.1		1,691	584.5		1,917	510.1		803	369.1		351	133.8
Flow From Other Basins (gpm)			0.0			0.0			0.0			0.0			347.0
Sub-Total (gpm)			270.1			584.5			510.1			369.1			480.7
Average Flowmeter Flow (gpm)			293.3			935.2			574.3			347.0			401.6
Percent Error			-8%			-37%			-11%			6%			20%

Appendix B

Wastewater Unit Loads

City of Avondale

	Flowmeter 6			Flowmeter 7			Flowmeter 8			Flowmeter 9			Septic System Areas		
Land Use	Unit Load (gpad)	Acreage	Load (gpm)	Unit Load (gpad)	Acreage	Load (gpm)	Unit Load (gpad)	Acreage	Load (gpm)	Unit Load (gpad)	Acreage	Load (gpm)	Unit Load (gpad)	Acreage	Load (gpm)
Rural Low Density Residential	25	0	0.0	25	0	0.0	25	0	0.0	25	123	2.2	0	93	0.0
Estate/Low Density Residential	126	72	6.4	126	0	0.0	126	0	0.0	126	1	0.1	0	332	0.0
Sports & Entertainment	664	0	0.0	664	0	0.0	664	0	0.0	664	288	132.9	0	0	0.0
Medium Density Residential	361	1502	376.6	361	80	20.2	361	80	20.1	361	97	24.3	0	2	0.0
City Center*	1627	14	15.8	1627	0	0.0	1627	0	0.0	1627	0	0.0	0	0	0.0
Historic Avondale	1444	0	0.0	1444	0	0.0	1444	32	31.7	1444	0	0.0	0	0	0.0
Medium/High Density Residential	1444	201	201.1	1444	0	0.0	1444	0	0.0	1444	0	0.0	0	0	0.0
High Density Residential****	4332	32	94.9	4332	12	36.1	4332	56	168.5	4332	0	0.0	0	0	0.0
Urban Commercial	2721	7	12.7	2721	0	0.0	2721	45	85.2	2721	0	0.0	0	0	0.0
Mixed Use	2835	118	232.9	2835	0	0.0	2835	0	0.0	2835	150	294.9	0	0	0.0
Urban Residential	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Local Commercial	1110	60	46.4	1110	0	0.0	1110	69	53.2	1110	0	0.0	0	0	0.0
Open Space & Parks	0	687	0.0	0	6	0.0	0	30	0.0	0	2355	0.0	0	0	0.0
Open Space - Irrigation	0	17	0.0	0	0	0.0	0	10	0.0	0	0	0.0	0	0	0.0
Freeway Commercial	975	3	2.1	975	0	0.0	975	1	0.4	975	0	0.0	0	0	0.0
Business Park	780	319	172.9	780	0	0.0	780	1	0.5	780	0	0.0	0	0	0.0
Education	660	157	71.9	660	0	0.0	660	62	28.3	660	0	0.0	0	0	0.0
Industrial	600	1	0.5	600	11	4.8	600	88	36.6	600	0	0.0	0	0	0.0
Public/Civic	660	8	3.5	660	0	0.0	660	3	1.3	660	193	88.7	0	0	0.0
Corporate Park	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Gila River Scenic District	780	0	0.0	780	0	0.0	780	0	0.0	780	24	13.0	0	8	0.0
High Intensity Office	780	0	0.0	780	0	0.0	780	0	0.0	780	0	0.0	0	0	0.0
Office/Professional	600	0	0.0	600	0	0.0	600	0	0.0	600	0	0.0	0	0	0.0
Total Total (gpm)		3,198	1237.8		110	61.1		475	425.8		3,231	556.2		435	0.0
Flow From Other Basins (gpm)			1509.6			0.0			349.7			4019.8			
Sub-Total (gpm)			2747.4			61.1			775.5			4576.0			
Average Flowmeter Flow (gpm)			2823.7			56.4			794.5			4027.8			
Percent Error			-3%			8%			-2%			14%			

Appendix C

GARDEN LAKES AND DEL RIO WATER QUALITY EVALUATION

City of Avondale

TECHNICAL MEMORANDUM GARDEN LAKES AND DEL RIO WATER QUALITY EVALUATION

FINAL | January 2018

City of Avondale

TECHNICAL MEMORANDUM

GARDEN LAKES AND DEL RIO WATER QUALITY EVALUATION

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Abbreviations

µg/L	micrograms per liter
1/cm	cm^{-1}
AI	Aggressive Index
CAP	Central Arizona Project
CCPP	calcium carbonate precipitation potential
City	City of Avondale
cm	centimeter
CSMR	chloride to sulfate mass ratio
degree C	degrees Celsius
DFI	Driving Force Index
GAC	granular activated charcoal
gpm	gallons per minute
iPFD	intelligent process flow diagram
LI	Larson Index
LSI	Langelier Saturation Index
MCL	maximum contaminant level
ME	Momentary Excess Index
MG	million gallons
mg/L	milligrams per liter
mgd	million gallons per day
N/A	not available
nm	nanometer
PFD	process flow diagram
RI	Ryznar Stability Index
RTW	Rothberg Tamburini & Winsor
s.u.	standard unit
SRP	Salt River Project
TDS	total dissolved solids
TOC	total organic carbon
TTHM	total trihalomethane
UV	ultraviolet
UV254	ultraviolet absorbance at 254 nm

Technical Memorandum

GARDEN LAKES AND DEL RIO WATER QUALITY EVALUATION

1.1 Introduction and Project Goals

The City of Avondale (City) is making a major decision to consider introducing surface water into the water distribution system, which has been supplied only by well water up to this point in time. Avondale has been having discussions with the City of Phoenix (Phoenix) to wheel up to 14 million gallons per day (mgd) of its Salt River Project (SRP) and Central Arizona Project (CAP) water allocation through the Phoenix water system to the Garden Lakes and Del Rio water storage and pumping facilities.

The Garden Lakes facility currently includes SRP Well #17, an ion exchange nitrate treatment facility, 2 million gallons (MG) of storage with space for an additional 2 MG, and a pump station. Two additional future wells, Well #27 and Well H, are slated to deliver water to this site. In addition, one more SRP well nearby could be re-drilled and water from that site could be delivered to Garden Lakes. The nearest Phoenix pipeline is located approximately three-quarters of a mile to the north at the intersection of 107th Avenue and Indian School Road. A connection is planned that would deliver up to 5 mgd from Phoenix.

The Del Rio facility is not currently in use. The two wells that deliver water to the site have very poor water quality, so these wells are also not in use. The site has a 3.5 MG storage reservoir and a pump station. If the Del Rio site could be brought back into use by delivering water from Phoenix, it would provide essential storage and pumping to Zones 2 and 3. The Del Rio site has space for one more reservoir and a pump station to Zone 3.

Initial cost estimates to wheel water through Phoenix and ensure water quality standards were met were based on assumed water treatment needs for pH adjustment and TTHM treatment. The benefits of blending surface water to reduce nitrate treatment requirements for groundwater were also not quantified. Therefore, the City asked Carollo to complete this study to more definitively determine treatment requirements so that CIP costs could be established accordingly.

The goals of this project are:

1. Evaluate the feasibility of wheeling water from Phoenix to Avondale at the Garden Lakes and Del Rio water facilities.
2. Model water quality impacts of blending water from Phoenix to Avondale's distribution system.
3. Develop conceptual layouts of the infrastructure to determine if the sites have sufficient space for treatment facilities.

City staff worked with its water quality lab and Phoenix water operations staff to quickly gather water quality data for Well #17 and several other Avondale wells, as well as water quality data at two Phoenix TTHM monitoring sites to be used in this analysis.

1.1.1 Water Treatment Goals

Table 1 lists the proposed water quality goals for Avondale customers. The City's goal is to treat water to 80 percent of maximum contaminant levels (MCLs).

Water quality goals is to blend groundwater and treated surface water (Phoenix Water). Then water treatment methods were applied to achieve the water quality goals as economically as possible.

Table 1 Proposed Water Quality Goals

Water Quality Parameters	Units	Proposed Finished Water Quality Goal
Total Trihalomethane (TTHM)	µg/L	≤ 64(1)
Nitrate	mg/L	≤ 8(2)
Calcium Carbonate Precipitation Potential (CCPP)	mg/L	4 ~ 10(3)

Notes:
(1) 80% of TTHM MCL (80 µg/L)
(2) 80% of nitrate MCL (10 mg/L)
(3) CCPP is an index to illustrate the water stability. CCPP index is usually recommended to be slightly toward scaling potential in order to protect pipeline from corroding.
Abbreviations:
µg/L = micrograms per liter; mg/L = milligrams per liter

1.2 Water Balance Model Development

Carollo's Blue Plan-it® Decision Support System was utilized to develop a customized model for the water quality evaluation. The water quality model consists of the following three components:

1. An integrated dynamic database allowing users to store and access historical and new operational data (e.g., flow, water quality, etc.).
2. A graphical process flow diagram interface consisting of smart blocks of each unit process, presenting operational data, input parameters, and model outputs.
3. An input and output interface using an Excel workbook with real time linkage between Blue Plan-it® and an Excel spreadsheet.

The goals of the modeling include:

1. Evaluating blending scenarios and potential processes required to meet the City's water quality goals.
2. Using water quality goals to determine the size of treatment process equipment.

1.2.1 Water Quality Data Collection and Review

Water quality data for the local groundwater sources and the potential water sources from City of Phoenix were collected by the City through a grab-sampling event during September 2017. Additionally, historical Phoenix water quality for Sites 1040 and 1790 was collected by the City staff (see Appendix B). Key parameters were implemented into the water blending analysis model including:

- Total Dissolved Solids (TDS)
- Alkalinity
- Calcium concentration
- Magnesium concentration
- Chloride concentration
- Sulfate concentration
- pH
- Temperature
- Total Trihalomethane (TTHM) concentration
- Total Organic Carbon (TOC)
- Ultraviolet (UV) absorbance at 254 nm (UV254)
- Free Chlorine Residual

Table 2 summarizes the key water quality of groundwater (Well #17, future Well #27, future Well H) and Phoenix water used in the blending analysis. An SRP well at 107th Avenue and Encanto Boulevard was also considered as a potential groundwater source to blend at Garden Lakes.

In general, Avondale groundwater contains higher nitrate concentrations than Phoenix water but lower TOC concentrations and UV254 nanometer (nm) wavelength. Avondale groundwater also shows higher alkalinity than Phoenix water, which indicates a stronger buffering capacity when blending with other water. Phoenix water has some higher TTHM concentrations (70 to 80 µg/L) in this grab sample event. This is expected during summer when temperature is high and water age is long. Moreover, water quality of Avondale Well Site #17 and Phoenix water are similar, but Phoenix water has a slightly higher TDS concentration.

Table 2 Key Water Quality Constituents Measured for Water Sources

	Unit	Well #10	Well #17	Well #23	SRP Well(1)	Phoenix Site 1040(5)	Phoenix Site 1790(6)
Alkalinity	mg/L as $CaCO_3$	151	127	187	N/A	116	118
Calcium	mg/L as $CaCO_3$	180	130	290	N/A	140	130
Chloride	mg/L	234	229	321	N/A	340	380
Free Chlorine Residual	mg/L	0	0.04	0.06	N/A	0.21	0.52
Magnesium	mg/L	47	39	51	N/A	21	20
Nitrate	mg/L	4.86	10.5	5.03	16.3	<0.2(2)	<0.2(2)
pH	s.u.	7.18	7.26	6.99	N/A	6.82	7.01
Sulfate	mg/L	267	82.3	113	N/A	107	90.5
Total Dissolved Solids	mg/L	644	644	857	944.75	794	808
Temperature	degree C	25	29.5	26	29	32	34
Total Organic Carbon	mg/L	<1.0(3)	<1.0(3)	<1.0(3)	N/A	2.16	2.03
TTHM	µg/L	3.3	<0.5	14	N/A	70.2	80.2
UV254	1/cm	<0.009(4)	<0.009(4)	<0.009(4)	N/A	0.0205	0.0234

Notes:
(1) Well site is located on the west side of 107th Ave. at Encanto Blvd. close to Well #17 at Garden Lakes. Constituent concentrations of Well #17 were used in place of missing data of the SRP well for blending analysis.
(2) The concentration is lower than the detection limit of 0.2 mg/L. 0.2 mg/L nitrate was used for blending analysis.
(3) The concentration is lower than the detection limit of 1.0 mg/L. 0.5 mg/L TOC was used for blending analysis.
(4) The concentration is lower than the detection limit of 0.009 1/cm. 0.009 1/cm UV254 absorbance was used for blending analysis.
(5) Phoenix Site 1040 is located north of Indian School and represents water quality for the Garden Lakes connection.
(6) Phoenix Site 1790 is near the future connection point for Del Rio.

Abbreviations:
s.u. = standard unit; N/A = not available; degree C = degrees Celsius; 1/cm = cm^{-1}

Table 3 presents the statistical results of a historical water quality dataset collected for Phoenix Water Site 1040 from 2012 to the present. The pH value varied between 6.3 and 8.3 over the last five years. These water quality variations could be attributed to varied temperature, biological activities, and/or chemical reactions. Low pH observed in the distribution system might lead to water corrosivity and potential pipe corrosion, although Phoenix water pH, averaged 7.7 , and was lower than 7 only three times out of the 152 data points. Based on the historical data, Phoenix water is relatively stable except for low pH events.

The lab results of the groundwater and Phoenix water collected during September 2017 are provided in Appendix B.

Table 3 City of Phoenix Site 1040 Water Quality Data

Phoenix Site 1040	Unit	Maximum	Minimum	Average
Alkalinity	mg/L as $CaCO_3$	197	121	141
Calcium Hardness	mg/L as $CaCO_3$	185	119	140
Chloride	mg/L	358	76	202
Magnesium - Total	mg/L	30	15	23
pH	s.u.	8.3	6.3	7.7
Sulfate	mg/L	234	52	126
Temperature	degree C	35	14	25

1.2.2 Water Quality Model Features

For the water stability and corrosivity analysis, the Blue Plan-it® model used an algorithm similar to the Rothberg Tamburini & Winsor (RTW) water quality model and other chemical equilibrium calculations to determine a list of corrosion and stability indices and estimate required chemical doses. The following highlights the technical features of the stability and corrosivity analysis:

- Tracks alkalinity, acidity, pH, sulfate, chloride, hardness, temperature, TDS, and other water quality parameters.
- Determines the characteristics of blended water from two to five separate sources while accounting for the equilibrium of the carbonate buffering system.
- Calculates the impact of pH adjustment (via caustic soda or acid) and blending ratio control on corrosivity and stability.
- Calculates seven corrosion and stability indices, including Langelier Saturation Index (LSI), Larson Index (LI), Ryznar Stability Index (RI), Aggressive Index (AI), Driving Force Index (DFI), Momentary Excess Index (ME), the calcium carbonate precipitation potential (CCPP), and Chloride-to-Sulfate Mass Ratio (CSMR).
- Tracks other water quality parameters such as TOC, UV254, bromide, etc.
- Calculates the effect of common water treatment chemicals (acids, base, chlorine, coagulants, etc.).
- Calculate the change in total trihalomethane concentration due to pH changes and chlorine or hypochlorite dose.
- Blends other water quality parameters (such as arsenic, nitrate, and fluoride) based on mass balance calculations.

Additional information on this corrosion and stability model are provided in Appendix A.

1.2.3 Intelligent process flow diagram

Figure 1 shows a screen shot of the water quality analysis model customized for the Garden Lakes water supply systems. This process flow diagram integrates all potential water sources for blending analysis, including existing Well #17, future Well #27 and Well H, Phoenix Water Main, and a SRP Well. Figure 2 shows a screen shot of the process flow diagram for the Del Rio water supply system.

The following assumptions were made to establish a comprehensive model:

- For Garden Lakes:
  - Well #17 is online (1,150 gpm)
  - Wells #27, H (assumed 1,250 gpm each), and SRP well at 107th Street and Encanto (2,720 gpm) can be added
  - Phoenix supply can be up to 5 mgd - for modeling typical flows assumed to be 4 mgd
  - Current storage is 2 MG with space for 2 additional MG
  - The booster pump station can be expanded up to a peak flow of 14.7 mgd
- For Del Rio:
  - Phoenix flow is up to 10 mgd
  - Well water is not blended at the site, but blending occurs in the distribution system
  - Current storage is 3.5 MG with space for another 3.5 MG
  - The maximum discharge flow rate is 20 mgd

The water quality model is capable of blending all above water sources dynamically to form a range of scenarios, each with varied input water qualities.

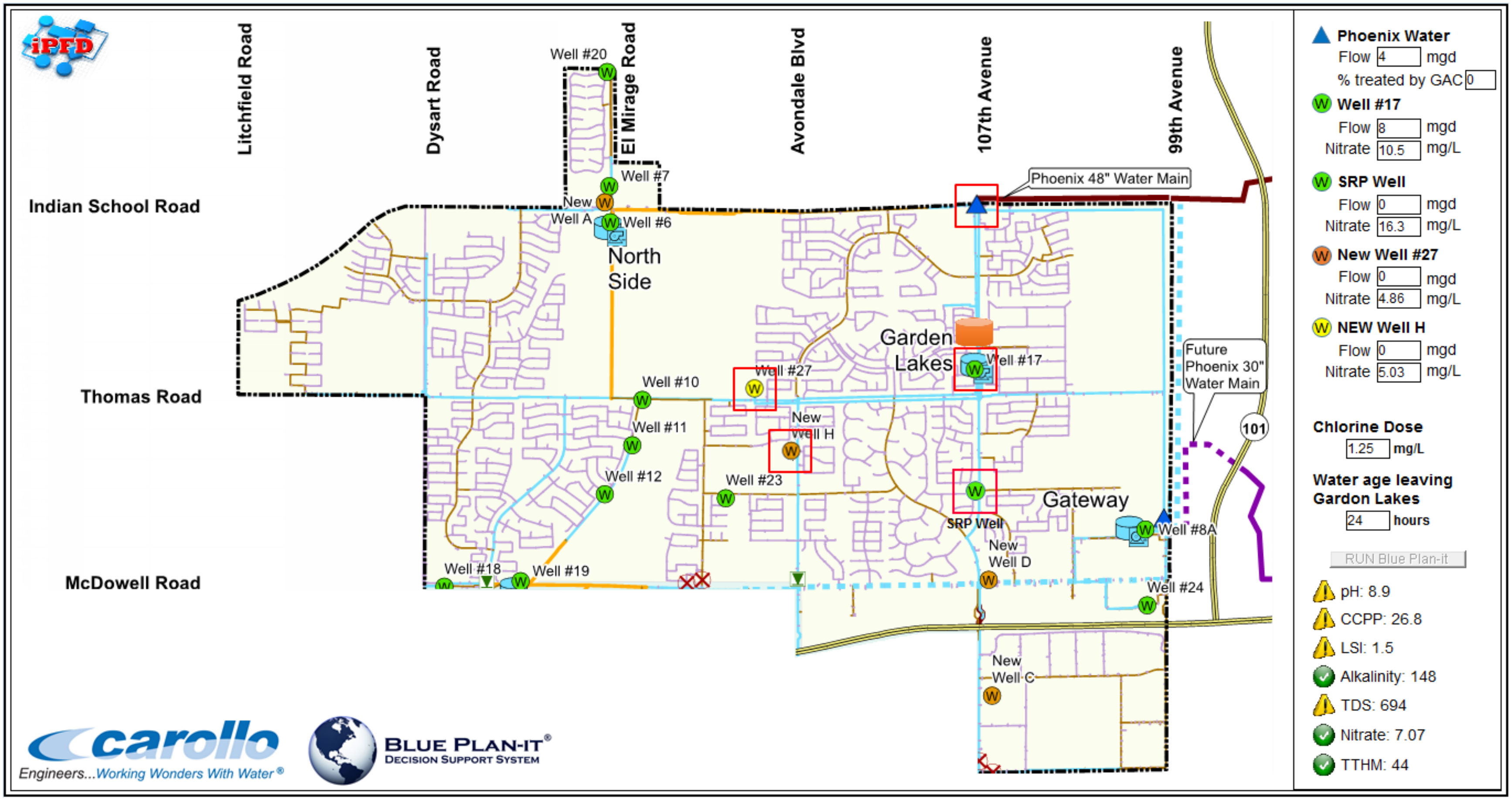

Figure 1 Blue Plan-it® Intelligent Process Flow Diagram for Garden Lakes

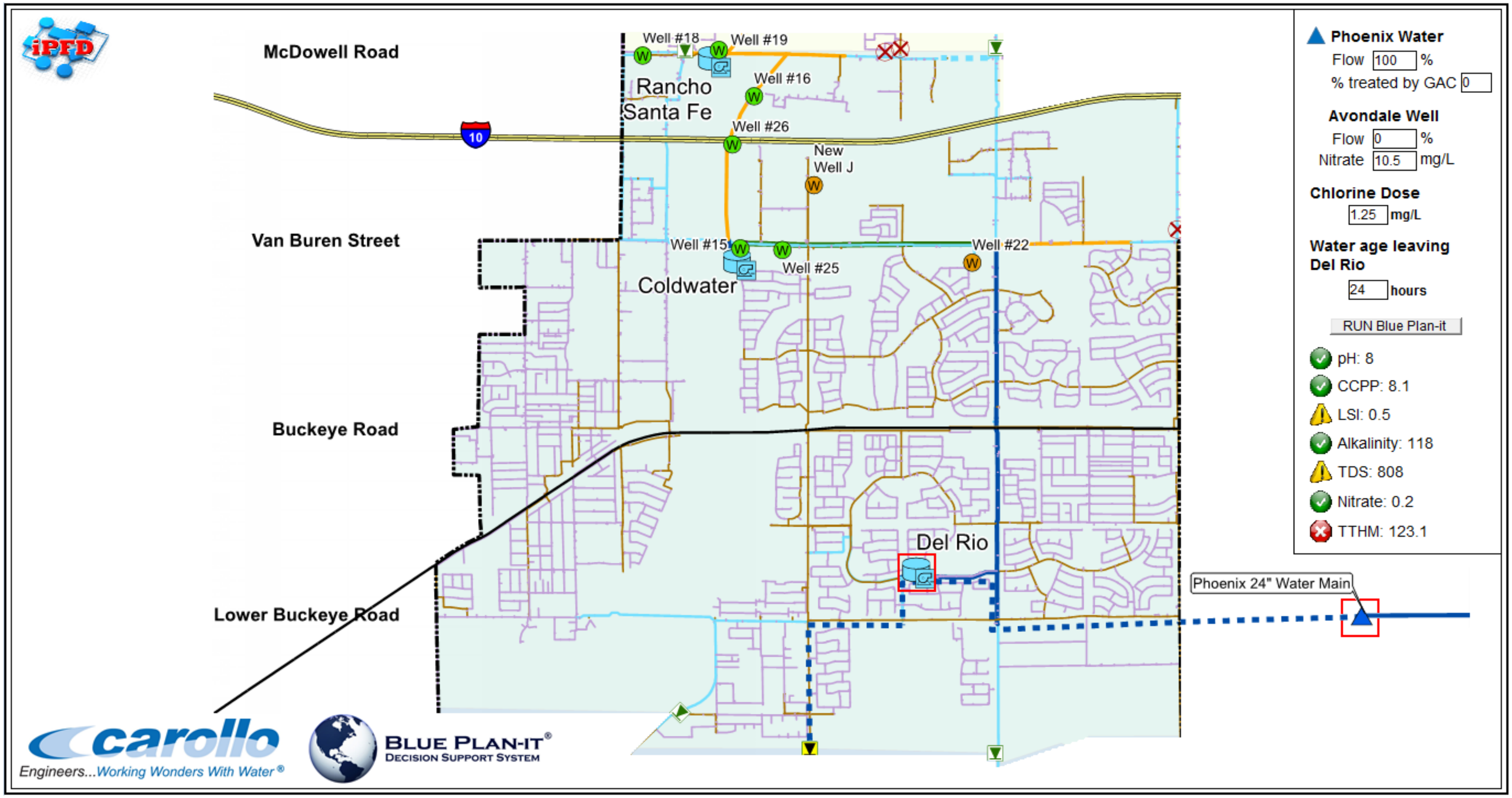

Figure 2 Blue Plan-it® Intelligent Process Flow Diagram for Del Rio

1.3 Blending Analysis for Garden Lakes

1.3.1 Water Quality and Corrosivity Results for Different Blend Ratios

Table 4 presents the water quality and corrosivity result under different blending ratios for Garden Lakes. To set up the blending scenario, Phoenix water flow was fixed at 4 mgd while Avondale groundwater varied from 0 to 8 mgd. Blending ratios were calculated based on flow and mass balance. The stability corresponding to Avondale groundwater was evaluated (first column in Table 4) as a baseline to show water quality and corrosivity inherent in the Avondale groundwater. Nitrate concentrations in the blended water for all scenarios are lower than 8 mg/L. 50% or more of Well #17 flow is required for blending to meet TTHM goal of 64 µg/L.

$CaCO_3$ precipitation potential (CCPP), Langelier Saturation Index (LSI), Ryznar Index, and Driving Force Index (DF) are carbonate buffer related indices, which indicate the tendency to form $CaCO_3$ precipitation or dissolve $CaCO_3$. Aggress Index (AI) is mainly used for evaluation when asbestos cement pipe is used. No significant indices change was observed across all blending ratios. A marginal pH adjustment using caustic soda can reduce corrosivity and enhance water stability (further discussed in a later section). Table 4 shows the results with worst case scenario (low pH and high temperature) from a corrosivity standpoint. If the pH and temperature are in a 50th percentile range as shown in Table 5, water tends to be stable when blended with a higher portion of Phoenix water without additional pH adjustment.

Alkalinity lower than 50 mg/L potentially tends to release color from unlined or galvanized iron pipe. From this perspective, the blended water alkalinity is in the stable range. Larson Index and chloride to sulfate mass ratio (CSMR) represent potential interference with natural film formation and resulting in galvanic corrosion of lead solder connected to copper pipe. The blended water shows higher corrosion tendency based on those two indices. Considering the distribution pipe material and minimal changes after blending, the water is considered relatively stable in the proposed scenarios.

Table 4 Blended Water Stability Results at Garden Lakes (Worst Case Scenario)

Phoenix Water Flow	**%**	**0**	**100**	**89**	**80**	**73**	**67**	**62**	**57**	**53**	**50**	**47**	**44**	**42**	**40**	**38**	**36**	**35**	**33**
Avondale Well Flow	**%**	**100**	**0**	**11**	**20**	**27**	**33**	**38**	**43**	**47**	**50**	**53**	**56**	**58**	**60**	**62**	**64**	**65**	**67**
pH	s.u.	7.3	6.9	6.9	6.9	6.9	7	7	7	7	7	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1
TDS	mg/L	644	794	777	764	753	744	736	730	724	719	715	711	707	704	701	699	696	694
Nitrate(1)	mg/L	10.5	0.2	1.3	2.3	3.0	3.6	4.2	4.6	5.0	5.4	5.7	5.9	6.2	6.4	6.6	6.8	6.9	7.1
TTHM(2)	µg/L	17	99	90	82	76	71	67	64	60	58	55	53	51	50	48	47	45	44
CCPP(3)		-6.4	-30	-28	-26	-24	-22	-21	-20	-19	-18	-17	-17	-16	-16	-15	-15	-14	-14
LSI(4)		-0.2	-0.7	-0.6	-0.6	-0.6	-0.6	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.4	-0.4	-0.4	-0.4	-0.4
Alkalinity(5)	mg/L as $CaCO_3$	127	116	117	118	119	120	120	121	121	122	122	122	122	123	123	123	123	123
Ryznar Index(6)		7.8	8.2	8.2	8.1	8.1	8.1	8.1	8	8	8	8	8	8	8	8	8	7.9	7.9
Aggress Index(7)		11.5	11.1	11.1	11.1	11.2	11.2	11.2	11.2	11.2	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3
DF Index(8)		0.58	0.21	0.23	0.24	0.26	0.28	0.29	0.31	0.31	0.33	0.34	0.34	0.35	0.36	0.37	0.38	0.39	0.39
Larson Index(9)		3.2	5.1	4.9	4.7	4.5	4.4	4.3	4.2	4.2	4.1	4.1	4	4	3.9	3.9	3.9	3.8	3.8
Cl-to-SO_4(10)		2.8	3.2	3.1	3.1	3.1	3.1	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	2.9	2.9

Notes: This blending analysis is based on pH = 6.8 for Phoenix water. According to historical field data at Phoenix site 1040, only 6 out of 152 data points were observed with pH lower than 7.0.

(1) Nitrate concentration > 10 mg/L: red, 8 to 10 mg/L: yellow, < 8 mg/L: green.
(2) TTHM concentration > 80 µg/L: red, 64 to 80 µg/L: yellow, < 64 µg/L: green.
(3) CCPP < 4: red (corrosive), 4 to 10: green (stable), > 10: red (scaling).
(4) LSI < -0.5: red (corrosive), -0.5 to 0: yellow (mild corrosive), 0 to 0.5: green (stable), > 0.5: red (scaling).
(5) Alkalinity < 50: red (corrosive), 50 to 80: yellow (mild corrosive), > 80: green (stable).
(6) Ryznar Index > 8: red (corrosive), 7 to 8: yellow (mild corrosive), 6 to 7: green (stable), < 6: red (scaling).
(7) Aggress Index < 10: red (corrosive), 10 to 12: yellow (mild corrosive), > 12: green (stable).
(8) DF Index < 0.1: red (corrosive), 0.1 to 10: green (stable), > 10: red (scaling).
(9) Larson Index > 0.6: red (corrosive), 0.2 to 0.6: yellow (mild corrosive), < 0.2: green (stable).
(10) Chloride to sulfate mass ratio > 0.8: red (corrosive), 0.5 to 0.8: yellow (mild corrosive), < 0.5: green (stable).

Table 5 Blended Water Stability Results at Garden Lakes

Phoenix Water Flow	**%**	**0**	**100**	**89**	**80**	**73**	**67**	**62**	**57**	**53**	**50**	**47**	**44**	**42**	**40**	**38**	**36**	**35**	**33**
Well #17 Flow	**%**	**100**	**0**	**11**	**20**	**27**	**33**	**38**	**43**	**47**	**50**	**53**	**56**	**58**	**60**	**62**	**64**	**65**	**67**
pH	s.u.	7.3	7.9	7.9	7.9	8	8	8	8	8	8	8	8	8	8	8	8	8	8
TDS	mg/L	644	794	777	764	753	744	736	730	724	719	715	711	707	704	701	699	696	694
Nitrate(1)	mg/L	10.5	0.2	1.3	2.3	3.0	3.6	4.2	4.6	5.0	5.4	5.7	5.9	6.2	6.4	6.6	6.8	6.9	7.1
TTHM(2)	µg/L	17	109	99	91	84	79	74	70	66	63	61	58	56	54	52	51	49	48
CCPP(3)		-6.4	4.2	4.5	4.6	4.8	5	5	5	5.2	5.2	5.2	5.4	5.4	5.4	5.4	5.4	5.4	5.6
LSI(4)		-0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Alkalinity(5)	mg/L as $CaCO_3$	127	116	117	118	119	120	120	121	121	122	122	122	122	123	123	123	123	123
Ryznar Index(6)		7.8	7.5	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4
Aggress Index(7)		11.5	12.1	12.2	12.2	12.2	12.2	12.2	12.2	12.2	12.2	12.2	12.2	12.2	12.2	12.2	12.2	12.2	12.2
DF Index(8)		0.58	1.7	1.8	1.8	1.8	1.9	1.9	1.9	1.9	1.9	1.9	2	2	2	2	2	2	2
Larson Index(9)		3.2	5.1	4.9	4.7	4.5	4.4	4.3	4.2	4.2	4.1	4.1	4	4	3.9	3.9	3.9	3.8	3.8
Cl-to-SO_4(10)		2.8	3.2	3.1	3.1	3.1	3.1	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	2.9	2.9

Notes: This blending analysis is based on pH = 7.8 for Phoenix water. According to historical field data at Phoenix site 1040, 93 out of 152 data points (> 60%) were observed with pH higher than 7.8.
(1) Nitrate concentration > 10 mg/L: red, 8 to 10 mg/L: yellow, < 8 mg/L: green.
(2) TTHM concentration > 80 µg/L: red, 64 to 80 µg/L: yellow, < 64 µg/L: green.
(3) CCPP < 4: red (corrosive), 4 to 10: green (stable), > 10: red (scaling).
(4) LSI < -0.5: red (corrosive), -0.5 to 0: yellow (mild corrosive), 0 to 0.5: green (stable), > 0.5: red (scaling).
(5) Alkalinity < 50: red (corrosive), 50 to 80: yellow (mild corrosive), > 80: green (stable).
(6) Ryznar Index > 8: red (corrosive), 7 to 8: yellow (mild corrosive), 6 to 7: green (stable), < 6: red (scaling).
(7) Aggress Index < 10: red (corrosive), 10 to 12: yellow (mild corrosive), > 12: green (stable).
(8) DF Index < 0.1: red (corrosive), 0.1 to 10: green (stable), > 10: red (scaling).
(9) Larson Index > 0.6: red (corrosive), 0.2 to 0.6: yellow (mild corrosive), < 0.2: green (stable).
(10) Chloride to sulfate mass ratio > 0.8: red (corrosive), 0.5 to 0.8: yellow (mild corrosive), < 0.5: green (stable).

Figure 3 illustrates the blended water corrosivity when mixing Avondale groundwater with Phoenix water using a contour plot. The blending ratio of groundwater and Phoenix water varied from 0% or 100% to 50% and 50% respectively and the groundwater pH varied from 7 to 9 in this sensitivity analysis. The color of the chart represents the CCPP. Water with a CCPP value less than 4 has a high corrosive tendency; CCPP greater than 10 has a high scaling tendency; CCPP between 4 and 10 is represents a stable water quality. When Phoenix water pH is lower than 7, the blended water becomes more corrosive across all blending ratios and varied groundwater pH. This is consistent to the CCPP results in Table 4. When a pH of groundwater available for blending is higher and/or the Phoenix water is blended with higher percentage of groundwater, the corrosivity is reduced. However, based on the historical field data (2012 to present), Phoenix water with a pH lower than 7 was only observed 3 times out of 152 data points. This indicates that a Phoenix water pH lower than 7 is more likely to be corrosive. To avoid corrosive water, adjusting the pH by dosing caustic soda is recommended when the pH of the receiving groundwater and Phoenix water are low. Required caustic soda dosages are presented in Figure 4.

Figure 3 shows the blending results when assuming Phoenix water pH equals 7.8 (representing ~60th percentile of the data observed). Blended water is stable in terms of CCPP across all blending scenarios (0 to 50% of Well #17 flow) even without additional pH adjustment, if groundwater pH is between 7.8 and 8.7. The results also indicate that the corrosive nature of the groundwater can be mitigated by blending with Phoenix water. Based on the historical data, Phoenix water is relatively stable except for sporadic low pH events. As mentioned above, a caustic soda injection system and a pH monitoring system are recommended for pH adjustment to stabilize blended water when pH is low in Phoenix water.

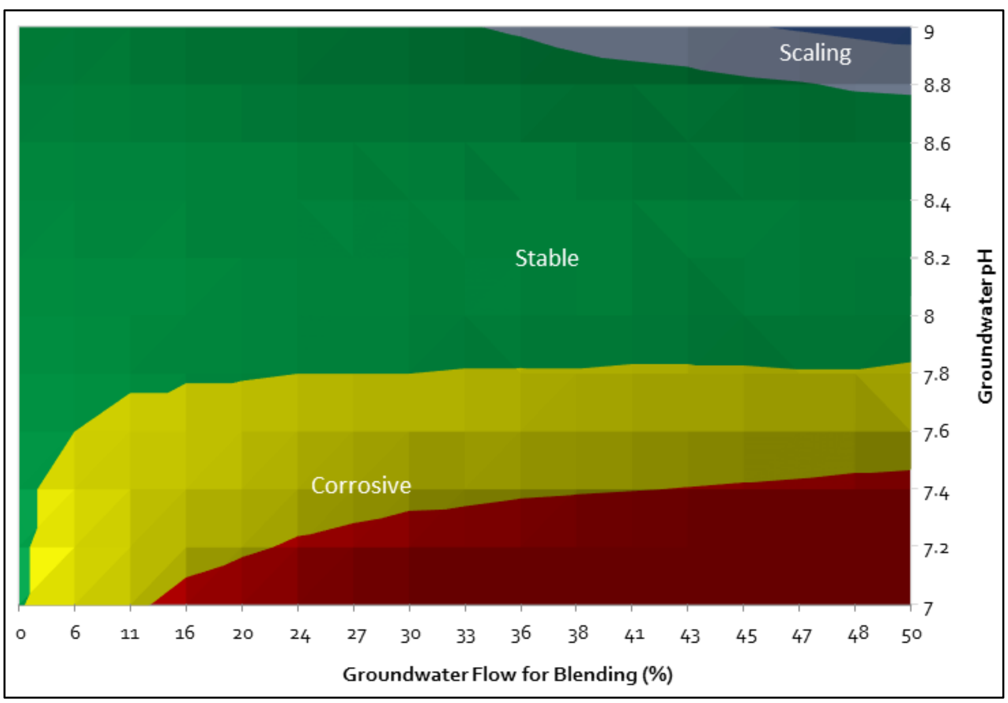

Figure 3 Blending Analysis for $CaCO_3$ Precipitation Potential (Phoenix Water pH = 7.8)

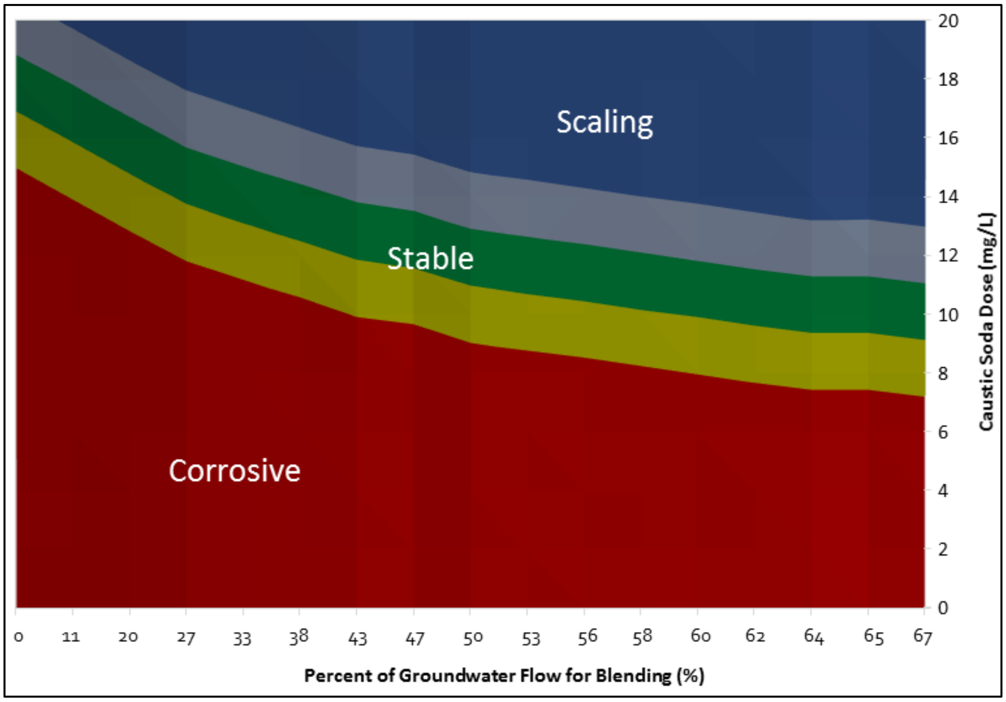

Figure 4 Water Stabilization by pH Adjustment (Phoenix Water pH = 6.8)

In order to reduce water corrosivity when worst case scenario occurs, caustic soda can be added to adjust the pH. Figure 4 shows how much of caustic soda should be dosed to stabilize the blended water across all blend ratios assuming low pH for both Phoenix water and Avondale groundwater. As a result, the required caustic soda dosages ranged between 10 and 18 mg/L, with the blending ratio of groundwater from 67% to 0%. Roughly 11 mg/L of caustic soda will be required when the blend ratio is 50% to 50%. Monitoring groundwater and Phoenix water pH is recommended to avoid corrosive water in the distribution system.

1.3.2 TTHM formation Results for Different Blend Ratios

In order to evaluate TTHM formation in the distribution system at the highest water age, the TTHM concentration at Phoenix water Site 1040 was used to calibrate the TTHM formation projection model. pH, temperature, UV254, TOC concentration, and bromide concentration were used to calibrate the model. Assumptions included:

- TTHM at Phoenix water Site 1040 is 70 µg/L.
- Phoenix water at Site 1040 has a water age around 72 hours.
- The initial chlorine dosage for Phoenix water leaving the Phoenix treatment facility is 3.4 mg/L.
- The bromide concentration in both Phoenix water and Avondale groundwater is 0.05 mg/L (no data available).
- The chlorine dosage after blending is 1.25 mg/L.
- The water will reside in the distribution system another 24 hours after blending, during which time additional TTHM will be formed.
- The blended water TTHM goal is to not exceed 64 µg/L in the distribution system with the highest water age proposed.

Based on the results shown in Figure 5, the TTHM formation is lower than the water quality goal of 64 µg/L if the blend ratio of Avondale groundwater is more than 50%. Blended water nitrate concentration (data not shown here) is lower than 8 mg/L across all blending scenarios. Based on the sensitivity analysis results, pH has a marginal impact on TTHM formation.

Additionally, a TTHM removing process called granular activated carbon contactor (GAC) was considered to treat Phoenix water partially before blending with groundwater. This analysis helps to size the GAC capacity required and evaluate the reliability of the treatment process. Figure 6 illustrates that without GAC treatment a 50% groundwater blend is required to dilute the TTHM concentration to lower than 64 µg/L. This is consistent with the results from Figure 5. If 40% of Phoenix water is treated with GAC as shown by the red line in Figure 6, blending with a groundwater is not required to reduce the TTHM level. Therefore, if a 2 mgd GAC contactor is designed to treat 40 percent of Phoenix water, the City can use up to 5 mgd of Phoenix water even if all the wells are out of service.

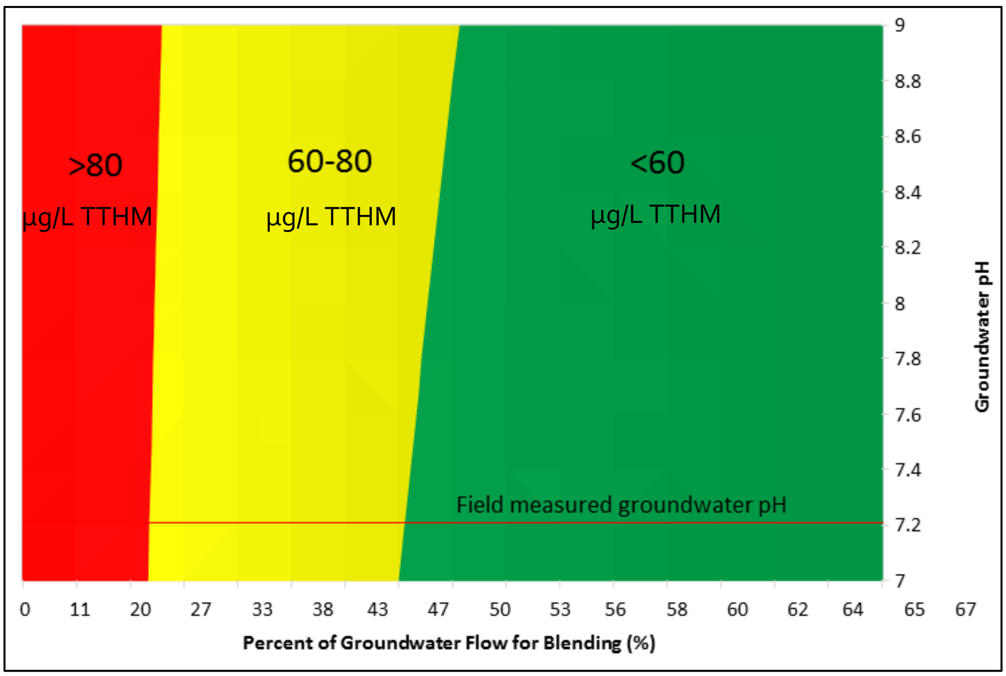

Figure 5 Blending Analysis for TTHM Formation

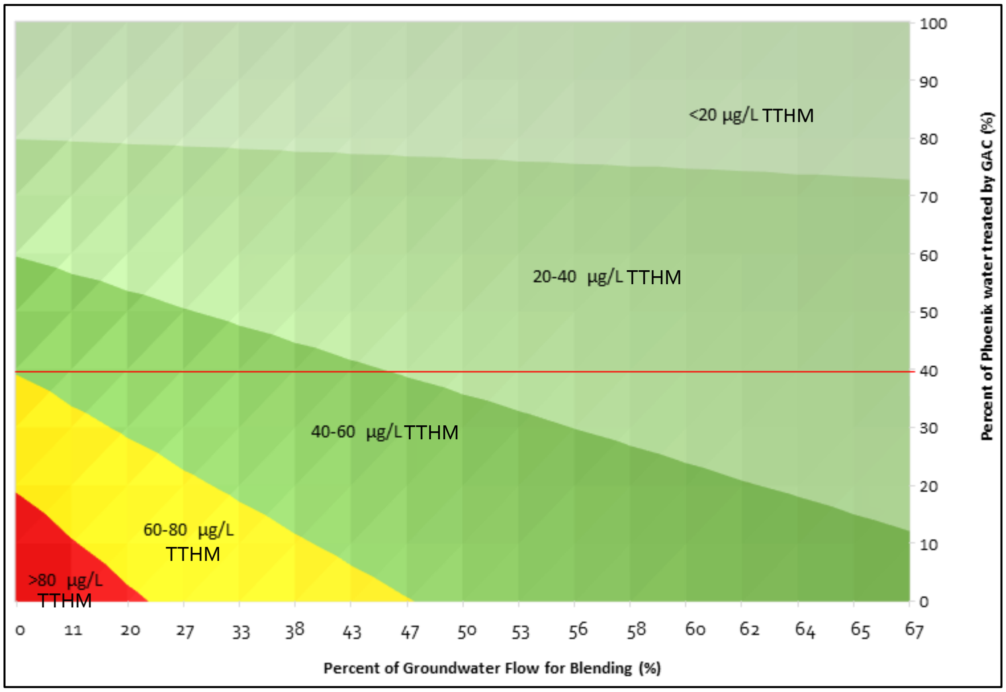

Figure 6 TTHM Formation When Treating Phoenix Water with GAC

1.3.3 Nitrate Concentration Results for Different Blend Ratios

An SRP Well at Encanto Boulevard and 107th Avenue, which is not far from the Garden Lakes site, is considered as an additional water supply to blend with Phoenix water. However, this SRP well is expected to have a higher nitrate concentration (up to 16.3 mg/L), which changes the blending ratio for this well. Figure 7 shows that nitrate concentrations could exceed 8 mg/L, if this SRP well provides more than 40% of the total groundwater flow. Nitrate treatment will be required to reduce nitrate concentrations if more than 40% of the SRP well is used for blending. In other words, Figure 7 also shows that a 50/50 blend of Phoenix water and groundwater successfully blends out nitrates, until the new SRP well provides more than 40% of the groundwater total flow.

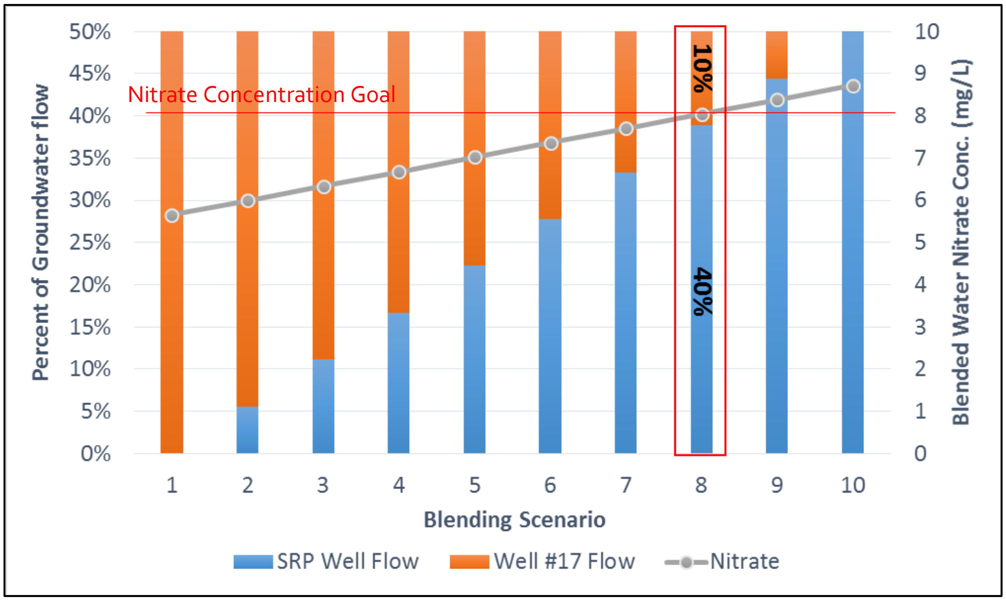

Figure 7 Impact of New SRP Well on Blended Water Nitrate Concentration

1.3.4 Site Layout for Garden Lakes

In order to provide safe drinking water, a TTHM reduction process using GAC and a pH adjustment system are recommended for the Garden Lakes well site. Assuming 10 mgd maximum discharge flow (5 mgd groundwater, 5 mgd Phoenix water) from the Garden Lakes site, two caustic soda storage tanks (10-foot height X 10-foot diameter) will be required for pH adjustment. Tanks are sized for one month storage capacity. Four GAC contactors (10-foot diameter, 10-foot media depth, and 0.6 mgd capacity, each) will be required to treat 40% (2 mgd) of Phoenix water. This allows full utilization of the 5 mgd of Phoenix water even if Avondale wells are out of service. Figure 8 shows the proposed site layout for the Garden Lakes site.

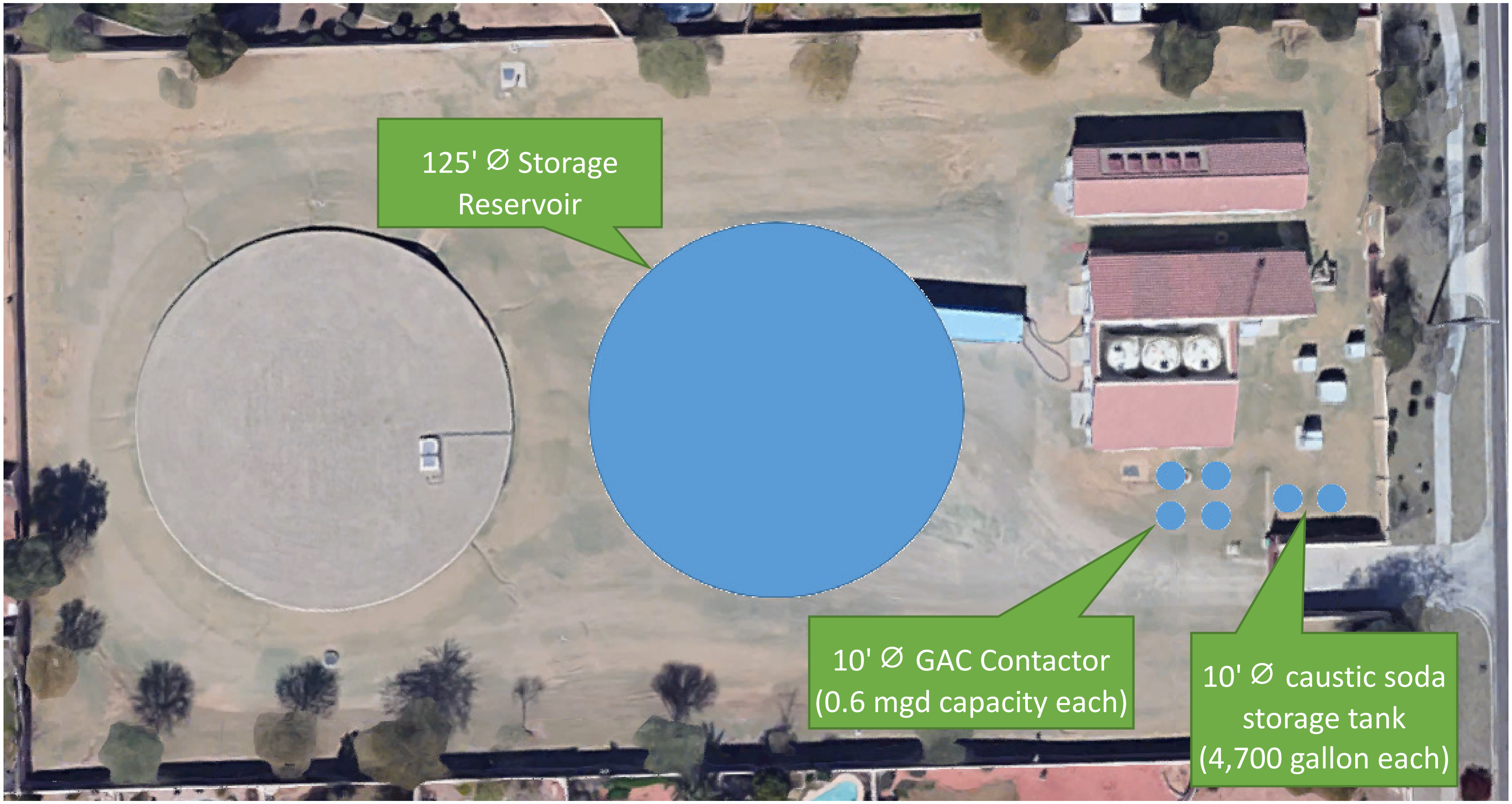

Figure 8 Proposed Garden Lakes Site Layout

1.4 Water Quality Analysis for Del Rio

1.4.1 Water Corrosivity Results

Assumptions made for Del Rio water quality analysis are summarized as follows:

- Phoenix flow is up to 10 mgd
- Well water is not blended at the site. Blending occurs in the distribution system with other water sources
- Del Rio has 3.5 MG storage with space for another 3.5 MG
- Maximum discharge flow rate is 20 mgd

The water quality results for Phoenix water Site 1079 was used for the Del Rio site. As shown in Table 6, the overall water quality of Phoenix water Site 1079 is very close to Site 1040. The water has a slight corrosive tendency when pH is lower than 7 and is more stable when pH is higher than 7.8.

Table 6 Phoenix Water Site 1079 Stability Results for the Del Rio Site

Parameter	Unit	High pH	Low pH
pH	s.u.	7.8	7
TDS	mg/L	808	808
Nitrate(1)	mg/L	0.2	0.2
TTHM(2)	µg/L	123	103
CCPP(3)		8.1	-17.9
LSI(4)		0.5	-0.5
Alkalinity(5)	mg/L as $CaCO_3$	118	118
Ryznar Index(6)		7	8
Aggress Index(7)		12.2	11.2
DF Index(8)		3	0.31
Larson Index(9)		5.3	5.3
Cl-to-SO_4(10)		4.2	4.2

Notes:
(1) Nitrate concentration > 10 mg/L: red, 8 to 10 mg/L: yellow, < 8 mg/L: green.
(2) TTHM concentration > 80 µg/L: red, 64 to 80 µg/L: yellow, < 64 µg/L: green.
(3) CCPP < 4: red (corrosive), 4 to 10: green (stable), > 10: red (scaling).
(4) LSI < -0.5: red (corrosive), -0.5 to 0: yellow (mild corrosive), 0 to 0.5: green (stable), > 0.5: red (scaling).
(5) Alkalinity < 50: red (corrosive), 50 to 80: yellow (mild corrosive), > 80: green (stable).
(6) Ryznar Index > 8: red (corrosive), 7 to 8: yellow (mild corrosive), 6 to 7: green (stable), < 6: red (scaling).
(7) Aggress Index < 10: red (corrosive), 10 to 12: yellow (mild corrosive), > 12: green (stable).
(8) DF Index < 0.1: red (corrosive), 0.1 to 10: green (stable), > 10: red (scaling).
(9) Larson Index > 0.6: red (corrosive), 0.2 to 0.6: yellow (mild corrosive), < 0.2: green (stable).
(10) Chloride to sulfate mass ratio > 0.8: red (corrosive), 0.5 to 0.8: yellow (mild corrosive), < 0.5: green (stable).

Figure 9 shows the caustic soda dosage required to stabilize the Phoenix water if the pH is lower than 7. Approximately 11 to 14 mg/L of caustic soda will be dosed to maintain the CCPP value between 4 and 10.

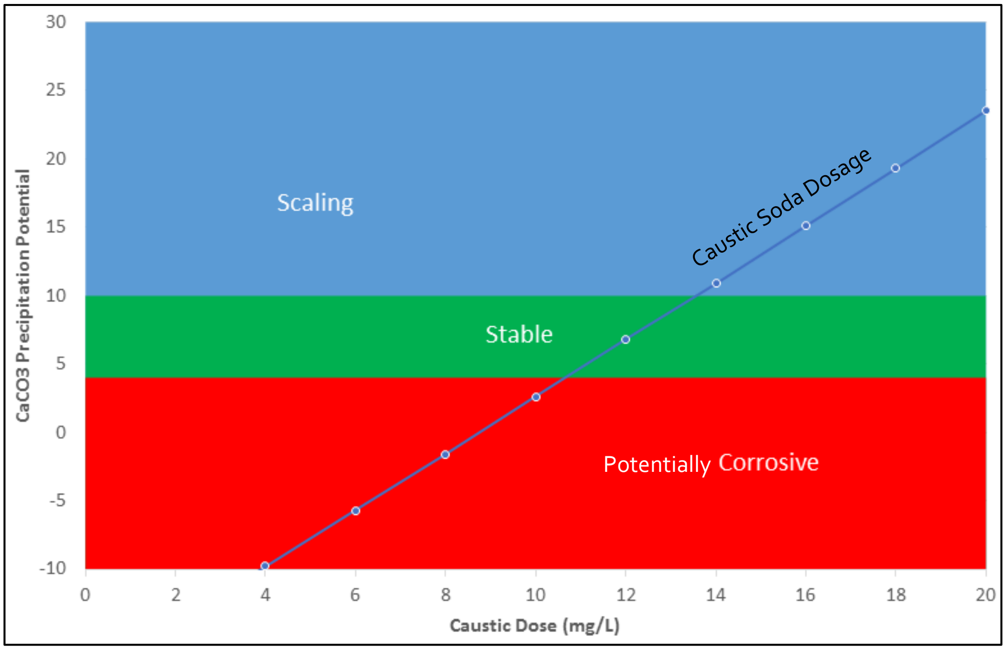

Figure 9 Caustic Soda Dosage for Water Stabilization for Del Rio

1.4.2 TTHM Formation Results

In order to evaluate TTHM formation in the distribution system, the TTHM concentration at Phoenix water Site 1079 was used to calibrate the TTHM formation projection model. Except for TTHM concentration, pH, temperature, UV254, TOC concentration, and bromide concentration were also considered for the model calibration. To be conservative, several assumptions were made as shown below:

- TTHM at Phoenix water Site 1079 is 70 µg/L
- The water age at Phoenix water Site 1079 is 72 hours
- The initial chlorine dosage for Phoenix water leaving the Phoenix treatment facility is 3.5 mg/L
- The bromide concentration in Phoenix water is 0.05 mg/L
- The chlorine dosage leaving the Del Rio site is 1.25 mg/L
- The maximum water age after leaving Del Rio site is 24 hours, during which additional TTHM will be formed
- Blended water TTHM goal is not to exceed 64 µg/L in the distribution system at the highest water age

Figure 10 presents the TTHM formation in the distribution system when the Phoenix water is partially treated by a GAC contactor. TTHM formation is lower than 64 µg/L if more than 40% of Phoenix water is treated by GAC and blended with untreated Phoenix water. Therefore if a 4 mgd GAC contactor partially treats Phoenix water, the City can use up to 10 mgd of Phoenix water even if all the wells are out of service.

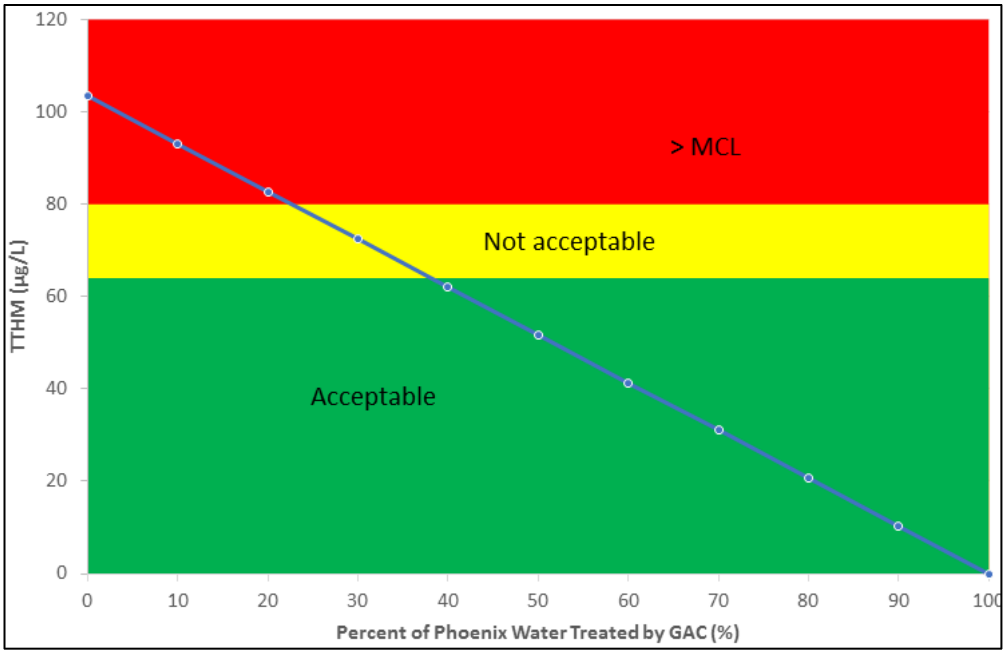

Figure 10 TTHM Formation when Treating Phoenix Water with GAC for Del Rio

1.4.3 Site Layout for Del Rio

In order to provide safe drinking water, a TTHM reduction process using GAC and a pH adjustment system are recommended for Del Rio well site. Assuming 10 mgd Phoenix water from Del Rio, two caustic soda storage tanks (10 feet high by 12 feet in diameter) will be required for pH adjustment. Tanks are sized for a one month storage capacity. Six GAC contactors (12-foot diameter, 10 feet media depth, and 0.8 mgd capacity, each) will be required to treat 40 percent (4 mgd) of Phoenix water. This allows full utilization of 10 mgd of Phoenix water even if Avondale wells are out of service. Figure 11 presents a layout of the Del Rio site with proposed improvements.

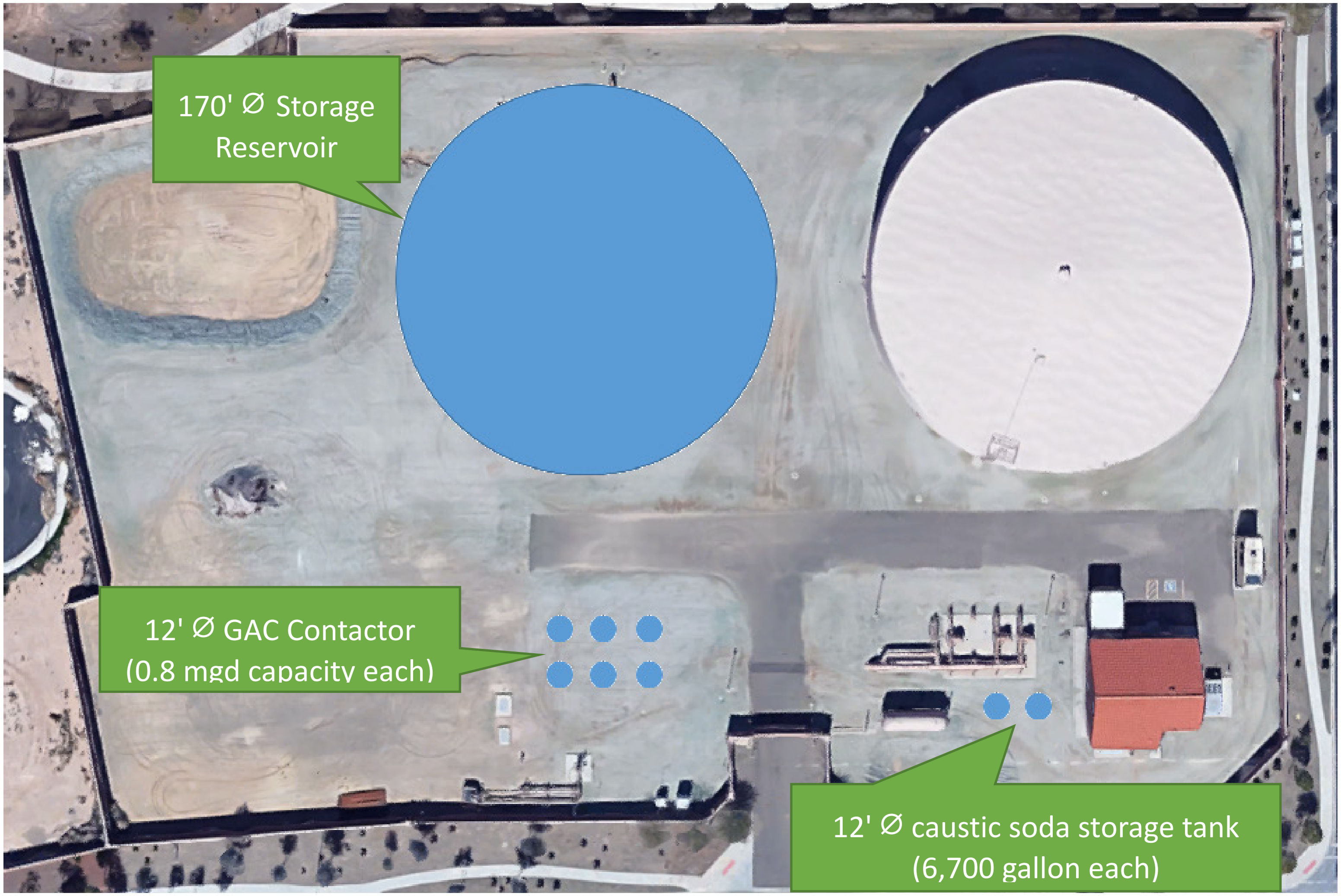

Figure 11 Proposed Del Rio Site Layout

1.5 Summary and Recommendations

In order to provide an additional water supply, Phoenix treated surface water is recommended for blending with Avondale groundwater. Phoenix water could contain high TTHM concentrations (> 70 µg/L) due to water age, but low nitrate concentration (lower than detection limit of 0.2 mg/L). Avondale groundwater has a lower organic content which results in lower TTHM formation potential but it has a relatively high nitrate concentration. Nitrate concentrations in existing Avondale wells (Well #17, Well #23, and Well #10) range from 4 to 11 mg/L. An optional future SRP well located at 107th Avenue and Encanto Boulevard near Well #17 has a high nitrate concentration (16.3 mg/L average).

The blending analysis results are summarized below:

- A 50:50 Phoenix water/groundwater blend ratio can be used to avoid both nitrate treatment and TTHM treatment. Using blending only, Well #17, future Well #27, and future Well H need to deliver water to Garden Lakes to fully use 5 mgd of Phoenix water.
- A blend ratio of 50% Phoenix water, 10% Avondale well water, and 40% SRP well water can also be used to avoid nitrate and TTHM treatment.
- pH adjustment is needed to avoid corrosive water after blending in case the groundwater and/or Phoenix water pH is lower than 7.
- Assuming a 10 mgd maximum discharge flow rate (5 mgd groundwater, 5 mgd Phoenix water) from the Garden Lakes site:
  - Two caustic soda storage tanks (10-foot height by 10-foot diameter) will be required for pH adjustment for one month storage capacity (see site layout for Garden Lakes in Figure 8).
  - Four GAC contactors (10-foot diameter, 10-foot media depth, and 0.6 mgd capacity, each) will be required to treat 40% (2 mgd) of Phoenix water. This allows full utilization of 5 mgd of Phoenix water even if Avondale wells are out of service.
- Assuming 10 mgd Phoenix water from Del Rio:
  - Two caustic soda storage tanks (10-foot height by 12-foot diameter) with one month storage capacity will be required for pH adjustment (see site layout for Garden Lakes in Figure 11).
  - Six GAC contactors (12-foot diameter, 10-foot media depth, and 0.8 mgd capacity, each) will be required to treat 40% (4 mgd) of Phoenix water. This allows full utilization of 10 mgd of Phoenix water even if Avondale wells are out of service.

Appendix A

WATER CORROSIVITY AND STABILITY ANALYSIS TOOL REFERENCE

WATER CORROSIVITY & STABILITY ANALYSIS USING BPI CORROSION AND STABILITY MODEL

The Blue Plan-it™ (BPI) corrosion and stability model was developed to assist engineers and clients to analyze the chemical composition of drinking water and assess its corrosivity and stability under various conditions.

This model was developed with water chemistry algorithms contained in the Blue Plan-it™ Decision Support System (referred as BPI desktop version). Instead of making decisions based on individual or a couple indices, this model utilizes a group of useful water quality indexes together to determine the corrosive nature and scaling potential of an influent or treated water. The following highlights its technical features:

- Tracks alkalinity, acidity, pH, sulfate, chloride, hardness, temperature, total dissolved solids (TDS), and other water quality parameters.
- Determine the characteristics of blended water from two to five separate sources while accounting for the equilibrium of the carbonate buffering system.
- Calculates impact of pH adjustment (via lime, caustic soda or acid) and blending ratio control on corrosivity and stability.
- Calculates seven corrosion and stability indices, including Langelier Saturation Index (LSI), Larson Index (LI), Ryznar stability Index (RI), Aggressive Index (AI), Driving Force Index (DFI), Momentary Excess Index (ME), the calcium carbonate precipitation potential (CCPP), and Chloride-to-sulfate Mass Ratio (CSMR).
- Tracks other water quality parameters such as total organic carbon (TOC), UV254 (Ultraviolet Absorbance at 254 nm wavelength), bromide, ortho-phosphate, polyphosphate, zinc, etc.
- Calculates the effect of more than 20 common water treatment chemicals (acids, base, chlorine, coagulants, etc.) with the ability to add a chemical to the list if the relevant chemical properties are known.
- Calculates the change in total trihalomethane concentration due to pH changes and chlorine or hypochlorite dose.
- Blending of other water quality parameters (such as arsenic, nitrate, and fluoride) based on mass balance calculations.

CORROSION AND STABILITY INDICES

Various factors influence corrosion and water stability, including physical factors (such as system pressure, soil moisture, the presence of stray electric currents, and water flow velocity), biological factors (the presence of iron bacteria and sulfate-reducing bacterial), and chemical factors (pH, TDS, hardness, alkalinity, temperature, chloride, sulfate, etc.). This analysis focuses on the chemical factors, i.e., water quality.

Natural waters from carbonaceous aquifers are generally saturated with calcite, which tend to precipitate out as calcium carbonate scale in the distribution system. Water treatment practices recommend the production of slightly scaling water so as to form a layer of calcium carbonate scale in the distribution pipelines to help prevent corrosion. Water-formed scale deposits in plumbing systems can restrict pipe flow, causing severe head loss, and reducing heat transfer capacity in water heating systems. Furthermore, when pipes become clogged with scale deposits, they may need to be replaced, which results in increased capital costs.

On the other hand, when the water is highly deficient in calcium concentration, the water turns corrosive towards the protecting layer or pipe constituent materials. The effect of corrosion is an important issue concerning both public health and economic issues. As a result, corrosion (or saturation) indices are important tools in assessing the potential corrosive nature of water supply distribution networks.

Due to the complexity of interaction among the physical, chemical, and biological reactions taking place within a typical distribution system, several corrosion (or saturation) indices are available to determine corrosion tendency based on empirical processes. Corrosion indices give simple generalizations to complex corrosion phenomena, which provide instant and continuous assessment.

Corrosion (or saturation) indices have been developed by researchers for simple calculation and prediction of corrosion or scaling tendency, and can be useful in a corrosion control programs. Seven different indices are often used: LSI, LI, RI, AI, DFI, ME, CCPP, and CSMR. A summary of how these water corrosion/saturation indices are calculated is presented in Table 1.

A brief description of these indices is provided below:

- Combining CCPP, DFI, ME, and LSI will provide a more reliable representation for the tendency to form calcium carbonate precipitate. Figure 1 presents the trends of these indices versus pH.
  - LSI is the most common scale prediction tool used for calcium carbonate scale (Antony et al., 2011), which is defined by a simple empirical relationship that was found by trial and error. LSI is commonly used to indicate the stability of the source waters due to a preponderance of evidence that calcium carbonate films inhibit corrosion to some degree (Keysar et al., 1997). The Langelier Index does not yield any information about the degree of scaling and corrosion, however, and therefore should be used with caution.
  - A rearranged form of the solubility expression was used by McCauley in 1960 and termed as the Driving Force Index (DFI). The DFI represents the tendency to deposit calcium carbonate.
  - The Momentary Excess Index (ME) defined by Dye (1952) is calculated by solving a quadratic equation considering hydrogen and calcium ion concentration, and alkalinity as variables. Similar to the DFI, the ME represents the tendency to form calcium carbonate precipitate. In general if the MEI is zero or greater, the water will tend to precipitate $CaCO_3$.

   – CCPP can also be calculated for an estimation of the amount of calcium carbonate that will precipitate or dissolve from the solution as it reaches equilibrium with solid $CaCO_3$.

- Many parameters have been implicated for causing red water in the distribution system caused by release of corrosion products from unlined and galvanized iron pipes. Empirical models showed strong negative correlation between apparent color change with alkalinity, but positive correlations with chloride, sulfates, sodium, DO, temperature, and hydraulic retention time. Alkalinity > 80 mg/L as $CaCO_3$ seems to have a beneficial effect on reducing release of color caused by iron release. (Imran et al. 2005)
- High CSMRs (> 0.5) tended to increase galvanic corrosion of lead solder connected to copper pipe. Lead leaching in the majority of systems responded favorably to raising pH, increasing alkalinity, or adding corrosion inhibitors (zinc with or without othrophophate). Coagulant changes (e.g., from alum to polyaluminum chloride, PACL) would result in an increase in CSMR and can trigger galvanic corrosion of lead solder and cause hazardous levels of lead in drinking water (Edwards and Triantafyllidou, 2007).
- In 1944, Ryznar used the pH as calculated by the Langelier equation to produce a stability index, i.e., RI. This index yields only positive values; the larger the value the more corrosive the water. Figure 2 presents a chart of this index vs scale results.
- From an empirical study, Larson and Skold developed an index based on chloride and sulfate aggressiveness toward pitting corrosion and alkalinity as minimizing factor toward aggression, called Larson Index (LI) (Larson and Skold, 1958).
- The Aggressiveness Index (AI) is a measure of the tendency of water to deteriorate the structure of asbestos-cement pipes.

Table 2 presents the theoretical tendencies when the values of these indices reach certain thresholds. For example, when LSI > 0, water is super saturated and tends to precipitate a scale layer of $CaCO_3$. When LSI = 0, water is saturated (in equilibrium) with $CaCO_3$. A scale layer of $CaCO_3$ is neither precipitated nor dissolved. When LSI < 0, water is under saturated and tends to dissolve solid $CaCO_3$.

The web model also calculates Buffer Capacity, Snoeyink Index, and Singley Index, which can provide additional insights for developing corrosion mitigation strategies. For example, the Singley Index takes into account the calcium concentration, alkalinity, temperature and Dissolve Oxygen as well as Chlorides, Sulfate, buffer intensity, and length of exposure time. It can help estimate the number of mils per year of steel that are corroded if the water is corrosive.

CORROSION AND STABILITY DECISION TREE

Table 3 summarizes recommended practically acceptable ranges for these corrosion and stability indices based on reference values used in literature and previous projects. Based on these, three types of corrosivity / stability analysis are programmed in this model:

- Carbonate Chemistry Related Corrosion and Scaling
- Sulfate and Chloride Related Corrosion
- Asbestos-cement Piping Related Corrosion

The algorithms used to determine the status of the red, yellow, and green icon animated on the process flow diagram in this model is presented in the Figure 3 and Table 3.

USE OF THIS TOOL

The results of this analysis can be used to identify whether new or additional water quality analysis should be conducted; and determine whether pH adjustment or anti-scalant addition is needed to reduce the likelihood of scaling or corrosion of pipes and equipment. It could help identify risks of scaling or corrosion when blending two or more sources (typically groundwater, surface water, softened or desalinated water). Based on the results, extra precautions may be taken to limit certain extreme blending ratios, gradually introduce new sources with close monitoring, implement pH adjustment and / or antiscalant addition, and provide sufficient mixing, degasification, or aeration.

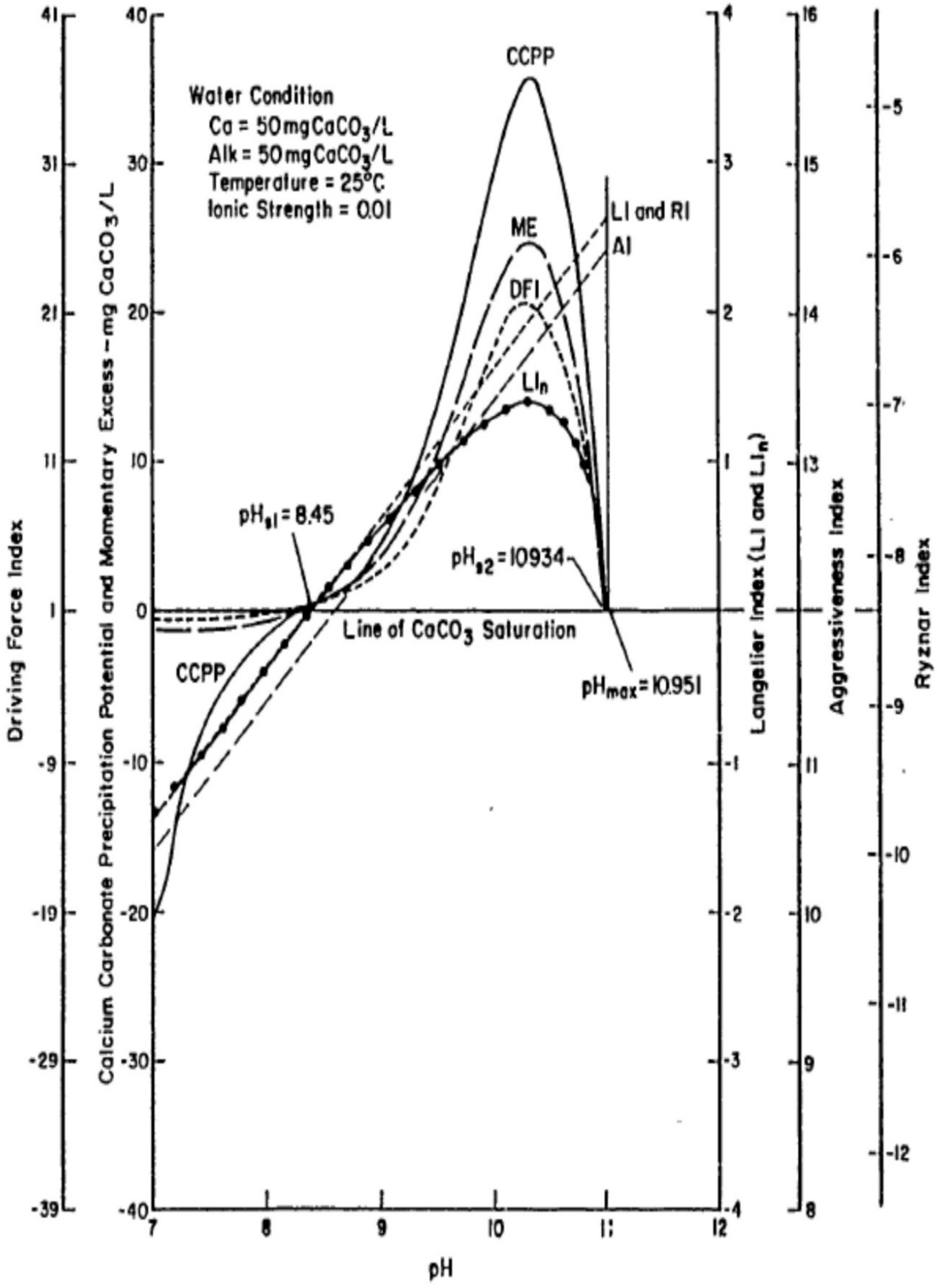

Figure 1. Saturation Indices vs. pH

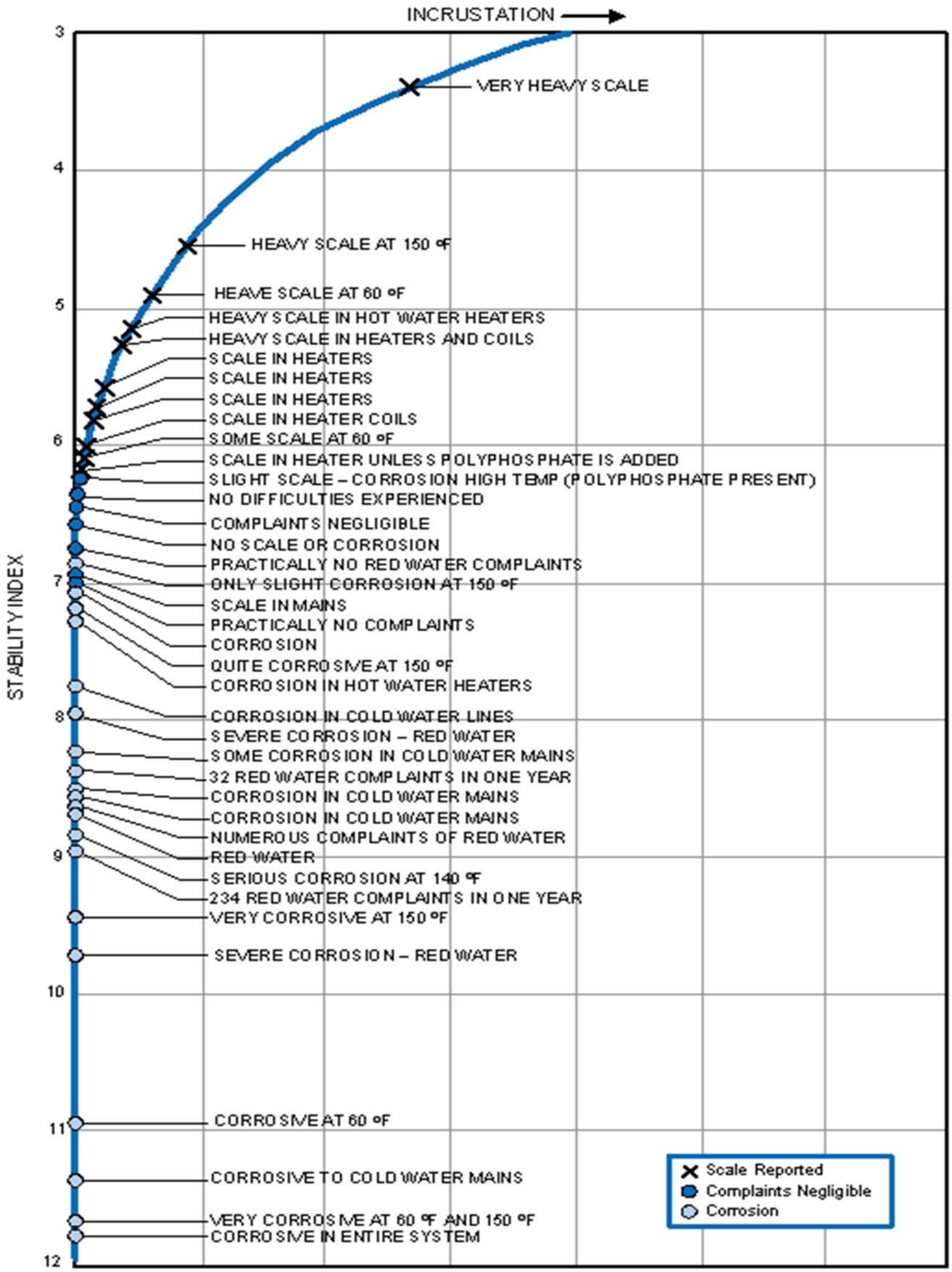

Figure 2. Ryznar Index vs Scale Results *(Nalco Chemical Co., Chicago, IL)*

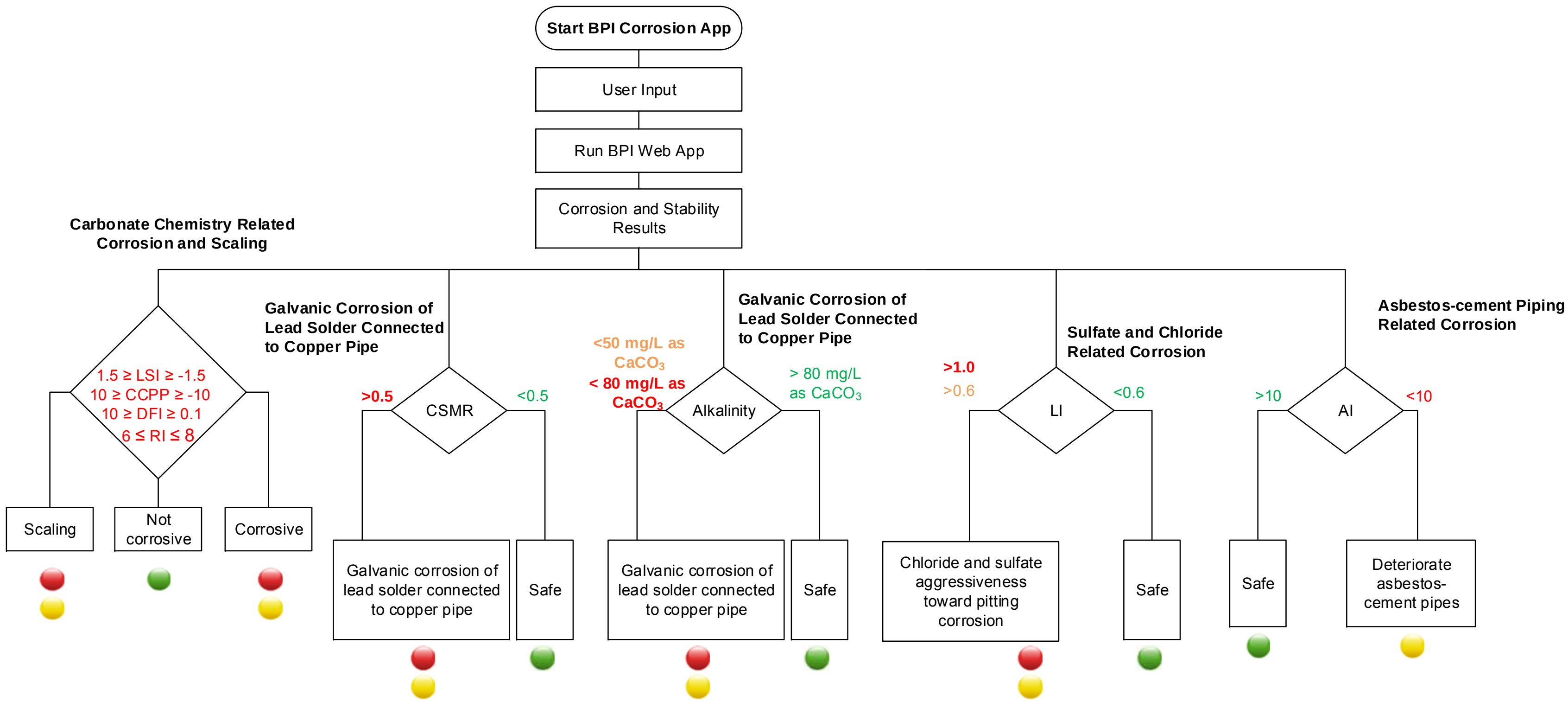

Figure 3: BPI Corrosion Model Decision Tree

Table 1 Equations of Water Corrosion Indices	
Corrosion Indices	**Equation or References**
Langelier Saturation Index (LSI)	$LSI = pH - pK_2 + pK_{SO} + \log[Ca^{2+}] + \log[Alk]$ K_2 = acidity constant for dissociation of bicarbonate K_{SO} = solubility constant for $CaCO_3$
Larson Index (LI)	$LI = \left([Cl^-] + [SO_4^{2-}]\right) \Big/ \left([HCO_3^-]\right)$
Ryznar Index (RI)	$RI = 2pH_S - pH_O$ $pH_S = pK_2 - pK_{SO} - \log[Ca^{2+}] - \log[Alk]$
Aggressive Index (AI)	$AI = pH + \log[Alk \times Hardness]$
Driving Force Index (DFI)	$DFI = \left([Ca^{2+}] \times [CO_3^{2-}]\right) \Big/ \left(K_{SO} \times 10^{10}\right)$
Momentary Excess Index (ME)	Reference: Dye, "Calculations of the effect of temperature on pH, free carbon dioxide and the three forms of alkalinity," JAWWA, Vol 44, No. 4 (1952).
Calcium Carbonate Precipitation Potential (CCPP)	Reference: Merrill and Sanks, "Corrosion control by deposition of calcium carbonate films: a practical approach for plant operators," JAWWA, Vol 69, No. 11 (1977).
Chloride-to-Sulfate Mass Ratio (CSMR)	$CSMR = [Cl^-] / [SO_4^{2-}]$

Table 2	Theoretic Water Conditions Defined by Water Stability Indices	
Corrosion Indices	**Index Value**	**Water Condition**
Langelier Saturation Index (LSI)	> 0	Super-saturated, tend to precipitate $CaCO_3$
	= 0	Saturated, $CaCO_3$ is in equilibrium
	< 0	Under-saturated, tend to dissolve solid $CaCO_3$
Larson Index (LI) *Independent of pH and Temperature	> 0.6	Tendency towards high corrosion rates of a local type should be expected as LI increases.
	0.2 ~ 0.6	Chlorides and sulfates may interfere with natural film formation. Higher than desired corrosion rates might be anticipated.
	< 0.2	Chlorides and sulfate probably will not interfere with natural film formation.
Ryznar Index (RI)	< 6	Super-saturated, tend to precipitate $CaCO_3$
	= 6	Saturated, $CaCO_3$ is in equilibrium
	> 6	Under-saturated, tend to dissolve solid $CaCO_3$
Aggressive Index (AI) *Independent of Temperature	> 12	Non-aggressive
	10 ~ 12	Moderately aggressive
	< 10	Highly aggressive
Driving Force Index (DFI)	> 1	Super-saturated, tend to precipitate $CaCO_3$
	= 1	Saturated, $CaCO_3$ is in equilibrium
	< 1	Under-saturated, tend to dissolve solid $CaCO_3$
Momentary Excess Index (ME)	> 0	Super-saturated, tend to precipitate $CaCO_3$
	= 0	Saturated, $CaCO_3$ is in equilibrium
	< 0	Under-saturated, tend to dissolve solid $CaCO_3$
Chloride-to-Sulfate Mass Ratio (CSMR)	< 0.5	Low galvanic corrosion and lead leaching
	> 0.5	Result in galvanic corrosion of lead solder connected to copper pipe.
Alkalinity	< 80 mg/L as $CaCO_3$	Reduced release of iron color
	> 80 mg/L as $CaCO_3$	Release of color for unlined or galvanized iron pipes

Table 3 Recommended Acceptable Ranges for Corrosion Indices

Type of Corrosion	Corrosion Indices	Acceptable Range	Warning	Extra Caution
Carbonate Buffer Related	Langelier Saturation Index (LSI)	0.5 ≥ LSI ≥ 0	≥ 0.5 Scaling ≤ 0 Corrosion	≥ 1.5 Scaling ≤ - 1.5 Corrosion
	Calcium Carbonate Precipitation Potential (CCPP)	10 ≥ CCPP ≥ 4	≥ 10 Scaling ≤ 4 Corrosion	≥ 10 Scaling ≤ -10 Corrosion
	Ryznar Index (RI)	7A ≥ RI ≥ 6	≥ 7 Corrosion ≤ 6 Scaling	≥ 8 Corrosion ≤ 6 Scaling
	Driving Force Index (DFI)	10 ≥ DFI ≥ 0.1	≥ 10 Scaling ≤ 0.1 Corrosion	Not a trigger
	Momentary Excess Index (ME)	No recommended range.	Not a trigger	Not a trigger
	Group	**All of above**	**Any of the above**	**Any of the above**
ARed Water Related to Iron Pipe Corrosion	Alkalinity	Alkalinity > 80 mg/L as $CaCO_3$	< 80 mg/L as $CaCO_3$	< 50 mg/L as $CaCO_3$
Galvanic Corrosion of Lead Solder Connected to Copper Pipe	Chloride-to-sulfate Mass Ratio (CSMR)	CSMR ≤ 0.5	≥ 0.5 Corrosion	≥ 0.8 Corrosion
Chloride and Sulfate Related	Larson Index (LI)	LI ≤ 0.2	0.6 ≥ LI ≥ 0.2	≥ 0.6 Corrosion
Asbestos-Cement Pipe Related	Aggressive Index (AI)	AI ≥ 12	12 ≥ LI ≥ 10	Mainly a concern when asbestos cement pipe is used

DISCLAIMER

Corrosion control is a complex science, requiring considerable knowledge of corrosion chemistry and of the system being evaluated. No one index can adequately describe the water. Even with a range of indices used together, full understanding of the given water quality and intended operation conditions, conservativeness, professional engineering judgement and experience are key to sound assessments of the corrosivity and stability of the water and the likelihood of different types of corrosion. Carollo and the BPI team is NOT responsible for the interpretation and the recommendation generated using this web model.

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Appendix B

FIELD AND LAB WATER QUALITY DATA

LEGEND Technical Services, Inc.

17631 North 25th Avenue • Phoenix, AZ 85023
P (602) 324-6100 • F (602) 324-6101
www.legend-group.com

10 October 2017

David Allred
City of Avondale DW
399 E. Lower Buckeye Rd. Ste 100
Avondale, AZ 85323

RE: Water Quality Samples

Laboratory Work Order No.: 7091040

Legend Technical Services of Arizona, Inc. is pleased to provide the enclosed analytical results for the aforementioned project. These results relate only to the items tested. This cover letter and the accompanying pages represent the full report for these analyses and should only be reproduced in full. Samples for this project were received by the laboratory on 09/12/17 14:55.

The samples were processed in accordance with the Chain of Custody document and the results presented relate only to the samples tested. The Chain of Custody is considered part of this report.

All samples will be retained by LEGEND for 30 days from the date of this report and then discarded unless other arrangements are made. Due to hold-time and method sample volume requirements, microbiological samples are not retained unless other arrangements are made.

This entire report was reviewed and approved for release by the undersigned. If you have any questions concerning this report, please feel free to contact me.

Sincerely,
LEGEND TECHNICAL SERVICES OF ARIZONA, INC.

Lisa Teter
Client Services Representative
(602) 324-6100

This laboratory report is confidential and is intended for the sole use of LEGEND and it's client.

ANALYTICAL REPORT FOR SAMPLES

Sample ID	Laboratory ID	Matrix	Type	Date Sampled	Date Received
WP 21 (Gateway EFF)	7091040-01	Drinking Water	Grab	09/12/17 09:05	09/12/17 14:55
GW 17 (Well 17)	7091040-02	Drinking Water	Grab	09/12/17 10:00	09/12/17 14:55
WP 20 (Garden Lakes EFF)	7091040-03	Drinking Water	Grab	09/12/17 10:45	09/12/17 14:55
GW 23 (Well 23)	7091040-04	Drinking Water	Grab	09/12/17 11:40	09/12/17 14:55
GW 10 (Well 10)	7091040-05	Drinking Water	Grab	09/12/17 12:50	09/12/17 14:55

Sample Condition Upon Receipt:

Temperature: 3.00 C

All samples were received in acceptable condition unless noted otherwise in the case narrative.

Case Narrative:

Holding Times: All holding times were met unless otherwise qualified.

QA/QC Criteria: All analyses met method requirements unless otherwise qualified.

Certifications: AZ(PHX)0004, AZ(TUC)OOO4, AIHA#102982, CDC ELITE Member.

Accreditation is applicable only to the test methods specified on each scope of accreditation held by LEGEND.

Comments: There were no problems encountered during the processing of the samples, unless otherwise noted.
All samples were analyzed on a "wet" basis unless designated as "dry weight".

Client provided field readings for pH and Temperature on 10/10/17 and requested that the Langlier Index be recalculated using the field readings. LT
Report revised on 10/10/17 LT

WP 21 (Gateway EFF) (7091040-01) Drinking Water (Grab) Sampled: 09/12/17 09:05 Received: 09/12/17 14:55

Analyte	Result	PQL	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
			Legend Technical Services of Arizona, Inc.						
Field Readings									
pH	**6.83**		pH Units	1	B7J1204	09/12/17 09:05	09/12/17 09:05	Field	
Temperature	**26**		°C	1	B7J1204	09/12/17 09:05	09/12/17 09:05	Field	
Total Metals									
Aluminum	<0.20	0.20	mg/L	1	B7I1235	09/13/17 12:11	09/13/17 14:24	EPA 200.7	
Antimony	<0.0005	0.0005	mg/L	1	B7I1278	09/14/17 10:00	09/14/17 15:30	EPA 200.8	
Arsenic III	**0.0033**	0.0010	mg/L	1	B7I1280	09/14/17 10:15	09/15/17 11:06	EPA 200.8	T6
Arsenic V	**0.0006**		mg/L	1	[CALC]	09/14/17 10:15	09/15/17 11:06	Calculation	
Arsenic	**0.0038**	0.0010	mg/L	1	B7I1278	09/14/17 10:00	09/14/17 15:30	EPA 200.8	
Cadmium	<0.0001	0.0001	mg/L	1	B7I1278	09/14/17 10:00	09/14/17 15:30	EPA 200.8	
Calcium	**110**	1.0	mg/L	1	B7I1235	09/13/17 12:11	09/13/17 14:24	EPA 200.7	
Chromium	**0.0074**	0.0050	mg/L	1	B7I1235	09/13/17 12:11	09/13/17 14:24	EPA 200.7	
Iron	<0.050	0.050	mg/L	1	B7I1235	09/13/17 12:11	09/13/17 14:24	EPA 200.7	
Lead	<0.0010	0.0010	mg/L	1	B7I1278	09/14/17 10:00	09/14/17 15:30	EPA 200.8	
Magnesium	**72**	1.0	mg/L	1	B7I1235	09/13/17 12:11	09/13/17 14:24	EPA 200.7	
Manganese	<0.020	0.020	mg/L	1	B7I1235	09/13/17 12:11	09/13/17 14:24	EPA 200.7	
Molybdenum	<0.020	0.020	mg/L	1	B7I1235	09/13/17 12:11	09/13/17 14:24	EPA 200.7	
Selenium	**0.0081**	0.0020	mg/L	1	B7I1278	09/14/17 10:00	09/14/17 15:30	EPA 200.8	
Silica, Total	**25**	0.21	mg/L	1	[CALC]	09/13/17 12:11	09/13/17 14:24	EPA 200.7	
Silicon	**12**	0.10	mg/L	1	B7I1235	09/13/17 12:11	09/13/17 14:24	EPA 200.7	
Calcium Hardness as CaCO3	**280**	2.5	mg/L	1	[CALC]	09/13/17 12:11	09/13/17 14:24	SM2340B	
Magnesium Hardness as CaCO:	**290**	4.1	mg/L	1	[CALC]	09/13/17 12:11	09/13/17 14:24	SM2340B	
Total Hardness as CaCO3	**580**	4.1	mg/L	1	[CALC]	09/13/17 12:11	09/13/17 14:24	SM2340B	
Uranium	**0.0023**	0.0010	mg/L	1	B7I1278	09/14/17 10:00	09/14/17 15:30	EPA 200.8	
Vanadium	**0.011**	0.0070	mg/L	1	B7I1235	09/13/17 12:11	09/13/17 14:24	EPA 200.7	

WP 21 (Gateway EFF) (7091040-01) Drinking Water (Grab) Sampled: 09/12/17 09:05 Received: 09/12/17 14:55

Legend Technical Services of Arizona, Inc.

Analyte	Result	PQL	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Inorganic Chemistry									
Total Alkalinity as CaCO3	**155**	10	mg/L	1	B7I1240	09/13/17 13:08	09/13/17 13:08	SM 2320 B	M2
Chloride	**418**	50.0	mg/L	10	B7I1377	09/15/17 09:07	09/15/17 09:07	EPA 300.0	D2
Fluoride	**0.15**	0.10	mg/L	1	B7I1298	09/14/17 16:10	09/14/17 16:10	SM 4500 F C	
Nitrate as N	**7.54**	0.20	mg/L	1	[CALC]	09/15/17 09:40	09/15/17 09:40	Calculation	
Nitrate + Nitrite as N	**7.54**	0.20	mg/L	1	B7I1258	09/15/17 09:40	09/15/17 09:40	SM 4500 NO3 F	
Nitrite as N	<0.10	0.10	mg/L	1	B7I1243	09/13/17 13:57	09/13/17 13:57	SM 4500 NO2 B	
Orthophosphate as P	<0.05	0.05	mg/L	1	B7I1236	09/13/17 10:11	09/13/17 10:11	SM 4500 P F	
Total Phosphorous	<0.05	0.05	mg/L	1	B7I1287	09/13/17 09:15	09/13/17 14:45	EPA 365.3	
Sulfate	**94.6**	50.0	mg/L	10	B7I1377	09/15/17 09:07	09/15/17 09:07	EPA 300.0	D2
Sulfide, total	<0.04	0.04	mg/L	1	B7I1367	09/16/17 12:45	09/16/17 12:45	HACH 8131	M2
Total Dissolved Solids	**1000**	1	mg/L	1	B7I1392	09/18/17 16:00	09/18/17 16:00	SM 2540 C	
Total Organic Carbon	<1.00	1.00	mg/L	1	B7I1401	09/15/17 14:43	09/15/17 14:43	SM 5310 C	
Total Suspended Solids	<1	1	mg/L	1	B7I1267	09/14/17 10:30	09/14/17 10:30	SM 2540 D	
Ultra Violet Absorption	<0.0090	0.0090	cm-1	1	B7I1242	09/13/17 11:10	09/13/17 11:10	SM 5910 B	
Volatile Organic Compounds									
Bromodichloromethane	<0.0005	0.0005	mg/L	1	B7I1226	09/13/17 10:00	09/13/17 11:26	EPA 524.2	
Bromoform	**0.0022**	0.0005	mg/L	1	B7I1226	09/13/17 10:00	09/13/17 11:26	EPA 524.2	
Chloroform	<0.0005	0.0005	mg/L	1	B7I1226	09/13/17 10:00	09/13/17 11:26	EPA 524.2	
Dibromochloromethane	**0.0009**	0.0005	mg/L	1	B7I1226	09/13/17 10:00	09/13/17 11:26	EPA 524.2	
Total THMs	**0.0031**	0.0005	mg/L	1	B7I1226	09/13/17 10:00	09/13/17 11:26	EPA 524.2	
Surrogate: 1,2-Dichlorobenzene-d4		*112 %*	*70-130*		*B7I1226*	*09/13/17*	*09/13/17*	*EPA 524.2*	
Surrogate: 1,2-Dichloroethane-d4		*94 %*	*70-130*		*B7I1226*	*09/13/17*	*09/13/17*	*EPA 524.2*	
Surrogate: 4-Bromofluorobenzene		*87 %*	*70-130*		*B7I1226*	*09/13/17*	*09/13/17*	*EPA 524.2*	
Surrogate: Pentafluorobenzene		*105 %*	*70-130*		*B7I1226*	*09/13/17*	*09/13/17*	*EPA 524.2*	

WP 21 (Gateway EFF) (7091040-01) Drinking Water (Grab) Sampled: 09/12/17 09:05 Received: 09/12/17 14:55

Analyte	Result	PQL	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Legend Technical Services of Arizona, Inc.									
Miscellaneous									
Langlier Index	**-0.541**	-5.00	N/A	1	B7I1444	09/19/17 15:22	09/19/17 15:23	Miscellaneous	

GW 17 (Well 17) (7091040-02) Drinking Water (Grab) Sampled: 09/12/17 10:00 Received: 09/12/17 14:55

Analyte	Result	PQL	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Legend Technical Services of Arizona, Inc.									
Field Readings									
pH	**7.26**		pH Units	1	B7J1204	09/12/17 10:00	09/12/17 10:00	Field	
Temperature	**30**		°C	1	B7J1204	09/12/17 10:00	09/12/17 10:00	Field	
Total Metals									
Aluminum	<0.20	0.20	mg/L	1	B7I1235	09/13/17 12:11	09/13/17 14:26	EPA 200.7	
Antimony	<0.0005	0.0005	mg/L	1	B7I1278	09/14/17 10:00	09/14/17 15:34	EPA 200.8	
Arsenic III	**0.0013**	0.0010	mg/L	1	B7I1280	09/14/17 10:15	09/15/17 11:06	EPA 200.8	T6
Arsenic V	**0.0040**		mg/L	1	[CALC]	09/14/17 10:15	09/15/17 11:06	Calculation	
Arsenic	**0.0053**	0.0010	mg/L	1	B7I1278	09/14/17 10:00	09/14/17 15:34	EPA 200.8	
Cadmium	<0.0001	0.0001	mg/L	1	B7I1278	09/14/17 10:00	09/14/17 15:34	EPA 200.8	
Calcium	**53**	1.0	mg/L	1	B7I1235	09/13/17 12:11	09/13/17 14:26	EPA 200.7	
Chromium	**0.025**	0.0050	mg/L	1	B7I1235	09/13/17 12:11	09/13/17 14:26	EPA 200.7	
Iron	<0.050	0.050	mg/L	1	B7I1235	09/13/17 12:11	09/13/17 14:26	EPA 200.7	
Lead	<0.0010	0.0010	mg/L	1	B7I1278	09/14/17 10:00	09/14/17 15:34	EPA 200.8	
Magnesium	**39**	1.0	mg/L	1	B7I1235	09/13/17 12:11	09/13/17 14:26	EPA 200.7	
Manganese	<0.020	0.020	mg/L	1	B7I1235	09/13/17 12:11	09/13/17 14:26	EPA 200.7	
Molybdenum	<0.020	0.020	mg/L	1	B7I1235	09/13/17 12:11	09/13/17 14:26	EPA 200.7	
Selenium	**0.0061**	0.0020	mg/L	1	B7I1278	09/14/17 10:00	09/14/17 15:34	EPA 200.8	
Silica, Total	**21**	0.21	mg/L	1	[CALC]	09/13/17 12:11	09/13/17 14:26	EPA 200.7	
Silicon	**9.6**	0.10	mg/L	1	B7I1235	09/13/17 12:11	09/13/17 14:26	EPA 200.7	
Calcium Hardness as CaCO3	**130**	2.5	mg/L	1	[CALC]	09/13/17 12:11	09/13/17 14:26	SM2340B	
Magnesium Hardness as CaCO3	**160**	4.1	mg/L	1	[CALC]	09/13/17 12:11	09/13/17 14:26	SM2340B	
Total Hardness as CaCO3	**290**	4.1	mg/L	1	[CALC]	09/13/17 12:11	09/13/17 14:26	SM2340B	
Uranium	**0.0042**	0.0010	mg/L	1	B7I1278	09/14/17 10:00	09/14/17 15:34	EPA 200.8	
Vanadium	**0.019**	0.0070	mg/L	1	B7I1235	09/13/17 12:11	09/13/17 14:26	EPA 200.7	

GW 17 (Well 17) (7091040-02) Drinking Water (Grab) Sampled: 09/12/17 10:00 Received: 09/12/17 14:55

Legend Technical Services of Arizona, Inc.

Analyte	Result	PQL	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Inorganic Chemistry									
Total Alkalinity as CaCO3	**127**	10	mg/L	1	B7I1240	09/13/17 13:08	09/13/17 13:08	SM 2320 B	
Chloride	**229**	50.0	mg/L	10	B7I1377	09/15/17 09:07	09/15/17 09:07	EPA 300.0	D2
Fluoride	**0.19**	0.10	mg/L	1	B7I1298	09/14/17 16:10	09/14/17 16:10	SM 4500 F C	
Nitrate as N	**10.5**	0.20	mg/L	1	[CALC]	09/15/17 09:40	09/15/17 09:40	Calculation	
Nitrate + Nitrite as N	**10.5**	0.20	mg/L	1	B7I1258	09/15/17 09:40	09/15/17 09:40	SM 4500 NO3 F	
Nitrite as N	<0.10	0.10	mg/L	1	B7I1243	09/13/17 13:57	09/13/17 13:57	SM 4500 NO2 B	
Orthophosphate as P	<0.05	0.05	mg/L	1	B7I1236	09/13/17 10:11	09/13/17 10:11	SM 4500 P F	
Total Phosphorous	<0.05	0.05	mg/L	1	B7I1287	09/13/17 09:15	09/13/17 14:45	EPA 365.3	
Sulfate	**82.3**	50.0	mg/L	10	B7I1377	09/15/17 09:07	09/15/17 09:07	EPA 300.0	D2
Sulfide, total	<0.04	0.04	mg/L	1	B7I1367	09/16/17 12:45	09/16/17 12:45	HACH 8131	
Total Dissolved Solids	**644**	1	mg/L	1	B7I1392	09/18/17 16:00	09/18/17 16:00	SM 2540 C	
Total Organic Carbon	<1.00	1.00	mg/L	1	B7I1401	09/15/17 14:43	09/15/17 14:43	SM 5310 C	
Total Suspended Solids	**1**	1	mg/L	1	B7I1267	09/14/17 10:30	09/14/17 10:30	SM 2540 D	
Ultra Violet Absorption	<0.0090	0.0090	cm-1	1	B7I1242	09/13/17 11:10	09/13/17 11:10	SM 5910 B	
Volatile Organic Compounds									
Bromodichloromethane	<0.0005	0.0005	mg/L	1	B7I1226	09/13/17 10:00	09/13/17 11:57	EPA 524.2	
Bromoform	<0.0005	0.0005	mg/L	1	B7I1226	09/13/17 10:00	09/13/17 11:57	EPA 524.2	
Chloroform	<0.0005	0.0005	mg/L	1	B7I1226	09/13/17 10:00	09/13/17 11:57	EPA 524.2	
Dibromochloromethane	<0.0005	0.0005	mg/L	1	B7I1226	09/13/17 10:00	09/13/17 11:57	EPA 524.2	
Total THMs	<0.0005	0.0005	mg/L	1	B7I1226	09/13/17 10:00	09/13/17 11:57	EPA 524.2	
Surrogate: 1,2-Dichlorobenzene-d4		*109 %*		*70-130*	*B7I1226*	*09/13/17*	*09/13/17*	*EPA 524.2*	
Surrogate: 1,2-Dichloroethane-d4		*95 %*		*70-130*	*B7I1226*	*09/13/17*	*09/13/17*	*EPA 524.2*	
Surrogate: 4-Bromofluorobenzene		*86 %*		*70-130*	*B7I1226*	*09/13/17*	*09/13/17*	*EPA 524.2*	
Surrogate: Pentafluorobenzene		*106 %*		*70-130*	*B7I1226*	*09/13/17*	*09/13/17*	*EPA 524.2*	

GW 17 (Well 17) (7091040-02) Drinking Water (Grab) Sampled: 09/12/17 10:00 Received: 09/12/17 14:55

Legend Technical Services of Arizona, Inc.

Analyte	Result	PQL	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Miscellaneous									
Langlier Index	**-0.505**	-5.00	N/A	1	B7I1444	09/19/17 15:22	09/19/17 15:23	Miscellaneous	

WP 20 (Garden Lakes EFF) (7091040-03) Drinking Water (Grab) Sampled: 09/12/17 10:45 Received: 09/12/17 14:55

Legend Technical Services of Arizona, Inc.

Analyte	Result	PQL	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Field Readings									
pH	**7.30**		pH Units	1	B7J1204	09/12/17 10:45	09/12/17 10:45	Field	
Temperature	**29**		°C	1	B7J1204	09/12/17 10:45	09/12/17 10:45	Field	
Total Metals									
Aluminum	<0.20	0.20	mg/L	1	B7I1235	09/13/17 12:11	09/13/17 14:29	EPA 200.7	
Antimony	<0.0005	0.0005	mg/L	1	B7I1278	09/14/17 10:00	09/14/17 15:44	EPA 200.8	
Arsenic III	<0.0010	0.0010	mg/L	1	B7I1280	09/14/17 10:15	09/15/17 11:06	EPA 200.8	T6
Arsenic V	**0.0053**		mg/L	1	[CALC]	09/14/17 10:15	09/15/17 11:06	Calculation	
Arsenic	**0.0053**	0.0010	mg/L	1	B7I1278	09/14/17 10:00	09/14/17 15:44	EPA 200.8	
Cadmium	<0.0001	0.0001	mg/L	1	B7I1278	09/14/17 10:00	09/14/17 15:44	EPA 200.8	
Calcium	**52**	1.0	mg/L	1	B7I1235	09/13/17 12:11	09/13/17 14:29	EPA 200.7	
Chromium	<0.0050	0.0050	mg/L	1	B7I1235	09/13/17 12:11	09/13/17 14:29	EPA 200.7	
Iron	<0.050	0.050	mg/L	1	B7I1235	09/13/17 12:11	09/13/17 14:29	EPA 200.7	
Lead	<0.0010	0.0010	mg/L	1	B7I1278	09/14/17 10:00	09/14/17 15:44	EPA 200.8	
Magnesium	**38**	1.0	mg/L	1	B7I1235	09/13/17 12:11	09/13/17 14:29	EPA 200.7	
Manganese	<0.020	0.020	mg/L	1	B7I1235	09/13/17 12:11	09/13/17 14:29	EPA 200.7	
Molybdenum	<0.020	0.020	mg/L	1	B7I1235	09/13/17 12:11	09/13/17 14:29	EPA 200.7	
Selenium	**0.0059**	0.0020	mg/L	1	B7I1278	09/14/17 10:00	09/14/17 15:44	EPA 200.8	
Silica, Total	**20**	0.21	mg/L	1	[CALC]	09/13/17 12:11	09/13/17 14:29	EPA 200.7	
Silicon	**9.4**	0.10	mg/L	1	B7I1235	09/13/17 12:11	09/13/17 14:29	EPA 200.7	
Calcium Hardness as CaCO3	**130**	2.5	mg/L	1	[CALC]	09/13/17 12:11	09/13/17 14:29	SM2340B	
Magnesium Hardness as CaCO3	**150**	4.1	mg/L	1	[CALC]	09/13/17 12:11	09/13/17 14:29	SM2340B	
Total Hardness as CaCO3	**280**	4.1	mg/L	1	[CALC]	09/13/17 12:11	09/13/17 14:29	SM2340B	
Uranium	<0.0010	0.0010	mg/L	1	B7I1278	09/14/17 10:00	09/14/17 15:44	EPA 200.8	
Vanadium	**0.013**	0.0070	mg/L	1	B7I1235	09/13/17 12:11	09/13/17 14:29	EPA 200.7	

WP 20 (Garden Lakes EFF) (7091040-03) Drinking Water (Grab) Sampled: 09/12/17 10:45 Received: 09/12/17 14:55

Legend Technical Services of Arizona, Inc.

Analyte	Result	PQL	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Inorganic Chemistry									
Total Alkalinity as CaCO3	**124**	10	mg/L	1	B7I1240	09/13/17 13:08	09/13/17 13:08	SM 2320 B	
Chloride	**283**	50.0	mg/L	10	B7I1377	09/15/17 09:07	09/15/17 09:07	EPA 300.0	D2
Fluoride	**0.19**	0.10	mg/L	1	B7I1298	09/14/17 16:10	09/14/17 16:10	SM 4500 F C	
Nitrate as N	**1.24**	0.20	mg/L	1	[CALC]	09/15/17 09:40	09/15/17 09:40	Calculation	
Nitrate + Nitrite as N	**1.24**	0.20	mg/L	1	B7I1258	09/15/17 09:40	09/15/17 09:40	SM 4500 NO3 F	
Nitrite as N	<0.10	0.10	mg/L	1	B7I1243	09/13/17 13:57	09/13/17 13:57	SM 4500 NO2 B	
Orthophosphate as P	<0.05	0.05	mg/L	1	B7I1236	09/13/17 10:11	09/13/17 10:11	SM 4500 P F	
Total Phosphorous	<0.05	0.05	mg/L	1	B7I1287	09/13/17 09:15	09/13/17 14:45	EPA 365.3	
Sulfate	**54.0**	50.0	mg/L	10	B7I1377	09/15/17 09:07	09/15/17 09:07	EPA 300.0	D2
Sulfide, total	<0.04	0.04	mg/L	1	B7I1367	09/16/17 12:45	09/16/17 12:45	HACH 8131	
Total Dissolved Solids	**668**	1	mg/L	1	B7I1392	09/18/17 16:00	09/18/17 16:00	SM 2540 C	
Total Organic Carbon	<1.00	1.00	mg/L	1	B7I1401	09/15/17 14:43	09/15/17 14:43	SM 5310 C	
Total Suspended Solids	<1	1	mg/L	1	B7I1267	09/14/17 10:30	09/14/17 10:30	SM 2540 D	
Ultra Violet Absorption	<0.0090	0.0090	cm-1	1	B7I1242	09/13/17 11:10	09/13/17 11:10	SM 5910 B	
Volatile Organic Compounds									
Bromodichloromethane	<0.0005	0.0005	mg/L	1	B7I1226	09/13/17 10:00	09/13/17 12:28	EPA 524.2	
Bromoform	**0.0009**	0.0005	mg/L	1	B7I1226	09/13/17 10:00	09/13/17 12:28	EPA 524.2	
Chloroform	<0.0005	0.0005	mg/L	1	B7I1226	09/13/17 10:00	09/13/17 12:28	EPA 524.2	
Dibromochloromethane	**0.0007**	0.0005	mg/L	1	B7I1226	09/13/17 10:00	09/13/17 12:28	EPA 524.2	
Total THMs	**0.0016**	0.0005	mg/L	1	B7I1226	09/13/17 10:00	09/13/17 12:28	EPA 524.2	
Surrogate: 1,2-Dichlorobenzene-d4		*109 %*		*70-130*	*B7I1226*	*09/13/17*	*09/13/17*	*EPA 524.2*	
Surrogate: 1,2-Dichloroethane-d4		*96 %*		*70-130*	*B7I1226*	*09/13/17*	*09/13/17*	*EPA 524.2*	
Surrogate: 4-Bromofluorobenzene		*83 %*		*70-130*	*B7I1226*	*09/13/17*	*09/13/17*	*EPA 524.2*	
Surrogate: Pentafluorobenzene		*107 %*		*70-130*	*B7I1226*	*09/13/17*	*09/13/17*	*EPA 524.2*	

WP 20 (Garden Lakes EFF) (7091040-03) Drinking Water (Grab) Sampled: 09/12/17 10:45 Received: 09/12/17 14:55

Analyte	Result	PQL	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes

Legend Technical Services of Arizona, Inc.

Miscellaneous

Langlier Index	**-0.483**	-5.00	N/A	1	B7I1444	09/19/17 15:22	09/19/17 15:23	Miscellaneous	

GW 23 (Well 23) (7091040-04) Drinking Water (Grab) Sampled: 09/12/17 11:40 Received: 09/12/17 14:55

Analyte	Result	PQL	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes

Legend Technical Services of Arizona, Inc.

Field Readings

pH	**6.99**		pH Units	1	B7J1204	09/12/17 11:40	09/12/17 11:40	Field	
Temperature	**26**		°C	1	B7J1204	09/12/17 11:40	09/12/17 11:40	Field	

Total Metals

Aluminum	<0.20	0.20	mg/L	1	B7I1235	09/13/17 12:11	09/13/17 14:31	EPA 200.7	
Antimony	<0.0005	0.0005	mg/L	1	B7I1278	09/14/17 10:00	09/14/17 15:47	EPA 200.8	
Arsenic III	**0.0015**	0.0010	mg/L	1	B7I1280	09/14/17 10:15	09/15/17 11:06	EPA 200.8	T6
Arsenic V	**0.0022**		mg/L	1	[CALC]	09/14/17 10:15	09/15/17 11:06	Calculation	
Arsenic	**0.0037**	0.0010	mg/L	1	B7I1278	09/14/17 10:00	09/14/17 15:47	EPA 200.8	
Cadmium	<0.0001	0.0001	mg/L	1	B7I1278	09/14/17 10:00	09/14/17 15:47	EPA 200.8	
Calcium	**110**	1.0	mg/L	1	B7I1235	09/13/17 12:11	09/13/17 14:31	EPA 200.7	
Chromium	<0.0050	0.0050	mg/L	1	B7I1235	09/13/17 12:11	09/13/17 14:31	EPA 200.7	
Iron	<0.050	0.050	mg/L	1	B7I1235	09/13/17 12:11	09/13/17 14:31	EPA 200.7	
Lead	<0.0010	0.0010	mg/L	1	B7I1278	09/14/17 10:00	09/14/17 15:47	EPA 200.8	
Magnesium	**51**	1.0	mg/L	1	B7I1235	09/13/17 12:11	09/13/17 14:31	EPA 200.7	
Manganese	<0.020	0.020	mg/L	1	B7I1235	09/13/17 12:11	09/13/17 14:31	EPA 200.7	
Molybdenum	<0.020	0.020	mg/L	1	B7I1235	09/13/17 12:11	09/13/17 14:31	EPA 200.7	
Selenium	**0.0040**	0.0020	mg/L	1	B7I1278	09/14/17 10:00	09/14/17 15:47	EPA 200.8	
Silica, Total	**31**	0.21	mg/L	1	[CALC]	09/13/17 12:11	09/13/17 14:31	EPA 200.7	
Silicon	**14**	0.10	mg/L	1	B7I1235	09/13/17 12:11	09/13/17 14:31	EPA 200.7	
Calcium Hardness as CaCO3	**290**	2.5	mg/L	1	[CALC]	09/13/17 12:11	09/13/17 14:31	SM2340B	
Magnesium Hardness as CaCO:	**210**	4.1	mg/L	1	[CALC]	09/13/17 12:11	09/13/17 14:31	SM2340B	
Total Hardness as CaCO3	**490**	4.1	mg/L	1	[CALC]	09/13/17 12:11	09/13/17 14:31	SM2340B	
Uranium	**0.0049**	0.0010	mg/L	1	B7I1278	09/14/17 10:00	09/14/17 15:47	EPA 200.8	
Vanadium	**0.013**	0.0070	mg/L	1	B7I1235	09/13/17 12:11	09/13/17 14:31	EPA 200.7	

GW 23 (Well 23) (7091040-04) Drinking Water (Grab) Sampled: 09/12/17 11:40 Received: 09/12/17 14:55

Legend Technical Services of Arizona, Inc.

Analyte	Result	PQL	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Inorganic Chemistry									
Total Alkalinity as CaCO3	**187**	10	mg/L	1	B7I1240	09/13/17 13:08	09/13/17 13:08	SM 2320 B	
Chloride	**321**	50.0	mg/L	10	B7I1377	09/15/17 09:07	09/15/17 09:07	EPA 300.0	D2
Fluoride	**0.12**	0.10	mg/L	1	B7I1298	09/14/17 16:10	09/14/17 16:10	SM 4500 F C	
Nitrate as N	**5.03**	0.20	mg/L	1	[CALC]	09/15/17 09:40	09/15/17 09:40	Calculation	
Nitrate + Nitrite as N	**5.03**	0.20	mg/L	1	B7I1258	09/15/17 09:40	09/15/17 09:40	SM 4500 NO3 F	
Nitrite as N	<0.10	0.10	mg/L	1	B7I1243	09/13/17 13:57	09/13/17 13:57	SM 4500 NO2 B	
Orthophosphate as P	<0.05	0.05	mg/L	1	B7I1236	09/13/17 10:11	09/13/17 10:11	SM 4500 P F	
Total Phosphorous	<0.05	0.05	mg/L	1	B7I1287	09/13/17 09:15	09/13/17 14:45	EPA 365.3	M2
Sulfate	**113**	50.0	mg/L	10	B7I1377	09/15/17 09:07	09/15/17 09:07	EPA 300.0	D2
Sulfide, total	<0.04	0.04	mg/L	1	B7I1367	09/16/17 12:45	09/16/17 12:45	HACH 8131	
Total Dissolved Solids	**857**	1	mg/L	1	B7I1392	09/18/17 16:00	09/18/17 16:00	SM 2540 C	
Total Organic Carbon	<1.00	1.00	mg/L	1	B7I1401	09/15/17 14:43	09/15/17 14:43	SM 5310 C	
Total Suspended Solids	<1	1	mg/L	1	B7I1267	09/14/17 10:30	09/14/17 10:30	SM 2540 D	
Ultra Violet Absorption	<0.0090	0.0090	cm-1	1	B7I1242	09/13/17 11:10	09/13/17 11:10	SM 5910 B	
Volatile Organic Compounds									
Bromodichloromethane	**0.0006**	0.0005	mg/L	1	B7I1226	09/13/17 10:00	09/13/17 12:59	EPA 524.2	
Bromoform	<0.0005	0.0005	mg/L	1	B7I1226	09/13/17 10:00	09/13/17 12:59	EPA 524.2	
Chloroform	**0.0134**	0.0005	mg/L	1	B7I1226	09/13/17 10:00	09/13/17 12:59	EPA 524.2	
Dibromochloromethane	<0.0005	0.0005	mg/L	1	B7I1226	09/13/17 10:00	09/13/17 12:59	EPA 524.2	
Total THMs	**0.0140**	0.0005	mg/L	1	B7I1226	09/13/17 10:00	09/13/17 12:59	EPA 524.2	
Surrogate: 1,2-Dichlorobenzene-d4		*111 %*		*70-130*	*B7I1226*	*09/13/17*	*09/13/17*	*EPA 524.2*	
Surrogate: 1,2-Dichloroethane-d4		*100 %*		*70-130*	*B7I1226*	*09/13/17*	*09/13/17*	*EPA 524.2*	
Surrogate: 4-Bromofluorobenzene		*85 %*		*70-130*	*B7I1226*	*09/13/17*	*09/13/17*	*EPA 524.2*	
Surrogate: Pentafluorobenzene		*108 %*		*70-130*	*B7I1226*	*09/13/17*	*09/13/17*	*EPA 524.2*	

GW 23 (Well 23) (7091040-04) Drinking Water (Grab) Sampled: 09/12/17 11:40 Received: 09/12/17 14:55

Legend Technical Services of Arizona, Inc.

Analyte	Result	PQL	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Miscellaneous									
Langlier Index	**-0.289**	-5.00	N/A	1	B7I1444	09/19/17 15:22	09/19/17 15:23	Miscellaneous	

GW 23 (Well 23) (7091040-04RE1) Drinking Water (Grab) Sampled: 09/12/17 11:40 Received: 09/12/17 14:55

Legend Technical Services of Arizona, Inc.

Analyte	Result	PQL	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Inorganic Chemistry									
Total Phosphorous	<0.05	0.05	mg/L	1	B7I1286	09/13/17 09:15	09/13/17 14:45	EPA 365.3	BQC, M2

GW 10 (Well 10) (7091040-05) Drinking Water (Grab) Sampled: 09/12/17 12:50 Received: 09/12/17 14:55

Legend Technical Services of Arizona, Inc.

Analyte	Result	PQL	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Field Readings									
pH	**7.18**		pH Units	1	B7J1204	09/12/17 12:50	09/12/17 12:50	Field	
Temperature	**25**		°C	1	B7J1204	09/12/17 12:50	09/12/17 12:50	Field	
Total Metals									
Aluminum	<0.20	0.20	mg/L	1	B7I1235	09/13/17 12:11	09/13/17 14:34	EPA 200.7	
Antimony	<0.0005	0.0005	mg/L	1	B7I1278	09/14/17 10:00	09/14/17 15:50	EPA 200.8	
Arsenic III	**0.0013**	0.0010	mg/L	1	B7I1280	09/14/17 10:15	09/15/17 11:06	EPA 200.8	T6
Arsenic V	**0.0045**		mg/L	1	[CALC]	09/14/17 10:15	09/15/17 11:06	Calculation	
Arsenic	**0.0058**	0.0010	mg/L	1	B7I1278	09/14/17 10:00	09/14/17 15:50	EPA 200.8	
Cadmium	<0.0001	0.0001	mg/L	1	B7I1278	09/14/17 10:00	09/14/17 15:50	EPA 200.8	
Calcium	**73**	1.0	mg/L	1	B7I1235	09/13/17 12:11	09/13/17 14:34	EPA 200.7	
Chromium	<0.0050	0.0050	mg/L	1	B7I1235	09/13/17 12:11	09/13/17 14:34	EPA 200.7	
Iron	<0.050	0.050	mg/L	1	B7I1235	09/13/17 12:11	09/13/17 14:34	EPA 200.7	
Lead	<0.0010	0.0010	mg/L	1	B7I1278	09/14/17 10:00	09/14/17 15:50	EPA 200.8	
Magnesium	**47**	1.0	mg/L	1	B7I1235	09/13/17 12:11	09/13/17 14:34	EPA 200.7	
Manganese	<0.020	0.020	mg/L	1	B7I1235	09/13/17 12:11	09/13/17 14:34	EPA 200.7	
Molybdenum	<0.020	0.020	mg/L	1	B7I1235	09/13/17 12:11	09/13/17 14:34	EPA 200.7	
Selenium	**0.0032**	0.0020	mg/L	1	B7I1278	09/14/17 10:00	09/14/17 15:50	EPA 200.8	
Silica, Total	**25**	0.21	mg/L	1	[CALC]	09/13/17 12:11	09/13/17 14:34	EPA 200.7	
Silicon	**12**	0.10	mg/L	1	B7I1235	09/13/17 12:11	09/13/17 14:34	EPA 200.7	
Calcium Hardness as CaCO3	**180**	2.5	mg/L	1	[CALC]	09/13/17 12:11	09/13/17 14:34	SM2340B	
Magnesium Hardness as CaCO:	**190**	4.1	mg/L	1	[CALC]	09/13/17 12:11	09/13/17 14:34	SM2340B	
Total Hardness as CaCO3	**370**	4.1	mg/L	1	[CALC]	09/13/17 12:11	09/13/17 14:34	SM2340B	
Uranium	**0.0049**	0.0010	mg/L	1	B7I1278	09/14/17 10:00	09/14/17 15:50	EPA 200.8	
Vanadium	**0.017**	0.0070	mg/L	1	B7I1235	09/13/17 12:11	09/13/17 14:34	EPA 200.7	

GW 10 (Well 10) (7091040-05) Drinking Water (Grab) Sampled: 09/12/17 12:50 Received: 09/12/17 14:55

Analyte	Result	PQL	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Legend Technical Services of Arizona, Inc.									
Inorganic Chemistry									
Total Alkalinity as CaCO3	**151**	10	mg/L	1	B7I1240	09/13/17 13:08	09/13/17 13:08	SM 2320 B	
Chloride	**234**	50.0	mg/L	10	B7I1377	09/15/17 09:07	09/15/17 09:07	EPA 300.0	D2
Fluoride	**0.26**	0.10	mg/L	1	B7I1298	09/14/17 16:10	09/14/17 16:10	SM 4500 F C	
Nitrate as N	**4.86**	0.20	mg/L	1	[CALC]	09/15/17 09:40	09/15/17 09:40	Calculation	
Nitrate + Nitrite as N	**4.86**	0.20	mg/L	1	B7I1258	09/15/17 09:40	09/15/17 09:40	SM 4500 NO3 F	
Nitrite as N	<0.10	0.10	mg/L	1	B7I1243	09/13/17 13:57	09/13/17 13:57	SM 4500 NO2 B	
Orthophosphate as P	<0.05	0.05	mg/L	1	B7I1236	09/13/17 10:11	09/13/17 10:11	SM 4500 P F	
Total Phosphorous	<0.05	0.05	mg/L	1	B7I1287	09/13/17 09:15	09/13/17 14:45	EPA 365.3	
Sulfate	**267**	50.0	mg/L	10	B7I1377	09/15/17 09:07	09/15/17 09:07	EPA 300.0	D2
Sulfide, total	<0.04	0.04	mg/L	1	B7I1367	09/16/17 12:45	09/16/17 12:45	HACH 8131	
Total Dissolved Solids	**644**	1	mg/L	1	B7I1392	09/18/17 16:00	09/18/17 16:00	SM 2540 C	
Total Organic Carbon	<1.00	1.00	mg/L	1	B7I1401	09/15/17 14:43	09/15/17 14:43	SM 5310 C	
Total Suspended Solids	<1	1	mg/L	1	B7I1267	09/14/17 10:30	09/14/17 10:30	SM 2540 D	
Ultra Violet Absorption	<0.0090	0.0090	cm-1	1	B7I1242	09/13/17 11:10	09/13/17 11:10	SM 5910 B	
Volatile Organic Compounds									
Bromodichloromethane	<0.0005	0.0005	mg/L	1	B7I1226	09/13/17 10:00	09/13/17 13:30	EPA 524.2	
Bromoform	<0.0005	0.0005	mg/L	1	B7I1226	09/13/17 10:00	09/13/17 13:30	EPA 524.2	
Chloroform	**0.0033**	0.0005	mg/L	1	B7I1226	09/13/17 10:00	09/13/17 13:30	EPA 524.2	
Dibromochloromethane	<0.0005	0.0005	mg/L	1	B7I1226	09/13/17 10:00	09/13/17 13:30	EPA 524.2	
Total THMs	**0.0033**	0.0005	mg/L	1	B7I1226	09/13/17 10:00	09/13/17 13:30	EPA 524.2	
Surrogate: 1,2-Dichlorobenzene-d4		*110 %*		*70-130*	*B7I1226*	*09/13/17*	*09/13/17*	*EPA 524.2*	
Surrogate: 1,2-Dichloroethane-d4		*99 %*		*70-130*	*B7I1226*	*09/13/17*	*09/13/17*	*EPA 524.2*	
Surrogate: 4-Bromofluorobenzene		*83 %*		*70-130*	*B7I1226*	*09/13/17*	*09/13/17*	*EPA 524.2*	
Surrogate: Pentafluorobenzene		*105 %*		*70-130*	*B7I1226*	*09/13/17*	*09/13/17*	*EPA 524.2*	

GW 10 (Well 10) (7091040-05) Drinking Water (Grab) Sampled: 09/12/17 12:50 Received: 09/12/17 14:55

Legend Technical Services of Arizona, Inc.

Analyte	Result	PQL	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Miscellaneous									
Langlier Index	**-0.370**	-5.00	N/A	1	B7I1444	09/19/17 15:22	09/19/17 15:23	Miscellaneous	

Total Metals - Quality Control

Legend Technical Services of Arizona, Inc.

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B7I1235 - EPA 200.7										
Blank (B7I1235-BLK1)				*Prepared & Analyzed: 09/13/17*						
Aluminum	<0.20	0.20	mg/L							
Calcium	<1.0	1.0	mg/L							
Chromium	<0.0050	0.0050	mg/L							
Iron	<0.050	0.050	mg/L							
Magnesium	<1.0	1.0	mg/L							
Manganese	<0.020	0.020	mg/L							
Molybdenum	<0.020	0.020	mg/L							
Silicon	<0.10	0.10	mg/L							
Vanadium	<0.0070	0.0070	mg/L							
LCS (B7I1235-BS1)				*Prepared & Analyzed: 09/13/17*						
Aluminum	2.1	0.20	mg/L	2.00		104	85-115			
Calcium	21	1.0	mg/L	20.0		104	85-115			
Chromium	0.51	0.0050	mg/L	0.500		103	85-115			
Iron	1.0	0.050	mg/L	1.00		103	85-115			
Magnesium	20	1.0	mg/L	20.0		102	85-115			
Manganese	1.0	0.020	mg/L	1.00		102	85-115			
Molybdenum	0.21	0.020	mg/L	0.200		107	85-115			
Silicon	4.2	0.10	mg/L	4.00		104	85-115			
Vanadium	0.72	0.0070	mg/L	0.700		103	85-115			
LCS Dup (B7I1235-BSD1)				*Prepared & Analyzed: 09/13/17*						
Aluminum	2.1	0.20	mg/L	2.00		104	85-115	0.09	20	
Calcium	21	1.0	mg/L	20.0		104	85-115	0.03	20	
Chromium	0.51	0.0050	mg/L	0.500		103	85-115	0.06	20	
Iron	1.0	0.050	mg/L	1.00		104	85-115	0.06	20	
Magnesium	20	1.0	mg/L	20.0		102	85-115	0.2	20	
Manganese	1.0	0.020	mg/L	1.00		102	85-115	0.4	20	
Molybdenum	0.21	0.020	mg/L	0.200		107	85-115	0.1	20	
Silicon	4.1	0.10	mg/L	4.00		104	85-115	0.2	20	
Vanadium	0.72	0.0070	mg/L	0.700		103	85-115	0.2	20	

Total Metals - Quality Control

Legend Technical Services of Arizona, Inc.

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B7I1235 - EPA 200.7										
Matrix Spike (B7I1235-MS1)	**Source: 7090320-02**			*Prepared & Analyzed: 09/13/17*						
Aluminum	2.2	0.20	mg/L	2.00	0.019	109	70-130			
Calcium	130	1.0	mg/L	20.0	110	75	70-130			
Chromium	0.50	0.0050	mg/L	0.500	0.0004	100	70-130			
Iron	1.0	0.050	mg/L	1.00	0.023	99	70-130			
Magnesium	72	1.0	mg/L	20.0	53	93	70-130			
Manganese	0.98	0.020	mg/L	1.00	0.0040	98	70-130			
Molybdenum	0.21	0.020	mg/L	0.200	0.0025	105	70-130			
Silicon	12	0.10	mg/L	4.00	7.5	101	70-130			
Vanadium	0.72	0.0070	mg/L	0.700	<0.0070	102	70-130			
Matrix Spike Dup (B7I1235-MSD1)	**Source: 7090320-02**			*Prepared & Analyzed: 09/13/17*						
Aluminum	2.2	0.20	mg/L	2.00	0.019	110	70-130	0.6	20	
Calcium	130	1.0	mg/L	20.0	110	88	70-130	2	20	
Chromium	0.51	0.0050	mg/L	0.500	0.0004	102	70-130	1	20	
Iron	1.0	0.050	mg/L	1.00	0.023	101	70-130	2	20	
Magnesium	73	1.0	mg/L	20.0	53	98	70-130	1	20	
Manganese	1.0	0.020	mg/L	1.00	0.0040	99	70-130	1	20	
Molybdenum	0.22	0.020	mg/L	0.200	0.0025	106	70-130	2	20	
Silicon	12	0.10	mg/L	4.00	7.5	105	70-130	1	20	
Vanadium	0.73	0.0070	mg/L	0.700	<0.0070	104	70-130	1	20	
Batch B7I1278 - EPA 200.8										
Blank (B7I1278-BLK1)				*Prepared & Analyzed: 09/14/17*						
Antimony	<0.0005	0.0005	mg/L							
Arsenic	<0.0010	0.0010	mg/L							
Cadmium	<0.0001	0.0001	mg/L							
Lead	<0.0010	0.0010	mg/L							
Selenium	<0.0020	0.0020	mg/L							
Uranium	<0.0010	0.0010	mg/L							

Total Metals - Quality Control

Legend Technical Services of Arizona, Inc.

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B7I1278 - EPA 200.8										
LCS (B7I1278-BS1)				*Prepared & Analyzed: 09/14/17*						
Antimony	0.027	0.0005	mg/L	0.0250		107	85-115			
Arsenic	0.026	0.0010	mg/L	0.0250		105	85-115			
Cadmium	0.026	0.0001	mg/L	0.0250		106	85-115			
Lead	0.026	0.0010	mg/L	0.0250		103	85-115			
Selenium	0.026	0.0020	mg/L	0.0250		103	85-115			
Uranium	0.027	0.0010	mg/L	0.0250		109	85-115			
LCS Dup (B7I1278-BSD1)				*Prepared & Analyzed: 09/14/17*						
Antimony	0.026	0.0005	mg/L	0.0250		106	85-115	0.6	20	
Arsenic	0.027	0.0010	mg/L	0.0250		109	85-115	3	20	
Cadmium	0.026	0.0001	mg/L	0.0250		103	85-115	3	20	
Lead	0.026	0.0010	mg/L	0.0250		104	85-115	1	20	
Selenium	0.025	0.0020	mg/L	0.0250		102	85-115	1	20	
Uranium	0.027	0.0010	mg/L	0.0250		109	85-115	0.5	20	
Matrix Spike (B7I1278-MS1)	**Source: 7091031-01**			*Prepared & Analyzed: 09/14/17*						
Antimony	0.028	0.0005	mg/L	0.0250	0.00005	114	70-130			
Arsenic	0.049	0.0010	mg/L	0.0250	0.020	116	70-130			
Cadmium	0.026	0.0001	mg/L	0.0250	<0.0001	104	70-130			
Lead	0.027	0.0010	mg/L	0.0250	<0.0010	108	70-130			
Selenium	0.032	0.0020	mg/L	0.0250	0.0045	109	70-130			
Uranium	0.031	0.0010	mg/L	0.0250	0.0009	122	70-130			
Matrix Spike (B7I1278-MS2)	**Source: 7091040-05**			*Prepared & Analyzed: 09/14/17*						
Antimony	0.029	0.0005	mg/L	0.0250	0.00003	114	70-130			
Arsenic	0.033	0.0010	mg/L	0.0250	0.0058	109	70-130			
Cadmium	0.026	0.0001	mg/L	0.0250	<0.0001	102	70-130			
Lead	0.026	0.0010	mg/L	0.0250	0.0002	101	70-130			
Selenium	0.029	0.0020	mg/L	0.0250	0.0032	105	70-130			
Uranium	0.033	0.0010	mg/L	0.0250	0.0049	114	70-130			

Total Metals - Quality Control

Legend Technical Services of Arizona, Inc.

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B7I1278 - EPA 200.8										
Matrix Spike Dup (B7I1278-MSD1)	**Source: 7091031-01**			*Prepared & Analyzed: 09/14/17*						
Antimony	0.030	0.0005	mg/L	0.0250	0.00005	118	70-130	4	20	
Arsenic	0.049	0.0010	mg/L	0.0250	0.020	113	70-130	2	20	
Cadmium	0.026	0.0001	mg/L	0.0250	<0.0001	105	70-130	0.4	20	
Lead	0.027	0.0010	mg/L	0.0250	<0.0010	107	70-130	1	20	
Selenium	0.032	0.0020	mg/L	0.0250	0.0045	108	70-130	0.8	20	
Uranium	0.031	0.0010	mg/L	0.0250	0.0009	119	70-130	3	20	
Matrix Spike Dup (B7I1278-MSD2)	**Source: 7091040-05**			*Prepared & Analyzed: 09/14/17*						
Antimony	0.029	0.0005	mg/L	0.0250	0.00003	115	70-130	0.6	20	
Arsenic	0.034	0.0010	mg/L	0.0250	0.0058	112	70-130	3	20	
Cadmium	0.026	0.0001	mg/L	0.0250	<0.0001	104	70-130	2	20	
Lead	0.026	0.0010	mg/L	0.0250	0.0002	105	70-130	3	20	
Selenium	0.030	0.0020	mg/L	0.0250	0.0032	108	70-130	2	20	
Uranium	0.035	0.0010	mg/L	0.0250	0.0049	120	70-130	5	20	

Inorganic Chemistry - Quality Control

Legend Technical Services of Arizona, Inc.

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B7I1236 - NO PREP										
Blank (B7I1236-BLK1)				*Prepared & Analyzed: 09/13/17*						
Orthophosphate as P	<0.05	0.05	mg/L							
LCS (B7I1236-BS1)				*Prepared & Analyzed: 09/13/17*						
Orthophosphate as P	0.20	0.05	mg/L	0.200		98	90-110			
LCS Dup (B7I1236-BSD1)				*Prepared & Analyzed: 09/13/17*						
Orthophosphate as P	0.20	0.05	mg/L	0.200		100	90-110	2	20	
Matrix Spike (B7I1236-MS1)		**Source: 7091040-05**		*Prepared & Analyzed: 09/13/17*						
Orthophosphate as P	0.20	0.05	mg/L	0.200	<0.05	99	80-120			
Matrix Spike Dup (B7I1236-MSD1)		**Source: 7091040-05**		*Prepared & Analyzed: 09/13/17*						
Orthophosphate as P	0.20	0.05	mg/L	0.200	<0.05	100	80-120	0.5	20	
Batch B7I1240 - NO PREP										
Blank (B7I1240-BLK1)				*Prepared & Analyzed: 09/13/17*						
Total Alkalinity as CaCO3	<10	10	mg/L							
LCS (B7I1240-BS1)				*Prepared & Analyzed: 09/13/17*						
Total Alkalinity as CaCO3	194	10	mg/L	200		97	80-120			
LCS Dup (B7I1240-BSD1)				*Prepared & Analyzed: 09/13/17*						
Total Alkalinity as CaCO3	193	10	mg/L	200		97	80-120	0.3	20	
Matrix Spike (B7I1240-MS1)		**Source: 7091040-01**		*Prepared & Analyzed: 09/13/17*						
Total Alkalinity as CaCO3	255	10	mg/L	200	155	50	80-120			M2

Inorganic Chemistry - Quality Control

Legend Technical Services of Arizona, Inc.

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B7I1240 - NO PREP										
Matrix Spike Dup (B7I1240-MSD1)		**Source: 7091040-01**		*Prepared & Analyzed: 09/13/17*						
Total Alkalinity as CaCO3	257	10	mg/L	200	155	51	80-120	1	20	M2
Batch B7I1242 - NO PREP										
Blank (B7I1242-BLK1)				*Prepared & Analyzed: 09/13/17*						
Ultra Violet Absorption	<0.0090	0.0090	cm-1							
Duplicate (B7I1242-DUP1)		**Source: 7091025-01**		*Prepared & Analyzed: 09/13/17*						
Ultra Violet Absorption	0.0270	0.0090	cm-1		0.0268			0.7	20	
Batch B7I1243 - NO PREP										
Blank (B7I1243-BLK1)				*Prepared & Analyzed: 09/13/17*						
Nitrite as N	<0.10	0.10	mg/L							
LCS (B7I1243-BS1)				*Prepared & Analyzed: 09/13/17*						
Nitrite as N	0.218	0.10	mg/L	0.200		109	80-120			
LCS Dup (B7I1243-BSD1)				*Prepared & Analyzed: 09/13/17*						
Nitrite as N	0.218	0.10	mg/L	0.200		109	80-120	0	20	
Matrix Spike (B7I1243-MS1)		**Source: 7090942-02**		*Prepared & Analyzed: 09/13/17*						
Nitrite as N	0.201	0.10	mg/L	0.200	<0.10	100	80-120			
Matrix Spike Dup (B7I1243-MSD1)		**Source: 7090942-02**		*Prepared & Analyzed: 09/13/17*						
Nitrite as N	0.201	0.10	mg/L	0.200	<0.10	100	80-120	0	20	

Inorganic Chemistry - Quality Control

Legend Technical Services of Arizona, Inc.

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B7I1258 - NO PREP										
Blank (B7I1258-BLK1)				*Prepared & Analyzed: 09/15/17*						
Nitrate + Nitrite as N	<0.20	0.20	mg/L							
Blank (B7I1258-BLK2)				*Prepared & Analyzed: 09/15/17*						
Nitrate + Nitrite as N	<0.20	0.20	mg/L							
Blank (B7I1258-BLK3)				*Prepared & Analyzed: 09/15/17*						
Nitrate + Nitrite as N	<0.20	0.20	mg/L							
Blank (B7I1258-BLK4)				*Prepared & Analyzed: 09/15/17*						
Nitrate + Nitrite as N	<0.20	0.20	mg/L							
LCS (B7I1258-BS1)				*Prepared & Analyzed: 09/15/17*						
Nitrate + Nitrite as N	10.1	0.20	mg/L	10.0		101	90-110			
LCS (B7I1258-BS2)				*Prepared & Analyzed: 09/15/17*						
Nitrate + Nitrite as N	10.2	0.20	mg/L	10.0		102	90-110			
LCS Dup (B7I1258-BSD1)				*Prepared & Analyzed: 09/15/17*						
Nitrate + Nitrite as N	10.1	0.20	mg/L	10.0		101	90-110	0	20	
LCS Dup (B7I1258-BSD2)				*Prepared & Analyzed: 09/15/17*						
Nitrate + Nitrite as N	10.2	0.20	mg/L	10.0		102	90-110	0	20	
Matrix Spike (B7I1258-MS1)		**Source: 7090942-02**		*Prepared & Analyzed: 09/15/17*						
Nitrate + Nitrite as N	11.0	0.20	mg/L	10.0	0.80	102	80-120			
Matrix Spike (B7I1258-MS2)		**Source: 7091040-04**		*Prepared & Analyzed: 09/15/17*						
Nitrate + Nitrite as N	15.6	0.20	mg/L	10.0	5.03	106	80-120			

Inorganic Chemistry - Quality Control

Legend Technical Services of Arizona, Inc.

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B7I1258 - NO PREP										
Matrix Spike (B7I1258-MS3)	**Source: 7091220-01**			*Prepared & Analyzed: 09/15/17*						
Nitrate + Nitrite as N	113	2.00	mg/L	100	12.0	101	80-120			D2
Matrix Spike (B7I1258-MS4)	**Source: 7091382-02**			*Prepared & Analyzed: 09/15/17*						
Nitrate + Nitrite as N	9.95	0.20	mg/L	10.0	<0.20	100	80-120			
Matrix Spike Dup (B7I1258-MSD1)	**Source: 7090942-02**			*Prepared & Analyzed: 09/15/17*						
Nitrate + Nitrite as N	11.0	0.20	mg/L	10.0	0.80	102	80-120	0	20	
Matrix Spike Dup (B7I1258-MSD2)	**Source: 7091040-04**			*Prepared & Analyzed: 09/15/17*						
Nitrate + Nitrite as N	15.6	0.20	mg/L	10.0	5.03	106	80-120	0	20	
Matrix Spike Dup (B7I1258-MSD3)	**Source: 7091220-01**			*Prepared & Analyzed: 09/15/17*						
Nitrate + Nitrite as N	114	2.00	mg/L	100	12.0	102	80-120	0.9	20	D2
Matrix Spike Dup (B7I1258-MSD4)	**Source: 7091382-02**			*Prepared & Analyzed: 09/15/17*						
Nitrate + Nitrite as N	9.94	0.20	mg/L	10.0	<0.20	99	80-120	0.1	20	
Batch B7I1267 - NO PREP										
Blank (B7I1267-BLK1)				*Prepared & Analyzed: 09/14/17*						
Total Suspended Solids	<1	1	mg/L							
Duplicate (B7I1267-DUP1)	**Source: 7091027-01**			*Prepared & Analyzed: 09/14/17*						
Total Suspended Solids	164	1	mg/L		160			2	5	
Batch B7I1286 - NO PREP										
Blank (B7I1286-BLK1)				*Prepared & Analyzed: 09/13/17*						
Total Phosphorous	<0.05	0.05	mg/L							

Inorganic Chemistry - Quality Control

Legend Technical Services of Arizona, Inc.

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B7I1286 - NO PREP										
Blank (B7I1286-BLK2)				*Prepared & Analyzed: 09/13/17*						
Total Phosphorous	<0.05	0.05	mg/L							
LCS (B7I1286-BS1)				*Prepared & Analyzed: 09/13/17*						
Total Phosphorous	0.11	0.05	mg/L	0.100		109	90-110			
LCS Dup (B7I1286-BSD1)				*Prepared & Analyzed: 09/13/17*						
Total Phosphorous	0.11	0.05	mg/L	0.100		110	90-110	0.6	20	
Matrix Spike (B7I1286-MS1)		**Source: 7090507-04**		*Prepared & Analyzed: 09/13/17*						
Total Phosphorous	0.03	0.05	mg/L	0.100	<0.05	34	90-110			M2
Matrix Spike (B7I1286-MS2)		**Source: 7091040-04**		*Prepared & Analyzed: 09/13/17*						
Total Phosphorous	<0.05	0.05	mg/L	0.100	<0.05		90-110			M2
Matrix Spike Dup (B7I1286-MSD1)		**Source: 7090507-04**		*Prepared & Analyzed: 09/13/17*						
Total Phosphorous	0.04	0.05	mg/L	0.100	<0.05	36	90-110	5	20	M2
Matrix Spike Dup (B7I1286-MSD2)		**Source: 7091040-04**		*Prepared & Analyzed: 09/13/17*						
Total Phosphorous	<0.05	0.05	mg/L	0.100	<0.05		90-110		20	M2
Batch B7I1287 - NO PREP										
Blank (B7I1287-BLK1)				*Prepared & Analyzed: 09/13/17*						
Total Phosphorous	<0.05	0.05	mg/L							
LCS (B7I1287-BS1)				*Prepared & Analyzed: 09/13/17*						
Total Phosphorous	0.11	0.05	mg/L	0.100		109	90-110			

Inorganic Chemistry - Quality Control

Legend Technical Services of Arizona, Inc.

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B7I1287 - NO PREP										
LCS Dup (B7I1287-BSD1)				*Prepared & Analyzed: 09/13/17*						
Total Phosphorous	0.11	0.05	mg/L	0.100		110	90-110	0.6	20	
Matrix Spike (B7I1287-MS1)	**Source: 7091040-04**			*Prepared & Analyzed: 09/13/17*						
Total Phosphorous	<0.05	0.05	mg/L	0.100	<0.05		90-110			M2
Matrix Spike Dup (B7I1287-MSD1)	**Source: 7091040-04**			*Prepared & Analyzed: 09/13/17*						
Total Phosphorous	<0.05	0.05	mg/L	0.100	<0.05		90-110		20	M2
Batch B7I1298 - NO PREP										
Blank (B7I1298-BLK1)				*Prepared & Analyzed: 09/14/17*						
Fluoride	<0.10	0.10	mg/L							
Blank (B7I1298-BLK2)				*Prepared & Analyzed: 09/14/17*						
Fluoride	<0.10	0.10	mg/L							
LCS (B7I1298-BS1)				*Prepared & Analyzed: 09/14/17*						
Fluoride	1.94	0.10	mg/L	2.00		97	90-110			
LCS Dup (B7I1298-BSD1)				*Prepared & Analyzed: 09/14/17*						
Fluoride	1.97	0.10	mg/L	2.00		99	90-110	1	20	
Matrix Spike (B7I1298-MS1)	**Source: 7090620-01**			*Prepared & Analyzed: 09/14/17*						
Fluoride	1.92	0.10	mg/L	2.00	<0.10	96	90-110			
Matrix Spike (B7I1298-MS2)	**Source: 7090936-01**			*Prepared & Analyzed: 09/14/17*						
Fluoride	2.58	0.10	mg/L	2.00	0.64	97	90-110			

Inorganic Chemistry - Quality Control

Legend Technical Services of Arizona, Inc.

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B7I1298 - NO PREP										
Matrix Spike Dup (B7I1298-MSD1)	**Source: 7090620-01**			*Prepared & Analyzed: 09/14/17*						
Fluoride	1.92	0.10	mg/L	2.00	<0.10	96	90-110	0	20	
Matrix Spike Dup (B7I1298-MSD2)	**Source: 7090936-01**			*Prepared & Analyzed: 09/14/17*						
Fluoride	2.56	0.10	mg/L	2.00	0.64	96	90-110	0.9	20	
Batch B7I1367 - NO PREP										
Blank (B7I1367-BLK1)				*Prepared & Analyzed: 09/16/17*						
Sulfide, total	<0.04	0.04	mg/L							
LCS (B7I1367-BS1)				*Prepared & Analyzed: 09/16/17*						
Sulfide, total	0.11	0.04	mg/L	0.121		94	80-120			
LCS Dup (B7I1367-BSD1)				*Prepared & Analyzed: 09/16/17*						
Sulfide, total	0.12	0.04	mg/L	0.121		100	80-120	7	20	
Matrix Spike (B7I1367-MS1)	**Source: 7091040-01**			*Prepared & Analyzed: 09/16/17*						
Sulfide, total	0.02	0.04	mg/L	0.121	<0.04	15	80-120			M2
Matrix Spike Dup (B7I1367-MSD1)	**Source: 7091040-01**			*Prepared & Analyzed: 09/16/17*						
Sulfide, total	0.01	0.04	mg/L	0.121	<0.04	10	80-120	40	20	M2
Batch B7I1377 - NO PREP										
Blank (B7I1377-BLK1)				*Prepared & Analyzed: 09/15/17*						
Chloride	<5.0	5.0	mg/L							
Sulfate	<5.0	5.0	mg/L							

Inorganic Chemistry - Quality Control

Legend Technical Services of Arizona, Inc.

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B7I1377 - NO PREP										
Blank (B7I1377-BLK2)				*Prepared & Analyzed: 09/15/17*						
Chloride	<5.0	5.0	mg/L							
Sulfate	<5.0	5.0	mg/L							
Blank (B7I1377-BLK3)				*Prepared & Analyzed: 09/15/17*						
Chloride	<5.0	5.0	mg/L							
Sulfate	<5.0	5.0	mg/L							
LCS (B7I1377-BS1)				*Prepared & Analyzed: 09/15/17*						
Chloride	10.1	5.0	mg/L	10.0		101	90-110			
Sulfate	20.5	5.0	mg/L	20.0		102	90-110			
LCS Dup (B7I1377-BSD1)				*Prepared & Analyzed: 09/15/17*						
Chloride	10.0	5.0	mg/L	10.0		100	90-110	1	20	
Sulfate	19.9	5.0	mg/L	20.0		100	90-110	3	20	
Matrix Spike (B7I1377-MS1)	**Source: 7090485-01**			*Prepared & Analyzed: 09/15/17*						
Chloride	24.4	5.0	mg/L	10.0	14.5	99	90-110			
Sulfate	28.5	5.0	mg/L	20.0	8.2	102	90-110			
Matrix Spike (B7I1377-MS2)	**Source: 7090485-04**			*Prepared & Analyzed: 09/15/17*						
Chloride	29.8	5.0	mg/L	10.0	19.8	100	90-110			
Sulfate	42.2	5.0	mg/L	20.0	21.3	104	90-110			
Matrix Spike (B7I1377-MS3)	**Source: 7091377-02**			*Prepared & Analyzed: 09/15/17*						
Chloride	12.2	5.0	mg/L	10.0	2.0	102	90-110			
Sulfate	20.6	5.0	mg/L	20.0	<5.0	103	90-110			
Matrix Spike Dup (B7I1377-MSD1)	**Source: 7090485-01**			*Prepared & Analyzed: 09/15/17*						
Chloride	24.8	5.0	mg/L	10.0	14.5	103	90-110	2	20	
Sulfate	28.8	5.0	mg/L	20.0	8.2	103	90-110	1	20	

Inorganic Chemistry - Quality Control

Legend Technical Services of Arizona, Inc.

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B7I1377 - NO PREP										
Matrix Spike Dup (B7I1377-MSD2)	**Source: 7090485-04**			*Prepared & Analyzed: 09/15/17*						
Chloride	29.6	5.0	mg/L	10.0	19.8	98	90-110	0.7	20	
Sulfate	41.6	5.0	mg/L	20.0	21.3	102	90-110	1	20	
Matrix Spike Dup (B7I1377-MSD3)	**Source: 7091377-02**			*Prepared & Analyzed: 09/15/17*						
Chloride	12.1	5.0	mg/L	10.0	2.0	101	90-110	0.8	20	
Sulfate	20.5	5.0	mg/L	20.0	<5.0	102	90-110	0.5	20	
Batch B7I1392 - NO PREP										
Blank (B7I1392-BLK1)				*Prepared & Analyzed: 09/18/17*						
Total Dissolved Solids	<1	1	mg/L							
Duplicate (B7I1392-DUP1)	**Source: 7090936-01**			*Prepared & Analyzed: 09/18/17*						
Total Dissolved Solids	586	1	mg/L		582			0.7	5	
Duplicate (B7I1392-DUP2)	**Source: 7091040-05**			*Prepared & Analyzed: 09/18/17*						
Total Dissolved Solids	650	1	mg/L		644			0.9	5	
Batch B7I1401 - NO PREP										
Blank (B7I1401-BLK1)				*Prepared & Analyzed: 09/15/17*						
Total Organic Carbon	<1.00	1.00	mg/L							
LCS (B7I1401-BS1)				*Prepared & Analyzed: 09/15/17*						
Total Organic Carbon	9.74	1.00	mg/L	10.0		97	80-120			

Inorganic Chemistry - Quality Control

Legend Technical Services of Arizona, Inc.

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B7I1401 - NO PREP										
LCS Dup (B7I1401-BSD1)				*Prepared & Analyzed: 09/15/17*						
Total Organic Carbon	9.75	1.00	mg/L	10.0		98	80-120	0.1	20	
Matrix Spike (B7I1401-MS1)	**Source: 7091040-03**			*Prepared & Analyzed: 09/15/17*						
Total Organic Carbon	9.81	1.00	mg/L	10.0	0.125	97	80-120			
Matrix Spike (B7I1401-MS2)	**Source: 7091074-01**			*Prepared & Analyzed: 09/15/17*						
Total Organic Carbon	12.8	1.00	mg/L	10.0	2.96	98	80-120			
Matrix Spike Dup (B7I1401-MSD1)	**Source: 7091040-03**			*Prepared & Analyzed: 09/15/17*						
Total Organic Carbon	9.81	1.00	mg/L	10.0	0.125	97	80-120	0	20	
Matrix Spike Dup (B7I1401-MSD2)	**Source: 7091074-01**			*Prepared & Analyzed: 09/15/17*						
Total Organic Carbon	12.7	1.00	mg/L	10.0	2.96	97	80-120	0.8	20	

Volatile Organic Compounds - Quality Control

Legend Technical Services of Arizona, Inc.

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B7I1226 - Default Prep VOC										
Blank (B7I1226-BLK1)				*Prepared & Analyzed: 09/13/17*						
Bromodichloromethane	<0.0005	0.0005	mg/L							
Bromoform	<0.0005	0.0005	mg/L							
Chloroform	<0.0005	0.0005	mg/L							
Dibromochloromethane	<0.0005	0.0005	mg/L							
Total THMs	<0.0005	0.0005	mg/L							
LCS (B7I1226-BS1)				*Prepared & Analyzed: 09/13/17*						
Bromodichloromethane	0.0019	0.0005	mg/L	0.00200		94	70-130			
Bromoform	0.0020	0.0005	mg/L	0.00200		99	70-130			
Chloroform	0.0019	0.0005	mg/L	0.00200		96	70-130			
Dibromochloromethane	0.0019	0.0005	mg/L	0.00200		96	70-130			
Total THMs	0.0077	0.0005	mg/L	0.00800		96	0-200			
LCS Dup (B7I1226-BSD1)				*Prepared & Analyzed: 09/13/17*						
Bromodichloromethane	0.0019	0.0005	mg/L	0.00200		96	70-130	2	20	
Bromoform	0.0019	0.0005	mg/L	0.00200		97	70-130	2	20	
Chloroform	0.0020	0.0005	mg/L	0.00200		102	70-130	5	20	
Dibromochloromethane	0.0020	0.0005	mg/L	0.00200		97	70-130	2	20	
Total THMs	0.0078	0.0005	mg/L	0.00800		98	0-200	2	200	

Notes and Definitions

T6	The reported result cannot be used for compliance purposes.
M2	Matrix spike recovery was low; the associated blank spike recovery was acceptable.
D2	Sample required dilution due to high concentration of target analyte.
BQC	Quality Control results provided as batch QC only. See final results from actual batch number listed with the analytical report.
BLK	Method Blank
LCS/Dup	Laboratory Control Sample/Laboratory Fortified Blank/Duplicate
MS/Dup	Matrix Spike/Duplicate
Dry	Sample results reported on a dry weight basis
RPD	Relative Percent Difference

Laboratory Sample ID: 7091040

CHAIN OF CUSTODY RECORD

LEGEND Technical Services, Inc.

☒ 17631 N. 25th Avenue • Phoenix, AZ 85023 • (602) 324-6100 • Fax (602) 324-6101
☐ 4585 S. Palo Verde Rd, Ste 423 • Tucson, AZ 85714 • (520) 327-1234 • Fax (520) 327-0511

Page 1 of 1

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CLIENT INFORMATION

Client Name	Address	City	State	Zip	Phone	Fax or Email
City of Avondale DW	399 E. Lower Buckeye Rd. Ste. 100	Avondale	AZ	85323	623-333-4457	dallred@avondale.org

System Name	PWS#	Contact	P.O. No.	
Water Quality Samples	07-088	David Allred		Fax Results ☐ QC Report ☐ EDD ☒ Email Results ☒ Special Detection Limits ☐

IOC OPTIONS: 5-day RUSH

REQUESTED ANALYSES — RUSH 9/19/17

Client's Sample Identification	Date	Time	POE # / DWR #	Compliance	No. of Containers	pH ✓ (Legend Use)	524 THM	Metals*	Arsenic V	Chloride	Fluoride	Langlier Index**	NO3, NO2	Orho Phos	Total Phos	Sulfate	Sulfide	TOC	TSS	UV 254	LAB NO.
WP21	9-12-17	0905	GATEWAY EFF		13	✓	x	x	x	x	x	x	x	x	x	x	x	x	x	x	-01
GW17	9-12-17	1000	WELL 17		13	✓	x	x	x	x	x	x	x	x	x	x	x	x	x	x	-02
WP20	9-12-17	1045	GARDEN LAKES EFF		13	✓	x	x	x	x	x	x	x	x	x	x	x	x	x	x	-03
GW23	9-12-17	1140	WELL 23		13	✓	x	x	x	x	x	x	x	x	x	x	x	x	x	x	-04
GW10	9-12-17	1250	WELL 10		13	✓	x	x	x	x	x	x	x	x	x	x	x	x	x	x	-05
					13	✓	x	x	x	x	x	x	x	x	x	x	x	x	x	x	-06
					13		x	x	x	x	x	x	x	x	x	x	x	x	x	x	-07

TO ENSURE COMPLETION OF ANALYSIS, SAMPLES MUST BE RECEIVED AT LEAST 6 HOURS PRIOR TO THE HOLD TIME EXPIRATION

Comments: *Metals= Al, Sb, Cd, Cr, Fe, Pb, Mg, Mn, Mo, Se, Si, Total Hardness, U, V
**Langlier Index= Ca, pH, TDS, Alk

☐ Yes, I have followed the instructions provided by the laboratory for dechlorination of my samples.

TURN AROUND TIME
☐ Standard 15 - 20 day
☒ Other 5 DAY RUSH
Laboratory Authorization Required for Rush: DSA

SAMPLE CONDITION UPON RECEIPT

No. of Containers	65
Temperature	3.0 °C
Custody Seals	Y (N)
Seals Intact	Y N
Preserved	(Y) N

White- Lab Yellow- Client
FORM GEN-173 (6/06)

	RELINQUISHED BY	Date / Time	SAMPLES RECEIVED BY	Date / Time
①	Sampler Signature: D.S. A.; Sampler Printed Name: David Allred	Date 9-12-17; Time 1334	Signature: [signature]; Printed Name: Jake Olson	Date 9-12-17; Time 1338
②	Sampler Signature: ; Sampler Printed Name:	Date ; Time	Signature: ; Printed Name:	Date ; Time
③	Sampler Signature: ; Sampler Printed Name:	Date ; Time	Signature: ; Printed Name: @ Lab 1455	Date ; Time

5- day 9/19 end of day

RUSH NOTICE W.O. #: 7091040

*** Only verbal or preliminary results can be guaranteed on RUSHES

*****If sample(s) does not come in on day indicated by client, RUSH may not be available.

Company: City of Avondale Phone:

Contact: David Allred

Prelim Due Date: 9/19/17 end of day Final Due Date:

Analysis:
524 THM, Chloride, Fluoride, pH, TDS, Alk, NO3+NO2, NO2, OP
Arsenic Speciation, Langlier Index, Total Phos, SO4, Sulfide, TOC, TSS, UV 254

Number of Samples: (x7) Date Samples Expected******: 9/12/17

Matrix: DW Expiration Date:

Supervisor Approval

Al, Sb, Cd, Cr, Fe, Pb, Mg, Mn, Mo, Se, Si, Hardness, U, V
Langlier Index
Arsenic Speciation

Inorganics:	9/7/17	Specifics:	
Metals:	9/7/17	Specifics:	
Micro:		Specifics:	
SOC:		Specifics:	
VOC:	9/7/17	Specifics:	
Sub1:		Specifics:	
Sub2:		Specifics:	

Comments:
Project = "Water Quality Samples"

COST:

Project Manager: Lisa

RUSH Initiator: Lisa

FORM CS-012 (02/15)

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10 October 2017

David Allred
City of Avondale DW
399 E. Lower Buckeye Rd. Ste 100
Avondale, AZ 85323

RE: Water Quality Samples

Laboratory Work Order No.: 7091361

Legend Technical Services of Arizona, Inc. is pleased to provide the enclosed analytical results for the aforementioned project. These results relate only to the items tested. This cover letter and the accompanying pages represent the full report for these analyses and should only be reproduced in full. Samples for this project were received by the laboratory on 09/14/17 15:15.

The samples were processed in accordance with the Chain of Custody document and the results presented relate only to the samples tested. The Chain of Custody is considered part of this report.

All samples will be retained by LEGEND for 30 days from the date of this report and then discarded unless other arrangements are made. Due to hold-time and method sample volume requirements, microbiological samples are not retained unless other arrangements are made.

This entire report was reviewed and approved for release by the undersigned. If you have any questions concerning this report, please feel free to contact me.

Sincerely,
LEGEND TECHNICAL SERVICES OF ARIZONA, INC.

Lisa Teter
Client Services Representative
(602) 324-6100

This laboratory report is confidential and is intended for the sole use of LEGEND and it's client.

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ANALYTICAL REPORT FOR SAMPLES

Sample ID	Laboratory ID	Matrix	Type	Date Sampled	Date Received
PHX 1790 (10606 W Hess)	7091361-01	Drinking Water	Grab	09/14/17 08:00	09/14/17 15:15
PHX 1040 (10601 W Roma Ave)	7091361-02	Drinking Water	Grab	09/14/17 09:00	09/14/17 15:15

Sample Condition Upon Receipt:

Temperature: 3.70 C

All samples were received in acceptable condition unless noted otherwise in the case narrative.

Case Narrative:

Holding Times: All holding times were met unless otherwise qualified.

QA/QC Criteria: All analyses met method requirements unless otherwise qualified.

Certifications: AZ(PHX)0004, AZ(TUC)OOO4, AIHA#102982, CDC ELITE Member.

Accreditation is applicable only to the test methods specified on each scope of accreditation held by LEGEND.

Comments: There were no problems encountered during the processing of the samples, unless otherwise noted. All samples were analyzed on a "wet" basis unless designated as "dry weight".

Client provided field readings for pH and Temperature on 10/10/17 and requested that the Langlier Index be recalculated using the field readinds. LT
Revised report on 10/10/17 LT

PHX 1790 (10606 W Hess) (7091361-01) Drinking Water (Grab) Sampled: 09/14/17 08:00 Received: 09/14/17 15:15

Legend Technical Services of Arizona, Inc.

Analyte	Result	PQL	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Field Readings									
pH	**7.01**		pH Units	1	B7J1202	09/14/17 08:00	09/14/17 08:00	Field	
Temperature	**34**		°C	1	B7J1202	09/14/17 08:00	09/14/17 08:00	Field	
Total Metals									
Aluminum	<0.20	0.20	mg/L	1	B7I1381	09/18/17 10:33	09/18/17 12:38	EPA 200.7	
Antimony	<0.0005	0.0005	mg/L	1	B7I1395	09/18/17 15:00	09/18/17 16:38	EPA 200.8	
Arsenic III	<0.0010	0.0010	mg/L	1	B7I1396	09/18/17 15:05	09/19/17 09:18	EPA 200.8	T6
Arsenic V	**0.0013**		mg/L	1	[CALC]	09/18/17 15:05	09/19/17 09:18	Calculation	
Arsenic	**0.0013**	0.0010	mg/L	1	B7I1395	09/18/17 15:00	09/18/17 16:38	EPA 200.8	
Cadmium	<0.0001	0.0001	mg/L	1	B7I1395	09/18/17 15:00	09/18/17 16:38	EPA 200.8	
Calcium	**53**	1.0	mg/L	1	B7I1438	09/19/17 14:01	09/19/17 17:00	EPA 200.7	
Chromium	<0.0050	0.0050	mg/L	1	B7I1381	09/18/17 10:33	09/18/17 12:38	EPA 200.7	
Iron	<0.050	0.050	mg/L	1	B7I1381	09/18/17 10:33	09/18/17 12:38	EPA 200.7	
Lead	<0.0010	0.0010	mg/L	1	B7I1395	09/18/17 15:00	09/18/17 16:38	EPA 200.8	
Magnesium	**20**	1.0	mg/L	1	B7I1381	09/18/17 10:33	09/18/17 12:38	EPA 200.7	
Manganese	<0.020	0.020	mg/L	1	B7I1381	09/18/17 10:33	09/18/17 12:38	EPA 200.7	
Molybdenum	<0.020	0.020	mg/L	1	B7I1381	09/18/17 10:33	09/18/17 12:38	EPA 200.7	
Selenium	**0.0027**	0.0020	mg/L	1	B7I1395	09/18/17 15:00	09/18/17 16:38	EPA 200.8	
Silica, Total	**14**	0.21	mg/L	1	[CALC]	09/18/17 10:33	09/18/17 12:38	EPA 200.7	
Silicon	**6.4**	0.10	mg/L	1	B7I1381	09/18/17 10:33	09/18/17 12:38	EPA 200.7	
Calcium Hardness as CaCO3	**130**	2.5	mg/L	1	[CALC]	09/19/17 14:01	09/19/17 17:00	SM2340B	
Magnesium Hardness as CaCO:	**82**	4.1	mg/L	1	[CALC]	09/19/17 14:01	09/18/17 12:38	SM2340B	
Total Hardness as CaCO3	**210**	4.1	mg/L	1	[CALC]	09/19/17 14:01	09/19/17 17:00	SM2340B	
Uranium	<0.0010	0.0010	mg/L	1	B7I1395	09/18/17 15:00	09/18/17 16:38	EPA 200.8	
Vanadium	<0.0070	0.0070	mg/L	1	B7I1381	09/18/17 10:33	09/18/17 12:38	EPA 200.7	

PHX 1790 (10606 W Hess) (7091361-01) Drinking Water (Grab) Sampled: 09/14/17 08:00 Received: 09/14/17 15:15

Legend Technical Services of Arizona, Inc.

Analyte	Result	PQL	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Inorganic Chemistry									
Total Alkalinity as CaCO3	**118**	10	mg/L	1	B7I1380	09/18/17 10:33	09/18/17 10:33	SM 2320 B	M2
Chloride	**380**	50.0	mg/L	10	B7I1377	09/15/17 09:07	09/15/17 09:07	EPA 300.0	D2
Fluoride	**0.72**	0.10	mg/L	1	B7I1456	09/19/17 16:52	09/19/17 16:52	SM 4500 F C	
Nitrate as N	<0.20	0.20	mg/L	1	[CALC]	09/19/17 09:43	09/19/17 09:43	Calculation	
Nitrate + Nitrite as N	<0.20	0.20	mg/L	1	B7I1386	09/19/17 09:43	09/19/17 09:43	SM 4500 NO3 F	
Nitrite as N	<0.10	0.10	mg/L	1	B7I1290	09/14/17 17:25	09/14/17 17:25	SM 4500 NO2 B	
Orthophosphate as P	<0.05	0.05	mg/L	1	B7I1342	09/15/17 16:35	09/15/17 16:35	SM 4500 P F	M1
Total Phosphorous	<0.05	0.05	mg/L	1	B7I1340	09/15/17 08:55	09/15/17 11:20	EPA 365.3	
Sulfate	**90.5**	50.0	mg/L	10	B7I1377	09/15/17 09:07	09/15/17 09:07	EPA 300.0	D2
Sulfide, total	<0.04	0.04	mg/L	1	B7I1367	09/16/17 12:45	09/16/17 12:45	HACH 8131	
Total Dissolved Solids	**808**	1	mg/L	1	B7I1392	09/18/17 16:00	09/18/17 16:00	SM 2540 C	
Total Organic Carbon	**2.03**	1.00	mg/L	1	B7I1401	09/15/17 14:43	09/15/17 14:43	SM 5310 C	
Total Suspended Solids	<1	1	mg/L	1	B7I1384	09/18/17 10:30	09/18/17 10:30	SM 2540 D	
Ultra Violet Absorption	**0.0207**	0.0090	cm-1	1	B7I1334	09/15/17 15:06	09/15/17 15:06	SM 5910 B	
Volatile Organic Compounds									
Bromodichloromethane	**0.0234**	0.0005	mg/L	1	B7I1302	09/15/17 10:00	09/15/17 12:09	EPA 524.2	
Bromoform	**0.0088**	0.0005	mg/L	1	B7I1302	09/15/17 10:00	09/15/17 12:09	EPA 524.2	
Chloroform	**0.0208**	0.0005	mg/L	1	B7I1302	09/15/17 10:00	09/15/17 12:09	EPA 524.2	
Dibromochloromethane	**0.0273**	0.0005	mg/L	1	B7I1302	09/15/17 10:00	09/15/17 12:09	EPA 524.2	
Total THMs	**0.0802**	0.0005	mg/L	1	B7I1302	09/15/17 10:00	09/15/17 12:09	EPA 524.2	
Surrogate: 1,2-Dichlorobenzene-d4		*110 %*	*70-130*		*B7I1302*	*09/15/17*	*09/15/17*	*EPA 524.2*	
Surrogate: 1,2-Dichloroethane-d4		*102 %*	*70-130*		*B7I1302*	*09/15/17*	*09/15/17*	*EPA 524.2*	
Surrogate: 4-Bromofluorobenzene		*84 %*	*70-130*		*B7I1302*	*09/15/17*	*09/15/17*	*EPA 524.2*	
Surrogate: Pentafluorobenzene		*109 %*	*70-130*		*B7I1302*	*09/15/17*	*09/15/17*	*EPA 524.2*	

PHX 1790 (10606 W Hess) (7091361-01) Drinking Water (Grab) Sampled: 09/14/17 08:00 Received: 09/14/17 15:15

Legend Technical Services of Arizona, Inc.

Analyte	Result	PQL	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Miscellaneous									
Langlier Index	**-0.786**	-5.00	N/A	1	B7I1496	09/20/17 15:32	09/20/17 15:32	Miscellaneous	

PHX 1790 (10606 W Hess) (7091361-01RE1) Drinking Water (Grab) Sampled: 09/14/17 08:00 Received: 09/14/17 15:15

Legend Technical Services of Arizona, Inc.

Analyte	Result	PQL	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Total Metals									
Chromium	**0.0060**	0.0050	mg/L	1	B7I1438	09/19/17 14:01	09/20/17 09:38	EPA 200.7	

PHX 1040 (10601 W Roma Ave) (7091361-02) Drinking Water (Grab) Sampled: 09/14/17 09:00 Received: 09/14/17 15:15

Legend Technical Services of Arizona, Inc.

Analyte	Result	PQL	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Field Readings									
pH	**6.82**		pH Units	1	B7J1202	09/14/17 09:00	09/14/17 09:00	Field	
Temperature	**32**		°C	1	B7J1202	09/14/17 09:00	09/14/17 09:00	Field	
Total Metals									
Aluminum	<0.20	0.20	mg/L	1	B7I1381	09/18/17 10:33	09/18/17 12:40	EPA 200.7	
Antimony	<0.0005	0.0005	mg/L	1	B7I1395	09/18/17 15:00	09/18/17 16:51	EPA 200.8	
Arsenic III	<0.0010	0.0010	mg/L	1	B7I1396	09/18/17 15:05	09/19/17 09:18	EPA 200.8	T6
Arsenic V	**0.0013**		mg/L	1	[CALC]	09/18/17 15:05	09/19/17 09:18	Calculation	
Arsenic	**0.0013**	0.0010	mg/L	1	B7I1395	09/18/17 15:00	09/18/17 16:51	EPA 200.8	
Cadmium	<0.0001	0.0001	mg/L	1	B7I1395	09/18/17 15:00	09/18/17 16:51	EPA 200.8	
Calcium	**55**	1.0	mg/L	1	B7I1438	09/19/17 14:01	09/19/17 17:15	EPA 200.7	
Chromium	<0.0050	0.0050	mg/L	1	B7I1381	09/18/17 10:33	09/18/17 12:40	EPA 200.7	
Iron	<0.050	0.050	mg/L	1	B7I1381	09/18/17 10:33	09/18/17 12:40	EPA 200.7	
Lead	<0.0010	0.0010	mg/L	1	B7I1395	09/18/17 15:00	09/18/17 16:51	EPA 200.8	
Magnesium	**21**	1.0	mg/L	1	B7I1381	09/18/17 10:33	09/18/17 12:40	EPA 200.7	
Manganese	<0.020	0.020	mg/L	1	B7I1381	09/18/17 10:33	09/18/17 12:40	EPA 200.7	
Molybdenum	<0.020	0.020	mg/L	1	B7I1381	09/18/17 10:33	09/18/17 12:40	EPA 200.7	
Selenium	**0.0025**	0.0020	mg/L	1	B7I1395	09/18/17 15:00	09/18/17 16:51	EPA 200.8	
Silica, Total	**13**	0.21	mg/L	1	[CALC]	09/18/17 10:33	09/18/17 12:40	EPA 200.7	
Silicon	**6.1**	0.10	mg/L	1	B7I1381	09/18/17 10:33	09/18/17 12:40	EPA 200.7	
Calcium Hardness as CaCO3	**140**	2.5	mg/L	1	[CALC]	09/19/17 14:01	09/19/17 17:15	SM2340B	
Magnesium Hardness as CaCO3	**86**	4.1	mg/L	1	[CALC]	09/19/17 14:01	09/18/17 12:40	SM2340B	
Total Hardness as CaCO3	**220**	4.1	mg/L	1	[CALC]	09/19/17 14:01	09/19/17 17:15	SM2340B	
Uranium	<0.0010	0.0010	mg/L	1	B7I1395	09/18/17 15:00	09/18/17 16:51	EPA 200.8	
Vanadium	<0.0070	0.0070	mg/L	1	B7I1381	09/18/17 10:33	09/18/17 12:40	EPA 200.7	

PHX 1040 (10601 W Roma Ave) (7091361-02) Drinking Water (Grab) Sampled: 09/14/17 09:00 Received: 09/14/17 15:15

Legend Technical Services of Arizona, Inc.

Analyte	Result	PQL	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Inorganic Chemistry									
Total Alkalinity as CaCO3	**116**	10	mg/L	1	B7I1380	09/18/17 10:33	09/18/17 10:33	SM 2320 B	
Chloride	**340**	50.0	mg/L	10	B7I1377	09/15/17 09:07	09/15/17 09:07	EPA 300.0	D2
Fluoride	**0.76**	0.10	mg/L	1	B7I1456	09/19/17 16:52	09/19/17 16:52	SM 4500 F C	
Nitrate as N	<0.20	0.20	mg/L	1	[CALC]	09/19/17 09:43	09/19/17 09:43	Calculation	
Nitrate + Nitrite as N	<0.20	0.20	mg/L	1	B7I1386	09/19/17 09:43	09/19/17 09:43	SM 4500 NO3 F	
Nitrite as N	<0.10	0.10	mg/L	1	B7I1290	09/14/17 17:25	09/14/17 17:25	SM 4500 NO2 B	
Orthophosphate as P	<0.05	0.05	mg/L	1	B7I1342	09/15/17 16:06	09/15/17 16:06	SM 4500 P F	
Total Phosphorous	<0.05	0.05	mg/L	1	B7I1340	09/15/17 08:55	09/15/17 11:20	EPA 365.3	M2
Sulfate	**107**	50.0	mg/L	10	B7I1377	09/15/17 09:07	09/15/17 09:07	EPA 300.0	D2
Sulfide, total	<0.04	0.04	mg/L	1	B7I1367	09/16/17 12:45	09/16/17 12:45	HACH 8131	
Total Dissolved Solids	**794**	1	mg/L	1	B7I1392	09/18/17 16:00	09/18/17 16:00	SM 2540 C	
Total Organic Carbon	**2.16**	1.00	mg/L	1	B7I1401	09/15/17 14:43	09/15/17 14:43	SM 5310 C	
Total Suspended Solids	**4**	1	mg/L	1	B7I1384	09/18/17 10:30	09/18/17 10:30	SM 2540 D	R9
Ultra Violet Absorption	**0.0205**	0.0090	cm-1	1	B7I1334	09/15/17 15:06	09/15/17 15:06	SM 5910 B	
Volatile Organic Compounds									
Bromodichloromethane	**0.0222**	0.0005	mg/L	1	B7I1302	09/15/17 10:00	09/15/17 14:13	EPA 524.2	
Bromoform	**0.0065**	0.0005	mg/L	1	B7I1302	09/15/17 10:00	09/15/17 14:13	EPA 524.2	
Chloroform	**0.0152**	0.0005	mg/L	1	B7I1302	09/15/17 10:00	09/15/17 14:13	EPA 524.2	
Dibromochloromethane	**0.0263**	0.0005	mg/L	1	B7I1302	09/15/17 10:00	09/15/17 14:13	EPA 524.2	
Total THMs	**0.0702**	0.0005	mg/L	1	B7I1302	09/15/17 10:00	09/15/17 14:13	EPA 524.2	
Surrogate: 1,2-Dichlorobenzene-d4		*112 %*		*70-130*	*B7I1302*	*09/15/17*	*09/15/17*	*EPA 524.2*	
Surrogate: 1,2-Dichloroethane-d4		*98 %*		*70-130*	*B7I1302*	*09/15/17*	*09/15/17*	*EPA 524.2*	
Surrogate: 4-Bromofluorobenzene		*81 %*		*70-130*	*B7I1302*	*09/15/17*	*09/15/17*	*EPA 524.2*	
Surrogate: Pentafluorobenzene		*108 %*		*70-130*	*B7I1302*	*09/15/17*	*09/15/17*	*EPA 524.2*	

PHX 1040 (10601 W Roma Ave) (7091361-02) Drinking Water (Grab) Sampled: 09/14/17 09:00 Received: 09/14/17 15:15

Legend Technical Services of Arizona, Inc.

Analyte	Result	PQL	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Miscellaneous									
Langlier Index	**-0.968**	-5.00	N/A	1	B7I1496	09/20/17 15:32	09/20/17 15:32	Miscellaneous	

PHX 1040 (10601 W Roma Ave) (7091361-02RE1) Drinking Water (Grab) Sampled: 09/14/17 09:00 Received: 09/14/17 15:15

Legend Technical Services of Arizona, Inc.

Analyte	Result	PQL	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Inorganic Chemistry									
Total Phosphorous	<0.05	0.05	mg/L	1	B7I1339	09/15/17 08:55	09/15/17 11:20	EPA 365.3	BQC, M2

Total Metals - Quality Control

Legend Technical Services of Arizona, Inc.

Batch B7I1381 - EPA 200.7

Blank (B7I1381-BLK1) *Prepared & Analyzed: 09/18/17*

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Aluminum	<0.20	0.20	mg/L							
Chromium	<0.0050	0.0050	mg/L							
Iron	<0.050	0.050	mg/L							
Magnesium	<1.0	1.0	mg/L							
Manganese	<0.020	0.020	mg/L							
Molybdenum	<0.020	0.020	mg/L							
Silicon	<0.10	0.10	mg/L							
Vanadium	<0.0070	0.0070	mg/L							

LCS (B7I1381-BS1) *Prepared & Analyzed: 09/18/17*

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Aluminum	2.1	0.20	mg/L	2.00		104	85-115			
Chromium	0.50	0.0050	mg/L	0.500		101	85-115			
Iron	1.0	0.050	mg/L	1.00		101	85-115			
Magnesium	20	1.0	mg/L	20.0		100	85-115			
Manganese	1.0	0.020	mg/L	1.00		100	85-115			
Molybdenum	0.20	0.020	mg/L	0.200		102	85-115			
Silicon	4.1	0.10	mg/L	4.00		103	85-115			
Vanadium	0.72	0.0070	mg/L	0.700		102	85-115			

LCS Dup (B7I1381-BSD1) *Prepared & Analyzed: 09/18/17*

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Aluminum	2.1	0.20	mg/L	2.00		104	85-115	0.4	20	
Chromium	0.50	0.0050	mg/L	0.500		101	85-115	0.08	20	
Iron	1.0	0.050	mg/L	1.00		101	85-115	0.2	20	
Magnesium	20	1.0	mg/L	20.0		100	85-115	0.2	20	
Manganese	1.0	0.020	mg/L	1.00		100	85-115	0.07	20	
Molybdenum	0.20	0.020	mg/L	0.200		102	85-115	0.5	20	
Silicon	4.1	0.10	mg/L	4.00		103	85-115	0.3	20	
Vanadium	0.72	0.0070	mg/L	0.700		102	85-115	0.04	20	

Total Metals - Quality Control

Legend Technical Services of Arizona, Inc.

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B7I1381 - EPA 200.7										
Matrix Spike (B7I1381-MS1)		**Source: 7090658-01**		*Prepared & Analyzed: 09/18/17*						
Aluminum	2.4	0.20	mg/L	2.00	0.25	106	70-130			
Chromium	0.50	0.0050	mg/L	0.500	0.0007	100	70-130			
Iron	1.0	0.050	mg/L	1.00	0.020	99	70-130			
Magnesium	32	1.0	mg/L	20.0	12	101	70-130			
Manganese	0.99	0.020	mg/L	1.00	0.0022	99	70-130			
Molybdenum	0.20	0.020	mg/L	0.200	<0.020	101	70-130			
Silicon	14	0.10	mg/L	4.00	10	101	70-130			
Vanadium	0.72	0.0070	mg/L	0.700	0.0060	102	70-130			
Matrix Spike (B7I1381-MS2)		**Source: 7091091-01**		*Prepared & Analyzed: 09/18/17*						
Aluminum	2.1	0.20	mg/L	2.00	0.018	105	70-130			
Chromium	0.49	0.0050	mg/L	0.500	0.0008	98	70-130			
Iron	1.0	0.050	mg/L	1.00	0.031	97	70-130			
Magnesium	59	1.0	mg/L	20.0	39	100	70-130			
Manganese	0.96	0.020	mg/L	1.00	0.0005	96	70-130			
Molybdenum	0.20	0.020	mg/L	0.200	<0.020	100	70-130			
Silicon	13	0.10	mg/L	4.00	8.9	101	70-130			
Vanadium	0.71	0.0070	mg/L	0.700	0.0070	100	70-130			
Matrix Spike Dup (B7I1381-MSD1)		**Source: 7090658-01**		*Prepared & Analyzed: 09/18/17*						
Aluminum	2.4	0.20	mg/L	2.00	0.25	106	70-130	0.06	20	
Chromium	0.50	0.0050	mg/L	0.500	0.0007	99	70-130	0.4	20	
Iron	1.0	0.050	mg/L	1.00	0.020	99	70-130	0.01	20	
Magnesium	32	1.0	mg/L	20.0	12	100	70-130	0.3	20	
Manganese	0.99	0.020	mg/L	1.00	0.0022	98	70-130	0.5	20	
Molybdenum	0.20	0.020	mg/L	0.200	<0.020	101	70-130	0.5	20	
Silicon	14	0.10	mg/L	4.00	10	101	70-130	0.1	20	
Vanadium	0.72	0.0070	mg/L	0.700	0.0060	102	70-130	0.2	20	

Total Metals - Quality Control

Legend Technical Services of Arizona, Inc.

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B7I1381 - EPA 200.7										
Matrix Spike Dup (B7I1381-MSD2)	**Source: 7091091-01**			*Prepared & Analyzed: 09/18/17*						
Aluminum	2.1	0.20	mg/L	2.00	0.018	105	70-130	0.03	20	
Chromium	0.49	0.0050	mg/L	0.500	0.0008	98	70-130	0.02	20	
Iron	1.0	0.050	mg/L	1.00	0.031	97	70-130	0.2	20	
Magnesium	59	1.0	mg/L	20.0	39	100	70-130	0.2	20	
Manganese	0.96	0.020	mg/L	1.00	0.0005	96	70-130	0.03	20	
Molybdenum	0.20	0.020	mg/L	0.200	<0.020	100	70-130	0.6	20	
Silicon	13	0.10	mg/L	4.00	8.9	101	70-130	0.03	20	
Vanadium	0.71	0.0070	mg/L	0.700	0.0070	101	70-130	0.1	20	
Batch B7I1395 - EPA 200.8										
Blank (B7I1395-BLK1)				*Prepared & Analyzed: 09/18/17*						
Antimony	<0.0005	0.0005	mg/L							
Arsenic	<0.0010	0.0010	mg/L							
Cadmium	<0.0001	0.0001	mg/L							
Lead	<0.0010	0.0010	mg/L							
Selenium	<0.0020	0.0020	mg/L							
Uranium	<0.0010	0.0010	mg/L							
LCS (B7I1395-BS1)				*Prepared & Analyzed: 09/18/17*						
Antimony	0.026	0.0005	mg/L	0.0250		103	85-115			
Arsenic	0.026	0.0010	mg/L	0.0250		103	85-115			
Cadmium	0.026	0.0001	mg/L	0.0250		103	85-115			
Lead	0.026	0.0010	mg/L	0.0250		103	85-115			
Selenium	0.025	0.0020	mg/L	0.0250		100	85-115			
Uranium	0.027	0.0010	mg/L	0.0250		108	85-115			

Total Metals - Quality Control

Legend Technical Services of Arizona, Inc.

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B7I1395 - EPA 200.8										
LCS Dup (B7I1395-BSD1)				*Prepared & Analyzed: 09/18/17*						
Antimony	0.026	0.0005	mg/L	0.0250		106	85-115	2	20	
Arsenic	0.026	0.0010	mg/L	0.0250		102	85-115	1	20	
Cadmium	0.026	0.0001	mg/L	0.0250		103	85-115	0.4	20	
Lead	0.025	0.0010	mg/L	0.0250		101	85-115	3	20	
Selenium	0.025	0.0020	mg/L	0.0250		100	85-115	0.3	20	
Uranium	0.027	0.0010	mg/L	0.0250		107	85-115	1	20	
Matrix Spike (B7I1395-MS1)		**Source: 7091361-01**		*Prepared & Analyzed: 09/18/17*						
Antimony	0.027	0.0005	mg/L	0.0250	0.0001	109	70-130			
Arsenic	0.029	0.0010	mg/L	0.0250	0.0013	113	70-130			
Cadmium	0.025	0.0001	mg/L	0.0250	<0.0001	100	70-130			
Lead	0.026	0.0010	mg/L	0.0250	0.0003	104	70-130			
Selenium	0.029	0.0020	mg/L	0.0250	0.0027	107	70-130			
Uranium	0.030	0.0010	mg/L	0.0250	0.0008	115	70-130			
Matrix Spike Dup (B7I1395-MSD1)		**Source: 7091361-01**		*Prepared & Analyzed: 09/18/17*						
Antimony	0.027	0.0005	mg/L	0.0250	0.0001	108	70-130	1	20	
Arsenic	0.030	0.0010	mg/L	0.0250	0.0013	116	70-130	3	20	
Cadmium	0.025	0.0001	mg/L	0.0250	<0.0001	99	70-130	1	20	
Lead	0.027	0.0010	mg/L	0.0250	0.0003	106	70-130	2	20	
Selenium	0.030	0.0020	mg/L	0.0250	0.0027	108	70-130	1	20	
Uranium	0.030	0.0010	mg/L	0.0250	0.0008	118	70-130	2	20	
Batch B7I1438 - EPA 200.7										
Blank (B7I1438-BLK1)				*Prepared & Analyzed: 09/19/17*						
Calcium	<1.0	1.0	mg/L							
Chromium	<0.0050	0.0050	mg/L							

Total Metals - Quality Control

Legend Technical Services of Arizona, Inc.

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B7I1438 - EPA 200.7										
LCS (B7I1438-BS1)				*Prepared & Analyzed: 09/19/17*						
Calcium	20	1.0	mg/L	20.0		100	85-115			
Chromium	0.50	0.0050	mg/L	0.500		100	85-115			
LCS Dup (B7I1438-BSD1)				*Prepared & Analyzed: 09/19/17*						
Calcium	20	1.0	mg/L	20.0		99	85-115	0.8	20	
Chromium	0.50	0.0050	mg/L	0.500		100	85-115	0.5	20	
Matrix Spike (B7I1438-MS1)	**Source: 7091361-01RE1**			*Prepared & Analyzed: 09/19/17*						
Calcium	70	1.0	mg/L	20.0	53	85	70-130			
Chromium	0.49	0.0050	mg/L	0.500	0.0060	97	70-130			
Matrix Spike Dup (B7I1438-MSD1)	**Source: 7091361-01RE1**			*Prepared & Analyzed: 09/19/17*						
Calcium	72	1.0	mg/L	20.0	53	95	70-130	3	20	
Chromium	0.50	0.0050	mg/L	0.500	0.0060	99	70-130	3	20	

Inorganic Chemistry - Quality Control

Legend Technical Services of Arizona, Inc.

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B7I1290 - NO PREP										
Blank (B7I1290-BLK1)				*Prepared & Analyzed: 09/14/17*						
Nitrite as N	<0.10	0.10	mg/L							
Blank (B7I1290-BLK2)				*Prepared & Analyzed: 09/14/17*						
Nitrite as N	<0.10	0.10	mg/L							
LCS (B7I1290-BS1)				*Prepared & Analyzed: 09/14/17*						
Nitrite as N	0.216	0.10	mg/L	0.200		108	80-120			
LCS Dup (B7I1290-BSD1)				*Prepared & Analyzed: 09/14/17*						
Nitrite as N	0.215	0.10	mg/L	0.200		108	80-120	0.5	20	
Matrix Spike (B7I1290-MS1)	**Source: 7091127-02**			*Prepared & Analyzed: 09/14/17*						
Nitrite as N	0.217	0.10	mg/L	0.200	<0.10	108	80-120			
Matrix Spike (B7I1290-MS2)	**Source: 7091290-01**			*Prepared & Analyzed: 09/14/17*						
Nitrite as N	0.099	0.10	mg/L	0.200	<0.10	50	80-120			M2
Matrix Spike Dup (B7I1290-MSD1)	**Source: 7091127-02**			*Prepared & Analyzed: 09/14/17*						
Nitrite as N	0.217	0.10	mg/L	0.200	<0.10	108	80-120	0	20	
Matrix Spike Dup (B7I1290-MSD2)	**Source: 7091290-01**			*Prepared & Analyzed: 09/14/17*						
Nitrite as N	0.099	0.10	mg/L	0.200	<0.10	50	80-120	0	20	M2
Batch B7I1334 - NO PREP										
Blank (B7I1334-BLK1)				*Prepared & Analyzed: 09/15/17*						
Ultra Violet Absorption	<0.0090	0.0090	cm-1							

Inorganic Chemistry - Quality Control

Legend Technical Services of Arizona, Inc.

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B7I1334 - NO PREP										
Duplicate (B7I1334-DUP1)		**Source: 7091361-02**		*Prepared & Analyzed: 09/15/17*						
Ultra Violet Absorption	0.0218	0.0090	cm-1		0.0205			6	20	
Batch B7I1339 - NO PREP										
Blank (B7I1339-BLK1)				*Prepared & Analyzed: 09/15/17*						
Total Phosphorous	<0.05	0.05	mg/L							
LCS (B7I1339-BS1)				*Prepared & Analyzed: 09/15/17*						
Total Phosphorous	0.10	0.05	mg/L	0.100		96	90-110			
LCS Dup (B7I1339-BSD1)				*Prepared & Analyzed: 09/15/17*						
Total Phosphorous	0.10	0.05	mg/L	0.100		97	90-110	0.8	20	
Matrix Spike (B7I1339-MS1)		**Source: 7091361-02**		*Prepared & Analyzed: 09/15/17*						
Total Phosphorous	0.05	0.05	mg/L	0.100	<0.05	48	90-110			M2
Matrix Spike Dup (B7I1339-MSD1)		**Source: 7091361-02**		*Prepared & Analyzed: 09/15/17*						
Total Phosphorous	0.05	0.05	mg/L	0.100	<0.05	49	90-110	2	20	M2
Batch B7I1340 - NO PREP										
Blank (B7I1340-BLK1)				*Prepared & Analyzed: 09/15/17*						
Total Phosphorous	<0.05	0.05	mg/L							
LCS (B7I1340-BS1)				*Prepared & Analyzed: 09/15/17*						
Total Phosphorous	0.10	0.05	mg/L	0.100		96	90-110			

Inorganic Chemistry - Quality Control

Legend Technical Services of Arizona, Inc.

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B7I1340 - NO PREP										
LCS Dup (B7I1340-BSD1)				*Prepared & Analyzed: 09/15/17*						
Total Phosphorous	0.10	0.05	mg/L	0.100		97	90-110	0.8	20	
Matrix Spike (B7I1340-MS1)	**Source: 7091361-02**			*Prepared & Analyzed: 09/15/17*						
Total Phosphorous	0.05	0.05	mg/L	0.100	<0.05	48	90-110			M2
Matrix Spike Dup (B7I1340-MSD1)	**Source: 7091361-02**			*Prepared & Analyzed: 09/15/17*						
Total Phosphorous	0.05	0.05	mg/L	0.100	<0.05	49	90-110	2	20	M2
Batch B7I1342 - NO PREP										
Blank (B7I1342-BLK1)				*Prepared & Analyzed: 09/15/17*						
Orthophosphate as P	<0.05	0.05	mg/L							
LCS (B7I1342-BS1)				*Prepared & Analyzed: 09/15/17*						
Orthophosphate as P	0.20	0.05	mg/L	0.200		100	90-110			
LCS Dup (B7I1342-BSD1)				*Prepared & Analyzed: 09/15/17*						
Orthophosphate as P	0.20	0.05	mg/L	0.200		100	90-110	0	20	
Matrix Spike (B7I1342-MS1)	**Source: 7091361-01**			*Prepared & Analyzed: 09/15/17*						
Orthophosphate as P	0.27	0.05	mg/L	0.200	<0.05	136	80-120			M1
Matrix Spike Dup (B7I1342-MSD1)	**Source: 7091361-01**			*Prepared & Analyzed: 09/15/17*						
Orthophosphate as P	0.24	0.05	mg/L	0.200	<0.05	122	80-120	11	20	M1
Batch B7I1367 - NO PREP										
Blank (B7I1367-BLK1)				*Prepared & Analyzed: 09/16/17*						
Sulfide, total	<0.04	0.04	mg/L							

Inorganic Chemistry - Quality Control

Legend Technical Services of Arizona, Inc.

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B7I1367 - NO PREP										
LCS (B7I1367-BS1)				*Prepared & Analyzed: 09/16/17*						
Sulfide, total	0.11	0.04	mg/L	0.121		94	80-120			
LCS Dup (B7I1367-BSD1)				*Prepared & Analyzed: 09/16/17*						
Sulfide, total	0.12	0.04	mg/L	0.121		100	80-120	7	20	
Matrix Spike (B7I1367-MS1)	**Source: 7091040-01**			*Prepared & Analyzed: 09/16/17*						
Sulfide, total	0.02	0.04	mg/L	0.121	<0.04	15	80-120			M2
Matrix Spike Dup (B7I1367-MSD1)	**Source: 7091040-01**			*Prepared & Analyzed: 09/16/17*						
Sulfide, total	0.01	0.04	mg/L	0.121	<0.04	10	80-120	40	20	M2
Batch B7I1377 - NO PREP										
Blank (B7I1377-BLK1)				*Prepared & Analyzed: 09/15/17*						
Chloride	<5.0	5.0	mg/L							
Sulfate	<5.0	5.0	mg/L							
Blank (B7I1377-BLK2)				*Prepared & Analyzed: 09/15/17*						
Chloride	<5.0	5.0	mg/L							
Sulfate	<5.0	5.0	mg/L							
Blank (B7I1377-BLK3)				*Prepared & Analyzed: 09/15/17*						
Chloride	<5.0	5.0	mg/L							
Sulfate	<5.0	5.0	mg/L							
LCS (B7I1377-BS1)				*Prepared & Analyzed: 09/15/17*						
Chloride	10.1	5.0	mg/L	10.0		101	90-110			
Sulfate	20.5	5.0	mg/L	20.0		102	90-110			

Inorganic Chemistry - Quality Control

Legend Technical Services of Arizona, Inc.

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B7I1377 - NO PREP										
LCS Dup (B7I1377-BSD1)				*Prepared & Analyzed: 09/15/17*						
Chloride	10.0	5.0	mg/L	10.0		100	90-110	1	20	
Sulfate	19.9	5.0	mg/L	20.0		100	90-110	3	20	
Matrix Spike (B7I1377-MS1)	**Source: 7090485-01**			*Prepared & Analyzed: 09/15/17*						
Chloride	24.4	5.0	mg/L	10.0	14.5	99	90-110			
Sulfate	28.5	5.0	mg/L	20.0	8.2	102	90-110			
Matrix Spike (B7I1377-MS2)	**Source: 7090485-04**			*Prepared & Analyzed: 09/15/17*						
Chloride	29.8	5.0	mg/L	10.0	19.8	100	90-110			
Sulfate	42.2	5.0	mg/L	20.0	21.3	104	90-110			
Matrix Spike (B7I1377-MS3)	**Source: 7091377-02**			*Prepared & Analyzed: 09/15/17*						
Chloride	12.2	5.0	mg/L	10.0	2.0	102	90-110			
Sulfate	20.6	5.0	mg/L	20.0	<5.0	103	90-110			
Matrix Spike Dup (B7I1377-MSD1)	**Source: 7090485-01**			*Prepared & Analyzed: 09/15/17*						
Chloride	24.8	5.0	mg/L	10.0	14.5	103	90-110	2	20	
Sulfate	28.8	5.0	mg/L	20.0	8.2	103	90-110	1	20	
Matrix Spike Dup (B7I1377-MSD2)	**Source: 7090485-04**			*Prepared & Analyzed: 09/15/17*						
Chloride	29.6	5.0	mg/L	10.0	19.8	98	90-110	0.7	20	
Sulfate	41.6	5.0	mg/L	20.0	21.3	102	90-110	1	20	
Matrix Spike Dup (B7I1377-MSD3)	**Source: 7091377-02**			*Prepared & Analyzed: 09/15/17*						
Chloride	12.1	5.0	mg/L	10.0	2.0	101	90-110	0.8	20	
Sulfate	20.5	5.0	mg/L	20.0	<5.0	102	90-110	0.5	20	

Inorganic Chemistry - Quality Control

Legend Technical Services of Arizona, Inc.

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B7I1380 - NO PREP										
Blank (B7I1380-BLK1)				*Prepared & Analyzed: 09/18/17*						
Total Alkalinity as CaCO3	<10	10	mg/L							
Blank (B7I1380-BLK2)				*Prepared & Analyzed: 09/18/17*						
Total Alkalinity as CaCO3	<10	10	mg/L							
LCS (B7I1380-BS1)				*Prepared & Analyzed: 09/18/17*						
Total Alkalinity as CaCO3	192	10	mg/L	200		96	80-120			
LCS Dup (B7I1380-BSD1)				*Prepared & Analyzed: 09/18/17*						
Total Alkalinity as CaCO3	194	10	mg/L	200		97	80-120	0.9	20	
Matrix Spike (B7I1380-MS1)	**Source: 7091361-01**			*Prepared & Analyzed: 09/18/17*						
Total Alkalinity as CaCO3	293	10	mg/L	200	118	88	80-120			
Matrix Spike (B7I1380-MS2)	**Source: 7091424-01**			*Prepared & Analyzed: 09/18/17*						
Total Alkalinity as CaCO3	230	10	mg/L	200	46	92	80-120			
Matrix Spike Dup (B7I1380-MSD1)	**Source: 7091361-01**			*Prepared & Analyzed: 09/18/17*						
Total Alkalinity as CaCO3	255	10	mg/L	200	118	69	80-120	14	20	M2
Matrix Spike Dup (B7I1380-MSD2)	**Source: 7091424-01**			*Prepared & Analyzed: 09/18/17*						
Total Alkalinity as CaCO3	233	10	mg/L	200	46	93	80-120	1	20	
Batch B7I1384 - NO PREP										
Blank (B7I1384-BLK1)				*Prepared & Analyzed: 09/18/17*						
Total Suspended Solids	<1	1	mg/L							

Inorganic Chemistry - Quality Control

Legend Technical Services of Arizona, Inc.

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B7I1384 - NO PREP										
Duplicate (B7I1384-DUP1)	**Source: 7091361-02**			*Prepared & Analyzed: 09/18/17*						
Total Suspended Solids	<1	1	mg/L		4			200	5	R9
Batch B7I1386 - NO PREP										
Blank (B7I1386-BLK1)				*Prepared & Analyzed: 09/19/17*						
Nitrate + Nitrite as N	<0.20	0.20	mg/L							
Blank (B7I1386-BLK2)				*Prepared & Analyzed: 09/19/17*						
Nitrate + Nitrite as N	<0.20	0.20	mg/L							
Blank (B7I1386-BLK3)				*Prepared & Analyzed: 09/19/17*						
Nitrate + Nitrite as N	<0.20	0.20	mg/L							
Blank (B7I1386-BLK4)				*Prepared & Analyzed: 09/19/17*						
Nitrate + Nitrite as N	<0.20	0.20	mg/L							
Blank (B7I1386-BLK5)				*Prepared & Analyzed: 09/19/17*						
Nitrate + Nitrite as N	<0.20	0.20	mg/L							
LCS (B7I1386-BS1)				*Prepared & Analyzed: 09/19/17*						
Nitrate + Nitrite as N	10.1	0.20	mg/L	10.0		101	90-110			
LCS (B7I1386-BS2)				*Prepared & Analyzed: 09/19/17*						
Nitrate + Nitrite as N	10.2	0.20	mg/L	10.0		102	90-110			
LCS (B7I1386-BS3)				*Prepared & Analyzed: 09/19/17*						
Nitrate + Nitrite as N	10.1	0.20	mg/L	10.0		101	90-110			

Inorganic Chemistry - Quality Control

Legend Technical Services of Arizona, Inc.

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B7I1386 - NO PREP										
LCS Dup (B7I1386-BSD1)				*Prepared & Analyzed: 09/19/17*						
Nitrate + Nitrite as N	10.0	0.20	mg/L	10.0		100	90-110	1	20	
LCS Dup (B7I1386-BSD2)				*Prepared & Analyzed: 09/19/17*						
Nitrate + Nitrite as N	10.2	0.20	mg/L	10.0		102	90-110	0	20	
LCS Dup (B7I1386-BSD3)				*Prepared & Analyzed: 09/19/17*						
Nitrate + Nitrite as N	10.1	0.20	mg/L	10.0		101	90-110	0	20	
Matrix Spike (B7I1386-MS1)	**Source: 7091280-01**			*Prepared & Analyzed: 09/19/17*						
Nitrate + Nitrite as N	10.4	0.20	mg/L	10.0	0.07	103	80-120			
Matrix Spike (B7I1386-MS2)	**Source: 7091362-01**			*Prepared & Analyzed: 09/19/17*						
Nitrate + Nitrite as N	14.5	0.20	mg/L	10.0	3.91	106	80-120			
Matrix Spike (B7I1386-MS3)	**Source: 7091519-01**			*Prepared & Analyzed: 09/19/17*						
Nitrate + Nitrite as N	121	2.00	mg/L	100	15.0	106	80-120			D2
Matrix Spike (B7I1386-MS4)	**Source: 7091577-03**			*Prepared & Analyzed: 09/19/17*						
Nitrate + Nitrite as N	11.5	0.20	mg/L	10.0	1.15	104	80-120			
Matrix Spike (B7I1386-MS5)	**Source: 7091586-02**			*Prepared & Analyzed: 09/19/17*						
Nitrate + Nitrite as N	11.5	0.20	mg/L	10.0	1.08	104	80-120			
Matrix Spike Dup (B7I1386-MSD1)	**Source: 7091280-01**			*Prepared & Analyzed: 09/19/17*						
Nitrate + Nitrite as N	10.4	0.20	mg/L	10.0	0.07	103	80-120	0	20	
Matrix Spike Dup (B7I1386-MSD2)	**Source: 7091362-01**			*Prepared & Analyzed: 09/19/17*						
Nitrate + Nitrite as N	14.4	0.20	mg/L	10.0	3.91	105	80-120	0.7	20	

Inorganic Chemistry - Quality Control

Legend Technical Services of Arizona, Inc.

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B7I1386 - NO PREP										
Matrix Spike Dup (B7I1386-MSD3)	**Source: 7091519-01**			*Prepared & Analyzed: 09/19/17*						
Nitrate + Nitrite as N	121	2.00	mg/L	100	15.0	106	80-120	0	20	D2
Matrix Spike Dup (B7I1386-MSD4)	**Source: 7091577-03**			*Prepared & Analyzed: 09/19/17*						
Nitrate + Nitrite as N	11.4	0.20	mg/L	10.0	1.15	102	80-120	0.9	20	
Matrix Spike Dup (B7I1386-MSD5)	**Source: 7091586-02**			*Prepared & Analyzed: 09/19/17*						
Nitrate + Nitrite as N	11.6	0.20	mg/L	10.0	1.08	105	80-120	0.9	20	
Batch B7I1392 - NO PREP										
Blank (B7I1392-BLK1)				*Prepared & Analyzed: 09/18/17*						
Total Dissolved Solids	<1	1	mg/L							
Duplicate (B7I1392-DUP1)	**Source: 7090936-01**			*Prepared & Analyzed: 09/18/17*						
Total Dissolved Solids	586	1	mg/L		582			0.7	5	
Duplicate (B7I1392-DUP2)	**Source: 7091040-05**			*Prepared & Analyzed: 09/18/17*						
Total Dissolved Solids	650	1	mg/L		644			0.9	5	
Batch B7I1401 - NO PREP										
Blank (B7I1401-BLK1)				*Prepared & Analyzed: 09/15/17*						
Total Organic Carbon	<1.00	1.00	mg/L							
LCS (B7I1401-BS1)				*Prepared & Analyzed: 09/15/17*						
Total Organic Carbon	9.74	1.00	mg/L	10.0		97	80-120			

Inorganic Chemistry - Quality Control

Legend Technical Services of Arizona, Inc.

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B7I1401 - NO PREP										
LCS Dup (B7I1401-BSD1)				*Prepared & Analyzed: 09/15/17*						
Total Organic Carbon	9.75	1.00	mg/L	10.0		98	80-120	0.1	20	
Matrix Spike (B7I1401-MS1)	**Source: 7091040-03**			*Prepared & Analyzed: 09/15/17*						
Total Organic Carbon	9.81	1.00	mg/L	10.0	0.125	97	80-120			
Matrix Spike (B7I1401-MS2)	**Source: 7091074-01**			*Prepared & Analyzed: 09/15/17*						
Total Organic Carbon	12.8	1.00	mg/L	10.0	2.96	98	80-120			
Matrix Spike Dup (B7I1401-MSD1)	**Source: 7091040-03**			*Prepared & Analyzed: 09/15/17*						
Total Organic Carbon	9.81	1.00	mg/L	10.0	0.125	97	80-120	0	20	
Matrix Spike Dup (B7I1401-MSD2)	**Source: 7091074-01**			*Prepared & Analyzed: 09/15/17*						
Total Organic Carbon	12.7	1.00	mg/L	10.0	2.96	97	80-120	0.8	20	
Batch B7I1456 - NO PREP										
Blank (B7I1456-BLK1)				*Prepared & Analyzed: 09/19/17*						
Fluoride	<0.10	0.10	mg/L							
LCS (B7I1456-BS1)				*Prepared & Analyzed: 09/19/17*						
Fluoride	1.98	0.10	mg/L	2.00		99	90-110			
LCS Dup (B7I1456-BSD1)				*Prepared & Analyzed: 09/19/17*						
Fluoride	1.96	0.10	mg/L	2.00		98	90-110	0.9	20	
Matrix Spike (B7I1456-MS1)	**Source: 7091361-01**			*Prepared & Analyzed: 09/19/17*						
Fluoride	2.69	0.10	mg/L	2.00	0.72	99	90-110			

Inorganic Chemistry - Quality Control

Legend Technical Services of Arizona, Inc.

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B7I1456 - NO PREP										
Matrix Spike Dup (B7I1456-MSD1)	**Source: 7091361-01**		*Prepared & Analyzed: 09/19/17*							
Fluoride	2.72	0.10	mg/L	2.00	0.72	100	90-110	1	20	

Volatile Organic Compounds - Quality Control

Legend Technical Services of Arizona, Inc.

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B7I1302 - Default Prep VOC										
Blank (B7I1302-BLK1)				*Prepared & Analyzed: 09/15/17*						
Bromodichloromethane	<0.0005	0.0005	mg/L							
Bromoform	<0.0005	0.0005	mg/L							
Chloroform	<0.0005	0.0005	mg/L							
Dibromochloromethane	<0.0005	0.0005	mg/L							
Total THMs	<0.0005	0.0005	mg/L							
LCS (B7I1302-BS1)				*Prepared & Analyzed: 09/15/17*						
Bromodichloromethane	0.0021	0.0005	mg/L	0.00200		103	70-130			
Bromoform	0.0022	0.0005	mg/L	0.00200		112	70-130			
Chloroform	0.0021	0.0005	mg/L	0.00200		103	70-130			
Dibromochloromethane	0.0022	0.0005	mg/L	0.00200		108	70-130			
Total THMs	0.0085	0.0005	mg/L	0.00800		106	0-200			
LCS Dup (B7I1302-BSD1)				*Prepared & Analyzed: 09/15/17*						
Bromodichloromethane	0.0021	0.0005	mg/L	0.00200		103	70-130	0	20	
Bromoform	0.0023	0.0005	mg/L	0.00200		116	70-130	4	20	
Chloroform	0.0021	0.0005	mg/L	0.00200		104	70-130	0.5	20	
Dibromochloromethane	0.0022	0.0005	mg/L	0.00200		111	70-130	3	20	
Total THMs	0.0087	0.0005	mg/L	0.00800		108	0-200	2	200	

Notes and Definitions

T6	The reported result cannot be used for compliance purposes.
R9	Sample RPD exceeded the laboratory acceptance limit.
M2	Matrix spike recovery was low; the associated blank spike recovery was acceptable.
M1	Matrix spike recovery was high; the method control sample recovery was acceptable.
D2	Sample required dilution due to high concentration of target analyte.
BQC	Quality Control results provided as batch QC only. See final results from actual batch number listed with the analytical report.
BLK	Method Blank
LCS/Dup	Laboratory Control Sample/Laboratory Fortified Blank/Duplicate
MS/Dup	Matrix Spike/Duplicate
Dry	Sample results reported on a dry weight basis
RPD	Relative Percent Difference

Laboratory Sample ID: 7091361 mw 9/14/17

CHAIN OF CUSTODY RECORD

LEGEND Technical Services, Inc.

☒ 17631 N. 25th Avenue • Phoenix, AZ 85023 • (602) 324-6100 • Fax (602) 324-6101
☐ 4585 S. Palo Verde Rd. Ste 423 • Tucson, AZ 85714 • (520) 327-1234 • Fax (520) 327-0511

Please Print Clearly

Page 1 of 1

CLIENT INFORMATION

Client Name	Address	City	State	Zip	Phone	Fax or Email
City of Avondale DW	399 E. Lower Buckeye Rd. Ste. 100	Avondale	AZ	85323	623-333-4457	dallred@avondale.org

System Name	PWS#	Contact	P.O. No.	
Water Quality Samples	07-088	David Allred		Fax Results ☐ QC Report ☐ EDD ☒ Email Results ☒ Special Detection Limits ☐

IOC OPTIONS: 5-day RUSH

REQUESTED ANALYSES

Client's Sample Identification	Date	Time	POE # / DWR #	Compliance	No. of Containers	pH ✓ (Legend Use)	524 THM	Metals*	Arsenic V	Chloride	Fluoride	Langlier Index**	NO3, NO2	Orho Phos	Total Phos	Sulfate	Sulfide	TOC	TSS	UV 254	LAB NO.
PHX 1790	9.14.17	0800	10606 W. HESS		13	✓	x	x	x	x	x	x	x	x	x	x	x	x	x	x	-01
PHX 1040	9.14.17	0900	10601 W. ROMA AVE.		13	✓	x	x	x	x	x	x	x	x	x	x	x	x	x	x	-02
					~~13~~		~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	-03
					~~13~~		~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	-04
					~~13~~		~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	-05
					~~13~~		~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	-06
					~~13~~		~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	-07

RUSH 9/21/17

CORRECTION MADE BY CLIENT OR COURIER PRIOR TO SAMPLE RECEIPT AT LEGEND mw 9/14/17

TO ENSURE COMPLETION OF ANALYSIS, SAMPLES MUST BE RECEIVED AT LEAST 6 HOURS PRIOR TO THE HOLD TIME EXPIRATION

Comments: *Metals= Al, Sb, Cd, Cr, Fe, Pb, Mg, Mn, Mo, Se, Si, Total Hardness, U, V
**Langlier Index= Ca, pH, TDS, Alk

☐ Yes, I have followed the instructions provided by the laboratory for dechlorination of my samples.

TURN AROUND TIME
☐ Standard 15 - 20 day
☐ Other____
Laboratory Authorization Required for Rush

SAMPLE CONDITION UPON RECEIPT

No. of Containers	26
Temperature	3.7 °C
Custody Seals	Y (N)
Seals Intact	Y N
Preserved	(Y) N

White- Lab Yellow- Client
FORM GEN-173 (6/06)

	RELINQUISHED BY	Date / Time	SAMPLES RECEIVED BY	Date / Time
①	Sampler Signature: [signature] Sampler Printed Name: David Allred	Date 9.14.17 Time 1330	Signature: [signature] Printed Name: Evan Northrup	Date 9-14-17 Time 1330
②	Sampler Signature: Sampler Printed Name:	Date Time	Signature: Printed Name: @ Lab 1515	Date Time
③	Sampler Signature: Sampler Printed Name:	Date Time	Signature: Printed Name:	Date Time

5- day 9/19 end of day 7091360 / mw 9/14/17

RUSH NOTICE W.O. #: 7091040

*** Only verbal or preliminary results can be guaranteed on RUSHES

*****If sample(s) does not come in on day indicated by client, RUSH may not be available.

Company: City of Avondale Phone: ______

Contact: David Allred

Prelim Due Date: 9/19/17 end of day Final Due Date: ______

Analysis:
524 THM, Chloride, Fluoride, pH, TDS, Alk, NO3+NO2, NO2, OP
Arsenic Speciation, Langlier Index, Total Phos, SO4, Sulfide, TOC, TSS, UV 254

Number of Samples: (x 7) Date Samples Expected*****: 9/12/17

Matrix: DW Expiration Date: ______

Supervisor Approval

Al, Sb, Cd, Cr, Fe, Pb, Mg, Mn, Mo, Se, Si, Hardness, U, V
Langlier Index
Arsenic Speciation

Inorganics:	9/7/17	Specifics:	
Metals:	9/7/17	Specifics:	
Micro:		Specifics:	
SOC:		Specifics:	
VOC:	9/7/17	Specifics:	
Sub1:		Specifics:	
Sub2:		Specifics:	

Comments:
project = "Water Quality Samples"

COST: ______

Project Manager: Lisa

RUSH Initiator: Lisa

FORM CS-012 (02/15)

Site 1040- 10601 W. Roma Avenue

Lab ID	Sample Date/Time	Sample location	Field pH S.U.	Field Chlorine mg/L	Field Temp C	Field Turbidity NTU
2012000257	1/3/2012 11:28	1040		0.72	17.9	0.31
2012000724	1/5/2012 9:35	1040	8.02	0.93	16.7	0.38
2012002580	1/12/2012 10:15	1040		0.79	17.4	0.44
2012002654	1/19/2012 9:40	1040	8.30	0.95	15.5	0.32
2012005128	1/31/2012 10:20	1040	8.00	1.00	16.5	0.43
2012005532	1/25/2012 9:45	1040		1.00	17.6	0.38
2012007156	2/1/2012 12:35	1040		0.81	17.7	0.47
2012008444	2/7/2012 10:50	1040		0.68	17.8	0.38
2012008641	2/14/2012 9:25	1040	8.24	1.00	15.6	0.38
2012010389	2/15/2012 9:55	1040		0.86	17.9	0.17
2012011775	2/22/2012 10:00	1040		0.88	18.3	0.40
2012011894	2/29/2012 9:45	1040	8.04	0.86	18	0.40
2012013642	3/1/2012 10:37	1040		0.66	18.8	0.20
2012014991	3/7/2012 9:40	1040		0.67	17.5	0.47
2012015536	3/15/2012 9:15	1040	7.88	0.94	19	0.57
2012017444	3/27/2012 9:45	1040	7.97	0.93	20.2	0.63
2012018091	3/20/2012 10:05	1040		0.76	19.7	0.36
2012020918	4/11/2012 9:25	1040	7.92	0.52	21.8	0.22
2012021064	4/4/2012 10:46	1040		0.50	22	0.19
2012023556	4/16/2012 10:15	1040		0.55	22.7	0.29
2012025171	4/23/2012 10:40	1040		0.66	23.7	0.17
2012025675	5/1/2012 9:55	1040	8.00	0.62	25.3	0.64
2012025684	5/1/2012 9:55	1040	8.00	0.62	25.3	0.64
2012027129	5/1/2012 12:29	1040		0.48	25.4	0.27
2012029062	5/8/2012 10:13	1040		0.39	26	0.17
2012029718	5/17/2012 9:00	1040	7.00	0.48	26	0.21
2012032605	5/21/2012 10:15	1040		0.41	28.2	0.18
2012033407	5/31/2012 8:15	1040	8.00	0.44	26.2	0.21
2012036238	6/6/2012 11:23	1040		0.67	28.7	0.27
2012037774	6/14/2012 8:32	1040	7.00	0.93	28.1	0.41
2012039109	6/18/2012 10:36	1040		0.99	29.9	0.19
2012040189	6/28/2012 9:21	1040	7.00	0.93	29.9	0.22
2012042585	7/2/2012 11:22	1040		1.08	30.7	0.23
2012044700	7/12/2012 8:25	1040	7.00	0.83	30.8	0.17
2012046695	7/18/2012 10:25	1040		0.98	31.7	0.27
2012047813	7/23/2012 10:44	1040		1.02	31.9	0.24
2012048448	7/30/2012 10:49	1040	7.00	0.99	31.7	0.22
2012051448	8/7/2012 10:10	1040		1.03	32.2	0.19
2012051510	8/9/2012 8:30	1040	7.00	1.05	32.7	0.32
2012053720	8/15/2012 10:19	1040		1.07	31.6	0.14
2012054075	8/23/2012 9:03	1040	7.00	0.58	32	0.35
2012056899	8/28/2012 12:20	1040		0.55	34.8	0.36

Site 1040- 10601 W. Roma Avenue

Lab ID	Sample Date/Time	Sample location	Field pH S.U.	Field Chlorine mg/L	Field Temp C	Field Turbidity NTU
2012057689	9/6/2012 8:43	1040	7.00	0.92	32.8	0.17
2012060411	9/12/2012 10:10	1040		0.87	30.6	0.26
2012060796	9/20/2012 9:03	1040	7.00	0.89	30.4	0.13
2012061432	9/17/2012 10:34	1040		0.44	30.6	0.20
2012063419	9/25/2012 10:15	1040		0.97	31	0.20
2012064823	10/4/2012 9:01	1040	7.00	0.81	28.1	0.11
2012066791	10/9/2012 9:40	1040		0.80	28.4	0.19
2012067130	10/18/2012 10:05	1040	7.00	0.68	27.4	0.14
2012069926	10/22/2012 10:45	1040		0.66	26.3	0.28
2012070548	10/29/2012 9:08	1040	7.00	0.80	24.1	0.28
2012070557	10/29/2012 9:08	1040	7.00	0.80	24.1	0.28
2012073651	11/6/2012 11:40	1040		0.64	24.7	0.56
2012074171	11/15/2012 10:20	1040	7.00	0.74	22.3	0.26
2012075008	11/13/2012 10:05	1040		0.64	23.2	0.21
2012076871	11/29/2012 9:45	1040	7.00	0.45	20.8	0.24
2012078288	11/28/2012 12:10	1040		0.42	23.4	0.34
2012079121	12/3/2012 10:59	1040		0.56	21.4	0.23
2012080491	12/12/2012 9:46	1040	7.00	0.63	17.6	0.31
2012081083	12/11/2012 9:41	1040		0.78	18.9	0.29
2012081594	12/12/2012 9:46	1040		0.63	17.6	0.31
2013000162	1/3/2013 11:00	1040	7.00	0.50	16.1	0.19
2013000179	1/3/2013 11:00	1040	N/A	0.50	16.1	0.19
2013001367	1/7/2013 10:46	1040		0.61	15	0.20
2013002868	1/14/2013 10:46	1040		0.65	14	0.56
2013003257	1/17/2013 10:00	1040	7.00	0.68	14.4	0.16
2013005564	1/28/2013 10:22	1040	7.00	0.68	16.1	0.22
2013007924	2/4/2013 10:37	1040		0.70	16.6	0.44
2013009912	2/12/2013 9:50	1040		0.55	16.8	0.55
2013009968	2/14/2013 10:30	1040	7.00	0.68	16.5	0.17
2013010004	2/14/2013 10:30	1040		0.68	16.5	0.17
2013012522	2/28/2013 10:40	1040	7.00	0.60	18.1	0.19
2013014671	3/5/2013 12:02	1040		0.67	20.4	0.43
2013015321	3/13/2013 10:35	1040	7.00	1.32	19.9	0.29
2013015341	3/14/2013 13:00	1040	7.00	0.52	23.2	0.19
2013015405	3/14/2013 13:00	1040		0.52	23.2	0.19
2013017511	3/18/2013 11:35	1040		0.73	21.2	0.33
2013019460	3/26/2013 10:11	1040		0.67	20.9	0.26
2013019799	3/28/2013 9:51	1040	7.00	0.67	21	0.11
2013021215	4/3/2013 11:35	1040		0.59	24.3	0.42
2013022576	4/11/2013 9:29	1040	7.00	0.93	22.2	0.18
2013023212	4/11/2013 9:29	1040	N/A	0.93	22.2	0.18
2013024446	4/16/2013 10:06	1040		0.64	23.5	0.23

Site 1040- 10601 W. Roma Avenue

Lab ID	Sample Date/Time	Sample location	Field pH S.U.	Field Chlorine mg/L	Field Temp C	Field Turbidity NTU
2013026372	4/29/2013 10:11	1040	7.80	0.53	24.7	0.31
2013026387	4/29/2013 10:11	1040	7.80	0.53	24.7	0.31
2013026388	4/29/2013 10:11	1040	7.80	0.53	24.7	0.31
2013026389	4/29/2013 10:11	1040	7.80	0.53	24.7	0.31
2013028438	5/2/2013 12:10	1040		1.02	26.7	0.43
2013029765	5/16/2013 9:14	1040	7.90	1.00	26.6	0.21
2013029925	5/9/2013 10:03	1040		1.08	26.7	0.23
2013033129	5/22/2013 11:34	1040		1.06	27.9	0.10
2013033255	5/30/2013 9:30	1040	7.90	0.85	28	0.22
2013036039	6/6/2013 10:50	1040		0.41	33	0.22
2013037090	6/11/2013 12:13	1040		0.63	32.8	0.20
2013037448	6/13/2013 9:32	1040	8.00	0.44	30.4	0.25
2013038769	6/27/2013 9:18	1040	8.00	0.38	30.8	0.39
2013040082	6/25/2013 9:46	1040		0.42	32.4	0.31
2013042274	7/11/2013 9:25	1040	7.90	0.56	32.5	0.10
2013042288	7/11/2013 9:25	1040	N/A	0.56	32.5	0.10
2013042657	7/8/2013 10:04	1040		0.74	33	0.10
2013044962	7/17/2013 10:23	1040		0.71	33.5	0.09
2013046973	7/30/2013 10:29	1040	6.30	0.30	34.5	0.12
2013046996	7/30/2013 10:29	1040	6.30	0.30	34.5	0.12
2013047223	7/25/2013 10:34	1040		0.52	33.3	0.11
2013049987	8/8/2013 9:23	1040	7.90	0.46	32.9	0.13
2013050000	8/8/2013 9:23	1040		0.46	32.9	0.13
2013050284	8/7/2013 11:41	1040		0.74	34.8	0.11
2013052292	8/15/2013 10:01	1040		0.48	33.6	0.16
2013052833	8/22/2013 9:38	1040	7.90	0.55	33.3	0.11
2013052859	8/22/2013 9:35	1040	N/A	0.55	33.3	0.11
2013055245	8/27/2013 10:03	1040		0.61	32.7	0.14
2013056862	9/5/2013 9:52	1040	7.90	0.51	33.2	0.17
2013058756	9/11/2013 11:20	1040		0.50	33.6	0.21
2013059938	9/19/2013 9:37	1040	7.60	0.39	32.5	0.12
2013059951	9/19/2013 9:37	1040	N/A	0.39	32.5	0.12
2013060147	9/17/2013 10:11	1040		0.33	33.1	0.19
2013062158	9/25/2013 11:07	1040		0.42	34.5	0.12
2013063420	10/3/2013 9:24	1040	7.70	0.60	29.4	0.21
2013064888	10/7/2013 10:43	1040		0.60	29.8	0.13
2013066037	10/17/2013 9:29	1040	7.00	0.69	25.8	0.21
2013068324	10/22/2013 11:41	1040		0.62	26.6	0.12
2013069113	10/29/2013 9:53	1040	7.90	0.87	24.4	0.16
2013069880	10/28/2013 9:59	1040		0.87	25.5	0.27
2013071675	11/4/2013 10:28	1040		0.99	24.1	0.51
2013073001	11/14/2013 9:07	1040	7.90	0.89	22.8	0.27

Site 1040- 10601 W. Roma Avenue

Lab ID	Sample Date/Time	Sample location	Field pH S.U.	Field Chlorine mg/L	Field Temp C	Field Turbidity NTU
2013073086	11/14/2013 9:07	1040	N/A	0.89	22.8	0.27
2013074330	11/14/2013 0:00	1040		N/A	N/A	N/A
2013075682	11/20/2013 10:44	1040		0.98	24.2	0.25
2013077284	12/5/2013 9:36	1040	7.80	1.03	17.3	0.52
2013077298	12/5/2013 9:36	1040		1.03	17.3	0.52
2013077600	12/2/2013 10:11	1040		0.89	20.5	0.15
2013081004	12/16/2013 10:11	1040		1.11	16.7	0.40
2013081110	12/19/2013 9:37	1040	8.00	1.38	16.6	0.15
2013081123	12/19/2013 9:37	1040	N/A	1.38	16.6	0.15
2014000847	1/9/2014 9:49	1040	7.90	1.26	16.2	0.28
2014000860	1/9/2014 9:49	1040	N/A	1.26	16.2	0.28
2014001396	1/8/2014 11:57	1040		1.02	16.9	0.27
2014003022	1/15/2014 9:31	1040		1.24	15.9	0.21
2014004255	1/28/2014 9:56	1040	8.00	1.01	16.6	0.14
2014005642	1/28/2014 9:56	1040		1.01	16.6	0.14
2014007686	2/5/2014 10:14	1040		1.07	16.4	0.17
2014008776	2/13/2014 9:34	1040	7.70	1.15	17.1	0.47
2014008799	2/13/2014 9:34	1040	N/A	1.15	17.1	0.47
2014010462	2/18/2014 10:09	1040		1.13	18.7	0.18
2014011087	2/27/2014 9:51	1040	7.60	1.24	19	0.30
2014012214	2/25/2014 9:11	1040		1.09	18.4	0.18
2014014376	3/6/2014 9:23	1040		1.16	19.5	0.31
2014015387	3/13/2014 9:41	1040	8.10	1.09	20.7	0.23
2014015700	3/12/2014 10:12	1040		1.05	21.3	0.13
2014015983	3/13/2014 9:41	1040	n/a	1.09	20.7	0.23
2014017478	3/20/2014 10:24	1040		1.03	21.2	0.26
2014018314	3/27/2014 9:27	1040	8.10	1.09	21.5	0.21
2014021718	4/10/2014 9:15	1040	7.20	1.25	22.7	0.13
2014021751	4/10/2014 9:17	1040		1.25	22.7	0.13
2014021964	4/9/2014 9:50	1040		1.14	22.4	0.23
2014024124	4/17/2014 9:47	1040		1.08	23.6	0.20
2014025350	4/29/2014 8:52	1040	7.90	1.01	23.4	0.10
2014025450	4/29/2014 8:52	1040	7.90	1.01	23.4	0.10
2014025517	4/29/2014 8:52	1040	7.90	1.01	23.4	0.10
2014025809	4/23/2014 10:12	1040		1.17	24.9	0.14
2014029936	5/15/2014 10:41	1040	6.90	1.09	25.7	0.19
2014029949	5/15/2014 10:41	1040		1.09	25.7	0.19
2014030814	5/14/2014 10:17	1040		1.02	25.6	0.17
2014033182	5/29/2014 9:52	1040	6.90	0.98	29	0.18
2014034106	5/28/2014 9:19	1040		0.93	27.4	0.23
2014035992	6/5/2014 10:03	1040		0.86	29.7	0.15
2014036858	6/12/2014 10:00	1040	7.40	0.82	30	

Site 1040- 10601 W. Roma Avenue

Lab ID	Sample Date/Time	Sample location	Field pH S.U.	Field Chlorine mg/L	Field Temp C	Field Turbidity NTU
2014037117	6/10/2014 10:10	1040		0.56	29.6	0.31
2014040150	6/24/2014 9:29	1040		0.52	30.4	0.14
2014040312	6/25/2014 9:15	1040	7.80	0.40	30.2	0.17
2014042463	7/10/2014 9:06	1040	7.80	0.83	31.2	0.11
2014043160	7/10/2014 9:06	1040		0.83	31.2	0.11
2014043872	7/9/2014 10:54	1040		0.92	32.3	0.20
2014045859	7/17/2014 9:25	1040		0.76	31.7	0.17
2014047596	7/24/2014 9:15	1040		0.84	32	0.38
2014048029	7/29/2014 9:37	1040	7.80	0.82	33	0.10
2014050057	8/4/2014 10:36	1040		0.55	33.5	0.12
2014050911	8/14/2014 11:58	1040	7.80	0.63	34.3	0.17
2014052095	8/12/2014 9:41	1040		0.76	32.4	0.06
2014054571	8/28/2014 9:14	1040	7.90	0.30	34.2	0.11
2014055720	8/26/2014 10:05	1040		0.55	32.6	0.13
2014057828	9/11/2014 9:38	1040	7.90	1.21	32.9	0.13
2014057979	9/4/2014 9:31	1040		0.37	33.1	0.18
2014059088	9/11/2014 9:38	1040		1.21	32.9	0.13
2014059312	9/10/2014 10:05	1040		0.57	33.5	0.25
2014061555	9/25/2014 9:26	1040	7.70	0.47	32.7	0.13
2014062870	9/25/2014 9:26	1040		0.47	32.7	0.13
2014064602	10/2/2014 10:22	1040		0.66	30.8	0.18
2014064981	10/9/2014 9:52	1040	7.90	0.27	28.6	0.07
2014065768	10/9/2014 9:52	1040		0.27	28.6	0.07
2014069034	10/20/2014 10:51	1040		0.55	28.2	0.16
2014070108	10/23/2014 9:53	1040		0.69	28.7	0.12
2014070461	10/28/2014 10:36	1040	7.60	0.57	27.1	0.11
2014070470	10/28/2014 10:36	1040	7.60	0.57	27.1	0.11
2014070639	10/28/2014 10:36	1040	7.60	0.57	27.1	0.11
2014073157	11/5/2014 12:30	1040		0.78	25.5	0.14
2014073654	11/13/2014 9:35	1040		0.78	22.5	0.13
2014073902	11/13/2014 9:35	1040	7.90	0.78	22.5	0.13
2014074660	11/12/2014 10:15	1040		0.76	25.5	0.17
2014076428	11/20/2014 9:48	1040		0.64	20.6	0.11
2014078417	12/4/2014 9:53	1040	8.00	0.50	20.4	0.08
2014078455	12/4/2014 0:00	1040		n/a	n/a	n/a
2014078896	12/3/2014 10:13	1040		0.67	20.2	0.11
2014080849	12/18/2014 10:12	1040		0.48	20	0.11
2014080859	12/18/2014 10:12	1040	7.90	0.48	20	0.11
2014081514	12/15/2014 10:08	1040		0.55	19.3	0.19
2014084989	1/8/2015 10:10	1040	7.90	0.70	16.5	0.34
2015002467	1/13/2015 12:02	1040		0.67	16.3	0.29
2015004491	1/21/2015 10:24	1040		0.65	17.4	0.21

Site 1040- 10601 W. Roma Avenue

Lab ID	Sample Date/Time	Sample location	Field pH S.U.	Field Chlorine mg/L	Field Temp C	Field Turbidity NTU
2015005139	1/27/2015 10:09	1040	7.70	0.86	16.8	0.11
2015005148	1/27/2015 10:09	1040	7.70	0.86	16.8	0.11
2015005155	1/27/2015 10:09	1040	7.70	0.86	16.8	0.11
2015008044	2/4/2015 9:43	1040		0.68	17.3	0.13
2015009954	2/11/2015 10:09	1040		0.73	20.1	0.18
2015010044	2/12/2015 10:57	1040	7.70	0.56	20.2	0.36
2015010088	2/12/2015 10:57	1040		0.56	20.2	0.36
2015013153	2/26/2015 10:27	1040	7.90	0.59	19.8	0.12
2015015138	3/4/2015 11:46	1040		0.74	20.2	0.09
2015016651	3/10/2015 11:27	1040		0.68	22.5	0.12
2015016775	3/12/2015 11:21	1040	7.90	0.61	22.3	0.28
2015018598	3/18/2015 9:58	1040		0.59	22.2	0.16
2015019437	3/26/2015 9:05	1040	na	0.58	23.2	0.10
2015020744	4/9/2015 10:52	1040	7.70	0.39	24.2	0.20
2015023071	4/6/2015 10:33	1040		0.42	24.6	0.24
2015025154	4/14/2015 12:45	1040		0.44	25.3	0.17
2015026520	4/28/2015 9:43	1040	8.00	0.37	24.9	0.13
2015029062	5/14/2015 12:11	1040	7.80	0.38	27.3	0.15
2015029074	5/28/2015 9:34	1040	7.60	0.43	27	0.15
2015029829	5/4/2015 10:18	1040		0.34	26.2	0.15
2015032064	5/12/2015 9:43	1040		0.50	26.4	0.09
2015034266	5/20/2015 10:05	1040		0.45	26.4	0.17
2015037283	6/3/2015 12:40	1040		0.30	30.2	0.12
2015037330	6/11/2015 10:53	1040	7.60	0.34	29.1	0.11
2015037341	6/25/2015 12:30	1040	7.80	0.33	33.1	0.17
2015040154	6/15/2015 10:37	1040		0.23	31.4	0.17
2015043563	7/9/2015 9:36	1040	7.70	0.33	31.6	0.21
2015044959	7/6/2015 11:08	1040		0.39	32	0.16
2015048331	7/28/2015 10:16	1040	7.80	0.66	32.1	0.12
2015048353	7/28/2015 10:16	1040	7.80	0.66	32.1	0.12
2015048360	7/28/2015 10:16	1040	7.80	0.66	32.1	0.12
2015048637	7/21/2015 10:42	1040		0.41	35.1	0.28
2015049257	7/28/2015 10:16	1040	na	0.66	32.1	0.12
2015051935	8/3/2015 11:16	1040		0.61	32.2	0.12
2015053037	8/13/2015 11:08	1040	7.80	0.53	33.1	0.21
2015054385	8/12/2015 11:40	1040		0.58	33.4	0.12
2015054416	8/13/2015 11:08	1040	na	0.53	33.1	0.21
2015055981	8/19/2015 10:58	1040		0.58	34.1	0.23
2015056559	8/27/2015 10:06	1040	7.80	0.46	33.4	0.13
2015058891	9/1/2015 12:07	1040		0.45	33.5	0.33
2015059583	9/10/2015 9:57	1040	7.80	0.37	33.1	0.12
2015060848	9/9/2015 10:58	1040		0.35	33	0.14

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Lab ID	Sample Date/Time	Sample location	Field pH S.U.	Field Chlorine mg/L	Field Temp C	Field Turbidity NTU
2015060950	9/24/2015 10:12	1040	8.10	0.41	32.1	0.15
2015063736	9/22/2015 10:57	1040		0.37	32.8	0.16
2015065556	10/8/2015 9:40	1040	7.70	0.74	29.3	0.09
2015066700	10/5/2015 11:04	1040		0.89	31.5	0.12
2015069549	10/15/2015 11:22	1040		0.84	30.4	0.17
2015070613	10/27/2015 10:24	1040	8.00	0.73	28	0.10
2015071979	10/26/2015 11:41	1040		0.82	28.9	0.17
2015074323	11/3/2015 12:04	1040		0.68	27	0.28
2015076448	11/12/2015 11:10	1040		0.53	24.2	0.19
2015077239	11/18/2015 9:49	1040	7.70	0.31	20.8	0.18
2015079924	12/3/2015 9:39	1040	7.70	0.49	17.9	0.16
2015080039	12/1/2015 11:12	1040		0.48	21	0.16
2015081560	12/8/2015 11:16	1040		0.66	19.7	0.19
2015082136	12/16/2015 9:53	1040	7.80	0.91	16	0.14
2015083461	12/16/2015 9:53	1040		0.91	16	0.14
2015084568	12/22/2015 11:27	1040		1.11	17.3	0.14
2015085725	12/28/2015 11:02	1040		1.04	17.5	0.16
2015086424	1/7/2016 9:57	1040	7.80	1.12	15.9	0.16
2016000228	1/4/2016 11:32	1040		1.03	17.3	0.34
2016003157	1/14/2016 11:48	1040		0.67	17.8	0.25
2016003654	1/26/2016 10:13	1040	7.90	0.60	16.9	0.20
2016004594	1/21/2016 12:04	1040		0.62	17.8	0.18
2016007207	2/2/2016 10:25	1040		0.66	17.2	0.29
2016008142	2/11/2016 9:41	1040	8.10	0.65	17	0.15
2016008659	2/8/2016 11:32	1040		0.71	17.9	0.18
2016010973	2/25/2016 9:42	1040	7.90	0.81	19.6	0.14
2016011780	2/22/2016 11:17	1040		0.77	19.5	0.21
2016013922	3/2/2016 9:06	1040		0.74	19.6	0.16
2016014527	3/10/2016 8:30	1040	7.90	0.78	20.4	0.20
2016015643	3/9/2016 11:33	1040		0.75	21.2	0.12
2016017099	3/24/2016 9:20	1040	7.90	0.81	22.1	0.16
2016020391	4/7/2016 8:55	1040	7.80	0.67	22.9	0.10
2016021205	4/4/2016 11:41	1040		0.79	22.6	0.15
2016023623	4/13/2016 11:17	1040		0.61	23.4	0.11
2016024990	4/26/2016 9:17	1040	7.90	0.50	25.4	0.11
2016025001	4/26/2016 9:17	1040	7.90	0.50	25.4	0.11
2016025067	4/26/2016 9:17	1040	7.90	0.50	25.4	0.11
2016026259	4/25/2016 11:18	1040		0.59	25.3	0.16
2016028828	5/5/2016 11:16	1040		0.52	25.4	0.14
2016029443	5/12/2016 9:27	1040	7.80	0.47	25.8	0.10
2016030479	5/11/2016 11:13	1040		0.46	26.2	0.14
2016032413	5/19/2016 11:13	1040		0.43	27.3	0.12

Site 1040- 10601 W. Roma Avenue

Lab ID	Sample Date/Time	Sample location	Field pH S.U.	Field Chlorine mg/L	Field Temp C	Field Turbidity NTU
2016032572	5/26/2016 9:04	1040	7.80	0.48	27.1	0.09
2016035561	6/2/2016 11:15	1040		0.42	28.2	0.15
2016035611	6/9/2016 8:52	1040	7.90	0.32	28.8	0.13
2016038623	6/23/2016 8:56	1040	7.80	0.57	30.6	0.15
2016039620	6/20/2016 11:03	1040		0.56	30	0.24
2016041891	7/7/2016 9:41	1040	6.90	0.43	32.4	0.14
2016043697	7/6/2016 11:29	1040		0.38	32.4	0.12
2016046445	7/18/2016 11:07	1040		0.48	33.2	0.33
2016047681	7/26/2016 10:28	1040		0.45	32.8	0.10
2016048439	7/26/2016 10:28	1040	6.80	0.45	32.8	0.10
2016050227	8/1/2016 10:59	1040		0.58	33.2	0.14
2016051808	8/11/2016 9:57	1040	7.70	0.52	33.7	0.21
2016054021	8/15/2016 11:49	1040		0.54	33.9	0.15
2016055508	8/25/2016 9:48	1040	7.80	0.61	32.9	0.57
2016058482	9/8/2016 9:38	1040	7.80	0.59	31.8	0.15
2016059853	9/7/2016 11:30	1040		0.66	31.8	0.38
2016061832	9/22/2016 9:51	1040	7.80	0.65	30.6	0.13
2016062489	9/19/2016 11:38	1040		0.59	31.1	0.16
2016065415	10/6/2016 10:50	1040	7.70	0.56	29	0.15
2016066398	10/4/2016 11:45	1040		0.42	30.1	0.18
2016068502	10/12/2016 11:31	1040		0.64	29.3	0.16
2016069852	10/25/2016 10:08	1040	7.90	0.42	28.7	0.30
2016069861	10/25/2016 10:08	1040	7.90	0.42	28.7	0.30
2016071221	10/24/2016 11:37	1040		0.50	27.7	0.23
2016073585	11/2/2016 11:29	1040		0.63	27.2	0.16
2016073611	11/9/2016 10:08	1040	7.80	0.56	26.4	0.15
2016076333	11/14/2016 11:36	1040		0.63	25.1	0.17
2016078145	11/21/2016 11:12	1040		0.61	33.6	0.09
2016079156	12/1/2016 9:56	1040	7.90	0.72	22.1	0.14
2016081397	12/5/2016 12:12	1040		0.75	19.9	0.17
2016082530	12/14/2016 9:49	1040	8.10	0.67	19.7	0.16
2016084342	12/15/2016 10:48	1040		0.72	20.2	0.13
2016086811	12/27/2016 11:36	1040		0.50	20.2	0.29
2017000941	1/5/2017 10:39	1040		0.85	18.6	0.11
2017001273	1/12/2017 9:12	1040	7.80	0.67	17.2	0.23
2017002720	1/11/2017 11:48	1040		0.80	18.3	0.20
2017004285	1/24/2017 9:48	1040	8.00	0.73	17.6	0.25
2017004316	1/24/2017 9:48	1040	8.00	0.73	17.6	0.25
2017005335	1/23/2017 11:09	1040		0.67	17.8	0.16
2017008159	2/2/2017 11:36	1040		0.58	17.6	0.22
2017008715	2/9/2017 10:03	1040	7.80	0.54	18.2	0.37
2017009884	2/9/2017 10:03	1040		0.54	18.2	0.37

Site 1040- 10601 W. Roma Avenue

Lab ID	Sample Date/Time	Sample location	Field pH S.U.	Field Chlorine mg/L	Field Temp C	Field Turbidity NTU
2017011440	2/14/2017 11:39	1040		0.52	19.6	0.27
2017013356	2/23/2017 9:28	1040	7.80	0.32	18.7	0.20
2017016010	3/2/2017 11:19	1040		0.42	19.4	0.25
2017016381	3/9/2017 9:21	1040	7.70	0.20	19.6	0.33
2017017407	3/4/2017 6:35	001040				
2017019153	3/14/2017 10:59	1040		0.32	21.2	0.16
2017020465	3/21/2017 10:13	1040	7.90	0.21	23	0.32
2017025073	4/6/2017 9:28	1040	7.90	0.40	23.5	0.27
2017025916	4/3/2017 11:29	1040		0.34	23.5	0.29
2017030131	4/25/2017 10:02	1040	7.90	0.23	25	0.49
2017030482	4/17/2017 11:21	1040		0.33	24.7	0.35
2017032521	4/24/2017 11:38	1040		0.20	25.2	0.27
2017034855	5/2/2017 11:50	1040		0.60	26.2	0.31
2017037192	5/11/2017 9:51	1040	7.80	0.32	26.3	0.52
2017037387	5/10/2017 11:23	1040		0.38	24.8	0.49
2017039032	5/23/2017 9:57	1040	7.90	0.40	28	0.53
2017040143	5/22/2017 11:31	1040		0.31	26.7	0.24
2017043044	6/1/2017 11:46	1040		0.71	28.6	0.45
2017043276	6/8/2017 10:11	1040	7.60	0.44	30.3	0.21
2017046159	6/14/2017 11:06	1040		0.58	30.2	0.28
2017047108	6/22/2017 9:40	1040	7.10	0.41	29.6	0.18
2017048357	6/21/2017 11:25	1040		0.55	29.3	0.31
2017049960	7/6/2017 9:34	1040	7.70	0.53	31.7	0.13
2017053627	7/11/2017 10:59	1040		0.69	31.8	0.13
2017055557	7/17/2017 11:41	1040		0.50	32.1	0.16
2017056528	7/25/2017 9:47	1040	7.90	0.32	33.5	0.19
2017056547	7/25/2017 9:47	1040	7.90	0.32	33.5	0.19
2017056982	7/20/2017 10:11	1040		0.55	33.3	0.13
2017061226	8/10/2017 8:55	1040	7.70	0.46	32.9	0.16
2017062549	8/9/2017 0:00	1040		0.66	32.4	0.15

Lab ID	Sample Date/Time	Site ID	Method	Parameter	Result	Unit	Dilution	Reporting Limit	Data Qualifier	Site Address
2012025684	5/1/2012 9:55	1040	SM20 2320 B	Alkalinity	126	mg/L	1	20		10601 W Roma Ave
2012070557	10/29/2012 9:08	1040	SM20 2320 B	Alkalinity	139	mg/L	1	20		10601 W Roma Ave
2013015321	3/13/2013 10:35	1040	SM20 2320 B	Alkalinity	136	mg/L	1	20		10601 W Roma Ave
2013026387	4/29/2013 10:11	1040	SM20 2320 B	Alkalinity	163	mg/L	1	20		10601 W Roma Ave
2014025350	4/29/2014 8:52	1040	SM20 2320 B	Alkalinity	137	mg/L	1	20	Q2	10601 W Roma Ave
2014070470	10/28/2014 10:36	1040	SM20 2320 B	Alkalinity	197	mg/L	1	20		10601 W Roma Ave
2015005148	1/27/2015 10:09	1040	SM20 2320 B	Alkalinity	125	mg/L	1	20		10601 W Roma Ave
2015048353	7/28/2015 10:16	1040	SM20 2320 B	Alkalinity	121	mg/L	1	20	Q2	10601 W Roma Ave
2016025001	4/26/2016 9:17	1040	SM20 2320 B	Alkalinity	135	mg/L	1	20		10601 W Roma Ave
2016069861	10/25/2016 10:08	1040	SM22 2320 B	Alkalinity	153	mg/L	1	20		10601 W Roma Ave
2017004316	1/24/2017 9:48	1040	SM22 2320 B	Alkalinity	123	mg/L	1	20		10601 W Roma Ave
2012025684	5/1/2012 9:55	1040	EPA 200.8	Arsenic - Total	<0.0020	mg/L	2	0.0020	D1	10601 W Roma Ave
2012070557	10/29/2012 9:08	1040	EPA 200.8	Arsenic - Total	<0.0020	mg/L	2	0.0020	D1	10601 W Roma Ave
2013015321	3/13/2013 10:35	1040	EPA 200.8	Arsenic - Total	<0.0020	mg/L	2	0.0020	D1	10601 W Roma Ave
2013046996	7/30/2013 10:29	1040	EPA 200.8	Arsenic - Total	<0.0020	mg/L	2	0.0020	D1	10601 W Roma Ave
2014025350	4/29/2014 8:52	1040	EPA 200.8	Arsenic - Total	<0.0020	mg/L	2	0.0020		10601 W Roma Ave
2014070470	10/28/2014 10:36	1040	EPA 200.8	Arsenic - Total	<0.0020	mg/L	2	0.0020	D1	10601 W Roma Ave
2015005148	1/27/2015 10:09	1040	EPA 200.8	Arsenic - Total	<0.0020	mg/L	2	0.0020	D1	10601 W Roma Ave
2015048353	7/28/2015 10:16	1040	EPA 200.8	Arsenic - Total	<0.0020	mg/L	2	0.0020	D1	10601 W Roma Ave
2016025001	4/26/2016 9:17	1040	EPA 200.8	Arsenic - Total	<0.0030	mg/L	3	0.0030	D1	10601 W Roma Ave
2016069861	10/25/2016 10:08	1040	EPA 200.8	Arsenic - Total	<0.0030	mg/L	3	0.0030	D1	10601 W Roma Ave
2017004316	1/24/2017 9:48	1040	EPA 200.8	Arsenic - Total	<0.0030	mg/L	3	0.0030	D1	10601 W Roma Ave
2017056528	7/25/2017 9:47	1040	EPA 200.8	Arsenic - Total	<0.0030	mg/L	3	0.0030	D1	10601 W Roma Ave
2012025684	5/1/2012 9:55	1040	SM20 2340 B	Calcium Hardness	119	mg/L		12.5		10601 W Roma Ave
2012070557	10/29/2012 9:08	1040	SM20 2340 B	Calcium Hardness	122	mg/L		12.5		10601 W Roma Ave
2013015321	3/13/2013 10:35	1040	SM20 2340 B	Calcium Hardness	128	mg/L		12.5		10601 W Roma Ave
2013026388	4/29/2013 10:11	1040	SM20 2340 B	Calcium Hardness	127	mg/L		12.5		10601 W Roma Ave
2013046996	7/30/2013 10:29	1040	SM20 2340 B	Calcium Hardness	130	mg/L		12.5		10601 W Roma Ave
2014025350	4/29/2014 8:52	1040	SM20 2340 B	Calcium Hardness	145	mg/L		12.5		10601 W Roma Ave
2014070470	10/28/2014 10:36	1040	SM20 2340 B	Calcium Hardness	135	mg/L		12.5		10601 W Roma Ave
2015005148	1/27/2015 10:09	1040	SM20 2340 B	Calcium Hardness	185	mg/L		12.5		10601 W Roma Ave
2015048353	7/28/2015 10:16	1040	SM20 2340 B	Calcium Hardness	170	mg/L	1	12.5		10601 W Roma Ave
2012025684	5/1/2012 9:55	1040	EPA 300.0	Chloride	241	mg/L	1	1.0		10601 W Roma Ave
2012070557	10/29/2012 9:08	1040	EPA 300.0	Chloride	294	mg/L	1	1.0		10601 W Roma Ave
2013015321	3/13/2013 10:35	1040	EPA 300.0	Chloride	209	mg/L	1	1.0		10601 W Roma Ave
2014025350	4/29/2014 8:52	1040	EPA 300.0	Chloride	266	mg/L	1	1.0		10601 W Roma Ave
2014070470	10/28/2014 10:36	1040	EPA 300.0	Chloride	76	mg/L	1	1.0		10601 W Roma Ave
2015005148	1/27/2015 10:09	1040	EPA 300.0	Chloride	116	mg/L	1	1.0		10601 W Roma Ave
2015048353	7/28/2015 10:16	1040	EPA 300.0	Chloride	188	mg/L	1	1.0		10601 W Roma Ave
2016025001	4/26/2016 9:17	1040	EPA 300.0	Chloride	358	mg/L	2	2.0	D2	10601 W Roma Ave
2016069861	10/25/2016 10:08	1040	EPA 300.0	Chloride	130	mg/L	1	1.0	N1	10601 W Roma Ave
2017004316	1/24/2017 9:48	1040	EPA 300.0	Chloride	109	mg/L	1	1.0		10601 W Roma Ave
2017056528	7/25/2017 9:47	1040	EPA 300.0	Chloride	233	mg/L	1	1.0		10601 W Roma Ave
2012025684	5/1/2012 9:55	1040	SM20 2340 B	Hardness - Total	181	mg/L		16.6		10601 W Roma Ave
2012070557	10/29/2012 9:08	1040	SM20 2340 B	Hardness - Total	192	mg/L		16.6		10601 W Roma Ave
2013015321	3/13/2013 10:35	1040	SM20 2340 B	Hardness - Total	212	mg/L		16.6		10601 W Roma Ave
2013026388	4/29/2013 10:11	1040	SM20 2340 B	Hardness - Total	236	mg/L		16.6		10601 W Roma Ave

Lab ID	Sample Date/Time	Site ID	Method	Parameter	Result	Unit	Dilution	Reporting Limit	Data Qualifier	Site Address
2013046996	7/30/2013 10:29	1040	SM20 2340 B	Hardness - Total	208	mg/L		16.6		10601 W Roma Ave
2014025350	4/29/2014 8:52	1040	SM20 2340 B	Hardness - Total	236	mg/L		16.6		10601 W Roma Ave
2014070470	10/28/2014 10:36	1040	SM20 2340 B	Hardness - Total	260	mg/L		16.6		10601 W Roma Ave
2015005148	1/27/2015 10:09	1040	SM20 2340 B	Hardness - Total	302	mg/L		16.6		10601 W Roma Ave
2015048353	7/28/2015 10:16	1040	SM20 2340 B	Hardness - Total	277	mg/L	1	16.6		10601 W Roma Ave
2016025001	4/26/2016 9:17	1040	SM20 2340 B	Hardness - Total	224	mg/L	1	16.6		10601 W Roma Ave
2016069861	10/25/2016 10:08	1040	SM22 2340 B	Hardness - Total	239	mg/L	1	16.6		10601 W Roma Ave
2017004316	1/24/2017 9:48	1040	SM22 2340 B	Hardness - Total	265	mg/L	1	16.6		10601 W Roma Ave
2017056528	7/25/2017 9:47	1040	SM22 2340 B	Hardness - Total	240	mg/L	1	16.6		10601 W Roma Ave
2012025684	5/1/2012 9:55	1040	EPA 200.7	Magnesium - Total	15	mg/L	1	1.00		10601 W Roma Ave
2012070557	10/29/2012 9:08	1040	EPA 200.7	Magnesium - Total	17	mg/L	1	1.00		10601 W Roma Ave
2013015321	3/13/2013 10:35	1040	EPA 200.7	Magnesium - Total	20.4	mg/L	1	1.00		10601 W Roma Ave
2013026388	4/29/2013 10:11	1040	EPA 200.7	Magnesium - Total	26.6	mg/L	1	1.00		10601 W Roma Ave
2013046996	7/30/2013 10:29	1040	EPA 200.7	Magnesium - Total	18.9	mg/L	1	1.00		10601 W Roma Ave
2014025350	4/29/2014 8:52	1040	EPA 200.7	Magnesium - Total	22.3	mg/L	1	1.00		10601 W Roma Ave
2014070470	10/28/2014 10:36	1040	EPA 200.7	Magnesium - Total	30.3	mg/L	1	1.00		10601 W Roma Ave
2015005148	1/27/2015 10:09	1040	EPA 200.7	Magnesium - Total	28.4	mg/L	1	1.00		10601 W Roma Ave
2015048353	7/28/2015 10:16	1040	EPA 200.7	Magnesium - Total	25.9	mg/L	1	1.00		10601 W Roma Ave
2016025001	4/26/2016 9:17	1040	EPA 200.7	Magnesium - Total	20.8	mg/L	1	1.00		10601 W Roma Ave
2016069861	10/25/2016 10:08	1040	EPA 200.7	Magnesium - Total	25.6	mg/L	1	1.00		10601 W Roma Ave
2017004316	1/24/2017 9:48	1040	EPA 200.7	Magnesium - Total	27.1	mg/L	1	1.00		10601 W Roma Ave
2017056528	7/25/2017 9:47	1040	EPA 200.7	Magnesium - Total	23.3	mg/L	1	1.00		10601 W Roma Ave
2012025684	5/1/2012 9:55	1040	EPA 300.0	Nitrate-N	<0.1	mg/L	1	0.1		10601 W Roma Ave
2012070557	10/29/2012 9:08	1040	EPA 300.0	Nitrate-N	0.4	mg/L	1	0.1		10601 W Roma Ave
2013015321	3/13/2013 10:35	1040	EPA 300.0	Nitrate-N	0.3	mg/L	1	0.1		10601 W Roma Ave
2014025350	4/29/2014 8:52	1040	EPA 300.0	Nitrate-N	0.4	mg/L	1	0.1		10601 W Roma Ave
2014070470	10/28/2014 10:36	1040	EPA 300.0	Nitrate-N	0.6	mg/L	1	0.1		10601 W Roma Ave
2015005148	1/27/2015 10:09	1040	EPA 300.0	Nitrate-N	0.7	mg/L	1	0.1		10601 W Roma Ave
2015048353	7/28/2015 10:16	1040	EPA 300.0	Nitrate-N	0.2	mg/L	1	0.1		10601 W Roma Ave
2016025001	4/26/2016 9:17	1040	EPA 300.0	Nitrate-N	0.2	mg/L	1	0.1		10601 W Roma Ave
2016069861	10/25/2016 10:08	1040	EPA 300.0	Nitrate-N	0.4	mg/L	1	0.1	N1	10601 W Roma Ave
2017004316	1/24/2017 9:48	1040	EPA 300.0	Nitrate-N	0.5	mg/L	1	0.1		10601 W Roma Ave
2017056528	7/25/2017 9:47	1040	EPA 300.0	Nitrate-N	0.2	mg/L	1	0.1		10601 W Roma Ave
2012025684	5/1/2012 9:55	1040	EPA 300.0	Sulfate	52	mg/L	1	1.0		10601 W Roma Ave
2012070557	10/29/2012 9:08	1040	EPA 300.0	Sulfate	64	mg/L	1	1.0		10601 W Roma Ave
2013015321	3/13/2013 10:35	1040	EPA 300.0	Sulfate	57	mg/L	1	1.0		10601 W Roma Ave
2014025350	4/29/2014 8:52	1040	EPA 300.0	Sulfate	110	mg/L	1	1.0		10601 W Roma Ave
2014070470	10/28/2014 10:36	1040	EPA 300.0	Sulfate	94	mg/L	1	1.0		10601 W Roma Ave
2015005148	1/27/2015 10:09	1040	EPA 300.0	Sulfate	234	mg/L	1	1.0		10601 W Roma Ave
2015048353	7/28/2015 10:16	1040	EPA 300.0	Sulfate	191	mg/L	1	1.0		10601 W Roma Ave
2016025001	4/26/2016 9:17	1040	EPA 300.0	Sulfate	94	mg/L	1	1.0		10601 W Roma Ave
2016069861	10/25/2016 10:08	1040	EPA 300.0	Sulfate	129	mg/L	1	1.0	N1	10601 W Roma Ave
2017004316	1/24/2017 9:48	1040	EPA 300.0	Sulfate	199	mg/L	1	1.0		10601 W Roma Ave
2017056528	7/25/2017 9:47	1040	EPA 300.0	Sulfate	158	mg/L	1	1.0		10601 W Roma Ave
2012025684	5/1/2012 9:55	1040	SM20 2540 C	Total Dissolved Solids	594	mg/L	1	10		10601 W Roma Ave
2012070557	10/29/2012 9:08	1040	SM20 2540 C	Total Dissolved Solids	708	mg/L	1	10		10601 W Roma Ave
2013015321	3/13/2013 10:35	1040	SM20 2540 C	Total Dissolved Solids	564	mg/L	1	10		10601 W Roma Ave

Lab ID	Sample Date/Time	Site ID	Method	Parameter	Result	Unit	Dilution	Reporting Limit	Data Qualifier	Site Address
2013026389	4/29/2013 10:11	1040	SM20 2540 C	Total Dissolved Solids	486	mg/L	1	10		10601 W Roma Ave
2014025350	4/29/2014 8:52	1040	SM20 2540 C	Total Dissolved Solids	718	mg/L	1	10		10601 W Roma Ave
2014070470	10/28/2014 10:36	1040	SM20 2540 C	Total Dissolved Solids	454	mg/L	1	10		10601 W Roma Ave
2015005148	1/27/2015 10:09	1040	SM20 2540 C	Total Dissolved Solids	644	mg/L	1	10		10601 W Roma Ave
2015048353	7/28/2015 10:16	1040	SM20 2540 C	Total Dissolved Solids	716	mg/L	1	10		10601 W Roma Ave
2016025001	4/26/2016 9:17	1040	SM20 2540 C	Total Dissolved Solids	854	mg/L	1	10		10601 W Roma Ave
2016069861	10/25/2016 10:08	1040	SM22 2540 C	Total Dissolved Solids	558	mg/L	1	10		10601 W Roma Ave
2017004316	1/24/2017 9:48	1040	SM22 2540 C	Total Dissolved Solids	588	mg/L	1	10		10601 W Roma Ave
2017056528	7/25/2017 9:47	1040	SM22 2540 C	Total Dissolved Solids	734	mg/L	1	10		10601 W Roma Ave
2012000724	1/5/2012 9:35	1040	EPA 524.2	Total THM	30	ug/L	1	0.5		10601 W Roma Ave
2012002654	1/19/2012 9:40	1040	EPA 524.2	Total THM	26	ug/L	1	0.5		10601 W Roma Ave
2012005128	1/31/2012 10:20	1040	EPA 524.2	Total THM	28	ug/L	1	0.5		10601 W Roma Ave
2012008641	2/14/2012 9:25	1040	EPA 524.2	Total THM	23	ug/L	1	0.5		10601 W Roma Ave
2012011894	2/29/2012 9:45	1040	EPA 524.2	Total THM	29	ug/L	1	0.5		10601 W Roma Ave
2012015536	3/15/2012 9:15	1040	EPA 524.2	Total THM	31	ug/L	1	0.5		10601 W Roma Ave
2012017444	3/27/2012 9:45	1040	EPA 524.2	Total THM	39	ug/L	1	0.5		10601 W Roma Ave
2012020918	4/11/2012 9:25	1040	EPA 524.2	Total THM	37	ug/L	1	0.5		10601 W Roma Ave
2012025675	5/1/2012 9:55	1040	EPA 524.2	Total THM	42	ug/L	1	0.5		10601 W Roma Ave
2012029718	5/17/2012 9:00	1040	EPA 524.2	Total THM	58	ug/L	1	0.5		10601 W Roma Ave
2012033407	5/31/2012 8:15	1040	EPA 524.2	Total THM	54	ug/L	1	0.5		10601 W Roma Ave
2012037774	6/14/2012 8:32	1040	EPA 524.2	Total THM	62	ug/L	1	0.5		10601 W Roma Ave
2012040189	6/28/2012 9:21	1040	EPA 524.2	Total THM	68	ug/L	1	0.5		10601 W Roma Ave
2012044700	7/12/2012 8:25	1040	EPA 524.2	Total THM	51	ug/L	1	0.5		10601 W Roma Ave
2012048448	7/30/2012 10:49	1040	EPA 524.2	Total THM	52	ug/L	1	0.5		10601 W Roma Ave
2012051510	8/9/2012 8:30	1040	EPA 524.2	Total THM	69	ug/L	1	0.5		10601 W Roma Ave
2012054075	8/23/2012 9:03	1040	EPA 524.2	Total THM	93	ug/L	1	0.5		10601 W Roma Ave
2012057689	9/6/2012 8:43	1040	EPA 524.2	Total THM	64	ug/L	1	0.5	N1	10601 W Roma Ave
2012060796	9/20/2012 9:03	1040	EPA 524.2	Total THM	66	ug/L	1	0.5		10601 W Roma Ave
2012064823	10/4/2012 9:01	1040	EPA 524.2	Total THM	44	ug/L	1	0.5		10601 W Roma Ave
2012067130	10/18/2012 10:05	1040	EPA 524.2	Total THM	48	ug/L	1	0.5		10601 W Roma Ave
2012070548	10/29/2012 9:08	1040	EPA 524.2	Total THM	38	ug/L	1	0.5		10601 W Roma Ave
2012074171	11/15/2012 10:20	1040	EPA 524.2	Total THM	59	ug/L	1	0.5		10601 W Roma Ave
2012076871	11/29/2012 9:45	1040	EPA 524.2	Total THM	62	ug/L	1	0.5		10601 W Roma Ave
2012080491	12/12/2012 9:46	1040	EPA 524.2	Total THM	33	ug/L	1	0.5		10601 W Roma Ave
2013000162	1/3/2013 11:00	1040	EPA 524.2	Total THM	49	ug/L	1	0.5		10601 W Roma Ave
2013003257	1/17/2013 10:00	1040	EPA 524.2	Total THM	32	ug/L	1	0.5		10601 W Roma Ave
2013005564	1/28/2013 10:22	1040	EPA 524.2	Total THM	37	ug/L	1	0.5		10601 W Roma Ave
2013009968	2/14/2013 10:30	1040	EPA 524.2	Total THM	28	ug/L	1	0.5		10601 W Roma Ave
2013012522	2/28/2013 10:40	1040	EPA 524.2	Total THM	29	ug/L	1	0.5		10601 W Roma Ave
2013015341	3/14/2013 13:00	1040	EPA 524.2	Total THM	44	ug/L	1	0.5		10601 W Roma Ave
2013019799	3/28/2013 9:51	1040	EPA 524.2	Total THM	38	ug/L	1	0.5		10601 W Roma Ave
2013022576	4/11/2013 9:29	1040	EPA 524.2	Total THM	47	ug/L	1	0.5		10601 W Roma Ave
2013026372	4/29/2013 10:11	1040	EPA 524.2	Total THM	48	ug/L	1	0.5		10601 W Roma Ave
2013029765	5/16/2013 9:14	1040	EPA 524.2	Total THM	53	ug/L	1	0.5		10601 W Roma Ave
2013033255	5/30/2013 9:30	1040	EPA 524.2	Total THM	58	ug/L	1	0.5		10601 W Roma Ave
2013037448	6/13/2013 9:32	1040	EPA 524.2	Total THM	72	ug/L	1	0.5		10601 W Roma Ave
2013038769	6/27/2013 9:18	1040	EPA 524.2	Total THM	76	ug/L	1	0.5		10601 W Roma Ave

Lab ID	Sample Date/Time	Site ID	Method	Parameter	Result	Unit	Dilution	Reporting Limit	Data Qualifier	Site Address
2013042274	7/11/2013 9:25	1040	EPA 524.2	Total THM	64	ug/L	1	0.5		10601 W Roma Ave
2013046973	7/30/2013 10:29	1040	EPA 524.2	Total THM	61	ug/L	1	0.5		10601 W Roma Ave
2013049987	8/8/2013 9:23	1040	EPA 524.2	Total THM	62	ug/L	1	0.5		10601 W Roma Ave
2013052833	8/22/2013 9:38	1040	EPA 524.2	Total THM	67	ug/L	1	0.5		10601 W Roma Ave
2013056862	9/5/2013 9:52	1040	EPA 524.2	Total THM	78	ug/L	1	0.5		10601 W Roma Ave
2013059938	9/19/2013 9:37	1040	EPA 524.2	Total THM	99	ug/L	1	0.5		10601 W Roma Ave
2013063420	10/3/2013 9:24	1040	EPA 524.2	Total THM	54	ug/L	1	0.5		10601 W Roma Ave
2013066037	10/17/2013 9:29	1040	EPA 524.2	Total THM	58	ug/L	1	0.5		10601 W Roma Ave
2013069113	10/29/2013 9:53	1040	EPA 524.2	Total THM	61	ug/L	1	0.5		10601 W Roma Ave
2013073001	11/14/2013 9:07	1040	EPA 524.2	Total THM	48	ug/L	1	0.5		10601 W Roma Ave
2013077284	12/5/2013 9:36	1040	EPA 524.2	Total THM	44	ug/L	1	0.5		10601 W Roma Ave
2013081110	12/19/2013 9:37	1040	EPA 524.2	Total THM	45	ug/L	1	0.5		10601 W Roma Ave
2014000847	1/9/2014 9:49	1040	EPA 524.2	Total THM	44	ug/L	1	0.5		10601 W Roma Ave
2014004255	1/28/2014 9:56	1040	EPA 524.2	Total THM	46	ug/L	1	0.5		10601 W Roma Ave
2014008776	2/13/2014 9:34	1040	EPA 524.2	Total THM	49	ug/L	1	0.5		10601 W Roma Ave
2014011087	2/27/2014 9:51	1040	EPA 524.2	Total THM	34	ug/L	1	0.5		10601 W Roma Ave
2014015387	3/13/2014 9:41	1040	EPA 524.2	Total THM	38	ug/L	1	0.5		10601 W Roma Ave
2014018314	3/27/2014 9:27	1040	EPA 524.2	Total THM	42	ug/L	1	0.5		10601 W Roma Ave
2014021718	4/10/2014 9:15	1040	EPA 524.2	Total THM	34	ug/L	1	0.5		10601 W Roma Ave
2014025517	4/29/2014 8:52	1040	EPA 524.2	Total THM	34	ug/L	1	0.5		10601 W Roma Ave
2014029936	5/15/2014 10:41	1040	EPA 524.2	Total THM	42	ug/L	1	0.5		10601 W Roma Ave
2014033182	5/29/2014 9:52	1040	EPA 524.2	Total THM	45	ug/L	1	0.5		10601 W Roma Ave
2014036858	6/12/2014 10:00	1040	EPA 524.2	Total THM	55	ug/L	1	0.5		10601 W Roma Ave
2014040312	6/25/2014 9:15	1040	EPA 524.2	Total THM	53	ug/L	1	0.5		10601 W Roma Ave
2014042463	7/10/2014 9:06	1040	EPA 524.2	Total THM	58	ug/L	1	0.5		10601 W Roma Ave
2014048029	7/29/2014 9:37	1040	EPA 524.2	Total THM	63	ug/L	1	0.5		10601 W Roma Ave
2014050911	8/14/2014 11:58	1040	EPA 524.2	Total THM	78	ug/L	1	0.5		10601 W Roma Ave
2014054571	8/28/2014 9:14	1040	EPA 524.2	Total THM	79	ug/L	1	0.5		10601 W Roma Ave
2014057828	9/11/2014 9:38	1040	EPA 524.2	Total THM	76	ug/L	1	0.5		10601 W Roma Ave
2014061555	9/25/2014 9:26	1040	EPA 524.2	Total THM	65	ug/L	1	0.5		10601 W Roma Ave
2014064981	10/9/2014 9:52	1040	EPA 524.2	Total THM	58	ug/L	1	0.5		10601 W Roma Ave
2014070461	10/28/2014 10:36	1040	EPA 524.2	Total THM	53	ug/L	1	0.5		10601 W Roma Ave
2014073902	11/13/2014 9:35	1040	EPA 524.2	Total THM	48	ug/L	1	0.5		10601 W Roma Ave
2014078417	12/4/2014 9:53	1040	EPA 524.2	Total THM	38	ug/L	1	0.5		10601 W Roma Ave
2014080859	12/18/2014 10:12	1040	EPA 524.2	Total THM	43	ug/L	1	0.5		10601 W Roma Ave
2014084989	1/8/2015 10:10	1040	EPA 524.2	Total THM	38	ug/L	1	0.5		10601 W Roma Ave
2015005139	1/27/2015 10:09	1040	EPA 524.2	Total THM	29	ug/L	1	0.5		10601 W Roma Ave
2015010044	2/12/2015 10:57	1040	EPA 524.2	Total THM	40	ug/L	1	0.5		10601 W Roma Ave
2015013153	2/26/2015 10:27	1040	EPA 524.2	Total THM	49	ug/L	1	0.5		10601 W Roma Ave
2015016775	3/12/2015 11:21	1040	EPA 524.2	Total THM	36	ug/L	1	0.5		10601 W Roma Ave
2015019437	3/26/2015 9:05	1040	EPA 524.2	Total THM	71	ug/L	1	0.5		10601 W Roma Ave
2015020744	4/9/2015 10:52	1040	EPA 524.2	Total THM	72	ug/L	1	0.5		10601 W Roma Ave
2015026520	4/28/2015 9:43	1040	EPA 524.2	Total THM	65	ug/L	1	0.5		10601 W Roma Ave
2015029062	5/14/2015 12:11	1040	EPA 524.2	Total THM	62	ug/L	1	0.5		10601 W Roma Ave
2015029074	5/28/2015 9:34	1040	EPA 524.2	Total THM	58	ug/L	1	0.5	N1	10601 W Roma Ave
2015037330	6/11/2015 10:53	1040	EPA 524.2	Total THM	57	ug/L	1	0.5		10601 W Roma Ave
2015037341	6/25/2015 12:30	1040	EPA 524.2	Total THM	78	ug/L	1	0.5	N1	10601 W Roma Ave

Lab ID	Sample Date/Time	Site ID	Method	Parameter	Result	Unit	Dilution	Reporting Limit	Data Qualifier	Site Address
2015043563	7/9/2015 9:36	1040	EPA 524.2	Total THM	56	ug/L	1	0.5		10601 W Roma Ave
2015048331	7/28/2015 10:16	1040	EPA 524.2	Total THM	54	ug/L	1	0.5		10601 W Roma Ave
2015053037	8/13/2015 11:08	1040	EPA 524.2	Total THM	58	ug/L	1	0.5		10601 W Roma Ave
2015056559	8/27/2015 10:06	1040	EPA 524.2	Total THM	53	ug/L	1	0.5		10601 W Roma Ave
2015059583	9/10/2015 9:57	1040	EPA 524.2	Total THM	68	ug/L	1	0.5		10601 W Roma Ave
2015060950	9/24/2015 10:12	1040	EPA 524.2	Total THM	54	ug/L	1	0.5		10601 W Roma Ave
2015065556	10/8/2015 9:40	1040	EPA 524.2	Total THM	50	ug/L	1	0.5		10601 W Roma Ave
2015070613	10/27/2015 10:24	1040	EPA 524.2	Total THM	64	ug/L	1	0.5		10601 W Roma Ave
2015077239	11/18/2015 9:49	1040	EPA 524.2	Total THM	74	ug/L	1	0.5	N1	10601 W Roma Ave
2015079924	12/3/2015 9:39	1040	EPA 524.2	Total THM	53	ug/L	1	0.5		10601 W Roma Ave
2015082136	12/16/2015 9:53	1040	EPA 524.2	Total THM	49	ug/L	1	0.5	N1	10601 W Roma Ave
2015086424	1/7/2016 9:57	1040	EPA 524.2	Total THM	39	ug/L	1	0.5		10601 W Roma Ave
2016003654	1/26/2016 10:13	1040	EPA 524.2	Total THM	50	ug/L	1	0.5		10601 W Roma Ave
2016008142	2/11/2016 9:41	1040	EPA 524.2	Total THM	48	ug/L	1	0.5		10601 W Roma Ave
2016010973	2/25/2016 9:42	1040	EPA 524.2	Total THM	48	ug/L	1	0.5		10601 W Roma Ave
2016014527	3/10/2016 8:30	1040	EPA 524.2	Total THM	53	ug/L	1	0.5		10601 W Roma Ave
2016017099	3/24/2016 9:20	1040	EPA 524.2	Total THM	55	ug/L	1	0.5		10601 W Roma Ave
2016020391	4/7/2016 8:55	1040	EPA 524.2	Total THM	62	ug/L	1	0.5		10601 W Roma Ave
2016024990	4/26/2016 9:17	1040	EPA 524.2	Total THM	71	ug/L	1	0.5		10601 W Roma Ave
2016029443	5/12/2016 9:27	1040	EPA 524.2	Total THM	86	ug/L	1	0.5		10601 W Roma Ave
2016032572	5/26/2016 9:04	1040	EPA 524.2	Total THM	84	ug/L	1	0.5		10601 W Roma Ave
2016035611	6/9/2016 8:52	1040	EPA 524.2	Total THM	84	ug/L	1	0.5		10601 W Roma Ave
2016038623	6/23/2016 8:56	1040	EPA 524.2	Total THM	67	ug/L	1	0.5		10601 W Roma Ave
2016041891	7/7/2016 9:41	1040	EPA 524.2	Total THM	54	ug/L	1	0.5		10601 W Roma Ave
2016048439	7/26/2016 10:28	1040	EPA 524.2	Total THM	51	ug/L	1	0.5		10601 W Roma Ave
2016051808	8/11/2016 9:57	1040	EPA 524.2	Total THM	61	ug/L	1	0.5		10601 W Roma Ave
2016055508	8/25/2016 9:48	1040	EPA 524.2	Total THM	40	ug/L	1	0.5		10601 W Roma Ave
2016058482	9/8/2016 9:38	1040	EPA 524.2	Total THM	45	ug/L	1	0.5		10601 W Roma Ave
2016061832	9/22/2016 9:51	1040	EPA 524.2	Total THM	42	ug/L	1	0.5		10601 W Roma Ave
2016065415	10/6/2016 10:50	1040	EPA 524.2	Total THM	49	ug/L	1	0.5		10601 W Roma Ave
2016069852	10/25/2016 10:08	1040	EPA 524.2	Total THM	49	ug/L	1	0.5		10601 W Roma Ave
2016073611	11/9/2016 10:08	1040	EPA 524.2	Total THM	43	ug/L	1	0.5		10601 W Roma Ave
2016079156	12/1/2016 9:56	1040	EPA 524.2	Total THM	42	ug/L	1	0.5		10601 W Roma Ave
2016082530	12/14/2016 9:49	1040	EPA 524.2	Total THM	44	ug/L	1	0.5		10601 W Roma Ave
2017001273	1/12/2017 9:12	1040	EPA 524.2	Total THM	34	ug/L	1	0.5		10601 W Roma Ave
2017004285	1/24/2017 9:48	1040	EPA 524.2	Total THM	31	ug/L	1	0.5		10601 W Roma Ave
2017008715	2/9/2017 10:03	1040	EPA 524.2	Total THM	51	ug/L	1	0.5		10601 W Roma Ave
2017013356	2/23/2017 9:28	1040	EPA 524.2	Total THM	72	ug/L	1	0.5		10601 W Roma Ave
2017016381	3/9/2017 9:21	1040	EPA 524.2	Total THM	68	ug/L	1	0.5		10601 W Roma Ave
2017020465	3/21/2017 10:13	1040	EPA 524.2	Total THM	65	ug/L	1	0.5		10601 W Roma Ave
2017025073	4/6/2017 9:28	1040	EPA 524.2	Total THM	71	ug/L	1	0.5		10601 W Roma Ave
2017030131	4/25/2017 10:02	1040	EPA 524.2	Total THM	75	ug/L	1	0.5		10601 W Roma Ave
2017037192	5/11/2017 9:51	1040	EPA 524.2	Total THM	62	ug/L	1	0.5		10601 W Roma Ave
2017039032	5/23/2017 9:57	1040	EPA 524.2	Total THM	61	ug/L	1	0.5		10601 W Roma Ave
2017043276	6/8/2017 10:11	1040	EPA 524.2	Total THM	54	ug/L	1	0.5		10601 W Roma Ave
2017047108	6/22/2017 9:40	1040	EPA 524.2	Total THM	52	ug/L	1	0.5		10601 W Roma Ave
2017049960	7/6/2017 9:34	1040	EPA 524.2	Total THM	52	ug/L	1	0.5	N1	10601 W Roma Ave

Appendix D

MODEL CALIBRATION GRAPHS

City of Avondale
2017 Integrated Water Master Plan
FLOW METER SITE 1 CALIBRATION

Avondale

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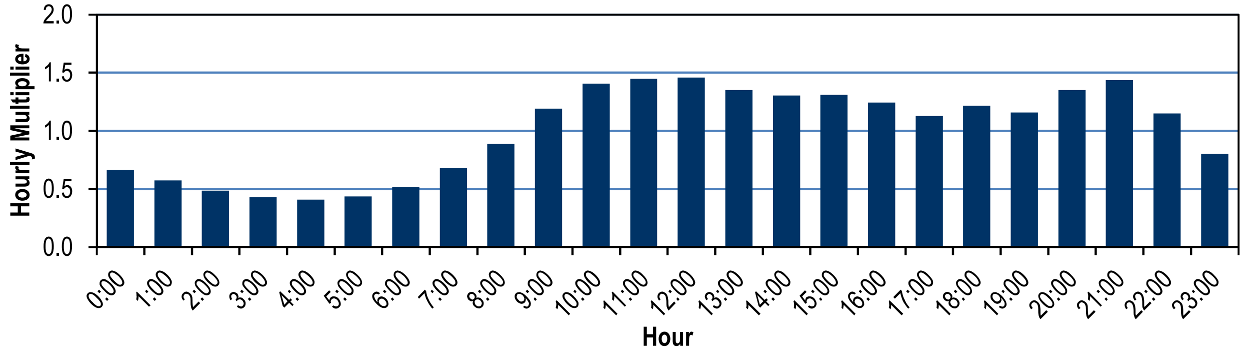
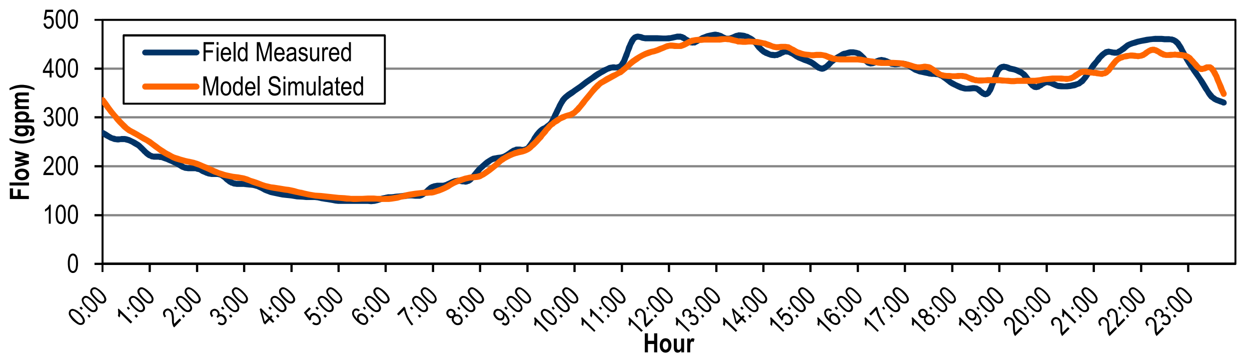
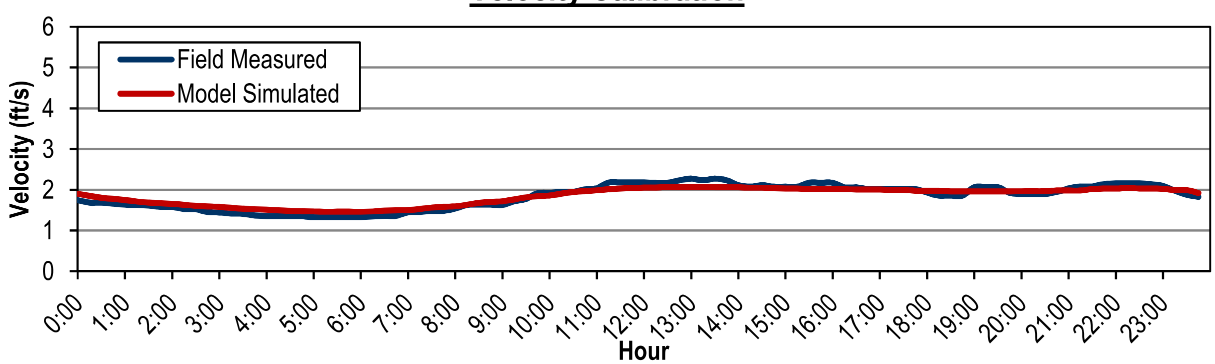
Calibrated Diurnal Pattern



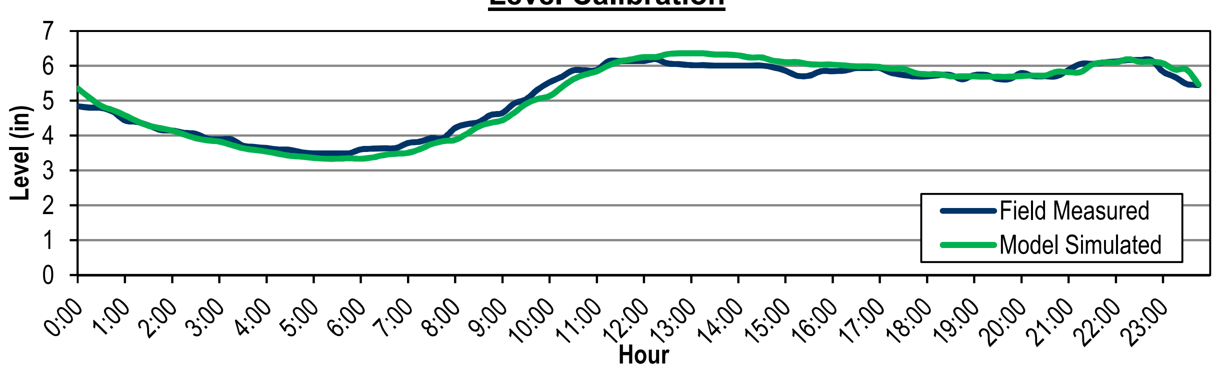
Flow Calibration



Velocity Calibration

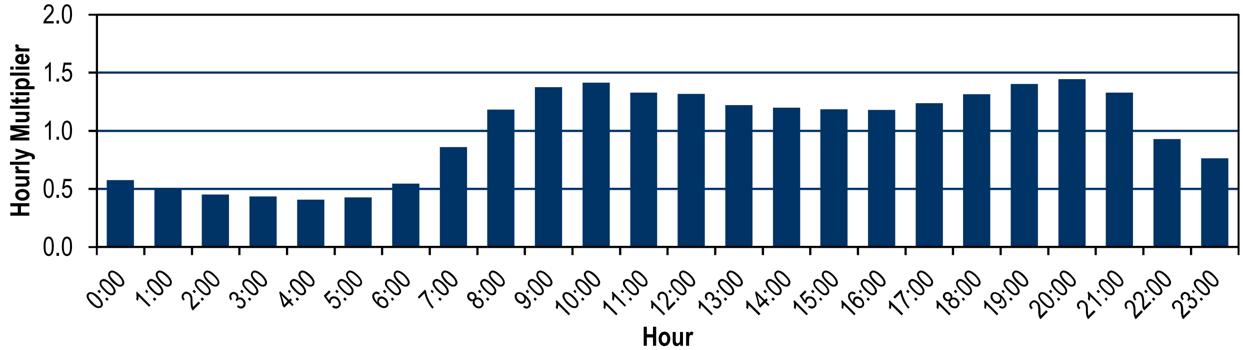


Level Calibration

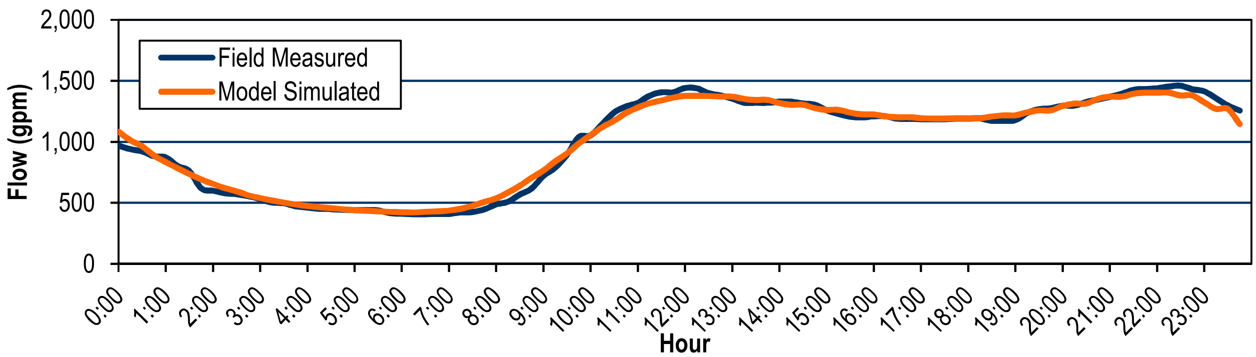


City of Avondale
2017 Integrated Water Master Plan
FLOW METER SITE 2 CALIBRATION

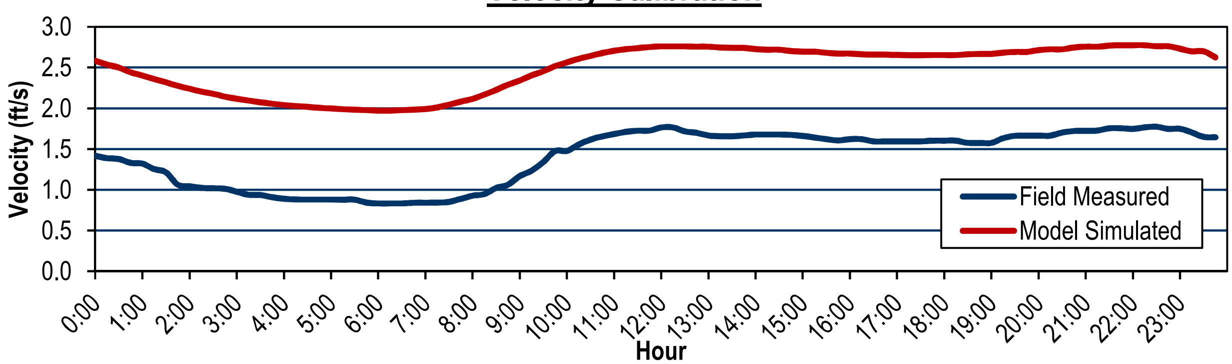
Calibrated Diurnal Pattern



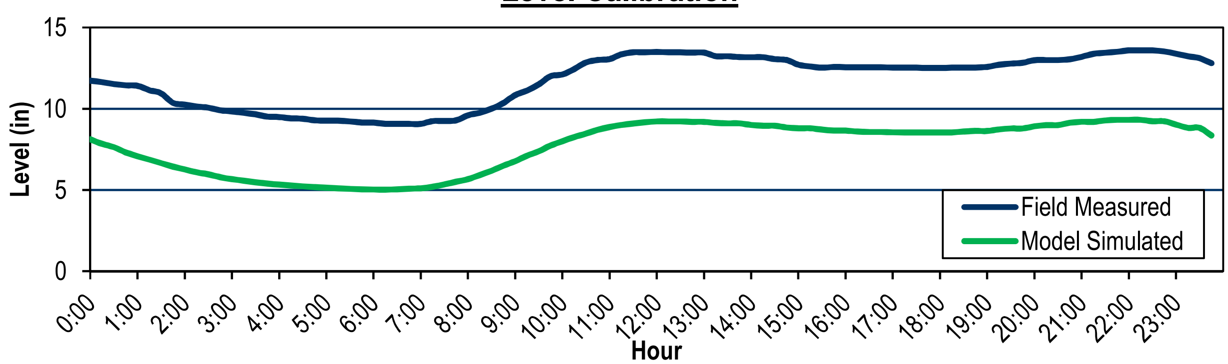
Flow Calibration



Velocity Calibration



Level Calibration



Avondale

City of Avondale
2017 Integrated Water Master Plan
FLOW METER SITE 3 CALIBRATION

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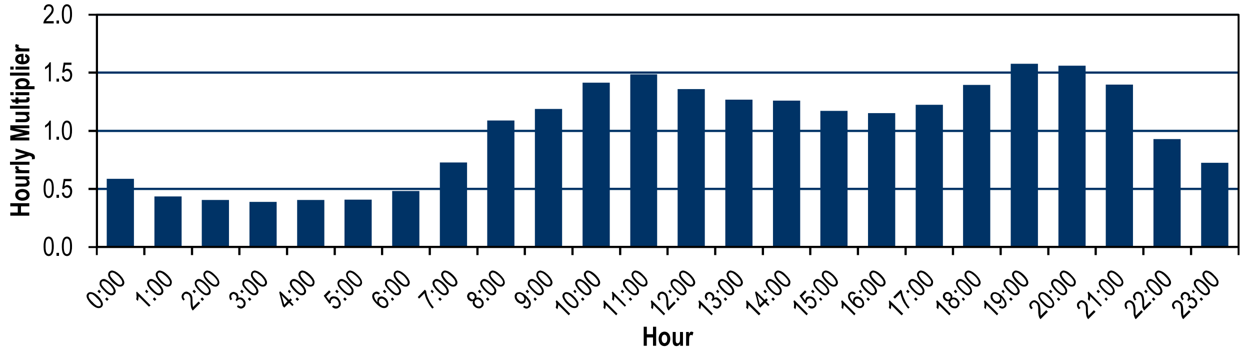
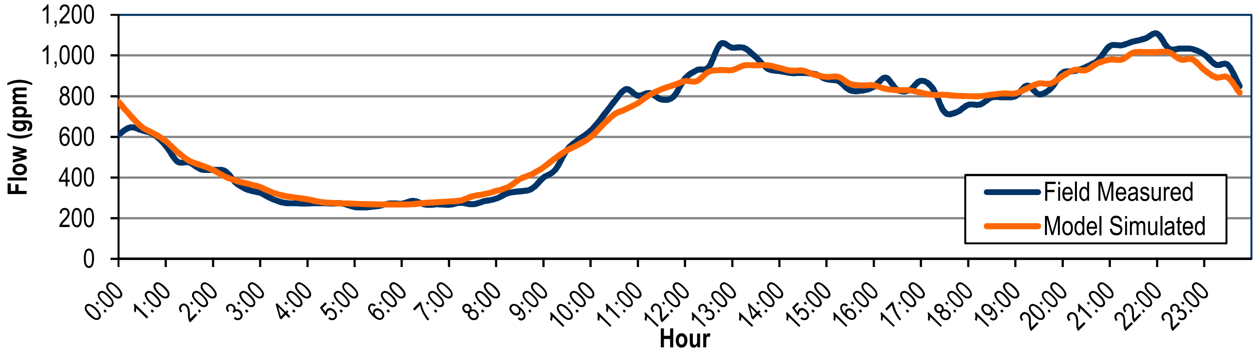
Calibrated Diurnal Pattern



Flow Calibration



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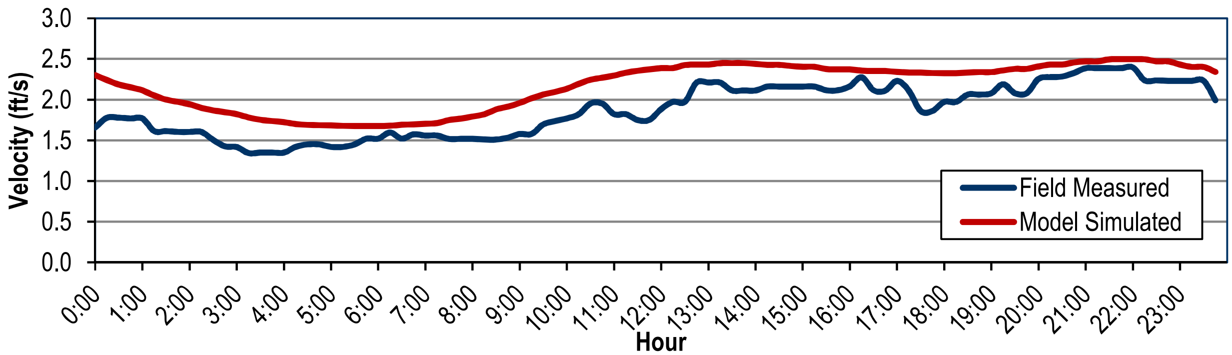
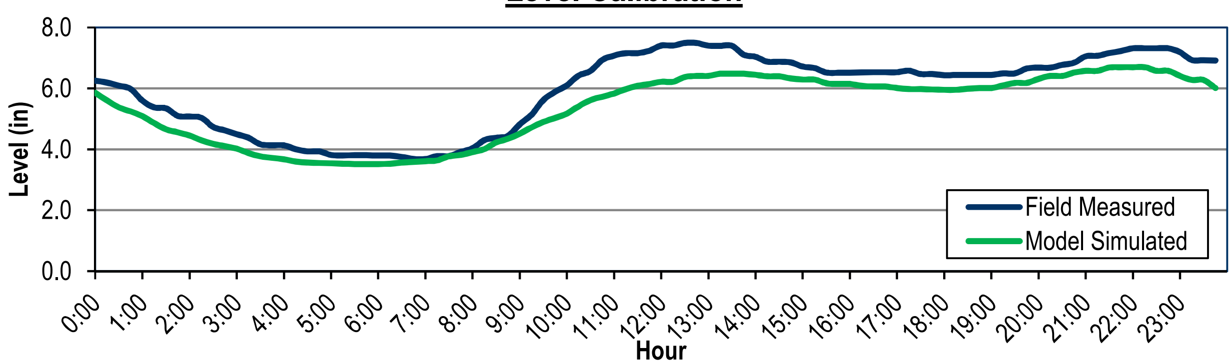


Level Calibration



Avondale

City of Avondale
2017 Integrated Water Master Plan
FLOW METER SITE 4 CALIBRATION

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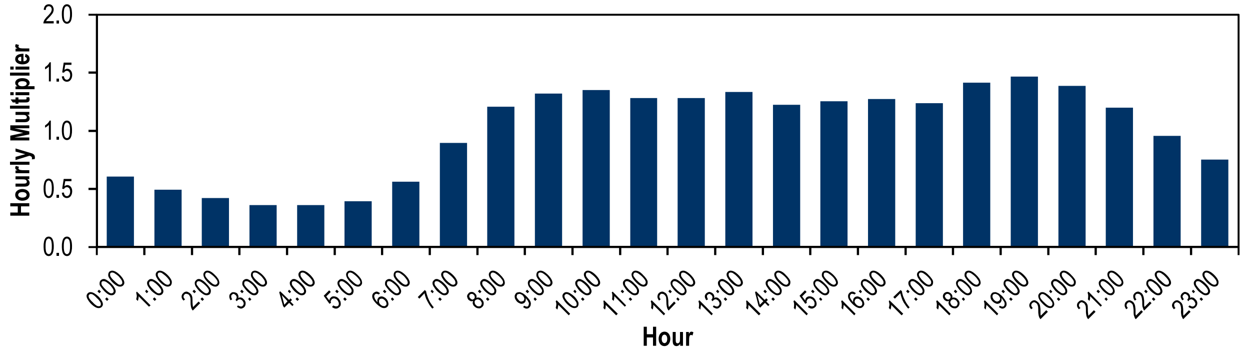
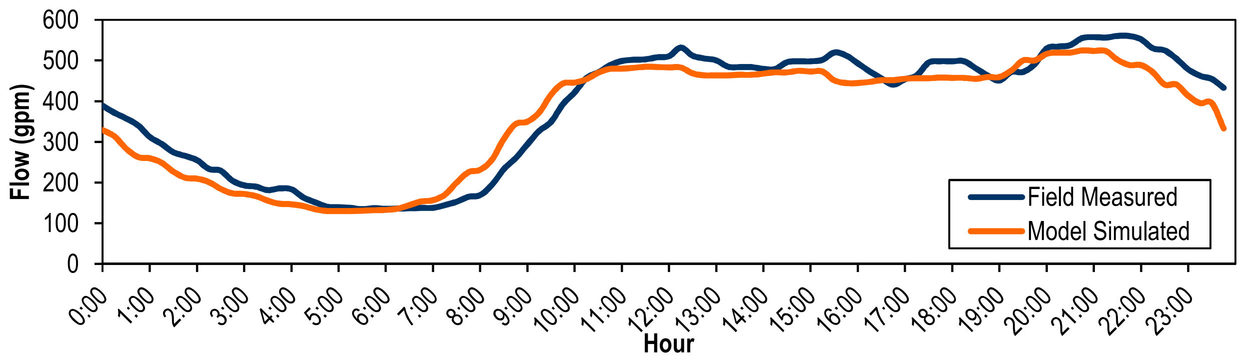
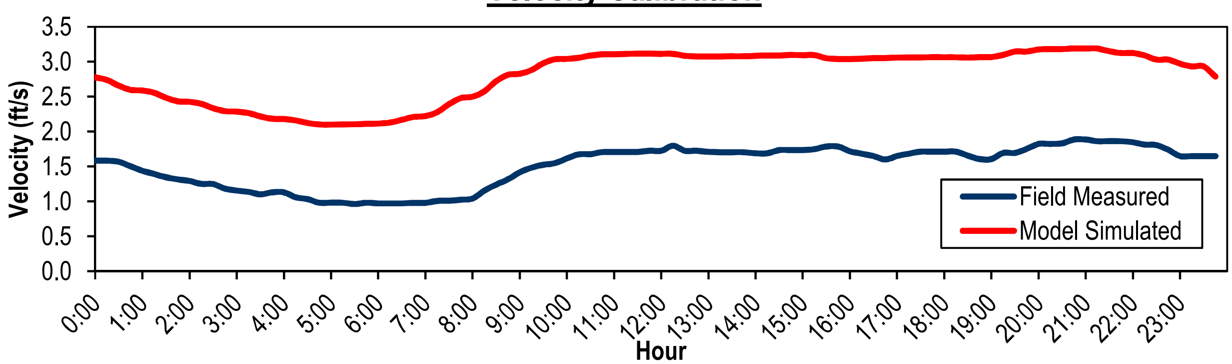
Calibrated Diurnal Pattern



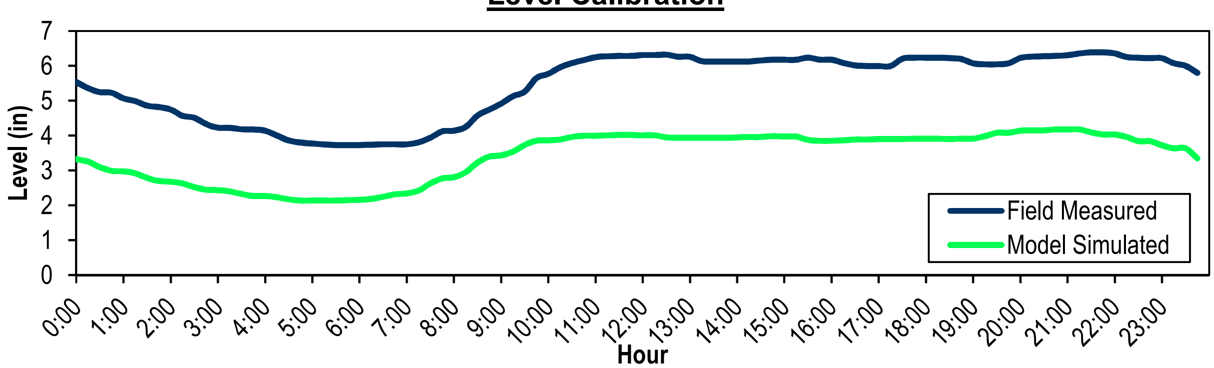
Flow Calibration



Velocity Calibration

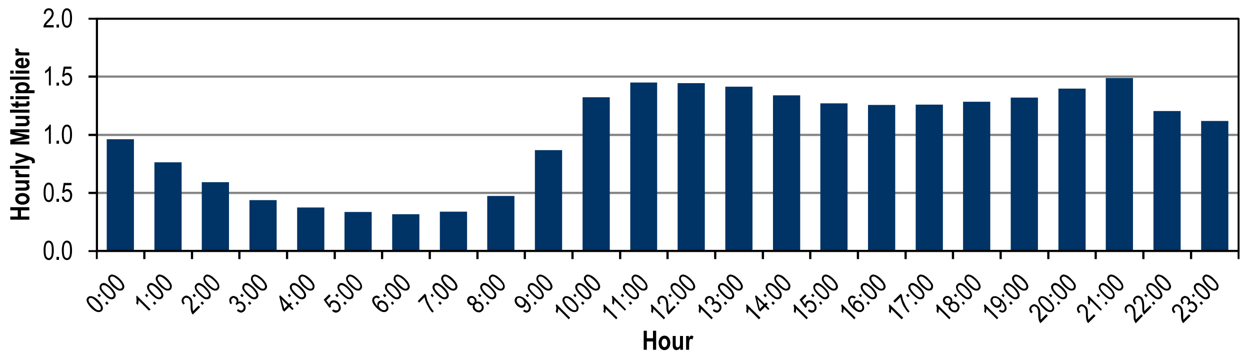


Level Calibration

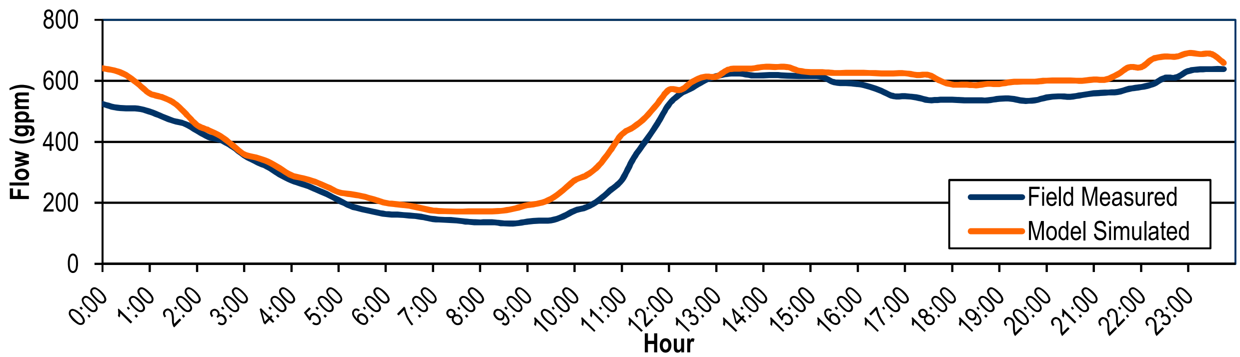


City of Avondale
2017 Integrated Water Master Plan
FLOW METER SITE 5 CALIBRATION

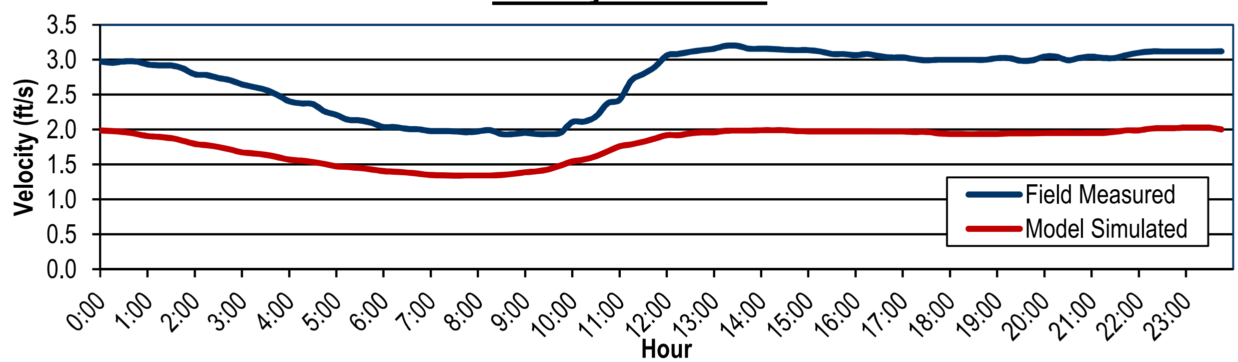
Calibrated Diurnal Pattern



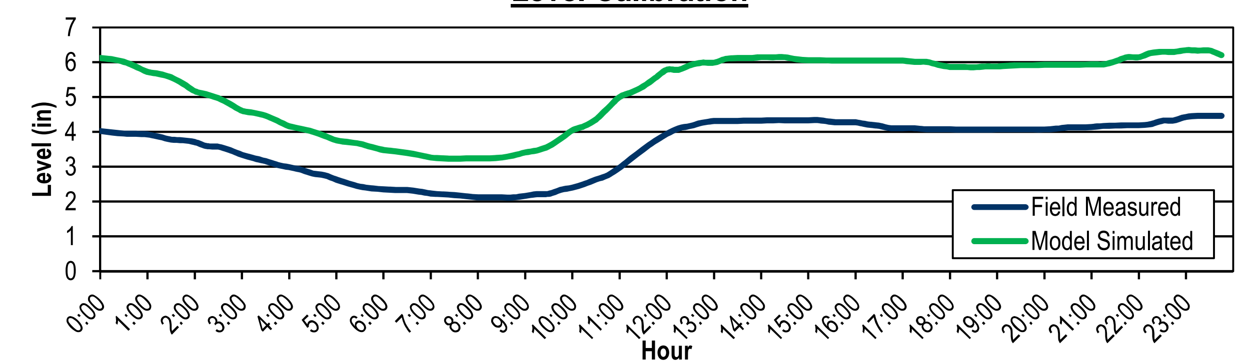
Flow Calibration



Velocity Calibration



Level Calibration



Avondale

City of Avondale
2017 Integrated Water Master Plan
FLOW METER SITE 6 CALIBRATION

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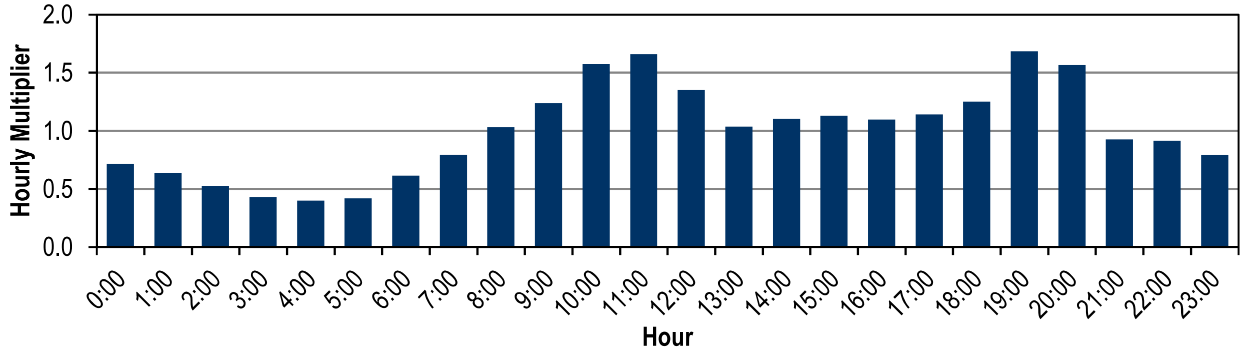
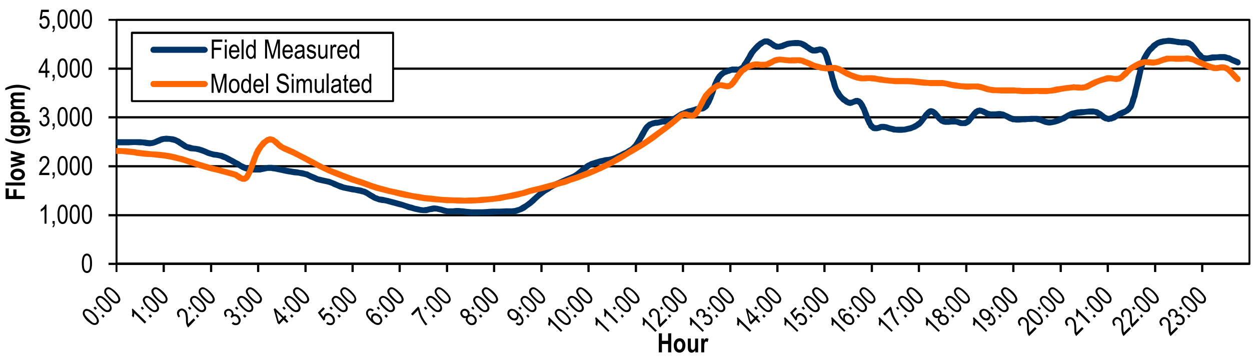
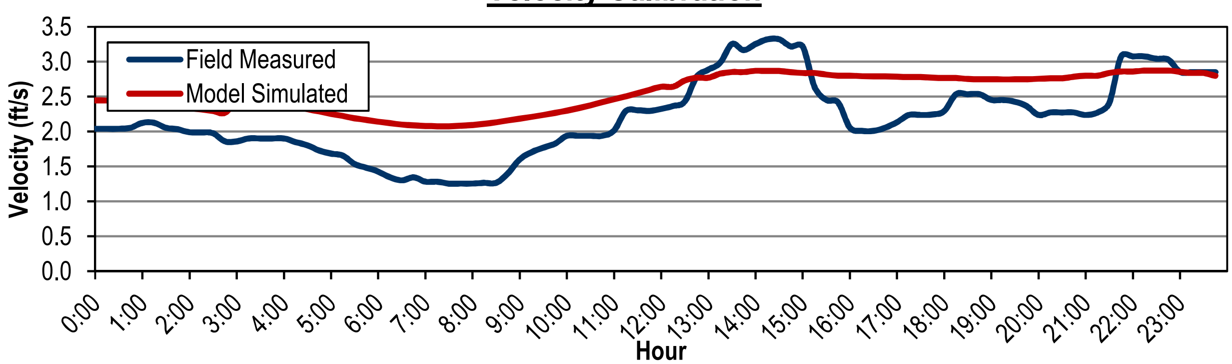
Calibrated Diurnal Pattern



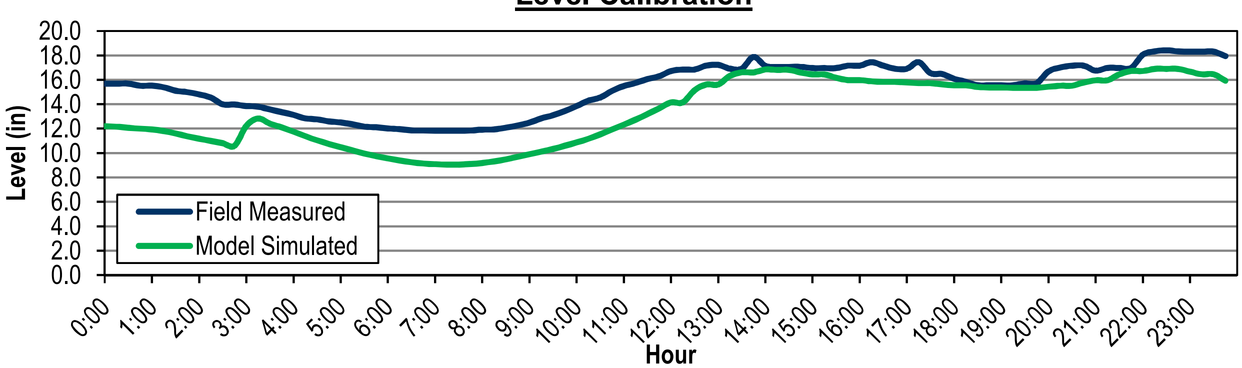
Flow Calibration



Velocity Calibration

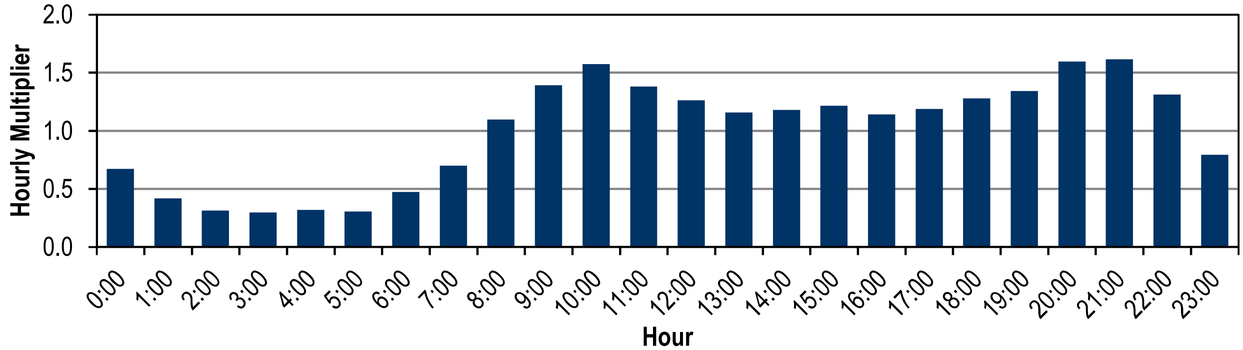


Level Calibration

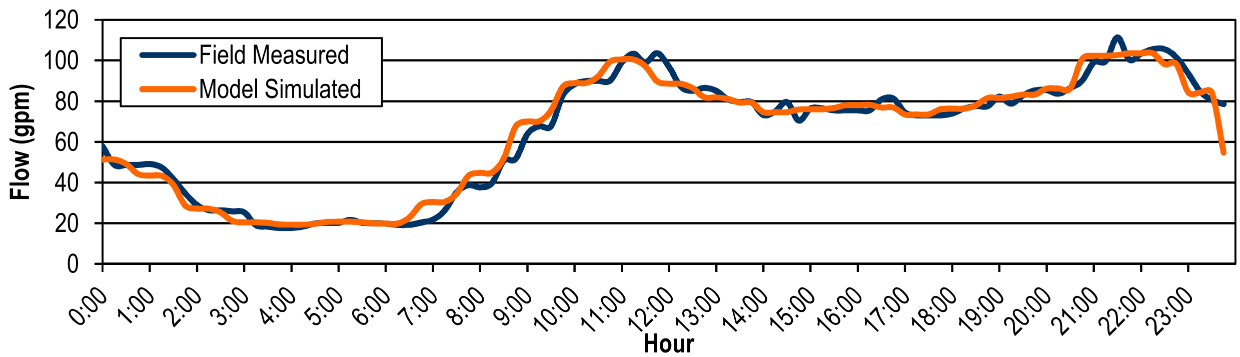


City of Avondale
2017 Integrated Water Master Plan
FLOW METER SITE 7 CALIBRATION

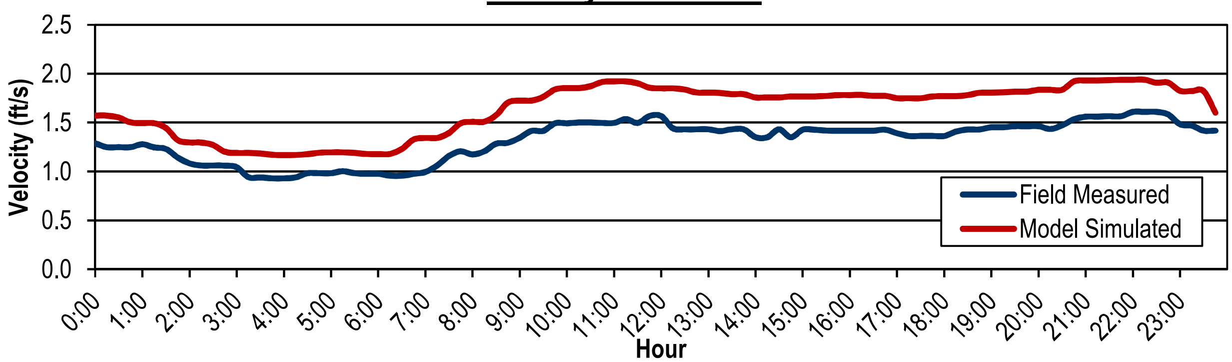
Calibrated Diurnal Pattern



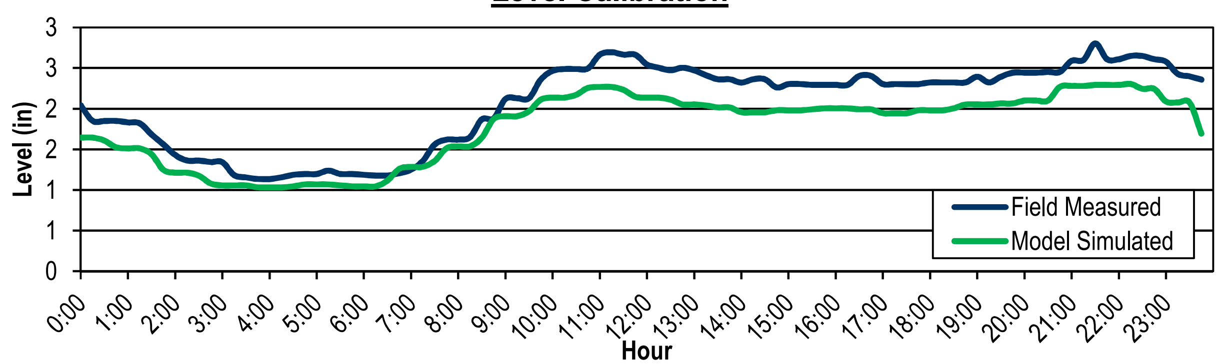
Flow Calibration



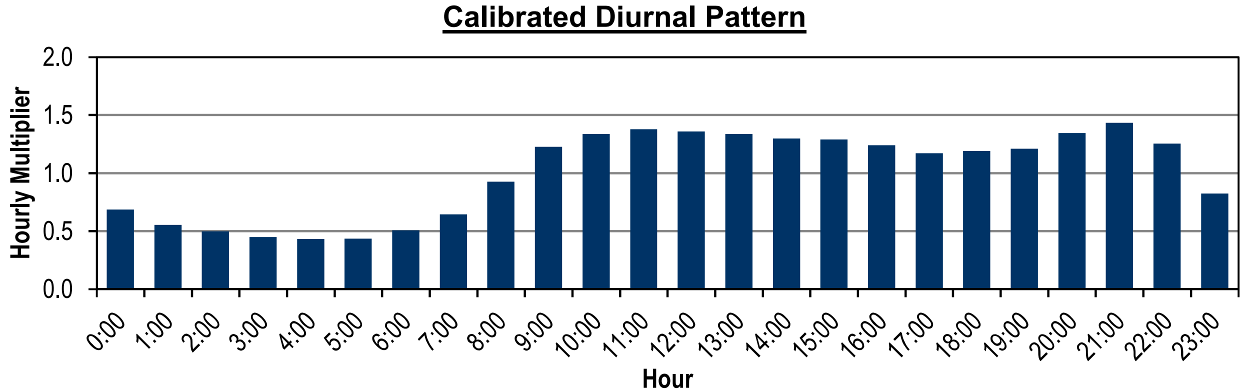
Velocity Calibration

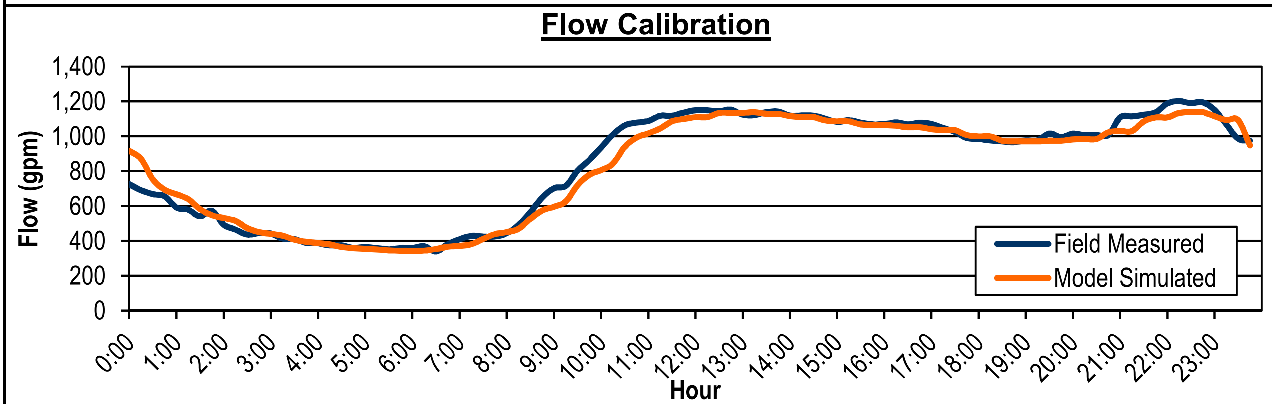


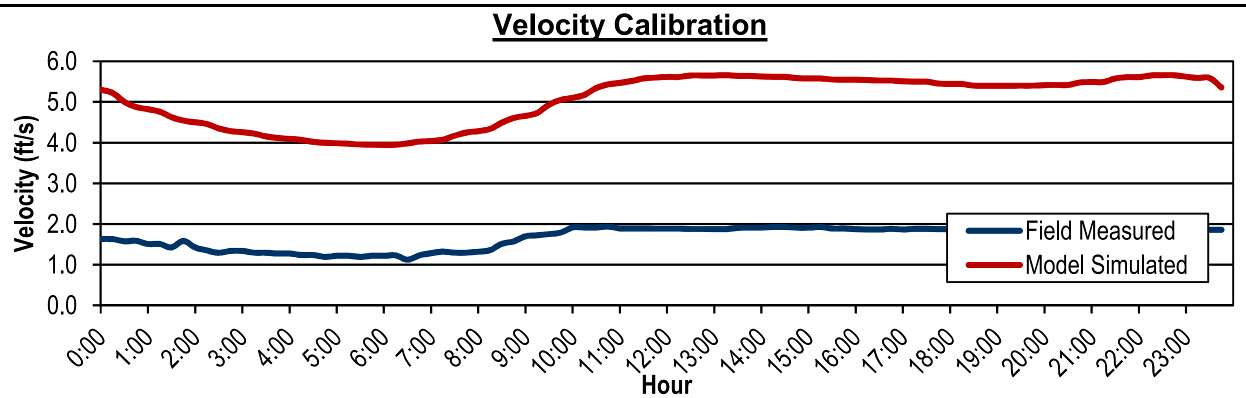
Level Calibration

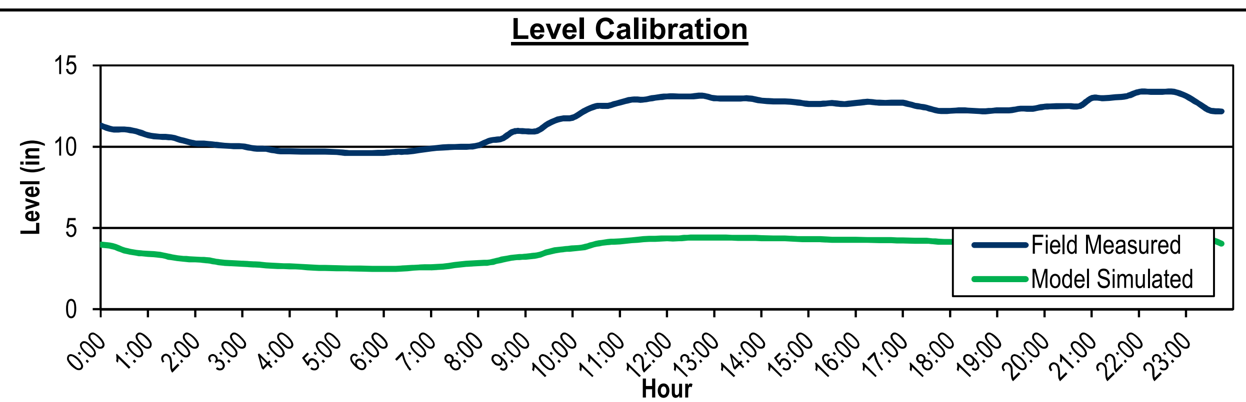


City of Avondale
2017 Integrated Water Master Plan
FLOW METER SITE 8 CALIBRATION



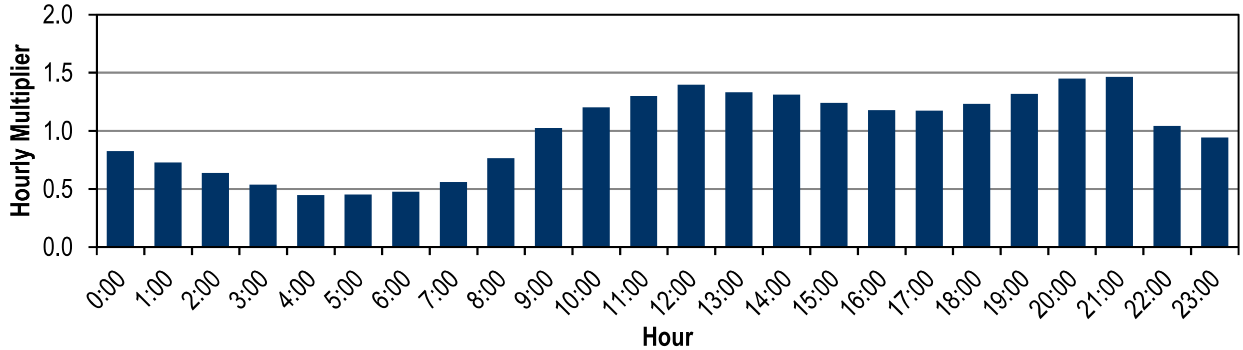




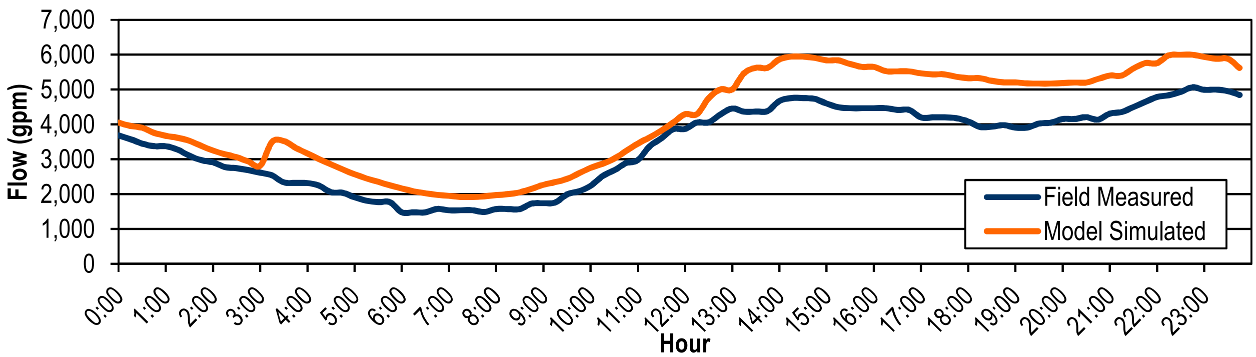


City of Avondale
2017 Integrated Water Master Plan
FLOW METER SITE 9 CALIBRATION

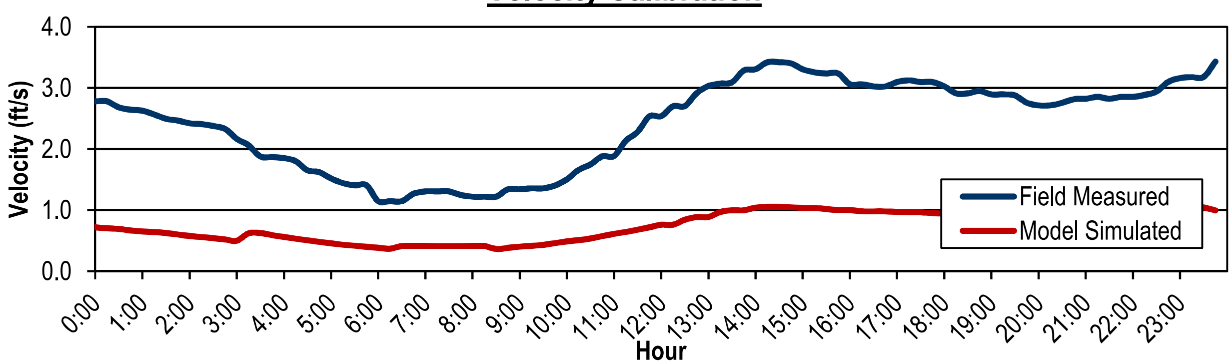
Calibrated Diurnal Pattern



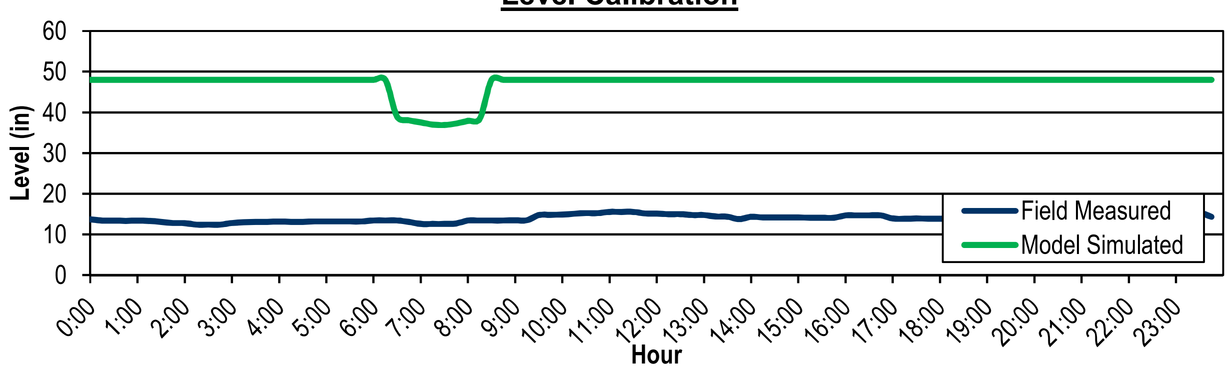
Flow Calibration



Velocity Calibration



Level Calibration



Appendix E

WATER INFRASTRUCTURE UNIT COSTS

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Engineers...Working Wonders With Water®

Pipeline Unit costs

Pipeline Diameter (in)	Pipeline Construction Cost ($/ft)	Pipeline Project Cost ($/ft)
8" (w/Hydrant)	$163	$ 228
8" (no paving)	$113	$ 158
12" (w/Hydrant)	$182	$ 254
12"	$154	$ 216
16"	$179	$ 251
20"	$236	$ 330
24"	$266	$ 372
30"	$352	$ 493
36"	$437	$ 612
(ENR CCI =10678)		

Carollo Engineers...Working Wonders With Water™

ENR PRESENT:

PROJECT :	**Integrated Utility Master Plan**	**LOCATION FACTOR:**	**0.873**
JOB # :	**10490A.00**	**DATE :**	April-17
CLIENT :	**City of Avondale**	**ENR :**	10678
ELEMENT :	**Water Main Construction**	**BY :**	BCC

	DESCRIPTION	**QUAN**	**UNIT**	**MATERIAL & LABOR**	**SUB**	**UNIT COST**	**SUBTOTAL**	**TOTAL**
PIPE	12" Cl 52 Cldi Mj Pipe In Open Trench	1	LF	$42.42	$0.00	$ 42	$ 42	
	TOTAL PIPING (per LF)							**$42.42**
EXCAV	EARTHWORK							
& BACKFILL	Cat 225 Trackhoe, 1Cy Bucket, Class B (Medium Digging), 0-16' D	0.7	CY	$4.16	$0.00	$ 4	$ 3	
	Trench Bracing, 3' W X 10' D, Wood Planks & X-Bracing	1.0	LF	$13.97	$0.00	$ 14	$ 14	
	Imported Pipe Bed & Zone/Confined Structure Backfill, Class A Material	0.2	CY	$54.10	$0.00	$ 54	$ 10	
	Native Trench Backfill/Unconfined Struct. Bf, Class A Material	0.4	CY	$11.79	$0.00	$ 12	$ 5	
	10% Site Specific Requirements	1	LS	$3.24	$0.00	$ 3	$ 3	
	TOTAL EARTHWORK (per LF)							**$35.67**
PAVING	Asphalt Pavement Cutting	8.0	inFT	$.56	$0.00	$ 1	$ 4	
DEMO &	Remove 4"-6" Asphalt Pavement	0.6	SY	$5.46	$0.48	$5.94	$ 3	
REPLACEMENT	4" Ac Paving On 8" Abc	0.6	SY	$49.32	$3.95	$53.27	$ 30	
	TOTAL PAVING (per LF)							**$37.37**
FITTINGS	12" 90° Cldi Mj Bend	2	EA	$1,308.20	$0.00	$1,308.20	$2,616.39	
& VALVES	12" Dimj Awwa Butterfly Valve, No Op	1	EA	$781.92	$0.00	$781.92	$ 782	
	C.I. Valve Box	1	EA	$1,309.15	$0.00	$1,309.15	$ 1,309	
	Air Release Valve Assembly	1	EA	$1,045.32	$0.00	$1,045.32	$ 1,045	
	TOTAL (per Mile)						$ 5,753	
	TOTAL FITTING & VALVES (per LF)							**$1.09**
	OVERHEAD (10%)							**$11.65**
	CONSTRUCTION PROFIT (6%)							**$6.99**
	SALES TAX (65% of above costs at 9.8%)							**$7.42**
	CONTINGENCY (10%)							**$11.65**
	GENERAL CONDITIONS (0%)							**$0.00**
	TOTAL CONSTRUCTION COST, LF							**$154.27**
	TOTAL PROJECT COST (1.4 times Const Cost), LF							**$215.98**

Engineers...Working Wonders With Water™

ENR PRESENT:

PROJECT : Integrated Utility Master Plan — **LOCATION FACTOR:** 0.873

JOB # : 10490A.00 — **DATE :** April-17

CLIENT : City of Avondale — **ENR :** 10678

ELEMENT : Water Main Construction — **BY :** BCC

	DESCRIPTION	QUAN	UNIT	MATERIAL & LABOR	SUB	UNIT COST	SUBTOTAL	TOTAL
PIPE	12" Cl 52 Cldi Mj Pipe In Open Trench	1	LF	$42.42	$0.00	$ 42	$ 42	
	TOTAL PIPING (per LF)							**$42.42**
EXCAV	EARTHWORK							
& BACKFILL	Cat 225 Trackhoe, 1Cy Bucket, Class B (Medium Digging), 0-16' D	0.7	CY	$4.16	$0.00	$ 4	$ 3	
	Trench Bracing, 3' W X 10' D, Wood Planks & X-Bracing	1.0	LF	$13.97	$0.00	$ 14	$ 14	
	Imported Pipe Bed & Zone/Confined Structure Backfill, Class A Material	0.2	CY	$54.10	$0.00	$ 54	$ 10	
	Native Trench Backfill/Unconfined Struct. Bf, Class A Material	0.4	CY	$11.79	$0.00	$ 12	$ 5	
	10% Site Specific Requirements	1	LS	$3.24	$0.00	$ 3	$ 3	
	TOTAL EARTHWORK (per LF)							**$35.67**
PAVING	Asphalt Pavement Cutting	8.0	inFT	$.56	$0.00	$ 1	$ 4	
DEMO &	Remove 4"-6" Asphalt Pavement	0.6	SY	$5.46	$0.48	$5.94	$ 3	
REPLACEMENT	4" Ac Paving On 8" Abc	0.6	SY	$49.32	$3.95	$53.27	$ 30	
	TOTAL PAVING (per LF)							**$37.37**
FITTINGS	12" 90° Cldi Mj Bend	2	EA	$1,308.20	$0.00	$1,308.20	$2,616.39	
& VALVES	12" Dimj Awwa Butterfly Valve, No Op	1	EA	$781.92	$0.00	$781.92	$ 782	
	C.I. Valve Box	1	EA	$1,309.15	$0.00	$1,309.15	$ 1,309	
	Air Release Valve Assembly	1	EA	$1,045.32	$0.00	$1,045.32	$ 1,045	
	TOTAL (per 1/4 Mile)						$ 5,753	
	TOTAL FITTING & VALVES (per LF)							**$4.36**
	TOTAL HYDRANT (per LF)							**$17.31**
	OVERHEAD (10%)							**$13.71**
	CONSTRUCTION PROFIT (6%)							**$8.23**
	SALES TAX (65% of above costs at 9.8%)							**$8.73**
	CONTINGENCY (10%)							**$13.71**
	GENERAL CONDITIONS (0%)							**$0.00**
	TOTAL CONSTRUCTION COST, LF							**$181.51**
	TOTAL PROJECT COST (1.4 times Const Cost), LF							**$254.12**

Engineers...Working Wonders With Water™

ENR PRESENT:

PROJECT : **Integrated Utility Master Plan** — **LOCATION FACTOR:** **0.873**

JOB # : **10490A.00** — **DATE :** April-17

CLIENT : **City of Avondale** — **ENR :** 10678

ELEMENT : **Water Main Construction** — **BY :** BCC

	DESCRIPTION	QUAN	UNIT	MATERIAL & LABOR	SUB	UNIT COST	SUBTOTAL	TOTAL
PIPE	16" Cl 52 Cldi Mj Pipe In Open Trench	1	LF	$53.59	$0.00	$ 54	$ 54	
	TOTAL PIPING (per LF)							**$53.59**
EXCAV	EARTHWORK							
& BACKFILL	Cat 225 Trackhoe, 1Cy Bucket, Class B (Medium Digging), 0-16' D	0.9	CY	$4.16	$0.00	$ 4	$ 4	
	Trench Bracing, 3' W X 10' D, Wood Planks & X-Bracing	1.0	LF	$13.97	$0.00	$ 14	$ 14	
	Imported Pipe Bed & Zone/Confined Structure Backfill, Class A Material	0.2	CY	$54.10	$0.00	$ 54	$ 13	
	Native Trench Backfill/Unconfined Struct. Bf, Class A Material	0.6	CY	$11.79	$0.00	$ 12	$ 7	
	10% Site Specific Requirements	1	LS	$3.71	$0.00	$ 4	$ 4	
	TOTAL EARTHWORK (per LF)							**$40.86**
PAVING	Asphalt Pavement Cutting	8.0	inFT	$.56	$0.00	$ 1	$ 4	
DEMO &	Remove 4"-6" Asphalt Pavement	0.6	SY	$5.46	$0.48	$5.94	$ 4	
REPLACEMENT	4" Ac Paving On 8" Abc	0.6	SY	$49.32	$3.95	$53.27	$ 32	
	TOTAL PAVING (per LF)							**$39.56**
FITTINGS	16" 90° Cldi Mj Bend	2	EA	$2,176.57	$0.00	$2,176.57	$4,353.14	
& VALVES	16" Dimj Awwa Butterfly Valve, No Op	1	EA	$1,209.12	$0.00	$1,209.12	$ 1,209	
	C.I. Valve Box	1	EA	$1,309.15	$0.00	$1,309.15	$ 1,309	
	Air Release Valve Assembly	1	EA	$1,045.32	$0.00	$1,045.32	$ 1,045	
	TOTAL (per Mile)						$ 7,917	
	TOTAL FITTING & VALVES (per LF)							**$1.50**
	OVERHEAD (10%)							**$13.55**
	CONSTRUCTION PROFIT (6%)							**$8.13**
	SALES TAX (65% of above costs at 9.8%)							**$8.63**
	CONTINGENCY (10%)							**$13.55**
	GENERAL CONDITIONS (0%)							**$0.00**
	TOTAL CONSTRUCTION COST, LF							**$179.37**
	TOTAL PROJECT COST (1.4 times Const Cost), LF							**$251.12**

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Engineers...Working Wonders With Water™

PROJECT :	**Integrated Utility Master Plan**	**LOCATION FACTOR:**	**0.873**
JOB # :	**10490A.00**	**DATE :**	April-17
CLIENT :	**City of Avondale**	**ENR :**	10678
ELEMENT :	**Water Main Construction**	**BY :**	BCC

	DESCRIPTION	**QUAN**	**UNIT**	**MATERIAL & LABOR**	**SUB**	**UNIT COST**	**SUBTOTAL**	**TOTAL**
PIPE	24" Cl 52 Cldi Mj Pipe In Open Trench	1	LF	$107.19	$0.00	$ 107	$ 107	
	TOTAL PIPING (per LF)							**$107.19**
EXCAV	EARTHWORK							
& BACKFILL	Cat 225 Trackhoe, 1Cy Bucket, Class B (Medium Digging), 0-16' D	1.0	CY	$4.16	$0.00	$ 4	$ 4	
	Trench Bracing, 3' W X 10' D, Wood Planks & X-Bracing	1.0	LF	$13.97	$0.00	$ 14	$ 14	
	Imported Pipe Bed & Zone/Confined Structure Backfill, Class A Material	0.3	CY	$54.10	$0.00	$ 54	$ 18	
	Native Trench Backfill/Unconfined Struct. Bf, Class A Material	0.6	CY	$11.79	$0.00	$ 12	$ 7	
	10% Site Specific Requirements	1	LS	$4.30	$0.00	$ 4	$ 4	
	TOTAL EARTHWORK (per LF)							**$47.32**
PAVING	Asphalt Pavement Cutting	8.0	inFT	$.56	$0.00	$ 1	$ 4	
DEMO &	Remove 4"-6" Asphalt Pavement	0.7	SY	$5.46	$0.48	$5.94	$ 4	
REPLACEMENT	4" Ac Paving On 8" Abc	0.7	SY	$49.32	$3.95	$53.27	$ 36	
	TOTAL PAVING (per LF)							**$43.95**
FITTINGS	24" 90° Cldi Mj Bend	2	EA	$4,085.30	$0.00	$4,085.30	$8,170.60	
& VALVES	24" 150# Fxf Awwa Butterfly Valve, No Op	1	EA	$8,992.15	$0.00	$8,992.15	$ 2,514	
	C.I. Valve Box	1	EA	$1,309.15	$0.00	$1,309.15	$ 1,309	
	Air Release Valve Assembly	1	EA	$1,045.32	$0.00	$1,045.32	$ 1,045	
	TOTAL (per Mile)						$ 13,039	
	TOTAL FITTING & VALVES (per LF)							**$2.47**
	OVERHEAD (10%)							**$20.09**
	CONSTRUCTION PROFIT (6%)							**$12.06**
	SALES TAX (65% of above costs at 9.8%)							**$12.80**
	CONTINGENCY (10%)							**$20.09**
	GENERAL CONDITIONS (0%)							**$0.00**
	TOTAL CONSTRUCTION COST, LF							**$265.96**
TOTAL PROJECT COST (1.4 times Const Cost), LF								**$372.34**

Engineers...Working Wonders With Water®

BOOSTER STATIONS - ESTIMATED CONSTRUCTION COSTS

Size (mgd)	Number of Pumps	Firm Capacity (gpm)	Construction Cost ($)	Project Cost ($)	Dollars Per Gallon ($/gal)
1.5	2	1,400	$1,416,000	$ 1,982,000	**$0.94**
2	2	1,400	$1,711,000	$ 2,395,000	**$0.86**
3	3	2,800	$2,012,000	$ 2,817,000	**$0.67**
4	3	2,800	$2,160,000	$ 3,024,000	**$0.54**
6	4	4,200	$2,559,000	$ 3,583,000	**$0.43**
8	5	5,600	$3,345,000	$ 4,683,000	**$0.42**
10	4	7,000	$3,846,000	$ 5,384,000	**$0.38**
12	4	8,400	$4,203,000	$ 5,884,000	**$0.35**
16	5	11,200	$5,160,000	$ 7,224,000	**$0.32**

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ENR for Apr-2017	10678

COST ESTIMATE

PROJECT:	4 MGD BOOSTER STATION	ESTIMATOR:	BCC
JOB NO.:	10490A.00	DATE:	1-May-17
CLIENT:	City of Avondale		

ITEM NO.	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	Mobilization and Demobilization (10%)	1	LS	$ 128,854.28	$ 128,854
2	Material Testing	1	LS	$ 3,466.88	$ 3,467
3	Piping - 16" MJ DIP	300	LF	$ 55.06	$ 16,518
4	16" DIP MJ Fittings	4	EA	$ 3,079.59	$ 12,318
5	125 hp Vertical Turbine Pump w/ Pump Can	3	EA	$ 53,760.00	$ 161,280
6	12" Discharge Piping FL DIP (10 FT per pump)	3	EA	$ 1,072.97	$ 3,219
7	12" FL Check Valve	3	EA	$ 5,801.99	$ 17,406
8	12" FL BFV	3	EA	$ 3,120.98	$ 9,363
9	16" DIP FL Fittings	4	EA	$ 3,079.59	$ 12,318
10	16" DIP FL Pipe - Manifold	30	LF	$ 181.04	$ 5,431
11	12" Flowmeter	1	EA	$ 8,288.88	$ 8,289
12	16" Reducers	2	EA	$ 1,066.57	$ 2,133
13	16" FL BFVs	2	EA	$ 2,576.86	$ 5,154
14	Pressure Transmitters and Instrumentation	2	LS	$ 8,320.52	$ 16,641
15	Piping Support Pad - (10'x20'x12")	7.5	CY	$ 624.04	$ 4,680
16	Misc Pipe Supports	1	LS	$ 1,920.00	$ 1,920
17	Chlorine Fiberglass Enclosure	1	LS	$ 8,960.00	$ 8,960
18	Chlorine Building Slab (6'x6'x8")	1	CY	$ 317.37	$ 317
19	Chlorine Equipment & Piping	1	LS	$ 4,480.00	$ 4,480
20	5,000 gallon hydromatic tank w/ air comp & controls	1	LS	$ 232,974.55	$ 232,975
21	Tank and A/C Pad (10'x20'x12")	7.5	CY	$ 624.04	$ 4,680
22	Electrical Service, Swichgear, Panels, Wiring, and Conduit	1	LS	$ 307,576.80	$ 307,577
23	125 hp Motor VFDs	3	EA	$ 45,762.86	$ 137,289
24	Electrical Pre-Cast Vault/Buidling	1	LS	$ 69,337.66	$ 69,338
25	Emergency Generator w/ Fuel Tank	1	LS	$ 79,599.64	$ 79,600
26	Generator Pad (15'x20'x18")	17	CY	$ 624.04	$ 10,609
27	RTU in NEMA Enclosure with Antenna	1	LS	$ 27,735.06	$ 27,735
28	Pole & Base	1	LS	$ 693.38	$ 693
29	Security Allowance	1	LS	$ 10,400.65	$ 10,401
30	Site Lighting	4	EA	$ 3,882.91	$ 15,532
31	Access Gate	1	EA	$ 2,080.13	$ 2,080
32	CMU Wall	590	LF	$ 140.73	$ 83,033
33	Site 4" ABC Finish	21780	SF	$ 0.43	$ 9,363
34	Concrete Drive	1	EA	$ 1,386.75	$ 1,387
35	Asphalt Driveway	1	LS	$ 2,357.48	$ 2,357
36	Contractor Overhead & Profit (16%)				$ 226,783.53
37	Sales Tax (65% of above costs at 9.8%)				$ 90,288.19
38	Contingency (15%)				$ 212,609.56
39	General Conditions (15%)				$ 212,609.56
	TOTAL CONSTRUCTION COST				$ 2,160,000.00
	TOTAL PROJECT COST				$ 3,024,000.00

Engineers...Working Wonders With Water®

ENR for Apr-2017	10678

COST ESTIMATE

PROJECT: 4,400 GPM BOOSTER STATION
JOB NO.: 10490A.00
CLIENT: City of Avondale

ESTIMATOR: BCC
DATE: 1-May-17

ITEM NO.	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	Mobilization and Demobilization	1	LS	$ 152,658.38	$ 152,658.38
2	Material Testing	1	LS	$ 3,466.88	$ 3,466.88
3	Piping - 20" MJ DIP	300	LF	$ 72.38	$ 21,714.00
4	20" DIP MJ Fittings	4	EA	$ 4,947.11	$ 19,788.43
5	125 hp Vertical Turbine Pump w/ Pump Can	4	EA	$ 58,243.64	$ 232,974.55
6	12" Discharge Piping FL DIP (10 FT per pump)	4	EA	$ 2,919.89	$ 11,679.57
7	12" FL Check Valve	4	EA	$ 5,801.99	$ 23,207.94
8	12" FL BFV	4	EA	$ 1,954.96	$ 7,819.83
9	20" DIP FL Fittings	4	EA	$ 5,817.68	$ 23,270.74
10	20" DIP FL Pipe - Manifold	30	LF	$ 283.53	$ 8,505.94
11	20" Flowmeter	1	EA	$ 16,409.97	$ 16,409.97
12	20" Reducers	2	EA	$ 1,488.06	$ 2,976.12
13	20" Fxf BFVs	2	EA	$ 7,696.75	$ 15,393.49
14	Pressure Transmitters and Instrumentation	2	LS	$ 8,320.52	$ 16,641.04
15	Piping Support Pad - (10'x20'x12")	7.5	CY	$ 624.04	$ 4,680.29
16	Misc Pipe Supports	1	LS	$ 2,080.13	$ 2,080.13
17	Chlorine Fiberglass Enclosure	1	LS	$ 9,707.27	$ 9,707.27
18	Chlorine Building Slab (6'x6'x8")	1	CY	$ 440.11	$ 440.11
19	Chlorine Equipment & Piping	1	LS	$ 4,853.64	$ 4,853.64
20	5,000 gallon hydromatic tank w/ air comp & controls	1	LS	$ 173,275.20	$ 173,275.20
21	Tank and A/C Pad (10'x20'x12")	7.5	CY	$ 624.04	$ 4,680.29
22	Electrical Service, Swichgear, Panels, Wiring, and Conduit	1	LS	$ 359,222.74	$ 359,222.74
23	125 hp Motor VFDs	4	EA	$ 45,762.86	$ 183,051.43
24	Electrical Pre-Cast Vault/Buidling	1	LS	$ 69,337.66	$ 69,337.66
25	Emergency Generator w/ Fuel Tank	1	LS	$ 145,609.09	$ 145,609.09
26	Generator Pad (15'x20'x18")	17	CY	$ 624.04	$ 10,608.66
27	RTU in NEMA Enclosure with Antenna	1	LS	$ 27,735.06	$ 27,735.06
28	Pole & Base	1	LS	$ 693.38	$ 693.38
29	Security Allowance	1	LS	$ 10,400.65	$ 10,400.65
30	Site Lighting	4	EA	$ 3,882.91	$ 15,531.64
31	Access Gate	1	EA	$ 2,080.13	$ 2,080.13
32	CMU Wall	590	LF	$ 145.15	$ 85,640.62
33	Site 4" ABC Finish	21780	SF	$ 0.43	$ 9,363.08
34	Concrete Drive	1	EA	$ 1,386.75	$ 1,386.75
35	Asphalt Driveway	1	LS	$ 2,357.48	$ 2,357.48
36	Contractor Overhead & Profit (16%)				$ 268,678.75
37	Sales Tax (65% of above costs at 9.8%)				$ 106,967.73
38	Contingency (15%)				$ 251,886.33
39	General Conditions (15%)				$ 251,886.33
	TOTAL CONSTRUCTION COST				$ 2,559,000.00
	TOTAL PROJECT COST				$ 3,582,600.00

Engineers...Working Wonders With Water®

ENR for Apr-2017	10678

COST ESTIMATE

PROJECT:	8 MGD BOOSTER STATION	ESTIMATOR:	BCC
JOB NO.:	10490A.00	DATE:	1-May-17
CLIENT:	City of Avondale		

ITEM NO.	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	Mobilization and Demobilization (10%)	1	LS	$ 167,496.24	$ 167,496
2	Material Testing	1	LS	$ 3,466.88	$ 3,467
3	Piping - 24" MJ DIP	300	LF	$ 108.47	$ 32,541
4	24" DIP MJ Fittings	4	EA	$ 6,380.72	$ 25,523
5	125 hp Vertical Turbine Pump w/ Pump Can	5	EA	$ 58,243.64	$ 291,218
6	12" Discharge Piping FL DIP (10 FT per pump)	5	EA	$ 2,919.89	$ 14,599
7	12" FL Check Valve	5	EA	$ 5,801.99	$ 29,010
8	12" FL BFV	5	EA	$ 1,954.96	$ 9,775
9	24" DIP FL Fittings	4	EA	$ 4,745.67	$ 18,983
10	24" DIP FL Pipe - Manifold	30	LF	$ 291.99	$ 8,760
11	20" Flowmeter	1	EA	$ 17,778.58	$ 17,779
12	24" Reducers	2	EA	$ 1,909.55	$ 3,819
13	24" FL BFVs	2	EA	$ 5,642.90	$ 11,286
14	Pressure Transmitters and Instrumentation	2	LS	$ 8,320.52	$ 16,641
15	Piping Support Pad - (10'x20'x12")	7.5	CY	$ 624.04	$ 4,680
16	Misc Pipe Supports	1	LS	$ 2,080.13	$ 2,080
17	5,000 gallon hydromatic tank w/ air comp & controls	1	LS	$ 232,974.55	$ 232,975
18	Tank and A/C Pad (10'x20'x12")	7.5	CY	$ 624.04	$ 4,680
19	Electrical Service, Swichgear, Panels, Wiring, and Conduit	1	LS	$ 425,309.38	$ 425,309
20	125 hp Motor VFDs	5	EA	$ 45,762.86	$ 228,814
21	Electrical Pre-Cast Vault/Buidling	1	LS	$ 69,337.66	$ 69,338
22	Emergency Generator w/ Fuel Tank	1	LS	$ 145,609.09	$ 145,609
23	Generator Pad (15'x20'x18")	17	CY	$ 624.04	$ 10,609
24	RTU in NEMA Enclosure with Antenna	1	LS	$ 27,735.06	$ 27,735
25	Pole & Base	1	LS	$ 693.38	$ 693
26	Security Allowance	1	LS	$ 10,400.65	$ 10,401
27	Site Lighting	4	EA	$ 3,882.91	$ 15,532
28	Site 4" ABC Finish	21780	SF	$ 0.43	$ 9,363
29	Concrete Drive	1	EA	$ 1,386.75	$ 1,387
30	Asphalt Driveway	1	LS	$ 2,357.48	$ 2,357
31	20% Site Specific Requirements				$ 368,491.72
32	Contractor Overhead & Profit (16%)				$ 353,752.05
33	Sales Tax (65% of above costs at 9.8%)				$ 117,364.61
34	Contingency (15%)				$ 331,642.55
35	General Conditions (15%)				$ 331,642.55
	TOTAL CONSTRUCTION COST				$ 3,345,000.00
	TOTAL PROJECT COST				$ 4,683,000.00

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ENR for Apr-2017	10678

COST ESTIMATE

PROJECT:	10 MGD BOOSTER STATION		ESTIMATOR:	BCC
JOB NO.:	10490A.00		DATE:	1-May-17
CLIENT:	City of Avondale			

ITEM NO.	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	Mobilization and Demobilization (10%)	1	LS	$ 151,786.39	$ 151,786.39
2	Material Testing	1	LS	$ 3,466.88	$ 3,466.88
3	Piping - 24" MJ DIP	300	LF	$ 108.47	$ 32,541.00
4	24" DIP MJ Fittings	4	EA	$ 6,380.72	$ 25,522.86
5	250hp Vertical Turbine Pump w/ Pump Can	3	EA	$ 72,804.55	$ 218,413.64
6	125 hp Vertical Turbine Pump w/ Pump Can	1	EA	$ 58,243.64	$ 58,243.64
7	16" Discharge Piping FL DIP (10 FT per pump)	4	EA	$ 1,270.89	$ 5,083.56
8	16" FL Check Valve	4	EA	$ 18,981.24	$ 75,924.94
9	16" FL BFV	4	EA	$ 5,058.66	$ 20,234.62
10	24" DIP FL Fittings	4	EA	$ 6,380.72	$ 25,522.86
11	24" DIP FL Pipe - Manifold	30	LF	$ 291.99	$ 8,759.68
12	20" Flowmeter	1	EA	$ 17,778.58	$ 17,778.58
13	24" Reducers	2	EA	$ 2,118.45	$ 4,236.91
14	24" FL BFVs	2	EA	$ 5,642.90	$ 11,285.81
15	Pressure Transmitters and Instrumentation	2	LS	$ 8,320.52	$ 16,641.04
16	Piping Support Pad - (10'x20'x12")	7.5	CY	$ 624.04	$ 4,680.29
17	Misc Pipe Supports	1	LS	$ 2,080.13	$ 2,080.13
18	Chlorine Fiberglass Enclosure	1	LS	$ 9,707.27	$ 9,707.27
19	Chlorine Building Slab (6'x6'x8")	1	CY	$ 327.34	$ 327.34
20	Chlorine Equipment & Piping	1	LS	$ 4,853.64	$ 4,853.64
21	10,000 gallon hydromatic tank w/ air comp & controls	1	LS	$ 216,594.00	$ 216,594.00
22	Tank and A/C Pad (10'x20'x12")	7.5	CY	$ 624.04	$ 4,680.29
23	Electrical Service, Swichgear, Panels, Wiring, and Conduit	1	LS	$ 517,033.50	$ 517,033.50
24	250 hp Motor VFDs	3	EA	$ 138,675.32	$ 416,025.97
25	125 hp Motor VFDs	1	EA	$ 45,762.86	$ 45,762.86
26	Electrical Pre-Cast Vault/Buidling	1	LS	$ 69,337.66	$ 69,337.66
27	Emergency Generator w/ Fuel Tank	1	LS	$ 159,199.27	$ 159,199.27
28	Generator Pad (15'x20'x18")	17	CY	$ 624.04	$ 10,608.66
29	RTU in NEMA Enclosure with Antenna	1	LS	$ 27,735.06	$ 27,735.06
30	Pole & Base	1	LS	$ 693.38	$ 693.38
31	Security Allowance	1	LS	$ 10,400.65	$ 10,400.65
32	Site Lighting	4	EA	$ 3,882.91	$ 15,531.64
33	Access Gate	1	EA	$ 2,080.13	$ 2,080.13
34	CMU Wall	590	LF	$ 140.73	$ 83,033.37
35	Site 4" ABC Finish	21780	SF	$ 0.43	$ 9,363.08
36	Concrete Drive	1	EA	$ 1,386.75	$ 1,386.75
37	Asphalt Driveway	1	LS	$ 2,357.48	$ 2,357.48
38	20% Site Specific Requirements				$ 358,771
39	Contractor Overhead & Profit (16%)				$ 366,226.38
40	Sales Tax (65% of above costs at 9.8%)				$ 145,565.37
41	Contingency (15%)				$ 343,337.23
42	General Conditions (15%)				$ 343,337.23
	TOTAL CONSTRUCTION COST				$ 3,846,000.00
	TOTAL PROJECT COST				$ 5,384,400.00

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ENR for Apr-2017	10678

COST ESTIMATE

PROJECT: 12 MGD BOOSTER STATION
JOB NO.: 10490A.00
CLIENT: City of Avondale

ESTIMATOR: BCC
DATE: 1-May-17

ITEM NO.	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	Mobilization and Demobilization (10%)	1	LS	$ 221,684.31	$ 221,684.31
2	Material Testing	1	LS	$ 3,466.88	$ 3,466.88
3	Piping - 24" MJ DIP	300	LF	$ 108.47	$ 32,541.00
4	24" DIP MJ Fittings	4	EA	$ 6,380.72	$ 25,522.86
5	250 hp Vertical Turbine Pump w/ Pump Can	4	EA	$ 72,804.55	$ 291,218.18
6	16" Discharge Piping FL DIP (10 FT per pump)	4	EA	$ 1,544.52	$ 6,178.09
7	16" FL Check Valve	4	EA	$ 18,981.24	$ 75,924.94
8	16" FL BFV	4	EA	$ 5,058.66	$ 20,234.62
9	24" DIP FL Fittings	4	EA	$ 6,380.72	$ 25,522.86
10	24" DIP FL Pipe - Manifold	30	LF	$ 291.99	$ 8,759.68
11	20" Flowmeter	1	EA	$ 17,778.58	$ 17,778.58
12	24" Reducers	2	EA	$ 2,118.45	$ 4,236.91
13	24" FL BFVs	2	EA	$ 5,642.90	$ 11,285.81
14	Pressure Transmitters and Instrumentation	2	LS	$ 8,320.52	$ 16,641.04
15	Piping Support Pad - (10'x20'x12")	7.5	CY	$ 624.04	$ 4,680.29
16	Misc Pipe Supports	1	LS	$ 2,080.13	$ 2,080.13
17	10,000 gallon hydromatic tank w/ air comp & controls	1	LS	$ 216,594.00	$ 216,594.00
18	Tank and A/C Pad (10'x20'x12")	7.5	CY	$ 624.04	$ 4,680.29
19	Electrical Service, Swichgear, Panels, Wiring, and Conduit	1	LS	$ 570,226.02	$ 570,226.02
20	250 hp Motor VFDs	4	EA	$ 138,675.32	$ 554,701.30
21	Electrical Pre-Cast Vault/Buidling	1	LS	$ 69,337.66	$ 69,337.66
22	Emergency Generator w/ Fuel Tank	1	LS	$ 184,438.18	$ 184,438.18
23	Generator Pad (15'x20'x18")	17	CY	$ 624.04	$ 10,608.66
24	RTU in NEMA Enclosure with Antenna	1	LS	$ 27,735.06	$ 27,735.06
25	Pole & Base	1	LS	$ 693.38	$ 693.38
26	Security Allowance	1	LS	$ 10,400.65	$ 10,400.65
27	Site Lighting	4	EA	$ 3,882.91	$ 15,531.64
28	Access Gate	1	EA	$ 2,080.13	$ 2,080.13
29	Concrete Drive	1	EA	$ 1,386.75	$ 1,386.75
30	Asphalt Driveway	1	LS	$ 2,357.48	$ 2,357.48
31	20% Site Specific Requirements				$ 487,705.48
32	Contractor Overhead & Profit (16%)				$ 390,164.38
33	Sales Tax (65% of above costs at 9.8%)				$ 155,334.19
34	Contingency (15%)				$ 365,779.11
35	General Conditions (15%)				$ 365,779.11
	TOTAL CONSTRUCTION COST				$ 4,203,000.00
	TOTAL PROJECT COST				$ 5,884,200.00

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ENR for Apr-2017	10678

COST ESTIMATE

PROJECT:	16 MGD BOOSTER STATION	ESTIMATOR:	BCC
JOB NO.:	10490A.00	DATE:	1-May-17
CLIENT:	City of Avondale		

ITEM NO.	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	Mobilization and Demobilization (10%)	1	LS	$ 279,567.69	$ 279,567.69
2	Material Testing	1	LS	$ 3,466.88	$ 3,466.88
3	Piping - 24" MJ DIP	300	LF	$ 108.47	$ 32,541.00
4	24" DIP MJ Fittings	4	EA	$ 6,380.72	$ 25,522.86
5	250 hp Vertical Turbine Pump w/ Pump Can	5	EA	$ 72,804.55	$ 364,022.73
6	16" Discharge Piping FL DIP (10 FT per pump)	5	EA	$ 1,544.51	$ 7,722.57
7	16" FL Check Valve	5	EA	$ 18,981.15	$ 94,905.75
8	16" FL BFV	5	EA	$ 5,058.63	$ 25,293.17
9	30" DIP FL Fittings	4	EA	$ 11,208.16	$ 44,832.62
10	30" DIP FL Pipe - Manifold	30	LF	$ 726.53	$ 21,796.02
11	24" Flowmeter	1	EA	$ 21,513.76	$ 21,513.76
12	30" Reducers	2	EA	$ 3,468.25	$ 6,936.51
13	30" FL BFVs	2	EA	$ 9,831.93	$ 19,663.86
14	Pressure Transmitters and Instrumentation	2	LS	$ 8,320.52	$ 16,641.04
15	Piping Support Pad - (10'x20'x12")	7.5	CY	$ 624.04	$ 4,680.29
16	Misc Pipe Supports	1	LS	$ 3,466.88	$ 3,466.88
17	Chlorine Fiberglass Enclosure	1	LS	$ 9,707.27	$ 9,707.27
18	Chlorine Building Slab (6'x6'x8")	1	CY	$ 624.04	$ 624.04
19	Chlorine Equipment & Piping	1	LS	$ 4,853.64	$ 4,853.64
20	10,000 gallon hydromatic tank w/ air comp & controls	1	LS	$ 216,593.02	$ 216,593.02
21	Tank and A/C Pad (10'x20'x12")	7.5	CY	$ 624.04	$ 4,680.29
22	Electrical Service, Swichgear, Panels, Wiring, and Conduit	1	LS	$ 688,495.32	$ 688,495.32
23	250 hp Motor VFDs	5	EA	$ 138,675.32	$ 693,376.62
24	Electrical Pre-Cast Vault/Buidling	1	LS	$ 69,337.66	$ 69,337.66
25	Emergency Generator w/ Fuel Tank	1	LS	$ 252,389.09	$ 252,389.09
26	Generator Pad (15'x20'x18")	17	CY	$ 624.04	$ 10,608.66
27	RTU in NEMA Enclosure with Antenna	1	LS	$ 27,735.06	$ 27,735.06
28	Pole & Base	1	LS	$ 693.38	$ 693.38
29	Security Allowance	1	LS	$ 10,400.65	$ 10,400.65
30	Site Lighting	4	EA	$ 3,882.91	$ 15,531.64
31	Access Gate	1	EA	$ 2,080.13	$ 2,080.13
32	CMU Wall	590	LF	$ 140.27	$ 82,759.16
33	Site 4" ABC Finish	21780	SF	$ 0.42	$ 9,061.05
34	Concrete Drive	1	EA	$ 1,386.75	$ 1,386.75
35	Asphalt Driveway	1	LS	$ 2,357.48	$ 2,357.48
36	20% Site Specific Requirements				$ 474,025
37	Contractor Overhead & Profit (16%)				$ 492,039.13
38	Sales Tax (65% of above costs at 9.8%)				$ 195,893.08
39	Contingency (15%)				$ 461,286.68
35	General Conditions (15%)				$ 461,286.68
	TOTAL CONSTRUCTION COST				$ 5,160,000.00
	TOTAL PROJECT COST				$ 7,224,000.00

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Above ground steel storage tank and appurtenances unit costs

Tank Volume (MG)	Tank Dimensions		Construction Cost ($)	Project Cost ($)
	Height (ft)	Diameter (ft)		
1	16	103	$2,078,000	$ 2,909,000
1.5	16	126	$2,400,000	$ 3,360,000
2	24	119	$2,744,000	$ 3,842,000
2.5	24	133	$3,234,000	$ 4,528,000
3	24	146	$3,711,000	$ 5,195,000
3.5	24	158	$4,147,000	$ 5,806,000
4	24	168	$4,625,000	$ 6,475,000
4.5	24	179	$5,067,000	$ 7,094,000
5	32	163	$5,515,000	$ 7,721,000
8	32	206	$8,059,000	$ 11,283,000
(ENR CCI =10678)				

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COST ESTIMATE

ENR for Apr-2017	10678

PROJECT:	1 MG Tank	ESTIMATOR:	BCC
JOB NO.:	10490A.00	DATE:	1-May-17
CLIENT:	City of Avondale		

ITEM NO.	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	Material Test	1	LS	$ 3,470	$ 3,470
2	Site Grading	10000	CY	$ 48	$ 479,100
3	Piping - 24" MJ DIP	300	LF	$ 110	$ 32,500
4	24" DIP MJ Fittings	8	EA	$ 6,400	$ 51,000
5	24" DIP Valve	3	EA	$ 6,700	$ 20,100
6	Backfill	2800	CY	$ 10	$ 28,000
7	Vapor Barrier	8000	SF	$ 1	$ 3,880
8	1.0 MG Steel Tank	1	LS	$ 725,500	$ 725,500
9	Level Transmitter and Instrumentation	1	LS	$ 10,400	$ 10,400
10	Tank Painting	3650	SF	$ 2.60	$ 9,600
11	Contractor Overhead & Profit (16%)				$ 218,170
12	Sales Tax (65% of above costs at 9.8%)				$ 86,860
13	Contingency (15%)				$ 204,530
14	General Conditions (15%)				$ 204,530
	TOTAL CONSTRUCTION COST				$ 2,078,000
	TOTAL PROJECT COST				$ 2,909,000

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COST ESTIMATE

ENR for Apr-2017	10678

PROJECT:	2 MG TANK	ESTIMATOR:	BCC
JOB NO.:	10490A.00	DATE:	1-May-17
CLIENT:	City of Avondale		

ITEM NO.	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	Material Test	1	LS	$ 3,466.88	$ 3,466.88
2	Site Grading	10000	CY	$ 47.91	$ 479,123.25
3	Piping - 24" MJ DIP	300	LF	$ 108.47	$ 32,541.00
4	24" DIP MJ Fittings	8	EA	$ 6,380.45	$ 51,043.61
5	24" DIP Valve	3	EA	$ 6,697.71	$ 20,093.14
6	Backfill	4150	CY	$ 10.00	$ 41,500.00
7	Vapor Barrier	10600	SF	$ 0.49	$ 5,144.85
8	2 MG Steel Tank	1	LS	$ 1,148,000.00	$ 1,148,000.00
9	Level Transmitter and Instrumentation	1	LS	$ 10,400.65	$ 10,400.65
10	Tank Painting	3650	SF	$ 2.63	$ 9,617.13
11	Contractor Overhead & Profit (16%)				$ 288,150
12	Sales Tax (65% of above costs at 9.8%)				$ 114,720
13	Contingency (15%)				$ 270,140
14	General Conditions (15%)				$ 270,140
	TOTAL CONSTRUCTION COST				$ 2,744,000
	TOTAL PROJECT COST				$ 3,842,000

ENR for Apr-2017	10678

COST ESTIMATE

PROJECT: 3.0 MG TANK
JOB NO.: 10490A.00
CLIENT: City of Avondale

ESTIMATOR: BCC
DATE: 1-May-17

ITEM NO.	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	Material Test	1	LS	$ 3,466.88	$ 3,466.88
2	Site Grading	10,000	CY	$ 47.91	$ 479,123.25
3	Piping - 24" MJ DIP	300	LF	$ 83.80	$ 25,140.41
4	24" DIP MJ Fittings	8	EA	$ 6,380.45	$ 51,043.61
5	24" DIP Valve	3	EA	$ 17,547.83	$ 52,643.49
6	Backfill	5,500	CY	$ 10.00	$ 55,000.00
7	Vapor Barrier	14,300	SF	$ 0.49	$ 6,940.70
8	3.0 MG Steel Tank	1	LS	$ 1,740,500.00	$ 1,740,500.00
9	Level Transmitter and Instrumentation	1	LS	$ 10,400.65	$ 10,400.65
10	Tank Painting	4,240	SF	$ 2.63	$ 11,171.68
11	Contractor Overhead & Profit (16%)				$ 389,670
12	Sales Tax (65% of above costs at 9.8%)				$ 155,140
13	Contingency (15%)				$ 365,310
14	General Conditions (15%)				$ 365,310
	TOTAL CONSTRUCTION COST				$ 3,711,000
	TOTAL PROJECT COST				$ 5,195,000

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ENR for Apr-2017	10678

COST ESTIMATE

PROJECT: 4.0 MG TANK

JOB NO.: 10490A.00

CLIENT: City of Avondale

ESTIMATOR: BCC

DATE: 1-May-17

ITEM NO.	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	Material Test	1	LS	$ 3,466.88	$ 3,466.88
2	Site Grading	10,000	CY	$ 47.91	$ 479,123.25
3	Piping - 24" MJ DIP	300	LF	$ 108.47	$ 32,541.00
4	24" DIP MJ Fittings	8	EA	$ 6,380.45	$ 51,043.61
5	24" DIP Valve	3	EA	$ 12,880.27	$ 38,640.81
6	Backfill	6,630	CY	$ 10.00	$ 66,300.00
7	Vapor Barrier	17,700	SF	$ 0.49	$ 8,590.94
8	4.0 MG Steel Tank	1	LS	$ 2,333,000.00	$ 2,333,000.00
9	Level Transmitter and Instrumentation	1	LS	$ 10,400.65	$ 10,400.65
10	Tank Painting	4,700	SF	$ 2.63	$ 12,383.71
11	Contractor Overhead & Profit (16%)				$ 485,680
12	Sales Tax (65% of above costs at 9.8%)				$ 193,360
13	Contingency (15%)				$ 455,320
14	General Conditions (15%)				$ 455,320
	TOTAL CONSTRUCTION COST				$ 4,625,000
	TOTAL PROJECT COST				$ 6,475,000

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ENR for Apr-2017	10678

COST ESTIMATE

PROJECT: 5.0 MG TANK
JOB NO.: 10490A.00
CLIENT: City of Avondale

ESTIMATOR: BCC
DATE: 1-May-17

ITEM NO.	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	Material Test	1	LS	$ 3,466.88	$ 3,466.88
2	Site Grading	10,000	CY	$ 47.91	$ 479,123.25
3	Piping - 24" MJ DIP	300	LF	$ 108.47	$ 32,541.00
4	24" DIP MJ Fittings	8	EA	$ 6,380.45	$ 51,043.61
5	24" DIP Valve	3	EA	$ 24,769.85	$ 74,309.54
6	Backfill	7,540	CY	$ 10.00	$ 75,400.00
7	Vapor Barrier	21,400	SF	$ 0.49	$ 10,386.78
8	5.0 MG Steel Tank	1	LS	$ 2,869,000.00	$ 2,869,000.00
9	Level Transmitter and Instrumentation	1	LS	$ 10,400.65	$ 10,400.65
10	Tank Painting	5,190	SF	$ 2.63	$ 13,674.77
11	Contractor Overhead & Profit (16%)				$ 579,100
12	Sales Tax (65% of above costs at 9.8%)				$ 230,550
13	Contingency (15%)				$ 542,900
14	General Conditions (15%)				$ 542,900
	TOTAL CONSTRUCTION COST				$ 5,515,000
	TOTAL PROJECT COST				$ 7,721,000

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ENR for Apr-2017	10678

COST ESTIMATE

PROJECT: 8.0 MG TANK
JOB NO.: 10490A.00
CLIENT: City of Avondale

ESTIMATOR: BCC
DATE: 1-May-17

ITEM NO.	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	Material Test	1	LS	$ 3,466.88	$ 3,466.88
2	Site Grading	10,000	CY	$ 47.91	$ 479,123.25
3	Piping - 24" MJ DIP	300	LF	$ 108.47	$ 32,541.00
4	24" DIP MJ Fittings	8	EA	$ 6,380.45	$ 51,043.61
5	24" DIP Valve	3	EA	$ 34,349.66	$ 103,048.99
6	Backfill	10,360	CY	$ 10.00	$ 103,600.00
7	Vapor Barrier	30,480	SF	$ 0.49	$ 14,793.88
8	8.0 MG Tank Construction	1	LS	$ 4,475,000.00	$ 4,475,000.00
9	Level Transmitter and Instrumentation	1	LS	$ 10,400.65	$ 10,400.65
10	Tank Painting	6,190	SF	$ 2.63	$ 16,309.60
11	Contractor Overhead & Profit (16%)				$ 846,290
12	Sales Tax (65% of above costs at 9.8%)				$ 336,930
13	Contingency (15%)				$ 793,400
14	General Conditions (15%)				$ 793,400
	TOTAL CONSTRUCTION COST				$ 8,059,000
	TOTAL PROJECT COST				$ 11,283,000

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Well Unit Costs

Flowrate (gpm)	Depth (ft)	Drilling Cost ($)	Equipping Cost ($)	Well Construction Cost ($)	Project Cost ($)
750	1100	$1,046,000	$ 895,000	$ 1,941,000	$2,717,000
1400	1100	$1,544,000	$ 1,298,000	$ 2,842,000	$3,979,000
(ENR CCI =10678)					

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ENR for Apr-2017	10678

COST ESTIMATE

PROJECT: DRILL WELL - 700 FT DEEP

JOB NO.: Integrated Utility Master Plan

CLIENT: City of Avondale

ESTIMATOR: BCC

DATE: 1-May-17

ITEM NO.	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	Mobilization and Demobilization	1	LS	$ 62,428.96	$ 62,428.96
2	Well Drilling	700	LF	$ 152.54	$ 106,780.00
3	Casing & Gravel Pack Installation	500	LF	$ 485.36	$ 242,681.82
4	Stainless Steel Screen & Gravel Pack Installation	200	LF	$ 763.97	$ 152,793.50
5	Well Logging and Sampling	1	LS	$ 69,337.66	$ 69,337.66
6	Well Development and Testing	1	LS	$ 52,696.62	$ 52,696.62
7	Contractor Overhead & Profit (16%)				$ 109,870
8	Sales Tax (65% of above costs at 9.8%)				$ 43,740
9	Contingency (15%)				$ 103,010
10	General Conditions (15%)				$ 103,010
	Construction Cost				$ 1,046,000
	Project Cost				$ 1,464,000

ENR for Apr-2017	10678

COST ESTIMATE

PROJECT:	WELL SITE - 150 HP, 750 GPM	ESTIMATOR:	BCC
JOB NO.:	Integrated Utility Master Plan	DATE:	1-May-17
CLIENT:	City of Avondale		

ITEM NO.	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	Mobilization and Demobilization	1	LS	$ 53,423.77	$ 53,423.77
2	150HP Well Pump & 400 ft Pipe Column	1	LS	$ 104,006.49	$ 104,006.49
3	Well Pad (6' x 6' 12")	1.5	CY	$ 624.04	$ 936.06
4	Piping Support Pad - (6'x12'x8")	1.75	CY	$ 624.04	$ 1,092.07
5	Piping - 10" MJ DIP & Excavation	300	LF	$ 121.07	$ 1,092.07
6	10" DIP MJ Fittings	8	EA	$ 2,047.71	$ 16,381.66
7	10" DIP BF Valve	2	EA	$ 2,480.28	$ 4,960.56
8	10" DIP Check Valve	2	EA	$ 5,147.27	$ 10,294.54
9	Misc Pipe Supports	1	LS	$ 693.38	$ 693.38
10	Shade Cover over Electrical Equipment	200	SF	$ 27.74	$ 5,547.01
11	Electrical Equipment Slab (10' x 20' x 8")	5	CY	$ 554.70	$ 2,773.51
12	Electrical Serivce, Conduit & Wiring	1	LS	$ 312,019.48	$ 312,019.48
13	RTU in NEMA Enclosure with Antenna	1	LS	$ 27,735.06	$ 27,735.06
14	Pole & Base	1	LS	$ 693.38	$ 693.38
15	Flow Meter, Transmitter and Instrumentation	2	LS	$ 18,845.98	$ 37,691.95
16	Equipment Testing & Start-up	1	LS	$ 8,320.52	$ 8,320.52
17	Contractor Overhead & Profit (16%)				$ 94,030
18	Sales Tax (65% of above costs at 9.8%)				$ 37,430
19	Contingency (15%)				$ 88,150
20	General Conditions (15%)				$ 88,150
	TOTAL CONSTRUCTION COST				$ 895,000
	TOTAL PROJECT COST				$ 1,253,000

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ENR for Apr-2017	10678

COST ESTIMATE

PROJECT: DRILL WELL - 1100 FT DEEP
ESTIMATOR: BCC
JOB NO.: Integrated Utility Master Plan
DATE: 1-May-17
CLIENT: City of Avondale

ITEM NO.	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	Mobilization and Demobilization	1	LS	$ 92,100	$ 92,100
2	Well Drilling	1100	LF	$ 150	$ 167,800
3	Casing & Gravel Pack Installation	900	LF	$ 490	$ 436,800
4	Stainless Steel Screen & Gravel Pack Installation	200	LF	$ 760	$ 152,800
5	Well Logging and Sampling	1	LS	$ 90,100	$ 90,100
6	Well Development and Testing	1	LS	$ 73,500	$ 73,500
7	Contractor Overhead & Profit (16%)				$ 162,100
8	Sales Tax (65% of above costs at 9.8%)				$ 64,530
9	Contingency (15%)				$ 151,970
10	General Conditions (15%)				$ 151,970
	TOTAL CONSTRUCTION COST				$ 1,544,000
	TOTAL PROJECT COST				$ 2,162,000

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ENR for Apr-2017	10678

COST ESTIMATE

PROJECT: DRILL WELL - 1000 FT DEEP - Stainless Steel

JOB NO.: Integrated Utility Master Plan

CLIENT: City of Avondale

ESTIMATOR: BCC

DATE: 1-May-17

ITEM NO.	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	Mobilization and Demobilization	1	LS	$ 94,700	$ 94,700
2	Well Drilling - 26-in Borehole	1000	LF	$ 150	$ 152,500
3	16-in SS Casing & Screen, .312-in Wall Thickness	980	LF	$ 540	$ 533,500
4	Gravel Pack & Annular Material	1000	LF	$ 98	$ 97,600
5	Well Logging and Sampling	1	LS	$ 90,100	$ 90,100
6	Well Development and Testing	1	LS	$ 73,500	$ 73,500
7	Contractor Overhead & Profit (16%)				$ 166,700
8	Sales Tax (65% of above costs at 9.8%)				$ 66,370
9	Contingency (15%)				$ 156,290
10	General Conditions (15%)				$ 156,290
	TOTAL CONSTRUCTION COST				$ 1,588,000
	TOTAL PROJECT COST				$ 2,223,000

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ENR for Apr-2017	10678

COST ESTIMATE

PROJECT:	WELL SITE - 400 HP, 1400 GPM	ESTIMATOR:	BCC
JOB NO.:	Integrated Utility Master Plan	DATE:	1-May-17
CLIENT:	City of Avondale		

ITEM NO.	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	Mobilization and Demobilization	1	LS	$ 76,700	$ 76,700
2	400HP Well Pump & 900 ft Pipe Column	1	LS	$ 148,400	$ 148,400
3	Well Pad (6' x 6' 12")	1.5	CY	$ 620	$ 940
4	Piping Support Pad - (6'x12'x8")	1.75	CY	$ 620	$ 1,090
5	Piping - 12" MJ DIP & Excavation	300	LF	$ 250	$ 74,700
6	12" DIP MJ Fittings	8	EA	$ 2,370	$ 19,000
7	12" DIP Valve	2	EA	$ 4,330	$ 8,700
8	12" DIP Check Valve	2	EA	$ 8,000	$ 16,100
9	Misc Pipe Supports	1	LS	$ 690	$ 690
10	Shade Cover over Electrical Equipment	200	SF	$ 28	$ 5,500
11	Electrical Equipment Slab (10' x 20' x 8")	5	CY	$ 550	$ 2,770
12	Electrical Serivce, Conduit & Wiring	1	LS	$ 346,700	$ 346,700
13	RTU in NEMA Enclosure with Antenna	1	LS	$ 27,700	$ 27,700
14	Pole & Base	1	LS	$ 690	$ 690
15	Flow Meter, Transmitter and Instrumentation	2	LS	$ 18,800	$ 37,700
16	Security Allowance	1	LS	$ 10,400.00	$ 10,400
17	Site Lighting	4	EA	$ 3,880.00	$ 15,500
18	Access Gate	1	EA	$ 2,080.00	$ 2,080
19	CMU Wall	300	LF	$ 140.00	$ 42,100
20	Site 4" ABC Finish	5625	SF	$ 0.40	$ 2,340
21	Concrete Drive	1	EA	$ 1,390.00	$ 1,390
22	Asphalt Driveway	1	LS	$ 2,360.00	$ 2,360
23	Equipment Testing & Start-up	1	LS	$ 8,300.00	$ 8,300
24	Contractor Overhead & Profit (16%)				$ 136,300
25	Sales Tax (65% of above costs at 9.8%)				$ 54,260
29	Contingency (15%)				$ 127,780
30	General Conditions (15%)				$ 127,780
	TOTAL CONSTRUCTION COST				$ 1,298,000
	TOTAL PROJECT COST				$ 1,817,000

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Well Treatment Unit Costs

Treatment Process	Construction Cost ($/gal)	Project Cost ($/gal)	O&M Cost ($/kgal)
Biological Filtration	$1.40	$1.96	$0.35
Adsorption	$1.40	$1.96	$0.38
Coagulation Filtration (w/ residuals handling)	$1.30	$1.82	$0.65
Ion Exchange	$1.80	$2.52	$0.95
Reverse Osmosis	$2.50 + Brine Management	$3.50 + Brine Management	$1.00 + Brine Management
Electrodialysis Reversal	$2.50 + Brine Management	$3.50 + Brine Management	$1.00 + Brine Management
Evaporation Pond	$100,000 per acre for Pond Construction; $150,000 per acre for land acquisistion	$140,000 per acre for Pond Construction; $150,000 per acre for land acquisistion	1% of construction costs per year

Note:
The Construction Costs include the following mark-ups:
Site: 5%; E&IC: 10-20%; Contingency: 20%; General Conditions and Contractor's profit: 10%; Sales Tax: 8%
Project Costs includ the following components:
Engineering: 10%; Construction Service: 10%; Admin: 10%; Contingency: 10%

(ENR CCI =10678)

Appendix F

WASTEWATER UNIT COSTS

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Pipeline Unit costs

	Pipeline Diameter (in)	Pipeline Construction Cost ($/FT)	Pipeline Project Cost ($/FT)
Force Main	6"	$134	$188
	6" Dual	$268	$376
	8"	$139	$194
	8" Dual	$277	$388
	12"	$158	$221
	12" Dual	$315	$441
	18"	$307	$430
	18" Dual	$614	$859
	20"	$321	$450
	20" Dual	$642	$899
Gravity Main	8"	$172	$241
	12"	$198	$277
	15"	$213	$299
	21"	$248	$348
	24"	$281	$393
	30"	$364	$510
	33"	$400	$559
	36"	$480	$672
	39"	$518	$726
	42"	$562	$787
	48"	$627	$878
	60"	$646	$905
	(ENR CCI =10678)		

Engineers...Working Wonders With Water™

PROJECT :	**Water Master Plan Update**	**LOCATION FACTOR:**	**0.873**
JOB # :	**10203A.00**	**DATE :**	May-17
CLIENT :	**City of Avondale**	**ENR CCI :**	10678
ELEMENT :	**Gravity Sewer Main Construction - 8"**	**BY :**	BCC

	DESCRIPTION	QUAN	UNIT	MATERIAL & LABOR	SUB	UNIT COST	SUBTOTAL	TOTAL
PIPE	8" VCP In Open Trench	1	LF	$19.13	$0.00	$ 19	$ 19	
	TOTAL PIPING (per LF)							**$19.13**
EXCAV	EARTHWORK							
& BACKFILL	Cat 225 Trackhoe, 1Cy Bucket, Class B (Medium Digging), 0-16' D	0.7	CY	$4.16	$0.00	$ 4	$ 3	
	Trench Bracing, 3' W X 10' D, Wood Planks & X-Bracing	1.0	LF	$13.97	$0.00	$ 14	$ 14	
	Imported Pipe Bed & Zone/Confined Structure Backfill, Class A Material	0.2	CY	$54.10	$0.00	$ 54	$ 9	
	Native Trench Backfill/Unconfined Struct. Bf, Class A Material	0.5	CY	$11.79	$0.00	$ 12	$ 6	
	10% Site Specific Requirements	1	LS	$3.17	$0.00	$ 3	$ 3	
	TOTAL EARTHWORK (per LF)							**$34.91**
PAVING	Asphalt Pavement Cutting	8.0	inFT	$.56	$0.00	$ 1	$ 4	
DEMO &	Remove 4"-6" Asphalt Pavement	0.6	SY	$5.46	$0.48	$5.94	$ 3	
REPLACEMENT	6" Ac Paving On 12" Abc	0.6	SY	$44.70	$3.58	$48.28	$ 27	
	TOTAL PAVING (per LF)							**$34.59**
MANHOLES	60" X 10' Deep Precast Manhole, No Ring & Cover, No Earthwork	10	EA	$4,002.71	$0.00	$4,002.71	$40,027.05	
	24" Dia. X 400 Lb Heavy Traffic Manhole Frame & Cover	10	EA	$407.30	$0.00	$407.30	$ 4,073	
	Concrete Manhole Invert, Single Channel	10	EA	$302.95	$0.00	$302.95	$ 3,030	
	Cast Iron Standard Steps (Precast In Manhole)	10	EA	$17.25	$0.00	$1,045.32	$ 1,045	
	TOTAL (per 1/4 Mile)						$ 48,175	
	TOTAL MANHOLES (per LF)							**$36.50**
	OVERHEAD (10%)							**$12.51**
	CONSTRUCTION PROFIT (6%)							**$7.51**
SALES TAX (65% of above costs at 9.8%)								**$7.97**
	CONTINGENCY (15%)							**$18.77**
	GENERAL CONDITIONS (15%)							**$0.00**
	TOTAL CONSTRUCTION COST, LF							**$171.89**
TOTAL PROJECT COST (1.4 times Const Cost), LF								**$240.65**

PROJECT :	Water Master Plan Update			LOCATION FACTOR:	0.873
JOB # :	10203A.00			DATE :	May-17
CLIENT :	City of Avondale			ENR CCI :	10678
ELEMENT :	Gravity Sewer Main Construction - 12"			BY :	BCC

	DESCRIPTION	QUAN	UNIT	MATERIAL & LABOR	SUB	UNIT COST	SUBTOTAL	TOTAL
PIPE	12" VCP In Open Trench	1	LF	$33.40	$0.00	$ 33	$ 33	
	TOTAL PIPING (per LF)							**$33.40**
EXCAV	EARTHWORK							
& BACKFILL	Cat 225 Trackhoe, 1Cy Bucket, Class B (Medium Digging), 0-16' D	0.7	CY	$4.16	$0.00	$ 4	$ 3	
	Trench Bracing, 3' W X 10' D, Wood Planks & X-Bracing	1.0	LF	$13.97	$0.00	$ 14	$ 14	
	Imported Pipe Bed & Zone/Confined Structure Backfill, Class A Material	0.2	CY	$54.10	$0.00	$ 54	$ 11	
	Native Trench Backfill/Unconfined Struct. Bf, Class A Material	0.5	CY	$11.79	$0.00	$ 12	$ 6	
	10% Site Specific Requirements	1	LS	$3.36	$0.00	$ 3	$ 3	
	TOTAL EARTHWORK (per LF)							**$36.95**
PAVING	Asphalt Pavement Cutting	8.0	inFT	$.56	$0.00	$ 1	$ 4	
DEMO &	Remove 4"-6" Asphalt Pavement	0.6	SY	$5.46	$0.48	$5.94	$ 4	
REPLACEMENT	6" Ac Paving On 12" Abc	0.6	SY	$44.70	$3.58	$48.28	$ 29	
	TOTAL PAVING (per LF)							**$37.00**
MANHOLES	60" X 10' Deep Precast Manhole, No Ring & Cover, No Earthwork	10	EA	$4,002.71	$0.00	$4,002.71	$40,027.05	
	24" Dia. X 400 Lb Heavy Traffic Manhole Frame & Cover	10	EA	$407.30	$0.00	$407.30	$ 4,073	
	Concrete Manhole Invert, Single Channel	10	EA	$302.95	$0.00	$302.95	$ 3,030	
	Cast Iron Standard Steps (Precast In Manhole)	10	EA	$17.25	$0.00	$1,045.32	$ 1,045	
	TOTAL (per 1/4 Mile)						$ 48,175	
	TOTAL MANHOLES (per LF)							**$36.50**
	OVERHEAD (10%)							**$14.39**
	CONSTRUCTION PROFIT (6%)							**$8.63**
SALES TAX (65% of above costs at 9.8%)								**$9.16**
	CONTINGENCY (15%)							**$21.58**
	GENERAL CONDITIONS (15%)							**$0.00**
	TOTAL CONSTRUCTION COST, LF							**$197.61**
TOTAL PROJECT COST (1.4 times Const Cost), LF								**$276.66**

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PROJECT :	**Water Master Plan Update**	**LOCATION FACTOR:**	**0.873**
JOB # :	**10203A.00**	**DATE :**	May-17
CLIENT :	**City of Avondale**	**ENR CCI :**	10678
ELEMENT :	**Gravity Sewer Main Construction - 15"**	**BY :**	BCC

	DESCRIPTION	QUAN	UNIT	MATERIAL & LABOR	SUB	UNIT COST	SUBTOTAL	TOTAL
PIPE	15" VCP In Open Trench	1	LF	$42.74	$0.00	$ 43	$ 43	
	TOTAL PIPING (per LF)							**$42.74**
EXCAV	EARTHWORK							
& BACKFILL	Cat 225 Trackhoe, 1Cy Bucket, Class B (Medium Digging), 0-16' D	0.9	CY	$4.16	$0.00	$ 4	$ 4	
	Trench Bracing, 3' W X 10' D, Wood Planks & X-Bracing	1.0	LF	$13.97	$0.00	$ 14	$ 14	
	Imported Pipe Bed & Zone/Confined Structure Backfill, Class A Material	0.2	CY	$54.10	$0.00	$ 54	$ 11	
	Native Trench Backfill/Unconfined Struct. Bf, Class A Material	0.6	CY	$11.79	$0.00	$ 12	$ 7	
	10% Site Specific Requirements	1	LS	$3.56	$0.00	$ 4	$ 4	
	TOTAL EARTHWORK (per LF)							**$39.17**
PAVING	Asphalt Pavement Cutting	8.0	inFT	$.56	$0.00	$ 1	$ 4	
DEMO &	Remove 4"-6" Asphalt Pavement	0.6	SY	$5.46	$0.48	$5.94	$ 4	
REPLACEMENT	6" Ac Paving On 12" Abc	0.6	SY	$44.70	$3.58	$48.28	$ 29	
	TOTAL PAVING (per LF)							**$37.00**
MANHOLES	60" X 10' Deep Precast Manhole, No Ring & Cover, No Earthwork	10	EA	$4,002.71	$0.00	$4,002.71	$40,027.05	
	24" Dia. X 400 Lb Heavy Traffic Manhole Frame & Cover	10	EA	$407.30	$0.00	$407.30	$ 4,073	
	Concrete Manhole Invert, Single Channel	10	EA	$302.95	$0.00	$302.95	$ 3,030	
	Cast Iron Standard Steps (Precast In Manhole)	10	EA	$17.25	$0.00	$1,045.32	$ 1,045	
	TOTAL (per 1/4 Mile)						$ 48,175	
	TOTAL MANHOLES (per LF)							**$36.50**
	OVERHEAD (10%)							**$15.54**
	CONSTRUCTION PROFIT (6%)							**$9.32**
	SALES TAX (65% of above costs at 9.8%)							**$9.90**
	CONTINGENCY (15%)							**$23.31**
	GENERAL CONDITIONS (15%)							**$0.00**
	TOTAL CONSTRUCTION COST, LF							**$213.48**
	TOTAL PROJECT COST (1.4 times Const Cost), LF							**$298.87**

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PROJECT :	Water Master Plan Update	LOCATION FACTOR:	0.873
JOB # :	10203A.00	DATE :	May-17
CLIENT :	City of Avondale	ENR CCI :	10678
ELEMENT :	Gravity Sewer Main Construction - 21"	BY :	BCC

	DESCRIPTION	QUAN	UNIT	MATERIAL & LABOR	SUB	UNIT COST	SUBTOTAL	TOTAL
PIPE	21" VCP In Open Trench	1	LF	$62.24	$0.00	$ 62	$ 62	
	TOTAL PIPING (per LF)							**$62.24**
EXCAV	EARTHWORK							
& BACKFILL	Cat 225 Trackhoe, 1Cy Bucket, Class B (Medium Digging), 0-16' D	0.9	CY	$4.16	$0.00	$ 4	$ 4	
	Trench Bracing, 3' W X 10' D, Wood Planks & X-Bracing	1.0	LF	$13.97	$0.00	$ 14	$ 14	
	Imported Pipe Bed & Zone/Confined Structure Backfill, Class A Material	0.3	CY	$54.10	$0.00	$ 54	$ 16	
	Native Trench Backfill/Unconfined Struct. Bf, Class A Material	0.6	CY	$11.79	$0.00	$ 12	$ 7	
	10% Site Specific Requirements	1	LS	$4.10	$0.00	$ 4	$ 4	
	TOTAL EARTHWORK (per LF)							**$45.12**
PAVING	Asphalt Pavement Cutting	8.0	inFT	$.56	$0.00	$ 1	$ 4	
DEMO &	Remove 4"-6" Asphalt Pavement	0.6	SY	$5.46	$0.48	$5.94	$ 4	
REPLACEMENT	6" Ac Paving On 12" Abc	0.6	SY	$44.70	$3.58	$48.28	$ 29	
	TOTAL PAVING (per LF)							**$37.00**
MANHOLES	60" X 10' Deep Precast Manhole, No Ring & Cover, No Earthwork	10	EA	$4,002.71	$0.00	$4,002.71	$40,027.05	
	24" Dia. X 400 Lb Heavy Traffic Manhole Frame & Cover	10	EA	$407.30	$0.00	$407.30	$ 4,073	
	Concrete Manhole Invert, Single Channel	10	EA	$302.95	$0.00	$302.95	$ 3,030	
	Cast Iron Standard Steps (Precast In Manhole)	10	EA	$17.25	$0.00	$1,045.32	$ 1,045	
	TOTAL (per 1/4 Mile)						$ 48,175	
	TOTAL MANHOLES (per LF)							**$36.50**
	OVERHEAD (10%)							**$18.09**
	CONSTRUCTION PROFIT (6%)							**$10.85**
	SALES TAX (65% of above costs at 9.8%)							**$11.52**
	CONTINGENCY (15%)							**$27.13**
	GENERAL CONDITIONS (15%)							**$0.00**
	TOTAL CONSTRUCTION COST, LF							**$248.44**
	TOTAL PROJECT COST (1.4 times Const Cost), LF							**$347.82**

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PROJECT : Water Master Plan Update
LOCATION FACTOR: 0.873

JOB # : 10203A.00
DATE : May-17

CLIENT : City of Avondale
ENR CCI : 10678

ELEMENT : Gravity Sewer Main Construction - 24"
BY : BCC

	DESCRIPTION	QUAN	UNIT	MATERIAL & LABOR	SUB	UNIT COST	SUBTOTAL	TOTAL
PIPE	24" VCP In Open Trench	1	LF	$77.79	$0.00	$ 78	$ 78	
	TOTAL PIPING (per LF)							**$77.79**
EXCAV	EARTHWORK							
& BACKFILL	Cat 225 Trackhoe, 1Cy Bucket, Class B (Medium Digging), 0-16' D	1.5	CY	$4.16	$0.00	$ 4	$ 6	
	Trench Bracing, 3' W X 10' D, Wood Planks & X-Bracing	1.0	LF	$13.97	$0.00	$ 14	$ 14	
	Imported Pipe Bed & Zone/Confined Structure Backfill, Class A Material	0.3	CY	$54.10	$0.00	$ 54	$ 16	
	Native Trench Backfill/Unconfined Struct. Bf, Class A Material	0.6	CY	$11.79	$0.00	$ 12	$ 7	
	10% Site Specific Requirements	1	LS	$4.35	$0.00	$ 4	$ 4	
	TOTAL EARTHWORK (per LF)							**$47.86**
PAVING	Asphalt Pavement Cutting	8.0	inFT	$.56	$0.00	$ 1	$ 4	
DEMO &	Remove 4"-6" Asphalt Pavement	0.7	SY	$5.46	$0.48	$5.94	$ 4	
REPLACEMENT	6" Ac Paving On 12" Abc	0.7	SY	$44.70	$3.58	$48.28	$ 34	
	TOTAL PAVING (per LF)							**$42.43**
MANHOLES	60" X 10' Deep Precast Manhole, No Ring & Cover, No Earthwork	10	EA	$4,002.71	$0.00	$4,002.71	$40,027.05	
	24" Dia. X 400 Lb Heavy Traffic Manhole Frame & Cover	10	EA	$407.30	$0.00	$407.30	$ 4,073	
	Concrete Manhole Invert, Single Channel	10	EA	$302.95	$0.00	$302.95	$ 3,030	
	Cast Iron Standard Steps (Precast In Manhole)	10	EA	$17.25	$0.00	$1,045.32	$ 1,045	
	TOTAL (per 1/4 Mile)						$ 48,175	
	TOTAL MANHOLES (per LF)							**$36.50**
	OVERHEAD (10%)							**$20.46**
	CONSTRUCTION PROFIT (6%)							**$12.27**
	SALES TAX (65% of above costs at 9.8%)							**$13.03**
	CONTINGENCY (15%)							**$30.69**
	GENERAL CONDITIONS (15%)							**$0.00**
	TOTAL CONSTRUCTION COST, LF							**$281.02**
	TOTAL PROJECT COST (1.4 times Const Cost), LF							**$393.43**

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PROJECT :	Water Master Plan Update	LOCATION FACTOR:	0.873
JOB # :	10203A.00	DATE :	May-17
CLIENT :	City of Avondale	ENR CCI :	10678
ELEMENT :	Gravity Sewer Main Construction - 30"	BY :	BCC

	DESCRIPTION	QUAN	UNIT	MATERIAL & LABOR	SUB	UNIT COST	SUBTOTAL	TOTAL
PIPE	30" VCP In Open Trench	1	LF	$113.06	$0.00	$ 113	$ 113	
	TOTAL PIPING (per LF)							**$113.06**
EXCAV	EARTHWORK							
& BACKFILL	Cat 225 Trackhoe, 1Cy Bucket, Class B (Medium Digging), 0-16' D	1.5	CY	$4.16	$0.00	$ 4	$ 6	
	Trench Bracing, 6' W X 10' D, Wood Planks & X-Bracing	1.0	LF	$21.21	$0.00	$ 21	$ 21	
	Imported Pipe Bed & Zone/Confined Structure Backfill, Class A Material	0.3	CY	$54.10	$0.00	$ 54	$ 16	
	Native Trench Backfill/Unconfined Struct. Bf, Class A Material	0.6	CY	$11.79	$0.00	$ 12	$ 7	
	10% Site Specific Requirements	1	LS	$5.08	$0.00	$ 5	$ 5	
	TOTAL EARTHWORK (per LF)							**$55.83**
PAVING	Asphalt Pavement Cutting	8.0	inFT	$.56	$0.00	$ 1	$ 4	
DEMO &	Remove 4"-6" Asphalt Pavement	0.7	SY	$5.46	$0.48	$5.94	$ 4	
REPLACEMENT	6" Ac Paving On 12" Abc	0.7	SY	$44.70	$3.58	$48.28	$ 34	
	TOTAL PAVING (per LF)							**$42.43**
MANHOLES	72" X 10' Deep Precast Manhole, No Ring & Cover, No Earthwork	10	EA	$6,272.51	$0.00	$6,272.51	$62,725.05	
	24" Dia. X 400 Lb Heavy Traffic Manhole Frame & Cover	10	EA	$407.30	$0.00	$407.30	$ 4,073	
	Concrete Manhole Invert, Single Channel	10	EA	$302.95	$0.00	$302.95	$ 3,030	
	Cast Iron Standard Steps (Precast In Manhole)	10	EA	$17.25	$0.00	$1,045.32	$ 1,045	
	TOTAL (per 1/4 Mile)						$ 70,873	
	TOTAL MANHOLES (per LF)							**$53.69**
	OVERHEAD (10%)							**$26.50**
	CONSTRUCTION PROFIT (6%)							**$15.90**
SALES TAX (65% of above costs at 9.8%)								**$16.88**
	CONTINGENCY (15%)							**$39.75**
	GENERAL CONDITIONS (15%)							**$0.00**
	TOTAL CONSTRUCTION COST, LF							**$364.04**
TOTAL PROJECT COST (1.4 times Const Cost), LF								**$509.65**

Lift Station Station Unit Costs

Station Size (mgd)	Lift Station Construction Cost ($)	Lift Station Project Cost ($)
0.2	$584,000	$818,000
0.5	$656,000	$919,000
0.8	$749,000	$1,049,000
3	$2,047,000	$2,866,000
6	$2,997,000	$4,196,000
9	$3,958,000	$5,542,000
12	$4,552,000	$6,373,000
15	$5,156,000	$7,219,000
(ENR CCI =10678)		